Economics Division Working Papers

China Economy

The FDI-led growth hypothesis: further econometric evidence from China

Jordan Shan, Garry Gang Tian and Fiona Sun

97/2

National Centre for Development Studies • The Australian National University
Research School of Pacific and Asian Studies

http://ncdsnet.anu.edu.au/publications/online

Published by the National Centre for Development Studies

Online Publications
http://ncdsnet.anu.edu.au

The Economics Division acknowledges the contribution made by the Australian Agency for International Development (AusAID) towards the publication of this working paper series.

ISBN 0 7315 2361X

ISSN 1441-9823

Key to symbols used in tables

n.a.	Not applicable
..	Not available
-	Zero
.	Insignificant

Jordan Shan is a lecturer at the Department of Applied Economics, Victoria University of Technology, Melbourne.

Garry Gang is a lecturer at the School of Economics, Flinders University of South Australia, Adelaide.

Fiona Sun is a post-doctoral fellow at the Centre for Strategic Economic Studies, Victoria University of Technology, Melbourne.

Key words: FDI, VAR model, economic growth in China.

abstract

Despite a large volume of econometric literature on the impacts of foreign direct investment (FDI) on economic growth in developing countries, the question of causality linkage between them has only been investigated very recently. This paper re-examines the FDI-led growth hypothesis in the case of China, a country which has become one of the major FDI recipient countries in the world. The study is based upon quarterly time series data and a vector autoregresion (VAR) model applying the Granger no-causality procedure, developed by Toda and Yamamoto (1995), to test the causal link between the inflow of FDI and real output growth. Four distinct features in this paper stand out as follows: first, the FDI-led growth study on China applying Granger no-causality testing procedure is the first attempt in the literature and hence is attractive; second, we have gone beyond the traditional two-variable relationship by building a six-variable VAR model in the production function context to avoid the possible specification bias; third, we follow Riezman, Whiteman and Summers (1996) to test the hypothesis while controlling for the growth of imports to avoid producing a spurious causality result; and finally, the methodology by Toda and Yamamoto is expected to improve the standard F-statistics in the causality test process. The results emerging from our research indicate a two-way Granger causality running between output growth and FDI inflows.

the FDI-led growth hypothesis: further econometric evidence from China

The linkage between FDI and economic growth has been the subject of considerable research for many decades, yet the link between FDI and economic growth which has been subjected to empirical scrutiny remains the subject of debate. Interest in the area has been revived in recent years largely due to the globalization of the world economy and to the recognition that multinational corporations play an increasingly important role in trade, capital accumulation and economic growth in developing countries. Three developments have added an additional twist to the literature on the FDI-led growth study, particularly in the area of empirical studies. First, previous econometric studies based on the assumption that there is one-way causality from FDI to GDP growth has been noted and criticised in more recent studies (Kholdy 1995). In other words, not only FDI can 'Granger-cause' GDP growth (with either positive or negative effects), but GDP growth can also affect the inflow of FDI. Failure to consider either direction of such a causality can lead to an inefficient estimation of the impacts of FDI/GDP on GDP/FDI and hence is subject to the problem of simultaneity bias. Second, the so-called 'new growth theory' has resulted in some reappraisal of the determinants of growth in modelling the role played by FDI in the growth process. Third, new developments in econometric theory, such as time series concepts of cointegration and causality testing, have further expanded the debate on the FDI-growth relationship.

The FDI-led growth study on China using Granger no-causality testing procedure is the first attempt in the literature and hence is attractive. Since the early 1990s China has become one of the most important FDI recipient developing countries in the world. During the 1980-95 period, the annual growth rates of actual FDI was 40 percent, and accompanied with this persistent strong FDI inflow, China has achieved a remarkable economic growth rate (9.5 per cent per annum).

Therefore, was economic growth in China FDI-led, or was it the other way around? The hypothesis can be further divided into three competing, although not mutually exclusive, hypotheses: (1) the FDI-led growth hypothesis; (2) the growth-driven FDI hypothesis; and (3) the two-way causal hypothesis, which is a combination of (1) and (2).

This paper contributes to the debate on the FDI-led growth hypothesis by constructing a six-variable Vector Autoregression (VAR) model for the Chinese economy on the basis of quarterly time series data in a production function context. Four distinct features in this paper stand out as follows: first, the FDI-led growth study on China applying Granger no-causality testing procedure is the first attempt in the literature and hence is attractive; second, we have gone beyond the traditional two-variable relationship by building a six-variable VAR model in the production function context to avoid the possible specification bias; third, we follow Riezman, Whiteman and Summers (1996) to test the hypothesis while controlling for the growth of imports to avoid producing a spurious causality result; and finally, the methodology by Toda and Yamamoto is expected to improve the standard F-statistics in the causality test process.

A review

Broadly speaking, the studies on the FDI-growth nexus can be categorised into two groups: (i) those focused on the role of multinational firms and on the determinants of FDI; and (ii) those, until very recently, applied casualty tests based on time series data to examine the nature of causal relationship between FDI and output growth. For the first group, some noteworthy studies are Scaperlanda and Mauer (1969), Dunning (1970) and Vernon (1971). More recently, Rugman (1994), Root and Ahmed (1978), Graham and Krugman (1989), O'Sullivan and Geyikdagi (1994), Lin (1995) , Cable and Persaud (1987), Tsai (1994) and Chao and Yu (1994), among others, have examined the factors that influence the inflows and outflows of foreign direct investment.

In the second group of the studies on the FDI-growth nexus, some scholars have applied time series data analysis and directed their FDI-led growth studies towards the use of the Granger no-causality testing procedure. See Karikari (1992), Saltz (1992), de Mello (1996), Kasibhatla and Sawhney (1996), Kholdy (1995), Pfaffermayr (1994), United Nations (1993). However, one problem with these studies is their arbitrary choice of the lag length (Kasibhatla and Sawhney 1996). Furthermore, these studies have applied F-test statistics for the causality test (United Nation 1993). It is now well established in the literature of econometrics that the F-test statistic is not valid if

times series are integrated (e.g., if they are *I*(1) variables) as argued by Zapata and Rambaldi 1997 and Gujarati 1995.

Some empirical studies on the FDI-led growth hypothesis have been directed towards the Chinese economy. Recent attempts are that by Chen, Chang and Zhang 1995, Zhang 1995, Chen 1996, Pomfret 1994, Kueh 1992, Plummer and Montes 1995, Sun 1996, Wei 1996, and Lee 1994 and Wang & Swain 1995. However, these studies suffer from two major problems. First none of these studies have tested for the direction of causality between GDP growth and FDI inflow, they have implicitly assumed a one-way causality running from FDI to GDP growth and estimated the impacts of FDI based on such a causality which is open for a test. Second, most of these studies have used cross-section data which is also subject to debate.

The main arguments against cross section data analysis, and in favour of times series analysis, have been that cross-country studies implicitly impose or assume a common economic structure and similar production technology across different countries which is most likely not true, and further, economic growth of a country is influenced not only by *FDI* and other factors inputs, but also by a host of domestic policies such as monetary, fiscal and external policies. Despite some developments in the panel data analysis, including the use of Random Coefficients (RC) to improve the power of the test based on cross section data, the significance of the conclusion drawing from cross section data is still subject to some debate in finding a long run causal relationship in the data (Enders 1995 and Marin 1992). Some studies have tried to overcome the problems with cross-section data analysis and the simultaneity bias by using a simultaneous equations model (Gupta and Islam 1983, Lee and Rana 1986 and Snyder 1990). However, these studies, as pointed out by White (1992a and 1992b), suffer from the problems of inadequate theoretical foundations and poor econometric methodology (e.g. their estimation methods).

As far as the model specification is concerned, most of these studies have used a simple two-variable relationship. It should be pointed out that the approach of using a simple two-variable framework in the causality test without considering the effects of other variables (such as export, import growth and investment growth) are subject to a possible specification bias. It is established in the literature of econometrics that causality tests are sensitive to model selection and functional form (Gujarati 1995). Riezman, Whiteman and Summers 1996 have pointed out an important finding omitting the imports variable in the VAR estimation process can result in both 'type I' and 'type II' errors, that is, spurious rejection of one causality as well as spurious detection of it (Riezman, Whiteman and Summers 1996).

Another problem that has often been ignored and/or has not been dealt with properly in the literature, yet is far more important, is the endogenous nature of a production function as argued by Greenaway and Sapsford (1994). Therefore, any

studies which do not consider the endogenous nature of the growth process, to a large extent, are subject to a simultaneity bias. The use of a VAR model has proved to generate more reliable estimates in an endogenous context (Gujarati 1995).

Although the choice of the optimal lag in the causality test has been noted in some studies, yet very few studies have considered the problem of the sensitivity of the causality test results under different lag structures. It is vital to obtain consistent causality results for at least some consecutive lag structures along with the optimal choice of the lag using some conventional criterion such as Akaike Information Criteria (AIC) and / or Schwartz Criterion (SC).

Theoretically, the causality between FDI and GDP growth could run either direction—FDI could promote further GDP growth as postulated, among others, by Todaro (1982), Chenery and Strout (1966), Dunning (1970), the World Bank (1993) and Kruger (1987). Recently economists, in line with 'new growth theory', argued that through the capital accumulation in the recipient economy, FDI is expected to generate non-convex growth by encouraging the corporation of new inputs and foreign technologies in the production function of the recipient economy. Further, through knowledge transfers, FDI is expected to augment the existing stock of knowledge in the recipient economy through labour training and skill acquisition, on one hand, and through the introduction of alternative management practices and organisational arrangements, on the other (de Mello and Sinclair 1995). As a result, foreign investors may increase productivity in the recipient economy and FDI can be deemed to be a catalyst for domestic investment and technological progress.

However, the causality could also run the opposite way—rapid GDP growth could induce the inflow of FDI (Dowling & Hiemenz 1982, Lee & Rana, 1986). This is because rapid GDP growth will usually create a high level of capital requirement (and the resource gap) in the host country and hence the host country will demand more FDI by offering concessional terms for FDI to attract overseas investors. Further, rapid economic growth in the host country (eg. in China) will build the confidence for overseas investors investing in the host country. More importantly, rapid economic growth, accompanied by an increased higher per capital income, will create huge opportunities for FDI to invest in industrial sectors, consumer durable goods and infrastructure sectors in the host country.

It should be pointed out that the direction of the causality between FDI and GDP growth depends on many economic as well as political and cultural factors, such as the level of economic development, the productivity of FDI and the policies shaping FDI inflow. Ultimately, we will have to ‘let data speak’ . China’s case fits neatly into this context. Since the adoption of the open-door policy, China has achieved a high level of economic growth. Some industries, such as infrastructure become a serious bottleneck to further economic development which has become available for the

introduction of foreign capital. During the 1990s, China's rapid economic growth increasingly hedged on the huge FDI inflow, while its rapid economic growth also attracted more foreign capital from overseas.

The data and model

Data

The VAR model is estimated using quarterly and seasonally-adjusted data, in logarithms and real terms (in 1990/1991 prices) over the period 1985:2-1996:2. The size of the VAR model requires quarterly rather than annual series to generate enough degrees of freedom for estimation. Therefore, we first collected monthly data for imports (Imp), industrial out(ind), energy consumption (en), labour force (lab), foreign direct investment (FDI) and capital expenditure (Inv). They were then converted into quarterly data and inflation-adjusted using CPI index except FDI which is in current price in US dollar. The data source is *China Monthly Statistics*, and is detailed in the data appendix at the end of this paper.

The model

Based upon the review in the previous section, the FDI-led growth hypothesis is tested according to a six-variable VAR model which is built upon the following augmented production function:

$$Y_t = f(Inv_t, Lab_t, Imp_t, FDI_t, En_t) \qquad \ldots \ldots \ldots \qquad (1)$$

where Y is industrial output; Inv_t, Lab_t, Imp_t, FDI_t, and En_t, respectively are capital, labour, imports, FDI inflows to China and the consumption of energy.

The Granger causality procedures

Testing for Granger no-causality in multiple time series has been the subject of considerable recent research in the literature of econometrics. It has been argued that the traditional F-Test in a regression context for determining whether some parameters of the model are jointly zero, eg. in the form of a causality test (in a stable VAR model), is not valid when the variables are integrated and the test statistic does not have a standard distribution (Gujarati 1995). Therefore, several alternative procedures have been developed attempting to improve the size and power of the Granger no-causality test (Toda and Phillips 1993, Mosconi and Giannini 1992).

Unfortunately, these tests are cumbersome and 'the simplicity and ease of application have been largely lost' (Rambaldi and Doran 1996:1).

In this paper, we have applied the Granger no-causality methodology, developed by Toda and Yamamoto (1995), to test the hypothesis that 'industrial growth in China is Granger-caused by FDI growth', versus the alternative hypothesis that 'industrial growth has driven the inflow of FDI in China'.

The advantage of using Toda and Yamamoto's (1995) method of testing for Granger causality lies in its simplicity and the ability to overcome many shortcomings of alternative econometric procedure—some studies have applied the cointegration technique by Johansen and Juselius (1990). However, this method involves transforming the suggested relationship into an Error Correction Model (ECM) and identifying the parameters associated with the causality. If the case involves more than two cointegration vectors, this is not simple. Further, there is growing concern among applied researchers that the cointegration likelihood ratio (LR) tests of Johansen (1988) and Johansen and Juselius (1990) have often not provided the degree of empirical support that might reasonably have been expected for a long run relationship. Furthermore, using a Monte Carlo experiment, Bewley and Yang (1996) argue that the power of LR tests is high only when the correlation between the shocks that generate the stationary and nonstationary components of typical macroeconomic series is sufficiently large and also that the power of LR tests deteriorates rapidly with over-specification of the lag length. This concern has also been supported by the simulation studies of Ho and Sorensen (1996).

The procedure developed by Toda and Yamamoto (1995) utilises a modified WALD test for restrictions on the parameters of a VAR(k), or MWALD procedure (where k is the lag length in the system). This test has an asymptotic c^2 distribution when a VAR($k + d_{max}$) is estimated (where d_{max} is the maximal order of integration suspected to occur in the system). A Monte Carlo experiment which included the above three alternative test procedures, presented in Zapata and Rambaldi (1997), provides evidence that the MWALD test has a comparable performance in size and power to the LR and WALD tests if (i) the correct number of lags for estimating $k + d_{max}$ is identified and (ii) no important variables are omitted, provided a sample of 50 or more observations is available.

Rambaldi and Doran (1996) have proved that the MWALD method for testing Granger no-causality can be computationally simple by using a Seemingly Unrelated Regression (SUR) which can be routinely computed by several of the available

econometric packages, such as Shazam. We have therefore built the following six-variable VAR system in a SUR form:

$$\begin{matrix} Ind_t \\ En_t \\ lab_t \\ imp_t \\ inv_t \\ FDI_t \end{matrix} = A_0 + A_1 \begin{matrix} Ind_{t-n} \\ En_{t-n} \\ lab \\ imp_{t-n} \\ inv_{t-n} \\ FDI_{t-n} \end{matrix} + \begin{matrix} \varepsilon_{ind} \\ \varepsilon_{en} \\ \varepsilon_{lab} \\ \varepsilon_{imp} \\ \varepsilon_{inv} \\ \varepsilon_{fdi} \end{matrix} \quad \text{.... ....} \quad (2)$$

The advantage of this procedure, as argued by Zapata and Rambaldi (1997), is that it does not require the knowledge of cointegration properties of the system. It has a normal standard limiting chi-square distribution and a usual lag selection procedure to the system can be applied even if there is no cointegration and/or the stability and rank conditions are not satisfied 'so long as the order of integration of the process does not exceed the true lag length of the model' (Toda and Yamamoto 1995:225). In addition, Toda and Yamamoto (1995:225) have shown how VARs can be estimated using data in levels and 'testing general restrictions even if the process may be integrated or cointegrated of an arbitrary order'.

It should be added that, by using a SUR type VAR model, we can compromise between the theory-driven and the data-driven approaches, since we have included the relevant set of variables in our VAR system following the recent literature of 'new growth theory', and at the same time, the simultaneity bias can be overcome by the VAR model. Gujarati (1995) points out that the VAR model is a truly simultaneous system in that all variables are regarded as endogenous considering the feedback effects in the system and that it can be estimated by OLS without resorting to any system methods such as two-least squares (2SLS).

To examine the first causality (from FDI to growth), we should test whether FDI_{t-n}, appears in the first equation (ie. the Ind equation).

H_0: $\alpha_1^{(1)} = \alpha^{(2)} = \alpha^{(3)} \ldots = \alpha^{(n)} = 0$

where: $\alpha_1^{(i)}$ are the coefficients of FDI for 1, . . . nth lags in the first equation of the system (2).

The existence of the causality from FDI to growth can be established by rejecting the null hypothesis, $\alpha_1 = \alpha_2, ..., ..., = \alpha_n = 0$ (ie. 'FDI does not Granger-cause Ind growth') which requires finding the significance of the MWALD statistic for the group of the lagged independent variables identified above. Similar restrictions and the testing procedure can be applied to examine the second causality (ie. Ind growth to FDI). This involves testing the following linear restrictions in the system (2):

$$H_0: \quad \alpha_6^{(1)} = \alpha^{(2)} = \alpha^{(3)} \ ... = \alpha^{(n)} = 0$$

where: $\alpha_6^{(i)}$ are the coefficients of Ind. for 1, . . . nth lags in the 6th equation of the system (2), ie. the FDI growth equation.

Thus we shall test whether Ind_{t-n}, appear in the FDI equation. The existence of the causality from industrial growth to FDI can be established by rejecting the hypothesis of 'Ind. growth does not Granger-cause FDI growth' which requires finding the significance of the MWALD statistic for the group of the lagged independent variables identified above.

Empirical results

Prior to testing for a causality relationship between the time series, it is necessary to establish that they are integrated of the same order. To this end, the Augmented Dickey-Fuller test (ADF) was carried out on the time series in undifferenced and differenced forms. The results of the ADF tests on the time series, expressed in natural logarithms, suggest that each series is a *I*(1) variable at the 95% confidence level when re-applying the test after transforming the time series into the first differenced form.

After the ADF test, we proceeded to the Granger no-causality test. Results derived from these methods are presented in Table 1.

The results in Table 1 suggest, in the case of China, that both the null hypotheses of 'Grange no-causality from FDI to growth' and the null hypothesis that 'Granger no-causality from growth to FDI' can be rejected at the 99% significance level. These indicate that there is a two-way causality running between industrial growth and FDI in China. Both FDI-led growth and growth-driven FDI hypothesis are therefore supported by empirical evidence from China.

Even though we have used AIC and SC to aid in the choice of lag length, we have estimated the model using several different lag structures to ensure that results are

Table 1 **Results of Granger causality test: China**

Ho	FDI does not cause GDP		Ind does not cause FDI	
Optimal lag (VAR order)	6(7)		6(7)	
P-values	0.0004		0.0009	
R^2	0.9895		0.9895	
	Test statistic		Test statistic	
Lag structure (VAR order)	P-value	MWALD statistic	P-Value	MWALD statistic
3 (4)	0.5504	2.5689	0.5541	2.5978
4 (5)	0.5710	2.0067	0.5748	1.9884
5 (6)	0.1058	7.4073	0.0360	10.2773
6 (7)	0.004	10.0005	0.0009	85.1379
7 (8)	0.003	16.9845	0.006	14.2302
8 (9)	0.0008	84.2364	0.0007	84.5609

Ind. = real industrial; FDI = foreign direct investment flows in real terms; optimal lag length is determined by AIC and SC. The results for other equations are not reported for the simplicity. Number in parenthesis represent VAR order. VAR order = k + d_{max}, where: k is the lag length used in the system; d_{max} is the maximum order of integration in the system, in our system is I (1) .

not sensitive to the choice of the lag length. As Pindyck and Rubinfeld (1991) point out, 'it is best to run the test for a few different lag structures and make sure that the results are not sensitive to the choice of m (lag length)' (1991:217). Bahmani-Oskooee and Alse (1993) have also warned us about the danger of an arbitrary choice of lag length, and one must 'select a strategy for choosing the optimum number of lags on each other when there is more than one independent variable' in a VAR model (Bahmani-Oskooee and Alse (1993:540).

Table 1 indicates that the results are consistent with each other for different lag, so we can conclude that our results are robust or sturdy, in a similar sense to Leamer's Extreme Bound Analysis (EBA), avoiding a fragile statistical inference.

The fact that both FDI-led growth and growth-driven FDI hypotheses are supported by our econometric evidence from China indicates that the FDI-led growth hypothesis, in the sense of a unidirectional causal ordering from FDI inflows to output growth, is not valid for China. The results merely demonstrate that both economic growth and FDI inflow reinforce each other in the course of economic development.

The observations for China's recent economic development fit into the above argument. The empirical evidence for the causality running from economic growth to FDI in the case of China indicate that rapid economic growth has accelerated the inflow of FDI into China. Along with the rapid economic growth during 1988-96, there have been swift structural changes within the Chinese economy, which attracted the investments from multinational corporations (MNCs) in the areas of capital or skill-intensive manufacturing and service sectors. Further, rapid economic growth, along with the rising per capita income in China, has created huge domestic markets and business opportunities for overseas investment and hence has strengthened business confidence for investing in China. At the same time, closer economic ties, through economic complementarities, between China and Hong Kong, Taiwan as well as Korea and Japan, have resulted in a favourable investment environment in China and hence have made it further attractive to foreign investment.

The econometric evidence in our paper for the FDI-led growth hypothesis is also consistent with recent China's economic record. This can be partly explained by the dynamic benefits brought about by FDI as it induces and creates the production from other industries which can be measured by the 'backward linkage index'. Sun (1996) for instance, has shown that the inflow of FDI in China has contributed to the expansion of industrial network in China by the so-called 'spill-over effect'. The large multinational projects invested in China, especially from the OECD countries and the United States, have contributed significantly in technology; managerial training; linkage effect; renovating the SOEs sector; easing the development bottleneck; and establishing the high-tech industries in China. It is argued that under import

protection, a dynamic gain of learning by introducing these MNCs might overwhelm the loss of static allocative efficiencies (Chao and Yu 1994).

Concluding remarks

This paper has used the methodology of the Granger no-causality test, developed by Toda and Yamamoto (1995), to examine the causality link between FDI growth and real industrial growth for China, in the context of the FDI-led growth hypothesis.

The test was based upon quarterly time series data, in a six-variable VAR model, for the period of 1988-1996. After surveying the literature on this topic, a VAR model built upon an augmented production function was applied to overcome the dual problems of simultaneity bias and weak theoretical foundations underpinning the models of previous studies. In particular, we have allowed for growth of imports and investment growth to be included in the VAR model; and the rigorous econometric method of the causality test, developed by Toda and Yamamoto (1995), has improved the power of the test as compared to the traditional F-test statistic. Further, we have tested the sensitivity of the causality tests using different lag structures, along with the choice of the optimal lag structure.

Our results indicate a two-way causality running between industrial growth and FDI growth for China. The results reported here cannot offer the support, in the sense of a unidirectional causal ordering, for the FDI-led growth hypothesis. In other words, the inflow of FDI and rapid industrial growth in China have reinforced each other. On one hand, the exceptional economic performance in China during the 1990s was propelled by strong FDI inflow in helping China to access overseas markets, improving technology and supplementing domestic saving and investment. On the other hand, China has benefited from the very rapid growth of domestic demand and hence a high level of domestic investment which has enabled China to achieve rapid economic growth and industrial restructuring. Therefore, the outcomes of this rapid growth in China are the emergence of huge domestic markets and increased per capita income along with the emergence of a large middle class in urban and rural areas. This has attracted foreign investments into China to capture China's huge domestic market and to take the advantages of China's natural and labour resources.

The implication arising from our research concerning the two-way causality between growth and FDI inflow is that a host country such as China should adopt a policy whereby FDI is attracted (eg. by offering concessional terms) to promote economic growth, domestic resources are mobilised and GDP growth is promoted by a continued commitment to an economic reform policy to attract new inflow of

FDI. In other words, the efforts of promoting further economic growth using a set of well-designed domestic policies is no less important than FDI inflows.

Data appendix

Monthly data, seasonally adjusted flow variables on exports, industrial output, labour force, total investment and energy consumption, were collected for the period 1985:2-1996:2 from various issues of *China Monthly Statistics* (CMS) published by the China Statistical Bureau (China Statistical Information and Consultancy Service Centre), and was cross referenced with annual data from the IMF's International Financial Statistics. They were then transformed into quarterly data. The details of each series are as follows: Total Industrial output value (Ind): Table 2.1 series in various issues of CMS; Exports(exp): Table 7.1 series in CMS; Labour Force(lab): Table 14.1 series in CMS; Total Investment(Inv) was obtained by adding 'Total Capital Construction investment' and 'Total Technical Updating and Transformation Investment'. They are from Table 4.1 and 4.2 series in CMS; Energy Consumption (EN): Table 3.5 series measured in Standard Coal Equivalents (SCEs) from CMS. The quarterly data on FDI is sought from *China Economic Information Centre*, State Statistical Bureau, Beijing.

Endnotes

1 Granger (1981, 1988a and 1988b) has introduced the concept of causality in the framework of bivariate VAR, defining Y is said to be Granger-caused by X if the information in past and present X helps to improve the forecasts of the Y variable.

2 Calculations based upon China Statistical Yearbook, 1994:32 and 527.

3 Calculations based upon China Statistical Yearbook, 1994:42 and 597.

4 There is a debate on choosing the theory-driven or the data-driven approach as the appropriate methodology in the literature of econometrics (Leamer 1985 and Cooley and Le Roy 1985). Marin (1992) argues that both techniques seem to be inadequate for testing theories, since 'the former assumes that the model is true and makes the data consistent with it; while in the latter many models, ... let the data 'speak themselves' (1992:690).

5 A plot of time series prior to the estimation of the model indicated some time trend in the data, hence the data was de-seasonalised using the method by Pindyck and Rubinfeld (1991) .

6 The results are not reported in this paper. The ADF regression equation is: $\Delta Y_t = \alpha_0 + \alpha_2 Y_{t-1} + \alpha_{2t} + \sum \gamma_j \Delta Y_{t-j} + \varepsilon_t$, where: ε_t for t=1, ... N is assumed to be Gaussian white noise. This equation is with constant and trend denoted by α_0 and α_2 . The lag length was determined using AIC and SC.

[7] Both AIC and SC minimised at the lag length = 6 (i.e. VAR is 7).

[8] Leamer (1978 and 1983) has discussed the importance of the model selection and model search in his EBA analysis in which, he distinguishes between free and doubtful variables. He suggested the construction of a range or a bound for the estimates from a set of different combinations of free and doubtful variables. The smaller the bound, the more robust for the estimates or a fragile inference will arise.

[9] In essence, it refers to inter-sectoral relations or potential inter-sectoral impacts within an economy, induced by input demand from given industry in which FDI locates. Sun (1996) has calculated this index for FDI in China and concluded that first, FDI activities are concentrated in the industries with high backward linkage effects; second, such backward linkage effects were realised by FDI to a considerable extent and further, FDI in China 'induces and stimulates exports from the local firms through the backward linkage effects' (Sun, 1996:23).

[10] The data were de-seasonalised using the method by Pindyck and Rubinfeld (1991)

References

Bahmani-Oskooee, M. and Alse, J., 1993. 'Export growth and economic growth: An application of cointegration and error correction modelling', *Journal of Developing Areas*, 27:535–42.

Bewley, R. and Yang, M., 1996. 'On the size and power of system tests for cointegration', in M. McAleer et. al. Eds. , *Proceedings of Econometric Society Australasian Meeting 1996*, Vol. 3:1–20, Perth, Australia.

Cable, Vincent and Bishnodat Persaud., 1987. 'New trends and policy problems in foreign investment: the experience of Commonwealth countries.' in V. Cable and B. Persaud eds. *Developing with Foreign Investment*, Croom Helm, London.

Chao, Chi-chur and E. S. H. Yu., 1994. 'Foreign capital inflows and welfare in an economy with imperfect competition,' *Journal of Development Economics* 4:141–54.

Chen, C.H., 1996. 'Regional determinants of foreign direct investment in mainland China', *Journal of Economic Studies*, 23(3)18–30.

Chen, C., Chang, L. and Zhang, Y., 1995. 'The role of foreign direct investment in China's post-1978 economic development', *World Development*, 23(24): 691–703.

Chenery, Hollis and Strout,W., 1966. 'Foreign assistance and economic development', *American Economic Review*, 66:679–733.

Cooley, T. and Le Roy, S., 1985. 'Atheoretical macroeconometrics', *Journal of Monetary Economics*, 16:283–308.

de Mello, L.R. and Sinclair , M. Thea., 1995. *Foreign Direct Investment, Joint Ventures, and Endogenous Growth*, Department of Economics, University of Kent, UK.

de Mello, L.R., 1996. *Foreign Direct investment-led growth: avidence from time series and panal data, Department of Economics*, Univeristy of Kent at Cantebrury, UK.

Dowling, J.M. and U. Hiemenz., 1982. 'Aid, savings and growth in the Asian region', *The Developing Economies*, 21:3–13.

Dunning, J.H., 1970. *Studies in Direct Investment*, Allen and Unwin, London.

Enders, W., 1995. *Applied Econometric Time Series*, John Wiley and Sons, New York.

Granger, C.W.J., 1981. 'Some properties of time series data and their use in econometric model specification', *Journal of Econometrics*, 16 :121—30.

Granger, C.W.J., 1988a . 'Some recent developments in the concept of causality', *Journal of Econometrics*, 39:199–211.

Granger, C.W.J., 1988b. 'Causality, cointegration and control', *Journal of Econometric Dynamics and Control*, 12:551–9.

Granham, E.M. and Krugman, P. R., 1989. *Foreign Direct Investment in the United States*, Institute for International Economics, Washington.

Greenaway, D. and Sapsford, D., 1994. 'What does liberalisation do for exports and growth?', *Weltwirschaftliches Archives*, 130:152–74.

Gujarati, D., 1995. *Basic Econometrics.* 3rd Ed, McGraw-Hill, New York.

Gupta, K. and Islam M., 1983 . *Foreign Capital, Savings and Growth: an international cross section study*, Reidel Publishing Company, Boston.

Ho, M.S. and Sorensen, B.E., 1996. 'Finding cointegration rank in high dimentional systems using the Johansen test—An illustration using data based on Monte Carlo simulations', R*eview of Economics and Statistics*, forthcoming.

Johansen, S., 1988. 'Statistical analysis of cointegration vectors', *Journal of Economic Dynamics and Control*, 12:231–54.

Johansen, S. and Juselius, K., 1990. 'Maximum likelihood estimation and inference on cointegration -with applications to the demand for money', *Oxford Bulletin of Economics and Statistics*, 52:169–210.

Karikari, J.A., 1992. 'Causality between direct foreign investment and economic output in Ghana', *Journal of Economic Development*, 17:7–17

Kasibhatla, K and Sawhney, B., 1996. 'Foreign direct investment and economic growth in the U. S.: evidence from co-integration and Granger causality

tests', *Rivista Internazionale di Scienze Economiche e Comerciali*, 43(2):411–20.

Kholdy, S., 1995. 'Causality between foreign investment and spillover efficency', *Applied Econoimcs*, 27: 74–749.

Krueger, A.O., 1987. 'Debt, capital flows and LDC growth', *American Economic Review*, 13:159–64.

Kueh, Y. Y., 1992. 'Foreign investment and economic change in China.' *The China Quarterly*, 132: 637–89.

Lee, J., 1994. 'Regional differences in the impact of the open-door policy on income growth in China', *Journal of Economic Development*, 19(1)215–33.

Lee, J. and Rana, P., 1986. 'The effect of foreign capital inflows on developing countries of Asia', *Asian Development Bank Economic Staff Paper*, 4:30, Manila.

Leamer, E., 1978 . *Specification Searches: ad hoc inference with nonexperimental data*, John Wiley and Sons, New York.

Leamer, E., 1983. 'Reporting the fragility of regression estimates', *Review of Economics and Statistics*, 65:306–17.

Leamer, E., 1985. 'Vector autoregressives for causal inference?', *Carnegie Rochester Conference Series on Public Policy*, 22:255–304.

Lin, A., 1995. 'Trade effects of foreign direct investment: evidence for Taiwan with four ASEAN countries', *Weitwirtshaftliches Archiv*, 131(4):737–47.

Marin, D., 1992. 'Is the export-led hypothesis valid for industrialised countries?', *Review of Economics and Statistics*, 74:678–87.

Mosconi, R. and Giannini, C., 1992. 'No-causality in cointegrated systems: representation, estimation and testing', *Oxford Bulletin of Economics and Statistics*, 54:399–417.

O'Sullivan, P. and Geyikdagi, Y., 1994. 'Japanese direct investment in the United States', *Rivista Internazionale di Scienze Economiche e Commerciali*, 9(41): 761–73.

Pfaffermayr, M., 1994. 'Foreign direct investment and exports: a time series approach', *Applied Economics*, 26:337–51.

Pindyck, R. S. and Rubinfeld, D. L., 1991. *Econometric Models and Economic Forecasts*, McGraw-Hill, New York.

Plummer, M. and M. F. Montes., 1995. 'Direct foreign investment in China: an introduction.' in Sumner J. La Croix ed , *Emerging Patterns of East Asian Investment in China, from Korea, Taiwan and Hong Kong*, Armond.

Pomfret, Richard., 1991. *Investing in China: Ten Years of the Open Door Policy*. Ames, Iowa State University Press, Iowa.

Rambaldi, A.N., and Doran, H.E., 1996. 'Testing for Granger non-causality in cointegrated systems made easy', *Working Papers in Econometrics and Applied Statistics* 88, Department of Econometrics, The University of New England,.

Riezman, R., Whiteman, C. H. and Summers, P. M., 1996. 'The engine of growth or its handmaiden? A time-series assessment of export-led growth', *Empirical Economics*, 21:77–110.

Root A. and Ahmed, A., 1978. 'The influence of policy instruments on manufacturing direct foreign investment in developing countries', *Journal of Internaitonal Business Studies*, 9: 81–93.

Rugman A. ed., 1994. *Foreign Investment and NAFTA*, Columbia, S.C.: University of South Carolina Press.

Saltz, I.S., 1992. 'The negative correlation between foreign direct investment and economic growth in the third world: theory and evidence', *Rivista Internationale di Scienze Economiche e Commmerciali*, 7(39): 617–33.

Scaperlanda A.E. and Mauer L.J., 1969.'The determinants of U.S. direct investment in the E.E.C.', *American Econoimc Review*, 59:558–68.

Snyder, D., 1990. 'Foreign aid and domestic savings: a spurious correlation', *Economic Development and Culture Change*, 45:175–81.

Sun, H., 1996. 'Direct foreign investment and linkage effects: the experience of China', *Asian Economies*, 25:1–28.

Toda, H. Y. and Phillips, P.C.B., 1993. 'Vector autoregressions and causality', *Econometrica*, 61:1367–93.

Toda, H. Y. and Yamamoto, T., 1995. 'Statistical inference in vector autoregressions with possibly integrated processes', *Journal of Econometrics'*, 66:225–50.

Todaro, M., 1982. *Economics for a Developing World*, Second edition, Longman.

Tsai, P. L., 1994. 'Determinants of foreign direct investment and its impact on economic growth', *Journal of Economic Development*, 19 (1):137–63.

United Nations., 1993. *Foreign Investment and Trade Linkages in Developing Countires*, New York.

Verno, R., 1971. *Sovereignty at Bay: The Multinational Spread of O. S. Enterprieses*, Basic Books, New York.

Wang, Z.Q. and Swain, N., 1995. 'The determiants of foreign direct investments in transforming economics: empirical evidence from Hungry and China', *Weltwirtschaftliches Archiv*, 131: 358–82.

Wei, S., 1996. 'Foreign direct investment in China: sources and Consequences', in Ho, T. and A. Krueger eds : *Financial Deregulation and Integration in East Asia*, the University of Chicago:77–105, Chicago.

White, H., 1992a. 'The macroeconomic impacts of development aid: critical survey', *Journal of development Studies*, 28(2 :163–240.

White, H., 1992b. 'What do we know about aid's macroeconomic impacts? an overview of the aid Effectiveness Debate', *Journal of International Development*, 4(2):121–37.

World Bank., 1993 . *East Asia Miracle: economic growth and public policy*, Oxford University Press, London.

Zapata, H. O. and Rambaldi A. N., 1997. 'Monte Carlo evidence on cointegration and causation', *Oxford Bulletin of Economics and Statistics*, 59, forthcoming.

Zhang, Z., 1995. 'International trade and foreign investment: further evidence from China', *Asian Economic Journal*, 23:23–56