THE GLOBAL BUSINESS CYCLE, COMMODITY PRICES
AND THE SMALL OPEN ECONOMY:
A MONETARY APPROACH

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STATEMENT OF ORIGINALITY

I hereby certify that the entire contents of this thesis are my own original work.

(Gary Edwin Bond)
I would like to record my appreciation of the valuable insights given to me by Professor Stephen Turnovsky during the early phases of this study and of the assistance provided by Dr Tony Chisholm during the final stages of preparation.

My thanks also go to Ms Kaye Filshie for her superb typing of the manuscript.

And finally, my very real appreciation of the support provided during the course of my studies by my wife, Lorraine Gardiner.
The analyses contained in this Thesis seek to provide insight into the complex mechanisms through which global monetary disturbances affect the small open economy. The key insight provided by this study is that the adjustment response within the small open economy depends critically on both the characteristics of the economy itself and the transmission linkages affected by the monetary shock.

An important contribution lies in the analysis of the case where the small open economy possesses no market power and must face terms of trade determined on world markets. The analysis demonstrates how a non-neutral monetary disturbance in the world economy can lead to relative price changes among traded goods which in turn imply terms of trade adjustments for the small economy. From this emerges additional perspectives on the transmission of global business cycle effects to small economies than have been previously established.

Within this framework, a number of other relevant considerations are investigated, such as the role of non-traded goods in the transmission of foreign disturbances, the implications of supply versus demand induced export growth, and the domestic consequences of supply versus monetary induced commodity price increases.

Wherever possible, the analytical results are examined against established empirical findings. This provides not only a 'real world' perspective on matters which might otherwise be regarded as purely hypothetical, but adds relevance to consideration of policy responses as well.
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CHAPTER ONE

INTRODUCTION AND OVERVIEW

Contents

1.1 Origins and objectives of the thesis

1.2 Structure of the thesis
1.1 Origins and objectives of the thesis

The worldwide increase in inflation over the past decade and the high degree of synchronisation in economic activity across individual nations has reactivated economists' interest in the issue of global transmission processes. An important development in this research has been a recognition of the need to account for the simultaneous changes that are taking place amongst global variables. Whereas the issue of 'imported inflation' was once the subject of intensive investigation, this has given way to a broader view of transmission linkages in which the effects of imported interest rate and income changes are analysed as well. The main implication of the more recent research is that the domestic effects of foreign inflation may vary considerably depending on the changes in foreign income and interest rates which accompany it.

The purpose of this Thesis is to augment these recent developments by focussing on the analysis of four specific issues:

- the role of monetary disturbances in the global business cycle;
- the transmission of monetary-induced income and interest rate disturbances to individual commodity markets;
- the transmission of global monetary disturbances to the small open economy; and
- the scope for domestic monetary policy as a stabilisation device.

For a small open economy (SOE) such as Australia, with highly developed trade and financial linkages internationally, these four issues are of crucial relevance in the conduct of economic policy. The experience of the past decade has demonstrated that pressures for economic adjustment can be imported from abroad in a number of guises, including interest rates and the terms of trade. With the importance that many analysts attach to global monetary disturbances as a source of international adjustment, it is natural to inquire as to the linkages through which these are transmitted to the SOE and the domestic adjustments they imply. From this emerges consideration of the options available to domestic policy makers to influence the behavior of the SOE in the face of international adjustment pressures.
It is not the intention of this Thesis to emulate in any precise manner the exact circumstances of a specific SOE. Rather, the approach is based on a recognition that there is a diversity of circumstances facing the numerous SOE's which make up the world economy. Hence, attention will be focussed on the domestic implications of a number of these differing circumstances including:

- trade composition, where a distinction may be drawn between a primary exporting-manufactured importing country on the one hand, and a manufactured exporting - primary importing country on the other;

- domestic versus globally determined terms of trade, where the issue of market power in exports becomes relevant; and

- sectoral composition, where the presence of non-traded goods may give rise to conflict in the pursuit of policy objectives.

In pursuing these various characterisations of the SOE, our objective will be to assess the robustness of propositions regarding the transmission of foreign disturbances and the scope for domestic policy. In the case of non-traded goods, for instance, it is of interest to know whether their presence in the SOE affects the direction of response to foreign disturbances and their implications for domestic policy effectiveness.

In the course of these analyses, we shall encounter a number of propositions which have received attention in both the theoretical and empirical literature. The modelling framework adopted here enables us to cast additional (and at times, alternative) perceptions on these issues, including:

- the proposition that fixprice commodities (such as manufactured goods) have different price formation processes than flexprice commodities (such as food, fibres and metals);

- the Gibson paradox, by which price movements tend to be positively correlated with interest rates;
- the consistency of sustained parity deviations in real exchange rates under generalised purchasing power parity;

- the proposition that global monetary disturbances create real impacts domestically only if they create real impacts abroad;

- the validity of various 'competitiveness index' measures in the presence of global monetary disturbances;

- the implications of supply-versus demand-induced export growth; and

- the domestic consequences of supply-versus monetary-induced commodity price increases.

The diversity of objectives and propositions contained in this brief overview reflects the complexity of the international transmission process itself and the very real need to obtain a broad perspective on these matters. In adopting an analytical, rather than empirical approach to this subject, we seek to provide insight into the linkages through which the transmission process may work and to obtain a theoretical perspective on a number of observed correlation and synchronisation patterns. The 'real world' perspective that this affords is achieved, however, only through the adoption of a number of simplifying assumptions, the robustness of which must be left to subsequent analysis.

1.2 Structure of the thesis

The sequence of presentation is as follows. In Chapter Two we provide a brief overview of the correlation and synchronisation patterns which have prevailed in the world economy over the past decade or so. The proposition which emerges from this is that a number of empirical regularities appear to be present in the data and that, where possible, these should be recognised at the analytical level. The correlation patterns are summarised in the form of a 'stylised global business cycle facts' which relate to the joint movements of global prices, income and interest rates over both expansionary and recessionary phases. What these data cannot tell us of course are the exogenous disturbance forces which
drive the global variables through their cyclical phases. Opinion within the economics profession is divided between supply side disturbances and monetary disturbances as the prime instigators of economic instability during this period. While this thesis offers no further empirical proof on this issue, it is suggested in Chapter Two that monetary forces may have been important and that in the analyses to follow attention is restricted mainly to monetary disturbances.

Our task is then set to determining the conditions under which the correlation patterns of the stylised global business cycle can be derived as monetary phenomena. This task is undertaken in Chapters Three and Four where it is shown how monetary disturbances may give rise to not only procyclical movements in aggregate income and interest rates, but to fixprice and flexprice phenomena as well. The monetary disturbances which give rise to these patterns take the form of proportional changes in current and expected stocks of money at the global level.

Figure 1.1 illustrates how these monetary-induced global adjustments are then transmitted to the small open economy.

Figure 1

Linkages Between the World Economy, Commodity Markets and the Small Open Economy

global
monetary
shock

world
inflation
interest rate

individual
commodity
market

small
open

commodity
supply
shock
Firstly, the small open economy receives inflation, income and interest rate signals from the world economy directly. This line of influence has been analysed by previous researchers and forms the basis of 'extended small country' analysis. Investigation of this scenario is appropriate for the case where the domestic economy produces and trades in a single aggregate commodity which is identical with the representative aggregate global commodity. For this scenario, there are no terms of trade effects and the implications of this 'base' situation are derived in Chapter Five.

The second line of transmission from the global monetary shock to the domestic economy is through the induced change in the price of an individual world traded commodity. Depending on the characteristics of this commodity, its price may respond to the monetary shock in a different manner to the aggregate global price level and it is through such differences in relative price movements that we generate monetary-induced terms of trade changes. An analysis of the scenario in which the domestic economy received impacts through not only the aggregate global variables, but through global terms of trade changes as well, is presented in Chapter Six.

A variation on this theme is then presented in Chapter Seven for the case where the domestic economy possesses market power in its exports. The main implication of this assumption is that the terms of trade are no longer exclusively determined on global markets but rather are influenced by both domestic and foreign events. The consequences of this structural property for both the transmission of global monetary disturbances and the effectiveness of domestic monetary policy will be brought out.

Chapters Eight and Nine then consider the case of the small open economy which faces terms of trade determined globally and where a non-traded goods sector is present. Again our concern is with the implications of this structural variation for both the transmission process and the efficacy of domestic policy. The analysis of Chapter Nine addresses the important issue of monetary versus supply induced commodity price increases and examines the implications of domestic monetary accommodation in each case.

A summary of the main findings is presented in Chapter Ten.
CHAPTER TWO
BUSINESS CYCLE CORRELATIONS
AND SYNCHRONISATION:
A BRIEF EMPIRICAL REVIEW

Contents

2.1 Introduction

2.2 Correlations and the global business cycle

2.3 Synchronisation of business cycles

2.4 Summary
2.1 Introduction

As mentioned in the previous chapter, a central concern of this thesis is the transmission of global disturbances to both individual commodity markets and to the small open economy. This concern has arisen out of observations which suggest not only a degree of correlation between movements in global variables, but an apparent degree of synchronisation in economic activity across individual countries as well.

The correlation issue has been emphasised by Flood (1982) who notes that a small open economy may be subject to not only 'imported inflation', but to the imported effects of foreign interest rate and income changes as well. Flood argues that the correlations between movements in these foreign variables must be clearly recognised if policy-making in the domestic economy is to be efficient.

The synchronisation issue, on the other hand, has been addressed by Barry and Guille (1976), and Daniel (1981) among others. There has been an apparent tendency for major business cycle fluctuations to be experienced simultaneously across a large number of countries, suggesting a high degree of international integration. The degree of synchronisation, however, appears to be less than perfect, giving rise to suggestions that different countries may be influenced through different foreign linkages, or that a certain degree of domestic insulation has been operative.

The purpose of this chapter is to provide a very brief overview of the empirical nature of these correlation and synchronisation issues. Our purpose is to provide a 'real world' perspective on matters which will subsequently be dealt with at an analytical level. To the extent that empirical regularities are evident in the data, we shall then seek to recognise them in our analytical models as and when they arise. This interaction between empirical phenomena on the one hand, and theoretical constructs on the other, is of course a traditional feature of economic model building. However, whereas many previous analysts have sought to impose empirical regularities onto the structure of their models, our approach will be to seek to derive these phenomena in the context of generalised models of behavior.
As a starting point therefore, it is necessary to examine some relevant data in order to see the correlation and synchronisation patterns which have prevailed. The impressions gained from this exercise will of course be a very 'stylised' interpretation of phenomena which are highly complex and variable. The simplified image of the global business cycle which emerges however, possesses sufficient intrinsic interest to give an air of realism to the theoretical analyses which follow.

The structure of this chapter is as follows. In the following section we examine the correlation properties of a number of key global variables. Of particular interest is the joint behavior of world inflation, real income and interest rates over the past decade or so. Section 2.3 then goes on to consider the synchronisation issue, focussing on the similarities and differences between individual countries in their economic performance. It is suggested that two factors which may have been of importance in this regard are the terms of trade which face individual countries and differences in domestic monetary policy. Finally, in Section 2.4, a summary of these correlation and synchronisation characteristics is presented, and from this we put forward a stylised interpretation of the global business cycle.

2.2 Correlations and the global business cycle

One of the main justifications for modelling the world economy explicitly is the proposition that world inflation, income and interest rate levels are simultaneously determined variables whose movements are not independent of one another. Extension of this proposition to incorporate the world prices of individual commodities implies also that these are determined within the same excess demand system as the aggregate global variables. To the extent that these propositions are valid, we may therefore expect to find correlations among not only the macroeconomic variables which describe the global system, but between these and individual commodity prices as well.

The question arises however, as to both the sign and the strength of these expected correlations. Are they dependent upon, for instance, the differing types of shocks which impinge upon the global system? Furthermore, there is the question of lags and the associated issue of
whether some parts of the global system respond more quickly than others to a given disturbance. Clearly, these are important matters and efforts aimed at their resolution have given rise to a substantial body of empirical research. (2) One of the main implications to emerge from these studies, at the national level at least, is that there is sufficient regularity in the behavior of aggregate variables to describe them as 'cyclical' phenomena. This does not imply that all business cycle fluctuations have been identical, however, nor that the relations among all aggregate variables have been steady through time. (3) Rather, it suggests that with due allowance made for differences in adjustment lags, we can distinguish a relative high in economic activity from a relative low.

Consider firstly, the relationship between interest rates and inflation. In Figure 2.1, the inflation-interest rate relation is compared for the United States and Germany over the years 1967 to 1980. In the case of the United States, there would appear to be a strong positive correlation between these two variables, suggesting that periods of high inflation are coincident with high interest rates and vice versa. This positive correlation is by no means exact, however, as the strongly divergent movements in these variables during 1975 attests. In the case of Germany on the other hand, the interest rate-inflation relationship appears to be much more variable, implying a strong positive correlation at some times, but no correlation during other periods. At no stage, however, is there any suggestion of a significant negative correlation.

Although it is difficult to extrapolate from national interest rate-inflation relationships to obtain an overall global perspective, the experiences of these two major OECD countries suggest that a positive correlation may be more typical than a negative correlation. (4) Hence, our first 'stylised fact' of the global business cycle is a positive link between interest rates and the aggregate inflation rate. (5)

The second relationship to consider is that between interest rates and the level of economic activity. In Figure 2.2 we again consider the recent experiences of the United States and Germany. The output-interest rate link does not appear to be as regular as the inflation-interest rate link examined in Figure 2.1. Rises and falls in each of these two series
do not coincide exactly, but it is possible that some lag process may be at work. In the case of the United States, for instance, falls in real GDP have either been coincident with or succeeded by falls in market rates of interest. In the case of Germany, on the other hand, it was only during 1975 that a substantial fall in interest rates coincided with an actual fall in real GDP. In other years, increases in German GDP occurred simultaneously with both rises and falls in interest rates.

It is evident that the interest rate-output relationship has been quite variable in recent years, certainly more so than the inflation-interest rate relationship. A semblance of a relatively weak positive link between aggregate output and interest rates appears to emerge for the case where lags are recognised, suggesting that as a longer term proposition, procyclical output-interest rate movements may be more typical than contracyclical movements. It is in this sense that our second stylised fact of the global business cycle in a positive correlation between interest rates and output.(6)

The third relation to consider is that between inflation and the level of economic activity. This is presented in Figure 2.3 for the average experiences of all OECD countries over the period 1967 to 1980. In keeping with the familiar Phillips curve hypothesis, we see that the data reveal a positive output-inflation relationship. As a contemporaneous phenomenon, however, the strength of this relationship may be fairly weak, since periods of record inflation coincide with periods of output increases which are close to zero. Again, it is possible that with due allowance for lags, the underlying strength of the output-inflation relationship may be greater than annual, contemporaneous data would suggest. As the studies of Lucas (1973) and Santomero and Seater (1978) have demonstrated, there may exist numerous elements in the economic system which influence the differential responses of prices and output in the shorter term. An additional complexity is that even if there is no long run association between inflation and output, the so-called natural rate of unemployment may itself be highly variable; see, for instance, Barro (1977).

As a third stylised fact of the global business cycle, therefore, we may postulate an aggregate inflation rate which is positive during
periods of both rising and falling output, but where inflation is higher during the expansionary phase. This characterisation is consistent with the phenomenon referred to by Cagan (1979) as 'persistent inflation' and reflects the observation that is aggregate, prices do not fall in line with falls in economic activity; only their rate of increase is varied.

The fourth set of relations to consider are those associated with movements in primary commodity prices. Studies of business cycle phenomena typically exclude these from explicit consideration, focusing instead on aggregate or industrial price behavior. From the viewpoint of many individual countries, however, primary commodity price movements represent important linkages with the rest of the world, either through export receipts (as is the case of Australia) or import payments (as is the case of Japan). The cyclical properties inherent in the movements of primary commodity prices are revealed in Figure 2.4. The lower panel of Figure 2.4 displays nominal price movements for three district primary commodities: copper, wool and wheat. Despite substantial differences in both production conditions and end-uses, the prices of these three commodities display a positive correlation which has led a number of analysts to postulate the existence of 'common cause' forces in primary commodity markets.(7) The main finding from these studies is that primary commodity prices are driven by real and monetary macroeconomic disturbances, the same as industrial and aggregate prices. The important difference of course is that whereas the latter display a resistance to downward movements, primary commodity prices move freely up and down in response to various stimuli. It is this difference in observed price behavior which has led to the dichotomous classification of commodities as being 'fixprice' or 'flexprice' in nature.

The upper panel of Figure 2.4 also reveals two other aspects of primary commodity prices which are of relevance to the global business cycle. The first is that, on average, real primary commodity prices are positively linked with interest rate movements (in this case, US interest rates). Comparison of the upper and lower panels of Figure 2.4 also reveals a positive correlation between the interest rate series and the nominal prices of primary commodities as well. The positive link between interest rates and commodity prices is a further manifestation of the Gibson Paradox referred to earlier and has been cited in a number of studies.(8)
The second aspect to consider is that because real commodity prices display an apparent cyclical movement, nominal primary prices may bear a systematic relation to nominal industrial prices. Given our postulated tendency for interest rates to follow economic activity, it is suggested that the relative price of primary commodities may rise and fall in line with world economic activity. This implies, for instance, that during an expansionary phase such as occurred between 1970 and 1973, primary commodity prices increase not only in nominal terms but in real terms as well. The rapid slowing down (and in many countries, decline) in economic activity which occurred in 1974 and 1975, also saw both real and nominal falls in primary commodity prices.

From Figure 2.4, therefore, we postulate an additional two stylised facts regarding the global business cycle. Stylised fact number four is that nominal prices for primary commodities are positively correlated with interest rates to varying degrees. This implies also a positive correlation between nominal primary commodity prices and global economic activity. Stylised fact number five is that real primary commodity prices are also positively correlated with global economic activity.

2.3 Synchronisation of business cycles

A major issue in the analysis of economic policy in recent years is the extent to which individual countries may influence their own levels of economic activity. This issue is often judged against the observed tendency for major shocks to be experienced by a number of countries simultaneously, giving rise to suggestions that complete insulation from foreign disturbances may be difficult to achieve.

An indication of the degree of business cycle synchronisation is given in Figure 2.5. Here the recent movements in industrial output of two small countries (Australia and Norway) are compared with production movements in three larger countries (Japan, Germany and the United Kingdom). The production cycles in the three larger countries bear a striking similarity, with below trend movements in 1971, 1975 and 1980, and significant above trend movements in 1973-74 and 1978. The magnitudes of these trend deviations are also of roughly similar order, giving rise to indications of close economic integration between these countries.
experiences of the two smaller countries, on the other hand, appear more diverse. Australia shared with the major western countries a downturn in production activity in 1971 and 1975, but did not experience the 1980 downturn. Australia also experienced the worldwide upsurge in production in 1973, but did not share in the strong growth that was evident in the latter part of the 1970s. Norway, on the other hand, avoided the major fluctuations which occurred prior to 1975, but experienced a relatively sharp downturn in economic activity in 1976 to be followed by an upsurge in 1978-79.

The point of these comparisons is that the experiences of individual countries in recent years reveal elements of both synchronisation and independence. As Flood (1982) and Daniel (1981) have emphasised, the key to the synchronisation issue is the transmission mechanism between foreign disturbances and domestic economic activity and this in turn leads us to consider the different linkages through which transmission takes place. A given global disturbance may affect different countries according to the differing linkages they have with the rest of the world.

A convenient summary measure of part of this linkage process is the terms of trade, defined as the ratio of the average value of exports to the average value of imports. In Figure 2.6, recent terms of trade movements for Australia and Norway are presented. It is evident that Australia has been subject to a much higher degree of terms of trade variability than Norway and it is possible that this may be linked with the differing patterns of production instability noted in Figure 2.5. The notable fall from trend in economic activity in Australia during 1971 may have been associated with the decline in the terms of trade that occurred in that and the preceding year. Similarly, the terms of trade pattern in the three to four years following this would also appear to be consistent with the pattern of economic activity in Australia. During 1980, however, the nature of the terms of trade-economic activity linkage appears to have altered, with a strong terms of trade decline being associated with a stable pattern of industrial production. For the Australian case, at least, there would appear to be some linkage effect through terms of trade movements and domestic economic activity, although this relationship is by no means exact.
In the case of Norway, it is possible that the downturn in economic activity during 1976 may have been associated with the terms of trade decline in that year. However, this linkage was not evident during 1979-80, when strong terms of trade increases coincided with an easing in industrial growth. For the Norwegian case, therefore, it would appear that the terms of trade linkage may not have been as significant as in the Australian case.

It is also evident that for both these small countries, foreign disturbances may not have been the only source of domestic economic behavior. As Mussa (1979) has noted, there exist a number of circumstances which enable even quite small countries to exert influence over their own economic performance and to the extent that this does occur, foreign linkages (through, say, terms of trade effects) may be nullified or even reversed. One implication of this is that synchronisation patterns may be substantially altered through events in small domestic economies.

Consider the role of domestic monetary variations in this process. A considerable literature has developed around the issue of whether money supply variations have any effects on economic activity in both closed and open economies. An examination of some of these contributions will be made in subsequent chapters, but for the present it is sufficient to note that money can be non-neutral under a wide range of circumstances.

At the global level, there has been a high degree of monetary instability over the past decade, as indicated in Figure 2.7. A number of recent empirical studies, some of which are mentioned in Footnote 7 above, have confirmed the relevance of these global monetary variations to the behavior of global prices and output. At the level of individual economies, there has also been a substantial degree of money supply variation, as illustrated in Figure 2.8. The pattern of monetary growth in the two larger economies, Japan and Germany, has been similar in that periods of rapid growth are followed by periods of sudden slowing down or contraction. This pattern is also reflected in the aggregate money supply data presented in Figure 2.7 and suggests an a priori case for examining the role of monetary variations as a source of the business cycle phenomena examined in the previous section.
Returning to the issue of the performance of small open economies, it is possible also that domestic monetary stimuli may also have an influence on the extent of business cycle synchronisation. As noted in Figure 2.5, the patterns of industrial activity in Australia and Norway have been substantially different over the past decade and part of this may be associated with differences in domestic monetary stimuli. Following the commodity price boom of 1973, for instance, Australia opted for a strongly contractionary monetary stance, while Norway achieved a slowing down in the rate of monetary expansion. At issue is whether these differing monetary stances may be linked in some way to the differences in economic performance in these two countries during and after this period. A similar instance is provided by the strong increase in monetary expansion in Australia in 1980 compared with most other OECD countries. The question is whether this event may have been associated in some way with the stability of economic activity in Australia at a time when many other countries were experiencing relative falls in output.

While these are clearly issues of empirical concern, our intention is simply to focus attention on some of the possible causes of differing economic performance in individual countries. The property of synchronisation, while evident to varying degrees in differing countries, is by no means universal and it is for this reason that we shall seek to isolate some of the mechanisms which affect the synchronisation process. As the data presented above suggest, both terms of trade and domestic monetary variations may have had some influence in this process and on this basis are regarded as suitable candidates for analytical examination.

2.4 Summary

The purpose of this chapter has been to provide a very brief empirical overview of events which will subsequently be examined at an analytical level. The data suggest that there is a strong case for modelling global events as simultaneous phenomena and that this applies not only to aggregate macroeconomic variables, but to individual commodity market adjustments as well. The data also point to the existence of synchronisation of business cycle activity across individual nations, but where the degree of synchronisation is clearly less than perfect.
Such an examination of data, even at a superficial level as this, leads one to consider a number of causality questions. For instance, what causes the prices of commodities such as wheat and copper to display such strong patterns of regularity not only amongst themselves but with other global variables as well. A particularly intriguing correlation is the positive association of commodity prices and interest rates, contrary to what intuitive, partial equilibrium reasoning would suggest. Furthermore, what are the implications of these global correlations for the economic performance of a small open economy like Australia which may or may not possess attributes for effective stabilisation.

The approach to be adopted in this Thesis is to employ analytical techniques as a means of gaining insight into these empirical phenomena. It is for this reason that the presentation and discussion of data in this chapter has been kept at such a simplified level. To explain the numerous complexities which are present in the data would require an equally complex modelling approach and it is likely that this can be achieved only at the expense of considerable loss of insight.

Hence, we have sought to present a simplified characterisation of global economic phenomena which have been referred to above as 'stylised facts'. The proposition we seek to investigate is whether the correlation patterns revealed in these stylised facts can be derived within the context of equilibrium models of economic activity. The stylised facts of the global business cycle are:

1. A positive correlation between the level of interest rates and the aggregate inflation rate.

2. A positive correlation between interest rates and the level of aggregate economic activity.

3. A positive correlation between the aggregate inflation rate and the aggregate level of economic activity.

4. Nominal primary commodity prices are positively correlated with interest rates.
Real primary commodity prices are positively correlated with economic activity.

With regards to the synchronisation of business cycles across individual nations, our simplified characterisation is that the sign and degree of synchronisation may be subject to both global and domestic influences. Our interest lies in examining the nature of these influences and the circumstances in which they may be operative.

As a final matter, this chapter has also highlighted the variability of money supplies over the past decade and it is suggested that monetary disturbances are a suitable candidate for analysis as a causal agent. This is not to suggest that supply-side disturbances, OPEC, etc. have been unimportant in recent years. Rather, our interest lies in determining the circumstances in which monetary disturbances give rise to the correlation patterns noted above and their role in the international transmission of business cycles. It is toward an examination of these issues that we now turn.
FOOTNOTES - CHAPTER TWO

(1) A frequently used example is the Phillips curve. This is a relationship between inflation and output (or unemployment) which has appeared with sufficient regularity in the data to lead to its acceptance as a theoretical construct (with or without an expectations appendage). A similar example is provided by the relatively slow adjustments made by industrial prices and wages compared with, say, primary commodity prices, interest rates and exchange rates. This observation has led a number of analysts to impose either price fixity or sluggish price adjustment mechanisms into their analytical models. Further discussion of these matters is given in Chapters Three and Four.

(2) See, for instance, the annual reports of the International Monetary Fund and also the Economic Outlook series published by OECD.

(3) An example of this latter point is provided by the apparent degree of instability in the inflation-unemployment relation over time. Up until the end of the 1960s, this relation possessed sufficient stability to enable it to be referred to as the Phillips 'curve', but since that time it has seemingly taken on a more non-linear character. This has given rise to terms such as loops, spirals and orbits to describe the inflation-unemployment relation; see, for instance, Kasper (1978).

(4) The problem of obtaining a global perspective in this case emerges from difficulties in aggregating individual countries' interest rates. As the statistics of agencies such as OECD and IMF reveal, there are more or less agreed techniques for aggregating over current variables such as prices and incomes using current exchange rates. In the case of intertemporal variables such as interest rates, however, there is the problem of incorporating unobservable exchange rate expectations, and because of this a representative global interest rate series may be unobtainable. It is worth noting in this regard also that the experiences of individual nations such as the US or Germany may be of great relevance to countries or commodity markets for which these larger nations are dominant.
(5) The tendency for interest rates to vary procyclically with the aggregate inflation rate is known as the Gibson paradox and is examined by Sargent (1969) and Roll (1972). See also Footnote 23 of Chapter Three.

(6) By obscuring the lags evident in the data, our postulated positive correlation between interest rates and output will possess validity only in a comparative static sense. Where questions of dynamic adjustment are involved, it is obvious that sequential adjustment patterns between these variables should not be overlooked.

(7) See Cooper and Lawrence (1975), Lawrence (1980), Grilli and Yang (1981), and Bond, Crowley and Vlastuin (1982).

(8) Heal and Barrow (1980), for instance, find that metal prices are significantly correlated with interest rates, but seek to explain this in terms of the theory of exhaustible resources. While this approach may possess some validity, it does not appear to be a suitable explanation for the behavior of non-metal commodity prices (such as wheat and wool), which also display a positive link with interest rates. The approach to be adopted in this Thesis is that commodity price-interest rate confluence is a business cycle phenomenon which reflects underlying movements in global economic activity; see Chapter Four.

(9) A recent contribution by de Grauwe (1981) points out the differing official attitudes of various international organisations to the role of domestic monetary policy in determining the economic performance of individual countries.
Figure 2.1
INFLATION AND INTEREST RATE MOVEMENTS
FOR THE UNITED STATES AND GERMANY:
1967-1980

United States


Per Cent

GDP deflator

10

5

Interest Rate

Germany


Per Cent

GDP deflator

10

5

Interest rate
Figure 2.2
REAL GROSS DOMESTIC PRODUCT AND INTEREST RATE MOVEMENTS IN THE UNITED STATES AND GERMANY: 1967-1980

United States

Per cent

Real gdp

1967 1970 interest rate 1980

Germany

Per cent

Real gdp

1970 interest rate 1980

Note: Real gdp is percentage change from previous year.

Interest rate is change in percentage points from previous year

Source: OECD (1982)
Figure 2.3
OUTPUT AND INFLATION FOR TOTAL OECD COUNTRIES: 1967-1980

Note: percentage changes from previous year

Source: OECD (1982)
Figure 2.4
PRIMARY COMMODITY PRICES AND THE RATE OF INTEREST

Sources: World Bank, Bureau of Agricultural Economics
Figure 2.5
CYCLES IN TOTAL INDUSTRIAL PRODUCTION

Australia

Norway

Japan

Germany

United Kingdom

Note: Data are percentage deviation from trend
Source: OECD (1982)
Fig. 2.6

TERMS OF TRADE: AUSTRALIA AND NORWAY 1967 TO 1980

Note: Ratio of average value of exports to average value of imports
Data are percentage changes from previous year

Source: OECD (1982)
Figure 2.7

MONEY SUPPLY (M1) AT CURRENT PRICES
AND EXCHANGE RATES: 1967 TO 1980

Note: Data are percentage changes from previous year.
The top seven OECD countries are the United States, Japan, Germany, France, United Kingdom, Italy and Canada.

Source: OECD (1982)
Figure 2.8

MONEY SUPPLY (M1) AT CURRENT PRICES AND EXCHANGE RATES: 1967 TO 1980

Note: Data are percentage changes from previous year.

Source: OECD (1982)
CHAPTER THREE

A MODEL OF GLOBAL ECONOMIC ACTIVITY

Contents

3.1 Outline of chapter
3.2 An equilibrium model of global economic activity
3.3 The global impacts of monetary disturbances
3.4 A characterisation of the global business cycle
3.5 Summary and conclusions
3.1 Outline of chapter

The purpose of this chapter is to develop an equilibrium model of world economic activity. The approach will be to model the world economy as a single, closed economy whose performance is independent of the activities of the small open economy. (1) For this reason, the world economy model of this chapter will parallel in some respects the recent equilibrium macroeconomic models of closed economies.

The objective is to obtain a characterisation of the joint behavior of several macroeconomic variables during periods of both rising and falling economic activity. The main variables of concern are real world income, the world inflation rate and the world rate of interest. In a system where each of these variables is treated endogenously, their movements will not in general be independent of one another and it is for this reason that a characterisation of their joint behavior is sought. Further, as will become clearer in subsequent chapters, the impacts of varying world economic conditions on both world commodity markets and the small open economy are transmitted via changes in each of these three variables. To the extent that variations in income, inflation and interest rates at the global level are jointly determined phenomena, it is evident that a model which treats each of these as endogenous is required. It is toward this end that the analysis of this chapter is directed.

There are several alternative approaches which may be adopted in the study of business cycle phenomena. The approach of this chapter will be based on that of Barro (1980) and Lucas (1975) in which variations in the level of economic activity are treated as equilibrating adjustments to various sources of disturbance. While this approach to the analysis of macroeconomic phenomena has attracted some degree of criticism, it is considered appropriate for the adjustment issues examined in this thesis. It is for this reason also that the analysis set out below forgoes consideration of dynamic adjustment paths and concentrates instead on the comparative static impacts of selected exogenous disturbances.

Attention is focussed on monetary disturbances as a source of variation in the level of economic activity. Following Fischer (1979), a
distinction is drawn between exogenous money supply variations which occur in the current period (and are, by definition, unexpected) and those which are expected to take place in some later period. An important result which emerges is that for a given change in the current supply of money, the level of economic activity can either increase or decrease depending on the associated variation in money supply expectations.

The plan of this chapter is as follows. In section 3.2, an equilibrium model of global economic activity is presented. The structure of excess demands within this model are interpreted on the basis of an 'asset market' approach to aggregate economic activity. One aspect of this which is highlighted is the nature of intertemporal resource decisions and the consequent expectations issues that arise. In section 3.3, the global impacts of monetary disturbances are investigated under the simplifying assumption of excess demand symmetry within the product market. Out of this arises a characterisation of both the expansionary and recessionary phases of the global business cycle which are presented in terms of the joint movements in income, inflation and interest rates that are induced by specific monetary disturbances. The properties of these business cycle phases are presented in section 3.4. A summary and conclusions are presented in section 3.5.

3.2 An equilibrium model of global economic activity

The model of this section follows recent contributions by Barro (1976, 1980) and Lucas (1972, 1973, 1975) on the equilibrium approach to modelling macroeconomic systems. As noted in section 3.1, it is our intention to characterise the world economy as a single, closed economy and for this reason the aggregate models developed by these authors are regarded as being an appropriate starting point.

The main feature of the equilibrium approach to macro-modelling is that the process of adjustment is shared by both output and prices. This distinguishes it from the familiar Keynesian models in which output and the rate of interest adjust to disturbances but where the aggregate price level is assumed constant. This distinction is brought out by the dichotomous terminology of 'fixprice' modelling for Keynesian (or disequilibrium) modelling systems and 'flexprice' modelling for equilibrium modelling systems.(2)
The model presented below is similar to that of Barro (1980) in the sense that the 'price' variables which appear in the excess demand functions are the market rate of interest and the anticipated rate of inflation. However, whereas Barro combined these variables into a single price (namely, the expected real rate of return), we shall be concerned with evaluating their separate impacts on product and money market excess demands.

The real side of the model is given by:

\begin{align*}
(3.1) & \quad Y_t = g_1 \pi_{t,t+1} + g_2 R_{t,t+1} \quad g_1 > 0, g_2 < 0 \\
(3.2) & \quad C_t = \delta Y_t \quad 0 < \delta < 1 \\
(3.3) & \quad I_t = \mu_1 \pi_{t,t+1} + \mu_2 R_{t,t+1} \quad \mu_1 > 0, \mu_2 < 0 \\
(3.4) & \quad Y_t = C_t + I_t
\end{align*}

where

- \( Y_t \) is real aggregate output (income)
- \( C_t \) is aggregate consumption demand
- \( I_t \) is aggregate investment (inventory) demand
- \( R_{t,t+1} \) is the market rate of interest posted at time \( t \) for the interval \( (t,t+1) \)
- \( \pi_{t,t+1} \) is the expected rate of inflation over the interval \( (t,t+1) \), where the expectation is made at time \( t \).

Equation (3.1) is the aggregate output relation in which the supply of goods and services (and the level of real income) responds positively to the anticipated rate of inflation and negatively to the nominal interest rate. For values of the response coefficients \( g_1 = -g_2 \), output is specified simply as a decreasing function of the real interest rate; in general, we shall not impose this condition. Support for (3.1) as a supply function comes from Lucas and Rapping (1969) who derive a utility-maximising labour supply function which has as its arguments \( \pi_{t,t+1} \) in addition to the current level of wealth. Citing the argument of Patinkin (1965), Lucas and Rapping suggest that for a given level of initial wealth, differential movements in interest rates and inflationary expectations affect the desire to transfer consumption from
one period to another. This, in turn affects decisions regarding levels of production and input supply. (3)

Consumption demand is given in (3.2) as a positive fraction, δ, of current real income. Investment demand, (3.3) on the other hand, involves an intertemporal trade-off between holdings of commodity stocks (either as capital equipment or inventories) and holdings of a bond; hence it is specified as an increasing function of \( \pi_{t,t+1} \) and a decreasing function of \( r_{t,t+1} \). (4) Product market equilibrium, in which aggregate supply equals aggregate demand, is given in (3.4).

The product market specification in (3.1) to (3.3) may be interpreted as an 'asset market' approach to the familiar IS schedule. Rather than emphasising the role of current price relativities (e.g. the ratio of wages to the price of output) as determinants of current production and investment levels, this model interprets these activities as part of a portfolio problem involving intertemporal resource allocation. For this reason, it is the rate of return variables, \( \pi_{t,t+1} \) and \( r_{t,t+1} \) which influence production and investment levels. (5)

The desire by individuals to maximise the expected rate of return on asset holdings also gives rise to a money demand equation in which portfolio objectives are present. Following Tobin (1969) and Turnovsky (1977a), the demand for real money balances is written as:

\[
M_t^d = L_1 y_t + L_2 \pi_{t,t+1} + L_3 r_{t,t+1} \quad L_1 > 0, L_2 < 0, L_3 < 0
\]

where \( p_t \) is the current aggregate price level.

and \( M_t^d \) is the quantity of nominal money balances demanded.

Equation (3.5) presents the demand for real money balances as depending on both transaction and portfolio objectives. The former depends positively on the level of real income. Portfolio demand for money, on the other hand, depends negatively on both the anticipated rate of inflation and the rate of interest. The latter reflects an assumption
of gross substitutability between money, commodities and the bond as alternative forms of wealth.

It is assumed that the supply of money is determined exogenously by monetary authorities. Some writers, such as McCallum (1980), have endogenised the money supply process through the specification of feedback rules in which money supply growth is conditional upon variables such as the rate of inflation and the level of economic activity. This approach to the specification of money supply variation is of seemingly more relevance to a model of domestic economic activity than to a model of global activity. Hence, it is assumed that:

\[
M^s_t = M_t
\]

(3.6)

In the analyses which follow, monetary disturbances will imply exogenous changes to the current stock of money, \(M_t\). Money market equilibrium is defined where:

\[
M^d_t = M^s_t = M_t
\]

Joint equilibrium in the product and money markets is found as:

\[
(1-\delta)(g_1^{pt},t+1 + g_2^{rt},t+1) - (\mu_1^{pt},t+1 + \mu_2^{rt},t+1) = 0
\]

\[
L_1(g_1^{pt},t+1 + g_2^{rt},t+1) + L_2^{pt},t+1 + L_3^{rt},t+1 - \frac{M_t}{P_t} = 0
\]

(3.7)

The equilibrium conditions specified in (3.7) may be compared with approaches adopted by previous analysts. First, the stock of real money balances, \(M_t/P_t\), does not appear as an argument of product market excess demand. This may be contrasted with the approach adopted by Barro (1980) in which money is assumed to affect commodity excess demand through its effect on wealth; see also Taylor (1977). In the model presented above, changes in the supply of money have an impact on the product market only through induced variations in the variables \(P_t, \pi_t,t+1\) and \(r_t,t+1\).
A second comparative feature is the property of behavioral asymmetry in the underlying supply and demand conditions. Whereas this property has hitherto been recognised as a determinant of money market behavior (Tobin 1969, Turnovsky 1977a), its role in product market relationships has received only scant attention. The imposition of product market behavioral symmetry into the model given in (3.7) is achieved by assuming:

\[
\begin{align*}
\rho_1 &= -\rho_2 \\
\mu_1 &= -\mu_2
\end{align*}
\]

Substituting from (3.8) into (3.7) gives the equilibrium conditions as:

\[
(\pi_{t,t+1} - r_{t,t+1}) (1-\delta)g_1 - \mu_1 = 0
\]

Further, any disturbance originating in the money market (such as an exogenous rise in \(M_t\) ) that leads to changes in \(\pi_{t,t+1}\) and \(r_{t,t+1}\) will be consistent with product market equilibrium only when the real interest rate is constant.(6) An immediate consequence of this is that the level of real output, which from (3.1) is now given as:

\[
Y_t = (\pi_{t,t+1} - r_{t,t+1}) g_1
\]

must also remain constant, despite the monetary disturbance.

This result provides us with an alternative perspective on the circumstances which lead to the 'neutrality of money' propositions.(7) Previous analysts have proposed that monetary 'surprises' may have real impacts whenever there exists 'informational asymmetries' in the economy. This is the case where producers interpret a global adjustment as being purely local and adjust their supply levels accordingly. Conversely, where the economy is characterised by 'full information', monetary disturbances are found to be neutral in the sense that they do not affect the level of output.
The result presented above suggests however, that the neutrality or otherwise of monetary disturbances may depend not just on the efficiency of information transmission within the economy, but on the responses of individuals to that information as well. To the extent that individuals adjust their supply and investment intentions equally as between a 1 per cent rise in \( \pi_{t,t+1} \) and a 1 per cent fall in \( r_{t,t+1} \), then for the class of model presented here, monetary disturbances are clearly neutral. If, on the other hand, individuals react differently to given changes in interest rates and inflationary expectations, then monetary disturbances may not necessarily be neutral. For this reason, the property of response symmetry (or asymmetry) will figure prominently in the analysis of monetary impacts in this chapter.

As it stands, the system described in (3.7) is incapable of direct solution as it contains two equations in three unknowns. The unknowns are the interest rate, \( r_{t,t+1} \), the rate of inflationary expectations, \( \pi_{t,t+1} \) and the current aggregate price level, \( p_t \). The latter variables are of course linked by the definition:

\[
(3.9) \quad \pi_{t,t+1} \equiv \frac{(p^*_{t+1} - p_t)}{p_t}
\]

where \( p^*_{t+1} \) is the price that is expected at time \( t \) to prevail at \( t+1 \).

A straightforward solution procedure is to assume either that \( p_t \) is fixed (as in the case of Keynesian fixprice models) or that the expected price \( p^*_{t+1} \) is fixed. Neither of these assumptions is particularly desirable since they impose a fixed relationship between \( \pi_{t,t+1} \) and either \( p_t \) or \( p^*_{t+1} \). In the Keynesian model, where \( p_t \) is held constant, a rise (fall) in inflationary expectations must necessarily be associated with a rise (fall) in the expected price level; this precludes variation in the current price level as a determinant of changes in inflationary expectations. Similarly, if the expected price is held constant, inflationary expectations must always be negatively related to movements in the current price level. To the extent that inflationary expectations tend to be positively related to interest rate movements (for reasons discussed below), the assumption of fixed \( p^*_{t+1} \) produces the curious result that a rise in the current price level must necessarily be associated with a fall in the rate of interest. The unrealistic nature of
this result is highlighted by the observation that positive rates of current price inflation have historically been associated with both rises and falls in the market rate of interest.

A more serious objection to the assumption of constant price expectations derives from the intertemporal substitution processes implicit in the formulation of the model presented above. Investment decisions taken at time $t$ affect the quantity of output which is transferred through to time $t+1$ and in so doing will alter the excess demands that are expected to prevail in the future period. The latter, in turn, affect expected prices in the same way that current excess demands affect current prices.

It is a consequence of the 'asset market' approach to macroeconomic relationships that the joint endogenous properties of both current and expected prices must be recognised. The linkage which defines the joint behavior of $p_t$ and $p_{t+1}$ is the transfer of stocks of assets and commodities between one time period and the next. In the model presented above, the variables which perform the stock carryover role are the current level of investment, $I_t$, and the current stock of money, $M_t$.

A convenient procedure for analysing the joint endogenous properties of $p_t$ and $p_{t+1}$ as part of the stock (or asset) transfer linkage, is provided by the technique of joint current market-forward market equilibrium. Essentially, this requires specification of a system which links prices expected to prevail at time $t+1$ to prices which are simultaneously determined in period $t$. Rewriting (3.7), the current market equilibrium conditions are:

$$
(3.10) \quad A_1 \pi_{t,t+1} + A_2 r_{t,t+1} = 0 \\
\phi_1 \pi_{t,t+1} + \phi_2 r_{t,t+1} - \frac{M_t}{P_t} = 0
$$

where

$$
A_1 = (1-\delta)g_1 - \mu_1 \geq 0 \\
A_2 = (1-\delta)g_2 - \mu_2 \geq 0 \\
\phi_1 = L_1 g_1 + L_2 \geq 0 \\
\phi_2 = L_1 g_2 + L_3 \geq 0
$$
The forward market equilibrium conditions are then found as the expectations analogue of (3.10), extended to include the effects of current period stock decisions. This is written as:

\[
\begin{align*}
A_1^n_{t+1,t+2} + A_2^r_{t+1,t+2} + \mu_1^n_{t,t+1} + \mu_2^r_{t,t+1} &= 0 \\
\phi_1^n_{t+1,t+2} + \phi_2^r_{t+1,t+2} - \frac{M^*_{t+1}}{P^*_{t+1}} &= 0
\end{align*}
\]

where

\[
\begin{align*}
\pi_{t+1,t+2} &= (P^*_{t+2} - P^*_{t+1})/P^*_{t+1} \quad \text{is the rate of inflation expected at } t \text{ to prevail over the interval } (t+1,t+2) \\
\rho_{t+1,t+2} &= \text{is the rate of interest expected at } t \text{ to prevail over the interval } (t+1,t+2) \\
M^*_{t+1} &= [M_t + \eta^*_{t+1}] \quad \text{is the expected money supply at } t+1 \\
\eta^*_{t+1} &= \text{is the increment to the current money supply expected to occur at } t+1.
\end{align*}
\]

The first equation in (3.11) specifies expected excess supply in the product market to depend on expected inflationary anticipations and interest rates and also an expected inventory carryover (since from (3.3), \( I_t = \mu_1^n_{t,t+1} + \mu_2^r_{t,t+1} \)). Hence, a rise in current investment (or inventories) occasioned by an increase in the current level of output, adds to excess supply on the forward market. Similarly, the second equation in (3.11) specifies expected excess demand on the money market to depend on the expected money supply, \( M^*_{t+1} \). From the definition of \( M^*_{t+1} \) given above, it can be seen that variations in the expected money supply can arise out of changes in either the current money supply, \( M_t \), or the expected money supply increment, \( \eta^*_{t+1} \). (12)

Combining equations (3.10) and (3.11), the joint current market-forward market equilibrium is given by the four-equation system:
The system described by (3.12) is sufficient to explain the joint behavior of the endogenous variables which are of concern \( (r_{t+1}, p_t, p^*_t) \) and also the functional relations which depend on them (such as the level of output, \( Y_t \)). In addition, the model can be solved for movements in the expected interest rate, \( r_{t+1,t+2} \).

A problem arises however, due to the presence of the two-period ahead price expectation, \( p^*_{t+2} \), in the forward market specification. Solving for \( p^*_{t+2} \) endogenously would mean specifying an additional forward market equilibrium condition for period \( t+2 \); but this would leave \( p^*_{t+3} \) undetermined and so the problem persists. Blanchard (1979, p. 115) notes that 'the origin of the indeterminacy comes from the presence of an expected future value in the equation. In each period, both the current price and the expected price clear the market. Over any number of periods, there is one more price (or expected price) than markets to clear. The indeterminacy will therefore be a general feature of models in which current prices depend on expected future prices'. Sargent and Wallace (1975) refer to this as the problem of 'anchoring' \( p_t \) and \( p^*_{t+1} \) and typically this is achieved by imposing a terminal condition on the value of \( p^*_{t+2} \). In the analyses which follow, it will be assumed that \( p^*_{t+2} \) is constant and that the burden of adjustment to monetary disturbances will be taken up by \( p_t, p^*_{t+1}, r_{t+1,t+1} \) and \( r_{t+1,t+2} \). This implies that currently held price expectations are stationary for a projection horizon of two periods and longer.

The analysis proceeds by a total differentiation of (3.12) to obtain four expressions involving the dependent variables, \( \pi_{t+1,t+2} \) and \( r_{t+1,t+2} \).
The changes in the inflationary expectations variables are decomposed into current and expected price changes as:

\[ \pi_{t+1,t+2} = \sum_{t+1}^{t+2} \Delta p_t \]

Assuming that at the initial equilibrium, all prices equal unity, these expressions reduce to

\[ \pi_{t+1,t+2}' = \Delta p_{t+1} - \Delta p_t \]

Totally differentiating (3.12) and substituting in (3.13') and (3.14') gives, in matrix form.

\[
\begin{bmatrix}
-A_1 & A_1 & A_2 & 0 \\
-M_1 & -A_1 & A_2 & 0 \\
0 & M_{t+1} & -\phi_1 & 0 \\
\end{bmatrix}
\begin{bmatrix}
\Delta p_t \\
\Delta p_{t+1} \\
\Delta r_{t+1,t+2} \\
\end{bmatrix}
= \begin{bmatrix}
0 \\
0 \\
\Delta M_t \\
\Delta M_{t+1} \\
\end{bmatrix}
\]

The Jacobian of this system is determined as

\[ J = A_1^2 \phi_2^2 + A_2^2 (\phi_2^2 + M_t M_{t+1}^* - M_t \phi_1 - M_{t+1}^* \phi_1) \\
+ A_1 A_2 (\phi M_{t+1}^* - 2 \phi_1 \phi_2 + \phi_2 M_t) + \phi_2 M_t (M_{t+1}^* - M_t \phi_1) \geq 0 \]

Without the imposition of further restrictions, the sign of J in (3.16) is indeterminate. The property of 'gross substitutability' suggests that excess demand in the product market is positively related to \( \pi_{t+1,t+2} \) and negatively related to \( r_{t+1,t+2} \). Applying this property, we obtain the following sign restrictions:

\[ A_1 < 0, A_2 > 0 \] (gross substitutability).
The sign of the term $\phi_1$ (defined below (3.10)) depends on whether a rise in inflationary expectations affects the portfolio demand for real money balances more or less than the transactions demand. A rise in $\pi_{t,t+1}$ makes money holdings less attractive as a store of wealth such that the portfolio objective would tend to make $\phi_1$ negative. However, the rise in $\pi_{t,t+1}$ also has a positive effect on the level of real income, which in turn adds to demand for money balances, thereby tending to make $\phi_1$ positive. In the analyses which follow, we shall assume that the portfolio objective dominates such that:

$$\phi_1 < 0 \tag{3.18}$$

Finally, it is assumed that at the initial equilibrium, both $M_t$ and $M^*_{t+1}$ are positive. From the definition of $M^*_{t+1}$ below (3.11) this also means that while the expected future money supply increment, $\pi^*_{t+1}$, can be negative initially, it must also satisfy

$$\pi^*_{t+1} > -M_t \tag{3.19}$$

In other words, at the initial equilibrium, market participants do not expect the current money supply to disappear completely in the next period.

When the conditions specified in (3.17) to (3.19) hold, we obtain the result that

$$J > 0 \text{ when } \frac{\mu_1}{g_1} < \frac{\mu_2}{g_2} \tag{3.20} \text{ (sufficient condition).}$$

The sufficient condition required for the positive signing of $J$ can be interpreted as follows. Both interest rates and inflationary expectations have supply and demand effects in the product market. A given rise in $\pi_{t,t+1}$ increases output by an amount $g_1$ and adds to investment demand by an amount $\mu_1$. Similarly, a rise in $r_{t,t+1}$ causes a reduction in output of an amount $g_2$ and a reduction in investment demand of an amount $\mu_2$. Hence the ratio $\mu_1/g_1$ measures the ratio of demand to supply effects associated with a given change in $\pi_{t,t+1}$ while the ratio $\mu_2/g_2$ measures the ratio of supply to demand effects of an equal
change in $r_{t,t+1}$. Condition (3.20) is satisfied for instance if $\pi_{t,t+1}$ is relatively more influential on production than on investment decisions and if $r_{t,t+1}$ is relatively more influential on investment than on production decisions.

Condition (3.20) provides an important instance of where 'behavioral asymmetry' influences the properties of the equilibrium solution. A related concept is that of 'excess demand symmetry' which holds when

\begin{equation}
(3.21) \quad A_1 = -A_2 \quad \text{(excess demand symmetry)}
\end{equation}

From the definitions of $A_1$ and $A_2$ given below (3.10), it is evident that if excess demand symmetry prevails, the sums of coefficients $(g_1 + g_2)$ and $(\mu_1 + \mu_2)$ must be of the same sign (since $0<\delta<1$). Hence excess demand symmetry in the form given by (3.21) requires that the dominance of, say, $\pi_{t,t+1}$ in production decisions necessarily implies the dominance of $\pi_{t,t+1}$ in investment decisions also.

It may be noted that introduction of assumption (3.21) simplifies the Jacobian of the joint current-forward equilibrium to

\begin{equation}
(3.22) \quad J' = A_1^2 \left[ (\phi_1 + \phi_2)^2 - (M_t + M_t^*) \right] (\phi_1 + \phi_2) + M_t M_t^*
\end{equation}

Again, invoking conditions (3.17) to (3.19), we find that the sufficient condition for $J' > 0$ is now

\begin{equation}
(3.23) \quad J' > 0 \text{ when } (\mu_1 + \mu_2) > 0 \quad \text{(sufficient condition)}
\end{equation}

This is a different sufficient condition than that obtained in (3.20) for the more general case. From the definitions of $A_1$ and $A_2$ however, we see that when (3.21) holds, the sufficient condition in (3.23) also implies that

\begin{equation}
(3.24) \quad (g_1 + g_2) > 0
\end{equation}

These conditions imply that both production and investment decisions respond at least more strongly to a given change in inflationary
expectations than to a change in interest rates of equal magnitude. The implications of this property for the derivation of monetary impacts will be considered in the next section.

3.3 The global impacts of monetary disturbances

In this section we evaluate the qualitative impacts on our model of global economic activity which result from specific monetary disturbances. As emphasised previously, our concern is not just with the direction of change in individual variables in response to money supply changes. Rather, we are also interested in the joint behavior of several variables simultaneously. At issue are the circumstances under which movements in interest rates, inflationary expectations, the current inflation rate and the level of output are confluent or opposing. It is the confluence properties of these endogenous variables which characterises this model of the global business cycle.

There are two sources of monetary disturbance in this model. One is an exogenous change in the current money supply, \( M_t \), which is assumed to occur 'unannounced'.(13) An isolated increase in \( M_t \) creates money market excess supply, not just in the current period, but on the forward money market as well.(14) The second source of monetary disturbance is an exogenous change in the expected money supply increment, \( \eta_{t+1}^* \). This variable exists as a subjective expectation in the minds of market participants, and may be influenced by, for instance, the announced money supply growth targets of monetary authorities. An isolated change in \( \eta_{t+1}^* \) affects excess supply on the forward money market only; the current market is affected only to the extent that price expectations and interest rates change.

The possibility exists, however, that variations in \( M_t \) and \( \eta_{t+1}^* \) may not be independent of one another. Market participants may view future money supply growth as being dependent in part on current rates of expansion. Recognition of this possibility enables us to investigate the impacts of joint variation in \( M_t \) and \( \eta_{t+1}^* \). In the analyses which follows, we postulate a simple relation between these disturbance terms as:

\[
(3.25) \quad d\eta_{t+1}^* = a_t M_t.
\]
41.

The analysis of this section is divided into three parts. Initially, we shall investigate the impacts of isolated changes in $M_t$. Then the impacts of isolated changes in $\eta_{t+1}^*$ will be considered. Finally, the impacts of joint variation in $\eta_{t+1}^*$ and $M_t$ (as given by (3.25)) will be investigated. These analyses will assume that the excess demand symmetry condition (3.21), holds.

(i) The impacts of current monetary expansion

The primary impacts associated with an increase in the current money supply are derived from (3.15) as:

\[
\frac{dp_t}{dM_t} = \frac{1}{J^1} \{h^2[M_t+1 - 2(\phi_1+\phi_2)] + A_1\phi_2(\mu_1+\mu_2)\} > 0
\]

\[
\frac{dp_{t+1}}{dM_t} = \frac{1}{J^1} \{h^2[M_t - (\phi_1+\phi_2)] + A_1\phi_2(\mu_1+\mu_2)\} > 0
\]

\[
\frac{dr_{t,t+1}}{dM_t} = -\frac{A_1}{J^1} \{\eta_{t+1}^* - (\phi_1+\phi_2)\} < 0
\]

\[
\frac{dr_{t+1,t+2}}{dM_t} = -\frac{A_1}{J^1} \{h^2[M_t - (\phi_1+\phi_2)] + [\eta_{t+1}^* - \phi_1][\mu_1+\mu_2]\} > 0
\]

The conditions imposed earlier are sufficient to determine the direction of current money supply impacts in all cases but one; the exception being the effect on expected interest rates, $r_{t+1,t+2}$. From (3.26), we see that current monetary expansion leads to an increase in the current aggregate price level, $p_t$. This result is in accordance with what is normally considered to be the money supply - inflation relationship; see for instance, Cagan (1979). In addition to this upward movement in the current price level, an expansion in $M_t$ also leads, from (3.27) to a rise in the expected price level. Comparing these impacts on current and expected prices, we obtain the result that the current price level
increases by more than the expected price level. This means, from the definition of the rate of inflationary expectations given in (3.13) that:

\[
(3.30) \quad \frac{d\pi_{t,t+1}}{dM_t} = \frac{A^l}{J^l} \left( \phi_1 + \phi_2 - \eta_{t+1}^* \right) < 0
\]

In other words, since the current aggregate price increases by more than the expected aggregate price, current monetary expansion results in a fall in the rate of inflationary expectations.

Current interest rates also fall in response to a rise in \( M_t \). This result is a standard property of traditional (Keynesian) IS-LM models in which the LM curve shifts to the right and the IS curve is downward sloping in \((r_{t,t+1}, Y_t)\) space. It may be noted that in the traditional model, the fall in interest rates is associated with a rise in both output and investment; the behavior of these variables in the present model will be considered below.

Comparing (3.28) and (3.30), we see that both the interest rate and the rate of inflationary expectations over the interval \((t,t+1)\) fall by exactly the same amount following an increase in \( M_t \). Thus we establish that under conditions of excess demand symmetry (as defined above), current monetary expansion leads to no change in the real interest rate. As discussed by Turnovsky (1977a, p. 111), this is synonymous with the Fisherian proposition in which nominal interest rates adjust fully to inflationary expectations.

The real sector impacts of an exogenous increase in \( M_t \) are as follows. From (3.1), the change in the level of output is given by:

\[
(3.31) \quad \frac{dY_t}{dM_t} = g_1 \frac{d\pi_{t,t+1}}{dM_t} + g_2 \frac{dr_{t,t+1}}{dM_t}
\]

which becomes

\[
(3.31') \quad \frac{dY_t}{dM_t} = (g_1 + g_2) \frac{dr_{t,t+1}}{dM_t} < 0 \quad \text{(by 3.24)}
\]
We see that a rise in $M_t$ leads to the level of real output either falling along with the nominal rate of interest, or remaining constant. Which of these two results prevails will depend on the sum of the output response coefficients $g_1$ and $g_2$. To the extent that the aggregate level of output responds in a symmetric manner to given changes in $\pi_{t,t+1}$ and $r_{t,t+1}$, then $(g_1+g_2)$ equals zero and the level of output is unaffected by the monetary disturbance. This is of course the 'neutrality proposition' which was referred to earlier in connection with the analyses of Lucas (1975) and Sargent and Wallace (1975). If, on the other hand, aggregate supply response is asymmetric with respect to $\pi_{t,t+1}$ and $r_{t,t+1}$, then the inequality in (3.24) suggests that output will fall along with the interest rate. The latter result is consistent with the observation made in Chapter Two, that in many cases nominal interest rates have been procyclical with the level of output. In the analyses which follow, we shall assume that this property holds, such that the inequalities in (3.24) and (3.31') are maintained.

As noted earlier, however, the assumption of excess demand symmetry implies that if $(g_1+g_2) > 0$, then the investment demand coefficients $(\mu_1+\mu_2)$ must sum to a positive number as well. From the definition of investment demand in (3.3), this implies that the effect of a current monetary expansion on the level of aggregate investment will be:

$$\frac{dI_t}{dM_t} = (\mu_2+\mu_2) \frac{dr_{t,t+1}}{dM_t} < 0$$

This result states that the level of aggregate investment will fall in response to an exogenous rise in $M_t$.

Summarising the impacts of current monetary expansion, the global economy displays an adjustment pattern which consists of a rise in the current price level (i.e., a positive rate of inflation), and falls in inflationary expectations, the current rate of interest, the level of output and the level of aggregate investment. The latter impacts are typically associated with a recessionary phase of a business cycle and as the equilibrium model above has demonstrated, these characteristics are not necessarily inconsistent with a positive rate of current price inflation. (15) As has also been demonstrated, these 'recessionary'
impacts can emerge even though the real rate of interest remains constant, contrary to the model of Barro (1980).

(ii) The impacts of anticipated monetary expansion

Consider now the impacts associated with a change in the expected future money supply increment, $n^*_{t+1}$. As discussed previously, the value of $n^*_{t+1}$ at the initial equilibrium reflects the subjective opinions of market participants as to the amount by which the future money supply, $M_{t+1}$ will differ from the current money supply, $M_t$. A rise in $n^*_{t+1}$ implies that individuals revise upwards their expectations of future money supply growth.

The primary impacts associated with an exogenous increase in $n^*_{t+1}$ are derived from (3.15) as:

\[ \frac{dp_t}{dn^*_{t+1}} = -\frac{A_1^2}{J^1} \{\phi_1 + \phi_2\} > 0 \]

\[ \frac{dp^*_{t+1}}{dn^*_{t+1}} = \frac{A_1^2}{J^1} \{M_t - \phi_1 - \phi_2\} > 0 \]

\[ \frac{dr_{t,t+1}}{dn^*_{t+1}} = \frac{A_1^2}{J^1} M_t > 0 \]

\[ \frac{dr_{t+1,t+2}}{dn^*_{t+1}} = -\frac{A_1}{J^1} \{A_1(M_t - \phi_1 - \phi_2) - M_t(\mu_1 + \mu_2)\} < 0 \]

It is seen that an increase in expected money supply growth creates a different pattern of impacts to current monetary expansion. The aggregate price level, $P_t$, increases under both forms of monetary expansion, which is in keeping with the general concept of inflation as being an essentially monetary phenomenon. However, comparing (3.26) with (3.33) we see that:

\[ \frac{dp_t}{dM_t} - \frac{dp_t}{dn^*_{t+1}} = \frac{1}{J^1} \{A_1^2(M^*_t - \phi_1 - \phi_2) + A_1 \phi_2(\mu_1 + \mu_2)\} > 0 \]
In other words, the extent of current inflation is greater under current monetary expansion than under anticipated monetary expansion.

Both types of monetary disturbance also lead to increases in the expected aggregate price level, $p_{t+1}^*$. Again we find that these impacts are not equal in magnitude and a comparison of (3.27) and (3.34) reveals that:

$$\frac{dp^*_{t+1}}{dt} - \frac{dp^*_t}{dt} + \frac{1}{J} \{A_1 \phi_2 (\mu_1 + \mu_2) \} > 0$$

As in the case of the current price level, it is found that expected prices respond more to current money supply growth than to expected money supply growth.

Combining the impacts on $p_t$ and $p_{t+1}^*$, the expected rate of inflation responds to a rise in $p_{t+1}^*$ as

$$\frac{d\pi^*_{t+1}}{dt} + \frac{A_1^2 M_t}{J} > 0$$

This is a reversal of the impact that $M_t$ has on $\pi_{t,t+1}$. The rise in inflationary expectations given in (3.39) results from the expected price level $p^*_{t+1}$ rising by more than the current price level. This is one instance where a monetary disturbance leads to increases in both the current rate of inflation and the expected rate of inflation.

The behavior of interest rates also differs markedly as between current and expected monetary expansion. Whereas a current money supply increase leads to a fall in $r_{t,t+1}$, we see from (3.35) that expected money supply growth causes interest rates to rise. Further, the rise in interest rates again matches exactly the increase in inflationary expectations. As mentioned earlier, this constant real rate of interest effect derives entirely from the assumption of excess demand symmetry.

A related reversal of impacts occurs in the real sector of the global economy. Corresponding to equations (3.31') and (3.32), we derive the impacts of anticipated monetary growth on the levels of output and investment as:
46.

\[ (3.40) \quad \frac{dy_t}{d\eta_{t+1}^*} = (g_1 + g_2) \frac{dr_{t, t+1}}{d\eta_{t+1}^*} > 0 \]

and

\[ (3.41) \quad \frac{dI_t}{d\eta_{t+1}^*} = (\mu_1 + \mu_2) \frac{dr_{t, t+1}}{d\eta_{t+1}^*} > 0 \]

These product market impacts are opposite to those obtained under current monetary expansion. With anticipated money supply growth, both output and investment increase in line with the rise in interest rates.

The pattern of impacts created by anticipated money supply growth may be summarised as follows. Following a rise in \( \eta_{t+1}^* \), the global economy displays an adjustment pattern which consists of increases in both the current and the expected rates of inflation, an increase in the rate of interest and rises in the levels of output and investment. These impacts are typically associated with the expansionary phase of a business cycle and, as noted earlier, occur despite the constancy of the real interest rate.

(iii) The impacts of joint current and anticipated monetary disturbances

Mention was made at the beginning of this section of the possibility that variations in the current money supply may not be independent of individual's expectations of future growth rates. The possible existence of such a relationship was given a simple form in (3.25) as \( \eta_{t+1}^* \) being a linear function, \( \alpha \), of \( M_t \). The analyses of the two previous subsections have assumed independence between \( M_t \) and \( \eta_{t+1}^* \); i.e. \( \alpha = 0 \).

The analysis of this subsection allows for the possibility that \( \alpha \) may take non-zero values. This implies that an increase in the current money supply may be occurring simultaneously with a revision in the public's subjective estimate of \( \eta_{t+1}^* \). Allowing for joint variation in these two sources of monetary disturbance provides additional scope for evaluating the variable impacts that a given change in \( M_t \) may create; recessionary impacts in the case where \( \alpha \) is low or negative and expansionary impacts in the case where \( \alpha \) is large and positive. Variation in the value of \( \alpha \)
over time will mean that a given increase in $M_t$ will produce rising prices, interest rates and output levels in some periods, and rising prices but falling interest rates and output levels in other periods. It is the critical value of $\alpha$ which is of concern in the analyses which follow.

Allowing for joint variation in $M_t$ and $n_{t+1}^*$, we obtain the following primary impacts.

\begin{align}
\frac{dP_t}{dM_t} &= \frac{1}{\alpha} \left[ A_1^2 (M_{t+1}^* - 2(\phi_1 + \phi_2)) + A_2 \phi_2 (\mu_1 + \mu_2) - \alpha A_1^2 (\phi_1 + \phi_2) \right] \\
\frac{dP_{t+1}^*}{dM_t} &= \frac{1}{\alpha} \left[ A_1^2 (M_t - \phi_1 - \phi_2) + A_2 \phi_2 (\mu_1 + \mu_2) + \alpha A_1^2 (M_t - \phi_1 - \phi_2) \right] \\
\frac{dR_{t,t+1}}{dM_t} &= \frac{1}{\alpha} \left[ A_1^2 (\phi_1 + \phi_2 - n_{t+1}^*) + \alpha A_1^2 M_t \right] \\
\frac{dR_{t+1,t+2}}{dM_t} &= \frac{1}{\alpha} \left[ A_1^2 (\phi_1 + \phi_2 - M_t) + A_2 (\phi_1 - n_{t+1}^*) (\mu_1 + \mu_2) \\
&\quad + \alpha [A_1^2 (\phi_1 + \phi_2 - M_t) + A_2 M_t (\mu_1 + \mu_2)] \right]
\end{align}

We note that it is no longer possible to determine the impacts associated with current monetary expansion without knowledge of the value of $\alpha$. This term may be positive or negative. A negative value of $\alpha$ does not necessarily mean that the public expects the future money supply to be less than the current money supply. Rather, it may mean a positive rate of expected money supply growth, but at a lower rate than was previously anticipated.

The current aggregate price level responds to an increase in $M_t$ according to:

\begin{align}
\frac{dP_t}{dM_t} > 0 \text{ when } \alpha > \frac{2 + A_2 (\mu_1 + \mu_2) + A_2 M_{t+1}}{A_1 (\phi_1 + \phi_2)}
\end{align}
The lower limit on \( a \) in (3.46) is a negative number which is less than minus two. This means that in order for current monetary expansion to be associated with anything but a rising aggregate price level, there has to be a substantially large contraction in the public's expectation of the future money supply. Any non-negative value of \( a \) will see current monetary growth being accompanied by a rise in the current price level. Further, it can also be seen from (3.46) that the larger is \( a \), the greater will be the increase in the current inflation rate (for given \( dM_t \)).

Turning to the effects of monetary expansion on the rate of interest, we obtain:

\[
(3.47) \quad \frac{dr_{t,t+1}}{dM_t} > 0 \text{ when } a > \frac{\eta_{t+1} - \phi_1 - \phi_2}{M_t}
\]

where the lower limit on \( a \) in (3.47) is positive. In other words, a given increase in the current money supply may lead to a rise in interest rates, but only if there is a corresponding upward lift in money supply expectations. The magnitude of the latter can be seen more clearly by expressing the constraint in (3.47) in elasticity form as:

\[
(3.48) \quad \frac{d\eta_{t+1}}{dM_t} \cdot \frac{M_t}{\eta_{t+1}^*} > 1 - \frac{\phi_1 + \phi_2}{\eta_{t+1}^*}
\]

where, by definition, \( d\eta_{t+1}^*/dM_t = \alpha \)

That is, current monetary expansion will give rise to higher interest rates only when there is a more than proportional rise in the expected money supply increment. To the extent that the public's expectation of \( \eta_{t+1}^* \) adjusts only sluggishly (or not at all) to changes in \( M_t \), the response of interest rates will be downward.

The behavior of inflationary expectations also depends on the magnitude of \( \alpha \). The joint movements in \( p_t \) and \( p_{t+1}^* \) imply that:

\[
(3.49) \quad \frac{dp_{t,t+1}}{dM_t} > 0 \text{ when } a > \frac{\eta_{t+1} - \phi_1 - \phi_2}{M_t}
\]
which is of course the same condition required for upward response of interest rates.

The dependence of aggregate output and investment on the rate of interest in this version of the model suggests immediately that:

\[
\frac{\Delta Y_t}{\Delta M_t} > 0 \quad \text{when} \quad \alpha > \frac{\phi_1 - \phi_2}{M_t}
\]

and

\[
\frac{\Delta I_t}{\Delta M_t} > 0 \quad \text{when} \quad \alpha > \frac{\phi_1 - \phi_2}{M_t}
\]

In other words, the value of \( \alpha \) required to produce upward movements in both \( \eta_{t+1} \) and \( r_{t+1} \) is identical to that required to produce increases in the levels of output and investment as well.

3.4 A characterisation of the global business cycle

The results of the previous section provide alternative bases for characterising the joint movements of the inflation rate, the interest rate and the level of economic activity during both the expansionary and recessionary phases of the global business cycle. However, not all of these approaches are consistent with observed regularities in global movements of these variables. A business cycle characterisation based solely on movements in the current money supply, for instance, implies that positive inflation rates must necessarily be associated with falling interest rates and levels of output. Conversely, the expansionary phase of the business cycle (in which \( r_{t+1} \) and \( Y_t \) are rising) implies that the aggregate price level must fall in absolute terms when \( M_t \) is also falling. This requirement is contrary to what has been observed in recent decades where both inflation rates and actual money supply expansion rates have not only been consistently positive at the global level, but where interest rates and levels of economic activity have been both rising and falling.(17)
A business cycle characterisation based solely on movements in money supply expectations (i.e., on $\eta_{t+1}^*$) has similar drawbacks. In this case the expansionary phase is associated with an increase in $\eta_{t+1}^*$ and creates upward movements in the aggregate price level, the interest rate and the level of output. A contractionary phase however, in which $\eta_{t+1}^*$ is falling, also implies that the aggregate price level must fall. As noted earlier, this requirement is clearly inconsistent with the phenomenon of persistent inflation during periods of falling demand.

Given the desirability of a business cycle characterisation which bears at least some resemblance to observed phenomena, we must consider the case of joint variation in both $M_t$ and $\eta_{t+1}^*$ as an appropriate disturbance mechanism. Historically, actual levels of money supply have tended to increase through time, albeit at varying rates. Hence we assume that $\Delta M_t > 0$ holds always and for simplicity the value of the increment in $M_t$ is taken to be constant. Associated with this constant level of current monetary growth are variations in the value of $\eta_{t+1}^*$ which we parameterise as changes in the value of the coefficient $\alpha$. The source of variations in $\alpha$ cannot be explained within the context of this model as both $M_t$ and $\eta_{t+1}^*$ are assumed to be exogenous to aggregate excess demands. (18)

The analysis of the preceding section derived critical values of which serve as demarcation points between the expansionary and recessionary phases of the business cycle. These critical values are denoted as:

\[(3.52) \quad \alpha_1 = -2 + \frac{\phi_2 (\phi_1 + \phi_2) + A_1 \eta_{t+1}^*}{A_1 (\phi_1 + \phi_2)} < 0\]

and

\[(3.53) \quad \alpha_2 = \frac{\eta_{t+1}^* - \phi_1 - \phi_2}{M_t} > 0\]

The following table illustrates how these critical values of $\alpha$ separate the different phases of the global business cycle and the characteristic behavior of the variables in each phase.
Figure 3.1

Characteristics of Global Business Cycle Phases Based on Movements in the Coefficient $\alpha$

<table>
<thead>
<tr>
<th>Depression</th>
<th>Recession</th>
<th>Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>$dpt &lt; 0$</td>
<td>$dpt &gt; 0$</td>
<td>$dpt &gt; 0$</td>
</tr>
<tr>
<td>$drt,t+1 &lt; 0$</td>
<td>$drt,t+1 &lt; 0$</td>
<td>$drt,t+1 &gt; 0$</td>
</tr>
<tr>
<td>$dY_t &lt; 0$</td>
<td>$dY_t &lt; 0$</td>
<td>$dY_t &gt; 0$</td>
</tr>
</tbody>
</table>

The three phases of the global business cycle identified by this procedure are labelled as depression, recession, and expansion. The depression phase is characterised by a falling current price level (i.e., a negative rate of inflation), falling interest rates and falling output (or real income). This phase results from a given increase in the current money supply being accompanied by a large contraction in the public's expectation of the future money supply increment. The magnitude of this required contraction is given by the definition of $\alpha_1$ in (3.52). An alternative way of interpreting this result is to express it as a relationship between the change in the current money supply and the expected money supply. From the definition of the expected money supply, we obtain:

$$\frac{dM^*_t}{dM_t} = 1 + \alpha$$  (3.54)

For values of $\alpha < \alpha_1$, this expression becomes:

$$\frac{dM^*_t}{dM_t} = -1 + \phi_2(\mu_1 + \mu_2) + \frac{A\cdot M^*_t+1}{A_1(\phi_1 + \phi_2)}$$  (3.55)

Hence, if the increase in $M_t$ is accompanied by a contraction in $M^*_t+1$ of larger magnitude (as given by (3.55)), the global economy will display the depressionary characteristics shown in Figure 3.1.

There are two aspects of this depressionary phase which make it unsuitable for further analytical development. The first is that it
depends on an anticipated money supply contraction of relatively large proportions. Although we have no hard data a global money supply expectations, the steady growth in actual world money supply over recent decades (19) would suggest a similar type of growth in monetary anticipations. Certainly the observed movement in actual money supply provides no basis for a reversal of the magnitude required by (3.55). The second unsatisfactory aspect of the depressionary phase is that it implies a negative inflation rate. Although extended periods of both inflation and deflation occurred in the world economy of the nineteenth century (20), the experience of this century, particularly in more recent decades, has been of persistent inflation. For these reasons the characterisation of the global business cycle in the analyses which follow shall exclude the depressionary phase as defined in Figure 3.2. (21)

Attention will be focussed instead on the recession and expansion phases of the business cycle. From Figure 3.1, the line of demarcation between these phases is given by the critical value $\alpha_2 > 0$. For values of $\alpha < \alpha_2$, the recessionary phase is characterised by rising prices, falling output and falling interest rates. For values of $\alpha > \alpha_2$ on the other hand, the expansionary phase is characterised by rising prices, rising output and rising interest rates. In both the recessionary and expansionary phases, the rate of aggregate price inflation is positive. From (3.42) however it is evident that the current rate of inflation is an increasing function of the value of $\alpha$. In other words, the current inflation rate is higher during the expansionary phase (with large $\alpha$) than during the recessionary phase (with small $\alpha$). This result is entirely in accordance with the observation that rates of price (and wage) inflation tend to be positively correlated with levels of economic activity and which has become embodied in such analytical constructions as the Phillips Curve. (22)

A related property is that the rate of interest (and the rate of inflationary expectations) is also an increasing function of $\alpha$ and is, therefore, higher during an expansionary phase than during a recession. Hence, one implication of this model is that a period of rising interest rates will also be a period of higher current inflation, since both depend on large values of $\alpha$. This result throws some light on the observed tendency for interest rates to be positively correlated with
current inflation rates, a relationship known as the Gibson paradox. These properties of our global business cycle model possess sufficient similarities with real world phenomena to make this model a suitable basis for analysing changes in global economic conditions. In this, we follow Lucas (1980) who proposes that a 'good' model will not be exactly more 'real' than a poor one, but it will provide better imitations.

3.5 Summary and Conclusions

The model of this Chapter provides a suitable basis for characterising changes in world economic activity in response to monetary disturbances. Emphasis has been placed on deriving the joint behavior of the inflation rate, the interest rate and the level of real income as equilibrating responses to changes in current and expected money supply levels. It is the systematic variation in the confluence properties of the endogenous variables that has been sought as a means of representing the global business cycle.

The excess demand functions which underly the model of this Chapter have been based on the 'asset market' approach to macroeconomic modelling in which rate of return variables figure in the intertemporal allocation of resources. Using the simplifying assumption of excess demand symmetry in the product market, we have derived the business cycle impacts of monetary disturbances for the case where the real rate of interest remains constant always. This is in contrast to the analysis of Barro (1980) in which the real sector impacts of monetary disturbances occur only through variations in the real rate of interest.

The present model also extends the arguments of Fischer (1979) by focussing on the role of anticipated monetary disturbances as sources of real impacts. This has followed from an expectations solution procedure in which the current equilibrium price level is derived as a function of current and expected money supplies; see also Turnovsky (1977b).

Adoption of this procedure has enabled us to provide one explanation for the phenomenon of rising inflation during periods of slack demand. The source of this phenomenon may be attributed to anticipations of future money supply growth, or, in terms of the analysis presented above,
to the coefficient $\alpha$. This result supports the proposition of Cagan (1979, p. 41) that persistent inflation may be due to persistent inflationary expectations and that the latter may be attributed to the general belief that the factors which underly inflationary processes are unlikely to disappear quickly.

This implies a shift in emphasis from inflationary expectations as a source of persistent inflation to expectations of future money growth as the causal factor. The former approach has figured prominently in the 'expectations augmented Phillips curve' approach to macroeconomic modelling; see, for instance, Turnovsky (1977a). The results of this model demonstrate, however, that the characteristics which underly the EAPC specification can in fact be derived as equilibrium responses in the presence of monetary disturbances.

An important difference between the results of the present model and those of Barro (1980), Fischer (1979), Lucas (1975) and Sargent and Wallace (1975), concerns the direction of causality from money to output. In the earlier models, there is a positive relation between monetary shocks and the level of output; an effect which is brought about by 'surprises' in the models of Lucas and Sargent-Wallace, incomplete information in the model of Barro, and variations in the expected inflation rate in the model of Fischer. In the present model, an isolated increase in the current money supply (which is by definition, unexpected), leads to a fall in the level of output. Conversely, an isolated increase in the anticipated money supply leads to a rise in the level of output. Where both the current and anticipated levels of money supply increase, a rise in output will be forthcoming only to the extent that the anticipated money supply increases by proportionally more than the current money supply.

While the present model differs from that of Fischer (1979) through the introduction of endogenous interest rates, the so-called Tobin effect (which provides a positive link between inflationary expectations and output) is present in both models. This property emerges through the assumption of gross substitutability between the commodity, money and bonds in the excess demand functions. As already indicated, however, the inclusion of interest rates in the present model provides for a
substantially different mechanism for transmitting monetary disturbances to the real sector than that analysed by Fischer; money and output are no longer necessarily confluent.

Whilst the results of this model of global economic activity possess an intrinsic interest from the point of view of equilibrium macroeconomic modelling, they also serve as a basis for the subsequent analysis of this Thesis. In the next Chapter, we shall investigate how the joint variations in income, interest rates and inflation, affect price formation on individual world commodity markets. This will be done for both the recessionary and expansionary phases of the global business cycle as characterised above. Then, in subsequent chapters, the impacts of changing both economic aggregates (incomes, inflation and interest rates) as well as world commodity prices on the small open economy will be investigated.
FOOTNOTES - CHAPTER THREE

(1) This characterisation of the interactions between the small open economy and the world economy has been adopted by Turnovsky (1980) and Cox (1980) among others.

(2) It may be noted at this stage that the 'flexprice' assumption underlying equilibrium macro models has been the source of much criticism; see, for instance, Meade (1981), Tobin (1981), Okun (1980). The source of these writers' objections is the observation that aggregate prices and wages display little or no downward movement during periods of repressed demand; a phenomenon known as 'persistent inflation' and discussed in Cagan (1979). As the results of this chapter will demonstrate, however, the phenomenon of persistent inflation is not necessarily inconsistent with both rising and falling economic activity within the context of an equilibrium system.

(3) Fischer (1979) similarly emphasises a process in which changes in the value of $\pi_{t, t+1}$ affects portfolio composition with consequent impacts on the desired capital stock and level of output. This relationship is referred to by Fischer as the 'Tobin effect' and it is also present in the equilibrium business cycle model of Lucas (1975).

(4) The demand for investment is taken to be an aggregation over the demands for physical assets by both households and firms. This is one reason for not imposing the condition that $\mu_1 = -\mu_2$ since the demand for, say, consumer durables may be relatively more responsive to $r_{t, t+1}$ whereas the demand by firms for capital equipment may be relatively more responsive to $\pi_{t, t+1}$.

(5) The relevance of rate of return variables as determinants of product market equilibrium has recently been emphasised by Fair (1978) in his critique of the rational expectations models of Barro (1976), Lucas (1971), Sargent (1973, 1976) and Sargent and Wallace (1975) (see also Footnote 3).
(6) This is seen by taking a total differential of the first equation in (3.7'). Clearly, for a non-zero value of \((1-\delta)\sigma_1-\mu_1\), satisfaction of product market clearing conditions requires that \(d[\pi_{t,t+1} - r_{t,t+1}] = 0\). In other words, the real interest rate must remain constant.


(8) A possible connection between 'informational asymmetries' and 'product market behavioral asymmetries' may exist in the sense that imperfect information about future states of the world could lead to \(\pi_{t,t+1}\) being perceived as 'risky' compared to \(r_{t,t+1}\). The reason for this is that at time \(t\), \(r_{t,t+1}\) is known with certainty by all individuals whereas \(\pi_{t,t+1}\) may vary across individuals according to their own perceptions of future states of the world. Further, the responses made by individuals to given changes in \(r_{t,t+1}\) and \(\pi_{t,t+1}\) may also admit of differences due to variations in risk attitudes. Under this interpretation, removal of product market behavioral asymmetries would coincide with the establishment of a 'grand futures market' within the context of a 'contingent claim equilibrium'; see Arrow (1964).

(9) It may be noted that this definition of the expected rate of price change overcomes the inconsistency noted by Poole (1976) in connection with the analysis of Lucas (1973), Sargent (1973, 1976) and Sargent and Wallace (1975). These authors postulate that today's output depends on the relationship of today's price to yesterday's expectation of that price. As noted by Poole, this approach is inconsistent with the argument that intertemporal resource allocations decisions depend on the expected relationship between today's and tomorrow's prices. The nature of this inconsistency becomes even more apparent in models such as that of Phelps and Taylor (1977) in which production decisions are based on both inflationary expectations and interest rates. In the Phelps-Taylor specification, decisions made at time \(t\) are based on inflationary expectations over the interval \((t-1,t)\) and on interest rates over the
interval \((t, t+1)\). Such specifications are difficult to justify on the basis of intertemporal resource allocation. The definition of inflationary expectations as given in (3.9) overcomes both of these inconsistencies.

(10) This comment would not be applicable in the case of a purely services economy in which there is no transfer of either resources or commodities through time. In such an economy, however, the issue of price expectations need not arise.

(11) Application of this technique to the issue of spot and forward price movements on foreign exchange markets is given in Stein (1980).

(12) Since variations in \(M_t\) are assumed to occur exogenously, changes in the value of \(\eta_t^{*+1}\) shall be treated as exogenous as well. In the analyses which follow, both \(M_t\) and \(\eta_t^{*+1}\) will be treated as sources of monetary disturbance, both separately and jointly.

(13) This means that a change in the value of \(M_t\) in this model plays the same role as a monetary 'surprise' as in the models of Lucas (1975) and Sargent and Wallace (1975). Due to differences in model specification, however, the impacts of these monetary surprises are different; see section 3.5.

(14) The forward market impact results from our definition of the expected money supply given below (3.11). In effect, it is implied that the current money stock is a durable asset which persists for at least one period. Incorporation of a simple depreciation adjustment coefficient to allow for physical damage and deterioration to the money stock over this interval may be achieved by defining \(M_{t+1}^* = \beta M_t + \eta_{t+1}^* \), \(0<\beta<1\).

(15) Cagan (1979) has argued that it is anomalous that the aggregate price level should move persistently upwards during periods of slack demand. The model of this chapter is based on the argument, however, that variations in demand levels are accommodated by changes in not just the current price level, \(p_t\), but by changes in interest rates and price expectations as well. It is because of this excess demand
specification that persistent inflation can coexist with slackening demand in the presence of current monetary expansion.

(16) Interpreted from the viewpoint of a domestic macroeconomic model, this result suggests that the discretionary powers of monetary authorities over the inflation rate depends both on its current policies (as they affect $M_t$) and on the public's expectations of its future policies (as they affect $\pi_{t+1}^e$). The latter constitutes what Fellner (1980) has described as the 'credibility effect', which is the argument that in order for stabilisation policy to be effective, it must possess credibility. Hence, a policy of say, 2 per cent monetary expansion which follows an extended period of 10 per cent growth may not achieved a significant slowdown in inflation if the public expects a return to a 10 per cent growth regime in the future. Further discussion on these matters is provided in Schelling (1982) and Taylor (1982).

(17) A discussion of global income and money supply movements in recent decades is given in Bond, Crowley and Vlastuin (1982). See also Chapter Two.

(18) As noted earlier in conjunction with the specification of money supply processes, the adoption of 'feedback rules' as a means of specifying $M_t$ and $\pi_{t+1}^e$, lacks realism in the context of a model of global economic activity. It is perhaps sufficient to regard changes in the value of $\alpha$ as emanating from 'capricious' acts of government spending, both current and expected, at the global level.

(19) See, for instance, Bond, Crowley and Vlastuin (1982); and Chapter Two.

(20) See, for instance, Jonung (1979).

(21) This is not to suggest that the problems associated with depressions of the type encountered during the late 1920s are not of analytical concern. Rather, it is intended to focus attention on aspects of the global business cycle which have been more typical of post-1940s experience.
(22) It may be noted however, that the Phillips curve relation is usually imposed on macro models as an a priori condition. The analysis of this model has derived this property as part of the underlying system of excess demands.

(23) See Sargent (1969). As noted by Roll (1972), it is important to distinguish between the Fisher effect (which links \( r_{t,t+1} \) to \( \pi_{t,t+1} \)) and the Gibson paradox (which links \( r_{t,t+1} \) to \( p_t \)). This becomes particularly difficult in empirical studies which attempt to proxy \( \pi_{t,t+1} \) by a distributed lag on \( p_{t-j} \) \( (j=0,1,...) \).
CHAPTER FOUR

WORLD COMMODITY PRICES AND THE
GLOBAL BUSINESS CYCLE

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4.2 The price behavior of primary and industrial commodities
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4.1 Outline of chapter

The purpose of this chapter is to analyse the behavior of world commodity prices during the expansionary and recessionary phases of the global business cycle. Our interest lies in the price behavior of two distinct groups of traded commodities: primary commodities such as metals, fibres and agricultural goods, whose prices typically display 'flexprice' characteristics; and manufactured commodities, such as motor vehicles, textiles and electrical goods, whose prices typically display 'fixprice' characteristics.

The objective in studying the nature of price determination for these two groups of commodities are twofold. Firstly, we seek to investigate whether the differences between fixprice and flexprice behavior can be derived within the context of a single model of commodity price determination. To put this another way, can differences in the relative magnitudes of commodity excess demand coefficients be invoked as a fundamental source of the fixprice:flexprice distinction? The second objective is to obtain a consistent characterisation of the movements in the prices of these two groups of commodities over the global business cycle.

The analytical approach of this chapter is quite innovative in that it links directly a model of individual commodity price determination to an equilibrium model of the business cycle. A major advantage of this approach is that it provides a direct connection between global monetary disturbances on the one hand, and the price response of a particular commodity on the other. A related advantage of this approach is that it provides insight into such phenomena as the observed confluence between primary commodity prices and interest rates; see for instance, Heal and Barrow (1980).

Interest in the macroeconomic determinants of world commodity price movements has grown in recent years as a result of the poor predictive performance of traditional, supply-oriented models. Cooper and Lawrence (1975) found statistical confirmation of the proposition that the prices of primary traded commodities respond strongly to variations in the level of industrial activity in major trading countries. More recently, Grilli
and Yang (1982) and Bond, Crowley and Vlastuin (1982) have demonstrated the dominance of world income and money supply variations as sources of primary commodity price movements.

Despite these empirical findings, however, a number of important questions regarding the linkages between macroeconomic disturbances and commodity price movements remain unanswered. Firstly, as the business cycle model of the previous chapter emphasises, variations in income (or output) levels globally do not occur independently of changes in interest and inflation rates. It is the implications of the joint variation in these aggregate variables which is of major concern. Secondly, much of the empirical work on traded commodity price movements has centred on primary commodities only. A consistent approach to the issue of price formation on world markets requires that 'common cause' proposition put forward by Cooper and Lawrence be as applicable to manufactured commodities as it is to primary commodities.

The analytical strategy to be adopted in this chapter is that excess demands for the commodity under consideration are insignificant from the point of view of the global economy. This assumption is the commodity market analogue of the 'small open economy' assumption which will be invoked in later chapters. Basically, this assumption means that changes in the supply or demand conditions prevailing in the commodity market have no influence on the levels of aggregate income, inflation or interest rate. From the point of view of participants in the commodity market, these aggregate variables are treated as parameters. The advantage of this strategy is that it enables us to derive a solution for the equilibrium price of the commodity in which the aggregate variables are treated as exogenous (even though the latter are not independent of one another).

The plan of this chapter is as follows. In section 4.2 a brief review of the differences and similarities between primary and industrial commodity price behavior is presented. The purpose of this is to provide an alternative perspective to recent propositions that prices for these two groups of commodities are determined under different mechanisms. The proposition is put forward that differing types of price behavior should, in principle at least, be derivable from a single model of commodity
market behavior. To this end, section 4.3 outlines a model which links individual price movements to various macroeconomic disturbances. The behavior of the latter are specified as independent phenomena in section 4.4 while section 4.5 goes on to consider the more complex situation of joint variation in income and interest rates in response to monetary disturbances. The latter strategy enables us, however, to derive a direct linkage between monetary phenomena on the one hand and the response of individual commodity prices on the other. The behavior of both current and expected commodity prices over the expansionary and recessionary phases of the global business cycle are then analysed in detail in sections 4.6 and 4.7. A simple classification of commodity price behavior for both primary and industrial commodities is given in section 4.8. In section 4.9 we then turn our attention to the issue of supply shocks and how these influence commodity price behavior. A comparison of monetary versus supply induced commodity price increases is also given. Section 4.10 contains a summary and main conclusions.

4.2 The price behavior of primary and industrial commodities

The price response of individual commodities to changes in aggregate economic conditions varies considerably as between primary and industrial commodities. Primary commodities tend to display a pattern which has become known as 'flexprice' movements wherein prices are procyclical with the level of economic activity.(1) The critical feature of the 'flexprice' label is that not only do prices move upwards during periods of rising demand, but more importantly, they fall in absolute value during periods of declining demand. This latter property is not in general possessed by industrial commodities, the prices of which display what has become known as 'fixprice' movements. This label does not imply that the prices of industrial commodities necessarily remain fixed over the course of the business cycle. Rather, it characterises price movements which are positive over both the expansionary and recessionary phases of the business cycle.

These observed differences in commodity price behavior have led a number of writers to propose different mechanisms for price formation on primary and industrial commodity markets. The typical approach to primary commodity price formation is to postulate a paradigm of competitive
equilibrium in which the market price adjusts in a Walrasian manner to non-zero excess demands. Most models of agricultural commodity price formation adopt this approach. The prices of industrial commodities, on the other hand, are usually modelled under alternative assumptions. These include 'markup' pricing over variable production costs (such as wages) and market structures which are characterised by monopolistic competition or oligopoly. The essence of these latter approaches is to play down the Walrasian, market-clearing role of current market prices for industrial commodities. (2)

It is in this context that Okun (1980) argued that while models of competitive equilibrium are relevant for commodities such as soybeans and silver, they are fundamentally inapplicable to the workings of the industrially-dominated US economy. Tobin (1980) similarly regards the competitive market paradigm as being applicable to primary commodities, but does not see its relevance to what he refers to as the 'familiar wage-price-production milieu of domestic industry' (p. 22). Again, it is the downward resistance of industrial prices (and wages) during periods of repressed demand that leads these and other writers to reject the market-clearing paradigm of competitive equilibrium. (3)

The question remains as to whether observed differences in the behavior of these two groups of commodities provides sufficient justification for the adoption of completely separate price formation mechanisms. At the theoretical level, there is the result of the previous chapter in which persistent inflation can coincide with the recessionary phase of a business cycle in an equilibrium model of market clearing. To the extent that the aggregate inflation level is dominated by the fixprice sectors of the global economy, this result provides one instance of where the descriptive attributes of industrial price behavior are clearly consistent with the analytical attributes of market equilibrium. As noted above, it is the latter which is generally considered to be appropriate also for the analysis of primary commodity price behavior.

The discussion of Chapter Two highlighted a number of empirical regularities which exist between not only primary and secondary price movements, but between these prices and other economic aggregates as well. The essence of these empirical regularities is that the demand
pressures which appear to underly large increases in the prices of finished goods and rising interest rates, also appear to act upon the prices of primary commodities. During a downturn in demand on the other hand, the prices of primary commodities tend to follow the downward movement in interest rates, while industrial prices maintain their upward progression (albeit at a slower pace).

Rather than attempt to put forward different price generation mechanisms for primary and industrial commodities, the approach of this chapter will be to set up a single model of generalised commodity price behavior and to derive both flexprice and fixprice movements from it. The conditions which give rise to commodity price - interest rate regularities will also be derived. An important feature of the commodity market model of this chapter is that it will be formulated on precisely the same excess demand functions as those which underly product market equilibrium in the global model of aggregate economic activity of Chapter Three. In this sense there is a consistency between the macro-theoretic and micro-theoretic specifications.

4.3 A model of world commodity price behavior

In this section we present a formal model of individual commodity price determination. The model is completely general with respect to the type of commodity being analysed; it is as applicable to manufactured commodities such as bread or motor vehicles as it is to the primary commodities wheat and metals. As will be demonstrated subsequently, the observed differences in the behavior of the prices of these distinct commodity groups over the course of the global business cycle can be explained entirely by reference to the relative magnitudes of specific behavioral coefficients. Hence we derive the source of the fixprice:flexprice distinction without resorting to the use of 'free parameters' of the type discussed and criticised by Lucas (1980).

The analytical model proceeds as follows. Current period supply and demand for a particular commodity $j$ are given by:

\[(4.1) \quad C_{jt} = a_{1j} Y_t \quad a_{1j} > 0\]

\[(4.2) \quad I_{jt} = b_{1j} \pi_{jt,t+1} + b_{2j} r_{t,t+1} \quad b_{1j} > 0, b_{2j} < 0\]
Equation (4.1) relates the current period consumption demand for commodity $j$ positively to the current level of aggregate real income. Equation (4.2) relates the current period investment (or inventory) demand for the commodity, positively to the expected rate of commodity price appreciation and negatively to the market rate of interest. Similarly, (4.3) specifies the current level of output as responding non-negatively to the expected rate of commodity price appreciation and non-positively to the market rate of interest. Equilibrium between current period supply and current period demands is given by (4.4).

It is possible to substitute (4.1) to (4.3) into (4.4) and obtain a single excess demand equation in the single unknown, $\pi_{jt,t+1}$. Solving for this variable would give a relation of the form:

\begin{equation}
\pi_{jt,t+1} = f_t(Y_t, r_{t,t+1})
\end{equation}

from which variations in the expected rate of price appreciation for commodity $j$ can be analysed in terms of the macroeconomic variables $Y_t$ and $r_{t,t+1}$.
In this form, the solution highlights the implicit assumption that the commodity under review is 'small' in relation to the economy generally. Variations in the commodity market excess demand have negligible impact on the aggregate level of economic activity and hence (4.6) represents a valid reduced-form solution to \( \Pi_{jt,t+1} \). This 'small-sector' assumption is formally analogous to the 'small-country' assumption employed extensively in the international economics literature and which is adopted in subsequent chapters of this Thesis.

As noted earlier, however, our interest lies not only in the behavior of \( \Pi_{jt,t+1} \), but in the behavior of its components, \( p_{jt} \) and \( p^*_{jt+1} \) as well. From the definition of \( \Pi_{t,t+1} \) in (4.5) it is evident that the separate behavior of these prices cannot be derived from an expression such as (4.6) alone. The only exception to this is in the limiting case where either the current price \( p_{jt} \), or the expected price \( p^*_{jt+1} \), is held constant and it is considered that neither of these cases is of particular analytical relevance.

A solution to the separate behavior of \( p_{jt} \) and \( p^*_{jt+1} \) is obtained as in the previous chapter by invoking the concept of joint spot market - forward market equilibrium. The forward market analogue of equations (4.1) to (4.4) is given by:

\[
\begin{align*}
(4.7) & \quad C^*_{jt+1} = a_{lj} Y^*_{t+1} \\
(4.8) & \quad I^*_{jt+1} = b_{lj} \Pi_{jt+1,t+2} + b_{2j} r_{t+1,t+2} \\
(4.9) & \quad X^*_{jt+1} = c_{lj} \Pi_{jt+1,t+2} + c_{2j} r_{t+1,t+2} + I_{jt} \\
(4.10) & \quad C^*_{jt+1} + I^*_{jt+1} = X^*_{t+1} 
\end{align*}
\]

where

\[
(4.11) \quad \Pi_{jt+1,t+2} = (p^*_{t+2}/p^*_{t+1}) - 1
\]

and

\[ C^*_{jt+1} \]

is the level of consumption of commodity j expected to prevail at time \( t+1 \) where the expectation is formed at time \( t \);
\[ Y_{t+1} \] is the level of aggregate real income expected at time \( t \) for time \( t+1 \);

\[ I_{jt+1}^* \] is the level of investment (inventory) demand for commodity \( j \) expected to prevail at time \( t+1 \);

\[ \pi_{jt+1,t+2} \] is the expected rate of price change for commodity \( j \) where the expectation is formed at time \( t \) for the interval \( t+1,t+2 \);

\[ r_{t+1,t+2} \] is the market rate of interest expected at time \( t \) to prevail at time \( t+1 \) for the interval \( t+1,t+2 \);

\[ X_{jt+1}^* \] is the level of supply of commodity \( j \) expected at time \( t \) to be forthcoming at time \( t+1 \);

\[ P_{jt+2}^* \] is the price of commodity \( j \) expected at time \( t \) to prevail at time \( t+2 \).

The behavioral relationships underlying the forward market supply and demand equations in (4.7) to (4.10) are equivalent to those underlying the spot (or current) market relationships in (4.1) to (4.4). An important difference between these specifications, however, is that the current level of commodity investment, \( I_{jt} \), appears in (4.9) as an addition to forward market commodity availability. This follows naturally from the definition of inventories as being that part of current (and past) production which is not currently consumed. A rise in inventories (or investment) of a particular commodity means that more of it is available in subsequent periods and, as specified in (4.9), this provides an important link through which current market excess demands interact with forward market excess demands. An increase in \( I_{jt} \), for instance, will simultaneously create an increase in current market excess demand and a decrease in forward market excess demand. As shown below, these processes act jointly on current and expected commodity prices in the establishment of the intertemporal equilibrium.
The joint spot market - forward market equilibrium is found by substituting into (4.4) and (4.10) as:

\[(4.12) \quad a_{lj} Y_t + (b_{lj} - c_{lj}) \pi_{jt, t+1} + (b_{2j} - c_{2j}) r_{t, t+1} = 0\]

\[(4.13) \quad a_{lj} Y^*_{t+1} + (b_{lj} - c_{lj}) \pi_{jt+1, t+2} + (b_{2j} - c_{2j}) r_{t+1, t+2} - b_{lj} \pi_{jt, t+1} - b_{2j} r_{t, t+1} = 0\]

Taking a total differential of (4.12) and (4.13), we obtain the following simultaneous equations in the endogenous variables, \(dp_{jt}\) and \(dp^*_{jt+1}\):

\[(4.14) \quad \begin{bmatrix} c_{lj} - b_{lj} & b_{lj} - c_{lj} \\ b_{lj} & c_{lj} - 2b_{lj} \end{bmatrix} \begin{bmatrix} dp_{jt} \\ dp^*_{jt+1} \end{bmatrix} = \begin{bmatrix} -a_{lj} dY_t + (c_{2j} - b_{2j}) dr_t, t+1 \\ -a_{lj} dY^*_{t+1} + (c_{2j} - b_{2j}) dr_{t+1, t+2} + b_{2j} dr_{t, t+1} \end{bmatrix}\]

It may be noted that in deriving (4.14) it has been assumed that \(\pi_{st}^* \pi_{st+2}\) equals zero and that at the initial equilibrium all prices equal unity.

### 4.4 Independent movements in income and interest rates

Equations (4.14) relate the behavior of current and expected commodity prices to variations in real income and interest rates. For the case where changes in the latter occur independently of one another, we solve for the commodity price impacts as follows. The Jacobian of (4.14) is solved as:

\[(4.15) \quad F = (c_{lj} - b_{lj})^2 > 0\]

which means that a solution to the endogenous variables exists as long as \((c_{lj} - b_{lj})\) does not equal zero. These coefficients measure the response of current inventory demand and current supply of the commodity in question to a given change in the expected rate of commodity price appreciation over the interval \((t, t+1)\). The requirement that \((c_{lj} - b_{lj}) \neq 0\) means that there must exist asymmetry of response within the commodity market as between the supply-increasing effects of a rise
in \( \pi_{jt,t+1} \) and the demand-increasing effects of \( \pi_{jt,t+1} \). A value of \((c_{1j} - b_{1j}) > 0\) means that a rise in \( \pi_{jt,t+1} \) creates excess supply in the commodity market, while \((c_{1j} - b_{1j}) < 0\) means that a rise in \( \pi_{jt,t+1} \) creates excess demand in the commodity market.

As outlined in section 2 of Chapter 3, however, the 'asset market' approach to equilibrium enables us to invoke the property of 'gross substitutability' in the excess demand functions. For the model of commodity market equilibrium presented above, gross substitutability implies that a rise in \( r_{t,t+1} \) adds to the excess demand for commodity \( j \) while a rise in \( r_{c,t+1} \) reduces commodity \( j \) excess demand. Hence we specify:

\[(4.16) \quad (c_{1j} - b_{1j}) < 0, (c_{2j} - b_{2j}) > 0 \quad \text{(gross substitutability)}\]

From (4.16) it is evident that the Jacobian of the commodity market excess demand system will be unambiguously positive under the assumption of gross substitutability.

Solving (4.14) for the response of the current commodity price to independent changes in real income and the market rate of interest gives:

\[(4.17) \quad \frac{dp_{jt}}{dy_t} = \frac{1}{F} \left( a_{1j} (2b_{1j} - c_{1j}) \right) > 0\]

\[(4.18) \quad \frac{dp_{jt}}{dr_{t,t+1}} = \frac{1}{F} \left( b_{1j} b_{2j} + c_{2j} (c_{1j} - 2b_{1j}) \right) > 0\]

\[(4.19) \quad \frac{dp_{jt}}{dy_{t+1}^*} = \frac{1}{F} \left( a_{1j} (b_{1j} - c_{1j}) \right) > 0\]

\[(4.20) \quad \frac{dp_{jt}}{dr_{t+1,t+2}} = \frac{1}{F} \left( (c_{1j} - b_{1j}) (c_{2j} - b_{2j}) \right) < 0\]

From (4.17) we see that a ceteris paribus increase in the current level of aggregate real income leads to a rise in the current commodity price level. This result is in accordance with the traditional approach to commodity price behavior in which an income rise is interpreted as an
outward shift in the commodity demand function. The impact of an isolated increase in the current market interest rate, on the other hand, is ambiguous. Whereas the condition in (4.16) states that a rise in the interest rate creates a fall in commodity excess demand in the current market (thereby implying a fall in commodity price level), it must also be remembered that the response of the current price level depends in part on the state of excess demands on the forward market. Changes in current output and inventory levels feed through to changes in forward market excess demands and the latter, in turn, affect the price that is posted on the current market. Inspection of the commodity price-interest rate impact given by (4.18) suggests that where current output decisions are affected only slightly (if at all) by current interest rate changes, the more likely it will be that the price-interest rate relationship will be negative. That is:

\( (4.18') \quad \frac{\partial p_{jt}}{\partial r_{t+1}} < 0 \quad \text{where } c_{2j} = 0 \)

If, on the other hand, current output of commodity \( j \) is highly responsive to interest rate changes, the more likely it will be that the price-interest rate relationship will be positive.

Changes in expected income and interest rate levels, on the other hand, produce more clear-cut results. From (4.19), we see that an isolated (and exogenous) rise in expected real income causes the current commodity price level to increase. Comparing this impact with that obtained in (4.17), it is clear that a given increase in the current income level will lead to a larger rise in \( p_{jt} \) than the same increase in the expected income level. An expected interest rate rise, on the other hand, will, ceteris paribus, cause the current commodity price level to fall. This result emerges as a result of induced excess supply on the forward commodity market being transferred to the current market. As emphasised previously, it is the joint resolution of non-zero excess demands on both these markets which is of relevance to the behavior of the endogenous variables.

These independent changes in income and interest rates also bring about variations in the expected commodity price level. Solving (4.14) for the induced changes in \( p_{jt+1}^* \), we obtain:
These impacts bear a strong similarity to those obtained previously for the current commodity price level. An exogenous increase in real income, either current or expected, leads to a rise in the expected commodity price level. Comparing (4.21) with (4.23), however, we again find that the magnitude of these responses in $p_{jt+1}^*$ is greater in the case of current income increase than for an expected income increase. The effect of an exogenous, independent rise in the current interest rate has an ambiguous effect on the expected commodity price, just as it has on the current commodity price. Again, the source of this ambiguity is related to the relative magnitudes of the investment demand coefficients $(b_{1j}, b_{2j})$ on the one hand and the supply coefficients $(c_{1j}, c_{2j})$ on the other. It is only in the case where either the supply response or the inventory demand for the commodity in question is completely unresponsive to changes in interest rates and expected rates of price change, that an unambiguous relationship between $p_{jt+1}^*$ and $r_{t,t+1}$ emerges. In this latter case, the expected commodity price is unaffected by the current interest rate rise.

Expected interest rate increases lead to an unambiguous fall in the expected price level. It will be recalled that this impact is in the same direction as that induced in the current commodity price level as well.

Combining the impacts on current and expected commodity prices leads to an expression for the change in the expected rate of commodity price
appreciation. Restricting our attention to the effects of variations in current income and the current interest rate, we obtain:

\[ d\pi_{jt,t+1} \over dt = {1 \over c} (a_{lj} (c_{lj} - b_{lj})) < 0 \]

\[ d\pi_{jt,t+1} \over dr = {1 \over c} (c_{lj} - b_{lj})(b_{lj} - c_{lj}) > 0 \]

Hence, a rise in the current income level leads to a fall in the expected rate of commodity price appreciation. This result derives from the property that an increase in income implies a rise in excess demand which can be equilibrated only by a fall in inflationary expectations.

An interest rate increase, on the other hand, implies a rise in \( \pi_{jt,t+1} \). This result derives from the assumption of gross substitutability given in (4.16), which implies that market participants will willingly hold existing commodity stocks only to the extent that \( \pi_{jt,t+1} \) is sufficiently attractive relative to \( r_{t,t+1} \). An interesting property which emerges from this result is the Fisher effect (discussed in Chapter 3) which implies that the expected rate of commodity price appreciation adjusts fully to the interest rate rise. From (4.26), the Fisher effect is specified as:

\[ d\pi_{jt,t+1} \over dr = 1 \quad \text{when} \quad (b_{lj} - c_{lj}) = (c_{lj} - b_{lj}) \]

In other words, the Fisher effect emerges only under conditions of excess demand symmetry in which the excess demand increasing impact of a rise in \( \pi_{jt,t+1} \) is perfectly offset by the excess demand reducing impact of the rise in \( r_{t,t+1} \).

It will be recalled from the global model of economic activity presented in Chapter Three that the property of excess demand symmetry also gives rise to the Fisher effect at the aggregate level. In other words, while the assumption of gross substitutability is sufficient to make interest rates and expected rates of commodity price change rise and
fall together, the much stronger assumption of excess demand symmetry is required to make this confluence property exact. The Fisher effect must ultimately reflect excess demand symmetry.

The results of this section have highlighted the linkages through which given changes in income and interest rates affect prices on individual commodity markets. As a description of the behavior of commodity prices over the course of a business cycle, however, these impacts are clearly insufficient in that they do not allow for the joint behavior of income and interest rates as determining influences. It is toward an examination of these that we now turn.

4.5 Income and interest rate movements as monetary phenomena

The behavior of individual commodity prices over the course of the global business cycle will be influenced by a number of macroeconomic variables, movements in which will be interrelated. The commodity market will therefore be subjected to a number of disturbances which are taking place simultaneously and, as the results of the previous section have demonstrated, the direction of these influences may not always be consistent. If, for instance, rising real incomes are associated with rising interest rates, the resultant response of commodity prices may involve a trade-off among the excess-demand-increasing and excess-demand-decreasing forces that these macroeconomic disturbances imply.

The purpose of this section is to analyse the cyclical behavior of world commodity prices in circumstances where a number of macroeconomic variables are undergoing change jointly. The characterisation of these joint macroeconomic phenomena will be derived from the global business cycle model of Chapter Three. One implication of this approach is that the behavior of individual commodity prices will be analysed in terms of responses to monetary disturbances. In this sense we shall be exploring a 'monetary approach' to commodity price determination. With reference to the discussion of primary and industrial commodity price behavior in section 4.2, we shall also seek to analyse these different types of price movement in response to joint cyclical influences.
The global business cycle model of Chapter Three characterised the expansionary phase in terms of rising income and interest rates and the recessionary phase as falling income and interest rates. In both the expansionary and recessionary phases, the rate of aggregate price inflation is positive. The property of excess demand symmetry that was assumed to hold in the aggregate product market (given in (3.21)), leads to income-interest relations of the form:

\[(4.28) \quad dY_t = (g_1 + g_2) \cdot dR_{t,t+1} \]

\[(4.29) \quad dY^*_{t+1} = (g_1 + g_2) \cdot dR_{t+1,t+2} \]

where \((g_1 + g_2) > 0\) gives rise to income-interest rate confluence over the global business cycle.

Substituting (4.28) and (4.29) into the commodity market equilibrium system (4.14) gives:

\[(4.30) \quad \begin{bmatrix} c_{1j} - b_{1j} & b_{1j} - c_{1j} \\ b_{1j} & c_{1j} - 2b_{1j} \end{bmatrix} \begin{bmatrix} dp_{jt} \\ dp_{jt+1} \end{bmatrix} = \begin{bmatrix} \gamma_j dR_{t,t+1} \\ b_{2j} dR_{t,t+1} + \gamma_j dR_{t+1,t+2} \end{bmatrix} \]

where \(\gamma_j = [c_{2j} - b_{2j} - a_{1j}(g_1 + g_2)] \geq 0\)

The system of equations in (4.30) now relate the cyclical movements of current and expected commodity prices solely to current and expected interest rate changes. The latter are, of course, functionally related via the aggregate model of Chapter Three and their joint behavior will be incorporated subsequently. Our immediate interest lies in the interest rate coefficient \(\gamma_j\), the sign of which is ambiguous. The components of \(\gamma_j\) are the behavioral coefficients which measure the response of inventory demand and output to interest rate changes, as well as the coefficient which measures the consumption effect due to income rises. A negative value of \(\gamma_j\) is more likely, the greater is the coefficient of supply response and the larger is the income coefficient of consumption demand. Alternatively, if supply responsiveness and the income
coefficient of demand are both small, then a large responsiveness of inventory holdings to interest rate charges will make \( \gamma_j \) positive.

It may be noted, however that the coefficient \( \gamma_j \) measures the change in current commodity market excess demand brought about by a rise in \( r_{t,t+1} \). That is:

\[
(4.31) \quad \frac{d E.D_t}{dr_{t,t+1}} = (b_{2j} - c_{2j} + a_{1j}(g_1+g_2)) = -\gamma_j
\]

where \( E.D_t \) denotes current commodity market excess demand. Applying the gross substitutability argument of the previous section would imply that \( E.D_t \) should fall with a rise in \( r_{t,t+1} \); in which case \( \gamma_j \) is positive. However, the coefficient \( \gamma_j \) embodies both relative price and income determinants of excess demand and it is evident that an invocation of the gross substitutability property depends on relative price impacts dominating the income impacts. It will be recalled from the discussion of money market equilibrium in Chapter Three that the problem of trading off relative price (or portfolio) objectives with income effects also leads to ambiguities in the excess demand for real money balances. Resolution of this problem in that instance was also achieved by assuming the dominance of portfolio objectives; see equation (3.18).

In the case of individual commodities, however, it is not at all clear that the dominance of either income or relative price effects should be put forward as a general proposition. However, as a means of eliminating at least part of the complexities associated with cyclical price movements, it becomes necessary to invoke such assumptions. In order to maintain consistency with the excess demand properties that have been imposed previously, we shall henceforth assume that gross substitutability prevails; hence the value of \( \gamma_j \) is positive. In addition, we shall also assume that excess demand symmetry holds:

\[
(4.32) \quad \frac{d E.D_t}{dr_{t,t+1}} = \frac{d E.D_t}{d\pi_{jt,t+1}}
\]

such that

\[
(4.33) \quad \gamma_j = (b_{1j} - c_{1j}) \quad (excess \ demand \ symmetry)
\]
Returning to the problem of deriving the response of commodity prices to business cycle phenomena, the system of equations in (4.30) is solved using (4.33) as:

\[
\text{(4.34)} \quad dp_{jt} = \frac{1}{F} \{ (b_{lj} - c_{lj})(c_{lj} - 2b_{lj} - b_{lj}) \ dr_{t,t+1} \\
- (b_{lj} - c_{lj})^2 \ dr_{t+1,t+2} \}
\]

\[
\text{(4.35)} \quad dp_{jt} = \frac{1}{F} \{ (c_{lj} - b_{lj})(b_{lj} + b_{lj}) \ dr_{t,t+1} \\
- (b_{lj} - c_{lj})^2 \ dr_{t+1,t+2} \}
\]

These equations link cyclical movements in current and expected commodity prices to joint changes in current and expected interest rates. As noted earlier, movements in the latter are functionally related via the equilibrium business cycle model of Chapter Three. We rewrite (4.34) and (4.35) as:

\[
\text{(4.34')} \quad dp_{jt} = \psi_{lj} \ dr_{t,t+1} - \ dr_{t+1,t+2} \\
\text{(4.35')} \quad dp_{jt+1} = \psi_{lj} \ dr_{t,t+1} - \ dr_{t+1,t+2}
\]

where \( \psi_{lj} = \frac{b_{lj} + b_{lj}}{c_{lj} - b_{lj}} - 1 \)

and

\[
\psi_{lj} = \frac{b_{lj} + b_{lj}}{c_{lj} - b_{lj}}
\]

Interpreted as monetary phenomena, the simultaneous changes in current and expected interest rates are obtained from (3.44) and (3.45) as:

\[
\text{(4.36)} \quad \frac{dr_{t,t+1}}{dM_t} = \frac{1}{J} \{ A_1^2 (\phi_1 + \phi_2 - \eta_{t+1}^e) + \omega A_1^2 M_t \}
\]
Substituting from (4.36) and (4.37) into (4.34) provides an expression for the change in the current commodity price in response to monetary disturbances as:

\[ (4.38) \quad \frac{dr_{t+1,t+2}}{dM_t} = \frac{1}{J} \left\{ A_1^2 (\phi_1 + \phi_2 - M_t) + A_1 (\phi_1 - \eta_{t+1}^*) (\mu_1 + \mu_2) \right. \\
\left. + \alpha [A_1^2 (\phi_1 + \phi_2 - M_t) + A_1 M_t (\mu_1 + \mu_2)] \right\} \]

Similarly, substituting from (4.36) and (4.37) into (4.35) provides an expression for the response of the expected commodity price to monetary disturbances as:

\[ (4.39) \quad \frac{dp_{t+1}}{dM_t} = \frac{1}{J} \left\{ A_1^2 \Psi_{1j}^2 (\phi_1 + \phi_2 - \eta_{t+1}^* + \alpha M_t) - (\phi_1 + \phi_2 - M_t) (1+\alpha) \right\} \\
- A_1 [\mu_1 + \mu_2] (\phi_1 - \eta_{t+1}^* + \alpha M_t) \}

These are fairly complex expressions which relate the responses of current and expected commodity prices to a current monetary disturbance. The magnitude of these responses can be seen to depend, among other things, on the size of \( \alpha \), which was defined in Chapter Three as a source of business cycle variations. They also depend on the commodity-specific coefficients, \( \Psi_{1j} \) and \( \Psi_{2j} \), which as we shall see subsequently, provide a fundamental source of differences in price movements over the course of the global business cycle.

Prior to evaluating the nature of these cyclical price movements, however, it is desirable to combine the responses of current and expected prices into a single expression for the expected rate of commodity price appreciation, \( \Pi_{jt,t+1} \) (defined in (4.5)). From (4.34') and (4.35'), this is derived as:
In other words, a monetary disturbance leads to a change in the expected rate of commodity price appreciation which is identical in both sign and magnitude to the change in the market rate of interest. As discussed previously, this result follows directly from the assumption of product market excess demand symmetry applied to both the aggregate economy and each particular commodity market. Among other things, this implies that \( \pi_{jt, t+1} \) will be procyclical with \( r_{t, t+1} \) in response to monetary disturbances. Reference to Figure 3.1 reveals that for values of the business cycle parameter \( \alpha < \alpha_2 \), both the interest rate and the expected rate of commodity price appreciation will be falling. For values of \( \alpha > \alpha_2 \) on the other hand, the economy is in the expansionary phase and both interest rates and expected rates of commodity price appreciation will be rising.

4.6 The cyclical response of current commodity prices

Whereas the property of universal excess demand symmetry leads to an exact confluence between \( r_{t, t+1} \) and all \( \pi_{jt, t+1} \) over the course of the global business cycle, such is not the case with the movement in current and expected commodity prices. There exists a more intricate relationship between commodity price movements and the level of economic activity that depends on both the business cycle parameter \( \alpha \) and the commodity coefficients \( \psi_{1j} \) and \( \psi_{2j} \).

Consider firstly the expression for the current commodity price movement given by (4.38). Solving this expression, we find that current monetary expansion will be associated with a rise in the price of commodity \( j \) as:

\[
\frac{d\pi_{jt}}{dM_t} > 0
\]
when $\alpha > \alpha_{3j}$

where

$$
(4.42) \quad \alpha_{3j} = \frac{A_1^2[\phi_1 + \phi_2 - M_{t+1} - \psi_{1j}(\phi_1 + \phi_2 - \eta_{t+1})] + A_1(\phi_1 - \eta_{t+1})(\mu_1 + \mu_2)}{A_1^2[M_t - \phi_1 + \phi_2 + \psi_{1j}M_t] - \lambda_1 M_t(\mu_2 + \mu_2)}
$$

In other words, just as the response of aggregate output and interest rates to current monetary expansion depends on the value of $\alpha$, so too does the response of the price of commodity $j$. However, it can be seen that the critical value of $\alpha$ which gives rise to an increase in $p_{jt}$ depends on the term $\psi_{1j}$, which is specific to commodity $j$. From the definition of $\alpha_{3j}$ in (4.42), we obtain the relationship between $\alpha_{3j}$ and varying levels of $\psi_{1j}$ as:

$$
(4.43) \quad \frac{d\alpha_{3j}}{d\psi_{1j}} = \frac{A_1^2}{f_2^2} \left( \frac{f_2(\eta_{t+1} - \phi_1 - \phi_2)}{f_1 M_t} - f_1 M_t \right)
$$

where $f_1$ is the numerator of $\alpha_{3j}$

$f_2$ is the denominator of $\alpha_{3j}$.

A higher value of $\psi_{1j}$ implies a higher value of $\alpha_{3j}$ according to

$$
(4.44) \quad \frac{d\alpha_{3j}}{d\psi_{1j}} > 0 \quad \text{when} \quad \alpha_{3j} < \frac{\eta_{t+1} - \phi_1 - \phi_2}{M_t}
$$

From the definition of $\alpha_2$ given in (3.53), however, this requirement may be written as

$$
(4.44') \quad \frac{d\alpha_{3j}}{d\psi_{1j}} > 0 \quad \text{when} \quad \alpha_{3j} < \alpha_2
$$

Substituting from (3.53) and (4.42) into (4.44'), we find that

$$
(4.45) \quad \alpha_{3j} - \alpha_2 < 0
$$
when

\[(4.46) \quad A_t (\phi_1 + \phi_2 - M_t) (\lambda _t + \lambda _{t+1} - \phi_1 - \phi_2) - M_t (\mu_1 + \mu_2) \phi_2 > 0\]

which is true always.

Hence, we obtain the result that the critical value of \( \alpha \) which differentiates the recessionary and expansionary phases of the business cycle, lies to the right of the critical \( \alpha \) value necessary to induce positive price movements. Further, we see from (4.44') that the higher is \( \psi_{1j} \), the larger the critical value of \( \alpha \) required to produce an upward response in the price of commodity \( j \).

The important feature of these results is that confluence between output, interest rates and the prices of all commodities can occur only during the expansionary phase of the global business cycle. As indicated in Figure 4.1 below, however, the recessionary phase will consist of a more diverse pattern of responses; see also Figure 3.1.

**Figure 4.1**

The Relationship Between Commodity Prices and the Global Business Cycle Based on Movements in the Coefficient \( \alpha \)

<table>
<thead>
<tr>
<th></th>
<th>Depression</th>
<th>Deep Recession</th>
<th>Mild Recession</th>
<th>Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>( dp_t )</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>( dr_{t,t+1} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>( dy_t )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>( dp_{jt} )</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

The positioning of \( \alpha_{3j} \) between \( \alpha_1 \) and \( \alpha_2 \) in Figure 4.1 is quite arbitrary; all that is required is that \( \alpha_{3j} \leq 2 \). The main feature of Figure 4.1 is that during the deep recessionary (or depression) phase of the global business cycle, the price of commodity \( j \) will change from a
downward movement to an upward movement. There is no commodity in this system for which the current price level is perfectly confluent with either interest rates or the level of output over all phases of the business cycle.

As suggested by Figure 4.1, there will exist some commodities whose prices will fall during the recessionary phase, at the same time that the aggregate price level, \( p_t \), is rising. If, on the other hand, \( \alpha_{3j} \) had been positioned to the left of \( \alpha_1 \), then clearly the commodity in question would reveal a rising price level even at a time when the aggregate price was falling. Restricting our attention to the recessionary and expansionary phases of the global business cycle, the important point to emerge is that it requires a lower value of \( \alpha \) to create an upward movement in the price of any commodity than to produce a rise in interest rates and the level of output. It is only after the global economy has entered the expansionary phase that price rises for all commodities coincide with rising income and interest rates.

The discussion of section 4.2 highlighted the difference between movements in primary and industrial commodity prices as depending on their fixprice:flexprice character. In brief, a flexprice characterisation involves a price level which moves up and down more or less in line with the level of economic activity; a fixprice characterisation, on the other hand, is given by price movements which are positive during both the recessionary and expansionary phases, but where the rate of change is higher in the expansionary phase.

The results of this model throw considerable light on the possible sources of these differences in price response. According to the analysis presented above, the price of a particular commodity will be more likely to reveal the fixprice characteristic, the closer that \( \alpha_{3j} \) is to \( \alpha_1 \); indeed any value of \( \alpha_{3j} \) to the left of \( \alpha_1 \) will create a price response that is positive under most circumstances. Higher values of \( \alpha_{3j} \) on the other hand, suggest a pattern of commodity price behavior which is more likely to reveal the flexprice characteristic. It is these types of commodities for which the current price will move in a way which resembles, to some extent, the response of interest rates and output.
Differences among commodities in the response of their prices to monetary expansion can be traced to variations in the coefficient, $\psi_{lj}$. As shown by equations (4.44') to (4.46), higher values of $\psi_{lj}$ imply higher values of $\alpha_{3j}$; the latter in turn are more likely to be associated with flexprice phenomena. From the definition of $\psi_{lj}$ given below (4.35') it is evident that variations in the value of this term across different groups of commodities can be traced ultimately to the commodity-specific coefficients of supply and inventory demand.

Consider, for instance, the restrictions that would need to be placed on the components of $\psi_{lj}$ such that the price of commodity $j$ moved identically with the aggregate price level, $p_t$. These are determined by setting:

$$\frac{dP_{jt}}{dM_t} = \frac{dP_t}{dM_t}$$

and will be representative of a commodity whose real price is constant over all phases of the business cycle. Solving (4.47), using (3.42) and (4.38) gives:

$$\left(\frac{b_{lj} + b_{2j}}{c_{lj} - b_{lj}}\right) = \frac{\mu_1 + \mu_2}{A_1}$$

The result in (4.48) means that if the price of commodity $j$ is to move exactly in line with the aggregate price level (i.e., remain constant in real terms), the ratio of excess demand coefficients which hold at the commodity level must be identical to that which prevails in aggregate. In other words, the coefficient sum $(b_{lj} + b_{2j})$ is the commodity market equivalent of the sum $(\mu_1 + \mu_2)$ which applies in aggregate. In both cases these coefficients refer to the net response of inventory demand to a given change in the market rate of interest (which is, by excess demand symmetry, equal to the expected rate of price appreciation). Similarly, the terms $(c_{lj} - b_{lj})$ and $A_1$ refer to the excess demand impacts of a given rise in interest rates (or expected rate of price appreciation) in the commodity and aggregate product markets, respectively.
It may be noted that there is no requirement for both 
\((b_{1j}+b_{2j}) = (\mu_1+\mu_2)\) and \((c_{1j}-b_{1j}) = \Lambda_1\) to hold simultaneously. Rather, it is the ratio of these terms which must be equated in order that the commodity price move in exact confluence with the aggregate price.

An interesting property which arises from the restrictions (and assumptions) which have been imposed previously, is that both of the ratios in (4.48) must be negative. This arises from the discussion of Chapter Three in which \((\mu_1+\mu_2)>0\) and \(\Lambda_1<0\). Similarly, from the analysis of this chapter, there is the requirement that \((c_{1j}-b_{1j})<0\). This implies that \((b_{1j}+b_{2j})>0\) as a necessary condition for (4.47) to be satisfied. In other words, for a commodity to display a constant real price over the course of a business cycle, it is necessary that its inventory demand be more responsive to \(u_j\) than to \(r_t\). Under these circumstances, the values of both \(\psi_{1j}\) and \(\alpha_{3j}\) for this type of commodity are unambiguously negative.

Consider now the case where the price of the commodity in question rises by more than the aggregate price level; i.e., the commodity experiences a real price increase. Solving this problem, we obtain:

\[
\frac{dP_{jt}}{dM_t} > \frac{dP_t}{dM_t}
\]

when

\[
\frac{b_{1j}+b_{2j}}{c_{1j}-b_{1j}} > \frac{\mu_1+\mu_2}{\Lambda_1} \quad \text{and} \quad \alpha > \alpha_2
\]

or

\[
\frac{b_{1j}+b_{2j}}{c_{1j}-b_{1j}} < \frac{\mu_1+\mu_2}{\Lambda_1} \quad \text{and} \quad \alpha < \alpha_2
\]

These results demonstrate that the real price of a commodity may rise in response to a monetary disturbance under two quite distinct sets of circumstances. The first is given by (4.50) and it requires that not only should the ratio of excess demand coefficients be higher for the commodity than for the aggregate product, but also that the global economy must be in the expansionary phase (as given by \(\alpha > \alpha_2\)). The
85.

former requirement may be satisfied, for instance, for any commodity for which \((b_{1j}+b_{2j})<0\). This latter condition is sufficient to make the ratio \((b_{1j}+b_{2j})/(c_{1j}-b_{1j})\) positive in which case it will always exceed its aggregate market equivalent. However, \((b_{1j}+b_{2j})>0\) implies that inventory demand for the commodity in question be more responsive to interest rate changes than to expected rates of price change; contrary to the property which holds in aggregate.

The second set of circumstances for which the real commodity price will increase is given in (4.51). This requires a ratio of excess demand coefficients which is less than that which holds in aggregate and, as given by \(\alpha<\alpha_2\), applies only during the recessionary phase.

By suitable switching of signs, these results may also be used to determine the circumstances under which the real commodity price falls. An important point to note about the conditions expressed in (4.50) and (4.51), however, is that they are mutually exclusive with respect to both the characteristics of commodity \(j\) and the stage of the business cycle. One consequence of this is that the real price of any given commodity cannot increase over both the recessionary and expansionary phases of the business cycle. The expansionary phase will give rise to real price rises only in those commodities which satisfy (4.50). The remainder of the commodities in the world economy will experience real price rises only during the recessionary phase. Some commodities, however, may satisfy condition (4.48) such their real price is constant always. As a general proposition, however, global monetary disturbances bring about changes in relative prices only when they also induce real impacts. If the global monetary disturbance is neutral, relative prices remain constant.

4.7 The cyclical response of commodity price expectations

The expected price of commodity \(j\) will also vary as a result of changing conditions in the global economy. From the expression for the response of commodity price expectations given in (4.39), we obtain:

\[
\frac{dp_{jt}^{*}}{dM_t} > 0
\]
when $\alpha > \alpha_{4j}$

where

$$\alpha_{4j} = \frac{A_1^2[\phi_1 + \phi_2 - M_t - \psi_2j(\phi_1 + \phi_2 - \eta_t)^* + 1] + A_1(\phi_1 - \eta_t^* + 1)(\mu_1 + \mu_2)}{A_1^2(M_t - \phi_1 - \phi_2 + \psi_2jM_t) - A_1M_t(\mu_1 + \mu_2)}$$

Comparing (4.53) with (4.42), it is apparent that the critical value of $\alpha$ required to produce upward movement in the current commodity price can be equal to that associated with a rise in the expected price only when $\psi_{1j} = \psi_{2j}$. From the definitions of these terms below (4.35'), however, such an equality is not possible and hence $\alpha_{3j} \neq \alpha_{4j}$.

In order to determine the relative magnitudes of the critical values $\alpha_{3j}$ and $\alpha_{4j}$, we obtain:

$$\alpha_{4j} - \alpha_{3j} = (\psi_{1j} - \psi_{2j}) \cdot \frac{Q_1}{Q_2}$$

where $Q_1 = A_1^4(\phi_1 + \phi_2 - M_t)(\psi_2j - \phi_2 - \phi_2 + \mu_1 + \mu_2) - A_1M_t(\mu_1 + \mu_2) \phi_2 < 0$

$$Q_2 = A_1^4(\psi_{2j} - \phi_1 - \phi_2 + M_t)(\psi_{1j}M_t - \phi_1 - \phi_2 + M_t)$$

$$+ A_1^2M_t(\mu_1 + \mu_2)^2 - A_1M_t(\mu_1 + \mu_2)M_t(\psi_{1j} + \psi_{2j} - 2(\phi_1 - \phi_2 - M_t)) > 0$$

and where the sign of $Q_2$ follows directly from the assumption made in footnote 7.

It is evident from (4.54) that $\alpha_{4j}$ will lie to the right of $\alpha_{3j}$ whenever $(\psi_{1j} - \psi_{2j}) < 0$. Indeed, from the definitions of $\psi_{1j}$ and $\psi_{2j}$, we see that this condition is satisfied always. Hence:

$$\alpha_{4j} > \alpha_{3j}.$$
always. Hence, the critical value of $\alpha$ required to induce an upward response in commodity price expectations is less than that required to bring about a rise in interest rates and the level of economic activity.

4.8 A classification of world commodity price behavior

The main analytical results of this Chapter may now be integrated with those of Chapter 3 to produce a scenario of the global business cycle which allows for the simultaneous behavior of both aggregate variables (such the level of aggregate output, the interest rate and the inflation rate) and individual commodity prices as well. The source of these simultaneous adjustments is a given increase in the current world money supply, $M_t$, accompanied by varying changes in the expected future money supply. Joint variations in these monetary variables are parameterised by the coefficient $\alpha$.

As mentioned in the Introduction to this Chapter, it is our intention to draw an explicit distinction between primary and industrial commodity price movements based on responses which are reasonably in accord with observed real world phenomena. In view of the discussion of section 4.2 and the analytical results derived above, the following commodity classification scheme will apply.

An industrial commodity will display positive price movements over both the recessionary and expansionary phases of the global business cycle. For the purpose of subsequent analysis, it will be assumed that there exists only a single industrial commodity traded on world markets and that its price is identical to the world aggregate price level. Hence, the industrial commodity possesses the following characteristics:

\[
\begin{align*}
\frac{b_{1j} + b_{2j}}{c_{1j} - b_{1j}} &= \frac{\mu_1 + \mu_2}{\lambda_1} \\
\frac{b_{1j}}{c_{1j} - b_{1j}} &= \frac{\mu_1}{\lambda_1}
\end{align*}
\]
\[
\frac{d p_{jt}}{d M_t} > 0 \text{ for all } \alpha > \alpha_1
\]

and where \( j=1 \) denotes the single industrial commodity.

A primary commodity, on the other hand, will display a falling nominal price level over at least part of the recessionary phase of the global business cycle. The key behavioral characteristics are specified as:

\[
b_{1j} + b_{2j} < 0
\]

\[
\frac{b_{1j} + b_{2j}}{c_{1j} - b_{1j}} > \frac{\mu_1 + \mu_2}{A_1}
\]

\[
\frac{d p_{jt}}{d M_t} \geq 0 \text{ for } \alpha \geq \alpha_3
\]

and where \( j=2 \) denotes the primary commodity.

The business cycle scenario generated by this commodity classification scheme is given in Figure 4.2.

**Figure 4.2**

**A Business Cycle Scenario Incorporating Primary and Industrial Commodity Price Movements**
The impacts presented in Figure 4.2 refer to movements in the aggregate variables \( (p^t, r^t, t+1 \text{ and } Y_t) \), the industrial commodity price \( p_{1t} \), and the primary commodity price, \( p_{2t} \). The responses of the aggregate variables to the monetary disturbance are the same as in Figures 3.1 and 4.1. The response of the industrial commodity price, \( p_{1t} \), is identical to that of the aggregate price level; hence not only is \( d(p_{1t}/p_t) = 1 \). The behavior of the primary commodity price over the global business cycle differs from that of the industrial commodity price. The critical \( \alpha \) value for commodity 2 lies to the right of that for commodity 1, implying that a lower value of \( \alpha \) is required to induce an increase in \( p_{1t} \) than in \( p_{2t} \). However, the real price of the primary commodity rises only during the expansionary phase of the business cycle, despite the increase in nominal prices which takes place during the recession.

These results exemplify the diversity of relationships that exist among macroeconomic variables on the one hand, and commodity market prices on the other, over the course of the global business cycle. Clearly, by relaxing a number of critical assumptions, it will be possible to obtain even more complex characterisations of commodity market - business cycle interactions. For the purposes of the analysis which follow, however, the characterisation presented above is sufficient.

### 4.9 Supply induced commodity price movements

The analyses of this chapter have focussed on global monetary disturbances as a source of commodity price movements. This has served the joint purposes of both providing insight into the empirical regularities which appear to hold between commodity prices on the one hand, and aggregate global variables on the other; and also of providing a mechanism for transmitting global terms of trade changes to the small open economy. The implications of the latter for the transmission of global monetary disturbances to the SOE will be analysed in Chapters Six and Nine below.
Also of relevance for the analysis of individual commodity price movements, however, are supply disturbances or shocks. A number of analysts have suggested that supply shocks dominated commodity market behavior during the 1970s and that these shocks were most influential in primary commodity markets. A list of references relating to this issue is given in section 9.1.

Despite the volume of empirical research which has been conducted into the determinants of commodity price changes, little systematic consideration has been given to the issue of whether a supply induced price rise possesses different qualitative attributes to a monetary induced price rise. By 'qualitative attributes' we mean changes in commodity price expectations and expected rates of price change that may accompany the rise in the current commodity price.

The purpose of this section is to subject the commodity price model of this chapter to exogenous supply shocks; i.e. supply shortfalls. We shall distinguish between current and anticipated shocks on the one hand, and temporary and permanent shocks on the other. The implications of the supply shock in each case may be easily reversed for the case of exogenous supply increases.

We proceed by incorporating into the market equilibrium conditions presented in section 4.3 an exogenous variable $Q_j$. A rise in $Q_j$ implies a fall in the supply of commodity $j$. If the supply shortfall is unanticipated and occurs at time $t$, it is denoted as $Q_{jt}$. The destruction of stored grain by insect attack would be representative of this type of supply disturbance. If, on the other hand, the drop in commodity supply is expected to occur one period hence, at $t+1$, it is denoted as $Q_{jt+1}$. The reduction in expected yield of a particular crop by frost or drought would be representative of this type of supply disturbance.(7)

From (4.4) we write the condition for equilibrium in the current commodity market as:

\[(4.57) \quad C_{jt} + I_{jt} = X_{jt} - Q_{jt} \]
where, as before, $C_{jt}$ is current consumption demand, $I_{jt}$ is current inventory demand; $X_{jt}$ is current output and $Q_{jt}$ is the current supply shock. Similarly, from (4.10), we write the condition for expected commodity market equilibrium as:

\[(4.58) \quad C_{jt+1}^* + I_{jt+1}^* = X_{jt+1}^* - Q_{jt+1}^* \]

where $Q_{jt+1}^*$ is the anticipated supply shock.

The current supply shock, having occurred, may be regarded by market participants as being either temporary or permanent. A temporary supply shock is defined by:

\[dQ_{jt} > 0 \quad \text{and} \quad dQ_{jt+1} = 0\]

while a permanent supply shock is defined by

\[dQ_{jt} = dQ_{jt+1} > 0\]

Substituting (4.57) and (4.58) into (4.14), we derive the following impacts of a commodity market supply shock. Dealing firstly with an unanticipated, temporary supply shock, we obtain:

\[(4.59) \quad \frac{dp_{jt}}{dQ_{jt}} = \frac{2b_{lj} - c_{lj}}{F} > 0\]

\[(4.60) \quad \frac{dp_{jt+1}^*}{dQ_{jt}} = \frac{b_{lj}}{F} > 0\]

\[(4.61) \quad \frac{d\pi_{jt,t+1}}{dQ_{jt}} = \frac{c_{lj} - b_{lj}}{F} < 0\]

Hence, an unanticipated, temporary supply shortfall causes both the current and expected prices of commodity $j$ to rise, but leads to a fall in the expected rate of price appreciation for $j$. The price impacts are more or less in line with intuition and are consistent with the proposition that price be an increasing function of excess demand. The fall in $\pi_{jt,t+1}$, on the other hand, occurs because the current price
increases by more than the expected price. With less stocks available, the demand for $j$ is in excess of supply until such time as it can be diverted towards alternative assets. This is achieved through a fall in the expected return on holding $j$, $\pi_{jt,t+1}$.

The impacts of an unanticipated, permanent supply shock, on the other hand, are derived as:

\[
\frac{dp_{jt}}{dQ_{jt}} = \frac{3bl_j - 2cl_j}{F} > 0
\]

\[
\frac{dp_{jt+1}^*}{dQ_{jt}} = \frac{2bl_j - cl_j}{F} > 0
\]

\[
\frac{d\pi_{jt,t+1}}{dQ_{jt}} = \frac{cl_j - bl_j}{F} < 0
\]

We see that the only difference between a temporary supply shock and a permanent supply shock is in the magnitude of the increase in $p_{jt}$ and $p_{jt+1}^*$. In both cases, the permanent supply shock leads to a larger increase than temporary supply shock. The response of $\pi_{jt,t+1}$ is the same for both types of supply shock, however.

Finally, an anticipated supply shock leads to increases in both $p_{jt}$ and $p_{jt+1}^*$ which are identical

\[
\frac{dp_{jt}}{dQ_{jt+1}} = \frac{dp_{jt+1}^*}{dQ_{jt+1}} = \frac{bl_j - cl_j}{F} > 0
\]

As a consequence of this, the expected rate of return on $j$ remains constant in the presence of anticipated supply disturbances

\[
\frac{d\pi_{jt,t+1}}{dQ_{jt+1}^*} = 0
\]

This result is consistent with the proposition that current market equilibrium prevails only when existing stocks are willingly held. Since $Q_{jt+1}^*$ implies no change in current stocks, there is no requirement for
adjustment in current excess demands either; hence $\pi_{jt,t+1}$ remains constant.

In summary, therefore, a supply shock causes both the current and expected prices of the commodity concerned to rise. The relative magnitude of these price adjustments depends, however, on whether the supply shock is anticipated or unanticipated. An unanticipated (or current) supply shock causes the current price of commodity $j$ to rise by more than its expected price; hence the expected rate of price appreciation falls. An anticipated supply shock leads to identical increases in both $p_{jt}$ and $p_{jt+1}^*$; for this type of supply disturbance, the expected rate of price appreciation remains constant.

If we now compare these results with those obtained in the case of a monetary stimulus we find that an important difference emerges regarding the relative magnitudes of the rises in $p_{jt}$ and $p_{jt+1}^*$. Whereas a supply shock causes $p_{jt}$ to increase either by more than $p_{jt+1}^*$ or by an amount equal to it, a monetary stimulus causes $p_{jt}$ to rise by less than $p_{jt+1}^*$. The implication of this is that $\pi_{jt,t+1}$ will either fall or remain constant in response to the supply shock, but will rise in response to the monetary stimulus. These differences in the behavior of $\pi_{jt,t+1}$ reflect the different adjustment pressures that supply shocks and monetary stimuli bring to bear on commodity markets. A major implication of this finding is that an observation of rising prices for a particular commodity, on its own, is not sufficient to determine the ultimate direction of market adjustment. The consequences of this for a small open economy subjected to global price shocks will be investigated in Chapter Nine.

4.10 Summary and conclusions

The main purpose of this chapter has been to analyse the changes which take place in world commodity prices in response to changes in the level of global economic activity. The macroeconomic model of Chapter Three has been appended to a simple model of commodity price determination and as a result, the impacts of global monetary disturbances on individual commodity prices have been derived.
A distinction has been drawn between the price behavior of industrial commodities and primary commodities. The source of this distinction has been attributed to differences in the relative magnitudes of various excess demand coefficients in each commodity market. In particular, where the demand for inventory holdings of the commodity is more responsive to expected rates of price change than to the market rate of interest, the more likely it is that the commodity will display the 'fixprice' characteristic frequently attributed to industrial commodities. Conversely, where inventory demand is relatively more responsive to interest rate changes, the more likely it is that the commodity will display the 'flexprice' characteristic of primary commodities. The latter characteristic is more or less one of downward price movement during the recession and upward movement during the expansion in global economic activity.

Under the business cycle specification derived in this thesis, however, the correlation between primary commodity prices and the level of economic activity will be less than perfect. The reason for this is that the value of the monetary disturbance parameter $\alpha$ which demarcates the recessionary from expansionary phases of the business cycle, differs from the $\alpha$-value which demarcates falling from rising prices. Thus, as $\alpha$ approaches the value which changes the global economy from recession to expansion, the prices of all commodities will have commenced an upward trajectory before such time that the expansion has got underway. This means that an inflationary movement in the prices of all commodities will be present even during the latter stages of the global recession. It is only after $\alpha$ has increased sufficiently to induce an expansionary response in the aggregate economy that once again the relationship between primary commodity prices, interest rates and the level of output will admit of confluence.

As with the macroeconomic analytical model of Chapter Three, the results of this Chapter allow additional insight into many of the empirical regularities which have long been within the bailiwick of applied econometricians. Included among these are the Gibson paradox which refers to the positive correlation between interest rates and commodity price changes, as well as the more recent investigations linking price movements to money supply and aggregate output changes.
Our objective, however, is to proceed towards analysing the implications of these global scenarios on the economic circumstances of the small open economy. For this reason, a more detailed comparison of the analytical propositions of this and the previous chapter with the findings of previous analysts will not be attempted. Instead, we seek to examine the effects of simultaneous changes in world income, interest rates, inflation and traded commodity prices of a small open economy during periods of both global expansion and recession. It is towards these issues that we now turn.
FOOTNOTES - CHAPTER FOUR

(1) Evidence of this property is contained in Cooper and Lawrence (1975) and Bond, Crowley and Vlastuin (1982).

(2) It is for this reason that the fixprice:flexprice distinction is not unrelated to issues of equilibrium versus disequilibrium modelling. See for instance Meade (1981), Drazen (1980).

(3) It may be noted that, as pointed out by Drazen (1980), 'market clearing' is not an observable event; simple observations will not reveal whether a market clears or not. It is for this reason that Drazen does not regard the co-existence of inflation and unemployment as sufficient reason to completely reject the paradigm of competitive equilibrium.

(4) Discussions of the problems of obtaining exact consistency between microtheoretic relations based on maximum principles and the specification of macrotheoretic relationships are given in Turnovsky (1977a) and Brock and Turnovsky (1981).

(5) 'Free parameters' are defined by Lucas (1980) as conditions imposed on the model in addition to those used to describe preferences and technology. Thus the assumptions of price fixity or exogenous price expectation movements that are imposed on models qualify as free parameters.

(6) The results in (4.41) has been derived on the assumption that

\[ \frac{b_1j + b_{2j}}{c_{1j} - b_{1j}} > \frac{\mu_1 + \mu_2}{A_1} + \frac{\phi_1 + \phi_2}{M_t} \]

where \((\phi_1 + \phi_2)/M_t < 0\). The implications of this assumption are discussed below equation (4.48).

(7) It is likely that anticipated supply disturbances are of relatively more importance in primary commodity markets than are unanticipated supply shocks. These markets are usually serviced by highly organised intelligence organisations which, combined with intrinsic lags in
production processes, are able to translate current information into revised supply forecasts. This interpretation suggests that 'news' of supply shocks, rather than realised shocks themselves, may be the dominant form of supply disturbance in these markets. Parallel to this is the proposition by Frenkel (1981) that 'news' has been a key factor influencing exchange rate movements in the past decade.

(8) This finding is consistent with the observation that inventory holdings of commodities such as grains and metals appear to be highly responsive to interest rate changes. Among other things, this suggests that from a portfolio viewpoint, primary commodities are perceived to be more readily substitutable for financial assets than are industrial commodities.

(9) The interest rate - price level connection is discussed and analysed in Sargent (1969), Yohe and Karnosky (1969), Roll (1972), and Heal and Barrow (1980). Empirical evidence linking primary commodity price movements to observed monetary disturbances is given in Bond, Crowley and Vlastuin (1982), Grilli and Yang (1981) and Lawrence (1980). It may be noted, however, that the empirical findings of Gordon (1975), (1980) imply either that money is irrelevant to the price determination process or its potential impact is realised only after very long delays stretching over several years. A contrary view, which attributes higher rates of price inflation to higher rates of monetary expansion, is presented in Cagan (1979). It is evident, however, that empirical testing of the propositions derived in this Chapter must overcome the problem of accounting for systematic variation in unobservable money supply expectations; see for instance, Barro (1978), Mishkin (1982) and Makin (1982).
CHAPTER FIVE
A BASE MODEL OF THE SMALL OPEN ECONOMY

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5.1 Outline of Chapter

The purpose of this chapter is to establish some basic propositions regarding the transmission of the global business cycle to the small open economy (SOE). The SOE model developed below is a highly simplified representation of an open economy and for this reason is referred to as the base SOE model. In subsequent chapters, it is our intention to modify some of the key assumptions upon which the base model is established, thereby providing a more critical perspective on the propositions derived below.

Over recent decades, a variety of approaches have been used by economists to analyse the impacts of international disturbances. (1) The more recent contributions have followed developments in general macroeconomic theory in that they have given prominence to expectations variables. Of major concern have been expectations of not only prices and exchange rates, but of exogenous variables such as monetary disturbances as well.

A distinction may be drawn, however, between analyses in which foreign prices, interest rates and income enter the domestic economy as separate disturbances, and those in which movements in these foreign variables are endogenous to global real or monetary disturbances. Whereas the former type of analysis would seem to appear more frequently in the literature, it is the latter which provides the most relevant insight into the business cycle transmission process. (2) Recent examples of studies in which economic activity in the domestic economy is linked directly to a model of the global economy are Cox (1980), Daniel (1981), Saidi (1980), Turnovsky (1980), Marston (1982), Harkness (1982), and Flood (1979).

A point which emerges from these studies is that both the mechanism through which international disturbances are transmitted, and the qualitative nature of response within the SOE, depend critically on the underlying structure of the SOE itself. A related point concerns the neutrality of domestic versus global monetary disturbances and how this in turn is linked to the SOE structure.
The strategy to be adopted in this and subsequent chapters is to examine the generality of propositions regarding both domestic and foreign monetary disturbances as the structure of the SOE is systematically varied. One aspect which will receive prominent attention is the role of the purchasing power parity (ppp) assumption in the transmission of disturbances. Recent criticisms of this assumption as being empirically untenable(3) highlight the need to consider its analytical implications and part of the discussion in following chapters will be devoted to this point.

As a starting position, however, the base SOE model of this chapter will present an open economy in which both purchasing power parity and interest rate parity prevail. Further, the SOE is assumed to produce and trade in only one type of commodity which is homogeneous with respect to the aggregate global commodity. The analysis will be concerned with the impacts of domestic monetary and real disturbances on the one hand, and foreign price, interest rate and income disturbances on the other. The latter will be analysed initially as separate, isolated disturbances and subsequently as endogenous joint responses to global monetary disturbances. The global business cycle model of Chapter Three will be used to characterise the joint behavior of the foreign variables.

5.2 An equilibrium model of the small open economy

The distinguishing characteristics of the base model of the SOE are as follows. The SOE consists of markets in three assets, namely, a single traded commodity, money and a bond. The commodity is identical to the aggregate world commodity which formed the subject of analysis in Chapter Three. In the absence of trade and transport impediments, purchasing power parity is assumed to hold. Domestic money is issued by the domestic monetary authorities independently of any money supply rule; hence, variations in nominal domestic money supply are taken to occur exogenously. It is assumed also that demand for domestic money stock is by residents of the SOE only. The domestic bond market is perfectly integrated with the global bond market and, by the assumption of perfect substitutability, interest rate parity prevails. The functional forms of each the supply and demand functions in the SOE are identical to their counterparts in the global economy.
The specification of the base model is as follows.

**Product Market Specification**

(5.1) \( y^d_t = f(\Omega_{t,t+1}, i_{t,t+1}) \), \( f_1 > 0, f_2 < 0 \)

(5.2) \( C_t^d = c y_t^d \) \( 0 < c < 1 \)

(5.3) \( i_t^d = I(\Omega_{t,t+1}, i_{t,t+1}) \), \( I_1 > 0, I_2 < 0 \)

(5.4) \( x_t = x(\pi_{t,t+1}, r_{t,t+l}, y^f_t) \), \( x_1 > 0, x_2 < 0, x_3 > 0 \)

(5.5) \( m_t = m(\Omega_{t,t+1}, i_{t,t+1}, y^d_t) \), \( m_1 > 0, m_2 < 0, m_3 > 0 \)

(5.6) \( q_t = p_t e_t \) (purchasing power parity)

(5.7) \( q_{t+1}^* = p_{t+1}^* e_{t+1}^* \) (purchasing power parity)

(5.8) \( i_{t,t+1} = r_{t,t+l} + \Delta_{t,t+1} \) (interest rate parity)

(5.9) \( \Delta_{t,t+1} = (e_{t+1}^* / e_t) - 1 \)

(5.10) \( \Omega_{t,t+1} = (q_{t+1}^* / q_t) - 1 \)

(5.11) \( \pi_{t,t+1} = (p_{t+1}^* / p_t) - 1 \)

(5.12) \( y_t^d = C_t^d + I_t^d + x_t - m_t + G_t \) (product market equilibrium)

where

- \( y_t^d \) is real domestic output
- \( C_t^d \) is real domestic consumption
- \( I_t^d \) is real domestic investment
Equation (5.1) specifies the domestic production of the traded good as responding positively to domestic inflationary expectations and negatively to the domestic interest rate. This specification is consistent with that presented in Chapter Three for the global economy where it was argued that a rise in inflationary expectations makes both the production and the holding of stocks of the physical commodity more attractive compared with the expected returns on alternative assets.

Domestic consumption of the local product is specified in (5.2) as a fixed, positive fraction of domestic production, while inventory demand by domestic residents for the local product is given in (5.3) as a function of domestic inflationary expectations and domestic interest rates. As in previous chapters, this specification of the inventory demand function is designed to reflect portfolio substitution objectives.

Export and import demand functions are given in equations (5.4) and (5.5). The export demand by foreigners is consistent with the commodity demand specification used in Chapter Three; namely that it consists of both consumption and inventory objectives. These objectives are represented by income and relative expected rate of return variables, respectively. Export demand responds positively to both its expected rate of return and the world income level (now denoted $Y_t$) and negatively to...
the world interest rate. An important characteristic of the export demand function is that it is completely independent of exchange rate effects. This follows from the joint assumptions of purchasing power parity and the domestic economy having no market power. In other words, domestic and foreign price relativities remain fixed and exchange rate movements (either current or expected) have no role as a determinant of export flows.

Import demand by domestic residents, on the other hand, is assumed to be influenced by exchange rate movements. By specifying the demand for imports as a function of domestic interest rate, income and rate of price change, exchange rate movements offer potential for variations in import flows. This is seen by a total differentiation of (5.5) which yields:

\[
(5.13) \quad d m_t = m_1 d\Omega_{t,t+1} + m_2 d i_{t,t+1} + m_3 d Y^d_t.
\]

From the definitions of \(\Omega_{t,t+1}\) and \(i_{t,t+1}\), and from the supply response function (5.1), this expression becomes:

\[
(5.14) \quad d m_t = m_1 d\pi_{t,t+1} + m_2 d r_{t,t+1} + (m_1 + m_2 + m_3(f_1 + f_2)) d\Delta_{t,t+1}.
\]

The coefficient attached to the change in the expected rate of exchange depreciation, \(\Delta_{t,t+1}\), consists of both portfolio and income objectives. Assuming initial values of unity for the current and expected exchange rates, we obtain from (5.5):

\[
(5.15) \quad d\Delta_{t,t+1} = d e^*_{t+1} - d e_t,
\]

such that an increase in the expected rate of exchange depreciation may arise out of \(e^*_{t+1}\) increasing relative to \(e_t\). Given that a rise in \(e_t\) corresponds to a devaluation of the domestic currency, \(\Delta_{t,t+1}\) may, for instance, increase if the expected devaluation exceeds the current devaluation. The relationship between import demand and the exchange rate is found by substituting from (5.15) into (5.14) to obtain:

\[
(5.16) \quad d m_t = m_1 d\pi_{t,t+1} + m_2 d r_{t,t+1} + (m_1 + m_2 + m_3(f_1 + f_2)) de^*_{t+1} - (m_1 + m_2 + m_3(f_1 + f_2)) de_t.
\]
Depending on whether the coefficient \((m_1 + m_2 + m_3(f_1 + f_2))\) is positive or negative, a devaluation may lead to a fall or a rise in the level of imports. If however, we define the trade balance, \(T_t\) as:

\[(5.17) \quad T_t = x_t - m_t,\]

then the response of the trade balance to a given change in the exchange rate is determined as:

\[(5.18) \quad \frac{dT_t}{de_t} = - \frac{dm_t}{de_t} = (m_1 + m_2 + m_3(f_1 + f_2))\]

The Marshall-Lerner condition for successful devaluation implies a positive relationship between the exchange rate and the trade balance.\(^{(4)}\) On this basis we assume that:

\[(5.19) \quad (m_1 + m_2 + m_3(f_1 + f_2)) > 0\]

such that the Marshall-Lerner condition is satisfied.

The condition for product market equilibrium in the domestic economy is given in (5.12). This includes an exogenous demand component, \(G_t\), which is traditionally associated with changes in government spending. For the purposes of our analysis, however, it will be convenient to allow \(G_t\) to represent any change in domestic product market excess demand which is not attributable to price, interest rate or income disturbances. One aspect which will be highlighted subsequently, is the role of \(G_t\) as a supply disturbance. That is, a fall in \(G_t\), \((dG_t < 0)\), is analytically equivalent to a fall in product market excess demand which may be brought about by an exogenous increase in either the level of stocks or the level of output. Given the attention which has been paid to supply side disturbances by analysts in recent years, we shall be interested in evaluating the impacts of both rises and falls in \(G_t\) on the domestic economy.

In an open economy, the domestic money supply consists of liabilities issued by the central monetary authority, plus or minus foreign reserve accumulations (depending on the state of the balance of payments). The
latter will vary according to adjustments in both the value of the trade balance (as defined above) and net capital inflow. A number of analysts have sought in recent years to model the transmission of foreign disturbances to the SOE via the changes induced in these components of the balance of payments (and, ultimately, to the domestic money supply). However, the assumption will be made in this analysis that the balance of payments adjusts automatically to zero in each period, such that the money supply-augmenting effects of foreign trade and capital transactions are eliminated. Hence, the only source of domestic money supply variation in this model is the exogenous behavior of the central monetary authority. As noted in section 5.1, this means that foreign disturbances are transmitted to the SOE in the first instance as product market effects.

Equilibrium in the domestic money market is specified along the same lines as that given in Chapter Three for the global economy:

\[(5.20) \quad \ell_1, \ell_2 < 0, \ell_3 > 0\]

The portfolio demand for real money balances \(L_t/q_t\) varies inversely with both the domestic rate of inflationary expectations \(\Omega_{t,t+1}\) and the domestic rate of interest \(i_{t,t+1}\). The transactions demand for real money balances rises with the level of real domestic income \(Y_{t,t}^d\). The current nominal money supply is \(L_t\) and in the analyses which follow we shall assume that exogenous variations in \(L_t\) are unanticipated.

5.3 Some simplifying assumptions

The conditions for equilibrium in the domestic product and money markets given in the previous section, can be solved jointly to derive expressions for the equilibrium behavior of the current and expected exchange rates, \(e_t\) and \(e_{t+1}^*\). Substituting into the equilibrium conditions (5.12) and (5.20), taking a total differential of each and rearranging gives:
Prior to considering the interpretation of the excess demand coefficients in (5.21), it is of value to note that a solution to the endogenous variables, $e_t$ and $e_{t+1}$, can be achieved on the basis of current period excess demand conditions alone. It will be recalled from the model of Chapter Three that in the global economy, a forward-looking rational expectations solution required the specification of the forward market analogue of the current period excess demands. In the domestic economy, however, the imposition of both purchasing power and interest rate parity is sufficient to ensure that price expectations are predetermined. One implication of this is that domestic money supply expectations are irrelevant as a source of disturbance in the SOE.

The excess demand coefficients contained in (5.21) are highly ambiguous and for the purposes of subsequent analysis, a few simplifying assumptions will be made. Firstly, the response of domestic output to equal changes in $\pi_t, t+1$ and $i_t, t+1$ is taken to be of the same sign as
in the global economy. That is, corresponding to (3.24), we impose:

\[(5.22) \quad (f_1 + f_2) > 0\]

Further, because we are dealing with a world in which there is a single, homogeneous commodity, it is assumed that the demand for imports with respect to income is identical to the demand for local production with respect to income. For the same reason, it is also assumed that inventory demands by domestic residents with respect to \(\pi_{t,t+1}\) and \(i_{t,t+1}\) are the same regardless of whether the product is imported or locally produced. Together, these perfect substitutability assumptions imply that:

\[(5.23) \quad c = m_3, \]
\[I_1 = m_1, \]
and \[I_2 = m_2.\]

Finally, it is assumed that the excess demand for money in the SOE possesses similar properties to the money demand conditions in the global economy. Hence, corresponding to (3.18) we impose:

\[(5.24) \quad \ell_1 + \ell_3 f_1 < 0\]

implying that the portfolio demand for money dominates the transaction demand.

A further point to note is that the vector of constants on the rhs of (5.21) contain both the foreign price level, \(p_t\) and the foreign rate of inflationary expectations, \(\pi_{t,t+1}\). By definition, these are not independent variables and the change in \(\pi_{t,t+1}\) must be broken up into the separate movements of its components, \(p_{t+1}\) and \(p_{t}\).

Substituting (5.23) into (5.21) gives the simplified excess demand system for the SOE as:

\[(5.25) \begin{bmatrix} B_1 & -B_1 \\ D_1 & L_t D_1 \end{bmatrix} \begin{bmatrix} de_{t+1}^* \\ K_1 \end{bmatrix} = \begin{bmatrix} K_2 \\ de_t \end{bmatrix}\]
where

\[ B_1 = -(f_1 + f_2) < 0 \]

\[ D_1 = \lambda_1 + \lambda_2 + \lambda_3 (f_1 + f_2) < 0 \]

\[ K_1 = (f_1 - x_1)dp_t^{e*} + (x_1 - f_1)dp_t + (f_2 - x_2)dr_t, t+1 \]

\[ - x_3 dp_t^{e*} - dg_t \]

\[ K_2 = -(\lambda_1 + \lambda_3 f_1)dp_t^{e*} + (\lambda_1 + \lambda_3 f_1 - L_t)dp_t \]

\[ - (\lambda_2 + \lambda_3 f_2)dr_t, t+1 + dL_t \]

The Jacobian of (5.25) is determined as:

\[ (5.26) \quad J = B_1 L_t < 0. \]

The system described by (5.25) relates the behavior of current and expected exchange rates to movements in current and expected global commodity prices, the global interest rate, the global income level, the domestic money supply, and an exogenous domestic demand variable. The strategy to be adopted in the following sections is to evaluate the response of the domestic economy to each of these disturbance terms. In order to facilitate comparisons with previous studies, the impacts of the four foreign disturbances will initially be evaluated separately. Following this, the joint variation in global prices, interest rates and income will be analysed as a function of world monetary disturbances.

5.4 The impacts of domestic monetary expansion

Solving (5.25) for \( e_t^{e*} + e_t \), and substituting back into the various behavioral relations which describe the SOE, the following impacts of an exogenous rise in the current domestic money supply, \( L_t \), are obtained.

\[ (5.27) \quad \frac{de_t^{e*}}{dL_t} = \frac{de_t}{dL_t} = \frac{dq_t}{dL_t} = \frac{dq_t^{e*}}{dL_t} = \frac{1}{L_t} > 0 \]
The impacts of an unanticipated increase in the domestic money supply are absorbed entirely by domestic prices and the exchange rate. A rise in \( L_t \) leads to an equiproportional increase in the domestic price level and an equiproportional devaluation of the exchange rate. More significantly, however, there is a simultaneous increase in both price and exchange rate expectations of exactly the same amount. The implication of this is that inter-temporal price relativities within the SOE remain unaltered and as a consequence, money supply disturbances are neutral with respect to output and trade flows.

While these neutrality properties may seem familiar in the context of open economy models, they are by no means universal. Turnovsky (1981), for instance, demonstrates that an unanticipated, permanent increase in the domestic money supply can be non-neutral. The critical feature of the Turnovsky model which distinguishes it from that presented above, is that whereas we have adopted purchasing power parity as a general proposition, Turnovsky treats the price of the domestically produced commodity as endogenous to the market for domestic output. As has been emphasised previously, the adoption of both purchasing power parity and interest rate parity implies that the relationship between current and expected nominal values in the SOE are predetermined, and hence cannot be disturbed by purely nominal phenomena. By relaxing the assumption of strict purchasing power parity for all prices in the economy, non-neutral monetary impacts can be obtained (see for instance, Chapter Seven).

These results would suggest that generalised purchasing power parity at the aggregate price level may be a necessary condition for domestic, unanticipated monetary disturbances to be neutral. That generalised ppp is not a sufficient condition for money neutrality, however, has been demonstrated by Saidi (1980), for the case of less than perfect current information. In the analysis which follow it will be assumed that full current information awareness prevails.
The effects of domestic demand (supply) disturbances

The exogenous component of the domestic product market is $G_t$, a rise in which corresponds to an increase in demand that is not derived from either price or income effects. In most analyses, an increase in $G_t$ is interpreted as a rise in fiscal demand associated with government spending. It is also true, however, that a fall in the value of $G_t$ can be interpreted as an exogenous increase in the supply of the domestic product, due possibly to resource-augmenting productivity gains, a technological breakthrough, or perhaps more simply, from the sudden discovery of new resources. The relevance of supply-side disturbances, particularly in recent years, has been emphasised by Turnovsky (1980) for both agricultural and industrial production processes. (8)

Solving the system of equations in (5.25) for an exogenous change in $G_t$, we obtain the following impacts.

\[
\begin{align*}
\frac{\partial e_t}{\partial G_t} &= \frac{\partial d_t}{\partial G_t} = \frac{D}{J} > 0 \\
\frac{\partial e_{t+1}}{\partial G_t} &= \frac{\partial d_{t+1}}{\partial G_t} = \frac{D_{t+1}}{J} > 0 \\
\frac{\partial \Delta_{t,t+1}}{\partial G_t} &= \frac{\partial i_{t,t+1}}{\partial G_t} = \frac{\partial \Delta_{t,t+1}}{\partial G_t} = \frac{-1}{B_1} > 0 \\
\frac{\partial Y_{t+1}}{\partial G_t} &= (f_1 + f_2) \frac{\partial \Delta_{t,t+1}}{\partial G_t} > 0 \\
\frac{\partial n_t}{\partial G_t} &= -(m_1 + m_2 + m_3 (f_1 + f_2)) \frac{\partial \Delta_{t,t+1}}{\partial G_t} < 0.
\end{align*}
\]

For the case where $(dG_t > 0)$ implies an exogenous rise in domestic demand, these results give rise to the following scenario. Increasing domestic demand leads to a rise in the domestic price level and to a devaluation of the exchange rate by exactly the same amount. Similarly, the expected exchange rate and the expected price level also rise.

Comparing (5.29) and (5.30) however, it can be seen that the current and
expected values of these two variables do not increase by exactly the same amount; in other words, a rise in $G_t$ leads to a distortion of inter-temporal price relativities. The consequences of this are seen in (5.31) where domestic inflationary expectations, the domestic interest rate and the rate of expected exchange depreciation all increase (and by the same amount). This in turn leads to a rise in the level of domestic output and a fall in the trade balance.

These results are contrary to the proposition derived by Fleming (1962) and Mundell (1963), that under floating exchange rates, fiscal policy would be impotent as a tool of macroeconomic management. As Tobin and deMacedo (1980) point out, an important element in the Fleming-Mundell framework which leads to the fiscal impotence result, is the omission of exchange rates from asset demand functions. The simple open economy model of this chapter demonstrates, however, that through the adoption of purchasing power and interest rate parity assumptions, exchange rates (and their expectations) affect the demand for the three types of asset in the economy. By altering the value of the current exchange rate relative to the expected exchange rate, the exogenous change in $G_t$ sets in train a series of adjustments which culminate in both output and trade impacts. Fiscal policy is no longer impotent.

The opposite scenario is implied by a fall in $G_t$; taken to imply an exogenous increase in domestic supply. In this case the SOE experiences a fall in the aggregate price level and a revaluation of the exchange rate. These price effects are accompanied by a fall in interest rates, a fall in the level of output and an improvement in the trade balance. These impacts can best be understood by interpreting the fall in $G_t$ as a sudden, unanticipated increase in the inventory of the domestic product. The reason that domestic production must fall in these circumstances is that for any given rise in supply, only a fraction, $c$, goes into consumption demand; the remainder ($1-c$) adds to inventories. Hence the level of output falls in order to eliminate excess supply in the domestic product market. Sharing in the adjustment burden is the trade balance and the results demonstrate that the increase in domestic inventories leads to a fall in imports. As might be expected, the additional foreign exchange revenues lead to downward pressure on $e_t$ (a revaluation).
5.6 The effects of foreign price disturbances

There are two foreign price variables in this model. One is $p_t^*$, the current aggregate global commodity price, changes in which are taken as being unanticipated. The other is $p_{t+1}^*$, the expected global commodity price, changes in which are, by definition, anticipated. As Turnovsky (1981a) has demonstrated, the impacts of foreign price changes on the SOE depend critically on whether the disturbance is anticipated or unanticipated. Turnovsky also emphasizes the need to distinguish between price disturbances which are regarded at the time they occur as being either permanent or temporary.

In this section, the effects of foreign price disturbances on the SOE shall be analysed under three sets of circumstances. These are:

(i) an unanticipated, temporary price disturbance, defined as $dp_t > 0$, $dp_{t+1}^* = 0$,

(ii) an unanticipated, permanent price disturbance, defined as $dp_t = dp_{t+1}^* > 0$, and

(iii) an anticipated price rise, defined as $dp_t = 0$, $dp_{t+1}^* > 0$.

An unanticipated, temporary foreign price disturbance

The effects of an unanticipated, temporary rise in the world price level are summarized as:

\[
\frac{de_{t+1}^*}{dp_t} = \frac{(x_1 - f_1)}{B_1} - \frac{(D_1(x_1 - f_1)) - B_1(\beta_1 + \gamma f_1)}{J} - 1 < 0
\]

\[
\frac{de_t}{dp_t} = \frac{[D_1(x_1 - f_1) - B_1(\beta_1 + \gamma f_1)]}{J} - 1 < 0
\]

\[
\frac{dq_t}{dp_t} = 1 + \frac{de_t}{dp_t} < 0
\]
(5.37) \[ \frac{dq^*_{t+1}}{dp_t} = \frac{de^*_{t+1}}{dp_t} < 0 \]

(5.38) \[ \frac{d\Delta_{t,t+1}}{dp_t} = \frac{di_{t,t+1}}{dp_t} = \frac{f_1}{B_1} = 0 \]

(5.39) \[ \frac{d\Delta_{t,t+1}}{dp_t} = \frac{d\Delta_{t,t+1}}{dp_t} - 1 < 0 \]

(5.40) \[ \frac{d\Delta_{t,t+1}}{dp_t} = d\Delta_{t,t+1} < 0 \]

(5.41) \[ \frac{dy_t}{dp_t} = f_1 + (f_1 + f_2) \frac{d\Delta_{t,t+1}}{dp_t} < 0 \]

\[ \frac{d\Delta_{t,t+1}}{dp_t} = -m_1 - m_2 - m_3 (f_1 + f_2) \frac{d\Delta_{t,t+1}}{dp_t} \]

The signing of the above impacts is based on the assumptions that:

(5.42) \( (x_1 - f_1) > 0 \)

and

(5.43) \( x_1 = m_1 \)

The assumption in (5.42) follows from the argument adopted throughout this thesis that the excess demand for any asset be an increasing function of its own expected rate of return. The assumption in (5.43), on the other hand, is consistent with the assumption of trade in a perfectly homogeneous commodity.

The main features of these results are that a rise in the foreign price level which is both unanticipated and not expected to be permanent, leads to a fall in domestic prices, a decline in domestic economic activity, an improvement in the trade balance, and a revaluation of the exchange rate. The source of these real impacts is that the expected exchange rate, \( e^*_{t+1} \), declines by more than the current exchange rate, \( e_t \). This implies a fall in the expected rate of exchange depreciation, \( \Delta_{t,t+1} \) and a distortion to the prevailing pattern of inter-temporal
relativities. It is the latter which induce adjustment pressures in the real sectors of the SOE.

An important characteristic of this type of foreign disturbance is that it causes the domestic rate of inflationary expectations, $\Omega_{t,t+1}'$, to fall by considerably more than the domestic interest rate. This is seen by substituting from (5.38) and (5.39) to obtain:

\[
(5.44) \quad \frac{d\Omega_{t,t+1}}{dp_t} = \frac{di_{t,t+1}}{dp_t} - 1.
\]

If the domestic, real rate of interest is given by $(i_{t,t+1} - \Omega_{t,t+1})$, then clearly an unexpected, temporary foreign price rise leads to an increase in the domestic real interest rate by a factor of unity. Consistent with models such as that employed by Barro (1980), the rise in the real interest rate is associated with a fall in the level of economic activity.

Turnovsky (1981a) obtains the result that an unexpected, temporary foreign price rise has ambiguous effects on domestic prices and output. However, if the Turnovsky model is converted to the case of a single traded good under ppp(9), then we find that an unexpected, temporary rise in the foreign price leads to results which are similar in some respects to those obtained above. That is, the domestic price and output levels will fall, and the exchange rate will appreciate. A major difference occurs, however, with respect to the magnitude of the exchange rate effect. Whereas in (5.35) above, the exchange rate revalues by more than the increase in $p_t$ (i.e. $de_t/dp_t < -1$), Turnovsky finds that the exchange rate fall is of smaller magnitude than the foreign price rise. The differences in these results are attributable to the differing supply specifications used in the two models.

An unanticipated, permanent foreign price disturbance

Suppose that the current foreign price level, $p_t$, rises unexpectedly, but having done so, is expected to remain at that level at least until the end of period $(t+1)$. Analytically, this implies that the expected world price, $p^*_{t+1}$, adjusts by exactly the same amount as $p_t$, such that $dp_t = dp^*_t$. 
The impacts of this type of foreign price disturbance on the SOE are derived as:

\[
\frac{de^*_{t+1}}{dp^*_t} = \frac{de_t}{dp_t} = -1
\]

\[
\frac{dq^*_{t+1}}{dp^*_t} = \frac{dq_t}{dp_t} = \frac{d\Delta_{t,t+1}}{dp_t} = \frac{di_{t,t+1}}{dp_t} = \frac{d\tau^d_t}{dp_t} = \frac{dT_t}{dp_t} = 0
\]

When the foreign price rise is expected to be permanent, there is an equiproportional appreciation of both the current and expected exchange rates which completely insulate the domestic economy from the external disturbance. This result is precisely the same as that obtained by Turnovsky (1981b) and further illustrates the central analytical proposition that real impacts arise only out of distortions to inter-temporal price relativities. In other words, \( dp_t = dp^*_{t+1} \) implies that foreign inflationary expectations remain constant \( (d\pi^*_{t+1} = 0) \) and this in turn means that no real impacts are experienced either at home or abroad. (10)

**An anticipated foreign price disturbance**

Suppose there is an exogenous rise in the world price expected to prevail one period hence. Assuming that the current global price is unaffected by this disturbance, we derive the impacts on the SOE as:

\[
\frac{de^*_{t+1}}{dp^*_t} = \frac{1}{J} [ (x_1^* - f_1^*) (D_1 - L_t^*) - B_1 (D_1^* + \varphi_1 f_1^*) ] > 0
\]

\[
\frac{de_t}{dp^*_t} = \frac{dq_t}{dp^*_t} = \frac{1}{J} [ (x_1^* - f_1^*) D_1 - B_1 (D_1^* + \varphi_1 f_1^*) ] > 0
\]

\[
\frac{dq^*_{t+1}}{dp^*_t} = 1 + \frac{de^*_{t+1}}{dp^*_t} > 0
\]

\[
\frac{d\Delta_{t,t+1}}{dp^*_t} = \frac{di_{t,t+1}}{dp^*_t} = - (x_1^* - f_1^*)/B_1 > 0
\]
These impacts are identically opposite to those which occur in response to an unanticipated, temporary foreign price rise. A rise in the expected overseas price level leads to higher prices, interest rates and output at home, at the same time as inducing a devaluation in the exchange rate and a deterioration in the trade balance. The rise in the domestic price level is equal to the devaluation of the current exchange rate.

Inflationary expectations, on the other hand, rise by more than the domestic interest rate, implying a real interest rate fall which is consistent with the rise in domestic economic activity.

The results of this section confirm the arguments made by Turnovsky (1981a), that the analysis of foreign price disturbances should distinguish carefully between anticipated versus unanticipated price changes on the one hand, and temporary versus permanent changes on the other. It also remains true, however, that foreign price disturbances rarely take place independently of changes in other global variables (such as the world interest rate and world income level).

5.7 The effects of foreign interest rate disturbances

A rise in the current global interest rate leads to the following impacts in the small open economy.

\[
\frac{d\Delta t_{t+1}}{dp_{t+1}} = 1 + \frac{d\Delta t_{t+1}}{dp_{t+1}} > 0
\]

\[
\frac{dy^d_{t}}{dp_{t+1}} = f_1 + (f_1 + f_2) \frac{d\Delta t_{t+1}}{dp_{t+1}} > 0
\]

\[
\frac{dT_{t}}{dp_{t+1}} = \left[ -m_1 - m_2 - m_3 (f_1 + f_2) \right] \frac{d\Delta t_{t+1}}{dp_{t+1}} + x_1 - m_1 - m_3 f_1 < 0
\]
Hence, under the assumptions given below, a ceteris paribus rise in the world interest rate has a depressing effect on the domestic economy, leading to falls in domestic output, prices, and the local interest rate. The trade balance, on the other hand, improves as a consequence of substitution and exchange rate effects.

The key assumptions underlying these responses are:

(5.60) \((x_2-f_2) < 0\),

(5.61) \(x_2 = m_2\),

and

(5.62) \((x_2+f_1) < 0\).

The assumption in (5.60) implies that interest rate variations have a larger impact on the demand for the commodity than on its supply; hence the overall effect of an interest rate rise is to reduce the excess demand for the commodity. This assumption is the interest rate counterpart of (5.42). The assumption given in (5.61) on the other hand, follows from the perfect substitutability between local and foreign goods, and implies that both export and import demands are equally responsive to the substitution pressures created by interest rate changes. Finally, the assumption given in (5.62) requires that export demand be more responsive to a 1 per cent rise in interest rates than supply response to a 1 per
cent rise in inflationary expectation. While these particular assumptions are by no means necessary for the results presented above, they are indicative of the types of circumstances that are conducive toward them.

One feature of these impacts which may be noted is that an exogenous increase in the foreign interest rate leads to a fall in the domestic interest rate. This result emerges because of the assumption made in (5.62) and effectively it means that the downward movement in the expected rate of exchange depreciation, $\Delta_t, t+1$, is of larger magnitude than the rise in $r_t, t+1$. Related to this effect, however, is the behavior of the domestic real interest rate, defined as $i_t, t+1$. The response of this variable to an exogenous increase in the global interest rate is found from (5.56) and (5.57) as:

$$\frac{di_t, t+1}{dr_t, t+1} = \frac{d\Omega_t, t+1}{dr_t, t+1} = 1$$

In other words, the domestic real interest rate adjusts upwards by exactly the same amount as the rise in the nominal foreign interest rate. This emerges because the fall in $\Omega_t, t+1$ is considerably in excess of the fall in $i_t, t+1$, and consistent with this, the level of domestic economic activity falls.

It should be stressed that the array of negative impacts presented above may easily be reversed or even neutralised, through variations in the conditions given in (5.60) to (5.62). In order for a reversal to take place, however, it would be necessary for the domestic supply coefficients, $f_1$ and $f_2$, to be in excess of the demand coefficient $x_2$ (or, equivalently, $I_2$). This raises the issues of flexibility in demand versus flexibility in supply in response to price and interest rate signals and observations would seem to suggest a relatively higher degree of demand flexibility. If this proposition does hold, exogenous global interest rate disturbances are more likely to be transmitted as negative impacts.

5.8 The effects of foreign income disturbances

A ceteris paribus rise in the global income level acts on the SOE directly through the export demand function. The impacts are derived as:
A rise in world income is inflationary and leads to a devaluation of the domestic currency. Both the domestic nominal interest rate and the domestic rate of inflationary expectations increase; their rate of increase being equal such that the real domestic rate of interest remains constant. Despite the constancy of the latter, domestic output responds to the altered inter-temporal price signals with the result that domestic real income rises along with global real income. The relative magnitudes of these two income changes are computed as:

\[
\frac{dY_t^d}{dy_t^f} = x_3 < 1
\]

In other words, the foreign income multiplier will in general be less than unity.

Despite the result that local and global income levels are positively related via the coefficient of export demand, a rise in world income has an ambiguous effect on the trade balance of the SOE. Inspection of (5.70) reveals that the response of the trade balance consists of two, opposing components. The first is the direct, positive effect associated with
rising world income on export demand. This is represented by the coefficient $x_3$. The second component is associated with the induced change in the rate of exchange expectations, $\Delta_{t,t+1}$, and this implies a deterioration in the trade balance (provided, of course, that the Marshall-Lerner condition holds). Substituting into (5.70) we obtain:

$$\left(\frac{dT_t}{dY_t}\right)_f > 0 \quad \text{when} \quad m_3 < 1 - \frac{(m_1 + m_2)}{(f_1 + f_2)}$$

In other words, an improvement in the trade balance requires that the additional imports associated with rising domestic income be less than the import effects of $\Delta_{t,t+1}$. For given values of $(m_1 + m_2) > 0$, an improvement in the trade balance is more likely the smaller is the income coefficient of import demand, $m_3$.

5.9 Effects associated with global monetary disturbances

The previous sections have analysed the impacts of changing world prices, interest rates and income levels on the basis of separate movements in these variables. An important point to emerge from this is the diversity of responses which take place among the key endogenous domestic variables; these are summarised in Figure 5.1.

Figure 5.1
Summary of Impacts Associated with Foreign Price, Interest Rate and Income Disturbances

<table>
<thead>
<tr>
<th></th>
<th>$e_t$</th>
<th>$q_t$</th>
<th>$i_{t,t+1}$</th>
<th>$y^d_t$</th>
<th>$T_t$</th>
<th>$(i_{t,t+1}-\zeta_{t,t+1})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$dpt_t$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
</tr>
<tr>
<td>$dp_{t+1}$</td>
<td>$-$</td>
<td>$0$</td>
<td>$0$</td>
<td>$0$</td>
<td>$0$</td>
<td>$0$</td>
</tr>
<tr>
<td>$dt_{t+1}$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$-$</td>
<td>$-$</td>
</tr>
<tr>
<td>$dy^f_t$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+/-$</td>
<td>$0$</td>
</tr>
</tbody>
</table>
The only two domestic variables which display perfect confluence across all types of foreign disturbances are $i_{t,t+1}$ and $Y_{t}^{d}$. In all cases these two variables rise and fall together. The relationships among the other domestic variables depend on the nature of the foreign disturbance term. An overall pattern which appears to emerge, however, is that higher income and interest rates appear to be associated with higher domestic prices, appreciation of the exchange rate, lower real interest rates and a worsening of the trade balance.

The question which is of concern in this section is whether this confluent response pattern is maintained when all of the foreign disturbances act on the SOE simultaneously. To this end we shall use the global business cycle model of Chapter Three to generate joint endogenous changes in global prices, interest rates and income as functions of global monetary disturbances. In effect, this will mean subjecting the SOE to global monetary impulses.

The main elements of the global business cycle model of Chapter Three are summarised as:

\begin{align}
\frac{\mathrm{d}n}{\mathrm{d}M_t} &= \frac{\mathrm{d}r_{t,t+1}}{\mathrm{d}M_t} \\
\frac{\mathrm{d}x^{f}_{t}}{\mathrm{d}M_t} &= (g_{1} + g_{2}) \frac{\mathrm{d}r_{t,t+1}}{\mathrm{d}M_t}, \quad (g_{1} + g_{2}) > 0 \\
\frac{\mathrm{d}r_{t,t+1}}{\mathrm{d}M_t} &= \frac{1}{J_1} \left[ A_{1}^{2}(\phi_{1}^{*}\phi_{2}^{*} - \eta_{t+1}^{*}) + \alpha A_{1}^{2}M_{t} \right] \\
\frac{\mathrm{d}P_{t}}{\mathrm{d}M_t} &= \frac{1}{J_1} \left[ A_{1}^{2}(M_{t+1}^{*}-2(\phi_{1}^{*}\phi_{2}^{*})) + A_{1}^{2}\phi_{2}(u_{1}^{*}u_{2}^{*}) - \alpha A_{1}^{2}(\phi_{1}^{*}\phi_{2}^{*}) \right]
\end{align}

where $\bar{m}_{t,t+1} = (p_{t+1}^{*}/p_{t}) - 1$ is the global expected rate of inflation and $r_{t,t+1}$ is the global interest rate.
An important feature of these results is that a monetary disturbance leads to changes in global output, interest rates and inflationary expectations that are positively correlated with respect to one another. Hence, for values of \( \alpha \) which give rise to a global expansion, the SOE will experience both rising interest rates and income from abroad. As noted earlier, increases in these variables will in general have opposing effects on the domestic economy and in the analyses below, our interest lies in determining which of these influences is dominant. An additional adjustment pressure comes from monetary-induced changes in the global aggregate price level, \( p_t \). Following the analysis of Chapter Three, \( p_t \) increases over both the expansionary and recessionary phases of the global business cycle, with the rate of increase being higher during the expansionary phase. Whilst this latter property is consistent with the observed tendency for inflation rates to be higher during periods of economic growth, it does provide an additional complexity in the transmission of foreign monetary disturbances.

The analysis proceeds by substituting from (5.73) and (5.74) into the \( K_1 \) and \( K_2 \) constants on the rhs of (5.25). This allows us to express the domestic endogenous variables as indirect functions of the global money supply and the main results are as follows.

The current exchange rate

The response of the current exchange rate to a global monetary impulse is determined as:

\[
(5.77) \quad \frac{de_t}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[ -\frac{D_1}{J} (x_1 + x_2 + x_3 (g_1 + g_2 ^1)) \right] - \frac{dp_t}{dM_t}
\]
Exchange rate behavior is influenced through two channels. One is through the adjustment in the global interest rate and the other is through the global inflation rate. The coefficient which determines the interest rate linkage is indeterminate in sign due to the presence of the term 
\[(x_1+x_2+x_3(g_1+g_2));\quad \text{where } x_1>0, \quad x_2<0 \quad \text{and } x_3(g_1+g_2)>0.\]
This term measures the overall response of export demand to the monetary-induced changes in global inflationary expectations, interest rates, and income. Our assumption of a single traded good implies, however, that these export demand coefficients must be identical to the corresponding demand coefficients within the model of global economic activity. That is:

\[(5.78) \quad x_1 = \mu_1, \quad x_2 = \mu_2 \quad \text{and} \quad x_3 = \delta\]

where \(\mu_1, \mu_2\) and \(\delta\) are defined in section 3.2. Further, we have assumed in (3.23) that \((\mu_1+\mu_2)>0\) on the basis that inventory demand in the global economy is at least as responsive to its own rate of return as to the rate of interest. Applying this condition to the present results, we obtain:

\[(5.79) \quad (x_1 + x_2 + x_3 (g_1+g_2)) > 0\]

Returning to the exchange rate equation in (5.77), we find from (5.79) that the interest rate coefficient is positive. Hence, this linkage implies that the exchange rate will exhibit procyclical movements with the global interest rate in response to world monetary disturbances. During the global expansionary phase, when foreign interest rates are rising, there will be underlying pressure for the exchange rate to devalue; during the global recession, there will be revaluation pressures.

The behavior of the exchange rate is also subject however, to the upward movement in the global aggregate price, \(p_t\), over both the expansionary and contractionary phases. Because of the negative relationship between \(e_t\) and \(p_t\) in (5.77), it is evident that this linkage implies revaluation pressure during both of these global phases. For every 1 per cent rise in the global price level, there will be pressure for a 1 per cent revaluation in the exchange rate.
The overall response of the exchange rate to the global monetary disturbance depends on the combined adjustments in $r_{t,t+1}$ and $p_t$. During the global recession, there is an unambiguous revaluation of the exchange rate, as the foreign interest rate and inflation pressures combine in the same direction. During the global expansion, on the other hand, the response of the exchange rate is indeterminate, being subject to both positive and negative forces.

Given these results, it is therefore hardly surprising that empirical tests of exchange rate behavior have failed to establish a close connection with foreign money supply variables. The highly simplified model set up by Dornbusch (1980), for instance, postulates that a 1 per cent rise in the foreign money supply induces a 1 per cent revaluation of the exchange rate. Tests carried out by Dornbusch fail to confirm this hypothesis and he, in turn, sees this as sufficient cause to reject the 'monetary approach' to exchange rate determination. The results presented above demonstrate however, that the processes by which foreign money disturbances become transmitted to the SOE exchange rate, may be more complex than the Dornbusch approach would suggest.

A final point regarding the behavior of the exchange rate is that if the global monetary disturbance is neutral with respect to the rest of the world, then only $p_t$ is affected. In this case the foreign interest rate, inflationary expectations and income variables remain constant and the exchange rate shows a negative response to rising $M_t$. As will be demonstrated subsequently, however, the fall in the exchange rate under these circumstances has no real implications for the domestic economy; leading us to the important conclusion that if a monetary disturbance is neutral overseas, then it will be neutral domestically as well.

The expected exchange rate

The endogenous response of exchange rate expectations to a global monetary disturbance is derived from (5.25) as:

$$\frac{dE_t}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \frac{(D_t - L_t)}{J} (x_1 + x_2 + x_3 (g_1 + g_2)) - 1 - \frac{dp_t}{dM_t}$$
The response of $e_{t+1}^*$ is similar to that of $e_t$ in the sense that both depend on the joint movements in $r_{t,t+1}$ and $p_t$. This time, however, the coefficient which links $e_{t+1}^*$ to $r_{t,t+1}$ is indeterminate in sign, depending on both money market and product market excess demand coefficients. It is not possible to obtain any simple generalisation regarding the size of these coefficients that would allow us to determine the nature of the $[r_{t,t+1} - e_{t+1}^*]$ linkage. The effect of foreign inflation on the expected exchange is, however, identical to the effect on $e_t$, having a coefficient value of minus one.

The current domestic price level

Under the assumption of generalised purchasing power parity, the current domestic price level, $q_t$, adjusts according to:

$$\frac{dq_t}{dt} = \frac{dp_t}{dt} + \frac{de_t}{dt}$$

From this, we derive the response of the domestic price to a global monetary disturbance, using (5.77) as:

$$\frac{dq_t}{dm_t} = \frac{dr_{t,t+1}}{dm_t} \frac{D_1}{J} \left( x_1 + x_2 + x_3 (g_1 + g_2) \right)$$

We find that the movement in the domestic price level is positively linked with the movement in the global interest rate. This implies that domestic prices may move up and down in response to $M_t$, despite the upward movement in the global price over both recessionary and expansionary phases. The latter is absorbed by the current exchange rate, $e_t$, and only the changes in $r_{t,t+1}$ are transmitted to the domestic price level. In other words, while flexible exchange rates provide insulation from the rise in foreign prices that a monetary disturbance creates, they do not protect domestic price levels from induced foreign interest rate movements. To the extent that the latter display procyclical behavior with global economic activity, then so too do domestic prices.
The expected rate of exchange depreciation

The joint endogenous responses of the current and expected exchange rates to the global monetary disturbance may be combined to give an expression for the behavior of the expected rate of exchange depreciation. Solving from (5.77) and (5.80) we obtain:

\[
\frac{d\Delta_{t,t+1}}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[ \frac{-L_t}{J} (x_1+x_2+x_3(g_1+g_2)) - 1 \right].
\]

We find that the response of \(\Delta_{t,t+1}\) to \(M_t\) occurs through a direct linkage with the movement in global interest rates. The sign of this linkage is, however, indeterminate. If we consider the case where the export demand coefficients satisfy (5.78) and where, in addition, the domestic supply function is identical to the foreign supply function (such that \((f_1+f_2) = (g_1+g_2)\)), then (5.83) becomes:

\[
\frac{d\Delta_{t,t+1}}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[ \frac{-L_t}{J} (1-\delta)(g_1+g_2) - \mu_1-\mu_2 \right].
\]

From the definitions of the terms \(A_1\) and \(A_2\) in (3.20) however, plus the assumption of excess demand symmetry in (3.21), we find that this relationship reduces to:

\[
\frac{d\Delta_{t,t+1}}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[ \frac{L_t}{J} (A_1+A_2) = 0.\right.
\]

Hence we see that under conditions of production homogeneity at home and abroad, the expected rate of exchange depreciation is unaffected by global monetary disturbances. It will be recalled from (5.28) that this variable is unrelated to domestic monetary disturbances also. The implication is that the 'gap' between \(e_{t+1}^*\) and \(e_t\), under these circumstances, remains constant in the presence of monetary disturbances, such that \(de_t = de_{t+1}^*\).

The domestic interest rate and expected inflation rate

The assumption of joint purchasing power and interest rate parity allows us to write the domestic interest rate and expected inflation rate as:
That is, both of these domestic variables are related to their foreign counterparts by the expected rate of exchange depreciation. If we maintain the assumption of production homogeneity between the domestic and foreign economies, such that \((f_1 + f_2) = (g_1 + g_2)\), then we may infer from (5.85) that:

\[
\frac{d\pi_{t+1}}{dM_t} = \frac{dr_{t+1}}{dM_t} = \frac{d\pi_{t}}{dM_t} = \frac{\Delta t_{t+1}}{\Delta t_t}.
\]

In other words, the domestic interest rate and expected inflation rate respond to \(M_t\) by exactly the same amount as their foreign counterparts. This means that both at home and abroad, real interest rates remain unaffected by purely nominal disturbances.

It may also be noted that if the production homogeneity condition does not hold, then from (5.83), (5.86) and (5.87) we obtain:

\[
\frac{d\pi_{t+1}}{dM_t} = \frac{dr_{t+1}}{dM_t} = \frac{\Delta t_{t+1}}{\Delta t_t} \left[ \frac{-L}{J} \left( x_1 x_2 x_3 (g_1 + g_2) \right) \right].
\]

This is a more general expression linking the joint movements of foreign and domestic interest rates in response to the global monetary disturbance. While these variables remain positively linked, the coefficient of transmission no longer equals unity. The question arises as to whether the response of the domestic interest rate will be of greater or smaller magnitude than that of the foreign interest rate. Solving this, we obtain from (5.89) the result that:

\[
\frac{d\pi_{t+1}}{dM_t} > \frac{dr_{t+1}}{dM_t} \quad \text{when } (f_1 + f_2) > (g_1 + g_2).
\]

In other words, differences in supply response coefficients between the local and foreign economies play an important role in determining the
relative stability of domestic and foreign interest rates. We see that the movement in local interest rates will be smaller than that of foreign interest rates only if the sum of the domestic supply coefficients is greater than that of the foreign supply coefficients. If we assume for instance, that \( f^1 \) and \( g^1 \) are of similar magnitude, this condition will be satisfied if local producers are less responsive to interest rate rises than foreign producers. Conversely, however, the more responsive are domestic producers to interest rate changes, the more likely it is that domestic interest rates will show a higher degree of movement than foreign interest rates.

The domestic level of output

Agggregate production in the SOE responds according to:

\[
(5.91) \quad \frac{dY_d}{dt} = f_1 \Omega_{t,t+1} + f_2 di_{t,t+1}
\]

As demonstrated in (5.88) and (5.89), a global monetary disturbance leads to equal changes in \( \Omega_{t,t+1} \) and \( i_{t,t+1} \). Hence the response of domestic output to the global monetary disturbance is given by:

\[
(5.92) \quad \frac{dY_d}{dM_t} = (f_1 + f_2) \frac{di_{t,t+1}}{dM_t}
\]

\[
= \frac{dr_{t,t+1}}{dM_t} \left[ x_1 + x_2 + x_3 (g_1 + g_2) \right]
\]

As in the global model of Chapter Three, domestic output is positively correlated with the domestic interest rate in the presence of global monetary disturbances. The important point to note here is that if the change in \( M_t \) is neutral with respect to the global economy, then it will be neutral with respect to the domestic economy as well. As outlined in section 3.4, a neutral global monetary disturbance will leave the foreign interest rate unchanged and, as a result, domestic output and interest rates remain unaffected also. The rise in global inflation that is caused by the monetary disturbance has no real impacts domestically because, as we have seen, it is absorbed completely by the exchange rate.
The relative magnitudes of domestic and foreign output responses to $M_t$ can be derived by substituting from (5.74), (5.78) and (5.92) to obtain:

\[
\frac{dr_t^d}{dM_t} - \frac{dr_t^f}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[ \mu_1 + \mu_2 + (\delta - 1)(g_1 + g_2) \right]
\]

\[
= \frac{dr_{t,t+1}}{dM_t} (A_1 + A_2)
\]

\[
= 0.
\]

In other words, since the response of domestic output to $M_t$ depends entirely on foreign excess demand coefficients, and since these same coefficients determine the response of foreign output to $M_t$, the magnitude of output adjustment is identical at home and abroad. Differences in relative output variability may arise however, through a breakdown of the demand homogeneity condition, (5.78), and examples of this will be investigated in subsequent chapters.

The Trade Balance

Finally, consider the response of the trade balance to the global monetary disturbance, which is given by:

\[
\frac{dT_t}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[ x_1 + x_2 + x_3 (g_1 + g_2) \right] [1 + \frac{(m_1 + m_2 + m_3) (f_1 + f_2)}{B_1}]
\]

Again, the change in the trade balance is linked directly to the movement in the global interest rate and hence to the level of world economic activity. Whether this linkage is pro- or countercyclical, however, depends on whether:

\[
(1 + \frac{(m_1 + m_2 + m_3) (f_1 + f_2)}{B_1}) \geq 0
\]

The source of this ambiguity arises because both domestic and global economic activity change in the same direction in response to $M_t$. 


Hence, the changes in export demand caused by foreign income, interest rate and price expectation movements is offset to some extent by the changes in import demand caused by movements in local variables. The magnitude of this offsetting process is determined by the sign of the term in (5.95). Solving this expression, we obtain the result that \( \frac{dT}{dM} \) is procyclical with the global business cycle when:

\[
(5.96) \quad m_1 + m_2 + (m_3-1)(f_1+f_2) < 0
\]

By virtue of the assumption made in (5.23) that imported and exported goods are perfect substitutes, this condition may be written as:

\[
(5.97) \quad I_1 + I_2 + (c-1)(f_1+f_2) < 0
\]

It may be noted that the coefficients which appear in (5.97) are the domestic economy equivalents of the term \( A_1 + A_2 \) in the global economy. As we have already noted, the assumption of excess demand symmetry within the global model implied \( A_1 + A_2 = 0 \). Hence, if this same symmetry property holds in the domestic economy, the trade balance shows no response whatever to the global monetary disturbance. In this case, the induced change in imports is perfectly-offset by the induced change in exports.

It is possible, however, that excess demands within the domestic economy may reveal asymmetric responses to given changes in \( \Omega_{t,t+1} \) and \( i_{t,t+1} \). If, for instance, the demand for inventories (whether of local or imported origin) is relatively more responsive to interest rate than to price expectation movements, then \( (I_1 + I_2) < 0 \) and the trade balance will display a procyclical pattern. This means that net exports will rise during the global expansionary phase and fall during the global recession. Conversely, if domestic excess demand responds more strongly to the expected rate of price change than to domestic interest rates, the trade balance will display a countercyclical pattern.

5.10 Summary and conclusions

The primary purpose of this chapter has been to establish a base model of the small open economy from which can be derived some simple
propositions regarding the effects of domestic and global disturbances. It has been demonstrated that unanticipated changes in the current domestic money supply are neutral with respect to the level of output, the domestic interest rate and the trade balance. They do, however, lead to adjustments in domestic prices and the exchange rate. The main reason for this neutrality property of the domestic money supply is generalised purchasing power and interest rate parity. Together, these parity assumptions imply a strict relation between current and expected prices in the SOE; purely nominal disturbances have no effect on inter-temporal price relativities and therefore have no real impacts.

Foreign monetary disturbances, on the other hand, do lead to real impacts in the SOE; at least inasmuch as they create real impacts abroad. To the extent that the foreign monetary disturbance is neutral in the global economy, it adds to the world inflation level, but nothing else changes overseas. As indicated in the previous section, a neutral global monetary disturbance will induce a revaluation in both the current and expected exchange rates that is equiproportional to the rise in world inflation. Inter-temporal price relativities at home remain constant and thus there are no real impacts in the SOE either.

This result confirms the argument put forward by Daniel (1981) that global monetary disturbances will have real impacts domestically only if they create real impacts abroad. The foreign price disturbances which accompany foreign monetary shocks are absorbed by exchange rate adjustments. In this limited sense, therefore, the floating exchange rate regime insulates the domestic economy from foreign price movements originating out of neutral global monetary disturbances.

In the case where the global monetary disturbance does lead to real impacts abroad, the world interest rate will change and it is through this linkage that real impacts are transmitted to the SOE. Unlike the models of Cox (1980) and Daniel (1981), in which real interest rate variations lead to real sector impacts, the model of this chapter has demonstrated how real shocks can be transmitted even when the real interest rate is constant. Further, flexible exchange rates no longer provide complete insulation against foreign monetary disturbances.
By interpreting the upward and downward responses of the global economy as business cycle phases, our analysis provides additional perspectives on the pattern of adjustments made by the SOE during the expansionary and contractionary phases. In this we have followed Lucas (1975) in attempting to derive an analytical scenario of procyclical and contracyclical phenomena. The results indicate that, under the conditions specified, economic activity in the SOE will be perfectly synchronised with the global business cycle. Both the domestic interest rate and the domestic price level will also vary procyclically with the foreign interest rate. The trade balance, on the other hand, may respond either pro- or contracyclically to the global business cycle, depending largely on the relative magnitudes of domestic excess demand coefficients. The exchange rate, however, displays no systematic relation to the business cycle that may be described as either pro- or contracyclical.

Expressed as monetary-induced, business cycle phenomena, the combined impacts of foreign income, interest rate and price variations imply a very different pattern of responses within the SOE than when these foreign variables are transmitted singularly. Reference to Figure 5.1 reveals for instance, that a ceteris paribus interest rate rise overseas has a depressing effect on domestic output and interest rates. Within the context of a monetary-induced, global expansion, however, rising world interest rates imply quite the opposite impacts domestically.

The main conclusion to emerge therefore, is that when global economic phenomena are endogenised with respect to movements in the world money supply, their impacts on the domestic economy can be vastly different than when they are transmitted in isolation. It will be recalled from the analysis of Chapter Four that this same conclusion emerged with respect to the relation between individual commodity prices and global macroeconomic events. As the recent analyses of Cox (1980), Daniel (1981), Saidi (1980) and Turnovsky (1980) have emphasised, it is not advisable to generalise about the impacts of a foreign disturbance without first being specific as to the source of that disturbance.
(1) An overview of some of the earlier approaches to the business cycle transmission process is given in Daniel (1981); see also Behnke (1980).

(2) Turnovsky (1981, footnote 15) for instance, comments that the analysis of foreign price disturbances on the SOE is 'incomplete' without due reference to accompanying changes in other foreign variables as well.

(3) See, for instance, Dornbusch (1980), Frenkel (1981) and Martinengo (1981). The analysis of Krugman (1978) suggests however, that while ppp does not represent a 'complete' theory of exchange rate determination, it is not entirely without empirical support.

(4) See, for instance, Turnovsky (1977). A related condition is the Bickerdike-Robinson-Metzler condition, referred to by Tobin and deMacedo (1980), which also relates a successful devaluation to an improvement in the trade balance.


(6) This assumption is made primarily for reasons of analytical tractability. The complexities associated with endogenising both the domestic money supply and the domestic level of output are not easily overcome in a qualitative analysis of this type.

(7) Turnovsky (1981, footnote 11) suggests that the source of money non-neutrality is the Lucas (1973) supply function. However, the model used in Turnovsky (1980) also contains the Lucas supply function and yet generates money-neutral impacts. The main feature which distinguishes these models is that the 1980 paper contains generalised ppp at the aggregate level while the 1981 paper specifies ppp for imported goods only.
Supply-side disturbances also figure prominently in two other branches of the literature. Gordon (1975) and Phelps (1978) have analysed the question of whether accommodatory monetary policy should be enacted subsequent to commodity-supply shocks. Gregory (1976) and Long (1981) analyse the effects of a booming exports industry on the rest of the economy when the source of export growth is an exogenous increase in supply. These issues will be examined further in Chapters Seven and Nine.

This is achieved by setting the coefficients $\delta = d_3 = 0$ in the Turnovsky (1981) model.

Turnovsky and Kingston (1977) find that the domestic economy will be fully insulated whenever the foreign real interest rate remains constant. Clearly, for the type of disturbance being investigated here, both the foreign rate of inflationary expectations, $\pi_{t,t+1}'$, and the foreign nominal interest rate, $r_{t,t+1}'$, are constant. This in turn means that the foreign real interest rate is constant and our results are therefore consistent with those of Turnovsky and Kingston.

More generally, (5.62) derives from the proposition that product market excess demand is more responsive to interest rate changes than to exchange rate changes. From (5.25), the product market response to a rise in $r_{t,t+1}'$ is $\left(x_2-f_2\right)$ while the response to a rise in $\Delta_{t,t+1}$ is $B_1$. The condition in (5.62) is therefore consistent with the argument that $B_1 - (x_2-f_2) > 0$.

Empirical support for accepting that the $[e_{t+1}^*-r_{t,t+1}]$ linkage may be of the same sign as the $[e_t-r_{t,t+1}]$ linkage, comes from the observed tendency for spot and forward exchange rates to show high correlation over time; see for instance Frenkel (1981) and Frenkel and Mussa (1980). This inference may not be entirely valid, however, since the forward exchange rate may depart systematically from the expected rate by virtue of a risk premium; see Stein (1980) and Eaton and Turnovsky (1980).
Dornbusch (1976) uses the term 'unit expectations elasticity' to describe equiproportional adjustments in current and expected exchange rates. Dornbusch assumes that the unit elasticity property may hold generally, but as the derivation of (5.85) demonstrates, it is contingent upon some rather special assumptions. The analyses of subsequent chapters will demonstrate circumstances in which the expected rate of exchange depreciation does respond to global monetary disturbances.
CHAPTER SIX
THE SMALL OPEN ECONOMY WITH TWO TRADED GOODS AND
TERMS OF TRADE EFFECTS

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6.1 Introduction

The purpose of this chapter is to evaluate the economic performance of a small open economy which produces and exports one type of commodity but which imports a commodity of an entirely different type. Our interest lies in the role of commodity terms of trade, defined as the ratio of export to import prices, in the transmission of global disturbances. In the SOE model of the previous chapter, we assumed that the domestic economy produced and traded in a single (composite) commodity which is identical to the aggregate global commodity. This assumption, combined with the ppp specification, effectively precluded consideration of relative price changes as an agent for international transmission. By making allowance for differences in trade composition, however, the model of this chapter provides scope for investigating the importance of the terms of trade.

The need to give adequate recognition to terms of trade effects in models of open economies has been emphasised by Lapan and Enders (1978). These writers express dissatisfaction with the view that relative price changes have little significance in determining the balance of trade. Related propositions have come from Martinengo (1981) and Van Duyne (1979) who also advocate the importance of differences in trade composition and price relativities in modelling open economy macroeconomics.

Reflecting these considerations, a number of analysts have sought in recent years to explicitly model terms of trade effects in studies of the SOE. The models adopted by these analysts have generally fallen into two categories. One is characterised by the models of Lucas (1980) and Katseli-Papaefstratiou (1980). These writers assume that the prices of both exported and imported goods are determined on world markets and are translated into domestic prices by purchasing power parity. In these models, changes in the terms of trade are exogenous to the domestic economy and are modelled parametrically; i.e. the global economy is not modelled explicitly. The second category of models in which terms of trade effects are present, are characterised by the contributions of Turnovsky (1980, 1981a, 1981b), Dornbusch and Fischer (1980), Daniel (1981) and Harkness (1982). In these models, it is assumed that the
domestic economy has some degree of market power in its exports, and as a result the terms of trade are endogenous to the SOE. As suggested by Mussa (1979) and Harkness (1982), this type of modelling strategy may be appropriate in cases of imperfect commodity substitutability.

The procedure to be adopted in this chapter is an extension of the first category of models in that we assume the domestic economy to be a price taker on all markets. This means that under strict PPP, the terms of trade faced by the domestic economy are determined solely on global markets. Our point of departure from the existing literature is that we endogenise global terms of trade movements with respect to world monetary disturbances. In doing so, we draw on the results of both Chapters Three and Four. An important point to have emerged from the analysis of Chapter Four is that global monetary disturbances lead to changes in relative prices only under the same circumstances required for real adjustments. In other words, if the global monetary disturbance is neutral with respect to world output and interest rate levels, it will be neutral with respect to relative prices as well. As a consequence of this, the domestic economy will experience monetary-induced terms of trade changes at the same time as it experiences monetary-induced changes in global output and interest rates. At issue is the nature of adjustments implied by the terms of trade shift relative to those implied by the income and interest rate movements.

At the analytical level, terms of trade adjustments create an additional mechanism for the inducement of domestic economic adjustment. In the previous chapter, sole emphasis was given to changes in intertemporal price relativities (expected rates of price change and interest rates) as agents for economic adjustment. To this is now added cross-commodity price relativities at a given point in time, as an additional source of adjustment. In this sense, the model of this chapter gives equal treatment to both the traditional terms of trade (or elasticities) approach as well as the more recent asset market (or expectations) approach.

The plan of this chapter is as follows. In section 6.2 we document the changes to the Base Model structure which are implied by the presence of differentiated traded goods. Particular attention is devoted to the
signs of various excess demand coefficients which now incorporate commodity substitution processes. Following this, the structure is the same as in the previous chapter, analysing the response of the SOE to disturbances arising out of the domestic money supply, domestic demand, foreign prices, foreign interest rates, foreign income and finally, the foreign money supply. A summary and the main conclusions are presented in section 6.9.

6.2 The small open economy with two commodities

The introduction of differentiated commodities implies a number of changes to the basic structure of the small open economy model and in this section we shall outline these changes. The SOE is now assumed to produce a single commodity, referred to as commodity j, which it also exports. Domestic expenditures are divided between commodity j and the imported commodity, where the latter is taken to be the aggregate world commodity which has formed the subject of analysis to date. It is assumed that the imported commodity is used for consumption and inventory purposes only; it is not used as a factor in the domestic production of j. (3)

The two commodities are taken to be freely traded across world markets and for this reason it is assumed that purchasing power parity continues to hold. Hence, our equilibrium price relationships are specified as:

\[ q_t = p_t e_t \]
\[ q_{jt} = p_{jt} e_t \]

where \( q_t (p_t) \) is the domestic (world) price of the imported good and \( q_{jt} (p_{jt}) \) is the domestic (world) price of commodity j. Changes in \( p_t \) are taken to be synonymous with movements in the global aggregate inflation rate. As in Chapter Four, it is assumed that the world market for commodity j is small relative to the world economy such that changes in \( p_{jt} \) have no impact on \( p_t \). The nominal exchange rate, \( e_t \), is assumed to adjust continuously to preserve the parity conditions in (6.1).
In the presence of multiple-commodity trading, the concept of the real exchange rate also becomes relevant. Following Tower (1980), the real exchange rate is defined by the ratio $e_t \cdot p_t / q_{jt}$ which, under ppp reduces to $p_t / p_{jt}$. Conversely, the terms of trade equals:

$\tau_t = q_{jt} / p_t \cdot e_t$

which under ppp reduces to:

$\tau_t = p_{jt} / p_t$

In other words, under ppp the terms of trade is synonymous with the ratio of export to import prices and is the inverse of the real exchange rate. A rise in the relative price of imported goods implies an increase in the real exchange rate which may in turn affect the trade balance. Tower (1980), for instance, proposes that the trade balance varies positively with movements in the real exchange rate on the grounds that an increase in the relative price of imports will, ceteris paribus, make local production more competitive. An alternative argument is presented by O'Mara, Carland and Campbell (1980) who suggest that the inverse of the real exchange rate can be interpreted as a 'competitive index' which is ultimately reflected in the trade balance.

Despite the intuitive appeal that may be attached to either of these arguments, it will be demonstrated below that the relationship between the trade balance and the real exchange rate (or the terms of trade) is not as straightforward as these authors would suggest. Among other things, it will be shown that the term 'competitiveness index' may under certain circumstances, be a highly misleading way of interpreting movements in the terms of trade (at least in the presence of purchasing power parity).

As in the base model of Chapter Five, it will be assumed that capital is perfectly mobile internationally and that interest rate parity prevails as an equilibrium condition:

$\Delta_{t,t+1} = r_{t,t+1} + \Delta_{t,t+1}$
where, as before, \( i_{t,t+1}(r_{t,t+1}) \) is the domestic (global) nominal interest rate, \( \Delta_{t,t+1} = \left( e_{t+1}^*/e_t^* \right) - 1 \), is the expected rate of exchange depreciation, and \( e_{t+1}^* \) is the expected value of the nominal exchange rate.

Following Turnovsky (1977a), we distinguish three prices in the domestic economy: \( q_{jt} \), the price of the locally-produced commodity \( j \); \( q_{t} \), the price of the imported good; and \( A_{t} \), the aggregate price level, which is a weighted average of \( q_{jt} \) and \( q_{t} \). The aggregate domestic price level is defined as:

\[
A_{t} = (1-w)q_{jt} + wq_{t}, \quad 0<w<1
\]

and where the weight \( w \) is defined by the proportion of domestic absorption consisting of imports. (4) It will be assumed throughout these analyses that at the initial equilibrium, import levels are positive such that \( w>0 \). The role of \( A_{t} \) in the analyses which follow is as a deflator in the specification of real domestic money balances. In this sense, the nominal money supply is made 'real' with respect to the prices of all of the goods that are available locally.

The specification of the domestic product market equilibrium condition is also altered in the presence of two traded goods. In the base model, where exports and imports took place in a single commodity, the issue of real versus nominal specification of the IS schedule was not encountered. In the present model, however, the import component of the IS schedule must be made real with respect to the price of the domestically produced good. Defining the nominal value of imports at \( t \) as \( q_{t}m_{t} \), real import expenditures are given by:

\[
m_{t}(R) = (q_{t}m_{t}/q_{jt})
\]

In the analyses which follow, the behavior of \( m_{t}(R) \) plays an important role in determining the response of the domestic economy to foreign disturbances.

Incorporating these additional elements into the base model of the SOE, we obtain the following specifications of domestic product market
and money market equilibrium. The equations describing the product market are:

\[(6.7) \quad Y^d_{jt} = f(\Omega_{jt,t+1}, i_{t,t+1}), \quad f_1 > 0, f_2 < 0\]

\[(6.8) \quad I^d_{jt} = I(\Omega_{jt,t+1}, i_{t,t+1}, \Omega_{jt,t+1}), \quad I_1 > 0, I_2, I_3 < 0\]

\[(6.9) \quad C^d_{jt} = cY^d_{jt} \quad 0 < c < 1\]

\[(6.10) \quad x_{jt} = x(q^*_t, i_{t,t+1}, \Omega_{jt,t+1}, \pi^*_t, \pi_{jt,t+1}), \quad x_1, x_2 > 0; x_3, x_4 < 0\]

\[(6.11) \quad m_t = m(\Omega_{jt,t+1}, i_{t,t+1}, Y^d_{jt}, \Omega_{jt,t+1}) + G_m; \quad m_1 > 0; m_2, m_3 < 0\]

where:

- \(Y^d_{jt}\) is real aggregate domestic output of \(j\);
- \(I^d_{jt}\) is real demand for \(j\) by domestic residents for inventory (investment) purposes;
- \(C^d_{jt}\) is real domestic consumption of \(j\);
- \(x_{jt}\) is real exports of \(j\);
- \(m_t\) is the quantity of imports;
- \(\Omega_{jt,t+1} = (q^*_t + q^*_t)/(q^*_t) - 1\) is the domestic expected rate of price change for \(j\);
- \(i_{t,t+1}\) is the domestic nominal interest rate;
- \(\Omega_{t,t+1} = (q^*_t + q^*_t)/(q^*_t) - 1\) is the expected rate of price change for the imported good, expressed in terms of domestic currency;
- \(Y^f_t\) is real foreign income;
- \(G_m\) is an exogenous component of import demand.
This specification follows closely the portfolio (or asset market) approach developed in previous chapters. Domestic production of \( j \) responds positively to the expected rate of price change for \( j \) and negatively to domestic nominal interest rates. As pointed out in Chapter Three, this specification of the supply function is based on the argument that for a given input price of \( q_{jt} \) and an expected output price of \( q_{jt+1}^* \) over the interval \((t,t+1)\), resources will flow into or out of the production process depending on whether \( \Omega_{jt,t+1} \) rises or falls relative to \( i_{t,t+1} \). (5) An important difference between the supply function in (6.7) and those adopted previously, however, is that the price variable determining output is no longer synonymous with the aggregate price level. Even if allowance for imported factors of production had been made, (such that the cost of production represented a weighted average of domestic and imported factors(6)), output would still depend on the expected price of \( j \), \( q_{jt+1}^* \), and not the expected, weighted price. As a consequence of this change, domestic output variations will be shown to be more closely linked with the commodity-specific real interest rate \((i_{t,t+1}-\Omega_{jt,t+1})\) than with the aggregate real interest rate \((i_{t,t+1}-F_{t,t+1})\), where:

\[
(6.12) \quad F_{t,t+1} = (A_{t+1}^*/A_t) - 1
\]

is the rate of inflationary expectations for the economy as a whole.

The specification of the investment, export and import schedules has been extended to allow for the substitution which may take place not only between commodities and bonds, but between individual commodities as well. Investment demands by domestic residents for commodity \( j \) (given in (6.8)), for instance, depend positively on the expected rate of price appreciation for \( j \) and negatively on the expected returns from alternative assets, \( i_{t,t+1} \) and \( \Omega_{t,t+1} \). These specifications are consistent with conventional commodity demand equations in the sense that the demand for a given good is negatively related to its own current price and positively related to the current price of substitutes. (7) Under the conditions imposed in this Thesis however, the effect of price expectations is given equal prominence as a determinant of commodity excess demand and for this reason the 'price' variables appearing in each
equation are written as anticipated rates of price change over the interval \((t, t+1)\). (8)

An important consequence of these specifications is that the trade balance depends not only on the 'terms of trade' (or real exchange rate), \(T\), but on expected relative commodity prices, the interest rate and income as well. The relevance of the expectation and interest rate effects was outlined in Chapter Five where it was argued that decisions to export or import a particular commodity at time \(t\) depend in part on its expected value at time \(t+1\), relative to the return on alternative forms of investment. For these reasons the specification of export and import flows in (6.10) and (6.11) may be interpreted as encompassing the 'elasticity' and 'absorption' approaches of traditional trade theory with the 'asset market' or expectations approach of the more recent theory. (9)

Equilibrium in the domestic product market is given as:

\[(6.13) \quad \chi^d_{jt} (c-1) + \chi^d_{jt} + x_{jt} - \frac{q_{mt}}{q_{jt}} + G_{jt} = 0\]

where \(G_{jt}\) is an exogenous component of the domestic demand for \(j\). As in previous chapters, we shall evaluate the consequences of both positive and negative movements in \(G_{jt}\), corresponding to exogenous demand and supply increases, respectively. It may be noted at this stage that the equilibrium condition (6.13) contains two exogenous demand components: \(G_{jt}\) and \(G_{mt}\) (where the latter appears in (6.11) as an exogenous import component). It is evident that a rise in domestic demand could be channelled either into the home good or the imported good (by discretionary fiscal spending, for instance) and the impacts associated with these two variables will be evaluated separately.

Following the treatment of Chapter Five, the domestic money market is specified as:

\[(6.14) \quad \lambda (P_{t,t+1}, i_{t,t+1}, \chi^d_{jt}) - L_t/A_t = 0, \quad \lambda_{1,2} < 0; \lambda_{3} > 0,\]

where \(L_t\) is the current nominal value of the domestic money supply. (10) The money supply deflator is \(A_t\), the aggregate domestic price level,
defined in (6.5). The demand for real money balances responds negatively to the rate of inflationary expectations, $F_{t,t+1}$ and the domestic nominal interest rate, $i_{t,t+1}$. From (6.12), the value of $F_{t,t+1}$ is expanded as:

$$(6.15) \quad F_{t,t+1} = \left[ (1-w^*) q_{jt+1}^* + w^* q_{t+1}^* \right] / \left[ (1-w) q_{jt} + w q_{t} \right] -1$$

where $w^*$ is the ratio of imports to domestic absorption expected to prevail at ($t+1$). In the analysis which follow, it will be assumed that this ratio is identical to the current imports-absorption ratio, such that $w^*=w$ and hence (6.15) becomes:

$$(6.15') \quad F_{t,t+1} = \left[ (1-w) q_{jt+1}^* + w q_{t+1}^* \right] / \left[ (1-w) q_{jt} + w q_{t} \right] -1$$

Equilibrium in the SOE requires that the product market and money market equilibrium conditions, (6.13) and (6.14), hold simultaneously.

Totally differentiating these equations, the equilibrating behavior of the SOE is described by the following simultaneous equations in $e_t$ and $e_{t+1}$:

$$(6.16) \begin{bmatrix} B_3 - B_3 \\ D_1 - L_t \end{bmatrix} \begin{bmatrix} de_{t+1} \\ de_t \end{bmatrix} = \begin{bmatrix} K_1 \\ K_2 \end{bmatrix}$$

where $B_3 = (c-1-m_3)(f_1+f_2) + I_1 + I_2 + I_3 - m_1 - m_2 - m_4 < 0$

$D_1 = l_1 + l_2 + l_3 (f_1+f_2) < 0$

$K_1 = -B_4 dp_{jt+1}^* + (B_4-m_t) dp_{jt} - B_5 dr_{t+1} - B_6 dp_{t+1}$

$+ (B_6+m_t) dp_t - x_3 d\gamma_{jt} + dG_{mt} - dG_{jt}$
\[ K_2 = \left[ \lambda^1 (1-w) + \lambda^2 f^1 \right] dp^*_{jt+1} + \left[ \lambda^1 (1-w) + \lambda^2 f^1 - L_t (1-w) \right] dp_{jt} \]

\[-\lambda^1 w dp^*_{t+1} + (J_t - L_t w) dp_t - (\lambda^2 + \lambda^3 f^2) dr_{t,t+1} + d_L \]

\[ B_4 = f_1 (c_1 - m_4) + I_1 + x_1 - m_4 > 0 \]

\[ B_5 = f_2 (c_1 - m_5) + I_2 + x_2 - m_2 < 0 \]

\[ B_6 = I_3 + x_4 - m_1 < 0 \]

The signing of these coefficients is based on the following propositions. The coefficients \( B_4, B_5 \) and \( B_6 \) measure the effects on the excess demand for \( j \) arising out of increases in \( \pi_{jt,t+1} \), \( c_{t,t+1} \) and \( c_{t,t+1} \) respectively. Under the 'gross substitutability' argument adopted in previous chapters, the excess demand for \( j \) is assumed to be an increasing function of its own expected rate of return and a decreasing function of the return on alternative assets. Hence the signs of \( B_4, B_5 \) and \( B_6 \) follow directly from the assumption of gross substitutability.

The coefficient \( B_3 \) measures the impact on product market excess demand of a rise in the expected rate of exchange depreciation, \( \Delta_{t,t+1} \) brought about by changes in \( e_t \) and \( e^{*}_{t+1} \). A rise in \( \Delta_{t,t+1} \) implies simultaneous and identical increases in the domestic interest rate, the expected rate of return or commodity \( j \) and in the expected rate of return on the imported good. The impacts created by the simultaneous changes in these rate of return variables may be broken down into three groups. Firstly, there is the trade balance effect. Defining the trade balance as:

\[ (6.17) \quad T_t = X_t - (q_t/q_{jt}) m_t \]

the trade balance response to an exchange rate depreciation is found as:

\[ (6.18) \quad \frac{\partial m_t}{\partial e_t} = m_1 + m_2 + m_4 + m_3 (f_1 + f_2) > 0 \]

The positive sign of this response is based on the assumption that the Marshall-Lerner condition is satisfied.
The second impact associated with an exchange rate change is the net output effect. This is given by the change in output, net of domestic consumption, induced by the simultaneous changes in \( i_t, t+1 \) and \( \Omega_{jt, t+1} \). That is:

\[
\frac{d (1-c)Y^d_t}{de_t} = - (1-c)(f_1 + f_2) < 0
\]

The negative sign of this impact is based on the assumption made in Chapters Three and Five that \((f_1 + f_2) > 0\).

Finally there is the domestic investment effect. This is measured by the effect on demand for domestic inventory holdings of equal increases in \( i_t, t+1 \) and \( \Omega_{jt, t+1} \) and is determined by the coefficient sum \((I_1 + I_2 + I_3)\). It will be recalled from the global model of Chapter Three that the coefficients of inventory demand in that model, \( \mu_1 \) and \( \mu_2 \), were assumed to have a non-negative sum. This was based on the proposition that the demand for the aggregate commodity was at least as responsive to a given change in its own expected rate of return as to the return on any alternative asset. The lower the degree of portfolio substitutability between assets, the more likely it is that their pairwise coefficient sums will be positive. The possibility was raised in Chapter Four, however, that commodities which display flexprice behavior may have inventory demand coefficients which reflect a higher degree of responsiveness to changes in returns or alternative assets. This could reflect the higher degree of portfolio substitutability that such commodities offer and in such cases it is possible that the coefficient sums will be closer to zero. In the analyses which follow, it will be assumed that an equal increase in the three domestic rate of return variables have perfectly offsetting effects on domestic inventory demand, such that:

\[
\frac{dI_1^d}{de_t} = - (I_1 + I_2 + I_3) = 0
\]

This assumption is made for analytical convenience and has no material impact on the results which follow. The coefficient \( B_3 \) can therefore be
seen as a combination of the trade balance, net output and domestic investment effects. Hence, from (6.18), (6.19) and (6.20) we obtain:

\[(6.21) \quad B_3 = (c-l-m_3) (f_1+f_2) + I_1 + I_2 + I_3 - m_1 - m_2 - m_4 < 0\]

An increase in the current exchange rate (a devaluation) will, ceteris paribus, cause the expected rate of exchange depreciation to fall which, through the coefficient $B_3$, leads to a rise in excess demand in the domestic product market. Conversely, an expected exchange rate depreciation $(de^*_{t+1} > 0)$ causes $\Delta_t$, $\Delta_{t+1}$ to rise and this creates a fall in domestic excess demand.

It may be noted that the signs of these exchange rate effects are the same as those derived under much simpler conditions in the base model of Chapter Five. From (5.25) and (6.21) we see that both $B_1$ and $B_3$ are negative coefficients whose magnitudes differ only by virtue of the degree of substitutability between domestic and imported goods. The $B_1$ coefficient in the base model assumes perfect substitutability while the $B_3$ coefficient of this model assumes less-than-perfect substitutability.

Turning now to the domestic money market, the exchange rate effects (current and anticipated) are given in (6.16) by the coefficients $D_1$ and $(L_t-D_1)$, respectively. These coefficients are identical to those which appear in (5.25) of the base model and their signs are determined on the basis of the discussion presented there. The money market disturbance term, $K^*_2$, contains four foreign price variables and the coefficient on each of these contains the price aggregation weight, $w$. Whereas the presence of $w$ provides no interpretational difficulties for the coefficients on $dp_{t+1}^*$ and $dp_t$, it may affect the sign of the coefficients on $dp_{j+1}^*$ and $dp_{jt}$. It will be assumed in the following analyses that the signs of these latter coefficients are the same as in the base model of Chapter Five. Specifically, it is assumed that:

\[(6.24) \quad w < 1 + (\frac{f_1}{f_1/\lambda_1})\]

such that
\[ (6.25) \quad [\lambda_1 (1-w) + \lambda_3 f_1] < 0 \]

and

\[ (6.26) \quad [(1-w)(\lambda_1 - L_t) + \lambda_3 f_1] < 0 \]

The upper limit on \( w \) in (6.24) is a positive number less than unity. From the definition of \( w \), this implies that the ratio of import expenditures to total domestic absorption cannot equal unity; at least some of the locally produced commodity must be purchased by domestic residents.

The Jacobian of the excess demand system (6.16) is determined as:

\[ (6.27) \quad J = B_3 L_t < 0 \]

In the sections which follow, we shall evaluate the response of the domestic economy to each of the disturbance terms which appear on the rhs of (6.16). Following the pattern of previous chapters, the foreign disturbance terms will initially be investigated on a ceteris paribus basis and following this, as simultaneous, endogenous responses to world monetary disturbances. In pursuing the latter strategy, we shall invoke the results of both Chapters Three and Four of this Thesis.

6.3 The impacts of domestic monetary expansion

Solving (6.16) for an exogenous rise in the domestic money supply, \( L_t \), we obtain the following familiar results:

\[ (6.28) \quad \frac{de^*_{t+1}}{dL_t} = \frac{de_t}{dL_t} = \frac{dq^*_{jt+1}}{dL_t} = \frac{dq_{jt+1}}{dL_t} = \frac{dq_t}{dL_t} = \frac{1}{L_t} > 0 \]

\[ (6.29) \quad \frac{d\Omega_{t,t+1}}{dL_t} = \frac{di_{jt,t+1}}{dL_t} = \frac{di_{t,t+1}}{dL_t} = \frac{dy^d_{jt}}{dL_t} = \frac{dT_t}{dL_t} = 0 \]

The nominal money supply disturbance, as before, leads only to increases in nominal exchange rates and prices; it has no effect on the expected rates of price change, the interest rate, the level of output or the trade balance. As has been emphasised previously, the critical element in
the SOE model which leads to this result is the symmetry of coefficients attached to \( \Delta t+1 \) and \( e_t \) in the product-market excess demand equation. This symmetry property is, in turn, derived from the assumption of ppp for both the local and the imported good. As the analysis of the next chapter will demonstrate, the introduction of a non-traded good, the price of which is not determined by a ppp-mechanism, is sufficient to create an asymmetric coefficient structure within the domestic product market and thereby give rise to money non-neutrality.(15)

6.4 The effects of domestic demand (supply) disturbances

There are two sources of exogenous demand shifts in the domestic product market: \( G_{jt} \), representing a demand (supply) change for \( j \); and \( G_{mt} \), representing a demand (supply) change for the imported good. Solving (6.16) for these disturbance terms we obtain the following impacts.

\[
\frac{\Delta t_{t+1}}{G_{jt}} = \frac{-\Delta t_{t+1}}{G_{mt}} = \frac{(D_t - L_t)}{J} > 0
\]

\[
\frac{e_t}{G_{jt}} = \frac{-e_t}{G_{mt}} = \frac{D_t}{J} > 0
\]

\[
\frac{\Delta Y_{jt}}{G_{jt}} = \frac{-\Delta Y_{jt}}{G_{mt}} = \frac{-1/B_3}{J} > 0
\]

\[
\frac{\Delta Y_{jt}}{G_{jt}} = \frac{-\Delta Y_{jt}}{G_{mt}} = \frac{1/B_3}{J} > 0
\]

\[
\frac{dY_{jt}}{G_{jt}} = \frac{-dY_{jt}}{G_{mt}} = \frac{(f_{1}+f_{2})/B_3}{J} > 0
\]

\[
\frac{\Delta t_{t+1}}{G_{jt}} = \frac{-\Delta t_{t+1}}{G_{mt}} = \frac{-[m_1+m_2+m_3(f_{1}+f_{2})+m_4]}{B_3} < 0
\]

\[
\frac{dT_{t}}{G_{mt}} = \frac{-[I_1+I_2+I_3+(c-1)(f_{1}+f_{2})]}{B_3} < 0
\]
For all variables except the trade balance, the effect of a rise in $G_{jt}$ is the exact opposite to the effect of a rise in $G_{mt}$. From (6.31) we see that an exogenous rise in the demand for the local product leads to a devaluation of the current exchange rate and, via ppp, hence creates an inflationary impact on all domestic prices. The expected rate of exchange depreciation, $\Delta_{t,t+1}$, also rises in response to $G_{jt}$ and from this the domestic economy experiences rising interest rates and output, and a fall in the trade balance.

When domestic aggregate demand exogenously shifts towards the imported good, however, the pattern of impacts is in general, reversed. In this case, the exchange rate moves downwards (revalues) and all domestic prices fall along with the interest rate and the level of output. The trade balance effect of a rise in $G_{mt}$ is, however, qualitatively the same as for a rise in $G_{jt}$. In both cases the trade balance deteriorates, representing a net gain in imports over exports.

The impacts associated with a rise in $G_{jt}$ are in accordance with those obtained in the base model: a domestic demand stimulus leading to increased output but at the expense of higher prices, interest rates and a deteriorating trade balance. Interpreted as a domestic supply disturbance emanating from improved technology, higher productivity or a resource discovery, a fall in $G_{jt}$ is in general deflationary, leading to lower output, prices and interest rates, but with an improved trade balance.

It is evident from the impacts derived above that in most cases, a fall in $G_{jt}$ will create adjustments which are identical to those associated with a rise in $G_{mt}$. In other words, the domestic impacts of, say, a resource discovery, will be equivalent to those induced by a fiscal-stimulated import boost. The only difference between the effects of falling $G_{jt}$ and rising $G_{mt}$ is, as noted previously, in the trade balance.

One implication of these results is that the effects of an exogenous demand increase in the SOE depend critically on whether it is directed towards the local or the imported good. To the extent that exogenous demand increases occur through government spending activities, is clear
that the domestic economy will undergo either deflationary or expansionary adjustment according to whether expenditures are made on imported or local goods, respectively. Under both forms of fiscal stimulus, however, the effect on the trade balance is negative.

6.5 The effects of foreign price disturbances

In previous chapters, we have analysed the effects of foreign price disturbances on the SOE by distinguishing between permanent versus transitory disturbances, on the one hand, and anticipated versus unanticipated disturbances on the other. In the analysis of this chapter we shall maintain these distinctions but with the added difference implied by the presence of two world prices; one for the locally-produced good, j, and one for the imported good. From the definition of the terms of trade, $\tau_t$, given in (6.3), it is clear that a ceteris paribus rise in the price of the imported good $p_t$, implies a deterioration in the terms of trade, while a ceteris paribus rise in $p_{jt}$ implies an improvement in the terms of trade. Hence, foreign price disturbances may also be interpreted in the form of terms of trade disturbances.

Due to the presence of price expectation variables in our analysis, we introduce the concept of the expected terms of trade, defined analogously to (6.3) as:

\begin{equation}
\tau_{t+1}^* = \frac{p_{jt+1}^*}{p_t^*}
\end{equation}

Combining the current and expected terms of trade into a single expression gives the expected rate of change in the terms of trade as:

\begin{equation}
H_{t,t+1} = \left(\frac{\tau_{t+1}^*}{\tau_t}ight)^{-1}
\end{equation}

The value of $H_{t,t+1}$ responds to individual foreign price movements according to:

\begin{equation}
dH_{t,t+1} = dp_{jt+1}^* - dp_{jt} + dp_t - dp_{t+1}^* \\
= d\pi_{jt,t+1} - d\pi_{t,t+1}
\end{equation}
where, from the notation of Chapter Four, $\pi_{t,t+1}$ is the aggregate global rate of inflationary expectations and $\pi_{jt,t+1}$ is the rate of inflationary expectations for commodity $j$.

With these additional terms of trade concepts at hand, we can investigate the impacts of foreign price disturbances on the SOE as follows:

(i) A temporary, unanticipated foreign price disturbance is defined by

(a) $dp_t > 0$, $dp^*_{t+1} = 0$ such that $d\pi_t < 0$, $dH_{t,t+1} > 0$

(b) $dp_{jt} > 0$, $dp^*_{jt+1} = 0$ such that $d\pi_t > 0$, $dH_{t,t+1} < 0$.

(ii) A permanent, unanticipated foreign price disturbance is defined by:

(a) $dp_t = dp^*_{t+1} > 0$ such that $d\pi_t < 0$, $dH_{t,t+1} = 0$

(b) $dp_{jt} = dp^*_{jt+1} > 0$ such that $d\pi_t > 0$, $dH_{t,t+1} = 0$

(iii) An anticipated foreign price disturbance, defined by:

(a) $dp^*_{t+1} > 0$, $dp_t = 0$ such that $d\pi_t = 0$, $dH_{t,t+1} < 0$

(b) $dp^*_{jt+1} > 0$, $dp_{jt} = 0$ such that $d\pi_t = 0$, $dH_{t,t+1} > 0$

It is evident that the relationship between a given foreign price disturbance, on the one hand, and the ensuing changes in $\pi_t$ and $H_{t,t+1}$ on the other hand, vary according to the nature of the price disturbance itself. In the analyses which follow we shall evaluate whether $\pi_t$ or $H_{t,t+1}$ provides the more appropriate basis for modelling the domestic impacts of foreign price disturbances.

**Unanticipated, temporary foreign price disturbances**

Consider firstly the impacts associated with an unanticipated temporary rise in the world price of the imported good, $p_{jt}$. These impacts are derived as:
\[
\frac{d\Delta_{t,t+1}}{dp_t} = \frac{d\Delta_{t,t+1}}{dp_t} = \frac{d\Delta_{t,t+1}}{dp_t} = \frac{d\Delta_{t,t+1}}{dp_t} = (B_6 + M_t) / B_3 \geq 0
\]

(6.45) \[\frac{d\tau_{t+1}}{dp_t} = \frac{d\tau_{t+1}}{dp_t} \geq 0\]

(6.46) \[\frac{d\tau_{t+1}}{dp_t} = \frac{d\tau_{t+1}}{dp_t} \geq 0\]

(6.47) \[\frac{d\tau_{t+1}}{dp_t} = \frac{d\tau_{t+1}}{dp_t} \geq 0\]

In all cases, a rise in \(p_t\) has ambiguous impacts on the domestic economy. This is quite unlike the result obtained in the base model where a rise in the world aggregate price level, \(p_t\), led to a fall in the exchange rate, the price level, the interest rate and the level of output in the SOE. The base model result was obtained, however, on the basis of some simplifying assumptions which were appropriate for the case where imports and exports were identical and therefore perfect substitutes. In the present model, imports and exports are not perfect substitutes and, as a consequence, a certain degree of ambiguity is present in the response coefficients.
A primary source of response ambiguity is the term \( B_6 + m_t \). It has been argued previously (below (6.16)) that \( B_6 \) is negative, whereas the import level \( m_t \) is taken to be positive. In the limiting case where at the initial equilibrium, imports are zero (such that both \( m_t \) and \( w \) are zero), the pattern of impacts is given by:

\[
\frac{de^*_t}{dp_t} = \frac{dq^*_t}{dp_t} = \frac{dM^*_t}{dp_t} > 0
\]

\[
\frac{de_t}{dp_t} = \frac{dq_t}{dp_t} > 0
\]

\[
\frac{dq_t}{dp_t} + 1 > 0
\]

\[
\frac{d\Delta_t}{dp_t} = \frac{di_t}{dp_t} = \frac{d\Omega_t}{dp_t} = \frac{dF_t}{dp_t} > 0
\]

\[
\frac{d\Omega_t}{dp_t} > 0
\]

\[
\frac{dy^d_t}{dp_t} > 0
\]

\[
\frac{dM_t}{dp_t} > 0.
\]

In this limiting case, most of the impacts associated with the rise in the aggregate world price, \( p_t \) are the opposite of those obtained in the base model. Now, we see that a rise in \( p_t \) overseas implies a devaluation of the exchange rate increases in all prices, interest rates and output domestically, but with ambiguous effects on the trade balance.

These results may be contrasted with the standard proposition (see Dearndorff and Stern, 1978) that in general a rise in import prices worsens the terms of trade and leads to a fall in domestic income. For the case analysed above, the fall in the terms of trade is accompanied not only by a devaluation in the current exchange rate, \( e_t \), but a rise
in the expected exchange rate as well. The rise in $e_{t+1}$ exceeds that of $e_t$, implying an increase not only in the expected rate of exchange depreciation, $\Delta_{t,t+1}$, but in the domestic interest rate and inflationary expectations as well. It is through this stimulus to domestic intertemporal price signals that the rise in $p_t$ leads to an increase in domestic output. A critical component in this process is the coefficient representing substitutability between domestic and imported goods, $B_6 < 0$.

The indeterminate response of the trade balance to the rise in the global price of imports (as given in 8.54) reflects the trade-off between exchange rate and terms of trade effects. In the absence of exchange rate expectation effects (i.e., when $dA_{t,t+1} = -d_{et}$), the trade balance shows an unambiguous improvement in response to rising import prices. However, the endogenous behavior of $e_{t+1}$ in this model makes the trade balance respond negatively to the increase in $\Delta_{t,t+1}$ and positively through the terms of trade (or relative price) change.

If we now consider the more realistic case where, at the initial equilibrium, imports are not zero, but positive, the relationships become somewhat more complex. The ambiguous coefficient $B_6 + m_t$ may be written more fully as:

\[(6.55) \quad B_6 + m_t = I_3 + x_4 - m_1 + m_t \]

where $I_3 < 0$, $x_4 < 0$, $m_1 > 0$ and $m_t > 0$. It may be noted that the sign of $(-m_1 + m_t)$ will be positive or negative depending on whether the own-price elasticity of real import demand is less than or greater than unity, respectively. In the case where this elasticity is less than unity, i.e., inelastic, then $(m_t - m_1) > 0$ and the real value of imports will rise following an increase in $p_t$. In the other hand, this elasticity is greater than unity, $(m_t - m_1) < 0$ and the real value of import expenditure will fall following a rise in $p_t$.

It is clear from the expression for $B_6 + m_t$ in (6.55) that this elasticity plays an important role in determining the response of the SOE to foreign changes in $p_t$. The more inelastic are imports with respect to $p_t$, the more likely it is that $B_6 + m_t$ will be positive. If this is the
case, then many of the impacts portrayed in (6.48) to (6.54) will be reversed; providing us once again with the scenario derived in section 5.6 of the base model. As noted earlier, one feature of this scenario is that the trade balance responds positively to the rise in the price of imports.

It is evident however, that no easy generalisations can be made with respect to a global price disturbance, the terms of trade and the behavior of the SOE. To impose the a priori condition that \( T_t \) is always a positive function of \( \tau_t \) (Tower 1980), is valid only to the extent that real import expenditures satisfy the elasticity condition outlined above. Clearly, where real import expenditures exhibit a high degree of elasticity with respect to movements in the world price of imports, \( p^t \), such a proposition will be unlikely to hold.

A related set of results concerning the impacts of temporary, unanticipated foreign price disturbances, can be derived for movements in the world price of the locally-produced and exported commodity, \( j \). A rise in \( p_{jt} \) implies, amongst other things, a rise in the terms of trade, \( \tau_t \), but as the results below indicate, this does not necessarily imply adjustments which are opposite to those of a rise in \( p^t \). Solving (6.16) for an exogenous increase in \( p_{jt} \), we obtain:

\[
\begin{align*}
\frac{dT_{t+1}}{dp_{jt}} &= \frac{dq^*_{jt+1}}{dp_{jt}} = \frac{dq^*_{t+1}}{dp_{jt}} = \frac{1}{J} \left\{ (B_4 - m_t) (L_t - D_t) ight\} \\
&+ B_3 \left( \gamma_1^t (1-t) + \gamma_3 f_1^t - L_t (1-t) \right) \geq 0
\end{align*}
\]

\[
\begin{align*}
\frac{d\tau_t}{dp_{jt}} &= \frac{dq_t}{dp_{jt}} = \frac{1}{J} \left\{ B_3 \left[ \gamma_1^t (1-t) + \gamma_3 f_1^t - L_t (1-t) \right] - D_t (B_4 - m_t) \right\} \geq 0
\end{align*}
\]

\[
\begin{align*}
\frac{dq_{jt}}{dp_{jt}} &= 1 + \frac{d\tau_t}{dp_{jt}} \geq 0
\end{align*}
\]

\[
\begin{align*}
\frac{d\Delta\tau_{jt+1}}{dp_{jt}} &= \frac{d\tau_{jt+1}}{dp_{jt}} = \frac{dn_{jt+1}}{dp_{jt}} = \frac{d\Omega_{jt+1}}{dp_{jt}} = \frac{(B_4 - m_t)}{B_3} \geq 0
\end{align*}
\]
\[ \frac{d\Omega_{jt,t+1}}{dp_{jt}} = \frac{(B_4-M_t)}{B_3} - 1 \geq 0 \]

\[ \frac{d\nu_{jt}}{dp_{jt}} = -f_1 + (f_1+f_2) \frac{d\Delta_{jt,t+1}}{dp_{jt}} \geq 0 \]

\[ \frac{dT_{jt}}{dp_{jt}} = -\left[ m_1 + m_2 + m_3 (f_1 + f_2) + m_4 \right] \frac{d\Delta_{jt,t+1}}{dp_{jt}} \]

\[ - [x_1 - m_3 f_1 - m_4 - m_t] \geq 0. \]

Once again we find that the presence of both own- and cross-price demand coefficients leads to a substantial degree of ambiguity. As in the previous set of results, this ambiguity disappears in the extreme case where, at the initial equilibrium, the level of imports is zero (such that \( m_t = w = 0 \)). In this case, we find that:

\[ \frac{d\nu_{jt+1}}{dp_{jt}} = \frac{dq_{jt+1}}{dp_{jt}} = \frac{d\nu_{jt+1}}{dp_{jt}} < 0 \]

\[ \frac{d\gamma_{jt}}{dp_{jt}} = \frac{dq_{jt}}{dp_{jt}} < 0 \]

\[ \frac{dq_{jt}}{dp_{jt}} = 1 + \frac{d\gamma_{jt}}{dp_{jt}} < 0 \]

\[ \frac{d\Delta_{jt,t+1}}{dp_{jt}} = \frac{d\gamma_{jt,t+1}}{dp_{jt}} = \frac{d\Omega_{jt,t+1}}{dp_{jt}} < 0 \]

\[ \frac{d\Omega_{jt,t+1}}{dp_{jt}} < 0 \]

\[ \frac{d\nu_{jt}}{dp_{jt}} < 0 \]

\[ \frac{dT_{jt}}{dp_{jt}} \geq 0. \]
The pattern of impacts implied by this extreme case is generally opposite to that obtained for a rise in $p_t$ as given in (6.48) to (6.54). In other words, where imports are initially zero (such that the aggregate domestic price reflects only the price of domestic output), a rise in $p_{jt}$ has a depressing effect on domestic prices, output and interest rates. This is in contrast to the inflationary and expansionary impact associated with a rise in the price of imports, $p_t$. Under the simple terms of trade argument, therefore, a fall in $\tau_t$ occurring either through falling $p_{jt}$ or rising $p_t$, acts as a stimulus to the domestic economy. The trade balance effects, however, remain ambiguous.

These results depend however, on the somewhat unrealistic assumption of a zero import level. Returning to the more general case presented in (6.56) to (6.62) we see that an important element determining the response of the domestic economy is the coefficient $(B_4 - m_t)$. This coefficient may be either positive or negative and writing it out in full gives:

\[(6.70) \quad (B_4 - m_t) = f_1(c-l-m_3) + I_1 + x_1 - m_4 - m_t\]

where $f_1(c-l-m_3)<0$, $I_1>0$, $x_1>0$, $m_4<0$ and $m_t>0$. The term $(-m_4 - m_t)$ in (6.70) is the elasticity of import demand with respect to a change in the price of the local commodity, $p_{jt}$. In this sense it is a cross-price elasticity. Where the value of this elasticity is greater than unity, $m_4+m_t<0$, such that $B_4 - m_t>0$. Under these circumstances, an exogenous increase in $p_{jt}$ leads to falls in domestic interest rates, prices and output. In the opposing case, however, the cross-price elasticity of import demand may be less than unity, such that $m_4+m_t>0$. Under these circumstances, it is possible that the value of $(B_4 - m_t)$ in (6.70) becomes negative with the result that rising $p_t$ will induce rising interest rates at home, but again the price, output and trade balance impacts remain ambiguous.

In summary, therefore, the impacts of unanticipated, temporary foreign price disturbances on the SOE are highly ambiguous in the presence of commodity substitution effects. The latter play a key role in determining whether the economy responds in a manner consistent with simple terms of trade arguments. In particular, the relationship between
the domestic level of economic activity and the terms of trade is more likely to be negative the more elastic are the own- and cross-price elasticities of import demand. In the case where these elasticities are significantly less than unity, however, it becomes more likely that domestic output may be stimulated by an improvement in the terms of trade. In either case, the simple relationship between the terms of trade and the SOE adopted by some authors should perhaps be treated with a good deal of caution. (17)

**Unanticipated, permanent foreign price disturbances**

We turn now to investigate the impacts associated with the second category of foreign price disturbances. These are characterised by unanticipated movements in the current value of either \( p_t \) or \( p_{jt} \), which, having occurred, are then expected to persist at least through to period \( t+1 \). Hence, the change in \( p_t \) \( \left( p_{jt} \right) \) is accompanied by an equal change in \( p_{t+1}^* \left( p_{jt+1}^* \right) \), such that the expected rate of commodity price change \( \pi_t, t+1 \left( \pi_{jt, t+1} \right) \) is zero. In either case, the expected rate of change in the terms of trade, \( H_t, t+1 \) remains constant.

Solving the system of equations (6.16) for a rise in the world price of imported goods, \( p_t \), and letting \( dp_{t+1}^* = dp_t \), we obtain the following impacts.

\[
\begin{align*}
(6.71) \quad \frac{de_{t+1}^*}{dp_t} &= -w + m_t (L_t - D_t) / J < 0 \\
(6.72) \quad \frac{de_t}{dp_t} &= -w - (m_t D_t / J) < 0 \\
(6.73) \quad \frac{dq_{jt}}{dp_t} &= \frac{de_t}{dp_t} < 0 \\
(6.74) \quad \frac{dq_t}{dp_t} &= 1 - w - (D_t m_t / J) \geq 0 \\
(6.75) \quad \frac{dH_t}{dp_t} &= -D_t m_t / J < 0
\end{align*}
\]
It may be noted immediately that if imports are zero at the initial equilibrium (such that \( m_t = w = 0 \)), the foreign price disturbance has no impacts on the SOE. This parallels the results obtained in equation (5.46) of the base model, where it was demonstrated that since \( dp_t = dp_t^* \) implies \( d\pi_{t,t+1} = 0 \), intertemporal price relativities remain constant and the foreign disturbance has no real domestic impacts. In the present model, however, this perfect insulation property emerges not only because of the preservation of intertemporal price relativities, but also because of the absence of import flows initially.

For the more general case where imports are positive initially, the impacts on the SOE are given by the inequality signs in (6.71) to (6.78). In this case we find that the global price disturbance is no longer neutral; in general it brings about falling prices, interest rates and output in the domestic economy, an appreciating exchange rate and a deterioration in the trade balance. Hence, the proposition that an unanticipated, permanent foreign price disturbance has no real domestic impacts is no longer true when the quantity of import flows is taken into account.(18)

These results also highlight the inadequacies of the simple terms of trade approach to modelling the domestic economy. Unanticipated rises in the world price of imported goods, whether temporary or permanent, will always be recorded as a deterioration in the terms of trade. This information, on its own, is clearly insufficient to determine the response of the domestic economy unless specific assumptions are also made about the simultaneous behavior of foreign price expectations.
The world price of commodity $j$ may also undergo an unanticipated, permanent increase. Solving (6.16) for a rise in $p_{jt}$ and letting $dp_{jt+1} = dp_{jt}$, we obtain the following impacts. (19)

\[
\frac{dp_{jt+1}}{dp_{jt}} = -\left[ \frac{m_t (L_t - D_1)}{J} \right] - (1-w) \geq 0
\]

\[
\frac{de_t}{dp_{jt}} = \frac{M_t D_1}{J} - (1-w) \geq 0
\]

\[
\frac{dq_{jt}}{dp_{jt}} = \frac{de_t}{dp_{jt}} \geq 0
\]

\[
\frac{dq_{jt}}{dp_{jt}} = m_t D_1/J + w > 0
\]

\[
\frac{d\lambda_{jt}}{dp_{jt}} = m_t D_1/J > 0
\]

\[
\frac{d\eta_{jt,t+1}}{dp_{jt}} = \frac{d\lambda_{jt,t+1}}{dp_{jt}} = \frac{d\eta_{jt,t+1}}{dp_{jt}} = -\frac{M_t}{B_3} > 0
\]

\[
\frac{dY_{jt}}{dp_{jt}} = \left( f_1 + f_2 \right) \frac{d\eta_{jt,t+1}}{dp_{jt}} > 0
\]

\[
\frac{dT_{jt}}{dp_{jt}} = m_t [(c-1)(f_1 + f_2) + I_1 + I_2 + I_3]/B_3 > 0.
\]

The main feature of these results is that in general they are opposite, in both sign and magnitude, to the effects of an unanticipated, permanent rise in $p_t$. Differences are present, however, between the price and exchange rate impacts of $p_t$ and $p_{jt}$. Hence, a rise in the current world price of the local product, which is accompanied by an equal increase in its expected value, will lead to rising prices, interest rates and output and an improvement in the trade balance.

An interesting conclusion which emerges from these and the previous set of results is that where foreign price disturbances are both
unanticipated and permanent, the terms of trade may provide a useful basis for delineating domestic impacts. An improvement in the terms of trade will, under these circumstances, stimulate domestic output and improve the trade balance. Conversely, a fall in the terms of trade will depress output and lead to a deterioration in the trade balance. The validity of these conclusions depend critically, however on the change in the terms of trade being accompanied by appropriate adjustments in price expectations such that the expected rate of change in the terms of trade, \( H_{t,t+1} \), remains constant. If this condition is not met then the applicability of the terms of trade argument will be considerably weakened.

**Anticipated foreign price disturbances**

The final category of exogenous foreign price disturbances to consider is an increase in the expected price of either the imported or the local good. Dealing first with the effects of a rise in \( P_{t+1}^* \), we obtain from (6.16) the following results.

\[
\frac{d e_{t+1}^*}{d p_{t+1}^*} = \frac{1}{J} \left[ B_6 (D_1 - L_t) - B_3 v_1^* w \right] \geq 0
\]

(6.86)

\[
\frac{d e_t}{d p_{t+1}^*} = \frac{1}{J} \left[ D_1 B_6 - B_3 v_1^* w \right] \geq 0
\]

(6.87)

\[
\frac{d \Delta t_{t+1}^*}{d p_{t+1}^*} = \frac{d i_{t,t+1}^*}{d p_{t+1}^*} = \frac{d \Delta t_{t+1}^*}{d p_{t+1}^*} = - \frac{B_6}{B_3} < 0
\]

(6.88)

\[
\frac{d \Delta t_{t+1}^*}{d p_{t+1}^*} = \left( B_4^* + B_5^* \right) / B_3 < 0
\]

(6.89)

\[
\frac{d \Delta t_{t+1}^*}{d p_{t+1}^*} = - \left( f_1 + f_2 \right) B_6 / B_3 < 0
\]

(6.90)

\[
\frac{d \Delta t_{t+1}^*}{d p_{t+1}^*} = \left( x_4 - m_1 \right) - \left( m_1^* + m_2^* + m_3^* \left( f_1 + f_2 \right) - m_4^* \right) \frac{d \Delta t_{t+1}^*}{d p_{t+1}^*} \geq 0
\]

(6.91)
A rise in the expected world price of the imported good has a depressing effect on the domestic interest rate, the level of output, and the rate of inflationary expectations. The price, exchange rate and trade balance impacts of this disturbance are, however, ambiguous.

In the case of a rise in the expected price of commodity $j$, however, a much clearer set of results emerges. Writing these impacts out, we obtain:

\begin{align}
\frac{de_{t+1}}{dp_{jt+1}} &= \frac{1}{J} \left\{ B_4 (D_1 - L_t) - B_3 (\mathcal{L}_1 (1-w) + \mathcal{L}_3 e_1) \right\} > 0 \\
\frac{de_t}{dp_{jt+1}} &= \frac{1}{J} \left\{ D_1 B_4 - B_3 (\mathcal{L}_1 (1-w) + \mathcal{L}_3 e_1) \right\} > 0 \\
\frac{\Delta t_{t+1}}{dp_{jt+1}} &= \frac{d \omega_{t+1}}{dp_{jt+1}} = \frac{d \omega_{t+1}}{dp_{jt+1}} = - \frac{B_4}{B_3} > 0 \\
\frac{\omega_{jt+1}}{dp_{jt+1}} &= 1 - \frac{B_4}{B_3} > 0 \\
\frac{\omega{jt+1}}{dp_{jt+1}} &= f_1 + (f_1 + f_2) \frac{\Delta t_{t+1}}{dp_{jt+1}} > 0 \\
\frac{\omega{jt+1}}{dp_{jt+1}} &= (x_1 - m_4 - m_3 e_1) - \left[ m_1 + m_2 + m_3 (f_1 + f_2) + m_4 \right] \frac{\Delta t_{t+1}}{dp_{jt+1}} > 0
\end{align}

As might be expected, an increase in the expected price of the locally-produced commodity leads to an increase in domestic output, interest rates and prices, while causing the exchange rate to depreciate. As is the case of rising expected import prices, however, the trade balance effect remains ambiguous.

A notable aspect of these results is that the domestic economy undergoes real adjustments despite the fact that the observable terms of trade, $p_{jt}/p_t$, remains constant. In this case it is the expected terms of trade $\tilde{r}_{t+1}$ which is causing the domestic adjustments and we see
that a rise in $\tau_{t+1}^*$ will, in general stimulate domestic economic activity but have ambiguous trade balance effects.

6.6 The effects of foreign interest rate disturbances

The analysis of Chapter Five revealed a certain degree of complexity in the effects of foreign interest rate disturbances on the SOE. Removal of this complexity was achieved primarily by invoking propositions regarding the relative magnitudes of excess demand coefficients. At issue is whether these same propositions are required in the present two-commodity model and whether any additional complexities are introduced by the presence of terms of trade effects.

Solving (6.16) for the impacts of an exogenous rise in the global interest rate, $r_{t,t+1}$, we obtain the following results.

\[
\begin{align*}
\frac{\Delta e^*_{t,t+1}}{dr_{t,t+1}} &= \frac{1}{J} \left( B_5(D_1 - L_t) - B_3 \left( l_2 + l_3 f_2 \right) \right) < 0 \\
\frac{\Delta e_t_{t,t+1}}{dr_{t,t+1}} &= \frac{1}{J} \left( D_1 B_5 - B_3 \left( l_2 + l_3 f_2 \right) \right) < 0 \\
\frac{\Delta l_{t,t+1}}{dr_{t,t+1}} &= \frac{\Delta n_{t,t+1}}{dr_{t,t+1}} = \frac{\Delta n_{t,t+1}}{dr_{t,t+1}} = - \frac{B_5}{B_3} < 0 \\
\frac{\Delta d_{t,t+1}}{dr_{t,t+1}} &= \left( B_3 - B_5 \right) / B_3 < 0 \\
\frac{\Delta y_{t,t+1}}{dr_{t,t+1}} &= f_2 + \left( f_1 + f_3 \right) \frac{\Delta e_{t,t+1}}{dr_{t,t+1}} < 0 \\
\frac{\Delta T_{t,t+1}}{dr_{t,t+1}} &= \left( x_2 - m_2 - m_2 f_2 \right) - \left[ m_1 + m_2 + m_3 \left( f_1 + f_2 \right) + m_4 \right] \frac{\Delta e_{t,t+1}}{dr_{t,t+1}} > 0
\end{align*}
\]

The propositions which underly the signing of these impacts are:

\[
\begin{align*}
\frac{\Delta E_{t,t+1}}{dr_{t,t+1}} - \frac{\Delta E_{t,t+1}}{\Delta e_{t,t+1}} < 0 & \quad B_3 - B_5 > 0
\end{align*}
\]
and

\[ (6.105) \ x_2 - m_2 - m_3 f_2 > 0. \]

where \( ED^j_t \) is period \( t \) excess demand in commodity market \( j \). In each case the effects of exogenous changes in \( r^j_{t,t+1} \) are qualitatively identical to those derived in Chapter Five. Furthermore, the assumptions required to obtain these results are the same as in Chapter Five as well. Condition (5.60) is equivalent to \( B_2 < 0 \) in (6.16); condition (5.61) is equivalent to (6.105) in the case of imperfect commodity substitutability; and finally, (5.62) is the equivalent of (6.104). An important point to note is that no further restrictions or assumptions are needed to derive these equivalence results. Hence, the introduction of terms of trade effects into the analysis implies no additional propositions in order to match the Chapter Five results.

The response of the domestic real interest rate to the foreign interest rate disturbance is now given by:

\[ \frac{dF_{t,t+1}^d}{dr^j_{t,t+1}} = \frac{dF_{t,t+1}^d}{dr^j_{t,t+1}} = 1 \]

where \( F_{t,t+1}^d \) is the domestic rate of inflationary expectations, defined in (6.15). Once again we find that a 1 per cent rise in the foreign nominal interest rate leads to a 1 per cent rise in the domestic real interest rate. This implies that the incorporation of separate imported and exported commodity prices into the specification of the aggregate price level (and its expected rate of change, \( F_{t,t+1}^d \)), has not altered the behavior of the real interest rate. The reason for this is due entirely to our assumption of generalised ppp for both of the traded goods, in combination with the assumption of interest rate parity. That is, from (6.4) and (6.15') we obtain:

\[ (6.106) \ d_{it,t+1} = dr^j_{t,t+1} + dA_t^i_{t,t+1} \]

\[ (6.107) \ dF_{t,t+1}^d = (1-w)\pi^j_{jt,t+1} + \pi^d_t + dA_t^i_{t,t+1} \]

In the present analysis, we are assuming that \( \pi^j_{jt,t+1} \) and \( \pi^d_t \) are independent of \( r^j_{t,t+1} \). Hence, by taking a difference of (6.106) and
(6.107), the exchange rate effects cancel out and the result in (6.105) emerges. By departing from either of the purchasing power - or interest rate parity assumptions, however, this cancelling effect is no longer operative and the behavior of the domestic real interest rate will be altered. Examination of this effect will be presented in Chapters Seven and Eight.

6.7 The effects of foreign income disturbances

Exogenous changes in foreign real income levels act on the small economy initially through the export demand function. An increase in $Y_f$ therefore adds to excess demand in the domestic product market and, not surprisingly, the qualitative impacts of exogenous global income disturbances are qualitatively similar to those brought about by the domestic demand parameter, $G_j$. Writing these impacts out we have:

\[
\frac{d\Delta_{t,t+1}}{dY_t} = \frac{d\Omega_{t,t+1}}{dY_t} = \frac{d\Omega_{j,t,t+1}}{dY_t} = \frac{dF_{t,t+1}}{dY_t} = -x_3/B_3 > 0
\]

\[
\frac{dy_d}{dy_t} = (f_1 + f_2) \frac{d\Delta_{t,t+1}}{dY_t} > 0
\]

\[
\frac{dT_t}{dy_t} = x_3 (m_1 + m_2 + m_3 (f_1 + f_2) + m_4) \frac{d\Delta_{t,t+1}}{dY_t} \geq 0
\]

In other words, a rise in real income overseas stimulates output, prices and the interest rate domestically, leads to a depreciation of the exchange rate, but has an indeterminate effect on the trade balance. The ambiguity of the trade balance effect was also present in the results obtained in the base model of Chapter Five and was found to be due to the
export-increasing effects of global income being offset by the
import-increasing effects of domestic income. In general, we again see
from (6.110) that an improvement in the trade balance is more likely the
smaller is the import demand effect \( (m^f_1 + f_2) \) relative to the
export demand effect, \( x^3 \).

6.8 Effects associated with the global business cycle

Following the pattern of the previous chapter, we now investigate the
impacts on the domestic economy which arise out of joint movements in
global prices, income and interest rates over the course of the global
business cycle. The behavior of these global variables is endogenised
with respect to disturbances in the world money supply which, as
demonstrated in Chapter Three, may give rise to either contractionary or
expansionary adjustments in the world economy.

A critical input to the analysis of this section however, is the
joint behavior of the two world prices, \( p_t \) and \( p_{jt} \) over the course of
the global business cycle. As demonstrated both by empirical observations
and in the analytical model of Chapter Four, changes in \( p_t \) and \( p_{jt} \)
occur systematically in response to global monetary disturbances and our
concern in this section is to link this systematic variation in relative
prices to the behavior of the domestic economy.

The main elements of the global business cycle model of Chapter Three
have been summarised in equations (5.73) to (5.76) in Chapter Five. These
equations link the behavior of the global interest rate, real income,
aggregate price and aggregate inflationary expectations variables to
movements in both the current and expected levels of the world money
supply. From the model of Chapter Four we also have the following
equations which summarise the key responses of the market for commodity \( j \)
to the global monetary disturbance.

Firstly, from (4.40), the change in the expected rate of price
appreciation for commodity \( j \), \( \pi_{jt,t+1} \) in response to the global
monetary disturbance, \( M_t \), is identical to the response of the global
nominal interest rate:
In other words, if the monetary disturbance is such that global interest rates rise by 1 per cent, then the expected return on commodity \( j \) will rise by 1 per cent also.

Secondly, from (5.73), we also have the condition that aggregate global inflationary expectations \( \pi_{t,t+1} \) adjust fully to monetary induced interest rate changes:

\[
(6.112) \quad \frac{d\pi_{t,t+1}}{dM_t} = \frac{d\pi_{t,t+1}}{dM_t} = \frac{dr_{t,t+1}}{dM_t}
\]

Comparing (6.111) with (6.112) we see that, as a result of simplifying symmetry conditions imposed in Chapters Three and Four, all expected rates of return adjust by exactly the same amount when subjected to monetary disturbances.

Thirdly, the price ratio \( p_{jt}/p_t \), which may be interpreted as the real price of commodity \( j \), will vary procyclically with the global business cycle whenever the condition (4.50) is satisfied, and will vary countercyclically with the global business cycle whenever condition (4.51) is satisfied. As noted in Chapter Four, there is a strong tendency for the real price of primary commodities (foods, metals, fibres) to vary procyclically with the global business cycle and on this basis it is suggested that primary commodities satisfy condition (4.50).

The current exchange rate

The response of the exchange rate, \( e_t \), to the global monetary disturbance is derived by endogenising the foreign variables on the rhs of (6.16) with respect to \( M_t \) and then solving for the change in \( e_t \). Following this procedure we obtain:

\[
(6.113) \quad \frac{de_t}{dM_t} = \frac{dr_{t,t+1}}{dM_t} D_1[x_1+x_2+x_4+x_3(g_1+g_2)/J]
\]
\[- \frac{dp_t}{dM_t} (w + (Dm_t/J)) \]
\[+ \frac{dp_t}{dM_t} [(Dm_t/J) - (1-w)] \]

The exchange rate receives adjustment pressures from three individual sources. Firstly, there is the general business cycle effect associated with movements in \( r_{t,t+1} \). The coefficient in this term is ambiguous and depends on the sign of the export coefficients \( x_1 + x_2 + x_4 + x_3 (g_1 + g_2) \).

If the sum of these coefficients is positive, then \( e_t \) will be procyclically related to the movement in global interest rates over the course of the business cycle. During the expansionary phase for instance, there will be pressure for the exchange rate to devalue. Conversely, if the sum of the export coefficients is negative, \( e_t \) will be countercyclically related to the movements in \( r_{t,t+1} \), and devaluation pressure will emerge during the recessionary phase of the global business cycle.

The export demand coefficients are, of course, identical to the demand coefficients which appear in the global commodity market model in Chapter Four. In that model, no restrictions were placed on the relative magnitudes of the demand coefficients, since the ultimate behavior of world price of \( j \) depended in part on the degree of substitutability between commodity \( j \) and other world assets; see the discussion following (4.51). In general, the greater the degree of substitutability, the closer that the coefficient of the own-rate of return \( x_1 \), will be to the coefficients of alternative rates of return, \( (x_2 + x_4) \). The income coefficient of demand, \( x_3 (g_1 + g_2) \) remains positive. For the analyses which follow, it will be assumed that the property established in (5.79) of the base model continues to hold such that:

\[(6.114) \quad x_1 + x_2 + x_4 + x_3 (g_1 + g_2) > 0 \]

On this basis, the exchange rate becomes positively linked to the movements in \( r_{t,t+1} \) brought about by the global monetary disturbances.

From (6.113), we see, however, that the overall response of \( e_t \) to \( M_t \) depends, not only on the \( r_{t,t+1} \) linkage, but on the movement in
import and export prices as well. The response of the import price, $p_t$, to the global monetary disturbance was the subject of analysis in Chapter Three while the response of the price of commodity $j$, $p_{jt}$, was the subject of analysis in Chapter Four. It will be recalled from (4.47) and (4.48) that unless some very stringent conditions are met, the response of these two prices to $M_t$ will not be identical. Indeed, it is possible that during the recessionary phase of the global business cycle that if $j$ is a primary commodity, $p_{jt}$ will be falling at a time that $p_t$ is rising. (22)

The coefficient attached to $\frac{dp_t}{dM_t}$ is negative, implying that over both the recessionary and expansionary phases of the global business cycle, $e_t$ will receive revaluation pressures from this source. This is the same effect that $p_t$ had on $e_t$ in (5.77) of the base model, except that this time the coefficient reflects the import weight, $w$. The coefficient attached to $\frac{dp_{jt}}{dM_t}$, on the other hand, is ambiguous, implying that a monetary-induced rise in the price of exports could have either a revaluation or devaluation effect on $e_t$.

**Domestic price levels**

As noted earlier, there are three domestic prices to be considered in this model: the price of the locally-produced (and exported) commodity, $q_{jt}$; the imported commodity price, $q_t$; and the aggregate domestic price, $A_t$. All of these prices obey strict purchasing power parity and their responses to the global monetary disturbance are given by:

$$
\frac{d q_{jt}}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[ D_1 (x_1 + x_2 + x_3 (q_1 + q_2)) / J \right] + \frac{dp_{jt}}{dM_t} \left( \frac{dp_t}{dM_t} \right) \left( (D_1 m_t / J) + w \right)
$$

$$
\frac{d q_t}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[ D_1 (x_1 + x_2 + x_3 (q_1 + q_2)) / J \right] + \frac{dp_{jt}}{dM_t} \left( \frac{dp_t}{dM_t} \right) \left( (D_1 m_t / J) - 1 + w \right)
$$
170.

\[
\left(6.118\right) \frac{dA_t}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[D_1(x_1 x_2 x_3 + x_1 x_4')/j\right]
+ \frac{dp_{jt}}{dM_t} - \frac{dp_t}{dM_t} \left(D_1 m_t/j\right)
\]

Once again we see that the transmission of foreign monetary disturbances to domestic prices occurs through two linkages: a link associated with movements in the global interest rate, and a link associated with movements in the global terms of trade. In all cases, the link with \( r_{t,t+1} \) is positive, suggesting that the three domestic prices will respond to \( M_t \) in a procyclical manner to the level of global economic activity. The terms of trade link varies however: in the case of \( q_{jt} \) and \( A_{jt} \), it is positive, whereas in the case of \( q_t \) it is indeterminate.

These results demonstrate that where the terms of trade vary positively with the level of global economic activity, both \( q_{jt} \) and \( A_t \) will exhibit strong procyclical responses to \( M_t \). Alternatively, if the terms of trade are negatively related to the global business cycle, the response of \( q_{jt} \) and \( A_t \) may be either pro- or countercyclical. Indeed it is possible in this latter case that the terms of trade effect may completely offset the interest rate effect and effectively insulate either \( q_{jt} \) or \( A_t \) from the effects of the global monetary disturbance.

The behavior of the domestic price of imported goods remains ambiguous however. It depends not only on the movement in the terms of trade, but also on the coefficient given in (6.117). To the extent that this coefficient is positive, then \( q_t \) will respond in a manner similar to \( q_{jt} \) and \( A_t \). Despite this ambiguity, however, we may note from (6.116) and (6.117) that the domestic price relativities bear a constant relationship to global price relativities:

\[
\left(6.119\right) \frac{dq_{jt}}{dM_t} - \frac{dq_t}{dM_t} = \frac{dp_{jt}}{dM_t} - \frac{dp_t}{dM_t}
\]

This result is to be expected under generalised ppp.
Given the widespread tendency for the real prices of primary commodities to display procyclical movements, these results suggest that the problems of achieving domestic price stability will be exacerbated in primary-producing countries. Furthermore, the more open the economy (as measured by \( w \) and \( m^\)\( m \)), the greater will be the tendency to import price instability from abroad. One factor which may tend to mitigate these effects however, is the income coefficient of export demand \( x^\_3 \), which for many primary commodities may be relatively small. As shown above, smaller values of \( x^\_3 \) reduce the impact on domestic prices associated with world interest rate (and hence income) movements.

The results of this section may also throw some light on the observed tendency for real exchange rates to display apparent cyclical movements over a number of years. The studies by Dornbusch (1980) for the United States and by O'Mara, Carlana and Campbell (1980) for Australia, both reveal that the real exchange rate has deviated from its 'parity' value for sustained periods over the past decade. Dornbusch (1980, p. 146) furthermore claims that the observed variation in real exchange rates is proof that purchasing power parity does not hold.

From the results presented above, however, we may demonstrate that not only are deviations in real exchange rates consistent with other global cyclical phenomena, but also they are consistent with ppp. With the world aggregate price level given by \( p^\_t \) and the domestic aggregate price level given by \( A^\_t \), the real exchange rate is defined by these authors as:

\[
(6.113) \quad e^R^\_t = e^\_t \cdot p^\_t / A^\_t
\]

According to Dornbusch (1980), \( e^R^\_t \) should remain constant if purchasing power parity prevails. The change in \( e^R^\_t \) is given by (again assuming all prices equal unity initially):

\[
(6.119) \quad de^R^\_t = de^\_t + dp^\_t - dA^\_t
\]

The response of the real exchange rate to global monetary disturbances is therefore found by substituting from (6.117) into (6.119) as:
In other words, over the course of the global business cycle, a country's real exchange rate will remain constant only if its terms of trade are constant. Any tendency for the terms of trade to vary procyclically with the global business cycle implies a countercyclical movement in $e_t^R$. Hence, for a primary producing country the real exchange rate will decline during the global expansion and rise during the global recession.

Furthermore, contrary to the arguments of Dornbusch, purchasing power parity is consistent with deviations from 'parity' in the real exchange rate. This is not to imply however, that all of the observed movements in real exchange rates are necessarily compatible with the result given in (6.120). Rather, it means that systematic movements in a country's terms of trade brought about by global monetary disturbances will, under ppp, be ultimately reflected in the real exchange rate. To assert, as Dornbusch does, that the real exchange rate must remain constant under ppp, is therefore clearly incorrect.

**The domestic interest rate and expected rates of return**

The joint assumptions of interest rate and purchasing power parity imply domestic relations of the form:

\[
(6.121) \quad \frac{d_i_{t,t+1}}{dM_t} = \frac{dr_{t,t+1}}{dM_t} + \frac{d\pi_{t,t+1}}{dM_t}
\]

\[
(6.122) \quad \frac{d\Omega_{t,t+1}}{dM_t} = \frac{d\pi_{t,t+1}}{dM_t} + \frac{d\pi_{t,t+1}}{dM_t}
\]

\[
(6.123) \quad \frac{d\Omega_{jt,t+1}}{dM_t} = \frac{d\pi_{jt,t+1}}{dM_t} + \frac{d\pi_{t,t+1}}{dM_t}
\]

\[
(6.124) \quad \frac{dP_{t,t+1}}{dM_t} = (1-w) \frac{d\Omega_{jt,t+1}}{dM_t} + \frac{wd\Omega_{t,t+1}}{dM_t}
\]
where, the response of the expected rate of exchange depreciation to $M_t$ is determined as:

$$
\frac{d\Delta_{t,t+1}}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \frac{-L_t \left[ x_3 (g_1 + g_2) + B_4 + B_5 + B_6 \right]}{J} - \frac{m_L t}{J} \left( \frac{d\pi_{jt}}{dM_t} - \frac{d\pi_t}{dM_t} \right)
$$

and where, as noted in (6.111) and (6.112):

$$
\frac{dr_{t,t+1}}{dM_t} = \frac{d\pi_{t,t+1}}{dM_t} = \frac{d\pi_{jt,t+1}}{dM_t}
$$

Hence, the response of the domestic nominal interest rate and the domestic expected rates of price change to the global monetary disturbance are given by:

$$
\frac{di_{t,t+1}}{dM_t} = \frac{d\pi_{jt,t+1}}{dM_t} = \frac{d\pi_{t,t+1}}{dM_t} = \frac{dF_{t,t+1}}{dM_t} = \frac{dr_{t,t+1}}{dM_t} \left[ \frac{-L_t}{J} \left( x_1 + x_2 + x_4 + x_3 (g_1 + g_2) \right) \right] - \frac{m_L t}{J} \left( \frac{d\pi_{jt}}{dM_t} - \frac{d\pi_t}{dM_t} \right)
$$

The transmission mechanism again depends on the two linkages identified earlier: one associated with global movements in $r_{t,t+1}$ and the other associated with global movements in the terms of trade. The terms of trade linkage is positive, implying that if the terms of trade varies procyclically with the global business cycle, then so will the domestic rate of return variables. The foreign interest rate linkage is also positive, leading once again to the familiar tendency for foreign and domestic interest rates to be positively correlated.

The important point to emerge from this result is that the terms of trade effect may act to either stabilise or destabilise the behavior of the domestic interest rate, depending on whether it behaves in a
countercyclical or procyclical manner. For reasons discussed previously, a country which produces and exports primary goods, and also imports manufactured goods will be more likely to face a terms of trade which varies procyclically with a monetary-induced global business cycle. Such a country will, under these circumstances, experience a relatively higher degree of imported interest rate instability than a manufacturing exporter.

The domestic level of output

The level of output in the domestic economy responds to price and interest rate signals according to:

\[ dy^d_{jt} = f_1 d\Omega_{jt,t+1} + f_2 d\Theta_{jt,t+1} \]

From (6.127), we therefore obtain the response of domestic output to the global monetary disturbance as:

\[ \frac{dy^d_{jt}}{dM_t} = (f_1 + f_2) \left( \frac{dr_{t,t+1}}{dM_t} - \frac{L_t [x_1 (g_1 + g_2) + x_1^2 + x_2^2 + x_4]}{J} \right) \]

This expression relates the movement in domestic output to both the world interest rate (real income) movement and the terms of trade movement. In both cases these linkages are positive, suggesting that a procyclical movement in the terms of trade will reinforce the tendency for domestic output to be positively correlated with foreign output.

An interesting case emerges, however, when the terms of trade vary countercyclically with the global business cycle. If this countercyclical response is sufficiently strong, it is possible for both interest rates and output in the SOE to become either zero or negatively correlated with their global counterparts. The possibility emerges therefore of the small open economy insulating itself from global monetary disturbances through the development of production and trade patterns which possess this countercyclical property. To the extent that production and trade
patterns are effectively circumscribed by resource endowments, however, it remains equally clear that primary producing countries which import manufactured goods will be subjected to a higher degree of domestic real income instability because of the terms of trade effect.

The trade balance

The results of previous sections have highlighted a substantial degree of ambiguity in the response of the trade balance to isolated changes in foreign income, interest rates and prices. By endogenising the movements in these foreign variables with respect to global monetary disturbances, however, we obtain the cyclical response of the trade balance as:

\[
\frac{dT_t}{dM_t} = \phi \left\{ (x_1 + x_2 + x_3 (g_1 + g_2)) \frac{dr_{t, t+1}}{dM_t} + m_t \left( \frac{dp_{1t}}{dM_t} - \frac{dp_{2t}}{dM_t} \right) \right\}
\]

where \( \phi = \left[ I_1 + I_2 + I_3 + (c-1)(f_1 + f_2) \right] / B_3 > 0 \)

In other words, the response of the trade balance to the global monetary disturbance is linked positively to the changes in both the global interest rate and the terms of trade. Hence, during the expansionary phase in world economic activity, when \( r_{t, t+1} \) and \( Y^f_t \) are rising, there will be pressure for the trade balance to improve. The magnitude of this upward pressure will be greater, the larger is the foreign income coefficient of export demand, \( x_3 \).

Whether or not the trade balance actually improves during the expansionary phase however, depends also on the associated movement in the terms of trade. If the country's trade pattern is such that its terms of trade is procyclical with respect to the global business cycle, then the trade balance will reveal an unambiguous improvement during the expansionary phase. If, on the other hand, the terms of trade respond countercyclically to the global business cycle, the trade balance response becomes ambiguous, reflecting a trade-off between income forces on the one hand and relative price forces on the other.
Perhaps the most significant aspect of the results of this section is the emergence of the terms of trade as a link in the transmission of foreign monetary disturbances. Expressed as a monetary phenomenon, the terms of trade has a direct, positive influence on the exchange rate, domestic prices, the interest rate, the level of output and the trade balance. This finding stands in contrast to the ambiguous role played by the terms of trade when foreign price disturbances are assumed to occur in isolation; see section 6.5 above. Furthermore, the results of this section confirm that the assumption of a positive relationship between the terms of trade on the one hand, and output and the trade balance on the other, is valid at least in the presence of global monetary disturbances.(24) Whether this positive relationship remains valid in the presence of other global disturbances has yet to be determined, however.

On the basis of these arguments, the concept of a 'competitiveness index', put forward by O'Mara, Carland and Campbell (1980), also possesses some merit. These authors define the competitiveness index \( c_i^t \) for a particular country as:

\[
(6.131) \quad c_i^t = \frac{\Lambda_t}{p_t e_t}
\]

In other words, the competitiveness index equals the ratio of domestic to foreign aggregate price levels, adjusted to domestic currency by the exchange rate, \( e_t \). Changes in this index occur via:

\[
(6.132) \quad d c_i^t = d\Lambda_t - dp_t - d e_t
\]

which, from (6.119) is seen to be the negative of the change in the real exchange rate, \( e_t^R \).

The response of the competitiveness index to the global monetary disturbance is determined as:

\[
(6.133) \quad \frac{d c_i^t}{d M_t} = (1-w) \left( \frac{d p_{it}}{d M_t} - \frac{d p_{et}}{d M_t} \right)
\]

Hence, the competitiveness index varies positively with the terms of trade (and, by implication, negatively with the real exchange rate).
Since both the level of domestic output and the trade balance also depend positively on the terms of trade (in response to $M_t$), it is evident that the concept of a competitiveness index as defined in (6.131) possesses a valid interpretation. Again, the qualification regarding the role of global monetary disturbances must be emphasised, however.

6.9 Summary and conclusions

The purpose of this chapter has been to investigate the behavior of the small open economy in the presence of two traded commodities. We have proceeded on the assumption that the SOE produces and exports one type of commodity and also imports another type of commodity. The explicit recognition of two goods has involved a number of structural modifications to the SOE model and detailed consideration has been given to the substitution processes brought about by relative price movements. Whereas in previous models we have concentrated solely on intertemporal price relativities as agents of change in the domestic economy, the model of this chapter augments this through recognition of terms of trade effects.

The presence of terms of trade effects has caused some of the base model conclusions to be modified, and has left others intact. Domestic money supply disturbances remain neutral, contrary to the suggestion by Mussa (1979) that imperfect substitutability among commodities may be sufficient to ensure an active role for monetary authorities. The qualitative impacts of exogenous domestic demand disturbances are also preserved, but this time a distinction has been drawn between demand rises aimed at the local product, and demand rises aimed at imports. These have opposing effects on domestic economic activity, although both types of demand stimulus lead to a worsening in the trade balance. One implication of this result is that the impact of a given rise in fiscal spending depends critically on where the expenditures are directed. The impacts of foreign income and interest rate disturbances are also the same as in the base model; leading to increases and decreases in domestic economic activity, respectively.

Substantial modifications to the base model results emerge, however, in the case of foreign price disturbances. Not only must a distinction be
drawn between anticipated versus unanticipated disturbances on the one hand, and temporary versus permanent disturbances on the other, but, in addition, a distinction must also be drawn between price disturbances according to how they affect the terms of trade. The presence of commodity substitution effects renders the impacts of unanticipated, temporary foreign prices disturbances highly ambiguous. However, the more elastic are the own- and cross-price elasticities of import demand, the more likely it is that a negative relationship between the terms of trade and the domestic level of output will prevail. In the case of unanticipated, permanent foreign price disturbances, on the other hand, there is a positive relationship between the terms of trade and domestic output. This contrasts with the neutral impact that these types of price disturbances were found to have in the base model of Chapter Five.

The transmission of global monetary disturbances to the SOE undergoes a substantial modification in the two-good model. In addition to the linkage associated with foreign income and interest rate movements, there is now an additional linkage created by changes in the terms of trade. In the presence of global monetary disturbances, the response of the domestic exchange rate, prices, interest rate, output and trade balance may be either stabilised or destabilised depending on the associated movement in the terms of trade. If, for instance, a country's terms of trade behaves in a procyclical manner with the global business cycle, it will experience a greater degree of price, output and trade instability as a consequence of global monetary disturbances. Conversely, however, a country may acquire a certain degree of insulation from foreign monetary disturbances if its terms of trade vary countercyclically with the global business cycle.

Drawing on the analyses of Chapter Four and the references cited therein, it is suggested that primary commodities are more likely to reveal a pronounced procyclical terms of trade pattern than manufactured commodities. Experience has shown that the real price of primary commodities tends to rise and fall more or less in line with global economic conditions. Hence, a country which produces and exports primary commodities and at the same time imports manufactured commodities, may experience a relatively high degree of domestic price, output and trade instability as a consequence of world monetary disturbances.
The analyses of this chapter have also thrown light on two related aspects of real exchange rate behavior. The first is an examination of the proposition put forward by Dornbusch (1980) that, in the presence of ppp, the real exchange rate must be constant. It has been demonstrated that this proposition is not correct in the presence of global monetary disturbances which bring about terms of trade changes. A country's real exchange rate will remain constant only if its terms of trade remain constant. For primary producing countries, it is suggested that the real exchange rate will decline during the global expansion and rise during the global recession.

The second aspect to be investigated was the 'competitiveness index', defined by O'Mara, Carland and Campbell (1980) to be the inverse of a country's real exchange rate. It has been demonstrated that in the presence of a global monetary disturbance, the competitiveness index, so defined, is a valid concept in the sense that it rises along with increases in the level of domestic output and the trade balance. The source of its validity has been shown to derive from the systematic variation in relative prices brought about by global money supply variations. It remains an open question, however, as to whether the competitiveness index retains this validity in the presence of other forms of disturbance.
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FOOTNOTES - CHAPTER SIX

(1) Lapan and Enders (1978) direct their criticism against the proposition of Frenkel and Johnson (1976), that under the monetary approach to the balance of payments, relative price changes play only a secondary role.

(2) The issue of endogenous price determination on domestic markets will be investigated in Chapter Seven for the case of non-traded goods and Chapter Eight for the case of traded goods with market power.

(3) This is not to imply, however, that changes in the price of imported goods have no impact on domestic production levels. As will be demonstrated subsequently, changes in import prices alter the relationship between current and expected exchange rates, which in turn affect domestic price and interest rate signals. It is through this indirect process that import prices affect domestic output levels.

(4) See Turnovsky (1977a), p. 219. As pointed out by Turnovsky, this definition of the price-aggregation weight allows us to identify \( w \) as a parameter measuring the degree of openness in the domestic economy.

(5) It is for this reason that output variations have been linked with movements in the real rate of interest, as in Barro (1980). We maintain the restriction, however, that \( f_1 + f_2 > 0 \), such that \( y_{jt}^d \) need not necessarily show a strict negative relation with the domestic real interest rate.

(6) The weights would necessarily reflect differences in factor intensities which may or may not coincide with the absorption expenditure weights \( w(1-w) \) used to define \( A_1 \).

(7) In the case of domestic investment, this property is revealed by noting that \( I_{jt}^d \) is positively linked to \( \Omega_{jt,t+1} \) and negatively linked to the expected return on stocks of imported goods, \( \Omega_{t,t+1}^x \). By definition, a rise in the current price of \( j \) means a fall in...
which in turn implies a fall in the inventory demand for \( j_t, t+1 \). Conversely, a rise in the current domestic price of the imported good, \( q_t \), will mean a fall in \( q_{t, t+1} \) and this in turn will stimulate inventory demand for \( j_t \). The interpretation of the trade equations, \( x_t \) and \( m_t \), follows the same line of argument.

(8) It will be recalled from the discussion of Chapter Three that we are dealing specifically with durable commodities which have a storage life of one period or more. Implicit in our specifications is the assumption that the quality of each commodity does not deteriorate over the \( t, t+1 \) interval. Consideration of non-durable goods (i.e., services) is given in Chapter Seven.

(9) See, for instance, Jones (1961), Alexander (1959), Mussa (1979) and Dornbusch and Fischer (1980).

(10) As in the previous chapter, we assume that \( L_t \) is held by domestic residents only.

(11) It is assumed that all prices and exchange rates equal unity initially.

(12) Translated into price elasticity terms, this condition parallels the proposition that the 'own-price' elasticity dominates the 'cross-price' elasticity. The important difference here of course is that we are dealing with excess demand, rather than simple demand, responses.

(13) As noted by Krugman and Taylor (1978), most theoretical treatments of currency devaluation conclude that it stimulates economic activity. In these cases, however, the positive relation between the exchange rate and domestic output usually depends on a terms of trade effect; see for instance Turnovsky (1981). In the present model the assumption of ppp for both traded goods rules out any terms of trade effects on output. Instead, the negative relation between \( Y^d_{jt} \) and \( e_t \) results from falls in both nominal interest rates and the expected rate of price appreciation for commodity \( j_t \). In this partial sense the output-exchange rate relation is determined, not
by a terms of trade effect, but by an intertemporal price relativities effect.

(14) This result is consistent with both output and demand falling in response to devaluation, but where the former falls by a relatively larger amount. Alternatively, the fall in output may be accompanied by a rise in aggregate demand. In either case, the critical feature of (6.21) is that over the interval \( (t, t+1) \), the substitution effects of relative price and interest rate changes are significant determinants of domestic demand.

(15) Mussa (1979) has suggested that the presence of imperfect substitutability between different categories of commodities on the one hand, or between commodities and financial assets on the other, may be sufficient to make domestic monetary disturbances non-neutral. As noted above, however, the property of less-than-perfect substitutability is already present in this model and yet, for reasons already discussed, the money-neutrality effect persists.

(16) In this respect, this analysis overcomes the effect contained in the Dornbusch (1980) and Dornbusch and Fischer (1980) papers, in which demand expansion at home leads to an appreciation of the exchange rate. This effect is regarded as anomalous by Branson (1980) and as Dornbusch (1980) recognises, it depends critically on assumptions made by him regarding the behavior of exchange rate expectations.

(17) Casas (1978) for instance, explicitly assumes that a rise in the terms of trade necessarily means an improvement in domestic real income. Krugman and Taylor (1978), however, question this proposition for the case where the terms of trade effect is due to a devaluation. As in the analysis of this chapter, they demonstrate that the linkage between exchange rate, price and output changes in the SOE depends in part on the relative magnitudes of export and import elasticities of demand. The empirical tests of the Laursen-Metzler (1950) proposition by Deardorff and Stern (1978) similarly indicate that across a number of different countries, the direction of the terms of trade effect on output and expenditure is
quite ambiguous. This is hardly surprising given the degree of ambiguity obtained in the analysis of this section.

(18) This proposition is to be found in Chapter Five of this Thesis and in Turnovsky (1981). In both of these models, the neutrality of unanticipated, permanent foreign price disturbances arises from coefficient symmetry on both current and expected foreign prices in the domestic product market equilibrium condition. Hence the product market impact of any change in $p_t$ will be perfectly offset by the impact of an equal change in $p_{t+1}^*$. The model of this chapter, however, has an asymmetric coefficient structure on $p_t$ and $p_{t+1}^*$ in the domestic product market. This is caused by the presence of non-zero import levels initially and it is through this asymmetry that the non-neutrality effects emerge.

(19) It is assumed that, at the initial equilibrium, import levels are positive, such that $m_t, w > 0$.

(20) The failure to distinguish between terms of trade effects on the one hand, and expected terms of trade effects on the other, may therefore give rise to severe interpretation problems in the empirical analysis of phenomena such as the Laursen-Metzler effect; see for instance, Deardorff and Stern (1978).

(21) As noted in Chapter Four, one of the implications of condition (4.50) is that the inventory demand for commodity $j$ show a relatively high response to interest rate changes. Observations of commodity market behavior suggest that this proposition may be valid in the case of primary commodities.

(22) From the expression for $d^p_t/dM$ in (3.42) however, the magnitude of the rise in $p_t$ is higher during the expansionary phase of the global business cycle than during the recessionary phase. In other words, the behavior of the global aggregate price is consistent with the Phillips-curve relation which implies that higher rates of inflation coincide with higher levels of output.

(23) See Chapter Four; also, Grilli and Yang (1981).

(24) See, for instance, Deardorff and Stern (1978) and Tower (1980).
CHAPTER SEVEN
THE SMALL OPEN ECONOMY WITH MARKET POWER IN ITS EXPORTS

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7.1 Introduction

Despite the world-wide acceleration of inflation and the apparent synchronisation of business fluctuations during the past decade, much evidence exists that the degree of confluence has been less than perfect. Recognition of this phenomenon has led a number of analysts to postulate that small open economies may possess some degree of market power in the goods that they export. The market power proposition implies that individual countries, rather than being passive recipients of global price and interest rate signals, may have some degree of influence over their own economic performance. The source of this influence lies in the fact that the terms of trade (ratio of export to import prices) is determined endogenously within the domestic economy, rather than globally as is the case under generalised purchasing power parity.

The premise of market power has figured prominently in models of small open economies in recent years. The standard approach has been to assume that the domestic economy is a price taker in the market for its imports but that the price it received for exports is determined locally. Models which incorporate endogenous terms of trade processes include Turnovsky (1980, 1981a, 1981b), Dornbusch and Fischer (1980), Weber (1981), Daniel (1981) and Harkness (1982).

Daniel (1981) highlights the importance of terms of trade endogeneity in the transmission of global economic disturbances. Unlike the case of purchasing power parity, endogenous terms of trade free the domestic price of domestic goods from the domestic price of foreign goods and this, says Daniel, is important in models in which the supply of output depends on prices. As the analysis of Daniel demonstrates, movements in the terms of trade can modify substantially the linkages through which foreign disturbances enter the domestic economy. For this reason one of the concerns of this chapter will be to examine the implications of the market power assumption for the transmission of global monetary disturbances.

Mussa (1979) attaches significance to the market power assumption because of the scope it provides domestic economies to pursue stabilisation policies. He points out that imperfect substitutability
among commodities traded on world markets may be sufficient to provide individual countries a limited degree of power in their exports. The scope for stabilisation policies emerges out of exchange rate movements creating terms of trade changes which in turn have real impacts. Given the neutrality of domestic monetary policy found in the ppp models of Chapters Five and Six, we shall also examine the implications of the market power assumption for non-neutral monetary intervention.

A further implication of the market power assumption is that the domestic economy has some degree of influence over its export performance. Under ppp, exports are determined solely by foreign price relativities and income levels; neither supply nor demand events within the SOE can influence the level of exports. In the presence of market power, however, the small open economy does influence the world price of the traded good. Scope exists therefore, for domestic events to determine levels of export performance, and with them, exchange rate and output movements as well. Of particular relevance here are domestic supply disturbances arising out of resource discoveries or productivity change, as these issues have received prominent attention in recent years. Hence, a further concern of this chapter will be to examine the issue of supply-induced versus demand-induced export growth, and the macroeconomic adjustments implied in each case.

The plan of this chapter is as follows. In section 7.2 we provide a detailed description of a model of the small open economy with market power. It is emphasised that because the price of domestic output is no longer linked directly to the exchange rate, separate market clearing conditions for price and exchange rate determination are required. In addition to this, there is the requirement for endogenous determination of price and exchange rate expectations.

Section 7.3 examines the impacts of domestic monetary expansion and we find that in general, money is no longer neutral. This result confirms the prospect of the domestic economy having some degree of influence over its own performance which, as noted above, may be a contributing factor to less-than-perfect synchronisation of business fluctuations.

The more complex case of global monetary disturbances is examined in section 7.4. The main findings are that not only are the transmission
linkages altered as a consequence of market power, but the synchronisation properties are affected as well. Indeed, in the presence of market power, it becomes virtually impossible for perfect synchronisation to take place.

The issue of supply-induced versus demand-induced export growth is investigated in Section 7.5. It is found that the macroeconomic implications of each type of export growth differ depending on the relative magnitudes of export demand coefficients. In general, where price and interest rate relativities dominate global income as determinants of export demand, there may be no appreciable difference in exchange rate, interest rate and output behavior between the two cases. Conversely, however, where the relative magnitudes of these export demand coefficients are reversed, then supply-induced export growth may imply a substantially different pattern of economic performance than demand-induced export growth. In the more complex case where demand increases are due to global monetary disturbances, the pattern of macroeconomic adjustment bears virtually no similarities to the case where export growth is supply induced.

A summary and main conclusions are presented in Section 7.6.

7.2 A model of the small open economy with market power

The purpose of this section is to establish a model of the SOE with market power in its exports. It is assumed that the domestic economy produces and exports a single (composite) commodity, which we shall refer to as commodity j. The SOE is a dominant supplier of commodity j on world markets and as a consequence, the price of j is endogenous to the domestic economy. We maintain the assumptions established in previous chapters, however, that the domestic economy is a price taker as far as its imports are concerned, and that its bond market is perfectly integrated with that in the rest of the world. Hence, purchasing power parity is retained for imported goods and, as in previous models, interest rate parity also prevails. Furthermore, the imported good is again taken to be synonymous with the aggregate global commodity which formed the subject of analysis in Chapter Three.
The main analytical implication of the market power assumption is that the current and expected prices of \( j \), \( q_{jt} \) and \( q^*_{jt+1} \) respectively, are no longer linked directly to current and expected exchange rates, \( e_t \) and \( e^*_{t+1} \). Rather, these four variables are now determined simultaneously within the excess demand structures that describe the domestic economy. As mentioned in Chapter Five, under the assumption of generalised PPP for both imported and exported goods, intertemporal price relativities within the SOE are determined completely by the relative values of current and expected exchange rates. Under these circumstances, only current period excess demands within the SOE are required to establish domestic equilibrium. When the generalised PPP assumption is no longer operative, however, the issue of forward market excess demands must also be invoked in order to establish domestic intertemporal price relativities. Hence, following the procedure adopted in Chapter Three, we shall be concerned with establishing a joint current market - forward market equilibrium for the small open economy.

The description of this equilibrium proceeds as follows. Firstly, the equations which make up current period excess demand in the domestic product market are specified as:

\[
(7.1) \quad y^d_{jt} = f(\Omega_{jt,t+1}, i_{t,t+1}); \quad f_1 > 0; f_2 < 0
\]

\[
(7.2) \quad l^d_{jt} = I(\Omega_{jt,t+1}, i_{t,t+1}, \Omega_{t,t+1}); \quad I_1 > 0; I_2, I_3 < 0
\]

\[
(7.3) \quad c^d_{jt} = c_y y_{jt}; \quad 0 < c < 1
\]

\[
(7.4) \quad x_{jt} = x[\Omega_{jt,t+1} - \Delta_{t,t+1} \Delta_{t,t+1}'; r_{t,t+1}, \Omega_{t,t+1}]; \quad x_1, x_3 > 0; x_2, x_4 < 0
\]

\[
(7.5) \quad m_t = m(\Omega_{t,t+1}, i_{t,t+1}, y^d_{jt}, \Omega_{jt,t+1}); \quad m_1, m_3 > 0; m_2, m_4 < 0
\]
where

\[ \gamma^d_{jt} \] is real domestic output (income);

\[ i^d_{jt} \] is real demand for \( j \) by domestic residents for inventory (investment) purposes;

\[ C^d_{jt} \] is real domestic consumption of \( j \);

\[ x_{jt} \] is real export demand for \( j \);

\[ m_t \] is real import demand;

\[ \Omega_{jt,t+1} = (q^*_t/q_{jt+1}) - 1 \] is the domestic expected rate of price change for \( j \);

\[ i_{t,t+1} \] is the current domestic nominal interest rate;

\[ \Omega_t,t+1 = (q^*_t/q_t) - 1 \] is the expected rate of price change for the imported good, expressed in terms of domestic currency;

\[ \Delta_t,t+1 = (e^*_t/e_t) - 1 \] is the expected rate of exchange depreciation;

\[ r_{t,t+1} \] is the current foreign nominal interest rate;

\[ y^f_t \] is real foreign income;

\[ \pi_{t,t+1} \] is the global expected rate of inflation, expressed in foreign prices;

\[ q^*_{jt+1} \] is the expected domestic price of \( j \);

\[ q_{jt} \] is the current domestic price of \( j \);

\[ q^*_{t+1} \] is the expected domestic price of imports;

\[ q_t \] is the current domestic price of imports;
The behavioral specifications are virtually identical to those given in Chapter Six. The only difference occurs with respect to the export demand function which now includes an exchange rate effect. In the model of Chapter Six, generalised ppp meant that the world price of commodity $j$ was determined on global markets and that exchange rate movements had no effect on the price paid by foreign buyers. In the present model, however, the price paid by foreign buyers on world markets is given by:

$$p_{jt} = q_{jt}/e_t$$

Hence, a rise in $e_t$ (a devaluation) reduces the world price of exports, $p_{jt}$. In keeping with the asset market approach, the export demand function in (7.4) depends not only on current prices, but on expected prices as well. For this reason, export demand responds positively to $q_{jt+1}$ and $e_t$, and negatively to $q_{jt}$ and $e^*_t$.

Equilibrium in the current domestic product market is specified as:

$$Y_j^d (c-l) + I_j^d + X_j = q_{jt} - \frac{q_t}{q_{jt}} \cdot m_t - G_{jt} = 0$$

As in Chapter Six, we have included an exogenous component, $G_{jt}$, in the equilibrium condition. A rise in $G_{jt}$ may be interpreted as an increase in product market supply not associated with price or income changes. The
supply increase may be caused perhaps by a resource discovery or technological progress.

The second excess demand specification to consider is the current money market. Following the treatments given in Chapters Five and Six, the current money market is specified as:

\[
(7.9) \quad \ell(F_{t,t+1}, i_{t,t+1}, Y^d_{jt}) - L_t/A_t = 0; \quad \ell_1, \ell_2 < 0; \quad \ell_3 > 0
\]

where

\[
(7.10) \quad F_{t,t+1} = (A^*_{t+1}/A_t) - 1
\]

\[
(7.11) \quad A^*_{t+1} = (1-w)q_{jt+1}^* + wq^*_t
\]

\[
(7.12) \quad A_t = (1-w)q_{jt} + wq_t
\]

The nominal money supply, \(L_t\), is deflated by the aggregate domestic price level \(A_t\), where, from (7.12) the latter is a weighted average of the prices of local and imported goods. As in Chapter Six, the aggregation weight \(w\) is given by the proportion of total domestic absorption consisting of imports. The demand for real money balances depends negatively on both \(F\) (the rate of domestic inflationary expectations) and \(i\) (the domestic nominal interest rate). Further, there is a positive response of money demand to real domestic income, \(Y^d_{jt}\).

Together, (7.8) and (7.9) specify the conditions for joint product market - money market equilibrium. These represent two equations in the four unknowns: \(e_t\), \(e^*_{t+1}\), \(q_{jt}\) and \(q^*_{jt+1}\). In order to obtain a solution for these four endogenous variables, we shall adopt the procedure used in Chapter Three to establish a joint current market - forward market equilibrium for the domestic economy. Essentially, this means specifying the forward market analogues of (7.8) and (7.9). The basic argument is that at time \(t\), market participants formulate subjective expectations of the product market and money market excess demands that will prevail one period hence. A critical feature of these expectations is that they be formulated in a manner which is structurally consistent with the current period excess demands. (1)
The forward market analogues of (7.8) and (7.9) are determined as:

\[(7.13) \quad Y_d^* (t+1) + I_d^* (t+1) + x^* (t+1) - q^* (t+1) m^* (t+1) - G^* (t+1) = 0\]

where, corresponding to (7.1) to (7.5) we have:

\[(7.14) \quad Y_d^* (t+1) = f(\Omega^{t+1, t+2}, i^{t+1, t+2})\]
\[(7.15) \quad I_d^* (t+1) = I(\Omega^{t+1, t+2}, i^{t+1, t+2}, \Omega^{t+1, t+2})\]
\[(7.16) \quad x^* (t+1) = x(\Omega^{t+1, t+2}, t+1, t+2, \Delta^{t+1, t+2}, R^{t+1, t+2}, Y^{t+1, t+2} \Omega^{t+1, t+2})\]
\[(7.17) \quad m^* (t+1) = m(\Omega^{t+1, t+2}, i^{t+1, t+2}, \Omega^{t+1, t+2}, Y^{t+1, t+2})\]

The rate of return variables appearing in the forward product market refer to the interval (t+1,t+2) and are defined by:

\[(7.18) \quad \Omega^{t+1, t+2} = (q^* (t+2)/q^* (t+1)) - 1\]
\[(7.19) \quad \Delta^{t+1, t+2} = (e^* (t+2)/e^* (t+1)) - 1\]
\[(7.20) \quad \Omega^{t+1, t+2} = (q^* (t+2)/q^* (t+1)) - 1\]

and where, as before, all expectations are made as at time t.

Turning now to the forward money market, the expected money supply is defined by:

\[(7.21) \quad L^* (t+1) = L_t + \ell^* (t+1)\]

where \(\ell^* (t+1)\) is an exogenously determined increment to the expected money supply. This increment may be positive or negative and variations in it may occur as a result of announcements made by the domestic monetary authorities or by subjective assessments on behalf of market participants.
Analogous to (7.9), the equilibrium condition for the forward money market is specified as:

\[(7.22) \ P_t^{F, t+2} = \left( Y^d_s, t+1, t+2 \right) - L_{t+1}^* / A_{t+1}^* = 0\]

where

\[(7.23) \ F_{t+1, t+2} = \left( A_{t+2}^* / A_{t+1}^* \right) - 1 \]

\[(7.24) \ A_{t+2}^* = (1-w)q_{jt+2}^* + wq_{jt+2}^* \]

The equilibrium conditions which describe the domestic economy now consist of the four equations (7.8), (7.9), (7.13) and (7.22). Together, these four equations define the joint current market-forward market equilibrium of the SOE and are sufficient to determine the equilibrium values of the four endogenous variables \(q_{jt}^*, q_{jt+1}^*, e_t^*, e_{t+1}^*\). It may be noted however, that the model also contains two additional unknowns: \(q_{jt+2}^*\) and \(e_{t+2}^*\). These are the two-period ahead forecasts of the domestic product price and the exchange rate and their presence is due to the 'forward-looking' expectations solution procedure we have adopted. (2)

Following the treatment adopted in Chapter Three, it will be assumed in subsequent analyses that these two-period ahead forecasts remain stationary. Specifically, we assume that:

\[(7.25) \ dq_{jt+2}^* = de_{t+2}^* = 0 \]

Our concern lies with the response of the domestic economy about its initial equilibrium to various disturbances. We proceed by taking a total differential of the four equilibrium conditions (7.8), (7.9), (7.13) and (7.22) to obtain the following simultaneous equation system. (3)

\[(7.26) \]

\[
\begin{bmatrix}
Z_1 & -(Z_1 + m_1) & Z_2 & -Z_2 + m_1 \\
V_1 & L_t (1-w) - V_1 & V_2 & L_t (1-w) - V_2 \\
-(Z_1 + m_1) & 0 & -Z_2 + m_1 & 0 \\
L_{t+1}^* (1-w) - V_1 & 0 & L_{t+1}^* (1-w) - V_2 & 0
\end{bmatrix}
\begin{bmatrix}
dq_{jt+1}^* \\
de_t^* \\
dq_{jt+1}^* \\
dq_{jt}^*
\end{bmatrix}
= \begin{bmatrix} K_1 \\ K_2 \\ K_3 \\ K_4 \end{bmatrix}
\]
where

\[ K_1 = -[f_2(c-l-m_3) + I_2 + x_2 - m_2] \, dr_{t,t+1} - x_3 \, df^f_t + dG_{jt} \]

\[ -[I_3 + x_4 - m_4] \, dp^*_{t+1} + (I_3+x_4) \, dp_t \]

\[ K_2 = dLt - (k_2 + k_3 f_2) \, dr_{t,t+1} - l_1 wdp^*_t + w(l_1-L_t) \, dp_t \]

\[ K_3 = -[f_2(c-l-m_3) + I_2 + x_2 - m_2] \, dr_{t+1,t+2} + [I_3+x_4] \, dp^*_{t+1} \]

\[ - x_3 \, df^f_{t+1} + dG^*_{jt+1} \]

\[ K_4 = dL^*_{t+1} - (k_2 + k_3 f_2) \, dr_{t+1,t+2} + w(l_1-L^*_{t+1}) \, dp^*_{t+1} \]

\[ Z_1 = f_2(c-l-m_3) + I_2 + I_3 - x_1 - m_1 - m_2 < 0 \]

\[ Z_2 = f_1(c-l-m_3) + I_1 - m_4 + x_1 > 0 \]

\[ V_1 = l_1 w + l_2 + l_3 f_2 < 0 \]

\[ V_2 = l_1 (1-w) + l_3 f_1 < 0 \]

The signs of the coefficients have been determined on the assumptions that in each market, excess demand is an increasing function of own-rate of return and a decreasing function of alternative-rates of return. For the purposes of subsequent analysis, we shall adopt the excess demand symmetry assumption that was used in Chapter Three:

(7.27) \[ Z_1 = -Z_2 \]

With this assumption, the Jacobian of (7.26) is given by:

(7.28) \[ J = (Z_1+m_1)^2 \left(L_t-v_1-v_2\right) \left(v_1+v_2-L^*_{t+1}\right) < 0 \]

Within the context of this simplified coefficient structure, we shall now proceed to evaluate a number of issues relevant to the behavior of the small open economy with market power.
7.3 Domestic monetary expansion

One of the features of the previous SOE models is that domestic monetary disturbances affect nominal variables only; they have no impact on either production or trade levels. Our interest in this section is to determine whether the existence of market power within the SOE affects this neutrality property.

From the description of the domestic money market presented above, it can be seen that there are two sources of monetary disturbance within this model. Firstly, there are exogenous variations in the current money supply, $L_t$, which are assumed to occur unexpectedly. An increase in $L_t$ affects not only the current excess demand for money, however, it may also affect the expected excess demand for money. From the definition of the expected money supply in (7.21), a rise in $L_t$ will, ceteris paribus, cause an equal increase in the expected money supply as well. The second source of monetary disturbance is $\lambda_{t+1}^*$, the expected money supply increment. Changes in $\lambda_{t+1}^*$ may or may not occur independently of changes in $L_t$ and in the analyses which follow we shall be interested in the implications of their joint variation. It will be recalled from the model of Chapter Three that relative changes in current and expected money supplies form the basis of global business cycle phenomena and our interest lies in evaluating this proposition at the domestic level as well.

Unanticipated, temporary monetary disturbances

Consider firstly the case where $L_t$ undergoes an exogenous increase, but where $L_{t+1}^*$ remains constant. Analytically, this case is represented by $dL_t = -d\lambda_{t+1}^*$ and is relevant to the situation where the current money supply undergoes an unexpected increase but is not expected to persist. The impacts of this type of monetary disturbance are derived as:

\begin{align}
\frac{d\lambda_{t+1}^*}{dL_t} &= 0 \\
\frac{dq_{jt}^*}{dL_t} &= \frac{dL_t}{L_t - v_1 - v_2} > 0
\end{align}
\[ d\Delta_{t,t+1} = \frac{d\Omega_{t,t+1}}{dL_t} = \frac{d\Omega_{t,t+1}}{dL_t} = -\frac{1}{(L_t - v_1 - v_2)} < 0 \]

\[ d\psi_{jt} = (f_1 + f_2) \frac{d\Delta_{t,t+1}}{dL_t} < 0 \]

\[ dx_{jt} = 0 \]

\[ \frac{dm_t}{dL_t} = [m_1 + m_2 + m_3 (f_1 + f_2) + m_4] \frac{d\Delta_{t,t+1}}{dL_t} < 0 \]

The rise in \( L_t \) brings about increases in both \( e_t \) and \( q_{jt} \) but leaves the expected values of these variables unaltered. It may be noted that the increases in \( e_t \) and \( q_{jt} \) are less than equiproportional, unlike the result established in Chapter Five. By increasing the current value of domestic prices relative to their expected values, expected rates of price change, as well as the nominal interest rate, fall. The latter induce a fall in the level of domestic output.

Exports of the domestic product are unaffected by this type of disturbance, since the domestic price increases by exactly the same amount as the devaluation in the exchange rate. Imports, on the other hand, react to the combined changes in domestic prices, interest rate and output, and fall as a result. Hence, the trade balance improves as a result of the monetary disturbance, in contrast to the neutrality effect derived in Chapter Five.

Unanticipated, permanent monetary disturbances

An alternative scenario is provided by the case where the current money supply increase is expected to be permanent. This case is represented by \( dL^*_{t+1} = dL_t \), such that \( dL^*_{t+1} = 0 \). The impacts created by this type of monetary disturbance are derived as:

\[ \frac{de^*_{t+1}}{dL_t} = \frac{dq^*_{t+1}}{dL_t} = \frac{1}{(L^*_{t+1} - v_1 - v_2)} > 0 \]
Once again, we find that the money supply increase leads to a rise in domestic prices and an equal devaluation of the exchange rate. The response of the domestic interest rate and expected rates of price change are however, ambiguous. The sign of these responses depends on the initial values of $L_t$ and $L^*_t$. If $L^*_t > L_t$ at the initial equilibrium, then $i_{t, t+1}$ and $\Omega_{jt, t+1}$ will fall and, as in the previous case of a temporary disturbance, output and imports will fall also. If, on the other hand, the current money supply satisfies $L_t > (L^*_t - \nu_1 - \nu_2)$, then the money supply increase will raise $i_{t, t+1}$ and $\Omega_{jt, t+1}$, stimulating both the level of domestic production and the level of imports. It is evident that this expansionary scenario will arise only if the current money supply lies somewhat in excess of the expected money supply at the initial equilibrium.

It is of interest to compare these results with those obtained by Turnovsky (1981). In the Turnovsky model, an unanticipated, permanent increase in the domestic money supply leads to unambiguous increases in domestic output, the price of domestic output, and the exchange rate. In the present model, whereas the price and exchange rate impacts are qualitatively similar to those obtained by Turnovsky, the output effects
are not. The differences in output response may be attributed to underlying differences in supply specification.

**Anticipated monetary disturbances**

Consider now the case where the current domestic money supply remains constant, but where the public raises its expectations of the future money supply. This case is represented by $dL_t = 0$ and $dL_{t+1} > 0$. The impacts created by this type of disturbance are derived as:

\[
\begin{align*}
\frac{de_{t+1}}{dL_{t+1}} &= \frac{dq_{jt+1}}{dL_{t+1}} = \frac{1}{(L_{t+1} - v_1 - v_2)} > 0 \\
(7.42) &
\end{align*}
\]

\[
\begin{align*}
\frac{de_t}{dL_{t+1}} &= \frac{dq_{jt}}{dL_{t+1}} = \frac{(v_1 + v_2)/(L_t - v_1 - v_2)}{(L_{t+1} - v_1 - v_2)} > 0 \\
(7.43) &
\end{align*}
\]

\[
\begin{align*}
\frac{d\Delta_{t,t+1}}{dL_{t+1}} &= \frac{d\omega_{jt,t+1}}{dL_{t+1}} = \frac{di_{t,t+1}}{dL_{t+1}} = \frac{L_t}{(L_t - v_1 - v_2)(L_{t+1} - v_1 - v_2)} > 0 \\
(7.44) &
\end{align*}
\]

\[
\begin{align*}
\frac{dy_{jt}}{dL_{t+1}} &= \frac{(f_1 + f_2)}{dL_{t+1}} > 0 \\
(7.45) &
\end{align*}
\]

\[
\begin{align*}
\frac{dx_{jt}}{dL_{t+1}} &= 0 \\
(7.46) &
\end{align*}
\]

\[
\begin{align*}
\frac{dm_t}{dL_{t+1}} &= [m_1 + m_2 + m_3 (f_1 + f_2) + m_4] \frac{d\Delta_{t,t+1}}{dL_{t+1}} > 0 \\
(7.47) &
\end{align*}
\]

Hence we see that a purely anticipated money supply increase, stimulates not only prices, but interest rates, output and imports as well. Once again, however, the demand for exports remains unaffected due to the identical impacts on domestic prices and the exchange rate. Turnovsky (1981) finds this type of disturbance to be neutral with regard to the level of domestic output, in contrast to the expansionary effect derived above. As noted earlier, output responses in the Turnovsky model hinge on an entirely different set of price signals to those adopted here and it is because of this that the two models give rise to differing output responses.
The results presented above parallel closely those derived in Chapter Three for the model of the global economy. In general, current monetary disturbances imply output and trade responses which are the converse of those associated with anticipated monetary disturbances. A given increase in $L_t$ therefore may or may not stimulate the domestic economy, depending on the magnitude of changes in money supply expectations that accompany it.

A convenient way of parameterising joint movements in $L_t$ and $L_{t+1}^*$ is as follows. The expected rate of money supply growth is defined as:

\[(7.48) \ \xi = \frac{L_{t+1}^* - L_t}{L_t} = \frac{\xi_{t+1}^*}{L_t}\]

The expected money supply growth rate changes according to:

\[(7.49) \ \frac{d\xi}{dL_t}(L_t dL_{t+1}^* - L_{t+1}^* dL_t) / L_t^2\]

such that

\[(7.50) \ d\xi > 0 \ \text{when} \ \frac{dL_{t+1}^*}{dL_t} \cdot \frac{L_t}{\xi_{t+1}^*} > 1\]

In other words, the expected money supply growth rate increases whenever there is a more than proportionate rise in $L_{t+1}^*$ for a given increase in $L_t$.

If we now solve from (7.31) and (7.44) we find that:

\[(7.51) \ \frac{d\Delta_{t,t+1}}{dL_t} > 0 \ \text{when} \ \frac{dL_{t+1}^*}{dL_t} \cdot \frac{L_t}{\xi_{t+1}^*} > 1 - \frac{(v_1 + v_2)}{\xi_{t+1}^*}\]

Hence, a rise in $L_t$ will produce an increase in $\Delta_{t,t+1}$ (and $i_{t,t+1}'$, $y_{jt}$, and $m_t$) only if it is associated with a more than proportional increase in $L_{t+1}^*$. From (7.50), we see that this condition also implies an increase in the expected money supply growth rate. However, the rise in $\xi$ is necessary, but not sufficient, for $L_t$ to stimulate domestic economic activity.
7.4 Global monetary disturbances

We have seen in previous chapters that global monetary disturbances are transmitted to the domestic economy in the form of foreign price, income and interest rate effects. It has been emphasised that these variables respond simultaneously to the global disturbance and the net impact on the SOE may at times involve trade-offs among opposing forces. The analysis of Daniel (1981) also highlights these trade-offs as determining whether there is a positive or negative transmission of foreign monetary disturbances.

In this section we shall be concerned with evaluating the nature of the transmission linkages to a small open economy with market power. As it turns out, the existence of market power implies a more complex association between the domestic economy and the global money supply than has been previously described. The additional complexities derive mainly from two sources. Firstly, global prices and interest rates are determined, as before, on world markets, but the competitiveness of domestic production is now determined locally. Secondly, not only do current values of foreign income, interest rates and prices enter the SOE, but the expected values of these foreign variables enter as well. Not surprisingly, the nature of the trade-offs implicit in the transmission of foreign monetary disturbances is altered dramatically as a consequence of these additional elements.

We proceed as in previous chapters by endogenising the foreign variables on the rhs of (7.26) with respect to the global money supply, $M_t$. The responses of the domestic endogenous variables are then derived and the main results are as follows.

Exchange rate and domestic price effects

In the base model of Chapter Five, it was shown that the exchange rate responded to the global monetary disturbance through both interest rate and price linkages. One implication of this result was that, under the conditions specified, the exchange would not reveal a response pattern that could be described in any simple terms as pro- or contracyclical to either the global or domestic business cycles.
For a small open economy with market power, the exchange rate response is derived as:

\[
\frac{d_e}{dM_t} = \phi_1 \frac{dr_{t,t+1}}{dM_t} + \phi_2 \frac{dr_{t+1,t+2}}{dM_t}
\]

where

\[
\begin{align*}
\phi_1 &= (\frac{1}{(1-\rho)})(L^*_{t+1} - v_1 - v_2) \left( \frac{1}{(1-\rho)} \right) + \left[ (1+\frac{1}{(1-\rho)}) \right] + X(v_1 - L_t (1-w)) \] \\
\phi_2 &= (\frac{1}{(1-\rho)})(L^*_{t+1} - v_1 - v_2) \left( \frac{1}{(1-\rho)} \right) + \left[ (1+\frac{1}{(1-\rho)}) \right] + X(v_1 - L_t (1-w))
\end{align*}
\]

The exchange rate now responds to on the basis of two linkages: the current world interest rate, \(r_f\), and the expected world interest rate, \(r_{t+1,t+2}\). The influences that foreign price and income changes have on have been incorporated into these two linkage variables on the basis of the endogenous relationships derived in Chapter Three. As a result of this, the coefficients \(\phi_1\) and \(\phi_2\) embody diverse influences and cannot be signed unambiguously. An important component of these coefficients is the term \(X\), which as shown above, is the sum of all the export demand coefficients. The term \(X\) has been given a positive sign consistent with (5.79) and (6.114): the basic proposition being that the income and own-rate of return coefficients of export demand dominate the cross-rate of return demand coefficients.

In the base model, the exchange rate responded to the global monetary disturbance through a positive linkage with the foreign interest rate, \(r_{t,t+1}\). With the property of market power, this relationship is preserved only if the coefficient \(\phi_1\) is positive. Solving for this condition, we obtain the result that:

\[
(7.53) \quad \phi_1 > 0 \text{ when } X < \frac{(1+\frac{1}{(1-\rho)})}{(v_1 - L_t (1-w))}
\]

and where the upper limit on \(X\) is positive.
Hence, $e_t$ will continue to receive a procyclical influence from $r_{t,t+1}$ provided that the sum of the export coefficients, $X$, is not too positive. In the event that this condition is not met, however, $e_t$ will be negatively linked to global movements in $r_{t,t+1}$ and will therefore receive contracyclical pressures from this source.

The second link between $e_t$ and $M_t$ is the expected global interest rate, $r_{t+1,t+2}$. It will be recalled from the analysis of Chapter Three that $r_{t+1,t+2}$ does not move confluenously with $r_{t,t+1}$ and that its behavior is neither positively nor negatively linked with the global business cycle. Briefly recapping the results of Section 3.3, current and expected foreign interest rates respond to the global money supply according to (4):

\[
\frac{dr_{t,t+1}}{dM_t} \geq 0 \quad \text{when} \quad \alpha \geq \alpha_2
\]

\[
\frac{dr_{t+1,t+2}}{dM_t} \geq 0 \quad \text{when} \quad \alpha \geq -1
\]

where $\alpha = \frac{\phi_1}{\phi_2}$ and

\[
\alpha_2 = \frac{(\eta_{t+1} - \phi_1 - \phi_2)}{M_t} > 0
\]

In other words, whereas positive values of $\alpha$ in excess of $\alpha_2$ are required to make $r_{t,t+1}$ (and global economic activity) rise, the expected interest rate increases only for $\alpha$ values less than minus one.

The pattern of responses in $r_{t,t+1}$ and $r_{t+1,t+2}$ is given in Figure 7.1.(5)

**Figure 7.1**

Movements in current and expected foreign interest rates, and global economic activity as functions of the business cycle parameter, $\alpha$

| Current global interest rate, $r_{t,t+1}$ | - | - | + |
| Expected global interest rate, $r_{t+1,t+2}$ | + | - | - |
| Global economic activity, $r^f_t$ | - | - | + |
| Global aggregate price level, $p_t$ | + | + | + |

\[-1 \quad \alpha_2 \quad \alpha\]
The main point to emerge from this table of impacts is that whereas \( r_{t,t+1} \) moves in a synchronous manner with the level of global economic activity, \( Y_t \), the expected global interest rate does not. Rather \( r_{t+1,t+2} \) and \( r_{t,t+1} \) are negatively correlated for values of \( \alpha \) in excess of \( \alpha_2 \) and less than \(-1\); and are positively correlated for \( \alpha \) values within this range. It is this tendency for \( r_{t+1,t+2} \) to display both negative and positive correlations with \( r_{t,t+1} \) over all phases of the global business cycle that creates such additional complexity in the exchange rate equation, (7.52).(6)

Consider now the response of the price of domestic output, \( q_{jt} \), to the global monetary disturbance. In the base model, where PPP prevailed, \( q_{jt} \) rose and fell in line with exchange rate movements, net of the rise in the global price level. As an endogenous response to the excess demands of the domestic economy, however, the behavior of \( q_{jt} \) is given by:

\[
\begin{align*}
\frac{dq_{jt}}{dt} &= \phi_3 \frac{dr_{t,t+1}}{dt} + \phi_4 \frac{dr_{t+1,t+2}}{dt} \\
&= X \left[ \frac{L_{t+1}^*}{L_t} - \frac{1}{L_t} \right] (1-w) \left[ \frac{v_1 - v_2}{w} \right] + (1-w) \left[ \frac{v_1 - v_2}{w} \right] > 0
\end{align*}
\]

As in previous models, the price of domestic output retains a positive linkage with the current global interest rate; implying a tendency for \( q_{jt} \) to rise and fall with the global business cycle. An additional source of influence is the expected global interest rate which, as pointed out above, does not possess a simple business cycle pattern. Hence, provided that \( \phi_4 \) is non-zero, the price of domestic output will no longer possess the simple cyclical properties obtained under purchasing power parity. In the case where \( \phi_4 \) is negative, for instance, \( q_{jt} \) will be inversely related to the expected foreign interest rate at the same time as being positively related to the current foreign interest rate. Reference to Figure 7.1 indicates that under these circumstances, the price of domestic output will unambiguously rise during the expansionary phase in global economic activity, but may either
rise or fall during the recessionary phase. The stronger is the 
$r_{t+1,t+2}$ linkage, the more likely it is that $q_{jt}$ will rise during the 
recessionary phase, thereby emulating the 'fixprice' characteristic of 
rising prices during periods of repressed demand. (7)

The domestic price of imported goods, $q_t$, is determined under 
purchasing power parity according to:

\[
\frac{dq_t}{dM_t} = \frac{dp_t}{dM_t} + \frac{de_t}{dM_t}
\]

Substituting from (7.52) into (7.56), we determine the response of 
imported goods prices as (8):

\[
\frac{dq_t}{dM_t} = \phi_5 \frac{dr_{t,t+1}}{dM_t} + \phi_6 \frac{dr_{t+1,t+2}}{dM_t}
\]

where

\[
\phi_5 = \frac{X}{J} [(Z_1+m_1)(L^*_t-v_1-v_2)(v_2-L_t(l-w)) < 0
\]

\[
\phi_6 = \frac{X}{J} [(Z_1+m_1)L^*_t+v_1(l-w)-v_2w + Z_1[L^*_t+v_2-L_t(l-w)] + (v_1+v_2)(L_t-v_2)] < 0
\]

The coefficients which describe the response of $q_t$ to $M_t$ are of 
similar structure to those which describe the behavior of $q_{jt}$. An 
important difference, however, is that $q_t$ is negatively linked to 
$r_{t,t+1'}$ opposite to the positive linkage found for $q_{jt}$. Further, $q_t$ 
is negatively linked to $r_{t+1,t+2'}$ compared with the ambiguous linkage 
found in $\phi_4$ for $q_{jt}$.

With reference to Figure 7.1, it can be seen that during the global 
recession (when $-1 < \alpha < \alpha_2$), monetary expansion overseas will lead to 
an unambiguous increase in the domestic price of imported goods. During 
the expansionary phase, on the other hand (when $\alpha > \alpha_2$), $q_t$ will 
receive mixed influences: downward pressure from the $r_{t,t+1}$ linkage 
and upward pressure from the $r_{t+1,t+2}$ linkage. It is possible, for 
instance, that if the $r_{t,t+1}$ influence dominates, then the domestic 
price of imported goods may fall during the global expansionary phase.
Differential movements in $q^*_t$ and $q_t$ may be interpreted as changes in the terms of trade. From (6.2), the terms of trade are defined as:

\[
T_t = q^*_t/q_t
\]

or, the ratio of export prices to import prices, expressed in terms of domestic currency. The response of the terms of trade to the global monetary disturbance is determined as:

\[
\frac{dT}{dM} = \phi_7 \frac{dr_{t+1,t+2}}{dM_t} + \phi_8 \frac{dr_{t,t+2}}{dM_t}
\]

where

\[
\phi_7 = \frac{X}{J} (z_1 + \alpha_1)(L^*_{t+1} - v_1 - v_2)(L_t - v_1 - v_2) > 0
\]

\[
\phi_8 = \frac{X}{J} z_1 L_{t+1} L_t + (v_1 + v_2)(v_1 + v_2 - L_t(l+w) - L^*) > 0
\]

Hence we find that in the presence of market power, a country's terms of trade are no longer perfectly aligned with the global business cycle. It will be recalled from the analysis of Chapter Six that under full purchasing power parity, price relativities are determined on global commodity markets. Further, from Chapter Four, we saw that global price relativities are perfectly synchronised with movements in the current global interest rate, $r_{t,t+1}$ and hence with the global business cycle. Under the conditions of market power however, the positive link between $T_t$ and $r_{t,t+1}$ is preserved, but with the additional influence provided by $r_{t+1,t+2}$. Reference to Figure 7.1 indicates that during the global recession (when $-1 < \alpha < \alpha_2$), the country's terms of trade will fall unambiguously due to the combined influences of current and expected global interest rates. During the global expansionary phase, however, the terms of trade may or may not show an improvement, depending on whether the $r_{t,t+1}$ linkage can dominate the $r_{t+1,t+2}$ linkage.

Domestic interest rate and output effects

It has been established above that the existence of market power in the SOE, creates additional complexities in the transmission of foreign
monetary disturbances. In addition to the linkage established in Chapter
Five provided by the current global interest rate, \( r_{t,t+1} \), we find that
the expected global interest rate, \( r_{t+1,t+2} \) also acts in the
transmission process. The implications of these dual transmission agents
for the behavior of domestic interest rates and output will now be
examined.

The domestic interest rate responds to the global monetary
disturbance according to:

\[
\frac{d_i}{dM_t} = \phi_9 \frac{dr_{t,t+1}}{dM_t} + \phi_{10} \frac{dr_{t+1,t+2}}{dM_t}
\]

where

\[
\phi_9 = \frac{X}{J} \left( Z_1 + m_1 \right) (v_1 + v_2 - L^*_{t+1})(v_2 - L_{t+1} (1-w)) > 0
\]

\[
\phi_{10} = \frac{X}{J} \left[ Z_1 L_t (v_2 w - v_1 (1-w)) - m_1 (L^*_{t+1} L_w + v_2 (v_1 + v_2 - L^*_{t+1}) \right] > 0
\]

Like the terms of trade, the domestic interest rate is positively linked
to both \( r_{t,t+1} \) and \( r_{t+1,t+2} \). For reasons already outlined, this means
that there is no longer a perfect synchronisation between local and
foreign interest rates over both phases of the global business cycle.
Rather, there will be a tendency for \( i_{t,t+1} \) to follow \( r_{t,t+1} \) down
during the recessionary phase, but an uncertain response from \( i_{t,t+1} \)
during the period that foreign interest rates are rising. Indeed, the
local interest rate may continue to fall during the latter phase if the
\( r_{t+1,t+2} \) linkage is sufficiently strong.

Excess demands on domestic markets are also influenced by \( \Omega_{jt,t+1} \),
the expected rate of price appreciation for commodity \( j \). Solving for the
behavior of this variable we obtain the following response:

\[
\frac{d\Omega_{jt,t+1}}{dM_t} = \phi_{11} \frac{dr_{t,t+1}}{dM_t} + \phi_{12} \frac{dr_{t+1,t+2}}{dM_t}
\]

where

\[
\phi_{11} = \frac{X}{J} \left( Z_1 + m_1 \right) (v_1 + v_2 - L^*_{t+1}) (L_{t+1} - v_1) < 0
\]

\[
\phi_{12} = \frac{X}{J} \left[ Z_1 L_t (v_2 w - v_1 (1-w)) + m_1 (L^*_{t+1} L_w + v_2 (v_1 + v_2 - L^*_{t+1}) \right] > 0
\]
The important feature to note about this result is that $\Omega_{jt,t+1}$ is negatively related to the current global interest rate. This is a reversal of the result established in Chapters Five and Six under purchasing power parity where domestic inflationary expectations were positively linked to the foreign interest rate.

These results have important implications for the transmission of foreign monetary disturbances to the real sector of the domestic economy. A rise in $r_{t,t+1}$ now induces not only an increase in the domestic interest rate, $i_{t,t+1}$, but a fall in the expected price appreciation rate for the local commodity as well. Together, the induced changes in these domestic variables suggest a fall in both the inventory demand for the local good as well as its production. Hence, contrary to the results established under PPP, the foreign interest rate rise now has a negative transmission impact on the local economy. The extent to which this negative impact is realised, however, depends also on the adjustments associated with foreign interest rate expectations.

From the supply response equation in (7.1), we obtain the impact of the global monetary disturbance on domestic output as:

$$
(7.62) \quad \frac{dy_{jt}}{dM_t} = \phi_{13} \frac{dr_{t,t+1}}{dM_t} + \phi_{14} \frac{dr_{t+1,t+2}}{dM_t}
$$

where

$$
\phi_{13} = X \left( z + \mu_2 \right) (v + v_2 - L^*) \left[ f_1 (L_t w - v_1) + f_2 (v_2 - L_t (1 - w)) \right] < 0
$$

$$
\phi_{14} = X \left( f_1 v_2 - f_2 v_1 \right) (v + v_2 - L^* - L_t) \left[ m_1 \left( f_1 - f_2 \right) L^* + m_2 \right] \geq 0
$$

As indicated, the coefficient which links $y^d_{jt}$ to $r_{t,t+1}$ is negative, implying a negative transmission of the foreign monetary disturbance to the domestic economy. The expected interest rate coefficient, on the other hand, is ambiguous and may act to offset the $r_{t,t+1}$ linkage in either the recession or expansion phase of the global business cycle. If, for instance, $\phi_{14}$ is positive, then during the global expansionary
phase \((\alpha > \alpha_2)\), the domestic economy will show a decline in economic activity. During the global recession however, a positive value of \(\phi_{14}\) implies a trade-off between the \(r_{t,t+1}\) and \(r_{t+1,t+2}\) linkages. The opposite scenario emerges if \(\phi_{14}\) is negative. In this case the domestic economy will improve during the global recession but may or may not move back during the global expansion.

Regardless of the value of the coefficient \(\phi_{14}\) therefore, there will be at least one phase of the global business cycle in which output in the domestic economy moves contracyclically. Whether this negative transmission effect occurs during the recession phase or the expansion phase can be determined only by resolving the sign of \(\phi_{14}\). The source of the negative transmission is the propensity for \(r_{t,t+1}\) to raise the domestic interest rate and to lower the expected return on the domestic product. In this sense the negative transmission arises out of a 'real interest rate' effect.

To summarise this section, it is clear that the existence of market power within the SOE creates significant differences in the transmission of foreign disturbances. Briefly, there is a change in the linkages through which foreign disturbances enter the domestic economy, there is no longer perfect synchronisation between domestic and foreign business cycles and there is increased propensity for the negative transmission of global monetary disturbances. An increase in economic activity overseas now acts on the SOE primarily through the export demand function(9) thereby creating excess demand in the domestic product market. With terms of trade endogenous to the SOE, the excess demand induces a fall in \(\Omega_{jt,t+1}\) and a rise in \(i_{t,t+1}\) which, together, imply a fall in domestic output. While this negative transmission scenario will not necessarily apply over both phases of the global business cycle, it does represent a significant departure from the result obtained when terms of trade are determined globally.

A final point which should be emphasised is that interest rate expectations have emerged as an agent for international business cycle transmission. One important implication of this is that the foreign monetary disturbance may be neutral globally and yet create real impacts within the SOE because of the expected interest rate linkage. This
finding contrasts with the 'global neutrality' proposition put forward by Daniel (1981) and which was found to exist in the ppp models of Chapters Five and Six. For a small open economy with market power, such a neutrality proposition may not be valid.

7.5 Supply- versus demand-induced export growth

The model of this Chapter provides a convenient framework for examining the issue of resource-based export growth. This issue has received prominent attention in recent years and well-publicised examples include mineral exports from Australia and the export of oil from Great Britain and Mexico.

A number of analysts have been concerned with the adjustment pressures that export growth may have on the economy and have adopted a variety of analytical strategies to investigate this phenomenon. Eastwood and Venables (1982), for instance, model the increase in North Sea oil exports from Great Britain as an exogenous addition to domestic revenue. Gregory (1976), Snape (1977), Stoeckel (1979) and Long (1981), on the other hand, model the increase in mineral exports from Australia as an exogenous supply increase.

Conspicuous by their absence, however, have been studies which evaluate the role of global demand forces as determinants of export growth. The relevance of demand forces for export performance has been forcefully demonstrated during 1981 and 1982 as trade in primary commodities has declined world-wide. Similarly, the Australian 'mineral export boom' was predicated during the latter part of the 1970s as a supply-fed phenomenon, with little attention being paid to the demand side of the market.

In this section, we shall be concerned with evaluating the implications of supply-induced export growth on the one hand, and demand-induced export growth on the other. Attention is restricted to the macroeconomic consequences in each case, and such matters as intersectoral resource competition will not be considered.
Supply-induced export growth

The excess demand system portrayed in (7.26) contains two supply disturbance terms, \( G_{jt} \) and \( G^*_{jt+1} \). A rise in \( G_{jt} \) implies an unanticipated increase in the current stock of commodity \( j \). A rise in \( G^*_{jt+1} \), on the other hand, implies an anticipated supply increase that will occur in period \( t+1 \). These two disturbance terms are not necessarily independent since an increase in the current level of supply may alter supply expectations. Hence, following the treatment of previous chapters we may distinguish three types of supply increase in the domestic economy: an unanticipated, temporary supply increase; an unanticipated, permanent supply increase; and an anticipated supply increase. The impacts associated with each type of supply disturbance will be evaluated in turn.

Unanticipated, temporary supply increase

Analytically, this type of supply increase is characterised by:

\[ \frac{dG_{jt}}{dt} > 0; \quad \frac{dG^*_{jt+1}}{dt} = 0 \]

It represents an increase in the stock of commodity \( j \) which at time \( t \) was unanticipated, but which does not affect supply expectations in future periods. The impacts associated with this type of disturbance are as follows:

\[
\begin{align*}
(7.63) \quad \frac{d\alpha_t}{dG_{jt}} &= \frac{1}{J} (Z_{1+m_1}) (L_t (1-w) - v_2) (L^*_{jt+1} - v_1 - v_2) > 0 \\
(7.64) \quad \frac{d\alpha_{jt}}{dG^*_{jt}} &= \frac{1}{J} (Z_{1+m_1}) (v_1 + v_2 - L^*_{jt+1}) (L_t w - v_1) < 0 \\
(7.65) \quad \frac{d\alpha_{t,t+1}}{dG_{jt}} &= \frac{1}{J} (Z_{1+m_1}) (L^*_{jt} - v_1 - v_2) (L_t (1-w) - v_2) < 0 \\
(7.66) \quad \frac{d\beta_{jt}}{dG_{jt}} &= \frac{1}{J} (Z_{1+m_1}) (L^*_{jt} - v_1 - v_2) [f_1(L_t t - v_1) - f_2(L_t (1-w) - v_2)] > 0 \\
(7.67) \quad \frac{d\gamma_{jt}}{dG_{jt}} &= \frac{x_1}{J} (Z_{1+m_1}) (L^*_{jt} - v_1 - v_2) (L_t - v_1 - v_2) > 0
\end{align*}
\]
This type of supply increase stimulates both the level of exports and the level of domestic production. The rise in exports is consistent with the fall in the price of j and the devaluation of the exchange rate. The output effect is also stimulated by the fall in q^t (relative to its expected value, q^t+1) as well as the decline in the interest rate.

Unanticipated, permanent supply increase

This type of supply increase is characterised by:
[dG^t/dG^t+1>0] and implies an exogenous rise in current supply that is expected to persist at least until period t+1. The impacts associated with this type of disturbance are as follows:

\[
\frac{de_t}{dG_jt} = \frac{1}{J} \left[ (Z_1+m_1) \left[ L_t (1-w) \left( L_{t+1}^* - v_1 - v_2 \right) + (v_1+v_2) \left( v_2 - L_t^* (1-w) \right) \right] 
+ Z_1 \left( L_{t+1}^* - v_1 - v_2 \right) \left( L_t (1-w) - v_1 \right) \right] > 0
\]

\[
\frac{dq_jt}{dG_jt} = \frac{1}{J} \left[ (Z_1+m_1) \left[ L_{tw} (v_1+v_2-L_{t+1}^*) + (v_1+v_2) \left( L_{t+1}^* - v_1 \right) \right] 
- Z_1 \left( L_{tw} - v_1 \right) \left( L_{t+1}^* - v_1 - v_2 \right) \right] < 0
\]

\[
\frac{di_{t,t+1}}{dG_jt} = \frac{1}{J} \left[ (Z_1+m_1) L_t \left[ v_1 (1-w) - v_2 w \right] - Z_1 \left( L_t (1-w) - v_2 \right) \left( L_{t+1}^* - v_1 - v_2 \right) \right] < 0
\]

\[
\frac{dy_jt}{dG_jt} = \frac{1}{J} \left[ (Z_1+m_1) L_t \left[ v_1 (1-w) - v_2 w \right] (f_1+f_2) 
+ Z_1 \left( L_{t+1}^* - v_1 - v_2 \right) \left[ f_1 \left( L_{tw} - v_1 \right) - f_2 \left( L_t (1-w) - v_2 \right) \right] \right] > 0
\]

\[
\frac{dx_jt}{dG_jt} = \frac{x_1}{J} \left[ Z_1 \left( L_{t+1}^* - v_1 - v_2 \right) \left( L_t - v_1 - v_2 \right) \right] > 0
\]

The qualitative impacts of the permanent supply increase are identical to those of the temporary supply increase. What distinguishes these disturbances are the magnitudes of adjustment involved. In each case the response is greater for the permanent supply increase than for the temporary supply increase, reflecting the feedback from forward market
excess demands to the current endogenous variables. Hence, a resource discovery or productivity improvement which is expected to be permanent will have greater export and production impacts in the current period than those which are regarded as being purely transitory. Equally, however, a permanent increase in supply will also imply larger falls in the domestic price and interest rate levels and a larger devaluation of the exchange rate.\(^{(12)}\)

**Anticipated supply increase**

Consider now the case where the current supply of commodity \(j\) is not subjected to exogenous disturbances, but its expected availability is revised upwards. This type of supply increase is characterised by:

\[(dG^*_jt+1 > 0;\ dG^*_jt = 0)\] and the main impacts are as follows:

\[
(7.73) \quad \frac{\partial \text{det}}{\partial G^*_jt+1} = \frac{1}{J} \left[ Z_1 (L_t (1-w) - v_2) (L^*_t+1 - v_1 - v_2) \right. \]
\[
- \left. (Z_1 + m_1) (L^*_t+1) (v_1 (1-w) - v_2 w) \right] > 0
\]

\[
(7.74) \quad \frac{\partial G^*_jt}{\partial G^*_jt+1} = \frac{1}{J} \left[ Z_1 (L_t^* - v_1) (v_1 + v_2 - L^*_t+1) \right.
\]
\[
- \left. (Z_1 + m_1) (L^*_t+1) (v_1 (1-w) - v_2 w) \right] \geq 0
\]

\[
(7.75) \quad \frac{\partial i^*_t+1}{\partial G^*_jt+1} = \frac{1}{J} \left[ Z_1 (L_t (1-w) - v_1) (v_1 + v_2 - L^*_t+1) \right.
\]
\[
+ \left. (Z_1 + m_1) (L^*_t+1) (v_1 + v_2 - L^*_t) \right] < 0
\]

\[
(7.76) \quad \frac{\partial x^*_jt}{\partial G^*_jt+1} = \frac{1}{J} \left[ (f_1 + f_2) [Z_1 L_t (v_1 (1-w) - v_2) - m_1 L^*_t+1 L_t w] \right.
\]
\[
- \left. f_1 m_1 v_1 (v_1 + v_2 - L^*_t+1 - L_t) \right]
\]
\[
+ \left. f_2 m_1 [L^*_t+1 + L_t + v_2 (v_1 + v_2 - L^*_t+1 - L_t)] \right] \geq 0
\]

\[
(7.77) \quad \frac{\partial x^*_jt}{\partial G^*_jt+1} = \frac{m_1 x^*_jt}{J} \left[ (v_1 + v_2) (L^*_t+1 + L_t - v_1 - v_2) - L^*_t L_t \right] > 0
\]
An expected increase in the supply of \( j \) leads to a devaluation of the exchange rate, a fall in the interest rate and a rise in the current level of exports. These impacts are the same as for an actual supply increase. The price and output effects of the increase in expected supply, however, are ambiguous. This is because the expected price of \( j^*_{jt+1} \) falls as \( G^*_{jt+1} \) rises, creating downward pressure on the expected rate of price appreciation, \( \Omega^*_{jt,t+1} \). Whether or not \( \Omega^*_{jt,t+1} \) actually falls, however, depends on the response of \( q^*_{jt} \): if \( q^*_{jt} \) rises, then \( \Omega^*_{jt,t+1} \) falls and so will current output, but if \( q^*_{jt} \) falls by more than \( q^*_{jt+1} \), \( \Omega^*_{jt,t+1} \) will rise and this, combined with the fall in interest rates, will make output increase.

The distinction between current versus expected supply increases on the one hand, and permanent versus temporary supply increases on the other, is therefore of relevance in the analysis of supply-induced export growth. While none of the authors referred to at the beginning of this section made mention of this type of distinction, it is clearly pertinent to the issues being analysed. Unexpected (i.e., current) supply increases, whether they be permanent or temporary, stimulate both exports and domestic production through terms of trade and real interest rate effects. In other words, an actual supply increase achieves these outcomes because of falls in \( q^*_{jt} \) and \( i^*_{t+1} \), and a rise in \( e^*_{t} \). Together, these price and interest rate adjustments imply an improvement in the overseas competitiveness of the domestic product and provide a stimulus for diverting resources into domestic production.

Export growth achieved through anticipated supply increases, on the other hand, may not be accompanied by higher levels of domestic economic activity. While the fall in interest rates provides a stimulus for increased domestic production, the ambiguous response of current domestic prices may not. In this case, the ambiguous response of output to the supply increase arises out of ambiguity in the behavior of the price signal, \( \Omega^*_{jt,t+1} \).

For all types of supply disturbance, the nominal exchange depreciates. Furthermore, contrary to the findings of Gregory (1976), Snape (1977) and Stoeckel (1979), the real exchange rate also falls.
with supply-induced export growth. That is, the real exchange rate is defined as in Chapter Six as the ratio of the domestic price of imports to the aggregate domestic price level:

\[ e_t^R = \frac{e_t \cdot p_t}{A_t} \quad \text{(real exchange rate)} \]

From the definition of the aggregate price level, \( A_t \), in (7.12), changes in the real exchange rate are given by:

\[ de_t^R = (1-w)(de_t + dp_t - dq_{jt}) \]

Substituting into (7.79), and noting that the global price of imports, \( p_t \), is constant in the presence of domestic disturbances, we obtain the response of the real exchange rate to supply variations as:

\[ \frac{de_t^R}{\delta s_{jt}} = \frac{(1-w)}{J} \left[ \left( z_1 + m_1 \right) (L_t^* + v_1 - v_2) (L_t - v_1 - v_2) \right] > 0 \quad \text{(unanticipated, temporary)} \]

\[ \frac{de_t^R}{\delta s_{jt}} = \frac{(1-w)}{J} \left[ (2z_1 + m_1) (L_t^* + v_1 - v_2) (L_t - v_1 - v_2) \right] > 0 \quad \text{(unanticipated, permanent)} \]

\[ \frac{de_t^R}{\delta s_{jt+1}} = \frac{(1-w)}{J} \left[ z_1 (L_t^* + v_1 - v_2) (L_t - v_1 - v_2) \right] > 0 \quad \text{(anticipated)} \]

The fall in the real exchange rate in each case arises out of the nominal exchange rate, \( e_t \), rising relative to the price of domestic output, \( q_{jt} \).

The reason that a real exchange rate depreciation is not found in the Gregory-Snape-Stoeckel analyses is that in their studies, the presence of a non-traded goods sector induces a rise in the aggregate price level, \( A_t \), in conjunction with export growth. (13) In the present model, with only a single traded good sector to represent aggregate domestic output, the supply increase will in general be deflationary and the real exchange rate devaluation flows directly from this. (14)
Demand-induced export growth

We now consider the case of demand-induced export growth. From the specification of the export demand function in (7.4), it can be seen that a rise in export demand can occur through basically two channels. Firstly, there is the asset substitution process, in which the foreign demand for \( j \) rises when its expected rate of return \( [\Omega_{jt,t+1} - \Delta_{t,t+1}] \) increases relative to returns on other assets (\( r_{t,t+1} \) and \( \pi_{t,t+1} \)). Secondly, there is the foreign income component of export demand, \( Y^f_t \), which may reflect demand for consumption purposes. Clearly, these two channels of influence are not independent of one another since a rise in \( Y^f_t \), say, will induce changes in \( (\Omega_{jt,t+1} - \Delta_{t,t+1}) \), thereby creating substitution effects.

Two approaches to the issue of global demand movements will be adopted. The first consists of an exogenous increase in real global income, \( Y^f_t \) which occurs independently of changes in foreign interest rates and prices. The second approach involves the effects of global monetary disturbances on exports when all of the foreign variables are adjusting simultaneously.

A rise in real global income, \( Y^f_t \), affects the domestic economy initially through the export demand coefficient, \( x_3 \). The impacts associated with this type of disturbance are:

\[
\frac{d\eta}{dy^f_t} = \frac{x_3}{J} (Z_1 + m_1)(v_1 + v_2 - L^*_{t+1})(L_t(l-w) - v_2) < 0
\]

(7.84)

\[
\frac{dq_{jt}}{dy^f_t} = \frac{x_3}{J} (Z_1 + m_1)(L^*_{t+1} + v_1 - v_2)(L_tw - v_1) > 0
\]

(7.85)

\[
\frac{di_{t,t+1}}{dy^f_t} = \frac{x_3}{J} (Z_1 + m_1)(L^*_{t+1} - v_1 - v_2)(L_t(l-w) - v_2) > 0
\]

(7.86)

\[
\frac{dv^d_{jt}}{dy^f_t} = \frac{x_3}{J} (Z_1 + m_1)(L^*_{t+1} - v_1 - v_2)[f_2(L_t(l-w) - v_2) - f_1(L_tw - v_1)] < 0
\]

(7.87)
The rise in foreign income leads to a revaluation in the exchange rate, a rise in the price of domestic output, an increase in the interest rate, a fall in output and an ambiguous effect on exports. Two aspects of these results which deserve comment are as follows. Firstly, the rise in foreign income is transmitted negatively to the domestic economy because of the interest rate and price effects. With a rise in foreign income, excess demand in the domestic product market increases, and this in turn leads to price and interest rate increases. The combined effect of the latter is a reduction in domestic output.

The second aspect to note is that the effect on exports is ambiguous and involves a trade-off between the income component of export demand and the asset substitution component. This trade-off emerges because of the terms of trade effect associated with the fall in \( e_t \) and the rise in \( q_{jt} \). In effect, the foreign competitiveness of domestic production falls as a result of the price and exchange rate adjustments, and this factor works against the initial stimulus to exports provided by \( Y^f_t \). The fall in competitiveness is synonymous with the expected return on \( j \) falling relative to the returns on alternative foreign assets, and hence the demand for \( j \) diminishes. The term in (7.88) which creates this ambiguity is \( (z_1^m + m_1^x_1) \geq 0 \).

If the income component of export demand dominates the asset substitution component, export levels will rise in line with the increase in global income. Under these circumstances, the increase in exports will be accompanied by an appreciation of the exchange rate in both real and nominal terms. This contrasts with the exchange rate depreciation which accompanies supply-induced export growth. Furthermore, the pattern of price, interest rate and output responses will also be opposite between the two forms of export growth.

If, on the other hand, the asset substitution component of export demand dominates the income component, there will be perfect consistency between the impacts in each case. Under these circumstances, export
growth will occur when there is a fall in global income, and from the results given above, this implies the same pattern of exchange rate, price and output adjustments as in the case of supply-led export growth.

These results highlight the importance of terms of trade movements as determinants of export growth. To the extent that terms of trade (or asset substitution) effects dominate export demand, there will be little to distinguish the impacts which accompany supply-induced from demand-induced export growth. In both cases, increased exports will be accompanied by an exchange rate devaluation, falls in domestic prices and interest rates and a rise in domestic output.\(^{(16)}\)

It should be emphasised that this conclusion has been derived for the case of a single aggregate commodity only; it need not necessarily apply in the case of individual commodities in the SOE. Indeed it is possible that the demand for an individual commodity may rise without being accompanied by any terms of trade effects. For this particular commodity, there may well be important differences between supply- and demand-induced export growth.

We now consider the case of export growth stimulated by global monetary disturbances. Our interest lies in determining the linkages through which foreign money supply changes affect export demand and the relationship (if any) between exports and the global business cycle. Solving for this relationship, we obtain:

\[
\frac{dx_{jt}}{dM_t} = \phi_{15} \frac{dr_{t,t+1}}{dM_t} + \phi_{16} \frac{dr_{t+1,t+2}}{dM_t}
\]

where

\[
\phi_{15} = \frac{X}{J} \left( Z_{1+m_1}v_1(L_{t+1} - L_{t}) + x_1(L_{t+1} - L_{t}) \right) < 0
\]

\[
\phi_{16} = \frac{X}{J} \left( x_{1+m_1}v_1(L_{t+1} - L_{t}) + x_1(L_{t+1} - L_{t}) \right) < 0
\]

As we found in section 7.4, the global monetary disturbance is transmitted via two linkages: \(r_{t,t+1}'\) the current foreign interest rate; and \(r_{t+1,t+2}'\) the expected foreign interest rate. The coefficient
\( \phi_{15} \) provides a direct link between exports and the global business cycle, but the sign of this coefficient is ambiguous. The source of the ambiguity is the term \((Z_1 + m_1 + x_1)\), which was identified previously in connection with the export effects of exogenous changes in \(Y_t^e\). If the income component of export demand dominates the asset substitution component, \((Z_1 + m_1 + x_1) < 0\), and \(\phi_{15} > 0\). Under these circumstances, \(x_{jt}\) will possess a positive linkage with the monetary induced global business cycle. If, on the other hand, the income component of export demand is relatively small compared with the asset substitution component, \((Z_1 + m_1 + x_1) > 0\) and \(x_{jt}\) will possess a negative linkage with the global business cycle.

In either case, perfect synchronisation of exports with the global business cycle is not possible because of the negative linkage with interest rate expectations. As emphasised in Section 7.4 (and illustrated in Figure 7.1), \(r_{t+1, t+2}\) is both positively and negatively correlated with \(r_{t, t+1}\) over the expansionary and contractionary phases of the global business cycle and because of this, perfect synchronisation between exports and the level of global output is not possible. As shown in Figure 7.1, for values of the parameter \(\alpha\) in excess of minus one, \(r_{t+1, t+2}\) falls in response to rising \(M_t\) and this implies upward pressure on exports during both the recessionary and expansionary phases.

If we restrict our attention to the case where \(\phi_{15} > 0\), it is evident that exports will rise unambiguously during the global expansion. The macroeconomic adjustments which accompany this type of export growth have been outlined in Section 7.4 above and in all cases the responses are ambiguous. It is no longer possible to state with any degree of generality whether rising exports will be accompanied by rising or falling exchange rates, rising or falling interest rates, or rising or falling output. In each case, the response of these macroeconomic variables depends on the trade-offs caused by joint movement in current and expected global interest rates. Without resolution of these trade-offs in a quantitative sense, it is not possible to hypothesise what the effects of rising exports on the exchange rate, the interest rate, or the level of output might be.
From this we may conclude that where export growth has been due to monetary-induced global demand forces, it may be accompanied by substantially different forms of macroeconomic adjustment than in the case of supply-induced export growth. It is for this reason that the simple propositions developed by, for instance, Gregory (1976), which envisage that export growth will be accompanied by real exchange rate revaluation, must be treated with a good deal of caution in the presence of global demand forces. Given the complex nature of the linkages that our analysis has identified, it is likely that resolution of these matters will require the adoption of simulation techniques.(17)

7.6 Summary and conclusions

The adoption of the market power assumption leads to major changes in the behavior of the small open economy from the case where ppp prevails. Not only is the extent of domestic influence greater, but the relationship with global economic forces is altered as well.

Domestic monetary disturbances create real impacts in the SOE, in contrast to the neutrality which was observed under ppp. The source of these real impacts is the alteration in domestic intertemporal price relativities brought about by changes in the money stock. The direction of response in domestic economic activity depends, however, on the change in the current stock of money relative to the expected stock of money. This finding parallels that obtained in Chapter Three for the global economy and highlights the possibility that domestic business fluctuations may arise out of variations in expected domestic money supply growth rates.

The relationship between the small open economy and the rest of the world becomes more complex in the presence of market power. The country's terms of trade (its ratio of export to import prices) are now endogenous to its internal excess demands and because of this, the transmission of foreign disturbances takes place via additional linkages. In the base model of Chapter Five, the transmission of foreign monetary disturbances took place through movements in the current global interest rate. Under these circumstances, domestic output and interest rates were perfectly synchronised with their foreign counterparts. In the model of Chapter Six
also, where the terms of trade was determined on global commodity markets, the perfect synchronisation property persisted, even if the sign of the correlation was indeterminate. In the present model, however, no synchronisation is possible because both the current and the expected foreign rates of interest act as agents for transmission. As pointed out in Chapter Three, the behavior of these two variables is not closely linked over both the expansionary and contractionary phases of the global business cycle and because of this, the response of the domestic economy becomes unsynchronised. The complications caused by the dual linkage with current and expected foreign interest rates have entered the model because of the market power assumption.

The third main implication of the market power proposition is that the SOE can influence its export levels through domestic supply variations. This channel of influence was not present under the ppp specification, since domestic events had no impact on the prices paid by foreign buyers. In the presence of market power and endogenous terms of trade, however, domestic events do influence the prices paid by foreign buyers and the impacts of supply variations were investigated. Actual (current) increases in supply were found to stimulate both exports and domestic production through terms of trade and real interest rate effects. Anticipated supply increases, on the other hand, also induce export growth, but have an uncertain effect on the level of output. In both cases, however, the rise in exports is accompanied by a devaluation in the exchange rate. The impact of global demand forces on export growth present a more complex scenario of macroeconomic adjustment. An exogenous rise in global income, for instance, will stimulate exports provided that the initial demand effect is not swamped by the ensuing terms of trade effect. This trade-off between income and substitution effects is also present in the response of exports to global monetary disturbances, and this, combined with the dual interest rate linkages referred to above, precludes any simple relationship between export performance and the global business cycle. In the light of these results, attempts to invoke simplistic linkages between, say, mineral export growth and real exchange rate behavior, should be regarded with considerable caution.
FOOTNOTES - CHAPTER SEVEN

(1) Turnovsky (1977b) refers to expectations of endogenous variables formed in this manner as 'structural expectations'. As pointed out in Chapters Three and Four, one element of expected excess demands which may be important in some circumstances is the expected inventory carryover from the current period to the next period. For the purposes of the analysis in this chapter, we shall assume that these stock transfers form a negligible part of the expected excess demand on the domestic product market. This assumption is made to simplify an already complex coefficient structure.

(2) A discussion of this problem is presented below equation (3.12) in Chapter Three.

(3) As in previous chapters, we assume that at the initial equilibrium all prices and exchange rates are equal to unity. It is also assumed that the own- and cross-price elasticities of import demand are both equal to unity such that $m_1 = -m_4 = m_t$.

(4) The critical $\alpha$-value which demarcates rising from falling values of $r_{t+1,t+2}$ has been derived under the simplifying assumption that intertemporal stock transfers in the global economy have negligible impacts on forward excess demands. This assumption does not affect the qualitative properties of the results and is consistent with the assumption made in footnote 1 above.

(5) See also Figure 3.1.

(6) The identification of interest rate expectations as a channel through which exchange rates respond to foreign monetary disturbances, provides additional insight into empirical studies of exchange rate behavior. Whilst we have not been able to generalise about the direction of this influence, it is evident that neglect of interest rate expectations may seriously impair the results of studies which concentrate solely on current interest rate linkages; see for instance Frenkel (1981).
(7) This effect may persist during the recessionary phase only while \( \alpha > 1 \). For values of \( \alpha \) less than this value, both \( r_{t,t+1} \) and \( r_{t+1,t+2} \) combine to produce an unambiguous fall in \( q_{jt} \).

(8) In deriving this result we have made use of the property that \( \frac{d[r_{t,t+1} + r_{t+1,t+2} + p_t]}{dM_t} = 0 \), derived from Section 3.3 under the condition given in footnote 1.

(9) The role of the export demand function in transmitting the foreign disturbance to the domestic economy is revealed by the presence of the term \( X \) in each of the response functions.

(10) Stoeckel (1979) recognises the need to incorporate demand-side effects into such modelling activities, but his contribution is limited to the case where the level of aggregate output is held fixed, and the demand disturbance pushes economic activity around a fixed production possibility frontier.

(11) A further limitation of this analysis is that it is relevant only in the case of market power in exports. In the absence of market power, of course, domestic supply disturbances have no effect on export levels and for this reason the comparisons we make here are not necessarily applicable under generalised ppp. As noted by Mussa (1979) however, the concept of market power may not be too restrictive in the sense that it applies in the case of imperfect substitutability among commodities. As Mussa points out, automobiles are traded goods, but a Volkswagen may not be a perfect substitute for a Chevrolet. In the case of primary commodities also, there exist numerous grades and standards which make the output of one country an imperfect substitute for the output of another. Australia versus North American wheat, or Nigerian versus Saudi Arabian oil provide instances of these grading differences.

(12) Marion (1982) also finds that permanent real disturbances have larger exchange rate effects than temporary ones.
(13) Shann (1981) identifies changes in the production of tradeables and non-tradeables as a factor determining the direction of movement in the real exchange rate. While Long (1981) does not address movements in real exchange rates directly, his analysis also implies that competition between domestic sectors for resources will affect real exchange rate behavior. The issue of traded good–non-traded good competition within the SOE will be examined in Chapter Eight.

(14) The analysis of Marion (1982) finds that an exogenous domestic supply increase leads to the same price and output effects as obtained in our model, but with uncertain exchange rate effects.

(15) Incorporated into this asset substitution component is the familiar 'terms of trade' determinant of export demand. Under the conventional approach, demand for exports will increase if the terms of trade, \( q_j t / p_t e_t \), falls. Under the asset substitution specification, this terms of trade effect is present in the rate of return variables \( \Omega_{jt,t+1}, \Delta_{t,t+1} \) and \( \pi_{t,t+1} \). The advantage of the asset substitution approach over the conventional approach is that expected relative prices and interest rates are also given a role in the determination of export flows.

(16) This result parallels that of Daniel (1981) in that it focusses on the trade-off between endogenous terms of trade effects on the one hand, and foreign income effects on the other.

(17) See, for instance, Nguyen and Turnovsky (1979).
CHAPTER EIGHT

NON-TRADED GOODS AND THE SECTORAL IMPACTS OF DOMESTIC DISTURBANCES IN THE SMALL OPEN ECONOMY

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8.1 Introduction

Previous studies of small open economies with non-traded goods have usually been concerned with two main themes. The first has been to investigate the scope which non-traded goods afford domestic authorities in pursuit of stabilisation goals. A country which lacks market power in any of its exports and is a price taker on both commodity and finance markets, will in general have extremely limited options for influencing its own level of economic activity. According to Mussa (1979), it has been this image of an impotent government in a small open economy which has stimulated research into the circumstances in which domestic policy can be effective. The general point is that if there are non-traded goods or services, then macroeconomic policies can be effective by influencing the demand for them. (1)

The second main theme of the non-traded goods literature is the issue of sectoral conflict between traded and non-traded sectors. Recent contributions by Prachowny (1981), Brecher and Heady (1979) and Rodseth (1979), reveal that the external influences that impinge on the SOE may not be evenly distributed among all sectors of the economy. The stabilisation strategy which suits the interests of one sector may not be compatible with the strategy sought by other sectors, and for this reason a sectoral conflict can emerge. The issue of sectoral conflict is also highlighted in the studies by Corden (1981, 1982), Gregory (1976) and Snape (1977).

The purpose of this chapter is to investigate both of these issues in the context of a small open economy model with traded and non-traded goods. Attention is focussed on the linkages through which domestic events affect prices and output in the traded and non-traded sectors. The three sources of domestic influence to be investigated are the domestic money supply, sectoral productivity changes and tariff imposition. The impacts of foreign disturbances on this SOE model will be investigated in Chapter Nine.

The analytical framework is that of an open economy with three domestic sectors: a traded goods sector, a non-traded goods sector, and a
money sector. The traded goods sector includes both locally produced and imported commodities. It is assumed that purchasing power parity holds for both imported and exported commodities and that interest rate parity holds for domestic bonds. The price of non-traded goods, however, is determined domestically on the basis of excess demands generated in each of the three markets. The model of this chapter is basically the Chapter Six model augmented to allow for non-traded goods.

The model presented here differs from the models of Lucas (1980) and Prachowny (1981) in that we give explicit consideration to expected prices and exchange rates. As has been emphasised in previous chapters, expectations variables may be critical determinants of both the supply and demand for durable commodities and the endogenous behavior of price and exchange rate expectations is an important element of our model. It will be assumed, however, that the non-traded good differs from the traded goods in that it is non-durable. Hence the non-traded goods sector may be thought of as a services sector and it is evident that the property of non-durability may be a sufficient rationale for immobility. As a consequence of the non-durability assumption, it is proposed that only current price relativities figure in the excess demand for the non-traded good. Expected prices and interest rates are of relevance only to wealth transfer decisions in this model, and for this reason do not appear as direct determinants of non-traded sector excess demand.(2)

The basic SOE framework under a free trade specification is presented in Section 8.2. In the following section, the impacts of domestic monetary expansion are investigated. It is found that while money continues to have inflationary impacts on all domestic prices, it has no effect on the sectoral terms of trade. This implies that the output of the non-traded sector is neutral with respect to the domestic money supply. The output of the traded sector may, however, be influenced by the local monetary disturbance, depending on the sign of the 'expenditure switching effect' (defined below).

In Section 8.4 we then consider the implications of exogenous productivity increases in the traded and non-traded sectors. In each case a productivity improvement implies an addition to excess supply in the
particular market concerned. The economic adjustments implied by the productivity gains are shown to depend critically on which sector they emanate from and in general, non-traded sector productivity implies a more complex pattern of adjustment than traded sector productivity.

In Section 8.5 we investigate the effects of tariff imposition, drawing a distinction between current versus anticipated tariff increases. We seek to investigate at a sectoral level the proposition that tariff impositions have a contractionary effect on domestic economic activity. Our results imply both qualifications and modifications to this traditional result.

The final matter for investigation is the behavior of the real exchange in the presence of non-traded goods. Real exchange rate movements have attracted attention from a number of economists and, as in Chapter Six, our objective is to demonstrate how variations in the real exchange rate are consistent with ppp for traded goods.

A summary and conclusions are presented in Section 8.6.

8.2 Model specification under free trade

Our analysis commences with the assumption that the SOE operates in a free trade environment; the effects of tariff imposition will be addressed in Section 8.5. The real side of the model consists of two locally-produced goods: a durable, tradeable good, j, which is sold at a price determined by ppp; and a non-durable, non-traded good, n, which is sold at a price determined within the domestic economy. Residents of the SOE also import the representative aggregate global commodity, which formed the subject of analysis in Chapter Three. Essentially, this is the same as the real side of the Chapter Six model, extended to allow for non-traded goods.

The existence of non-traded goods implies that substitution between them and traded goods may take place in both consumption and production processes. A detailed specification of these processes is as follows.
Traded goods sector

Domestic output of the exported good $j$ is specified as:

\[(8.1) \quad S_{jt} = S_j \left[ \frac{q_{jt+1}^t}{v_{jt}} - 1, i_{t,t+1} \right], \quad S_{jt} > 0, \quad S_{jt} < 0
\]

where

- $S_{jt}$ is production of $j$;
- $q_{jt+1}^t$ is the expected domestic price of $j$;
- $v_{jt}$ is the current domestic price of $j$;
- $i_{t,t+1}$ is the current domestic interest rate;
- $q_{jt}$ is the current domestic price of the non-traded good, $n$.

This supply specification is similar to that used in previous Chapters. Output of $j$ is postulated to respond positively to its own expected price, and negatively to both its current price and the rate of interest. An additional element in this model is that the non-traded good also acts as a factor in the production of $j$, and a rise in $q_{nt}$ has a negative impact on the output of $j$. Both $j$ and $n$ are used as factors of production, in the proportions $v$ and $(1-v)$, respectively.

The demand for $j$ comes from three sources. Firstly there is demand for consumption purposes, $C_{jt}$:

\[(8.2) \quad C_{jt} = c_j Y^d_t, \quad 0 < c_j < 1
\]

where $Y^d_t$ is aggregate real domestic income. The latter is defined as the sum of outputs in the traded and non-traded goods sectors, $S_{jt}$ and $S_{nt}$, respectively:

\[(8.3) \quad Y^d_t = S_{jt} + S_{nt} \cdot \frac{q_{nt}}{q_{jt}}
\]

It may be noted that $Y^d_t$ is made real with respect to the price of the traded good, $j$. The specification of $S_{nt}$ is given below.
The second source of demand for j is for inventory purposes by domestic residents:

\[ I_{jt}^d = \Omega_{jt,t+1} \Omega_{t,t+1} q_{jt,t+1}, \]

where \( \Omega_{jt,t+1} = \frac{q^*_{jt+1} - 1}{q_{jt}} \) is the expected rate of price change for j;

\( \Omega_{t,t+1} = \frac{q^*_{t+1} - 1}{q_t} \) is the expected rate of price change for the imported good;

\( q^*_{t+1} \) is the expected domestic price of imports;

\( q_t \) is the current domestic price of imports.

This specification follows the approach adopted in previous chapters in that the asset demand for j responds positively to its own expected rate of return and negatively to the return on alternative assets. An additional element, however, is that the price of the non-traded good also affects the demand for j: following conventional treatment, we assume that a rise in \( q_{nt} \) increases the demand for j (i.e., traded and non-traded goods are substitutes in demand).

The third source of demand for j is the demand for exports by foreign residents:

\[ x_{jt}^e = x(\pi_{jt,t+1}^*, r_{t,t+1}, y^e_t, \pi_{t,t+1}^*), x_1, x_3 > 0; x_2, x_4 < 0. \]

where \( \pi_{jt,t+1}^* = \frac{p^*_{jt+1} - 1}{p_{jt}} \) is the expected rate of price change for j in terms of foreign currency;

\( r_{t,t+1} \) is the foreign interest rate;

\( y^e_t \) is real world income;
\[
\pi_{t,t+1} = \left( \frac{P_{t+1}}{P_t} \right)^{-1}
\]
is the expected rate of price change for the imported good in terms of foreign currency (equal to the global aggregate rate of expected inflation);

\(p_{jt}^{*+1}\) is the expected world price of \(j\);

\(p_{jt}\) is the current world price of \(j\);

\(p_{jt}^{*}\) is the expected world price of imports;

\(P_t\) is the current world price of imports.

The export demand function is identical to that specified in Chapter Six and reflects the impotence of domestic events as determinants of export performance. In particular, the exchange rate plays no role in determining export flows, unlike the market power model of Chapter Seven.

Excess demands within the traded goods sector are also influenced by expenditures on imported goods. The demand for imports by domestic residents is given by:

\[
(8.4) \quad m_t = m(\Omega_{t,t+1} i_t, t+1, \gamma^d_t, \Omega_{jt,t+1}, q_{nt})
\]

\[
m_1, m_3, m_5 > 0; m_2, m_4 < 0.
\]

This import specification is the same as in Chapter Six, with the additional influence created by the price of non-traded goods, \(q_{nt}\). As in the case of the demand for \(j\), a rise in \(q_{nt}\) induces a rise in demand for imports, implying substitutability in demand.

Equilibrium in the traded goods sector is defined by:

\[
(8.5) \quad c_j y_t^d + I_{jt} + X_{jt} - S_{jt} - q_{jt}^m - G_{jt} = 0
\]

This equilibrium condition includes an exogenous supply component, \(G_{jt}\). In the analyses which follow we shall interpret a rise in \(G_{jt}\) in terms
of a rise in the productivity of producing j. It will also be assumed that the income effects on consumption equal the income effects on imports; i.e. $c_m$.

**Non-traded goods sector**

It is assumed that the non-traded good is non-durable, similar to a services sector. The main analytical implication of this assumption is that the expected price of the non-durable good has no behavioral significance for current excess demands. For this reason, and following Prachowny (1981), we introduce the concept of the *sectoral terms of trade*, $\varepsilon_t$, as the variable which determines behavior in the non-traded goods sector. The sectoral terms of trade is defined as:

$$\varepsilon_t = q_{nt} / w_t$$

where $w_t = w_{q,t} + (1-w)q_t$, is the average domestic price of traded goods. The demand for the non-traded good is specified as:

$$D_{nt} = D_n(\varepsilon_t), \quad D'_n < 0$$

and its supply is specified as:

$$S_{nt} = S_n(\varepsilon_t), \quad S'_n > 0.$$ 

Equilibrium in the non-traded goods sector is therefore written as:

$$D_n(\varepsilon_t) - S_n(\varepsilon_t) - G_{nt} = 0.$$ 

Once again, we have included an exogenous supply variable, $G_{nt}$, into the equilibrium condition. In this case, a rise in $G_{nt}$ is taken to imply an increase in productivity in the supply of non-traded goods.

**Money market**

Following the treatment of previous chapters, equilibrium in the domestic money market is specified as:
The important aspect to note is that only the prices of traded goods appear in the excess demand for real money balances. The reason for this is that non-traded goods, being non-durable, do not qualify as alternatives to money as a means of storing wealth. Traded goods, on the other hand, do exist as alternative forms of wealth and for this reason nominal money supplies, $L_t$, are made real with respect to $w_t$, the average price of traded goods.\(^{(5)}\)

**Parity conditions**

As noted above, it is assumed that purchasing power parity holds for both imported and exported goods.\(^{(6)}\) In addition, it is assumed that interest rate parity also applies. Hence, we specify:

\[
(8.11) \quad e_t = \frac{q_t}{p_t} = \frac{q_{jt}}{p_{jt}}
\]

\[
(8.12) \quad e^{*}_{t+1} = \frac{q^{*}_{t+1}}{p^{*}_{t+1}} = \frac{q^{*}_{jt+1}}{p^{*}_{jt+1}}
\]

and

\[
(8.13) \quad i_{t,t+1} = r_{t,t+1} + \Delta_{t,t+1}
\]

where \( \Delta_{t,t+1} = (\frac{e^{*}_{t+1}}{e_t} - 1) \) is the expected rate of exchange depreciation; \( e^{*}_{t+1} \) is the expected exchange rate.

**General equilibrium**

A general equilibrium in the domestic economy holds when each of the market-clearing conditions (8.5), (8.9) and (8.10) hold simultaneously.
Our interest lies in the equilibrating responses of the domestic variables to specific disturbances and we proceed by taking a total differential of these three market clearing conditions. Substituting in the parity conditions gives the following three equation system in the unknowns: $de^*_{t+1}$, $de_t$, and $dq_{nt}$.

\[
\begin{bmatrix}
B_1-S_{j1} & S_{j1}V-B_1 & B_2 \\
D_1 & D_2 & D_3 \\
0 & S'_n-D'_n & D'_n-S'_n
\end{bmatrix}
\begin{bmatrix}
de^*_{t+1} \\
d_{t} \\
dq_{nt}
\end{bmatrix}
= 
\begin{bmatrix}
K_1 \\
K_2 \\
K_3
\end{bmatrix}
\]

where

\[
K_1 = (B_3+S_{j1})\ dp^*_t - (B_3+S_{j1}V+m_t)\ dp_t + B_4\ dr_t,t+1
+ B_5\ dp^*_t + (m_t-B_5)\ dp_t - x_3\ dy^f_t + dG_{jt}
\]

\[
K_2 = -(l_1w + l_3s_{j1})\ dp^*_t + l_1(l-w)\ dp^*_{t+1} + D_4\ dp_{jt}
+ D_5\ dp_t - (l_2+l_3s_{j2})\ dr_t,t+1 + dl_t
\]

\[
K_3 = (D'_n-S'_n)\ wp_{jt} + (D'_n-S'_n)(l-w)\ dp_t + dG_{nt}
\]

\[
B_1 = I_1+I_2+I_3-m_1-m_2-m_4-S_{j2} < 0
\]

\[
B_2 = S_{j1}(1-v) + I_4 - m_5 > 0
\]

\[
B_3 = m_4x_1-I_1 < 0
\]

\[
B_4 = S_{j2}-I_3-x_2+m_2 > 0
\]

\[
B_5 = m_1x_4-I_2 > 0
\]

\[
D_1 = l_1+l_2+l_3(S_{j1}+S_{j2}) < 0
\]

\[
D_2 = L_t-l_1-l_2-l_3(S_{j1}V+S_{j2}+S'_n+S_{nt}) > 0
\]

\[
D_3 = l_3(S'_n+S_{nt}-S_{j1}(1-v)) > 0
\]
\[ D_4 = w(\ell_1 - L_t) + \lambda_3 (S_1 v + S_1 w + S_{nt}) < 0 \]

\[ D_5 = (1-w)(\ell_1 + \lambda_3 S_{nt} - L_t) < 0 \]

The signing of these excess demand coefficients is based on the proposition that excess demand in each market be an increasing function of own-rate of return and a decreasing function of the rate of return on alternative assets. Even with this proposition, however, the coefficient \( D_3 \) remains ambiguous. This coefficient measures the money market effects of a rise in the price of the non-traded good, \( q_{nt} \). As emphasised earlier, \( q_{nt} \) plays no direct role in determining money market excess demand, and the presence of \( D_3 \) reflects the impact of \( q_{nt} \) on aggregate domestic income. To the extent that \( q_{nt} \) has a greater impact on non-traded good production than on the production of \( j \), then \( D_3 \) will be positive. Conversely however, the more important is the non-traded good in the production of \( j \), the larger is the weight \((1-v)\) and the more likely it becomes that \( D_3 \) is negative.

The Jacobian of (8.14) is determined as:

\[ (8.15) \quad J = (D'_n - S'_n) [L_t (B_1 - S_{jl}) + D_1 (m_5 - I_4)] \geq 0. \]

The ambiguity in the sign of \( J \) is due to the presence of the term \((m_5 - I_4)\). This term measures the effects of a rise in \( q_{nt} \) on import demand, net of its effect on the demand for \( j \). If the demand for both imports and the local product are equally responsive to the price of the non-traded good, then \((m_5 = I_4)\) and \( J > 0 \) unambiguously. If import demand is more responsive to \( q_{nt} \) than is demand for the local product, then \((m_5 - I_4 > 0)\) and \( J > 0 \) once again. Indeterminacy persists, however, in the case where \((m_5 - I_4 < 0)\) such that \( J \not\geq 0 \).

For the analyses which follow, it will be assumed that \( J > 0 \) on the grounds that the demand for the imported good shows a similar response to \( q_{nt} \) as does demand for the local good. This is not to imply however, that we necessarily regard these commodities as being equally substitutable, for, as the next section demonstrates, the sign of \((M_5 - I_4)\) is a critical determinant of domestic monetary impacts.
8.3 Domestic monetary expansion

Exogenous changes in the stock of domestic money, \( L_t \), give rise to the following adjustments. Firstly, the exchange rate and price of non-traded goods respond according to:

\[
\frac{d\epsilon_t}{dL_t} = \frac{dq_{nt}}{dL_t} = \frac{1}{J} (B_n - S_{1j}) (D_n - S_{1n}) > 0
\]

Hence, with purchasing power parity, the prices of both traded goods, \( q_{jt} \) and \( q_{nt} \), increase by this same amount. This means that the sectoral terms of trade, \( \epsilon_t \) (defined in (8.6)) is not affected by the monetary disturbance. Given the dependence of the output of the non-traded good (\( S_{nt} \)) on \( \epsilon_t \), we see also (using (8.8)) that:

\[
\frac{d\epsilon_t}{dL_t} = \frac{dS_{nt}}{dL_t} = 0
\]

In other words, domestic monetary disturbances are neutral with respect to the output of the non-traded good. This result is identical to the long run neutrality proposition derived by Prachowny (1981) in the case of flexible exchange rates.

The response of the traded good \( j \) to the monetary disturbance is slightly more complex. The supply of \( j \) depends not only on current price relativities but on intertemporal price relativities as well. The latter are influenced by the movement in price and exchange rate expectations, which we solve as:

\[
\frac{de_{t+1}}{dL_t} = \frac{dq_{jt+1}}{dL_t} = \frac{1}{J} (S_{n} - D_n^j) (S_{j}^n v^j - B_1^j + B_2^j) > 0
\]

Hence, the monetary disturbance causes both current and expected prices (and exchange rates) to rise. The relative magnitudes of these adjustments is solved from (8.18) and (8.16) as:

\[
\frac{d\Delta_t}{dL_t} = \frac{di_{t+1}}{dL_t} = \frac{1}{J} (D_n^j - S_{n}^j) (S_{j}^n (1 - v)^j - B_2^j)
\]

\[
= \frac{1}{J} (D_n^j - S_{n}^j) (m_n^j - I_n^j) > 0
\]
In other words, the rise in $e_t$ may be greater or less than the rise in $e_{t+1}$ and because of this, the response of $\Delta_t$, $\Delta_{t+1}$ and $i_t$, $i_{t+1}$ to $L_t$ is indeterminate. The source of the indeterminacy is the term $(m_5 - I_4)$, which we encountered previously in connection with the signing of the Jacobian $J$. An exogenous increase in the money shock will raise (lower) the domestic nominal rate of interest whenever the term $(m_5 - I_4)$ is less than (greater than) zero. Alternatively, $L_t$ will have no effect on $i_t$, $i_{t+1}$ if $(m_5 - I_4)$ equals zero; that is when import demand and domestic stock demand are equally responsive to a rise in $q_{nt}$.

This result suggests that the interest rate effect of the money supply increase is linked closely to the expenditure-switching effect that the rise in $q_{nt}$ brings about. It will be recalled from Chapters Five and Six that under generalised purchasing power parity, domestic monetary disturbances are neutral with respect to the interest rate. A neutrality result emerges in this model only if the rise in $q_{nt}$ does not imply any expenditure switching between imports and the local product. To the extent that such switching does take place, the domestic interest rate will respond accordingly.

Substituting into (8.1), we find that the output of the traded good $j$ responds to the monetary disturbance according to:

$$
(8.20) \quad \frac{dS_{jt}}{dt_t} = (S_{j1} + S_{j2}) \frac{di_t, t+1}{dl_t} \geq 0
$$

If, as in previous chapters we assume that the sum of the production coefficients is positive, such that $(S_{j1} + S_{j2}) > 0$, then the output of $j$ responds to $L_t$ in the same direction as the change in the interest rate. The latter, in turn, depends on the expenditure switching effect associated with rising $q_{nt}$. It is evident that money will be neutral with respect to the traded goods sector only if the rise in $q_{nt}$ does not imply any expenditure switching between commodity $j$ and imports (i.e., if $m_5 = I_4$). If expenditure shifts relatively more towards imported goods, then $(m_5 - I_4) > 0$, and both interest rates and the output of $j$ will fall. If, on the other hand, the rise in $q_{nt}$ shifts expenditures relatively more toward the local traded good, then $(m_5 - I_4) < 0$, and both interest rates and the output of $j$ will rise.
The implications of domestic monetary disturbances for aggregate economic activity, \( \gamma^d \), therefore depend entirely on the response of the output of the traded sector. To the extent that \( S_jt \) rises in response to \( L_t \), then the traded goods sector will increase not only in absolute size, but as a proportion of total domestic economic activity as well. Conversely, however, if \( S_jt \) falls in response to \( L_t \), then monetary expansion will induce a fall in both the absolute and relative sizes of the traded goods sector. Which of these scenarios eventuates depends critically on the relative substitutability between the non-traded good on the one hand, and locally produced and imported traded goods on the other.

These results suggest that while monetary disturbances may not be neutral with respect to the traded goods sector, they do not imply sectoral conflict either. Variations in the output of the traded good occur independently of the output of the non-traded good. This property emerges because we have not constrained the economy to lie at a full-employment equilibrium such that expansion in one sector occurs only at the expense of contraction in the other. Clearly, if this full employment (or fixed production possibility frontier) constraint had been applied, then non-neutrality in the traded goods sector would necessarily imply non-neutrality in the non-traded goods sector. Under these circumstances, monetary policy may give rise to sectoral conflict if expenditure switching takes place.

8.4 Productivity increases

Consider now the sectoral impacts which may arise out of productivity changes. Within each sector, we have specified supply-augmenting variables, \( G_{jt} \) and \( G_{nt} \), which may be interpreted as productivity increases. The impacts associated with each of these variables are derived as follows.

**Traded sector productivity**

An increase in the productivity of the traded goods sector is parameterised by an increase in \( G_{jt} \). From (8.5) we see that the initial impact of the productivity increase is to create excess supply in the
market for \( j \) which in turn leads to the following price and exchange rate adjustments:

\[
\frac{\Delta e^*_{t+1}}{\Delta G_{jt}} = \frac{1}{J} (D' - S') (L - D) < 0
\]

\[
\frac{\Delta q_{nt}}{\Delta G_{jt}} = \frac{-D_1}{J'} (D' - S') < 0
\]

The productivity increase leads to a fall in the price of the non-traded good and to an appreciation in both the current and expected exchange rates. From (8.22) we see that there are identical falls in \( e_t \) and \( q_{nt} \), which implies that under ppp, all domestic prices fall by exactly the same amount. This result may be contrasted with that obtained in Chapter Seven, where an exogenous increase in the supply of \( j \) led to a fall in the price of \( j \), but to a devaluation of the exchange rate. The Chapter Seven result was obtained, however, under the assumption that the price of \( j \) was endogenous to the domestic economy and it is evident that the exchange rate effects of domestic supply disturbances depend critically on whether the ppp assumption is invoked.

A further implication of (8.22) is that the sectoral terms of trade, \( e_t \), are unaffected by the productivity change in sector \( j \). The average domestic price of traded goods, \( w_t \), falls by the same amount as the fall in the non-traded good price, \( q_{nt} \), such that \( \Delta e = 0 \). From (8.8), this means that the output of the non-traded good remains unaffected by productivity changes in the traded good sector:

\[
\frac{\Delta q_{nt}}{\Delta G_{jt}} = 0
\]

The response of sector \( j \) depends, however, on price appreciation, cost of production and interest rate effects. Solving for these, we obtain:

\[
\frac{\Delta q_{jt}}{\Delta G_{jt}} = \frac{\Delta e^*_{t+1}}{\Delta G_{jt}} < 0
\]

\[
\frac{\Delta V_{jt}}{\Delta G_{jt}} = \frac{\Delta e_t}{\Delta G_{jt}} < 0
\]
The productivity increase leads to a fall in the cost of producing $j$, $v_{jt}$, which is identical to the fall in the exchange rate. This result emerges because the price of the traded factor of production changes by the same amount as the non-traded factor of production. The domestic interest rate, $i_{t,t+1}$, on the other hand, falls in response to the productivity increase. The interest rate fall is identical to the drop in the expected rate of exchange depreciation and emerges because the expected exchange rate responds to $G_{jt}$ by more than the current exchange rate. It may be noted that a negative relationship between the interest rate and the supply of $j$ was also obtained in Chapter Seven under conditions of market power.

The combined effects of these price and interest rate changes on the output of $j$ are derived as:

\[
(8.26) \quad \frac{d\Delta_{t,t+1}}{dG_{jt}} = \frac{d\Delta_{t,t+1}}{dG_{jt}} = \frac{L_t}{J} \quad (D'_n - S'_n) < 0
\]

Hence the increase in sectoral productivity induces a fall in the output of $j$. In deriving this result, we have maintained the assumption of previous chapters that the sum of the production coefficients is positive, i.e. $S_{j1} + S_{j2} > 0$. In effect, this means that current output decisions are more responsive to the fall in the expected return on producing $j$ than to the (equal) fall in the interest rate.

It will be recalled from the analysis of Chapter Seven that under the assumption of market power, the output of $j$ increased as a result of an exogenous supply increase. That result emerged because the expected return on producing $j$ increased in response to $G_{jt}$ while the domestic interest rate fell. The result in this chapter, however, is parallel to that obtained in Chapter Six which was also estimated under conditions of generalised purchasing power parity. An important implication to emerge from these results, therefore, is that the existence of non-traded goods does not affect in any qualitative sense the real impacts of a domestic supply disturbance. The existence of market power, however, does lead to substantial qualitative differences.
From these results, we also see that aggregate economic activity falls in response to the traded goods sector productivity increase. The burden of adjustment is taken up entirely by the fall in output of j since non-traded good output remains constant. This result may be regarded as conventional in the sense that it is the converse of the traditional result that increased demand leads to increased output. In the present analysis, it is a case of increased supply inducing a fall in output of commodity j.

**Non-traded sector productivity**

An exogenous increase in the productivity of the non-traded goods sector is represented by an increase in $G_{nt}$. From (8.9) we see that this has the immediate effect of creating excess supply in the non-traded good market and this in turn leads to the following price and exchange rate adjustments:

\[
\frac{dP_{t+1}^e}{dG_{nt}} = \frac{1}{J} \left( D_3 (S_{j1} B_1 - B_2 D_2) \right) \geq 0
\]

\[
\frac{dP_t}{dG_{nt}} = \frac{1}{J} \left( D_3 (S_{j1} B_1 + B_2 D_1) \right) \geq 0
\]

\[
\frac{dQ_{nt}}{dG_{nt}} = \frac{1}{J} \left( B_1 (D_1 + D_2) - S_{j1} (D_1 V + D_2) \right) \geq 0
\]

The indeterminancy in each of these impacts arises because of the effects that are associated with the income coefficient of the demand for real money balances, $\lambda_3$. If we take the limiting case where the demand for real balances is unresponsive to income changes, such that $\lambda_3 = 0$, then:

\[
D_3 = 0, \quad D_1 + D_2 = L_t, \quad \text{and} \quad D_1 V + D_2 = L_t - (1-v)(\lambda_1 + \lambda_2).
\]

Under these circumstances, we obtain:

\[
\frac{dP_{t+1}^e}{dG_{nt}} = -\frac{B_2 D_2}{J} < 0
\]
The negative relation between $q_{nt}$ and $G_{nt}$ is reasonably in accord with intuition in the sense that a supply rise puts downward pressure on prices. In this model however, the result is slightly more complex in the sense that the initial excess supply in the non-traded goods market stimulates a fall in the sectoral terms of trade, $\varepsilon_t$. This in turn implies output adjustments in both domestic sectors which then create income effects in the money market. By excluding the latter, we have obtained the ultimate changes in prices and exchange rates as being consistent with the portfolio component of money market demand (as reflected in the coefficients, $l_1$ and $l_2$).

The sectoral terms of trade effect is derived as:

$$
(8.34) \quad \frac{d\varepsilon_t}{dG_{nt}} = \frac{1}{J} \left[ L_t (B_1 - S_{j1}) - D_1 (I_4 - m_5) \right] \geq 0
$$

This result has been derived independently of any assumption concerning the value of $l_3$ and in this case the indeterminacy emerges because of the expenditure switching term $(I_4 - m_5)$. It will be recalled from the previous section, that the neutrality or otherwise of domestic monetary disturbances depends critically on the sign of this term and that money is neutral only if $(I_4 - m_5) = 0$. In (8.34), we see that the sectoral terms of trade respond in the 'correct' direction (i.e. downward) whenever $I_4 - m_5 < 0$. Whilst this condition is sufficient, but not necessary for the re-establishment of non-traded sector equilibrium, we may note that it is consistent with money having either neutral or depressing effects on total output.

To the extent that $\varepsilon_t$ does fall in response to $G_{nt}$, then the output of the non-traded good must fall also. Hence, the negative relationship between productivity and output that was found for the traded goods sector, is present in the non-traded goods sector also. The
The fall in output in each case is a reflection of the excess supply that productivity gains imply.

The output of the traded sector in this case depends in part on the movement in interest rates. Solving for this, we obtain:

\[
(8.35) \quad \frac{d_i}{dG_{nt}} = \frac{1}{J} \left[ D_3 (I_4 - m_5) - B_2 L_t \right] \geq 0
\]

This impact is indeterminate, again due to the terms \(D_3\) and \((I_4 - m_5)\). To the extent that either of these is zero, then \(i_{t,t+1}\) will fall in response to \(G_{nt}\), as it did in response to \(G_{jt}\). For non-zero values of these terms, however, the interest rate response is indeterminate.

For these reasons, the output of the traded good is also indeterminate and in general no simple relationship exists between productivity in the non-traded good sector and output in the traded good sector. A number of limiting cases may however be deduced. The general response of \(S_{jt}\) to \(G_{nt}\) is given by:

\[
(8.36) \quad \frac{dS_{jt}}{dG_{nt}} = \frac{1}{J} \left[ S_{j1} \left( (m_5 - I_4) (D_1 v + D_2) - B_1 L_t (1-v) \right) + S_{j2} \left( D_3 (m_5 - I_4) - B_2 L_t \right) \right]
\]

The simplest case is where \(m_5 - I_4 = 0\). In this case the response of \(S_{jt}\) to \(G_{nt}\) is positive due to the rise in the expected return on producing \(j\) and the fall in the interest rate. In other words, the condition required for money neutrality is consistent with a positive transmission of a productivity gain in the non-traded sector to output in the traded sector.

An alternative possibility exists where the income coefficient of money demand is close to zero: \(\lambda_3 = 0\). As shown above, this case is characterised by falling exchange rates and prices. From (8.35), we also find that this assumption implies a fall in the interest rate. The output of the traded good is now given by:
The output of \( j \) remains indeterminate due to the presence of \( (m_5 - I_4) \).

If this term is non-negative, the response of \( S_{jt} \) is unambiguously positive, again reflecting a rise in expected profitability and the fall in the interest rate. As noted earlier, however, \( (m_5 - I_4) > 0 \) implies a negative transmission from domestic money to the output of \( j \).

The general conclusion to emerge therefore is that non-traded sector productivity implies a more complex adjustment pattern than traded sector productivity. Non-traded sector productivity changes lead to movements in the sectoral terms of trade, \( \epsilon_t \), and these in turn lead to adjustments in both sectors of the economy. Productivity changes in the traded goods sector, on the other hand, leave \( \epsilon_t \) unchanged, and for this reason lead to adjustments in the traded sector only. Hence we find an asymmetry in the sectoral transmission of productivity changes: non-traded sector productivity gains are transmitted to both sectors of the domestic economy; traded sector productivity gains are absorbed by the traded sector only.

The negative link between productivity and output in the traded goods sector may seem counter-intuitive in the sense that productivity gains are usually associated with a fall in production costs which, ceteris paribus, stimulate output. The approach of this chapter has emphasised however, the effect that productivity gains have on the excess supply of the good in question, and how this in turn stimulates a fall in output. As noted above, this result is consistent with the conventional argument that exogenous demand increases (rather than supply increases) stimulate output to rise. The role of the ppp assumption in achieving a negative relation between productivity and output should be stressed however. In Chapter Seven we found that an exogenous supply increase led to a rise in output because the global competitiveness of the traded commodity was increased. Under ppp, however, the fall in the domestic price of the traded good does nothing for its global competitiveness, since it is offset by a revaluation of the exchange rate. Instead, we have found that the productivity rise leads to a reduction in the expected profitability
of domestic production and this in turn leads to a negative productivity-output relation for the traded good \( j \).

In the non-traded goods sector, we have also found a tendency for a negative link between productivity and output, due to the downward pressure applied on the sectoral terms of trade. This result emerges most clearly in the case where 'expenditure switching' effects are absent; i.e., where \( I_4 = m_5 \) in (8.34). In the event that this condition does hold, there is an unambiguous positive transmission of productivity to output from the non-traded goods sector to the traded goods sector. Under these circumstances, efforts aimed at stimulating productivity in the non-traded sector will achieve the seemingly perverse result of stimulating growth in the traded goods sector at the expense of the non-traded goods sector.

8.5 The effects of tariff imposition

Reference was made in the Introduction to this chapter to the unequal impact that foreign disturbances may have on the traded and non-traded sectors of the domestic economy. Governments may attempt to alter the nature of these impacts by using tariffs or subsidies on traded goods so as to change not only the domestic terms of trade between traded goods, but the sectoral terms of trade between traded and non-traded goods as well.\(^8\)

A number of analysts have concluded that, at the aggregate level, the imposition of a tariff leads to a contraction in domestic economic activity. Mundell (1961, 1968) for instance, proposes that a tariff improves the terms of trade, increases domestic saving via a Laursen-Metzler effect, and therefore leads to a fall in output. More recent studies by Chan (1978) and Eichengreen (1981) also find a tariff to be contractionary, but for different reasons. In the Chan-Eichengreen analyses, the contraction emerges because the tariff creates excess supply in the money market (through the accumulation of foreign reserves) and this, in turn implies downward pressure on aggregate output and prices. Ruffin (1979) similarly concentrates on the domestic money market effect as the major factor influencing response to the tariff imposition.
The analysis of this section seeks to extend these studies by evaluating the sectoral as well as the aggregate impacts of tariff imposition. Our approach is to assume that the tariff causes a discrete rise in the domestic price of the imported good which in turn creates relative price distortions. In order to focus attention on this relative price effect, we also assume that the revenue collected from the tariff does not add directly to the domestic money supply. (9)

A tariff is incorporated into the model of this chapter by specifying the domestic price of the imported good as:

\[ q_t = p_t \cdot e_t \cdot (1 + \lambda_t) \]  

(8.38)

The tariff is represented by the parameter \( \lambda_t \), which is assumed to be zero initially and subject to exogenous variation. A rise in \( \lambda_t \) has the immediate effect of increasing the domestic price of the imported good which, in turn, creates excess demand on each of the three domestic markets. From the coefficient matrix given in (8.14), this implies the following price and exchange rate adjustment pressures in each of the three markets (see Table 8.1).

Table 8.1: PRICE AND EXCHANGE RATE ADJUSTMENT PRESSURES IN DOMESTIC MARKETS FOLLOWING THE IMPOSITION OF A TARIFF

<table>
<thead>
<tr>
<th></th>
<th>( e_t )</th>
<th>( q_{nt} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traded goods market</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-traded goods market</td>
<td>-</td>
<td>+/-</td>
</tr>
<tr>
<td>Money market</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

In each market there is an initial pressure on the exchange rate to fall (i.e. revalue) following imposition of the tariff. Whether or not an actual revaluation emerges, however, depends on the associated behavior of the price of non-traded goods, \( q_{nt} \). As shown in Table 8.1, the pressures applied to \( q_{nt} \) differ in each of the three markets and because of this, the ultimate change in both \( e_t \) and \( q_{nt} \) becomes quite complex. As demonstrated below, the simple proposition derived by, for
instance, Chan (1978) that a tariff causes exchange rate revaluation, emerges only as a special case in the presence of non-traded goods.

Apart from emphasising traded sector: non-traded sector interactions, the following analyses will also highlight the differences between anticipated and unanticipated tariff imposition. The tariff $\lambda_t$ in (8.38) is regarded as being an unanticipated imposition in the sense that it is introduced at time $t$ without any forewarning. Corresponding to (8.38), we may also specify the expected domestic price of the imported good as:

$$q^*_{t+1} = p^*_{t+1} \cdot e^*_{t+1} \cdot (1+\lambda^*_{t+1})$$

The parameter $\lambda^*_{t+1}$ represents tariff that at time $t$ is expected to be imposed one period hence. As before, we assume that at the initial equilibrium $\lambda^*_{t+1}$ is zero.

For the purposes of this analysis, it will be assumed that the tariff imposed at time $t$ is regarded by market participants as being temporary. Analytically, this implies that changes in $\lambda^*_{t+1}$ are independent of changes in $\lambda_t$ and we shall treat these two cases separately. (10)

**Unanticipated tariff imposition**

Consider firstly the exchange rate effect of a rise in $\lambda_t$.

Substituting (8.38) into (8.14) and solving, we obtain:

$$\frac{\partial e}{\partial \lambda_t} = \frac{(D_1' - S_1')} {n} \cdot [D_1(B_6 + (1-w) B_2 - m_t) + (B_1 - S_{j1})(D_5 - (1-w)D_3)] \geq 0$$

This expression for the exchange rate response contains both positive and negative influences. The devaluation pressures enter through the term $(B_6 + (1-w) B_2 - m_t)$. This term consists of two positive elements: $(B_6 - m_t)$, which measures the direct effect of $\lambda_t$ on the excess demand for $j$; and $(1-w)B_2$ which measures the indirect effect of $\lambda_t$ on the excess demand for $j$ through an induced change in the price of the non-traded good. It is not possible to obtain any simple generalisation as to whether these devaluation forces will be dominated by the revaluation forces. As indicated earlier, the tariff sets off adjustment
pressures in each of the three markets simultaneously and it is because of the diversity of these adjustment pressures that no clear response of the exchange rate can be obtained.

The response of the sectoral terms of trade, $e_t$, to the tariff imposition does, however, reveal a clearer picture. Solving for this we obtain:

$$\frac{de_t}{d\lambda_t} = \frac{(1-w)(D'-S')}{J} \left[ L_t(B_1-S_j) - D_1(I_4-m_5) \right]$$

This expression is unambiguously positive whenever the 'expenditure switching' term, $(I_4-m_5)$, is zero or negative. In other words, if the demand for imports responds by an equal or greater amount to a change in $q_{nt}$ than does the demand for $j$, the sectoral terms of trade will show an unambiguous improvement. This implies that while we are unable to determine the separate response of either $e_t$ or $q_{nt}$ with any degree of generality, their ratio ($e_t = q_{nt}/e_t$) increases in response to $\lambda_t$. Furthermore, given the positive dependence of the output of non-traded goods on $e_t$, it is also evident that under these circumstances the non-traded sector will be stimulated by the tariff.

It is feasible, of course, for the expenditure switching term $(I_4-m_5)$ to be positive and still have an increase in the output of non-traded good. This result emerges however, only if $(I_4-m_5)$ satisfies an upper limit implicit in (8.41); that is, the demand for $j$ can be more responsive to $q_{nt}$ than the demand for imports, but not by too much.

The response of the traded goods sector to the tariff is slightly more complex and depends in part on the movement in the interest rate, $i_{t,t+1}$. Solving for the latter, we obtain:

$$\frac{di_{t,t+1}}{d\lambda_t} = \frac{(D'-S')}{J} \left[ \frac{R}{n} \left( m - B_6(1-w)B_2 \right) \right.$$

$$- \left. (I_4-m_5)(1-w)(L_t + S_j(1-v) - S_{nt}) \right]$$
Once again, the expenditure switching effect is present in the term \((I_4 - m_5)\). The simplest case emerges when we let this term approach zero in which case the interest rate rises in response to the tariff. It may be noted that a rise in the interest rate will also occur for negative values of \((I_4 - m_5)\).

The effect of the tariff on the output of the traded good sector depends on its effects on both the expected return from producing \(j\) and the interest rate response. Restricting our attention to the simplest case where the expenditure switching effect is not present (i.e. where \(I_4 - m_5 = 0\)), we obtain the response of the traded good sector as:

\[
\frac{dS_{jt}}{d\lambda_t} = \frac{(D' - S')}{J} L_t \left[ (S_{j1} + S_{j2})(m_t - B_t) - (1-w) S_{j1}(1-v)B_t + B_2S_{j2} \right]
\]

Even with this simplifying assumption, the response of \(S_{jt}\) is ambiguous. One factor contributing to this ambiguity is the term \((1-w)\), which represents the weight assumed by import prices in the average domestic price of traded goods. The smaller is this weight, the smaller the influence of import prices on average domestic prices and the more likely it becomes that \(dS_{jt}/d\lambda_t > 0\). Conversely, however, the larger is the initial contribution of imported goods to average domestic prices, the more likely it is that a contractionary effect on \(S_{jt}\) will be recorded. Under these circumstances, the tariff may result in a fall in the output of the traded good sector.

Hence, we find that in the absence of expenditure switching effects (as defined above), a tariff will stimulate domestic production of the non-traded good but may induce a fall in the production of the traded good. In this sense the tariff will be a source of sectoral conflict, favouring the non-traded sector to the possible detriment of the traded sector.

The overall effect on aggregate economic activity remains indeterminate, however. Unlike previous models in which a direct link was postulated between tariff-induced exchange rate movements and aggregate economic activity, this model possesses a less determinate linkage. The source of the ambiguities lies in the flexibility with which each of the
domestic sectors may respond to price and interest rate signals and within this setting, no exact link between the tariff and aggregate economic activity can be established.

Anticipated tariff imposition

Consider now the impacts associated with a tariff imposition which at time $t$ is expected to take place at time $t+1$. It is assumed for convenience that the expectation is formed exogenously of current events, although the model could be extended to allow for a 'tariff policy reaction function'. We proceed by incorporating (8.39) into (8.14) and solving for an increase in the expected tariff level, $\lambda_{t+1}^*$. The price and exchange rate effects of an exogenous increase in $\lambda_{t+1}^*$ are qualitatively similar to those associated with a current tariff imposition. That is, we find the presence of trade-offs within these responses which reflect the multi-market impacts that initially accompany the rise in $q_{t+1}^*$. Writing these out we obtain:

$$\frac{de_t}{d\lambda_{t+1}^*} = \frac{dq_{nt}}{d\lambda_{t+1}^*} = \frac{(D_1 - S')}{J} \left( - B\frac{D_1}{D_1} - \frac{\lambda}{(1-w)}(B_1 - S_{ij}) \right)$$

The main point to note is that $q_{nt}$ and $e_t$ adjust by exactly the same amount. Unlike the case of current tariff imposition, we find therefore that anticipated tariff change implies no sectoral terms of trade effect. It follows directly from this that anticipated tariff changes have no impact on output from the non-traded goods sector either.

The interest rate effect of anticipated tariff imposition is determined as:

$$\frac{di_{t,t+1}}{d\lambda_{t+1}^*} = \frac{(D_1 - S')}{J} \left[ L_t B_6 + (1-w) \frac{\lambda}{(I_4 - m_3)} \right]$$

The interest rate falls in response to $\lambda_{t+1}^*$ whenever the expenditure switching term $(I_4 - m_3)$ is zero or negative. This is opposite to the
result obtained for current tariff imposition and reflects differences in adjustments made by current and expected exchange rates. In the case of current tariff imposition, the gap between $e_t$ and $e_{t+1}^*$ widens, thereby inducing $i_{t,t+1}$ to increase.\(^{(11)}\) In the case of anticipated tariff imposition on the other hand, the gap between $e_t$ and $e_{t+1}^*$ narrows, causing $i_{t,t+1}$ to fall.

The absence of any sectoral terms of trade effect means that the response of traded sector output to $\lambda^*_{t+1}$ reduces to a very simple form. Solving for this, we obtain:

\[
\frac{dS_{jt}}{d\lambda^*_{t+1}} = (S_{j1}+S_{j2}) \frac{di_{t,t+1}}{d\lambda^*_{t+1}}
\]

With $(S_{j1}+S_{j2}) > 0$, this result implies that the output of $j$ responds to $\lambda^*_{t+1}$ in the same direction as $i_{t,t+1}$. As indicated above, for values of $(I_4-m_5) < 0$, the interest rate effect is negative and under these circumstances the output of $j$ falls also.

Hence we find that anticipated tariff imposition implies a substantially different adjustment scenario than current tariff imposition. For zero or negative values of the expenditure switching term, the imposition of an import tariff at time $t$ stimulates the output of the non-traded sector, but with ambiguous effects on the traded goods sector. Anticipated tariff imposition, on the other hand, leads to a 'neutrality or worse' result: non-traded sector production remains constant, but traded sector production falls. In the aggregate therefore, anticipated tariff imposition has a contractionary effect.

The differences between these results and those cited above, arise out of both intersectoral substitution effects and differing behavioral specifications. The former emerge in the presence of the expenditure substitution term $(I_4-m_5)$, non-zero values of which imply complex coefficient trade-offs. When these intersectoral substitution effects are netted out (i.e. when $I_4-m_5=0$), a much simpler adjustment pattern emerges. The implications of differing behavioral specifications, on the other hand, are seen most clearly in the response of the traded goods sector. In this analysis, we have given emphasis to both current and
expected price signals, as well as interest rates, as determinants of the output of \( j \). This means that the linkages between tariff imposition, on the one hand, and the response of traded sector output on the other, are somewhat more complex than in previous models. It is for this reason that we cannot establish with any degree of certainty whether there is a positive or negative connection between a current tariff imposition and the current output of the traded good.

8.6 The real exchange rate and the sectoral terms of trade

The final issue we wish to address concerns the behavior of the real exchange rate in the presence of non-traded goods. It will be recalled from the discussion in Section 8 in Chapter Six that real exchange rate movements are attracting increasing attention by economists and that further study of their determinants is warranted. The analysis of Chapter Six revealed also that apparent cyclical movements in real exchange rates can be at least partly explained by changes in global relative prices over the course of the world business cycle. This led to the conclusion that deviations from parity in the real exchange rate need not necessarily invalidate the ppp assumption.

The focus of this section will be on the domestic determinants of real exchange rate movements in the presence of non-traded goods. Prior to doing this however, it is of importance to clarify an issue regarding the definition of the real exchange rate. In (6.118) of Chapter Six, we defined the real exchange rate as the nominal exchange rate multiplied by the ratio of the global aggregate price level to the domestic aggregate price level:

\[
(8.47) \quad e^R_t = e_t \cdot p_t/A_t \quad \text{(real exchange rate I)}
\]

where \( p_t \) is the global aggregate price level and \( A_t \) is the domestic aggregate price level. Other analysts, however, such as O'Mara, Carland and Campbell (1980), define the real exchange rate as the relative price of traded and non-traded goods. This latter definition of the real exchange rate corresponds to the inverse of the sectoral terms of trade, \( \epsilon_t \), defined in (8.6) above:

\[
(8.48) \quad e^R_t = 1/\epsilon_t \quad \text{(real exchange rate II)}
\]
The question is under what circumstances these two definitions of the real exchange rate are compatible. We proceed by defining the domestic aggregate price level as a weighted average of traded and non-traded goods prices:

\[(8.49) \quad A_t = aw_t + (1-a)q_{nt}, \quad 0 < a < 1\]

where \(w_t\) is the average domestic price of traded goods as defined in (8.6) above. Using (8.49), we differentiate (8.47) and (8.48) to give:

\[(8.50) \quad \frac{de^R}{t(I)} = (1-a)(de_t - dq_{nt}) + dp_t(l-a(l-w)) - awdp_{jt}\]

\[(8.50') \quad \frac{de^R}{t(II)} = de_t - dq_{nt} + (1-w)dp_t + wdp_{jt}\]

We see that the main qualitative difference is that whereas \(e_t^R(I)\) is negatively linked to \(p_{jt}\), \(e_t^R(II)\) is positively linked to \(p_{jt}\). This inconsistency disappears, however, whenever the export to import price ratio is constant: i.e., when \(dp_{jt} = dp_t\). Under these circumstances we obtain:

\[(8.51) \quad e_t^R(I) = (1-a)(de_t + dp_t - dq_{nt})\]

\[(8.52) \quad e_t^R(II) = de_t + dp_t - dq_{nt},\]

such that the implicit behavior of the real exchange rate is the same under both definitions. In the more general case, however, where the foreign terms of trade is changing, these two measures of the real exchange rate will not necessarily give consistent results.\(12\)

In the presence of domestic disturbances, of course, there is no conflict between these two approaches to the real exchange rate, since both of the foreign prices remain constant. By substituting into (8.51), we derive the real exchange rate impacts of the domestic disturbance terms as:

\[(8.53) \quad \frac{de^R_t}{dL_t} = \frac{de^R_t}{dG_{jt}} = \frac{de^R_t}{d\lambda^*_t + 1} = 0\]
These results establish that the real exchange rate is independent of the domestic money supply $L_t$, productivity changes in the traded goods sector $G_{jt}$, and anticipated tariff impositions on imports, $\lambda_{t+1}^*$. This independence emerges because in each case the nominal exchange rate responds by exactly the same amount as the price of non-traded goods.

In the case of non-traded sector productivity gains $G_{nt}$ and current tariff impositions $\lambda_t$, however, the real exchange rate is affected through unequal adjustments in $e_t$ and $q_{nt}$. In both cases however, the response of the real exchange rate is indeterminate through the presence of the expenditure switching term, $(I_{4t}-m_5)$. If we assume that this latter term is zero, then we obtain:

\[
\frac{d e_t^R}{d G_{nt}} = - \frac{(1-a)}{J} L_t (B - S_{jl}) > 0
\]

(8.56)

\[
\frac{d e_t^R}{d \lambda_t} = (1-w) (D_{n}^{'} - S_{n}^{'}) \frac{d e_t^R}{d G_{nt}} < 0
\]

(8.57)

Hence, productivity improvements in the non-traded goods sector induce a rise in the real exchange rate; i.e. a real depreciation. Tariff imposition, on the other hand, leads to a fall in $e_t^R$, or a real appreciation. It may also be noted that the magnitudes of adjustment in these two cases are linked by a factor of $(1-w)(D_{n}^{'} - S_{n}^{'}) < 0$.

The main result to emerge is that the presence of non-traded goods provides scope for certain domestic disturbances to influence the behavior of the real exchange rate. These results provide a further instance of where the ppp assumption for traded goods is consistent with
variations in the real exchange rate; contrary to the proposition put forward by Dornbusch (1980).

8.7 Summary and conclusions

The primary purpose of this chapter has been to investigate the sectoral impacts of various domestic disturbances in the presence of traded and non-traded goods. One of the main findings is that the incorporation of non-traded goods into the SOE model provides substantial scope for domestic authorities to influence domestic economic activity. Three modes of domestic influence have been investigated: monetary expansion, productivity changes and tariff imposition.

Our analyses have highlighted the importance of an 'expenditure switching effect' in determining the final outcomes of these disturbances. The 'expenditure switch' refers to the effect that a change in the price of non-traded goods has on the demand for local and imported traded goods. This interpretation of an expenditure switching effect is somewhat different to the traditional interpretation of this term, which relies instead on the relative price effects of exchange rate movements. The Marshall-Lerner condition is a familiar example of the traditional interpretation of expenditure switching. Instead, we have given recognition to the possibility that a change in the price of non-traded goods can affect the demand for traded goods, and that the latter effect may not be evenly distributed between locally-produced traded goods and imports. Whether or not this expenditure switch takes place, and whether or not it favors local over imported goods, emerges as an important element in the results of our analyses.

In the case of domestic monetary expansion, for instance, all domestic prices rise by the same amount implying that the domestic terms of trade between the non-traded and traded sectors remains constant. One implication of this result is that output from the non-traded sector is neutral with respect to the domestic money supply. The rise in the price of non-traded goods, however, increases the demand for both locally produced and imported traded goods, giving rise to a possible expenditure switching effect. The effect of monetary expansion on output from the domestic traded sector then depends on which way the expenditure switch
operates. If the rise in the non-traded price shifts expenditures relatively more toward the local traded good, then production of the latter increases. If, on the other hand, demand for imports is stimulated by a relatively greater amount than demand for the local traded good, production in the traded good sector will fall.

The general conclusion to emerge is that the effects of monetary expansion on aggregate economic activity depend entirely on the response of the traded goods sector. This means that domestic monetary disturbances will be non-neutral whenever the expenditure switching effect is operative. The direction of output response depends on whether the demand for imports or the demand for the local product responds more to non-traded good price increases.

In the case of domestic productivity increases, we have shown how the response of the economy depends on from which sector the productivity gains emerge. Where productivity gains are achieved in the traded goods sector, there is a fall in traded good output and no change in output from the non-traded sector. In this case, aggregate economic activity falls in response to the productivity increase. On the other hand, where productivity gains emerge from the non-traded sector, there is a more complex pattern of results. Non-traded output may rise or fall, depending in part on the expenditure switching effect referred to earlier. To the extent that the expenditure switch is absent (or favours imported goods), non-traded output will fall in response to a productivity rise in that sector. Under these same circumstances, output from the traded goods sector will increase.

Hence we find an asymmetry in the sectoral transmission of productivity changes: non-traded sector productivity gains are transmitted to both sectors of the domestic economy, while traded sector productivity gains are absorbed by that sector only. The overall tendency for productivity gains to have a contractionary effect on output within each sector may seem counter-intuitive, but it emerges because of the excess supply that productivity gains create. Hence our conclusions regarding the sectoral impacts of productivity change are consistent with the familiar proposition that sectoral output be an increasing (decreasing) function of sectoral excess demand (supply).
The sectoral impacts of tariff imposition depend also on the expenditure switching effect. An unanticipated tariff imposition (made in the current period), will stimulate output from the non-traded sector when the expenditure switching effect is either absent or favours imports. This condition regarding the expenditure switching effect is sufficient, but not necessary to obtain a positive response from the non-traded sector. Conversely, however, the tariff will have a negative effect on the non-traded sector only if the expenditure switching effect is substantially in favour of the local traded good. The effect of the import tariff on the traded good sector remains highly ambiguous, even in the absence of any expenditure switching effect.

The effect of anticipated tariff changes are substantially different to those of a current tariff imposition. Where market participants anticipate that a tariff will be imposed in the next period, there is no response from the non-traded sector while output from the traded sector falls. In this case, there is a contraction in aggregate economic activity, in contrast to the ambiguous aggregate effect that current tariff imposition implies.

The final issue to have been investigated was the behavior of the real exchange rate in the presence of non-traded sector. We have drawn a distinction between the definition of the real exchange rate based on the ratio of domestic to foreign aggregate prices, and that which is based on the domestic ratio of traded to non-traded prices. These two definitions are consistent only if the global relativity of export and import prices remains constant; in situations where this relativity is changing the broader definition of the real exchange rate is to be preferred.

In the presence of non-traded goods, the real exchange is responsive to some domestic disturbances, but not others. It is neutral with respect to domestic monetary expansion, traded sector productivity gains and anticipated tariff imposition. This neutrality effect is present despite the real impacts that these disturbance sources have on traded sector output.

Changes in the real exchange rate can emerge however, through variations in non-traded sector productivity and current tariff
imposition. In the absence of expenditure switching effects, a productivity increase in the non-traded sector induces a real depreciation of the exchange rate, while the tariff imposition induces a real appreciation. Because of the ppp assumption, however, neither of these real exchange rate changes has any effect on export performance.
(1) Studies of 'policy effectiveness in the small open economy' may therefore be divided into two groups. On the one hand are studies which invoke the assumption of market power; see Chapter Seven. On the other hand are studies which invoke assumptions of non-traded goods or labour sectors. The latter include Dornbusch (1973, 1974) and Sachs (1980, 1982); see also the recent review article by Frenkel and Mussa (1981).

(2) This is not to suggest, however, that the price and output of the non-traded sector are independent of expectations and interest rate variables. Indeed, through a process of sectoral interdependence, all variables, including those of the non-traded sector, are jointly determined and are therefore interdependent.

(3) This is perhaps the simplest way of characterising the supply-increasing effects of an exogenous rise in productivity. An alternative way is to embody a productivity parameter within the production function for \( j \) which is then reflected in the supply function, \( S_{jt} \); see, for instance, Long (1981).

(4) The weights \( w \) and \((1-w)\) reflect the proportion of domestic absorption on traded goods taken up by local production and imports, respectively. The less open is the economy, the closer is \( w \) to unity.

(5) The validity of this proposition is supported by the empirical results of Ruffin (1979). Ruffin's analyses demonstrate that while the demand for real money balances in the US has been significantly related to movements in the prices of durable commodities, it is not significantly affected by the prices of non-durables. One implication of this proposition is that aggregate price indexes (such as the CPI) which include the prices of non-durable commodities, may not be suitable deflators for the specification of real money balances.

(6) An alternative approach is to incorporate non-traded goods into a model of the SOE with market power. Under this approach, both the terms of trade between traded goods and the intersectoral terms of
trade between traded and non-traded goods, become endogenous. The complexities associated with this approach are substantial, however, and are more amenable to analysis by numerical techniques; see, for instance, Dixon et al. (1977).

(7) In carrying out the differentiation, it has been assumed that, at the initial equilibrium, all prices and exchange rates equal unity.

(8) Lucas (1980) for instance, examines the scope for using tariff (subsidy) policies in reaction to global terms of trade movements in a model of fixed exchange rates and sticky prices.

(9) This assumption effectively implies that the tariff acts on the domestic economy in a manner similar to an exogenous increase in the foreign price of the imported good. It should be noted however, that these two classes of disturbance are not synonymous since the foreign price will have an export demand effect, while the tariff increase will not. Studies in which there is a feed-back from tariff revenue to domestic demand include Chan (1978) and Lucas (1980).

(10) An intermediate case exists where the rise in $\lambda_t$ is both unanticipated and permanent; i.e. $d\lambda_{t+1}^* = \lambda_t$. However, the results of this intermediate case provide few additional insights into the nature of the sectoral trade-offs, and for this reason will not be reported.

(11) This statement assumes that $e_{t+1}^*$ is above $e_t$ at the initial equilibrium. More generally, we would observe that $e^*_{t+1}$ increases relative to $e_t$.

(12) The question of which of the two real exchange rate measures is the more appropriate depends very much on the purposes for which it is used. O'Mara, Carland and Campbell (1980) for instance, attempt to infer a link between the real exchange rate and the economic performance of Australian export industries.
CHAPTER NINE

SUPPLY VERSUS MONETARY INDUCED PRICE INCREASES AND ACCOMMODATION POLICY IN THE SMALL OPEN ECONOMY

Contents

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9.2 Supply versus monetary induced commodity price movements
9.3 The small open economy impacts of a monetary induced price increase
9.4 The impacts of a supply induced price increase
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9.6 Summary and conclusions
9.1 Introduction

With the major commodity price hikes of 1973-74 and 1979-80, economists have devoted increasing attention to the effects of price disturbances on the domestic economy. The consensus opinion appears to be that these price booms were the result of forces exogenous to the world economy: bad harvests, strikes, embargoes and, in particular the monopoly behavior of the OPEC oil cartel. This supply-side interpretation of the commodity price increases is fairly widespread and may be found in Tobin (1980), Blinder (1981), Gordon (1975), Gramlich (1979), Phelps (1978), Van Duyne (1979), Cebula and Frewer (1980) and Sachs (1982). The conclusions derived by these authors regarding the macroeconomic implications of commodity price increases reflect to a very great extent the presumption that exogenous forces were at work.

Recent analyses of commodity price behavior during the 1970s give support to an alternative view: that global monetary forces played a key role in the two price booms of the past decade. See, for instance Lawrence (1980), Grilli and Yang (1981), and Bond, Crowley and Vlastuin (1982). It is evident that monetary induced price increases may imply substantially different adjustment pressures on the domestic economy than exogenous supply induced price increases. Yet surprisingly, little systematic consideration has been given to the differing macroeconomic implications of price increases from these two sources.

The purpose of this chapter is to undertake a comparative analysis of supply versus monetary induced price increases and their implications for the small open economy. Attention is focussed on the linkages through which each type of disturbance is transmitted and the adjustment pressures which impinge on key domestic variables. Following Blinder (1981) and Phelps (1978), we then evaluate the scope for domestic monetary policy to offset these adjustment pressures.

The analysis is conducted within the framework of the SOE model of Chapter Eight. This model contains two traded goods (imported and exported) and a single non-traded good. It is assumed that the supply disturbance takes place in the world market for the exported good and that while this commodity is insignificant with respect to global excess
demands, it is of some importance to excess demands in the domestic economy. The main implication of this assumption is that the commodity supply shock affects prices in the commodity market only and has no effect on aggregate global prices, output or interest rates.

The global monetary disturbance, on the other hand, affects all markets simultaneously such that the domestic economy is subjected to not only the change in the commodity price, but to changes in global income, inflation and interest rates as well. Under these circumstances, the commodity price increase will be correlated with the changes in the other global variables, implying a substantially different pattern of adjustment than when commodity prices change in isolation. As Flood (1982) emphasises, it is critical for the efficiency of domestic policy making to recognise these correlations and in order to do this one must first seek to distinguish the source of the price disturbance.

In the analyses which follow, we summarise in section 9.2 the main characteristics of supply versus monetary induced commodity price increases. The summary draws on results previously established in Chapter Four. In section 9.3 we investigate the domestic impacts of a monetary induced commodity price rise, giving attention to the role of non-traded goods in the transmission process. The effects of a supply induced price increase are then examined in section 9.4. A comparison of the main domestic impacts of the two disturbance sources is summarised in section 9.5, which also contains an evaluation of the scope for domestic monetary accommodation. A summary and conclusions appear in section 9.6.

9.2 Supply- versus monetary-induced commodity price movements

Some important differences between supply- and monetary-induced commodity price movements were derived in Chapter Four. We summarise these briefly as follows, restricting our attention to the case of a commodity price increase.

A shortfall in the global supply of commodity j will lead to an increase in the world price of j, $p_{jt}$, the magnitude of which varies according to whether the supply disturbance is anticipated or unanticipated, temporary or permanent. In general, an unanticipated
supply disturbance leads to a larger increase in \( p_{jt} \) than an anticipated disturbance, and similarly, a permanent supply shortfall induces a larger rise in \( p_{jt} \) than a temporary shortfall. In the presence of exogenous supply disturbances, the expected price of \( j \), \( p^*_{jt+1} \), also responds. The direction of change in \( p^*_{jt+1} \) is always the same as that of \( p_{jt} \), such that the current price and the expected price of the commodity always move in unison. The relative magnitudes of current and expected price adjustment vary, however, depending on the nature of the supply shock. In the case of unanticipated supply shortfalls, \( p_{jt} \) rises by more than \( p^*_{jt+1} \), implying a fall in the expected rate of price change for \( j \), \( \pi^*_{jt,t+1} \). The fall in \( \pi^*_{jt,t+1} \) is the same however, regardless of whether the drop in current supplies is temporary or permanent. In the case of anticipated supply shortfalls, on the other hand, the rise in \( p_{jt} \) is identically equal to the rise in \( p^*_{jt+1} \), such that the expected rate of price change for \( j \) remains constant. A final point to be emphasised is that because the market for \( j \) is small relative to the global economy, any shocks to its supply are not transmitted to aggregate global variables. Hence the adjustments in \( p_{jt} \) and \( p^*_{jt+1} \) are not accompanied by movements in other global variables.

By contrast, a monetary-induced increase in the price of \( j \) will be accompanied by changes in other global variables. The exact nature of these simultaneous adjustments depends, however, on the stage of the global business cycle at which the rise in \( p_{jt} \) is taking place. As demonstrated in Chapter Four, a global monetary disturbance may cause \( p_{jt} \) to rise during either the recessionary or expansionary phases of the global business cycle. During the recessionary phase, the increase in \( p_{jt} \) will be accompanied by falling world interest rates and world income (\( r_{t,t+1} \) and \( Y^f_t \) respectively), and during the expansionary phase the increase in \( p_{jt} \) will be accompanied by rising interest rates and income.

For the analyses which follow, it will be assumed that the monetary-induced increase in \( p_{jt} \) takes place in the expansionary phase of the global business cycle. The main reason for this assumption is that, as demonstrated in section 4.6, the magnitude of the increase in \( p_{jt} \) is greatest during the expansionary phase, which would be the phase
corresponding to a price 'boom'. Hence, the rise in $p_{jt}$ is accompanied by increases in $r_{t,t+1}$ and $Yf_t$ also.

During the expansionary phase of the global business cycle, the expected price of $j$ increases in response to the global money supply, $M_t$. The magnitude of the increase in $p_{jt+1}$ exceeds that of $p_{jt}$, however, such that the expected rate of price change for $j$ increases. This observation provides a further important distinction between supply and monetary-induced price increases. In the case of a supply shortfall, $\pi_{jt,t+1}$ falls or remains constant; in the case of a monetary stimulus, however, $\pi_{jt,t+1}$ rises along with $p_{jt}$.

The global aggregate price level, $p_t$, increases also in response to the monetary stimulus and because of this the real price of $j$, $p_{jt}/p_t$, may or may not rise along with the nominal price increase. As outlined in Chapters Two and Four, however, there is an observed tendency for primary commodities to display real price movements which are procyclical with respect to global economic activity. For the analyses which follow, it will be assumed that commodity $j$ is a primary commodity, in keeping with the discussion of section 9.1. This implies that $p_{jt}/p_t$ increases during the expansionary phase along with the rise in $p_{jt}$. It may be noted that in the case of supply shortfalls, the real price of $j$ also increases with the nominal price of $j$, since the aggregate price $p_t$ is unaffected by this type of disturbance.

A summary of the main differences between supply and monetary induced increases in the price of commodity $j$ is provided in Table 9.1.

It is evident from this Table that the overall pattern of adjustments is substantially different in each case. On its own, the increase in the price of commodity $j$ tells us nothing of the simultaneous behavior of the other global variables. Previous studies which have characterised commodity market disruptions simply on the basis of an exogenous increase in the current price, have clearly neglected the potentially important impacts that these other variables may have. It is towards an evaluation of these two disturbance scenarios for the small open economy that we now turn.
Table 9.1: A COMPARISON OF ADJUSTMENTS ACCOMPANYING SUPPLY AND MONETARY INDUCED INCREASES IN Pjt

<table>
<thead>
<tr>
<th></th>
<th>Supply shortfall</th>
<th>Monetary stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pjt</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Pjt+1</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Tjt,t+1</td>
<td>-/0</td>
<td>+</td>
</tr>
<tr>
<td>Pt</td>
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<td>+</td>
</tr>
<tr>
<td>Pjt/Pt</td>
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<td>+</td>
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<tr>
<td>Rj,t+1</td>
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<td>+</td>
</tr>
<tr>
<td>Yt</td>
<td>0</td>
<td>+</td>
</tr>
</tbody>
</table>

9.3 The small open economy impacts of a monetary-induced price increase

Consider firstly the domestic impacts associated with a monetary-induced rise in the price of commodity j. We shall examine this issue using the SOE model of Chapter Eight, which contained a non-traded goods sector and a traded goods sector. The SOE produces and exports commodity j under conditions of purchasing power parity. It imports a composite good which is representative of the aggregate global commodity, also under ppp.

The increase in monetary expansion overseas increases not only the world price of exports, p_{jt}', but other global variables as well; see Table 9.1. The simultaneous adjustments in these foreign variables enter the three excess demand conditions of the domestic economy as specified in (8.14). Our interest lies in determining whether the rise in global economic activity which accompanies the increase in p_{jt}', is transmitted positively or negatively to the domestic economy, and what the sectoral response pattern might be. The scope for domestic monetary policy to ameliorate the effects of the foreign monetary disturbance will be examined in section 9.5 below.
The exchange rate effect of the global monetary stimulus is derived from (8.14) as follows.(1)

\[ \frac{de_t}{dM_t} = \frac{(Dn1'-Sn1')}{J} \frac{dr_{t,t+1}}{dM_t} (D_1 X) \]

\[ + \frac{dp_{jt}}{dM_t} [D_1 (wB_2-S_{j1}(1-v) + m_t) - L_t w (B_1 - S_{j1})] \]

\[ + \frac{dp_t}{dM_t} [D_1 (B_2 (1-w) - m_t) - L_t (1-w) (B_1 - S_{j1})] \]

where \( X = (x_1 + x_2 + x_3 (g_1 + g_2) + x_4) > 0 \)

As in Chapter Six, the exchange rate responds to the global monetary disturbance through three linkages. There is a positive linkage with the upward movement in the foreign interest rate, \( r_{t,t+1} \). This linkage implies devaluation pressure on \( e_t \) and will be stronger the more positive is the sum of the export coefficients, \( X \). Secondly, there is an ambiguous linkage with the increase in the world price of exports, \( p_{jt} \). And thirdly, there is an ambiguous linkage with the upward movement in the world price of imports, \( p_t \). The combined impacts of these three linkage variables imply no clear adjustment in the exchange rate in response to the global monetary stimulus. Hence, as we found in previous chapters, the existence of non-traded goods in the SOE does not alter the basic conclusion that exchange rates need not respond to \( M_t \) in any simple pro- or contracyclical manner.

A special case occurs, however, when the coefficients attached to \( dp_{jt} \) and \( dp_t \) in (9.1) are simultaneously zero. Solving for this condition, we obtain the result that:

\[ \frac{de_t}{dM_t} = \frac{(Dn1'-Sn1')}{J} D_1 X \frac{dr_{t,t+1}}{dM_t} > 0 \]

when

\[ S_{j1}(1-v) = \frac{m_t}{(1-w)} \]
The condition in (9.3) requires equality between the supply response effect of a fall in \( q^\text{nt}(S_{jl}(1-v)) \) with the initial real expenditure on imports, weighted by the proportion of imports to total domestic expenditure on traded goods. The latter term is clearly equal to total domestic traded good absorption, \( E_t \), such that (9.3) becomes:

\[
(9.3') \quad S_{jl}(1-v) = \frac{M_t}{(1-w)} = E_t
\]

It is evident that satisfaction of this condition implies a high degree of responsiveness in the supply of \( j \) to relative price signals. To the extent that it is satisfied, however, we see from (9.2) that the exchange rate will increase in response to \( M_t \), along with the rise in the foreign interest rate, \( r_{t,t+1} \). Under these circumstances, the monetary-induced rise in the world price of \( j \) will be associated with a devaluation in the exchange rate.

If we now examine the effects of the global monetary stimulus on the domestic price of the non-traded good, \( q_{\text{nt}} \), we obtain from (8.14):

\[
(9.4) \quad \frac{dq_{\text{nt}}}{dM_t} = \frac{D_n' - S_n'}{j} \left( \frac{dr_{t,t+1}}{dM_t} (D_X) \right) + \frac{(dp_{jl,t} - dp_{t})}{dM_t} D_l (m_t - S_{jl}(1-w)(1-v))
\]

There are simply two linkages at work on the non-traded good price. The rise in the foreign interest rate implies upward pressure on \( q_{\text{nt}} \), the same as it implies devaluation pressure on the exchange rate. The second linkage in (9.4) is the terms of trade adjustment; i.e. the change in the global export to import price ratio brought about by the global monetary stimulus. It will be recalled that terms of trade adjustments figured prominently in the Chapter Six analysis of global transmission. On the assumption that \( j \) is a primary commodity, we have proposed earlier that the terms of trade (or the real price of \( j \)) increases in response to the monetary stimulus; see Table 9.1. The effect of this increase in the terms of trade on \( q_{\text{nt}} \) is, however, ambiguous and may imply either
rising or falling pressure on the price of the non-traded good. If we invoke condition (9.3'), the terms of trade linkage disappears and $q_{nt}$ responds to $M_t$ through the interest rate linkage only. Under these circumstances, the domestic price of the non-traded good displays an unambiguous increase in line with the rise in $r_{t,t+1}, p_{jt}$, as well as the domestic prices of traded goods. In this sense the inflationary impact of the global monetary disturbance is transmitted to all prices in the domestic economy not through a direct price linkage, but indirectly through the interest rate linkage. (2)

The sectoral terms of trade has been defined in Chapter Eight as the ratio of the non-traded good price to the average domestic price of traded goods. That is, from (8.6), the sectoral terms of trade is given by:

$$\varepsilon_t = \frac{q_{nt}}{w_t}$$

where $w_t = w_{jt} + (1-w)q_t$ is the average domestic price of traded goods.

The impact of the global monetary stimulus on the domestic sectoral terms of trade is derived from (8.14) as:

$$\frac{d\varepsilon_t}{dM_t} = 0$$

In other words, the sectoral terms of trade is completely insulated from the foreign monetary stimulus. This occurs because the domestic prices of both traded and non-traded goods increase by proportionally the same amount to $M_t$. It may be recalled from section 8.3 that domestic monetary disturbances are also neutral with respect to the sectoral terms of trade. The interesting feature of the result in (9.6) is that whereas the global terms of trade (between exports and imports) does respond to $M_t$, the domestic sectoral terms of trade (between traded and non-traded goods) does not.

From this we obtain the result that the non-traded sector of the domestic economy is also completely insulated from the global monetary
disturbance. This follows from (8.8) in which the supply of non-traded goods varies positively with the sectoral terms of trade, such that:

\[
\frac{dS_{nt}}{dM_t} = S_n', \quad \frac{dc_t}{dM_t} = 0
\]

where \( S_{nt} \) is output of the non-traded sector.

The main implication of this result is that a monetary stimulus which creates economic expansion abroad has no effect on domestic activity in the non-traded sector. This result provides an important qualification to the proposition derived in Chapters Five and Six that global monetary disturbances are transmitted as real disturbances domestically only if they create real impacts abroad. (3) We now find that \( M_t \) can lead an expansion in economic activity abroad and yet be neutral with respect to the domestic non-traded sector. The converse proposition also applies: a monetary-induced global recession has no effect on the domestic non-traded sector. (4)

The response of the domestic interest rate, \( i_{t,t+1} \), to the global monetary disturbance occurs via the combined effects of the foreign interest rate movement as well as the change in the expected rate of exchange depreciation, \( \Delta_{t,t+1} \). Solving for this impact, we obtain:

\[
di_{t,t+1} = \frac{\{Dn'-Sn'\}}{J} \left\{ -L_t \frac{dX_{t,t+1}}{dM_t} \right\} \\
+ L_t (S_{ji}(1-v)(1-w) - m_t) \left( \frac{dp_{jt}}{dM_t} - \frac{dp_t}{dM_t} \right)
\]

As in the model of Chapter Six, the domestic interest rate responds to \( M_t \) via two linkages: a foreign interest rate linkage and a global terms of trade linkage. The foreign interest rate linkage is positive, implying that the rise in \( r_{t,t+1} \) exerts upward pressure on the domestic interest rate, as in Chapter Six. The rise in the foreign terms of trade, however, has an ambiguous effect on the domestic interest rate, again due to the term \( (S_{ji}(1-v)(1-w) - m_t) \). In the Chapter Six model, the terms of trade linkage was positive, implying that an increase in \( (p_{jt}/p_t) \)
would also exert upward pressure on local interest rates. The presence of non-traded goods in this model makes this impact uncertain however. A positive linkage between the terms of trade and the domestic interest rate emerges in (9.8) the less important are non-traded goods in the production of \( j \) (i.e. the smaller is the weight, \((1-v)\)). Conversely, where non-traded goods make up a significant proportion of the costs of producing \( j \), the more likely it is that the terms of trade linkage will be negative. In this case the rise in the terms of trade will produce a negative impact on the domestic interest rate, offsetting the positive pressure associated with \( r_{t,t+1} \). In the special case where \((9.3')\) is satisfied, the terms of trade effect is eliminated and the domestic interest rate becomes perfectly synchronised with the global interest rate. This means that during the global expansionary phase when both commodity prices and foreign interest rates are increasing, the domestic interest rate increases also.

Consider now the effect of the global monetary stimulus on domestic production of commodity \( j \). From the supply response function in (8.1), we see that the output of \( j \) responds positively to its expected domestic price, and negatively to its current domestic price, the current price of non-traded goods and the domestic interest rate. Substituting into (8.1), we obtain the output response of \( j \) as:

\[
\frac{dS_{jt}}{dM_t} = \frac{(Dn'-Sn')}{J}L_t(S_{jt} + S_{j2}) \times \frac{dr_{t,t+1}}{dM_t} \\
+ \left( \frac{dp_{jt}}{dM_t} - \frac{dp_t}{dM_t} \right) [S_{jt}L_t(B_1 (1-v) (1-w) - m_t) + D_1 (1-v) (1-w) (m_5 - I_4)] \\
+ S_{j2}L_t(S_{jt} (1-v) (1-w) - m_t)]
\]

Unlike the non-traded sector, output from the domestic traded goods sector will in general be effected by the global monetary stimulus. Two transmission linkages are at work here: a positive linkage with the rise in the global interest rate, implying an increase in output of \( j \); and an ambiguous linkage with the global terms of trade. The expression in (9.9) may be compared with that in (6.129). In both cases, domestic output of the traded good responds positively to movements in the global interest
rate, implying that the presence of non-traded goods has no qualitative effect on this linkage. The terms of trade linkage is however, affected by the presence of non-traded goods. In the absence of non-traded goods, as in (6.129), there is an unambiguously positive link between domestic output and the monetary induced change in the terms of trade. In the present model, however, this linkage is rendered ambiguous by the substitution effects that non-traded good prices bring about in both demand and supply processes.

If we restrict out attention to the case where (9.3') holds, it may be seen from (9.9) that the terms of trade linkage will depend in part on the 'expenditure switching' term, \((m^-I^-4^-)\). As outlined in Chapter Eight, the sign of this term depends on whether a given rise in the price of the non-traded good diverts domestic expenditure towards the local traded good or towards the imported good. To the extent that the effect of \(q^-nt^-\) either has a neutral effect on domestic expenditures, or shifts them relatively in favour of the imported good, then \((m^-5^-I^-4^-)>0\), and the terms of trade coefficient in (9.9) becomes unambiguously positive. In this case, rises in both the foreign interest rate and the foreign terms of trade will combine to increase domestic output of commodity j. If, on the other hand, the expenditure switching effect favours domestically produced goods, then \((m^-5^-I^-4^-)<0\) and the terms of trade coefficient remains ambiguous. It is still possible under these circumstances for the global monetary stimulus to increase domestic output of j, but the outcome is less clearcut.

Aggregate output in the domestic economy consists of the sum of outputs from the traded and non-traded goods sectors. We have seen that the global monetary disturbance is neutral with respect to the non-traded sector and this in turn means that the response of aggregate domestic economic activity hinges entirely on the behavior of the traded goods sector. So the issue of whether the rise in the global price of j is associated with a rise or a fall in domestic economic activity depends on the trade-offs embodied within the response equation (9.9). As noted earlier, there is a positive tendency for domestic output to rise through the interest rate linkage, which may or may not be reinforced through the terms of trade linkage. In the absence of non-traded good affects, the latter linkage provides an unambiguous stimulus for domestic output to
rise. Where non-traded good effects are present however, the terms of trade linkage is rendered ambiguous and domestic economic activity may or may not rise in line with the monetary induced rise in the global price of exported commodity \( j \).

9.4 The impacts of a supply induced price increase

Consider now the alternative scenario in which the world price of exported commodity \( j \) rises because of a supply shock. As indicated in Table 9.1, the pattern of changes brought about by this type of disturbance is somewhat different to that associated with a monetary induced commodity price rise. The supply shock leads to increases in both the current world price of \( j \) \( p^*_{jt} \) and the expected world price of \( j \) \( p^*_{jt+1} \), but leaves the aggregate global variables unchanged.

This means that the SOE receives adjustment pressures from only two foreign sources: \( p^*_{jt} \) and \( p^*_{jt+1} \). As emphasised earlier, the nature of the adjustments in these foreign price variables depends critically on the type of supply shock experienced. In the case of unanticipated supply shortfalls, for instance, the spot price increases by a relatively greater amount than the expected price; with anticipated supply shortfalls, on the other hand, both \( p^*_{jt} \) and \( p^*_{jt+1} \) rise by the same amount. For much of what follows, we shall concentrate on anticipated supply disturbances.

Consider firstly the exchange rate adjustment that is induced by simultaneous changes in \( p^*_{jt} \) and \( p^*_{jt+1} \). Solving from (8.14), we obtain:

\[
(9.10) \quad \Delta e_t = \left( \frac{D^n_t - S^n_t}{J} \right) \left\{ dp^*_{jt+1} \left[ -D_1 (B_3 + S_{1j}) - \lambda w (B_1 - S_{1j}) \right] \\
+ dp^*_{jt} \left[ D_1 (B_3 + S_{1j} v + m_t) + w (B_2 D_1 + (\lambda - L_t) (B_1 - S_{1j})) \right] \right\}
\]

From this we see that the exchange rate is positively linked to the movement in \( p^*_{jt+1} \); implying devaluation pressure from a supply shock. The effect of a rise in \( p^*_{jt} \) on \( e_t \) is however ambiguous, containing a mixture of both revaluation and devaluation elements. If we consider the case of an anticipated supply shock, however, some of this ambiguity may be removed. In this case, the rise in \( p^*_{jt} \) equals the rise in \( p^*_{jt+1} \) and the change in \( e_t \) is expressed as:
(9.11) \[ \frac{dQ_{jt+1}^*}{dQ_{jt+1}^*} = \frac{dp_{jt}}{dQ_{jt+1}^*} \cdot (Dn'-Sn') \cdot \left[D_1 \left(m_j - S_{j1} (1-v) (1-w) + w(I_4 - m_5) \right) - wL_t (B_1 - S_{j1}) \right] \]

where \( dQ_{jt+1}^* \) is an exogenous increase in the expected global supply of commodity \( j \).

The key point about this result is that the supply disturbance is transmitted to the exchange rate via the current price linkage only. Even under this simplified condition, however, the response of \( e_t \) remains ambiguous, again due to the term \( M_t - S_{j1} (1-v) (1-w) \). If we invoke condition (9.3'), the exchange rate response simplifies to:

(9.12) \[ \frac{de_t}{dQ_{jt+1}^*} = - \frac{dp_{jt}}{dQ_{jt+1}^*} < 0 \]

In other words, if condition (9.3') holds, the exchange rate undergoes an unambiguous revaluation in response to an anticipated supply disturbance. The magnitude of the revaluation is smaller in absolute value than the rise in the world price of \( j \), since \( 0 < w < 1 \).

We may contrast this revaluation effect with the devaluation response given in (9.2), also obtained when condition (9.3') is invoked. It is evident that a rise in the world price of the exported good may be associated with either positive or negative movements in the exchange rate, depending on whether monetary or supply factors are at work. Not only are the transmission mechanisms different in each case, but the qualitative response of the exchange rate may differ also.

Exchange rate adjustments combine with movements in world prices to create changes in the domestic price of traded goods. Under purchasing power parity, the changes in the domestic prices of export and import goods are given by:

(9.13) \[ dq_{jt} = dp_{jt} + de_t \]

(9.14) \[ dq_t = dp_t + de_t \]
Substituting into these expressions from (9.12) (and noting that the world price of imports, $p_t$, is unaffected by the commodity market supply shock), we obtain:

\[
\begin{align*}
\frac{dq_{jt}}{dQ^*_jt+1} & = (1-w) \frac{dp_{jt}}{dQ^*_jt+1} > 0 \\
\frac{dq_t}{dQ^*_jt+1} & = -w \frac{dp_{jt}}{dQ^*_jt+1} < 0
\end{align*}
\]

In other words, the supply shock leads to divergent movements in the domestic prices of the two traded goods. The local price of the exported good, $q_{jt}$, increases in line with its global counterpart, but by a proportionally smaller amount. The domestic price of the imported good, on the other hand, declines due to the exchange rate revaluation.

The effect of the anticipated supply disturbance on the average domestic price of traded goods, $w_t$ (defined in (8.6)) is given by:

\[
(9.17) \quad \frac{d w_t}{dQ^*_jt+1} = w \frac{dq_{jt}}{dQ^*_jt+1} + (1-w) \frac{dq_t}{dQ^*_jt+1} = 0
\]

Hence we find that the average domestic price of traded goods is not affected by the anticipated supply disturbance. Central to this result is the downward exchange rate movement (revaluation) which works to offset the rise in the foreign price of exports. This result may be contrasted with the domestic inflationary impacts created by the global monetary stimulus. By inducing an exchange rate devaluation (as in (9.2)) as well as increases in all foreign prices, the monetary stimulus has inflationary impacts both at home and abroad. The anticipated supply shock on the other hand, leaves the traded component of domestic prices unchanged.

The price of non-traded goods is also influenced by the supply disturbance. As in the case of the exchange rate response, there is a mixture of influences on $q_{nt}$ associated with the joint increases in both $p_{jt}$ and $p^*_jt+1$. If we again limit our attention to the case of an
anticipated supply shortfall, however, the response of the price of the non-traded good simplifies to:

$$\frac{d q_{nt}}{d Q_{jt+1}} = \frac{d p_{jt}}{d Q_{jt+1}} \frac{(Dn' - Sn')}{J} D_l (m - S_j l (1-w)(1-v))$$

$$= 0 \text{ when (9.3') applies.}$$

Hence, corresponding to the results obtained in (9.15) and (9.16) (where (9.3') is applicable), the anticipated supply shock leaves the price of non-traded goods unchanged. This means that relative prices within the SOE are altered as a result of the foreign supply shock, with $q_{jt}$ increasing relative to $q_{nt}$, and $q_{t}$ decreasing relative to $q_{nt}$. In aggregate however, the domestic price level remains unchanged since both $w_{t}$ and $q_{nt}$ remain constant. This means that, under the conditions specified, the foreign supply shock is neither inflationary nor deflationary for the SOE in aggregate. Hence the inflation created in the foreign export price is not 'imported' back into the aggregate domestic price level; only relative domestic prices are altered.

This result contrasts sharply with the inflationary implications of the global monetary stimulus. For the case where (9.3') holds, the rise in $M_{t}$ causes the domestic values of both traded and non-traded prices to increase. In this case, the foreign inflation is imported into the domestic economy.

The effects of a supply shock on the sectoral terms of trade, $\epsilon_{t}$, are derived from (8.14) as:

$$\frac{d \epsilon_{t}}{d Q_{jt}} = \frac{d \epsilon_{t}}{d Q_{jt+1}} = 0$$

Both anticipated and unanticipated supply shocks ($Q_{jt+1}^{*}$ and $Q_{jt}^{*}$, respectively) leave the sectoral terms of trade unchanged. This result has been derived independently of any assumption regarding the term in (9.3') and is consistent with the neutral impact of the monetary stimulus. As a direct consequence of (9.19), it is also apparent that supply shocks have no effect on the output of the non-traded sector:
Hence, we find that the non-traded sector is perfectly insulated from the foreign price rise, regardless of whether it is supply or monetary induced.

The interest rate effect of the supply disturbance occurs through changes in the expected rate of exchange depreciation, \( \Delta_{t,t+1} \). Unlike the case of the monetary stimulus where the domestic interest rate was also subject to the rise in the foreign interest rate, this time there is only the induced change in current and expected exchange rates to affect the local interest rate. Again restricting our attention to the case of an anticipated supply shock, we derive the interest rate response as:

\[
(9.21) \quad \frac{\partial S_{nt}}{\partial Q_{jt}} \frac{dQ_{jt}}{dQ_{jt}} = \frac{S'_{n} \cdot d_{t}}{dQ_{jt}} = 0
\]

To the extent that (9.3') is applicable, we obtain an interesting comparison between the monetary stimulus and the supply shock. As shown in (9.8), the monetary stimulus causes the domestic interest rate to increase in line with the foreign interest rate rise. In the case of an anticipated supply shock, on the other hand, both foreign and domestic interest rates remain constant. This means that in both cases, domestic interest rate behavior parallels that of the foreign interest rate. In the event that (9.3') is not applicable, however, this tendency for confluence between foreign and domestic interest rates may break down, particularly in the case of supply disturbances. In this latter case it is quite possible for the domestic interest rate to change at a time when the foreign interest rate is constant.

Finally, we consider the impact of the commodity market supply shock on the domestic output of commodity j. As specified in (8.1), production of j responds positively to expected profit and negatively to the domestic interest rate. The general expression relating the production of j \( (S_{jt}) \) to supply shocks is understandably complex and we shall restrict
our attention to the case of an anticipated supply disturbance and where (9.3') holds. As noted above, under these circumstances both the domestic interest rate and the price of the non-traded good remain unaffected by the supply shock. The response of the output of $j$ is then derived as:

\[ \frac{dS_{jt}}{dQ_{jt+1}} = S_j (1-v) (1-w) \frac{dp_{jt}}{dQ_{jt+1}} > 0 \]

Hence the anticipated supply shortfall which leads to a rise in the world price of $j$ also, under these conditions, stimulates domestic output of $j$. This result may be compared with the production effect of the monetary disturbance which contained a mixture of both interest rate and terms of trade effects. As noted below (9.9), the monetary stimulus has an unambiguously positive effect on domestic production of $j$ only if the expenditure switching term $(m_{5-I_7})$ is zero or positive.

Since the non-traded sector is unaffected by the supply shock, aggregate domestic economic activity is affected only through variations in the output of the traded good $j$. From (9.22) this means that in the case of an anticipated commodity market shortfall, domestic economic activity is stimulated through the increase in the production of $j$. Under these circumstances domestic economic activity rises at a time when global economic activity remains constant. Hence the commodity market supply shock provides one instance of where domestic economic activity responds to an overseas shock but global economic activity does not. The reason for this difference lies in our assumption that whereas commodity $j$ is significant in the domestic economy, it is insignificant in the global economy.

9.5 The scope for domestic monetary response

As mentioned in the Introduction to this chapter, a number of analysts have addressed the issue of whether 'price shocks' should or should not be accommodated by monetary expansion. As Blinder (1981) emphasises, the issue of monetary accommodation hinges firstly on whether there is an exploitable trade-off between output and inflation, and secondly on whether this trade-off should be exploited and, if so, in
which direction. Our concern in this section is with the first of these aspects, as an adequate answer to the second can only be made with reference to some sort of social preference function.

The previous sections have demonstrated that the domestic impacts of a 'price shock' vary considerably depending on the source of the price increase. It is useful for the discussion which follows to summarise the domestic impacts of the two foreign disturbances we have examined; see Table 9.2. (5) It may be noted that Table 9.2 also includes the effects that domestic monetary expansion has on each of the nominated variables. The latter impacts are derived from Section 8.3.

The first point to be emphasised from Table 9.2 is that the global stimulus and the supply shock have comparable domestic effects only with respect to the price of the exported good, $q_{jt}$, the sectoral terms of trade, $\epsilon_t$, and non-traded output, $S_{nt}$. The effects of these two disturbance sources on the output of the traded good, $S_{jt}$, may also be similar. With respect to the exchange rate and other price effects, however, some substantial differences emerge. In particular, whereas the global monetary stimulus brings about a devaluation of the exchange rate, the supply shock implies a revaluation. Similarly, with respect to the aggregate price level, the monetary stimulus implies an inflationary effect, while the supply shock leaves the aggregate price level unchanged.

Table 9.2: A SUMMARY OF DOMESTIC IMPACTS ASSOCIATED WITH GLOBAL MONETARY EXPANSION, SUPPLY SHOCK, AND DOMESTIC MONETARY EXPANSION

<table>
<thead>
<tr>
<th></th>
<th>Global monetary expansion</th>
<th>Supply shock</th>
<th>Domestic monetary expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange rate ($\epsilon_t$)</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Non-traded price ($q_{nt}$)</td>
<td>+</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Export price ($q_{jt}$)</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Import price ($q_{t}$)</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Aggregate price ($A_t$)</td>
<td>+</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Sectoral terms of trade ($\epsilon_t$)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Interest rate ($i_{t,t+1}$)</td>
<td>+</td>
<td>0</td>
<td>+/-</td>
</tr>
<tr>
<td>Non-traded output ($S_{nt}$)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Traded output ($S_{jt}$)</td>
<td>+/-</td>
<td>+</td>
<td>+/-</td>
</tr>
</tbody>
</table>

Note: The aggregate price, $A_t$, is defined in (8.49) and is a weighted sum of traded and non-traded prices.
If we now compare these impacts against those associated with domestic monetary expansion, we may note immediately the strong similarities between global monetary impacts and domestic monetary impacts. Both types of monetary expansion are inflationary and both lead to a devaluation of the exchange rate. Furthermore, both types of monetary expansion have neutral impacts with respect to the sectoral terms of trade and the non-traded goods sector.

It is in relation to interest rate and traded sector output adjustments, that possible differences between domestic and foreign monetary expansion may emerge. The interest rate effect of a global monetary stimulus is positive, reflecting in part the upward movement in foreign interest rates during the expansionary phase in the global business cycle. The interest rate effect of domestic monetary expansion, on the other hand, was shown in (8.19) to depend critically on the expenditure switching term \( m_5 - I_4 \). This term measures the extent to which a rise in the non-traded price, \( q_{nt} \), diverts domestic expenditures towards either the local traded good \( (j) \) or the imported good. If \( (m_5 - I_4) \) is negative, then domestic monetary expansion will lead to a rise in the local interest rate, the same as for global monetary expansion. It is possible however, that \( (m_5 - I_4) \) may be zero or positive implying stationary or negative interest rate responses to domestic money supply increases, respectively. In these latter cases there will of course be a difference between domestic and foreign monetary stimuli.

The expenditure switching term also plays a key role in determining the response of traded sector output, \( S_{jt} \) to both domestic and foreign monetary stimuli. Consider the case where \( (m_5 - I_4) \) is positive. This situation applies when a rise in \( q_{nt} \) diverts expenditure relatively more towards the imported good. In this situation, \( S_{jt} \) responds positively to the foreign monetary stimulus, but negatively to the domestic monetary stimulus. To the extent that the authorities may wish to stabilise production in the traded goods sector, then clearly a policy of domestic monetary expansion is called for to offset the stimulus to \( S_{jt} \) provided by the world money supply. The expansion in domestic money will also serve to offset the upward movement in the domestic interest rate that the global monetary stimulus induces. Against this, however,
the expansion in the domestic money supply will also exacerbate the inflationary effects of global monetary expansion. Hence, when \((m_5 - I_4)\) is positive, there is clearly a trade-off between the simultaneous achievement of inflation and output stability objectives through the use of accommodative monetary policy.

Consider next the case where \((m_5 - I_4)\) is zero. In this situation, domestic monetary policy has no effect on either domestic output or the rate of interest, but it still maintains its inflationary impacts. This means that if domestic monetary expansion coincides with foreign monetary expansion, output and interest rates will increase but with a higher level of inflation than if accommodation had not occurred. Under these circumstances, all that domestic monetary authorities can influence is the level of prices and if price stability is their aim then a policy of monetary contraction is called for. In this way the economy may experience a rise in economic activity associated with the global monetary stimulus, but with a lower level of inflation than would otherwise have occurred. To the extent that such an outcome is seen as desirable, the domestic money supply will vary contracyclically with the global business cycle.

A slightly more complex situation emerges in the case where \((m_5 - I_4)\) is negative. This applies when the rise in \(q_{nh}\) diverts domestic expenditures relatively in favour of the locally produced traded good. Under these circumstances, domestic monetary expansion stimulates both output and interest rates, in addition to adding to local inflation. The output effects of the global monetary disturbance, however, are ambiguous. This means that an accommodative domestic monetary response may either compound or offset the output effects of the global money supply. To the extent that the response of \(S_{jt}\) to the global monetary stimulus is negative, then monetary accommodation at home will assist in stabilising production in the traded goods sector. It will do so, however, only at the possible expense of even higher interest and inflation rates. If, on the other hand, \(S_{jt}\) still responds in a positive manner to the foreign money supply when \((m_5 - I_4)\) is negative, then stabilisation of output, interest rates and inflation can be achieved through a contraction of the domestic money supply. Blinder (1981) labels this type of response as 'anti-accommodation'.

If we now consider the response of domestic monetary policy to commodity market supply shocks, a somewhat different picture emerges. As characterised in Table 9.2, the supply shock stimulates domestic production but at the same time leaves the aggregate price level unchanged. It does, however, induce a fall (revaluation) in the exchange rate and a restructuring of domestic price relativities. The extent to which domestic monetary variation can alter the pattern of these impacts depends once again on the sign of the expenditure switching term, \((m_5-I_4)\).

For the case where \((m_5-I_4)\) is negative, an accommodative monetary policy will provide additional stimulus to the production of \(j\) and in addition, will push up both interest rates and inflation. To the extent that these impacts are seen as undesirable, the opposite policy of a monetary contraction will assist in stabilising sector \(j\)'s output and lead to falls in both the aggregate price level and the interest rate. This latter policy stance will, however, add to the revaluation pressures on the exchange rate, pushing it down further than the level already implied by the supply shock. Hence, for negative values of \((m_5-I_4)\) there is clearly a trade-off between exchange rate and production stability objectives.

For zero values of \((m_5-I_4)\), on the other hand, domestic monetary variations have only price and exchange rate implications. Hence, monetary policy is ineffective in stabilising the increase in the production of \(j\) that the supply shock induces. In this case the trade-off is between exchange rate and aggregate price stability. An accommodative monetary policy will assist in offsetting the revaluation pressure but will add to domestic inflation. Conversely, however, a contraction in the domestic money supply will lead to a fall in aggregate prices but compound the revaluation pressures implied by the supply shock. To the extent that both exchange rate and price stability objectives are desired by the authorities, it is evident that under these circumstances a conflict will emerge regardless of the monetary stance.

Finally, in the event that \((m_5-I_4)\) is positive, we again return to a situation where domestic monetary policy has both output and price effects. In this case an increase in the domestic money supply has a
negative effect on domestic output, offsetting the rise created by the supply shock. Further, monetary expansion also assists in stabilising the exchange rate by offsetting the revaluation pressures that the supply shock induces. Against these stabilising influences, however, the increase in the domestic money supply adds to the inflation rate and leads to a fall in the interest rate.

Hence we find that the effects of monetary accommodation depend critically, not only on the source of the foreign price increase, but on the sign of the expenditure switching term as well. To the extent that the domestic authorities wish to stabilise more than one aggregate target variable, it is clear also that this cannot be achieved without invoking some sort of trade-off. The nature of these trade-offs is illustrated in Figure 9.3.

### Figure 9.3

Stabilising Versus Destabilising Impacts of Domestic Monetary Accommodation to Global Monetary and Supply Shocks

<table>
<thead>
<tr>
<th>(m5-I4)</th>
<th>Global monetary stimulus</th>
<th>Supply shock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Output</td>
<td>?</td>
<td>0</td>
</tr>
<tr>
<td>Inflation</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

where (+) implies a stabilising effect
(-) implies a destabilising effect
(0) implies a neutral effect

The main point to emerge from this Table is that regardless of the source of the global price rise and the sign of the expenditure switching term, there is always a trade-off in the pursuit of output, inflation and exchange rate stability goals through accommodation policy. For this reason, the issue of whether accommodation policy should or should not be
pursued in response to foreign price increases, requires detailed examination of the magnitudes involved and the preference weighting attached to each objective.

Even in the simpler case where stabilisation of only one domestic variable is sought, difficulties will persist. In order to achieve the desired stabilisation goal, the monetary authorities must know whether the rise in the foreign price of exports had monetary or supply origins. In addition to this, they must also have knowledge of the sign of the expenditure switching term, at least inasmuch as output stability is sought. It is only where the authorities seek a simple anti-inflationary objective that these obstacles are removed: in this case a policy of anti-accommodation would be necessary. In all other cases, however, no such simple prescription exists.

Despite substantial differences in analytical frameworks, our results are similar to that of Blinder (1981) in the sense that the desirability of accommodation policy depends on both the nature of the price shock and the policy objectives of domestic authorities. Blinder also concludes however, that some type of monetary response is more likely to be preferable than no accommodation policy at all. This proposition begs the question of whether the monetary authorities possess sufficient knowledge of both the source of the price shock and the sign of the expenditure switching term to make a rational policy choice. To the extent that their knowledge of these matters is limited, it is obvious that any policy stance will involve an uncertain payoff; doing nothing does not remove uncertainty. As Buiter (1981) has argued, even in the presence of uncertainty, there will always exist an optimal contingent policy rule that dominates an optimal fixed rule. The implication is that simple fixed-growth money supply rules associated with Friedman (1968) may be inferior to activist accommodation (or anti-accommodation) policies, even in the presence of uncertainty.

The essence of the Buiter proposition is that it is preferable to make full use of limited information than to ignore it completely. The contribution of this Chapter has been to demonstrate what the components of the information set might include in order to arrive at policy
decisions. The need to distinguish between supply induced and monetary induced price changes is paramount in this exercise.

9.6 Summary and conclusions

By itself, an increase in the world price of a traded good provides virtually no guidance as to the pressures that will impinge in the SOE or the policy stance that domestic authorities should make. The price rise may ultimately be associated with inflation or deflation, increased economic activity or contraction, revaluation or devaluation, higher or lower interest rates, all depending on the events which gave rise to the price increase in the first place.

In this chapter we have provided a comparative analysis of the domestic adjustments which arise out of supply induced and monetary induced commodity price increases. A summary of the main comparative impacts is given in Table 9.2. Briefly, a monetary induced commodity price rise impinges on the domestic economy in the form of higher inflation, a devaluation of the exchange rate, a rise in interest rates, and an indeterminate effect on output. The commodity market supply shock, on the other hand, has no inflationary effect, causes an exchange rate revaluation, leaves the interest rate unchanged and also creates an indeterminate impact on output. While these results reflect to some degree a number of simplifying assumptions, they demonstrate quite clearly the importance of looking to the source of global price movements for policy guidance.

The optimal policy response may or may not involve monetary accommodation, depending not only on the source of the price movement, but also on the domestic trade-offs among price, output and exchange rate stabilisation goals. One of the factors contributing to these trade-offs is the traded sector impacts of non-traded sector price changes. As emphasised in Chapter Eight, movements in non-traded prices may either increase or decrease excess demand in the traded sector, depending on the sign of the expenditure switching coefficient. This same expenditure switching effect also emerges in this model as a critical element in the transmission of foreign disturbances. An important conclusion to emerge is that the presence of non-traded goods can lead to substantial changes in the synchronisation of domestic and foreign business cycles.
FOOTNOTES - CHAPTER NINE

(1) In the results which follow, it has been assumed that domestic income variations have negligible impacts on the demand for real money balances. This assumption is made to reduce the clutter in the algebraic expressions and is not critical to the qualitative results obtained.

(2) As we have explained in previous chapters, the 'interest rate' linkage embodies the joint movements in global income, interest rates and inflationary expectations in response to the global monetary disturbance. The joint changes in these foreign variables affect the demand for exports through both income and asset demand processes; their combined influence being revealed in the export coefficient $X$ in (9.4). This mechanism for the international transmission of inflation is substantially different to the 'direct price effect' emphasised by, for instance, Bruno (1978), Hamada and Sakurai (1978) and Cebula and Frewer (1980).

(3) This proposition is also derived by Daniel (1981) and is consistent with an earlier argument put forward by Friedman (1953). Our result serves to emphasise the point that propositions which prevail at the aggregate level need not necessarily hold at the sectoral level. A related issue concerns differences between the aggregate price impacts of a disturbance and the sectoral, relative price impacts; see Section 9.4.

(4) It should be emphasised that this neutrality result derives entirely from the simplified excess demand specification adopted for the non-traded sector. Any alteration to the excess demand equilibrium condition given in (8.9), such as the inclusion of income or asymmetric price effects, would in general lead to a non-neutral response of $S_{nt}$ to $M_{t}$.

(5) The impacts listed in Table 9.2 refer to the simplified case of an anticipated supply shortfall and where condition (9.3') holds.
CHAPTER TEN

SUMMARY AND MAIN CONCLUSIONS

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10.1 Four areas of innovation
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10.6 The effectiveness of domestic monetary policy
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10.8 The real exchange rate and purchasing power parity
10.9 Supply- versus demand-induced export growth
10.10 The effects of tariff imposition
10.1 Four areas of innovation

The purpose of this Thesis has been to develop an integrated framework in which to analyse the joint behavior of the world economy, international commodity markets and the small open economy. The stimulus for this research has been the observation that an SOE like Australia receives price and interest rate signals from abroad which are not only correlated, but appear to come in waves. Allied to this has been the concern that in the face of rising and falling adjustment pressures from abroad, domestic policy effectiveness may be low or perhaps self-defeating.

In pursuing these objectives, the analyses of this Thesis have introduced innovations to existing treatments of international macroeconomics on a number of fronts. Firstly, with respect to the model of the world economy (presented in Chapter Three), a monetary approach to business cycle phenomena has been developed in which income, inflation and interest rates vary systematically over periods of both rising and falling economic activity. This has provided a more complete characterisation of the global business cycle than most existing treatments, which typically treat at least one of these three variables as a constant.

An important result to emerge from the model presented in Chapter Three is that the phenomenon of persistent inflation during periods of falling economic activity can be rationalised as an equilibrating force under fairly plausible conditions. The source of this phenomenon may be attributed to anticipations of future money supply growth rates which for a number of reasons can maintain prices on an upward trajectory at a time when economic activity and interest rates are falling. As outlined in Chapter Three this result supports the popular notion that persistent inflation will prevail while there remains a general belief that the factors which underly inflationary processes are unlikely to disappear quickly.

This result typifies the stance taken in Chapter Three (and Chapter Four as well) that theoretical characterisations of global economic activity should, where possible, provide reasonable imitations of
observed business cycle phenomena. The data presented in Chapter Two give some support to the proposition that a number of correlation patterns can be identified from recent business cycle experience. These correlations have been summarised as 'stylised business cycle facts' and by imitating these patterns, the global business cycle model of Chapter Three provides a more realistic perspective than do models that choose to ignore such correlations. Attainment of this goal has, however, required the imposition of a number of substitutability and symmetry conditions to coefficients which would have otherwise remained ambiguous. Whether or not these conditions can be supported by empirical evidence remains to be determined.

A second major innovation contained in this Thesis is the direct linking of a single international commodity market model to a model of world economic activity. As outlined in Chapter Four, this linkage has enabled further insights to be obtained on two important and related issues. The first has been to obtain analytical insight into various aspects of commodity market behavior which hitherto have remained largely within the domain of empirical analysis. Important results concerning such phenomena as the link between money and commodity prices, the Gibson paradox, and the fundamental source of fixprice:flexprice behavior have emerged. The second issue investigated in Chapter Four is the behavior of relative prices over the course of a business cycle. The relative prices of primary commodities, for instance, are known to be procyclical with respect to levels of economic activity and the analysis of Chapter Four provides further insight into the circumstances which give rise to this. More importantly, perhaps, this procedure for analysing relative price changes at the global level leads to further innovations in subsequent studies of SOE transmission impacts. In effect, it enables us to endogenise the SOE's terms of trade with respect to the global business cycle in a manner which has not previously been attempted.

The third main innovation contained in this Thesis is the study of global transmission processes in the presence of systematic variation of the domestic economy's structure. Existing treatments of global transmission processes have tended to concentrate on specific forms of SOE structure, making it difficult to draw conclusions regarding the elements which make, say, domestic monetary policy effective. The
approach taken in this Thesis (in Chapters Five to Eight) has been to systematically vary the structure of the SOE, noting the differences in transmission that are implied, and the scope for domestic policy effectiveness as well. Out of this emerges a clearer perception of insulation and stabilisation issues than would have been the case had only a single characterisation of the SOE been given.

As a fourth innovation, this Thesis has sought to draw attention to the issue of commodity price shocks and the crucial distinction which should be drawn between supply-induced price shocks on the one hand and monetary-induced price shocks on the other. The analysis of Chapter Nine demonstrates that an SOE which faces sudden price rises in either imported or exported commodities cannot plan rational policy responses without first knowing the source of the price rise. Previous contributions on the subject of monetary accommodation to price shocks have been based on the assumption that only supply shocks have mattered. By neglecting consideration of monetary forces as a source of sudden commodity price increases, these previous studies draw conclusions on monetary accommodation which may be highly misleading.

10.2 Money and the global business cycle

The model of Chapter Three sought to provide a suitable basis for characterising changes in world economic activity in response to monetary disturbances. The driving force underlying these changes is the relationship between the current stock of money and the future (expected) stock of money. Previous studies have also demonstrated that money can be non-neutral by invoking such levers as price 'surprises', incomplete information, lagged wage indexation and inflationary expectation adjustments. The present model differs from previous studies in that monetary shocks affect output through induced changes in both interest rates and inflationary expectations and where the coefficient structure of the aggregate supply function is asymmetric. This implies that output levels may vary even in circumstances where the expected real interest rate is constant.

Within this model, a rise in economic activity occurs when a given increase in the current money supply is accompanied by a more than
proportional increase in the expected money supply. Under these circumstances the expected growth rate of money stock is positive. Accompanying the rise in output are increases in nominal interest rates and prices.

Conversely, a downturn in economic activity occurs when the expected growth rate of the money stock is negative. This can occur, for instance, when the current money supply is expanding but money supply expectations remain stationary. It is for this reason that a given increase in the actual money supply may be associated with either rising or falling levels of output, depending on the corresponding changes in monetary expectations. The recession phase in economic activity is characterised by falling output and nominal interest rates, but rising prices. As noted above, the phenomenon of persistent inflation during a downturn in economic activity is a key feature of this model, and as a further reflection of reality, the inflation rate during the recessionary phase is lower than during the expansionary phase.

10.3 Money and world commodity prices

The model of Chapter Four addressed the issue of price determination on individual commodity markets and the role of global monetary disturbances in this process. The steadily accumulating body of empirical evidence points to global monetary shocks (both anticipated and unanticipated) as major determinants of commodity price changes in recent decades, yet there has been little systematic consideration of the linkages through which such impacts take place. By appending a simple model of commodity price determination to the global business cycle model of Chapter Three, a monetary approach to commodity prices has been developed.

An important result is that the fixprice:flexprice distinction which is usually drawn between primary and industrial commodities can be rationalised on the basis of differences in relative magnitudes of excess demand coefficients. In particular, the more responsive that demand for inventory purposes is to interest rates, the more likely it is that the commodity will display 'flexprice' characteristics; i.e., its price will move up and down more or less in line with economic activity. Conversely,
where inventory demand is more responsive to expected rates of price change than to interest rates, the more likely it is that the commodity will display the 'fixprice' characteristic frequently attributed to industrial commodities.

Similarly, the model of Chapter Four provides an explanation for the observed tendency of real primary commodity prices to vary positively with economic activity. As a general proposition, it is found that global monetary disturbances bring about changes in relative commodity prices only when they also induce real impacts. If the global monetary disturbance is neutral, relative prices remain constant.

10.4 Supply- versus monetary-induced commodity price shocks

A sudden rise in the price of a particular commodity, by itself, explains nothing of the likely adjustment pressures that are to follow. The analysis of Chapter Four compared the implications of price shocks arising from two sources: a supply shortfall and a monetary disturbance. Important differences emerge regarding the relative changes between the current price of the commodity and its expected price. In the case of a supply shock, the current price increases either by a greater or equal amount to the expected price; hence the expected rate of price appreciation for the commodity will fall or remain steady. A monetary shock on the other hand, will cause the expected price to rise by more than the current price such that the expected rate of price appreciation rises. In addition, the monetary shock sets in train changes in output, interest rates and inflation which accompany the sudden rise in the price of the commodity. The implications of these two causes of commodity price rise for policy in the SOE will be presented below.

10.5 Flexible exchange rates and insulation

All of the SOE models developed in this Thesis included flexible exchange rates in their specification. Contrary to the findings of some previous models, it was found that in no case do flexible exchange rates insulate the domestic economy from the global business cycle. The reason for this is that non-neutral global monetary disturbances lead to changes not only in income and interest rates, but in price relativities as well.
The change in relative prices refers to both relativities between commodities and, for a given commodity, the relativity between current and expected price. The nature of these transmission linkages is such that any given adjustment in the exchange rate will not be capable of neutralising all of them simultaneously. It is the inability of the exchange rate to deal with the multiplicity of adjustment pressures created by a global monetary shock that denies it a perfect insulation role. This result holds regardless of the structure of the SOE.

Other attributes of the SOE may, however, assist in providing some degree of insulation from global monetary shocks. Depending on the nature of a country's trade patterns, it is possible that the globally-determined terms of trade could offset the pressures caused by foreign income and interest rate changes. A country which specialises in the export of industrial commodities and the importation of primary commodities (and which does not possess significant market power in either) will tend to face a terms of trade which varies contracyclically with the global business cycle. As outlined in Chapter Six, this contracyclical property may ameliorate to some extent the pressures which are simultaneously being brought to bear on domestic interest rates and output. It is in this sense that a country's terms of trade can assist in providing insulation from global monetary disturbances.

The opposite result may hold, however, for countries which specialise in the export of primary commodities and the import of industrial commodities. For these countries the terms of trade is more likely to vary procyclically with the global business cycle and hence may exacerbate the domestic impacts of foreign interest rate and income movements. In this case the terms of trade acts to destabilise the small open economy.

The only instance in which the insulating property of flexible exchange rates was found to emerge was the case where the global monetary disturbance is neutral with respect to the rest of the world. In this case foreign income and interest rates remain constant and only foreign inflation is transmitted to the SOE. Under purchasing power parity, the rise in world inflation induces an equiproportional revaluation in both current and expected exchange rates. Hence, intertemporal price
relativities at home remain constant and thus there are no real impacts in the SOE either.

It should be noted, however, that the assumption of generalised purchasing power parity for traded goods is essential to this result. As the analysis of Chapter Seven demonstrates, the possession of market power by the SOE in its exports can lead to a breakdown of this simple insulation property. The reason for this is that market power implies a more complex set of linkages for global transmission where not only current values of foreign interest rates and income are involved, but expected values of these variables as well. A neutral global monetary disturbance may leave current values of income and interest rates unchanged, but still transmits changes in the expectations of those variables to the SOE. The latter in turn have real impacts domestically, demonstrating once again the impotence of flexible exchange rates as a perfect insulation device. Furthermore, this result runs contrary to the 'global neutrality' proposition which suggests that if the foreign money disturbance is neutral globally, then it will be neutral domestically as well. For a small open economy with market power, such a neutrality proposition may not be valid.

10.6 The effectiveness of domestic monetary policy

The extent to which domestic monetary authorities may influence economic activity in the SOE hinges on the existence of levers through which price relativities can be altered by monetary expansion. For an SOE with traded goods and generalised purchasing power parity, no such levers exist since intertemporal and cross-commodity price relativities are governed entirely by current and expected levels of the exchange rate. In this type of economy, domestic monetary policy affects the general level of prices, but has no impact on economic activity.

Two sources of monetary leverage have been identified. The first is the existence of market power in exports from the SOE, as outlined in Chapter Seven. This means that not only are the country's terms of trade endogenous to local excess demands, but so too are intertemporal price relativities. Variations in the current stock of domestic money relative
to the expected stock now lead to relative price changes and through this mechanism monetary policy has an influence on local economic activity.

The second source of monetary leverage is the presence of non-traded goods, as outlined in Chapter Eight. In this case domestic monetary expansion leads to all domestic prices rising by the same amount which may in turn lead to 'expenditure switching' effects between domestic output and imports. Hence the effect of monetary expansion on output from the domestic traded sector depends on which way the expenditure switch operates. If the rise in the non-traded good price shifts expenditures relatively more toward the local traded good, then its production will increase. If, on the other hand, demand for imports is stimulated by a relatively greater amount than demand for the local traded good, production in the traded goods sector will fall. It may be noted however that output from the non-traded sector remains neutral with respect to the domestic money supply.

10.7 Price shocks and monetary accommodation policy

Related to the issue of domestic monetary effectiveness is the question of whether price shocks should be accommodated by increases in the money supply. The analysis of Chapter Nine investigated this question in the context of supply-induced and monetary-induced increases in the world price of exports. By itself, the increase in the world price of the traded good provides virtually no guidance as to the pressures that will impinge on the SOE or the policy stance that domestic authorities should take. Answers to these issues requires knowledge of the source of the price rise.

A monetary-induced commodity price rise impinges on the domestic economy in the form of higher inflation, a devaluation of the exchange rate, a rise in interest rates and an indeterminate effect on output. The commodity supply shock on the other hand, has no inflationary effect, causes an exchange rate revaluation, leaves the interest rate unchanged, but also creates an indeterminate effect on output. In both cases the output effect depends on the direction of the 'expenditure switching' effect referred to in 10.6.
Further, the optimal policy response may or may not involve monetary accommodation, depending not only on the source of the price movement, but also on the domestic trade-offs among price, output and exchange rate stabilisation goals. It is only where the authorities seek a simple anti-inflationary objective that these indeterminancies are removed: in this case, a policy of anti-accommodation would be necessary. In all other cases, however, no such simple prescription exists.

10.8 The real exchange rate and purchasing power parity

One of the main objections to the ppp assumption in analytical models is based on the observation that in reality, real exchange rates deviate from parity for sustained periods. This is regarded by some as being contrary to the conditions which flow from the ppp assumption.

The analyses of this Thesis have uncovered a number of instances where deviations in real exchange rates are consistent with ppp for traded goods. As pointed out in Chapter Six, global monetary disturbances which bring about terms of trade (i.e., relative price) changes will also induce changes in the real exchange rate, even under ppp. To the extent that relative price changes are synchronised with the global business cycle, it is plausible that real exchange rates may display an apparent cyclical pattern around parity. For primary producing countries (where terms of trade tend to be procyclical with the global business cycle), it is suggested that the real exchange rate will decline during the global expansion and rise during the global recession.

At the domestic level, real exchange rates may also vary, despite the assumption of ppp for traded goods. As outlined in Chapter Eight, in the presence of non-traded goods, the real exchange rate may adjust through variations in non-traded sector productivity and tariff adjustments. In the absence of the expenditure switching effects referred to earlier, a productivity increase in the non-traded sector induces a real depreciation of the exchange rate, while a tariff imposition induces a real appreciation. Because of the ppp assumption, however, neither of these real exchange rate changes has any effect on export performance.
10.9 Supply- versus demand-induced export growth

In the wake of the 'minerals export boom' literature in Australia, the 'North Sea oil export boom' literature in the UK, and similar resource-based studies elsewhere, came a number of propositions regarding exchange rate pressures and intersectoral competition. One drawback with most of these studies was the limiting assumption that growth in exports depended only on supply-augmenting resource discoveries; the role of demand as a determinant of export growth was by and large forgotten.

The comparison of supply-induced versus demand-induced export growth carried out in Chapter Seven, reveals the substantially different forms of macroeconomic adjustment implied in each case. Exogenous supply increases stimulate both exports and domestic production through terms of trade and real interest rate effects (i.e. through falls in the domestic price of exports and the domestic interest rate, and a devaluation of the exchange rate). Together these price and exchange rate adjustments imply an improvement in the international competitiveness of the domestic product and provide a stimulus for diverting resources into domestic production of these goods. In contrast with some previous studies, it is also found that the resource discovery leads to a real depreciation of the exchange rate.

In the case of demand-induced export growth, the pattern of macroeconomic adjustment is more complex. A rise in foreign income, for instance, leads to a revaluation of the exchange rate, a rise in the price of domestic output, an increase in interest rates and a fall in output. The level of exports will increase only if the income component of foreign demand dominates the loss of competitiveness implied by the exchange rate and domestic price adjustments. It may be noted that the foreign real income rise is transmitted negatively to the output of the SOE as a consequence of domestic price and interest rate increases.

In the event that export growth is stimulated by an expansionary global monetary stimulus, the domestic macroeconomic adjustments for an SOE with market power become even more complex. This time there are trade-offs caused by joint movements in current and expected values of foreign interest rates. The rise in exports may be accompanied by rising
or falling exchange rates, rising or falling interest rates, and rising or falling output. It is concluded that the simple propositions developed in the supply-based export growth literature will be unlikely to hold in the presence of global demand shifts.

10.10 The effects of tariff imposition

For an SOE with both traded and non-traded goods, the analysis of Chapter Eight revealed that the sectoral impacts of import tariff imposition hinged critically on the expenditure switching effect referred to earlier. An unanticipated tariff imposition will stimulate output from the non-traded sector when the expenditure switching effect is either absent or favours imports. But if the expenditure switching effect is substantially in favour of the locally-produced good, the tariff will have a negative effect on the non-traded sector. In both cases, the effect of the import tariff on the exporting sector remains highly ambiguous.

By contrast, an anticipated tariff imposition (expected to be imposed in some future period) has no effect on the non-traded sector while output from the traded sector falls. In this case, a tariff expectation leads to a fall in aggregate economic activity.

10.11 Limitations and Qualifications

As might be expected within the constraints imposed by an analytical modelling framework, the results obtained above depend critically on assumptions regarding the behavioral responses of economic agents in the aggregate. Although extensive referencing to relevant works has been carried out, the behavioral relations which underly these results have not been derived from optimisation principles and as a consequence there is no guarantee that the derived equilibrium conditions represent either feasible or optimal outcomes.

Two sets of assumptions warrant recognition in this regard. Firstly, there are the assumptions relating to the exogeneity of expected money supply growth rates which represent the driving force behind the business
cycle properties of the world economy and small open economy models. Whilst money supply exogeneity is a common feature of many macroeconomic models and need not imply inconsistency with rationality, it is nevertheless a limiting assumption for studies which purport to provide insight into real world phenomena. Overcoming this deficiency requires specification of various feedback rules or policy reaction functions which describe the responses of monetary authorities to selected economic variables. However endogenising money growth processes in this way implies the introduction of new exogenous shocks into the macroeconomic system and this is achievable only at the expense of additional complexity. Furthermore, it is generally recognised that the priorities and concerns of monetary authorities differ widely between countries and may also vary over time and it would seem that the implications of varying monetary growth specifications would constitute a field of study in their own right.

The second set of limiting assumptions concern the property of 'behavioral asymmetry' which lies at the source of the monetary nonneutrality results presented above. In other words, the ability of the model to generate specific changes in real output, relative prices and foreign trade in response to nominal money supply changes depends critically on assumed responses to induced movements in price expectations and interest rates. At the aggregate level, for instance, it is assumed that output and investment decisions are more responsive to a given change in inflationary expectations than to the same change in interest rates. Similarly, at the commodity market level, it is found that the distinction between fixprice and flexprice behavior can be rationalised through differences in the relative strengths of interest rates and price expectations as determinants of inventory demand. Whilst the principle of response asymmetry is widely accepted in economic models, the question remains as to whether the particular asymmetry assumptions used above provide reasonable representations of real world behavior. Unfortunately, there is little direct evidence that is available to answer this question but in view of the implications of what has been presented there is clearly a case for investigating these matters as a subject of further research.
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