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DISCUSSION PAPERS

THE EFFECTS OF MARGINAL EXPORT SUBSIDIES

E. Kleiman and J.J. Pincus *

Discussion Paper No. 12

June 1980

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A B S T R A C T

The Crawford Committee on structural adjustment recommended the introduction of a scheme to expand exports - under which a subsidy is paid on the excess of export revenues over the average of some number of previous years (a moving average base marginal export subsidy or MAMES for short). Schemes of this type exist in other countries - including New Zealand, Pakistan and Singapore. It is shown that such a scheme may introduce a novel element of instability in prices and quantities, producing a regular cycle in exports and in domestic sales and prices. A MAMES-induced cycle is unlikely to be avoided in most Australian manufacturing export industries. The cycle will persist - except under conditions of rapid inflation or rapid productivity growth. The cyclical pattern can be avoided, at some cost to the Treasury, by setting the subsidy base at some fraction of actual past performance.

THE EFFECTS OF MARGINAL EXPORT SUBSIDIES*

E. Kleiman and J.J. Pincus

I. Introduction

Although they are generally in violation of the rules of the General Agreement on Tariffs and Trade, export subsidies of various kinds are offered by a number of countries, especially in the Third World. Whereas tariff protection of import-competing industries brings in tax revenue, export subsidies, whether direct payments or tax rebates, are a drain on Treasuries. Various methods have been devised, therefore, to reduce this drain whilst still providing significant export stimuli. In theory, the cost to the Treasury can be reduced to the minimum and the stimulus left undiminished, if the subsidy contains no component of pure rent; that is, if the subsidy is paid only on marginal exports. Relatively simple administrative arrangements have been made in attempts to approach the desirable joint outcomes of low cost and large effects in, among other places, New Zealand, Pakistan and Singapore - see U.N.C.T.A.D. (1970, Part Two). It turns out, however, that administrative simplicity and economic desirability are in conflict.

Because the advantages of marginal subsidies may seem self-evident, their rationale has not often been spelt out. In its report on structural adjustment, the Crawford Committee recommended that, to stimulate exports,

The Export Expansion Grant Scheme be amended to provide a non-taxable flat percentage grant of 15 percent of the increase in exports over a moving three year base period. (Study Group on Structural Adjustment, 1979, p. 7.64)

* We had fruitful discussions of Sections I to V with Paul Volker. We are grateful to him and Onko Kingma for first bringing the problem to our attention, and to Wayne Naughton for computer calculations of Tables 1, 3 and 4. Kleiman wishes to acknowledge the financial support of the Reserve Bank of Australia through a grant of a Research Fellowship in Economic Policy.

The Committee did not elaborate on the detailed justifications of the scheme it recommended. These were set out by the Industries Assistance Commission (1978, appendix D), which the Committee's own report broadly endorsed. The I.A.C.'s main considerations for favouring this scheme were: the lower cost to the Treasury, compared with a subsidy on all exports; the extension of the period during which the subsidy encourages exports; and the minimization of the effects on the subsidy of fluctuations in domestic and foreign markets, and vice versa.

We note in passing that a tax-free subsidy of 15 per cent is roughly equivalent to a taxable 30 per cent increase in the price received by the exporter.

This paper discusses the nature of a moving-average base, marginal export subsidy (henceforth referred to as MAMES), and its effects. It is shown that MAMES introduces a new element of instability in the output of exportable products, in export proceeds, and in the home price and consumption of exportables. Under conditions of stationary cost and demand curves, MAMES produces a regular cycle in volumes and prices, so that in the long run, the resulting increases in export revenue will be only about half that achieved in the short run. The cycle is accompanied by a somewhat surprising behaviour of the 'cost-effectiveness' of the subsidy: the cost to the taxpayer, of an extra dollar of export revenues in excess of their moving-base level, is constant; but, in terms of their excess over the level of revenues achieved in the period before the scheme is first introduced, the cost per extra dollar gradually decreases to a minimum, and then fluctuates between zero and that minimum in a cyclical fashion.

It is shown that the cyclical pattern can be avoided, at some cost to the Treasury, by setting the subsidy base at some fraction of actual past

performance.

In the later sections of this paper we examine the effects of inflation and of productivity and demand growth on the operation of the subsidy scheme. We conclude that the MAMES-induced cycle is unlikely to be avoided in most Australian manufacturing export industries.

II. Ordinary Export Subsidy

It is useful to begin our discussion with the familiar, ordinary, export subsidy. Figure 1 illustrates, in partial equilibrium terms, the effects of an ordinary export subsidy when the exporter faces perfectly elastic foreign demand at price shown by P_f , but has a monopoly of the home market.¹ The domestic demand curve is D_d , with its marginal revenue curve MR_d ; the foreign marginal revenue curve (in this case, identical with the foreign demand curve) is MR_f before the subsidy and $MR_f' = (1+s)MR_f$ afterwards, where s is the rate of subsidy to marginal (and in this case also to average) export receipts.

The exporter will maximize profits by equalizing marginal revenue in both markets to overall marginal cost, and so will produce OQ before the subsidy, of which DQ is exported, and OD consumed at home at price OP_d . After the subsidy, output rises to OQ' , exports to $D'Q'$, and domestic price to OP_d' , while domestic consumption falls to OD' .

The relative magnitude of the stimulus given to exports by a subsidy at rate s can be written in terms of θ , the elasticity of export supply:

$$D'Q'/DQ = 1 + s\theta = 1 + s(\zeta - (1-x)\eta)/x \quad (1)$$

where ζ = elasticity of marginal cost curve

η = elasticity of domestic marginal revenue curve

x = DQ/OQ = initial share of exports in domestic output.

In turn, the elasticity of the domestic marginal revenue curve can be derived from the ordinary demand elasticity, e , of the demand curve $q = f(p)$: $\eta = (1+e)/[2+qf''(p)/f'(p)]$; for a linear demand curve, $\eta = (1+e)/2$; for log-linear demand, $\eta = e$.

The elasticity of export supply can be very large when the export share (x) is small, as it is likely to be in industries the exports of which are sought to be increased.

The average value of x for Australian manufacturing was 6.5 per cent in 1971-72 (I.A.C. 1974, Table 4.1.2). An industry with unitary elastic marginal cost and domestic marginal revenue curves, and $x = 0.065$, would have an export supply elasticity $\theta = 29.8$. Table 1 gives, for $x = 0.1$, 0.2 and 0.5, the values of θ corresponding to various values of ξ and η . Only three Australian manufacturing industry groups exported, in 1971/72, more than 20 percent of their turnover. They were ASIC group 292-293, nonferrous metal basic products, which exported 36.6 percent of turnover (and accounted for one-fifth of all manufacturing exports); and groups 213 (fruit and vegetable products) and 217-218 (sugar and other food products), both exporting about 23 percent of turnover (and together accounting for another one-fifth of manufactured exports). Apart from these three manufacturing industry groups, it would be surprising if the value of θ did not generally exceed five. (Of course, an export subsidy would be expected to raise the share of exports, and so reduce θ .)

Under the partial equilibrium assumptions of Figure 1, the export subsidy reduces national welfare by the loss of domestic consumer surplus; by the cost of diverting resources from higher-valued production; by the opportunity cost of diverting $D'D$ to the export market (area EBJ), and by the excess burden of collection of the taxes to finance the export subsidy. For convenience, we assume that the taxes are of the

TABLE 1

Values of Export Supply Elasticity, θ , For Selected Values of ζ , η and x

- η =	$x = 0.1$				$x = 0.2$				$x = 0.5$			
	0.1	0.5	1.0	2.0	0.1	0.5	1.0	2.0	0.1	0.2	1.0	2.0
$\zeta = 0.1$	1.9	5.5	10.0	19.0	0.9	2.5	4.5	8.5	0.3	0.7	1.2	2.2
$\zeta = 0.5$	5.9	9.5	14.0	23.0	2.4	4.5	6.5	10.5	1.1	1.5	2.0	3.0
$\zeta = 1.0$	10.9	14.5	19.0	28.0	5.4	7.0	9.0	13.0	2.1	2.5	3.0	4.0
$\zeta = 2.0$	20.9	24.5	29.0	38.0	10.4	12.0	14.0	18.0	4.1	4.5	5.0	6.0

NOTES: $\theta = (\zeta - (1-x)\eta)/x$, where: ζ = elasticity of marginal cost curve η = elasticity of domestic marginal revenue curve x = share of exports in output

mythical, lump-sum sort. The general equilibrium effects of the subsidy are then analogous to those of an import tariff. If all imports pay a rate of customs duty t and all exports receive a subsidy at a rate of $s=t$, then the two measures cancel out in general equilibrium, and the free-trade quantities re-occur. The Crawford Committee's recommendation, however, is that the export subsidy be confined to manufacturing. In view of the existing tariff structure it is thus unlikely (though not impossible) that this partial "tariff compensation" via manufacturing export subsidy, would actually improve the overall efficiency of resource allocation.²

The cost to the Treasury of the ordinary export subsidy in Figure 1 is shown by the area of the rectangle EJGF, while the increase in total profits of the exporter is shown by the bathtub-shaped area EBCF. These extra profits can usefully be factored into three components: HCF, which is the marginal profit on the additional output (the expansion effect); EBA, which is the marginal profit obtained by diverting output from the home to the subsidized market (the substitution effect); and ABCH, which is the "infra-marginal" subsidy, that is, subsidy paid on account of that amount of exports (DQ) which would have occurred in the absence of the subsidy.

III. Marginal Export Subsidy, Fixed Base

We now turn to a consideration of a subsidy paid on the excess of export sales revenue over and above some standard or basic revenue. It is clear that the effects on output, exports, and domestic price and consumption achieved by an ordinary export subsidy costing the Treasury EJGF could be obtained by a subsidy costing less than that. In particular, a subsidy paid only on the revenue from sales above the initial quantity of exports, DQ, would cost the Treasury EJBA + HCGF, would yield marginal

profit of $EBA + HCF$, and would leave prices and quantities just as under an ordinary export subsidy.³

With a fixed base, the cost to the Treasury of attaining a given increase in the level of exports, over their initial one, is determined by the actual base chosen. It will be maximized when the base is zero, i.e., when the subsidy is paid on all exports. And it will be minimized when the base is such that the marginal profit to the exporter from expanding exports beyond their initial level is reduced to zero.⁴ In Figure 1 this corresponds to an export base of $D''Q''$. There, the losses of profit due to increasing exports from DQ to $D''Q''$ are shown by the two heavily-shaded "triangles"; the gains in profit by going from $D''Q''$ to $D'Q'$ by the hatched "triangles"; the sum of former just equals the sum of the latter, so that the firm is indifferent between exports of DQ and those of $D'Q'$.

We will call it the critical export base which exactly produces zero marginal profit. It is important to stress that an export subsidy at rate s can have only one of two possible effects: for any base greater than the critical base, no stimulus in exports occurs; for any base less than the critical base, the full export stimulus of $D'D + QQ'$ occurs.

IV. A Moving Export Base

The Crawford Committee recommended that the export base, in excess of which exports are to be subsidized, be moved with actual performance, rather than be fixed at some given level. Though it does not say so explicitly, the Committee's report suggests that it may have regarded a fixed-base marginal subsidy as similar to a subsidy on all exports in having little effect on improving export competitiveness in the longer term. The report seems to assume that its recommended form of subsidy, being offered on the margin of a, by implication, constantly growing base, would serve as an incentive for a continuous export expansion. As will be

shown here, this is not, however, the case.

In a world of stationary demand and cost curves, gearing the base to actual performance results in cyclical fluctuations in the base and, consequently, also in actual exports. Consider the case in which the base is set equal to last year's export receipts; in the terms of the Committee's report, this is a scheme with a one-year moving base (call it MAMES 1). With the initial base equal to exports in the pre-subsidy period, DQ, MAMES 1 will induce an expansion in exports in the first subsidy period to D'Q'. But the base for the calculation of the MAMES 1 subsidy in the second year will now be D'Q' itself, which must be larger than the critical value, as defined in the previous section. Therefore, in the second subsidy period, exports will fall back to DQ, which will once again serve as base, and so on and so forth, in a two-year cycle in which the export level alternates between the pre-subsidy value, DQ, in one year and the highest level profitable under the subsidy, D'Q', in the other.

Such a subsidy, paid for exports in excess of a base that moves with export performance, raises the possibility of firms reallocating exports over time so as to qualify for the largest possible subsidy payments. Assuming the costs of carrying a stock of goods for one year to be some fraction, k , of their subsidized value to the producer, a firm will pursue a strategy of producing X' in every year, but exporting 0 and $2X'$ in alternate years, as long as (with the curves linear in the relevant range)

$$k < s(1+s\theta/2)/[(1+s)(1+s\theta)]$$

To illustrate: when $s = 0.3$ the maxima for k are 18 per cent if $\theta = 3$, and 14 per cent if $\theta = 15$. Adoption of this strategy would turn a marginal subsidy into a total one. The Treasury would obtain twice the average boost in exports, but at considerably more than twice the cost in terms of subsidy payments. Although there would be no fluctuations in output, the fluctuations in exports would be huge. Were the base

period to exceed one year, condition (2) alters so that, to satisfy it, the value of k has to diminish rapidly with the length of the base period, thereby reducing the opportunities for firms to utilize the strategy.⁵

This discussion assumes that a possible method for qualifying for a subsidy on all exports without incurring any carrying costs has been eliminated, the method being the setting-up of new, nominal exporting or manufacturing firms each year.

V. N-Period Moving Base

It is probable that the Crawford Committee, following the I.A.C. (1978), recommended the base to be an average of actual export receipts in the three years preceding a claim for a subsidy payment, in order to prevent the exploitation of the strategy described above. An N-period moving average base will eliminate the strategy, with its violent fluctuations in exports and high Treasury costs, but will not make the export cycle disappear.

Thus, although the base itself will change less abruptly than in the single-year case, it will still fluctuate between two levels only, once the scheme has been operating for some time. The periodicity of the cycle will depend on the speed at which the base reaches the critical level. This is determined by the length of the averaging or base period, and by the shapes of the marginal cost and domestic marginal revenue curves. In the linear case illustrated in Figure 1, the critical base is equal to $(X+X')/2$, where the exports of DQ are denoted by X , and those of D'Q' by X' .⁶

More generally, the critical base is equal to $(1-\lambda)X + \lambda X'$, where $0 < \lambda < 1$. For well-behaved cost and revenue curves, $\lambda \geq \frac{1}{2}$ according to whether the export supply curve is concave from above, or not; that is, the size of λ depends on the sign of the difference between the second derivatives of the MC and MR curves.

Table 2 illustrates the effects of the three-year moving average subsidy, MAMES 3, operating from year $t=1$, for the linear case of $\lambda = \frac{1}{2}$; P_f is the price of exports.

Table 2

Effect of a 3-year moving-average export subsidy (MAMES 3)

Year (t)	Base	Real Exports	Subsidy Paid
-2	-	X	-
-1	-	X	-
0	-	X	-
1	$(3X)/3$	X'	$s(P_f)(X'-X)$
2	$(2X+X')/3$	X'	$(2/3)s(P_f)(X'-X)$
3	$(X+2X')/3$	X	-
4	$(X+2X')/3$	X	-
5	$(2X+X')/3$	X'	$(2/3)s(P_f)(X'-X)$
6	$(2X+X')/3$	X'	$(2/3)s(P_f)(X'-X)$

In general, marginal export subsidies with N-year moving average bases will produce cycles of frequency equal to $N+1$ years, with the subsidy operating to increase exports for about the first $(N+1)/2$ years, and then having no effect (and costing nothing) for the next approximately $(N+1)/2$ years.⁷ With both MC and MRd linear in the relevant ranges, odd values of N mean that the base will be always either below or above its critical level. The resulting cycle would then, as in the case illustrated in the table, be perfectly symmetrical. If N were even, say $N=4$, then in the linear case the critical base would be exactly attained after 2 years. In the third year the firm would, however, not be indifferent between exporting X or exporting X' even though the total profit in year three would be invariant to the choice. The firm would export the smaller quantity, X, in order to hasten the year in which the subsidy base falls below the critical level and, therefore, to earn more profits in the long run. Thus, for even values of N, and with a

planning horizon longer than one year, exports would be at their higher level for the first $(N/2)$ years of the cycle, and at their initial level in the subsequent $(N/2)+1$ years.

Except when the actual and critical bases coincide, if it takes M years for the base to exceed the critical value, then the cycle is one of M years at the higher export level, followed by $N-M+1$ years at the lower, during which no subsidy is paid. In the non-linear case, the exact value of M will be determined by the sum of the third and, depending on N , also of higher derivatives of the variable costs and domestic revenue functions.

The variation in the 'cost-effectiveness' of the subsidy scheme is illustrated in Table 2. During the first M years of operation ($M=2$ in the Table), the base rises from X to $(2X+X')/3$, which is the highest value still below the critical level, so that the amount of subsidy paid falls (column 4). Therefore, during those first M years, the ratio of the value of the extra exports to the Treasury cost will fall to a minimum. Because of the nature of the export cycle and the use of a moving average, in all subsequent years in which the subsidy is paid, the ratio of the value of subsidy-induced exports to subsidy outlays remains at this minimum. Of course, the ratio of subsidy payment to the value of the excess of exports over the base (as opposed to X , the initial level of exports) is a constant equal to s , which is the rate of subsidy itself.

During the first M years of higher exports, the subsidy appears to become more and more effective, because exports remain at their higher level while subsidy payments fall. In the next $N-M+1$ years, the subsidy is ineffective and not paid. It is possible, even likely, that proponents of the scheme would then press for more generous subsidy, one with a smaller base or higher subsidy rate. To bolster their case, they could point to the excellent results obtained in the last few years in which the subsidy

was effective, that is, years immediately prior to $t=M$. Say the subsidy rate were raised from s starting in the year $t = M+1$; then the initial period of increased exports would be extended by a maximum of M years. Without progressive rises in the rate of subsidy, however, the cycle of period $N+1$ would be re-established.

If foreign demand fluctuates randomly, an export subsidy (whether on fixed or moving base) will tend to have a perverse pattern - when foreign demand is high, a large subsidy will be paid; when foreign demand is low, little or no subsidy will be paid (more, however, to any firms that overestimated the level of demand and produced inappropriately high volumes). This pattern could lead to dissatisfaction with the scheme both by the exporters and the Treasury.

When foreign demand is less than perfectly elastic, similar results occur. In Figure 2, for simplicity, the home market is ignored. The curve MR_f is the foreign marginal revenue curve before the subsidy. With a subsidy on a revenue base corresponding to exports of OQ'' , the marginal revenue curve is the kinky line $ABCD$ extended. The shaded area shows the loss on exports between Q and Q'' , and the hatched area the gain on those between Q'' and Q' . The level Q'' becomes the critical level when the "triangles" are equal in area.⁸

VI. A Non-Cyclical Base

It has been pointed out above that a subsidy at rate s has only one of two possible effects: either the critical base falls short of the actual base, and so the higher level of exports, $X' = (1+s\theta)X$, occurs; or the reverse, and exports of level X occur. Exports fluctuate because the actual base comes to exceed the critical base. The latter is a constant in the stationary case, but the actual base rises when the higher level X' is exported. Therefore, the cycle can be avoided if the specification of the

actual base is modified so that the actual never exceeds the critical base.

The critical base, as defined in Section III, is the weighted average of the two export levels, X and X' , and may be written as

$$B_c = [(1-\lambda) + \lambda(1+s\theta)]PX$$

(where the subscript on ' P_f ' is omitted for convenience). The actual base under a MAMES scheme is

$$B_a = \frac{1}{N} P \sum_{i=1}^N X_i$$

where the X_i 's take the value X' or X . In the stationary case, the highest possible value of B_a will occur when $X_i = X'$ for all $i=1, \dots, N$.

Then, $B_a = (1+s\theta)PX > (1+\lambda s\theta)PX = B_c$. No subsidy would be paid if X' were to be exported and, in consequence, X only is exported. However, if the actual base were set at some fraction, μ , of the average export performance of the previous N years, the higher level of exports would always be chosen if

$$\mu(1+s\theta)PX < [(1-\lambda)+\lambda(1+s\theta)]PX$$

or

$$\mu < (1+\lambda s\theta)/(1+s\theta) \quad (3)$$

When $\mu = 0$, the subsidy is not a marginal but an ordinary export subsidy.

The Treasury cost is minimized when μ is maximized (subject to (3)), say at $\mu = \mu^*$. In the linear case ($\lambda = \frac{1}{2}$), μ^* ranges from 75 per cent for $s\theta = 1$ to 58 per cent for $s\theta = 5$. The cycle can thus be avoided, and the higher level of exports sustained, at the cost to the Treasury of the payment of a subsidy to some infra-marginal exports. However, because θ (the export supply elasticity) differs between industries, μ^* will also differ, and the minimization of Treasury payments requires a careful tailoring of the scheme to the individual product, what Corden (1974, p.221) calls a "made-

to-measure" subsidy.⁹ In the remainder of the text, we assume $\mu = 1$.

VII. Inflation

Let us now relax our stationary assumptions and consider what happens when either or both cost and demand curves shift. The simplest case occurs when the shifts are due to an equal inflation of all relevant costs and prices. Then, the real values of X and $X' = (1+s\theta)X$ remain unchanged (recalling that $s\theta$ measures the original stimulus to exports, s being the rate of subsidy, and θ the export supply elasticity). Assume a uniform inflationary process such that the world price in period t is $P_t = (1+\pi)^t P$. Although the real values of the critical and actual bases are unaffected, inflation alters their money values. The nominal value of the critical base depends on the price level of the current year, whereas the money value of the actual base depends on the lower price levels of earlier years. In consequence the effect of a continuing inflation on the value of the actual base is not proportionate to its effects on the critical base. Indeed, with inflation rapid enough, the actual base may always fall short of the critical one, resulting in the disappearance of the cyclical pattern observed in the stationary case, and its replacement by a steady-state with real exports of X' in all periods.¹⁰

In the t -th period of operation of the subsidy scheme, the value of exports will amount to $(1+\pi)^t PX$ if the exporter is not eligible for the subsidy, and $(1+\pi)^t PX(1+s\theta)$ if he is. The critical base in this period is, as before, some average of X and X' , valued at current prices:

$$B_{ct} = (1+\pi)^t PX(1+\lambda s\theta)$$

With real exports at a steady-state level of X' , the actual base would be equal to X' valued at the arithmetical average price level in the N preceding years, where N is the length of the base period:¹¹

$$B^*_{at} = \frac{1}{N} \sum_{i=1}^N (1+\pi)^{t-i} PX(1+s\theta)$$

However, X' will be the steady-state exports, and B^*_{at} be the actual steady-state base, only if $B_{ct} > B^*_{at}$:

$$(1+\pi)^t PX[(1+\lambda s\theta) - \frac{1}{N} \sum_{i=1}^N (1+\pi)^{-i} (1+s\theta)] > 0 \quad (4)$$

We may define $Z \equiv \frac{1}{N} \sum_{i=1}^N (1+\pi)^{-i}$ as the arithmetical average of the price levels obtained for exports during the N years that serve to define the actual base; note that for $\pi > 0$, $0 < Z < 1$. The inequality (4) can now be rewritten as

$$(1+\pi)^t PX[(1-Z) - (Z-\lambda)s\theta] > 0 \quad (5)$$

If $Z < \lambda$, $B_{ct} > B^*_{at}$ irrespective of the value of $s\theta$, and the steady state is assured.

If $Z > \lambda$, B_{ct} will only exceed B^*_{at} when

$$s\theta < (1-Z)/(Z-\lambda) \quad (6)$$

in which case inflation again removes the cyclical pattern and results in X' being the level of exports in all periods.¹²

These results are illustrated in Figure 3 for a one period lagged base; we will ignore, for expository convenience, the domestic market, and will standardize $X = 1$ and $P = 1$. With $N = 1$, condition (6) becomes

$$s\theta < \pi / [1-\lambda(1+\pi)] \quad (7)$$

or

$$\pi(1+\lambda s\theta) > (1-\lambda)s\theta \quad (7')$$

This last condition has a geometrical interpretation. In Figure 3, the critical base is $(1+\pi)(1+\lambda s\theta)$, and is depicted by the area OBDJ. If this is larger than an actual base of $1+s\theta$, depicted by the area OAEH, the export cycle will have been eliminated. Because both bases have in common the area OAFJ, the condition for no cycles reduces to ABDJ being larger than JFEH (the two shaded areas in the Figure). This will be fulfilled if $\pi(1+\lambda s\theta) > (1-\lambda)s\theta$, which is condition (7') above.

Similarly the sufficient condition for no cycles can be illustrated.

The cross-hatched area GCDF, equal to $\pi(\lambda s\theta)$, is part of ABDF. Its being larger than JFEH is thus a sufficient condition for the cycles to disappear. But this latter is equal to $(1-\lambda)s\theta$, and is smaller than the former if $\pi > (1-\lambda)/\lambda$ which is the same as the condition $1/(1+\pi) = Z < \lambda$ for $N = 1$. With the export supply curve linear in the relevant range, $\lambda = \frac{1}{2}$; under a one year lagged base, inflation at rates of 100 per cent or more per annum will be sufficient for the increase in export revenues to push the currently valued critical base always above the actual one, valued, as it is, at past prices.

Under inflation, the longer the base period, the lower is the average price level at which actual export performance is valued for purposes of calculating the actual base. The condition $Z < \lambda$ (which is sufficient to prevent the cycle) can be rewritten as

$$1 - \lambda N \pi < (1 + \pi)^{-N} \quad (8)$$

For $N = 3$ and $\lambda = \frac{1}{2}$, (8) is satisfied by rates of inflation of 45 percent or more.

At lower rates of inflation, the elimination of the cycle will depend, as in (6), on the value of $s\theta$. In the first row of Table 3 we present the pairs of values of $s\theta$ and the steady-state inflation rates π just satisfying condition (6) for $N = 3$. It can be seen that with an annual inflation rate of 10 per cent or less, the cycle will vanish only if $s\theta < 0.52$; taking the subsidy rate $s = 0.3$, this requires an export elasticity $\theta < 1.7$. Reference to Table 1 shows that, for industries exporting less than 20 per cent of output (and only three Australian manufacturing industries exported more), $\theta > 1.7$ unless the ordinary supply elasticity is very small.¹³ For the large majority of industries exporting less than 10 per cent of output, even a 20 per cent inflation rate would be very unlikely to eliminate the export cycle. At its present

TABLE 3

Maximum Values of Subsidy-Effect, $s\theta$, Consistent With No Cycle
or Modified Cycle, For Selected Inflation Rates, Π

	Inflation Rate Π						
	0.05	0.10	0.15	0.20	0.30	0.40	0.50
No Cycle ^(a)	0.23	0.52	0.92	1.47	3.75	15.90	∞
Modified Cycle ^(b)	0.77	2.18	5.70	32.17	∞	∞	∞

(a) Values of subsidy effect, $s\theta$, exactly satisfying (6) for

$$\lambda = \frac{1}{2}: s\theta = (1-Z)/(Z-\frac{1}{2}), \text{ where } Z = \sum_{i=1}^3 (1+\Pi)^{-i}/3$$

(b) Values of subsidy effect, $s\theta$, exactly satisfying (9) for

$$\lambda = \frac{1}{2}: s\theta = [3/2 - (1+\Pi)^{-3}]/[(1+\Pi)^{-2} + (1+\Pi)^{-1} - 3/2]$$

rates, therefore, we cannot expect inflation to remove the MAMES-induced export flip flop.¹⁴

Even if, given $s\theta$, the inflation rate is too low for the cyclical pattern to disappear completely, it may suffice to modify this pattern. As demonstrated in the preceding section, the use of a three-year moving average base resulted in the stationary case in a steady-state cycle in which two year runs of X' alternated with two year runs of X . This was due to the fact that a three-year run of X' alternating with one year of X would (in the linear case, at least), result in the actual base exceeding the critical one, and therefore could not be sustained. Under inflation, however, such a pattern would yield runs of three actual bases, corresponding to the different sequences in which X and X' occurred, of which the highest value would be

$$B^{**at} = \frac{1}{3} PX \{ (1+\pi)^{t-3} + [(1+\pi)^{t-2} + (1+\pi)^{t-1}] (1+s\theta) \}$$

For this not to exceed B_{ct} , and therefore be sustainable, it is required that

$$s\theta < [3\lambda - (1+\pi)^{-3}] / [(1+\pi)^{-2} + (1+\pi)^{-1} - 3\lambda] \quad (9)$$

In the second row of Table 3 we present the values of $s\theta$ and π just satisfying condition (9). As could be intuitively expected, the rates of inflation required to modify the cycle are lower than those needed to eliminate the cycle completely. Thus, for example, 10 per cent inflation will produce a cycle in which three years at the higher export level (X') are followed by one year at the lower (X), unless $s\theta > 2.18$, that is, (again taking $s = 0.3$, $N = 3$ and $\lambda = \frac{1}{2}$), unless $\theta > 7.27$. We would expect that a not inconsiderable number of Australian manufacturing industries would be prone to this modified cycle of real exports. Few, however, would escape the cycle completely.

VIII Productivity Growth

The shift in the export supply curve considered in the preceding section was a vertical one, due to a rise in prices. We shall now consider the case of horizontal shifts, such as would occur as a result of productivity growth and of changes in domestic demand. Because both the critical and the actual export bases refer to export revenues, the effect on revenues of an equi-proportionate horizontal shift in the export supply curve is the same as of inflation, for now $P_t X_t = P(1+\gamma)^t X$, where γ is the growth rate of the export supply.¹⁵ (And the lagging of the actual base behind the critical one is now due to the former being an average of lower physical exports in the past, rather than of lower past prices.) However, constant productivity growth cannot reasonably be expected to result in the export supply curve shifting at a constant annual rate, there being no reason to expect domestic demand for the good to increase at the same rate as output productivity. Let us consider, therefore, the case where productivity growth results in the total supply curve of the good shifting horizontally at the rate of α per annum, while the domestic marginal revenue curve (and domestic demand curve) shifts similarly at the annual rate of β . The critical base in period t will again be equal to some average of the quantities exported with and without the subsidy, $X_t = Q_t - D_t$ and $X'_t = Q_t(1+s\zeta) - D_t(1+sn)$, with weights $(1-\lambda)$ and λ respectively, where Q_t and D_t are the quantity produced, and that marketed domestically, in period t .

As $Q_t = (1+\alpha)^t Q$, and $D_t = (1+\beta)^t D$, and $D = (1-x)Q$,

the critical base in this case can be written as

$$B_{ct} = PQ[(1+\alpha)^t(1+\lambda s\zeta) - (1+\beta)^t(1-x)(1+\lambda sn)] \quad (10)$$

The highest possible actual base is now

$$B^*_{at} = P \frac{1}{N} \sum_{i=1}^N X'_{t-i}$$

which can be written as

$$B^*_{at} = PQ \left[\frac{1}{N} \sum_{i=1}^N (1+\alpha)^{t-i} (1+s\zeta) - (1-x) \frac{1}{N} \sum_{i=1}^N (1+\beta)^{t-i} (1+s\eta) \right] \quad (11)$$

For this to be sustained, and the cycle to vanish

it is required that (10) > (11); that is,

$$PQ \{ (1+\alpha)^t [(1-A) - (A-\lambda)s\zeta] - (1+\beta)^t (1-x) [(1-B) - (B-\lambda)s\eta] \} > 0 \quad (12)$$

where $A \equiv \frac{1}{N} \sum_{i=1}^N (1+\alpha)^{-i}$ can now be regarded as the arithmetical average of the position of the marginal cost curve in the base periods, relative to its position in the current period; and where B is, similarly, the relative arithmetical average position of the domestic marginal revenue curve.

It can be seen that $A < \lambda > B$ is sufficient for (12), irrespective of the values of s, ζ and η . (For $N=3$ and $\lambda=\frac{1}{2}$, this is ensured by $\alpha \leq 0.45 \geq \beta$.)

Otherwise, condition (12) requires that

$$s\zeta + \left(\frac{1+\beta}{1+\alpha} \right)^t (1-x) \left[\frac{(1-B) - (B-\lambda)s\eta}{A-\lambda} \right] < \frac{1-A}{A-\lambda} \quad (13)$$

With $\alpha > \beta$, the effect of the subsidy on the substitution of exports for sales on the domestic market becomes less and less important in time, relative to its effect on expanding production. For high values of t, the second term on the left hand side of (13) will practically vanish. Thus, even if the subsidy scheme results initially in a cycle, a steady-state non-cyclical pattern will ultimately occur provided that

$$s\zeta < [1-A]/[A-\lambda] \quad (14)$$

Table 3 can be used to put numbers into condition (14), reading the π of the Table as α , and θ as ζ .

Examination of the partial derivatives of (12) indicates that, for $A > \lambda < B$, the condition is more likely to be met, the higher are α, η, t, λ and N , and the lower are β, ζ and s . Thus, if condition (12) is not fulfilled immediately by virtue of $A < \lambda > B$, the earlier years of the scheme's operation will be characterized by a cyclical behaviour. With condition (14) fulfilled, the cycle will ultimately vanish. The number of periods required for the cycle to disappear will be smaller, the higher the rate of productivity growth and the smaller the rate of growth in domestic demand. And it will take longer for the cycle to vanish the higher the subsidy rate, and the larger the elasticities both of supply and of domestic demand.

Some idea of the number of years it might take for the cycle to disappear is given by Table 4, in which the influences of inflation as well as productivity are allowed for. The Table is based on the following set of assumptions - unitary elasticities of supply and domestic marginal revenue (ζ and $-\eta$); initial export share, x , equal to 10 percent (so initially $\theta = 19$); real domestic demand increasing at 2 per cent per year ($\beta = 0.02$); and a 30 per cent subsidy rate, with the base taken over three years.

Where ∞ is entered into Table 4, condition (14), suitably modified so that $A = \frac{1}{N} \sum_{i=1}^N (1+\alpha)^{-i} (1+\pi)^{-i}$, is not met, so that the critical base could never exceed the actual base. Where zero is entered, the sufficient condition $A < \lambda > B$ is met, where B is modified, as was A above, to account for π . There are four cases, in Table 4, in which an initial cycle would disappear before the end of this century. All involve inflation or real productivity increases of 10 percent or more per annum.

TABLE 4

Number of Years for Export Cycle to Disappear,
For Selected Parameter Values

Productivity Growth	Inflation Rate			
	$\pi = 0.05$	$\pi = 0.10$	$\pi = 0.15$	$\pi = 0.20$
$\alpha = 0.03$	∞	>50	39	21
$\alpha = 0.05$	39	19	10	6
$\alpha = 0.10$	7	0	0	0

NOTE:

The numbers of years in the body of the Table are derived from the formula:

$$(1+\alpha)^t [(1-A)-(A-\lambda)s\zeta] - (1+\beta)^t (1-x)[(1-B)-(B-\lambda)s\eta] \geq 0$$

where:

$$A = \sum_{i=1}^3 (1+\alpha)^{-i} (1+\pi)^{-i/3}$$

$$B = \sum_{i=1}^3 (1+\beta)^{-i} (1+\pi)^{-i/3}$$

and assuming

$\beta = 0.02$ = growth rate in real domestic demand

$\lambda = 0.5$ (linear approximation)

$s = 0.3$ = subsidy rate

$\zeta = 1.0$ = elasticity of supply

$\eta = -1.0$ = elasticity of domestic demand

$x = 0.1$ = initial export share in output

If the MAMES scheme were to last for seven years¹⁶ a cycle would disappear before its termination only if the inflation rate were 20 per cent, or productivity improvement 10 per cent each year.¹⁷

IX Permanent Effects

In the cases considered so far, an export subsidy will have its effects on exports only during the life of the MAMES scheme. Once the scheme terminates, exports will become what they would have been if the scheme had never operated. Because we have assumed productivity growth to be independent of the level of both exports and output, there could be no consequences for exports lasting beyond the life time of the MAMES subsidy.¹⁸

For effects to persist beyond the life of the subsidy scheme, it is not enough that productivity be, in itself, a function of the volume of output or of exports. Consider the case when the current productivity level is a function of the level of currently produced output; for example, when costs are reduced by the lengthening of production runs. Presumably, this is a discrete process, depending on the crossing of certain thresholds (or else it would have been incorporated already in the cost curve currently perceived by the producer). A rise in the level of productivity would then only occur if $s\theta$ were large enough for the threshold to be crossed. It is, however, a once-and-for-all rise, which will not be repeated by the continuous application of the subsidy. By the same token, once the subsidy is removed, production runs will be shortened to below the threshold, and exports will revert to their pre-subsidy level.

The subsidy will have a permanent influence on exports only if the productivity effect is irreversible; in particular where current productivity is a function either of total accumulated levels of output (or exports) until now, or of the highest level attained at any moment in

the past. The former corresponds to a learning-by-doing process; the latter to increasing returns to scale of plant and equipment. In both cases, the subsidy-induced expansion would trigger a self-perpetuating process of productivity growth. The termination of the subsidy would lower the level of exports but not, with the productivity growth being irreversible, to the pre-subsidy level.

In other words, if productivity is a function of accumulated past output, it would have grown in the absence of the subsidy, albeit at a slower rate; in this case the subsidy scheme has the effect of accelerating the rate of growth of productivity above its quondam rate, to which it now reverts once the subsidy is withdrawn. However, the consequence will be that the absolute level of exports, in the years after the scheme's termination, will be higher than if the scheme never operated. The same is true when productivity is a function of the highest output levels achieved in the past.

X Conclusions

The attraction of a marginal subsidy as opposed to an ordinary subsidy, whether on production or exports, is that it reduces the cost to the Treasury by lessening the rent element in the subsidy payment. The chief disadvantage is that a scheme like MAMES might induce fluctuations in domestic demand and prices, in output and in export volumes and receipts. Fluctuations occur whenever the export base, for purposes of subsidy calculation, exceeds the critical level (which is located about halfway between the unsubsidized level of exports, and the subsidized one). There is, therefore, a limit to Treasury economizing on subsidy payments if fluctuations are to be avoided. Firms may, depending on carrying costs, raise this limit by adopting a strategy of reallocating exports through time; this strategy involves a cycle in yearly exports but not in

production for export. However, as the export base period lengthens, the profitability of this strategy diminishes rapidly. An important conclusion of this paper is that a lengthening of the base period does not guarantee the elimination of the undesirable fluctuations or cycle in prices and quantities. Frustratingly for the proponents of MAMES schemes, when the subsidy has a large proportional effect (measured by s_0), the cycle is more likely to happen. There is, indeed, a trade-off between stability and cost, the exact terms of which depend upon (among other things) the length of the averaging period, N , and the value of the fraction we have called μ . Although inflation and productivity growth may with the passage of time, reduce the incidence of the cycle, they cannot confidentially be relied upon to eliminate it.

In the particular Australian circumstances, there is a reasonable presumption that the cycle will occur in all but the few substantial export manufacturing industries - nonferrous basic metals, fruit and vegetable products, sugar and other food products - and most likely in those Australian manufacturing (and they make up the majority) exporting less than 10 per cent of output. For some intermediate industries (some textiles, food products and other machinery), the cycle is less likely to occur or may be modified over time. The larger the proportional boost given to exports by the subsidy, the more likely the cycle is to occur.

When a somewhat symmetrical cycle of N years does happen, the subsidy-induced increase in exports, when averaged over the cycle, will be equal to about one-half of the increase achieved in the first years of the scheme. Initial enthusiasm over the results (mounting as the "cost-effectiveness" rises) could be replaced by criticism. Whether the MAMES subsidy would, in consequence, substantially smooth the path to structural adjustment via lower and less dispersed tariff rates is a

matter of nice judgement. By the time serious tariff reductions are proposed, the unfavourable consequences of MAMES might have become apparent, and the "bribe" that MAMES represents cease to have the effect of weakening the resistance of manufacturers to tariff reductions.

The MAMES scheme would have permanent effects, those lasting beyond the life time of the scheme itself, to the extent that it sparks off irreversible productivity improvements (see Section IX). If so, the scheme would then have some economic benefits to offset, at least partly, the likely, static, economic costs of misallocation of resources.

FOOTNOTES

- 1 The assumption of a home market monopoly simplifies the analysis by avoiding questions of "competitive myopia", that is, an over-reaction by domestic firms to the profit opportunities made available by the export subsidy. The case of downward sloping foreign demand curve is discussed briefly below.
- 2 See Lloyd (1978, pp. 265-268) for a survey of the tariff compensation debate. In its report Export Incentives (1978, p. 75), the Industries Assistance Commission states that "the average effective rate of protection given to manufacturing industries in the home market is now of the order of 30 percent. To offset the disadvantage occurring from this structure of protection to the development of manufacturing exports, export incentives would have to afford assistance of a similar order". R.G. Gregory has suggested to us that, because the elasticity of non-manufacturing export supply is not zero, an effective rate of export subsidy less than 30 percent (maybe considerably less) would suffice to boost manufacturing exports to something like their free trade level.
- 3 Because of the constancy of foreign price in Figure 1, there is a one-to-one ratio between marginal export quantity and marginal export sales revenue. Nothing of substance in this paper depends on the constancy of foreign price. For convenience, when discussing Figure 1 or Table 2, we assume that the foreign price, P_f , is normalized to unity.
- 4 In practical terms, this may be attained by subsidizing incremental exports only in excess of some proportion of their present level. (In terms of our discussion in Section IV below, this amounts to setting $\mu > 1$.)
- 5 For a one year base, the Treasury cost per unit of extra exports is s when the strategy is not used, and $s+1/\theta$ when it is used. It can be shown that, when the export base is taken as the average exports of the previous N years, condition (2) becomes

$$k < \frac{s(1+s\theta/2)}{N(1+s)(1+s\theta)}$$
- 6 The export base could have been drawn with D' or D or any point in between as its "origin"; the way used to illustrate the critical base in Figure 1 (i.e. by the distance $D''Q$, where D'' bisects $D'D$ and Q bisects QQ') was chosen for its heuristic value. An alternative presentation, one which could be used to illustrate why $(X+X')/2$ is indeed the critical base, would involve deriving the export supply curve by subtracting $M R_d$ horizontally from the MC curve.
- 7 Exact results depend on strict linearity assumptions, and on whether N is odd or even.
 The results of this model contrast with the conclusion of the I.A.C. report on Export Incentives:

"If the growth in exports were measured by relating export

income in the current year to the level in the previous year, it would encourage more of the less desirable export responses and would probably contribute little to the achievement of export growth in the longer term. Sustained export development is more likely to be encouraged if current exports are related to a base which averages export income for a number of years because this will extend the period of assistance to firms before assistance falls off. This would be achieved if exports were averaged over a three year base period." (I.A.C., 1978, p. 73)

Consideration of Figure 1 and Table 2 indicates an extension of the averaging period from one to three years will produce an extension of the period of export boost by one year only.

- 8 Under the flat percent subsidy envisaged by the Crawford Committee, MRF' is not parallel to MRF but equi-proportionate to it. In the linear case, therefore, the critical level Q'' is less than half-way along the interval QQ' and so the timing of the export cycle will differ somewhat from that of Figure 1.
- 9 Strictly speaking, in order to minimize subsidy payments without causing a cycle, the value of μ would have to be lowered in each of the first N years, until it reached the value μ^* defined in the text.
- 10 Of course, if domestic inflation exceeds that in export markets, the effects of the subsidy on increasing exports will ultimately be dissipated; and vice versa, with inflation in export markets more rapid than in domestic costs and prices, exports will rise even without the subsidy.
- 11 Being interested in the long-run steady-state effects of inflation, we assume $N < t$, and ignore here a possible transition period in the early stages of the scheme's operation (a question taken up later).
- 12 In their effects on the relationship between the actual and critical bases, there is symmetry between inflation (represented by the value of Z) and μ (discussed in Section IV). When $\mu \neq 1$, the cycle is avoided if $s \theta < (1-\mu Z) / (\mu Z - \lambda)$. When $\mu = 1$, this becomes condition (6) above; when $\pi = 0$, it becomes $s \theta < (1-\mu) / (\mu - \lambda)$.
- 13 The maximum value for the ordinary supply elasticity (ζ) consistent with $\theta = 1.7$ and $x = 0.2$ is $\zeta = 0.34 (= 1.7 \times 0.2)$.
- 14 For $\pi = 0.2$, $s \theta \leq 1.47$ is required, that is, $\theta \leq 4.9$. The maximum value of the ordinary supply elasticity consistent with $\theta \leq 4.9$ and $x = 0.1$ is $\zeta = 0.49$; if domestic marginal revenue has the low elasticity of -0.5 , then the maximum for ζ is 0.05 .

As an indication of the degree of sensitivity, to variations in λ , of the numerical results reported in Table 3, we note that for 20 per cent inflation ($\pi = 0.2$), the maximum values of $s \theta$ satisfying inequality (5) are 1.18 for $\lambda = 0.45$, 1.47 for $\lambda = 0.5$ (as in the Table), and 1.96 for $\lambda = 0.55$.

- 15 There is a difference between the two cases, inflation and real shifts. In the inflation case, the share of exports, x , does not change except as the subsidy is utilized or not. Thus the export elasticity is constant. With real shifts, unless output and exports increase in the same proportion, x changes, and so does θ .
- 16 The IAC (1978, p. 79) recommended that MAMES operate for at least seven years; the Crawford Committee (1979, p.7.17) stressed that MAMES should be temporary, "extending perhaps over a number of years".
- 17 Industries would pass through a phase of a modified cycle before the cycle disappears. It is possible that if domestic demand shifts fast enough, in comparison with supply, an industry could start under MAMES with no cycle, and finish with a cycle. On the other hand, if $\alpha = \beta = 0.02$, condition (13) reduces to the "inflation-only" condition (5), and Table 3 applies.
- 18 The Crawford Committee seemed to conclude that MAMES could have only temporary effects: "Such a subsidy could enable manufacturers to develop export markets, but of itself it may do little to improve their competitiveness in the longer term" (1979, p.7.17). The emphasis seems to be "overcoming inertia (perhaps due to once-only, entry costs): "This package [including MAMES] will facilitate the entry of Australian firms into export markets on a larger scale than at present, once they have been induced to think positively about export" (1979, p.7.16).

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Revenues
and cost

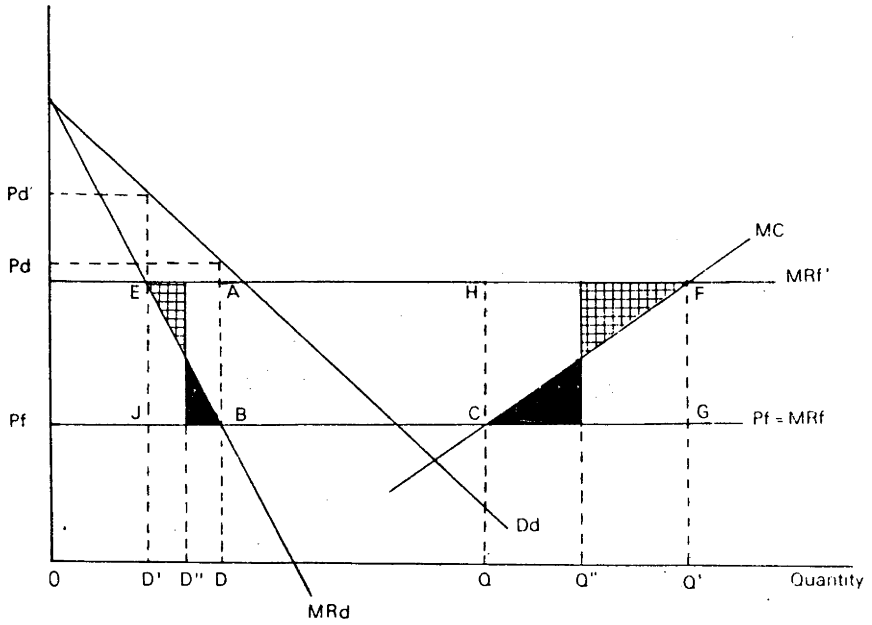


Figure 1

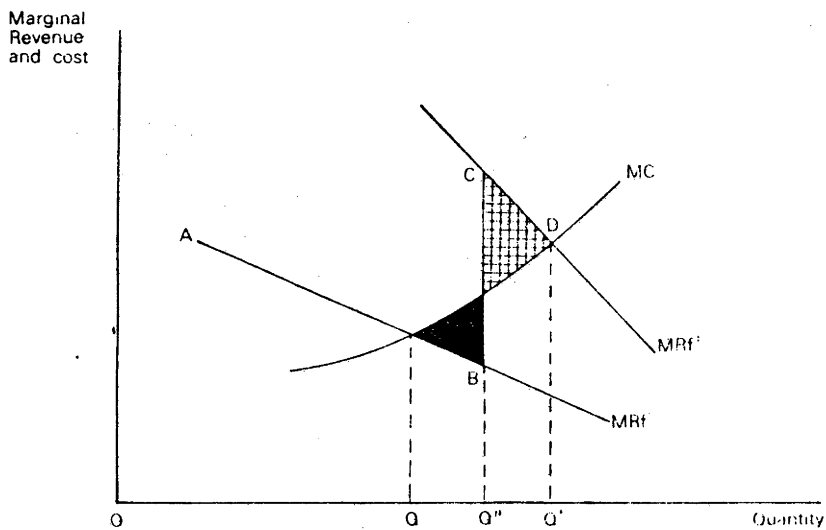


Figure 2

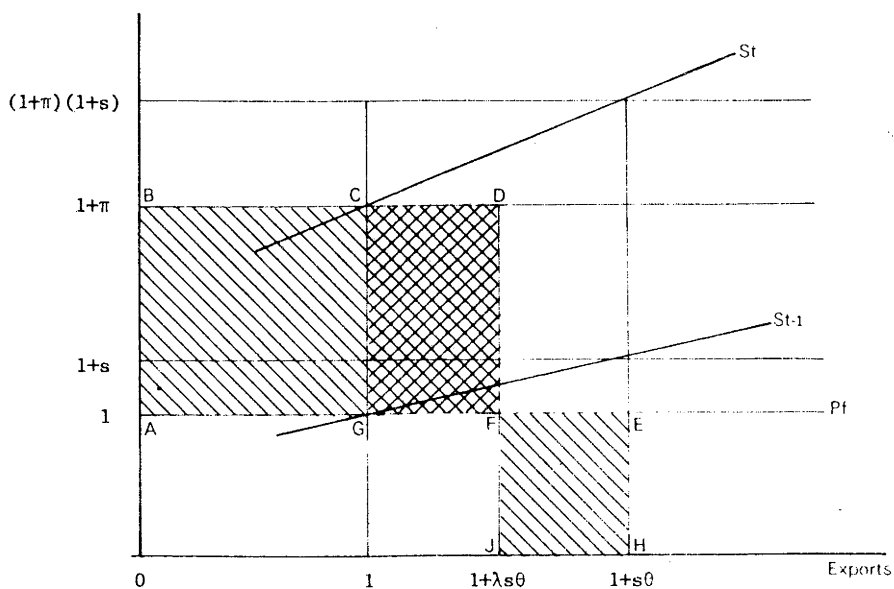


Figure 3

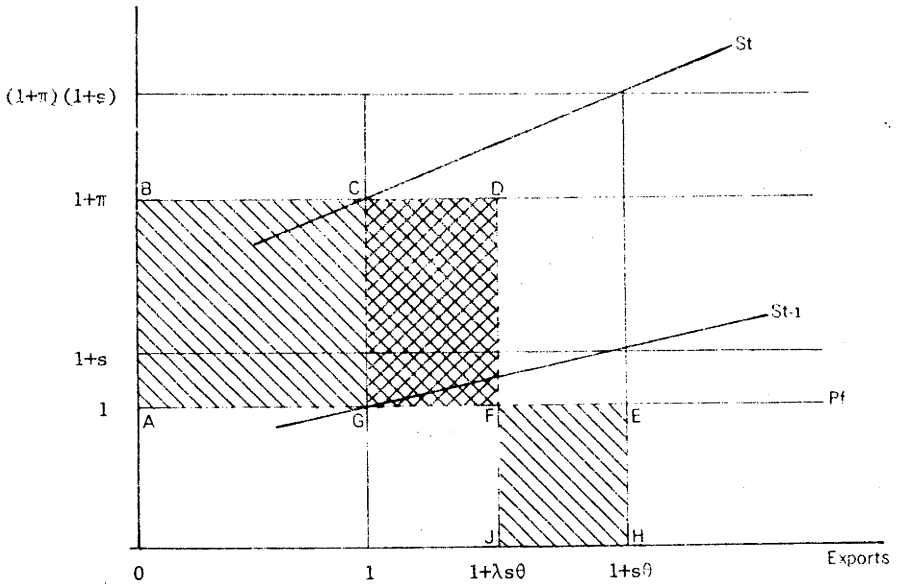


Figure 4