Indices for the Effects of Exchange Rate Changes in Small Open Economies

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Few economists or policy makers would argue nowadays that exchange rates should be left to their own devices. In the light of experiences during the 1970s most would now recommend some degree of exchange rate management. In a world where rates fluctuate this creates a need for a yardstick by which to measure exchange rate performance - the exchange rate manager's guide to intervention. In response, weighted exchange rate indices have grown in popularity, though their serious limitations have been often exposed (Maciejewski [1983]).

There have been several attempts to improve on crude trade weighted exchange rates, unfortunately still the most widely used measure. The best known alternative derives from the IMF's multilateral exchange rate model (MERM) which distinguishes commodities by source of origin and estimates the elasticities of response to price. These elasticities form the basis of the weighting system (Artus and Rhomberg [1973]). It has been recognised that the weights used to compute an exchange rate index will vary with the objective of exchange rate adjustment. The index which represents effects on prices will not necessarily reflect effects on the trade balance (Bélanger [1976]). Some writers have therefore suggested the use of several indices together (Branson-Katseli [1982]). Also, in recent times, the use of trade-weighted exchange rates, adjusted by the ratio of prices at home to those abroad, has become increasingly popular.

Existing usage of indices for exchange rate management leaves much to be desired. The simplier indices - import weighted and trade weighted - are easily understood but of limited usefulness. They measure the effect on the prices of imports or traded goods of exchange rate changes, if volumes are unaffected by price. They may give some indication of the effect of exchange rate changes on wholesale or producer prices, if the impact on non-traded prices is small, but this is insufficient information for the policy maker concerned with competitiveness and the balance of payments. Attempts to measure competitiveness have spawned the increasingly popular, but dangerously flawed, price adjusted weighted exchange rate indices. They face basic difficulties in the selection of prices to be used for comparison and adequate measurement to take account of differences in the baskets of goods produced in the home country, its trading partners and its potential rivals. Moreover, users of price-adjusted trade weighted indices frequently confuse the normative with the positive. If the index appreciates it does not follow that the home country has become less competitive, as is usually assumed. Successful adjustment to changed structures of product or factor prices will be accompanied by an appreciation in the index. Judgements about competitiveness must therefore be based on assessment of the induced volume effects (Worrell [1984]).

The present study suggests that exchange rate policy be guided by evaluating several indices simultaneously. Each index measures the impact on a different target of interest, following

the example of Branson and Katseli. The weights used to compute the indices are derived from the elasticities which measure the responses to the exchange rate changes. Commodities are broken down by origin or destination, avoiding Branson-Katseli's unnecessary reliance on elasticities with respect to trade-weighted traded prices[1]. In all other respects our methodology is similar to theirs. The elasticities used are derived from a model designed to reflect the adjustment process in small open economies (Holder and Worrell [1984]).

The next section describes the indices to be used and explains their computation. It is followed by an evaluation of the exchange rate strategy of Barbados in the period 1960-82, using the indices offered in this study and comparing with analysis based on conventional indices. The analysis explores whether it mattered a great deal in practice what the authorities' objectives were and whether conventional indices might have served as useful rough and ready proxies for the real effects. The following section deals with alternative exchange rate strategies, based on several different objectives. A complete set of indicators accompanies each alternative, providing authorities with several scenarios from which they may choose their preferred compromise. The study concludes with comments on the implications and limitations of the analysis.

Indices of Exchange Rate Effects

The procedure is to estimate elasticities which measure the impact of exchange rate changes on each of a list of economic

targets in turn. The effect of a one percent change in each individual exchange rate is expressed as a proportion of the total effects of all relevant exchange rate changes and that proportion is used to weight the exchange rate. Starting with an index to measure trade effects, the presentation continues with indices keyed to effects on inflation, relative prices of tradable and non-tradable goods (the 'real' exchange rate) and overall output.

The small open economies which are the focus of interest in this study are price-takers in the market for tradable goods. The demand for exports is infinitely large and their output is determined by supply considerations; imports are in infinite supply, and volume depends on demand. There is an equation for each destination of exports and each source of imports, with the possibility that exchange rate changes may cause switches between sources and between markets. The equations are all estimated in rates of change.

The export supply equations are given by:

(1) $x_j = x_j\ (Px_i,\ Pm_i,\ s,\ r) \qquad i, j : 1, 2 \ldots\ldots n$

The x_j are real exports to country j; Px_i are prices available in all countries (including j), in local currency units; Pm_i represents the costs of imported inputs for the production of x_j, also in local currency; s is a measure of unit labour costs and r is the cost of finance. The number of trading partners is n.

The import demand functions are conventional:

(2) $m_j = m_j\ (y,\ Pm_i - P)$

The m_j are real imports from country j, y is real domestic income and P is a domestic price index.

If P^x_i is the price of exports to i, measured in the currency of i,

$$p^x_i = Px_i + e_i$$

e_i being the value of currency of i, expressed in local money.

Similarly,

$$p^m_i = Pm_i + e_i$$

Using equations (1) and (2), assuming no change in foreign currency prices, the change in the trade balance which results from a one percent change in e_i is given by:

(3) $w_j = \Sigma_i\ x_j(-1)\ (\alpha_{ij}{}^x + \beta_{ij}{}^x) - \Sigma_i\ m_i(-1)\ \beta_{ij}{}^m(e_i - P)$

$$+ x_j(-1) - m_j(-1)$$

where $\alpha_{ij}{}^x$ is the coefficient of Px_i in the x_j equation, $\beta_{ij}{}^x$ is the coefficient of Pm_i in the same equation and $\beta_{ij}{}^m$ is the coefficient of $(Pm_i - P)$ in the m_j equation (See appendix 1). The change in the trade volume is represented by the first and second terms, while the last two terms give terms of trade effects.

The exchange rate index for trade effects is:

$i_t = \Sigma w_j\ e_j/e^0_j\ \Sigma w_j$ where e^0_j is the base year value.

It captures only the direct impact of exchange rate changes and does not reflect the possible consequences of exchange rate changes for interest costs, unit labour costs or output, all of which would influence the trade outcome. For the moment, these

indirect effects are assumed to have a negligible impact on trade.

To derive a similar index based on exchange rate effects on prices we employ the model mentioned earlier (Holder and Worrell). The focus is the GDP deflator, divided into a price index for non-tradables, where prices are determined by market demand and supply, and a price index for tradables, with prices fixed by foreign currency prices and exchange rates. Changes in the deflator are represented by

(4) $P = aP_t + (1-a)P_n$

The price of output of tradable goods is the weighted average of the prices of exports (themselves a weighted average of commodities by destination), home use of exportables (h_x) and home consumption of domestically produced importables (h_m)

(5) $P_t = (xP_x + h_xP_x + h_mP_m)/(x + h_x + h_m)$

A one percent change in all exchange rates provokes changes in the prices of tradables which may be represented by

(6) $\hat{P}_t = [x(-1)(1 + \hat{x})\ \hat{P}_x + h_x\hat{P}_x + h_m\hat{P}_m]/[x(-1)(1 + \hat{x}) + h_x + h_m]$

The hats represent exchange rate induced changes. The price changes are weighted by volumes of trade produced by the new constellation of exchange rates, which are assumed to have no effect on home consumption of tradables. In the first expression on the right hand side the $\hat{x}$ are an export weighted sum of $\hat{x}_j$ to each country, and the $\hat{P}_x$ a similarly weighted sum of exchange rate changes, since the exchange rate is assumed to be the only

source of changes in tradable prices. P_m is an import weighted sum of the e_i.

The price effects on non-tradables are derived from a reduced form of demand and supply relationships in the Holder-Worrell model. At the beginning of the production period (by assumption, one year) firms decide on output levels on the basis of the following expected demand:

(7) $y_n^* = y_n^*(y,\ P_n - P_t)$

Actual output is set to partially close the gap between y_n^* and $y_n(-1)$:

(8) $y_n - y_n(-1) = \lambda(y_n^* - y_n(-1))$

This amount is offered at a price given by:

(9) $P_n = P_n(y_n,\ P_m,\ s,\ r)$

Factor costs (s, r) are the same as for firms producing tradables and P_m is the cost of imported inputs. Testing the reduced form of equations (7)-(9) provides an estimate of the elasticity of P_n's response to exchange rate changes, which is combined with the results of equation (6) to produce a measure of the overall price effect. If we simplify expressions by assuming that the exchange rate induced changes in trade weights can be neglected, the weight which reflects the influence of currency j is given by:

$$w_j^P = [(a - \alpha^P)(x_j + hm_j/m)]/[(1 - \alpha^P)(x + h)] + (1 - a)\beta_j^P m_j/m(1 - \alpha^P)$$

Where α^P is the coefficient of P_m in the P_n equation (in its reduced form) and β^P is the coefficient of $(P_n - P_t)$ in the same equation.

This expression has also been simplified by assuming h_x is negligible (and therefore $h_m = h$), an assumption which is quite close to the reality of the Barbadian economy. None of the assumptions is necessary to the argument; they merely keep the expressions to manageable proportions. The index which measures the effects of exchange rate movements on prices is given by:

$$i_p = \Sigma w_j^P \, e_j/e_j^0 \, \Sigma w_j^P$$

The elasticities just calculated may be used to compute an index to reflect changes in the 'real' exchange rate - the ratio of tradable to non-tradable prices. This effect is of interest to small open economies because of the belief that an increase in the relative price of tradables might induce a shift towards the production of tradables and consumption of non-tradables, producing an expansion path which economises in the use of foreign exchange. The index for relative prices, using the assumptions of the previous paragraph, is derived from the following weights:

$$w_j^r = (1 + \alpha^P)(x_j + hm_j/m)/(1 - \alpha^P)(x + h) - \beta_j^P \, m_j/m(1 - \alpha^P)$$

The index is

$$i_r = \Sigma w_j^r \, e_j/e_j^0 \, \Sigma w_j^r$$

These indices, like i_t, fail to incorporate indirect exchange rate effects which depend on the impact of exchange rates on real income, unit labour costs and finance costs. Whether these assumptions should be sustained, even as a first assumption, may be subjected to empirical tests in an amplified

model such as that which appears in the Holder and Worrell study. If indirect effects are significant the weights should be adjusted accordingly. They would then include elasticity combinations - for example the product of coefficients measuring the response of wages to inflation and of inflation to the exchange rate.

If the exchange rate effects on output are large enough, the growth of output itself may replace trade and prices as the principal target of exchange rate policy. In this case we need an index which is designed to reflect the impact on growth. Such an index may be computed, using equations (7)-(9) to derive the effect on output of non-tradables, and the following supply schedule for tradables:

$$Y_t = y_t \, (P_t, \, s, \, r)$$

This is an equation similar to those used earlier for the supply of exports and the supply of non-tradables, presented in more aggregated form. Assuming once more that exchange rate changes do not alter the trade weights applied to the calculation of P_t, that they have no significant effects on the local consumption of home produced tradables and that home consumption of exportables is negligible, we get the simplified weights:

$$w^Y = \{[\alpha^{Yt}(1 - \beta^{Yn} \, \alpha^{Pn}) - \beta^{Yn}](x_j + hm_j/m) + \beta^{Yn} \, \beta^{Pn} \, (x + h)\} / \{(1 + \alpha^{Yn} \, \beta^{Pn} - \alpha^{Pn})(x + h)\}$$

The coefficients are: α^{Yt}, the elasticity of y_t with respect to P_t; β^{Yn}, the elasticity of y_n with respect to changes in the real exchange rate ($P_n - P_t$); and β^{Pn}, the elasticity of P_n with respect to P_m. The index which reflects the exchange rate impact

on the growth rate is:

$$i_y = \Sigma w_j^y \, e^j / e_j^0 \, \Sigma w_j^y$$

Evaluation of Exchange Rate Strategy in Barbados, 1960-82

Barbados is a small Caribbean country with strong economic links with North America and important, though weakening, ties with the UK, with which it severed a colonial relationship in 1966. The Barbados currency was linked to sterling at an unchanged parity up to June 1975, when it was pegged to the US dollar. The parity with the US dollar has remained unchanged since then. We now evaluate this strategy, using each of the indices just introduced in turn, as well as conventional indices, import weighted, trade weighted and trade weighted adjusted by relative consumer price indices in Barbados and her major trading partners.

The trade weighted exchange rate (TWER) for Barbados, computed on the basis of shares in goods and services because of the important contribution of tourism to Barbados' current account, remains little changed between 1960 and 1973 (chart 1). The only large movement came as a result of the devaluation of sterling in 1968, when Barbados retained the old sterling parity. The index begins to fluctuate regularly in 1974; a depreciation in that year is followed by a sharp appreciation in 1975, its effects partly eroded by slow appreciation from 1976 to 1980. After 1980 there is another reversal, with slow appreciation to the end of the period. The import-weighted index tells much the same story (chart 2).

The effect of adjusting the trade-weighted index by relative prices is to introduce greater volatility in the index for 1960 to 1973, and to exaggerate the depreciation of 1968 (chart 3); it goes from less than 5% without the price adjustment to 15%. Although inflation rates were low everywhere at that time, prices increased in Barbados much more slowly than in the economies of her major trading partners. The price-adjusted rate also slows a small appreciation in 1971, caused entirely by a relative acceleration in domestic prices. Between 1974 and 1982 the adjustment for relative prices leaves the pattern of fluctuation in the index unchanged, but the amplitude of the movements is much larger.

A comparison between i_t (chart 4) and the trade-weighted index serves to indicate whether the latter may serve as a useful indicator of trade effects. Between 1960 and 1967, when TWER remains stable, it appreciates, but they produce similar measures for the effect of the 1968 sterling devaluation. Discrepancies appear between 1969 and 1973 when i_t appreciates while TWER remains steady. Between 1974 and 1982 i_t depreciates, rapidly up to 1976 after which it appreciates a little before depreciating once more - a pattern which bears no resemblance to that of TWER.

The trade weighted exchange rate may be a tolerable proxy for effects on inflation, however, judging by the correspondence of TWER and i_p (chart 5). Both indices exhibit a similar pattern of variation, and the magnitude of variation demonstrated by the TWER is very close to that recorded by i_p. The large appreciation

between 1974 and 1976, for example, is registered as 12% by TWER and 14% by i_p. The result indicates the extent to which overall domestic price formation is dominated by the prices of traded goods.

In contrast, the price adjusted trade weighted rate (PATWER) is not a reliable indicator of real exchange rate movements, measured by i_r (chart 6). The latter index depreciates steadily between 1960 and 1974, and there is no sign of the appreciation measured by PATWER between 1968 and 1974. The 1968 sterling devaluation, which PATWER measures as a 15% depreciation, in fact had no perceptible effect on the real exchange rate. After 1974 the two ratios exhibit somewhat similar pattern, but with differences in the magnitudes of the changes they measure. The appreciation between 1974 and 1977 is measured as 13% and 21%, respectively, by i_r and PATWER.

We have no conventional measure of the exchange rate impact on the growth of output. The index suggested for this purpose, i_y, produces a record significantly different from all others (chart 7). Between 1960 and 1968 i_y appreciates, showing no special effect of the sterling devaluation. There is rapid depreciation between 1969 and 1971, followed by sharp appreciation to record levels between 1972 and 1978. A period of depreciation sets in from 1979, lasting until 1982.

It appears that TWER may be of limited usefulness as a quick proxy for the inflationary effects of exchange rate changes on the Barbadian economy. Conventional exchange rate indices

have no other uses; the price-adjusted index seems particularly misleading as a guide to real exchange rate implications and the trade-weighted index offers no guide to balance of trade effects. No one index may stand for the many effects of a given constellation of exchange rate changes. The same set of rates drives different indices at different rates and often in different directions. Successful policy-making will depend on a skilful assessment, based on the computation of rates linked to each important target. One may then choose several hypothetical strategies for examination, measure the effects of each one on all targets and compare the results to identify a preferred strategy. An exercise along these lines is the burden of the next section.

Hypothetical Exchange Rate Strategies

Calculations were made for several alternative exchange rate strategies, each based on a different target. Targets were chosen so as to attain the performance of 1971, a year of reasonable output growth, low inflation and modest overall balance of payments surplus. For the first exercise the exchange rate was to be adjusted so that the effects on the balance of trade would be the same as in 1971; a value of Barbados currency in terms of a numeraire (the US dollar) was chosen for each year to secure this result. The paths of all other targets were then simulated and compared with the actual outturn. The process was repeated in turn for strategies which would have the same impact every year with respect to prices and the real exchange rate, and for a strategy designed to accelerate the output growth rate.

An exchange rate strategy to produce a constant trade balance effect equivalent to that of 1971, would have implied continuous appreciation of the Barbados dollar in terms of US currency throughout the period (chart 8). It turns out that the 1971 exchange rate effects on trade were the most adverse for the period surveyed (chart 9). If the authorities had decided to live with those trade effects for each of the years considered, significant dampening in prices would have resulted during the 1962 to 1975 period - except for 1971 (chart 10). In the earlier years, this anti-inflationary effect would not have been particularly helpful because these were years of low inflation in any case. The inflation dampening might have been more helpful in 1973 and 1974 when Barbados recorded its highest ever inflation rates. Exchange rate policy could have reduced those rates by 8% and 15% respectively in the two years. The second half of the 1970s witnessed generally higher inflation rates than the 1960s, but the exchange rate strategy being examined here would not have yielded much anti-inflationary benefit during those years. Its dampening effect would have been only on the order of two to four percent.

The same pattern can be observed for the real exchange rate (chart 11). There is a very large appreciation - a decline in the relative price of traded goods - in the 1960s and early 1970s, with a less marked appreciation between 1975 and 1982. The effects were quite large in both periods, ranging from 10% to 70% between 1961 and 1975 and remaining in the region of five percent thereafter. This strategy would have had very damaging

effects on the growth of output in the early years (chart 12). Growth rates would have slowed by up to one percent per year between 1962 and 1966 and by as much as four percent in 1968. In the late 1960s the effects would have been about one half percent at most. This exchange rate strategy is not a particularly attractive alternative; it yields generally poorer trade performance than the strategy actually followed, with weaker output growth. The only gain was some price deflation, of importance only for two years.

Our second strategy would provide for a constant impact on prices. It produces another general appreciation compared to the actual - 1968 is the only year when this strategy would have produced a rate lower than that actually recorded (chart 8). The pattern for this strategy would have been alternating periods of appreciation and depreciation ending with a rate twelve percent above the actual 1982 rate. The observed rates were more inflationary than this hypothetical rate in 1968, 1974 and 1978-80. They were less inflationary in 1975, 1976, 1981 and 1982 (chart 13). In these latter years the trade balance improves by up to 28% percent of the actually recorded balance. In the years when the hypothetical strategy would have been less inflationary (1968, 1974 and 1978-80) the trade balance worsened by up to 54% percent of the actual balance; in other years there was not much difference (chart 14). The real exchange rate appreciates when the inflation abates, by up to 17% in (1968) an depreciates when inflation accelerates up to a maximum of 26% in 1976 (chart 15). Growth is inhibited in the years when this

strategy produces lower inflation but the impact is not very large for most years. The inhibition of growth is about half of a percentage point in 1968 and again between 1978 and 1980. On the other hand, there is growth acceleration of about one percent in 1976 (chart 16). This second hypothetical strategy produces exchange rate results which are quite similar to those of the strategy actually pursued. The exchange rate pattern is a little more inflationary on occassion and this is associated with slight improvement in the trade balance and depreciation in the real exchange rate. There are a few years where the effects are exactly the opposite. Only on isolated occasions is there a disturbance of any importance to the income growth pattern.

A third objective might have been to produce a constant real exchange rate. The pattern here is very similar to the changes necessary to keep inflation effects constant. However, in comparison with observed exchange rate changes the extent of appreciation is much less (chart 8). The rate stays much closer to the observed rate for the most part and ends with an appreciation of only three percent compared to the actual 1982 value. The results are very similar to the rates described in the last paragraph - a few years where the trade balance improves and inflation is higher and some years where the reverse occurs. In both cases the time periods are the same as those for the inflation effects (charts 17-20). However, the magnitude of the effects in this case are much smaller, in general. Again, there is not much to choose between this strategy and the strategy actually followed on the basis of these effects.

The final alternative was an exchange rate strategy which would add half a percentage point to the income growth rate each year. This produces an alternative which is the exact opposite of the first, that is, a continuous depreciation of the exchange rate, which ends at 150% below its actual value in 1982. This strategy improves the trade balance markedly, except for 1968, 1968, 1974, 1981 and 1982. However, it boosts inflation by 5 - 10% each year except for those four years. The real exchange rate appreciates by as much as a maximum of 12% in 1980 (charts 21-24). This strategy produces faster growth and a more favourable trade balance but it is rather inflationary.

The exchange rate authority might now employ these results to provide guidelines for exchange rate strategy. If inflation were of little concern and high priority attached to accelerating a sluggish growth rate, the strategy would tend towards the last alternative considered. Conversely, a strongly anti-inflationary exchange rate policy would have implied even greater appreciation that the first hypothetical strategy, at least after 1975. It could have been contemplated only if growth were particularly robust. It appears that the actual strategy followed allowed for reasonable compromise of growth - modest and sustained - and inflation, which was in double digits for only five years of the period.

Conclusion

An exercise such as we have just performed provides the policy maker with a range of alternative scenarios from which to choose, on the basis of judgements about the social costs and/or benefits of faster growth, higher inflation, a larger trade deficit, an improved international competitive position and greater instability of any of these effects over time. This procedure might replace popular trade weighted exchange rates - which give no information on effects of exchange rate policy, apart from the direct impact on the prices of traded goods - and relative price-adjusted trade weighted exchange rate indices, which are misleading.

In practice, these computations will be only the first step in designing the exchange rate strategy. Policy makers must bring to bear insights about expectations of external exchange rate movements, evaluation of public opinion about the authorities' commitment to particular strategies (actual or expected), the incentives for black market trading in foreign exchange, the availability of balance of payments finance, the country's debt service capacity and actual or desirable changes in the commodities produced and traded.

The analytical tools described in the paper may be extended by removing simplifying assumptions and incorporating indirect exchange rate effects. Measures might also be derived for longer-lasting effects by estimating elasticities in suitable (long-run) form. Ultimately, if one constructed a complete

structural model of the economy where commodities are broken down by country of origin or destination, it would be possible to evaluate exchange rate strategies by directly simulating their effects on prices, growth and the balance of payments. So long as a majority of countries lack such a model, elasticity-based indices, used in combination, are reasonable substitutes as guides for exchange rate policy.

Footnote

1. The distinction is important for trade volume effects but perhaps not for price effects. Branson and Katseli use only one elasticity to measure the response of exports to demand prices, for example. The results of switches between markets in response to exchange rate changes therefore disappear. To capture them we estimate an elasticity for each market, taking account of relevant prices in other markets.

Appendix 1

The Exchange Rate Indices

To derive the expression for w_j write the export and import relationships as:

$$x_i = \alpha_{io}^x + \Sigma\alpha_{ij}^x P_{xj} + \Sigma_j \beta_{ij}^x P_{mj} + \alpha_i^x s + \gamma_i^x r$$

$$m_i = \alpha_{io}^m + \Sigma_j \beta_{ij}^m (P_{mj} - P)$$

The expression for w_j simply collects all the terms in j, for all x_i and subtracts all the terms in j for all m_i; $\hat{x}$ is the change in real exports induced by a one percent change in all exchange rates and $\hat{m}$ is the corresponding change in imports. To these expressions must be added the terms of trade effects of a one percent change in all currencies.

To arrive at the formula for w_j^P we first calculate the change in an index of tradable goods prices induced by a one percent change in each exchange rate. The price of tradables is the sum of the export-weighted prices of exports, the export-weighted average price of exports weighted by home consumption of exportables, and an import-weighted average price of imports weighted by home consumption of domestically produced importables:

$$\hat{P}_t = (\hat{x}\,\hat{P}_x + h_x\,\hat{P}_x + h_m\hat{P}_m)/(\hat{x} + h_x + h_m)$$

where $\hat{P}_x = \Sigma_j[x_j(-1)(1 + x_j)e_j/\Sigma x_j(-1)(1 + \hat{x}_j)]$ is the export weighted average change in export prices;

$\hat{x} = \Sigma_j x_j(-1)(1 + \hat{x}_j)$ is the sum of exchange rate induced changes in exports;

$x_j = e_j + \Sigma_j(\alpha_{ji}^x + \beta_{ji}^x)e_j$ is the exchange rate induced change in x_j;

$P_m = \Sigma_j[m_j(-1)(1 + m_j)e_j/\Sigma_j\, m_j(-1)(1 + \hat{m}_j)]$ is the import-weighted average change in inport prices; and

$m_j = e_j + \Sigma_j\beta_{ji}^m(e_i - P)e_j$ is the exchange rate induced change in m_j.

For the effects on the price of non-tradables we write the reduced form of equations (7) to (9) as:

$$P_n = \alpha^P{}_0 + \alpha^P{}_1 y + \beta^P(P_n - P_t) + \alpha^P P_m + \gamma^P s + \Sigma^P r + \delta^P\, y_n(-1)$$

The exchange rate changes cause P_n to shift according to

$$\hat{P}_n = \beta^P(\hat{P}_n - \hat{P}_t) + \alpha^P\hat{P}_m$$

Using the identity (4) and collecting all terms in e_j gives the expression for w_j^P.

The weights for relative prices are derived from the same expressions, combined by the identity:

$$RP = P_t - P_n$$

For the index which reflects output changes we estimate the supply function for tradables as:

$$y_t = \alpha_0{}^{yt} + \alpha^{yt}P_t + \beta^{yt}s + \alpha^{yt}r$$

Equations (7) and (8) are combined to give the estimating equation for y_r

$$y_n = \alpha_0{}^{yn} + \alpha^{yn}y + \beta^{yn}(P_n - P_t) + \gamma^{yn}y_n(-1)$$

In order to determine the effect on relative prices in the above expression we estimate equation (9) as

$$P_n = \alpha_0{}^{Pn} + \alpha^{Pn}y_n + \beta^{Pn}P_m + \gamma^{Pn}s + \delta^{Pn}r$$

Exchange rate movements will produce the changes in the output of tradables, given by:

$$\hat{y}_t = \alpha^{yt}\,\hat{P}_t$$

Changes in the output of non-tradables are given by:

$$\hat{y}_n = \alpha^{yn}\hat{y} + \beta^{yn}(\hat{P}_n - \hat{P}_t)$$

The expression for P_t is given earlier in this appendix. The effects on the price of non-tradables are:

$$\hat{P}_n = \alpha^{Pn}\hat{y}_n + \beta_j{}^{Pn}\,\hat{P}_m$$

Combining these results gives the overall effect on output, and the weight to be attributed to e_j is found by isolating its coefficients.

Appendix 2

Estimates of the Elasticities

Separate equations were estimated for real merchandise exports, real merchandise imports and real tourist expenditures, for each of Barbados' largest trading partners - the US, the UK and Trinidad and Tobago. Between them they accounted for about 65% of current account transactions in 1982. The remaining activities are assumed to be denominated in US dollars or in currencies whose movements closely match those of the US dollar, an assumption which may be readily relaxed in the interests of greater precision.

All estimates are in logarithmic form and the observations end in 1982. The t-statistics appear below the estimates of the coefficients; R^2 is unadjusted, DW is the Durbin-Watson statistic, SEE the standard error of the estimate, rho the coefficient of autocorrelation (accompanied by its standard error in brackets) and n the number of observations. Coefficients which are significant at the 10% level in a two-tailed test are indicated by an asterisk and are used in calculating the exchange rate index. Where the Durbin-Watson test indicates (at the 5% significance level) an absence of serial correlation an asterisk appears; positive or negative correlation is indicated by the appropriate sign.

The exports estimates are:

Exports to the UK

$$\underset{}{\text{LnXUK}} = \underset{(0.91)}{1.71} + \underset{(2.98)}{4.92^{*}\text{lnPXUS}} - \underset{(-2.99)}{5.04^{*}\text{lnPXUK}} - \underset{(-1.84)}{3.65^{*}\text{lnPMUS}}$$

$$+ \underset{(2.12)}{3.23^{*}\text{lnPMUK}} + \underset{(0.24)}{0.02\text{lnS}} + \underset{(0.38)}{0.05\text{lnR}}$$

$R^2 = 0.4135$ DW = 2.39* SEE = 0.38 n =29

Exports to TT

$$\underset{}{\text{LnXTT}} = \underset{(-1.57)}{-1.72} - \underset{(-2.39)}{0.69^{*}\text{lnPXTT}} - \underset{(-0.03)}{0.03\text{lnPMUS}} + \underset{(1.93)}{1.24^{*}\text{lnPMUK}}$$

$$- \underset{(-0.28)}{0.01\text{lnS}} + \underset{(1.37)}{0.10\ \text{lnR}}$$

$R^2 = 0.9344$ DW = 0.88 SEE = 0.21 n = 29

All Other Exports

$$\underset{}{\text{LnXOTH}} = \underset{(-1.15)}{1.91} + \underset{(1.34)}{1.94\text{lnPXUS}} - \underset{(-1.36)}{2.03\text{lnPXUK}} - \underset{(1.33)}{2.33\text{lnPMUS}}$$

$$+ \underset{(2.47)}{3.31^{*}\text{lnPMUK}} - \underset{(-2.83)}{0.18\text{lnS}} + \underset{(0.92)}{0.11\text{lnR}}$$

$R^2 = 0.8900$ DW = 1.76 SEE = 0.34 n = 29

The Trinidad market does not compete with exports to the rest of the world because Barbados and Trinidad belong to the Caribbean regional common market (Caricom).

Although we have employed the coefficients indicated in our calculations, the equations are not wholly satisfactory. The signs of the coefficients are almost always the reverse of what we would expect and the XUK equation does not explain most of the

variation. The residuals of the XUK equation do not appear to be correlated, but we do not have an unambiguous results in the other equations. Still, we accept these results as a description of how the export supply curve actually looks, pending further investigation.

The tourism estimates:

Expenditure by North American Tourists

$$\begin{array}{l} \text{LnTRUS} = 3.97 + 0.77^{*}\text{lnPTUS} + 0.65\text{lnPMUS} - 0.79\text{lnPMUK} \\ \qquad\quad (2.98)\ (2.31) \qquad\quad (0.78) \qquad\quad (-1.11) \\ \qquad + 0.21\text{lnS} - 0.003\ \text{lnR} \\ \qquad\quad (1.16) \qquad (-0.33) \end{array}$$

$R^2 = 0.9852$ DW = 1.55 SEE = 0.14 n = 24 rho = 0.91 (10.85)

Expenditure by UK Tourists

$$\begin{array}{l} \text{LnTRUK} = 4.15 + 0.77^{*}\text{lnPTUK} + 1.06\text{lnPMUS} - 1.23\text{lnPMUK} \\ \qquad\quad (3.08)\ (2.60) \qquad\quad (1.19) \qquad\quad (-1.56) \\ \qquad + 0.19\text{lnS} - 0.03\text{lnR} \\ \qquad\quad (-0.40) \qquad (-0.40) \end{array}$$

$R^2 = 0.9856$ DW = 1.73 SEE = 0.41 n = 24 rho = 0.90 (10.28)

Expenditure by Trinidad-Tobago Tourists

$$\begin{array}{l} \text{LnTRTT} = 4.98 + 0.66^{*}\text{lnPTTT} + 0.13\text{lnPMUS} - 0.25\text{lnPMUK} \\ \qquad\quad (5.80)\ (3.60) \qquad\quad (0.25) \qquad\quad (-0.56) \\ \qquad + 0.07\text{lnS} - 0.16^{*}\text{lnR} \\ \qquad\quad (-2.94) \qquad (-2.94) \end{array}$$

$R^2 = 0.9821$ DW = 1.46 SEE = 0.09 n = 24 rho = 0.83 (7.30)

The tourism equations explain most of the variation and the significant coefficients have plausible signs. However, the very small impact of cost factors, both import and domestic, is surprising.

The import equations:

Imports from US and miscellaneous sources

$$\begin{array}{l} \text{LnMUS} = 0.29 + 0.26^{*}\text{lnY} - 2.98^{*}\text{ln(PMUS/P)} + 2.58^{*}\text{lnPMUK/P} \\ \qquad\quad (1.76)\ (3.40) \qquad (-5.75) \qquad\quad (5.99) \end{array}$$

$R^2 = 0.8210$ DW = 0.41 SEE = 0.33 n = 29

Imports from UK

$$\begin{array}{l} \text{LnMUK} = 1.88 - 0.15^{*}\text{lnY} + 0.79\text{ln(PMUS/P)} - 1.28^{*}\text{ln(PMUK/P)} \\ \qquad\quad (6.26)(-2.54) \qquad (1.58) \qquad\quad (-2.71) \end{array}$$

$R^2 = 0.7498$ DW = 0.98 SEE 0.13 n = 28 rho 0.87 (9.15)

Imports from Trinidad

$$\begin{array}{l} \text{LnMTT} = 1.82 - 0.18^{*}\text{lnY} - 2.00^{*}\text{ln(PMTT/P)} + 0.77\text{ln(PMUS/P)} \\ \qquad\quad (2.27)(-2.36) \qquad (-1.70) \qquad\quad (0.90) \\ \qquad + 0.40\text{ln(PMUK/P)} \\ \qquad\quad (0.42) \end{array}$$

$R^2 = 0.8968$ DW = 1.64 SEE = 0.16 n = 28 rho = 0.95 (16.70)

The equation for the US produces reasonable results, but we have not yet identified the nature of the serial correlation which appears to be present. The UK and Trinidad equations both indicate a decline in real imports with respect to rising real income, a surprising result which may reflect a shift over time from these sources to the US. The UK result is not yet

satisfactory; positive serial correlation appears to be present; with no attempt to correct it the estimation produces unacceptable results - low coefficient of determination, insignificant coefficient for real income and perverse effect of import prices. The equation reported above, which the results from the use of the Cochrane-Orcutt technique, is in line with maintained hypotheses about the effect of income and prices, but serial correlation remains.

The reduced form equation for the price of non-tradables used in the index for price effects is:

$$\begin{aligned} LnPN = {} & -0.20 - 0.21lnY + 0.99^{*}lnPM + 0.74^{*}ln(PN/PT) + 0.12lnS \\ & (-0.07)(-0.37) \quad (7.42) \quad (4.39) \quad (0.14) \\ & + 0.04lnR + 0.32lnYN(-1) \\ & (0.20) \quad (0.67) \end{aligned}$$

$R^2 = 0.9924$ DW = 1.71 SEE = 0.08 n = 21

which is an acceptable result, if a little surprising: domestic costs and demand have no measurable impact.

The equations used are computing the index for output were estimated as follows:

$$\begin{aligned} LnYT = {} & 2.53 + 0.45^{*}lnPT + 0.19lnS - 0.46lnR \\ & (7.04) \ (7.10) \quad (1.54) \quad (-2.56) \end{aligned}$$

$R^2 = 0.8693$ DW = 1.20 SEE = 0.09 n = 22

$$\begin{aligned} lnYN = {} & -393.64 + 58.90^{*}lnY - 6.93ln(PN/PT) + 13.56lnYN(-1) \\ & (-4.74) \ (3.19) \quad (-1.07) \quad (0.65) \end{aligned}$$

$R^2 = 0.7920$ DW - 1.41 SEE = 3.63 n = 21

$$\begin{aligned} lnPN = {} & 0.58 - 0.46lnY + 1.41^{*}lnPM + 0.02lnS + 0.35lnR \\ & (0.14)(-0.78) \quad (8.95) \quad (0.09) \quad (1.39) \end{aligned}$$

$R^2 = 0.9794$ DW = 1.04 SEE = 0.13 n = 22

This system is no more than a disaggregation of the reduced form estimated in the previous paragraph, so it tells the same story.

Appendix 3

Hypothetical Exchange Rate Strategies

We may write the index relating to trade effects as

$$i_t = e_n \left[\Sigma w_j \, r_j / r_j^0\right] / e_n^0 \, \Sigma w_j$$

where e_n is the value of local currency in terms of a numeraire and r_j is the value of the numeraire in terms of foreign currencies.

$$e_n = i_t \, e_n^0 \, \Sigma w_j / \left[\Sigma w_j r_j / r_j^0\right]$$

From this we may generate values for e_n, keeping i_t constant at its value in the reference year (1971). The new series for e_n can now be used to generate the pattern of trade effects, price effects and output effects. Trade effects are given by $(\Sigma x_j - \Sigma m_j)$, price effects by $\hat{P}$, relative price effects by $(\hat{P}_t - \hat{P}_n)$ and output effects by y. The expression for each of these variables is given in appendix 1.

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ırt 1

ıde-weighted Exchange Rate (TWER)

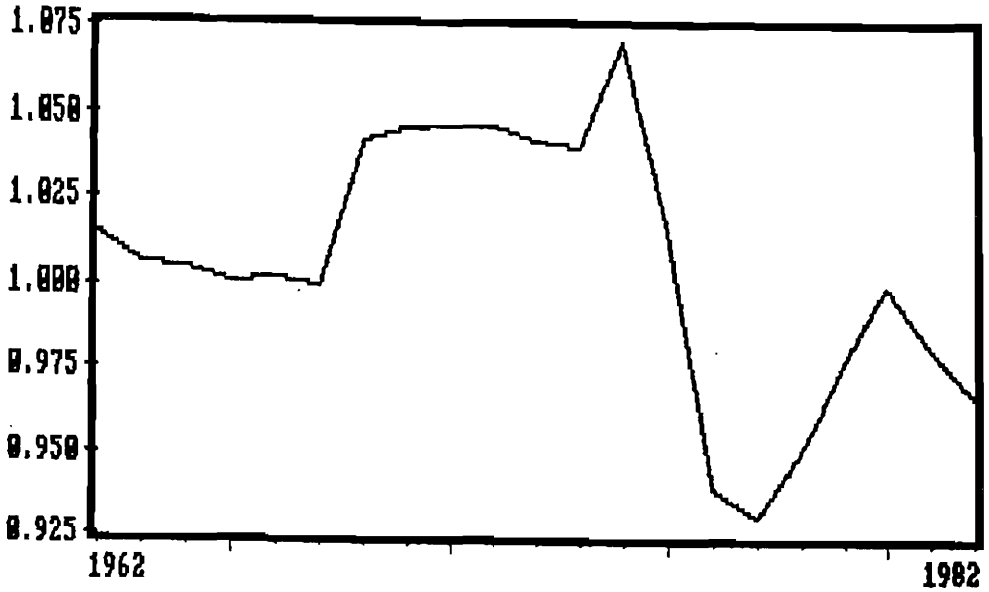


Chart 2

Import-weighted Exchange Rate (MWER)

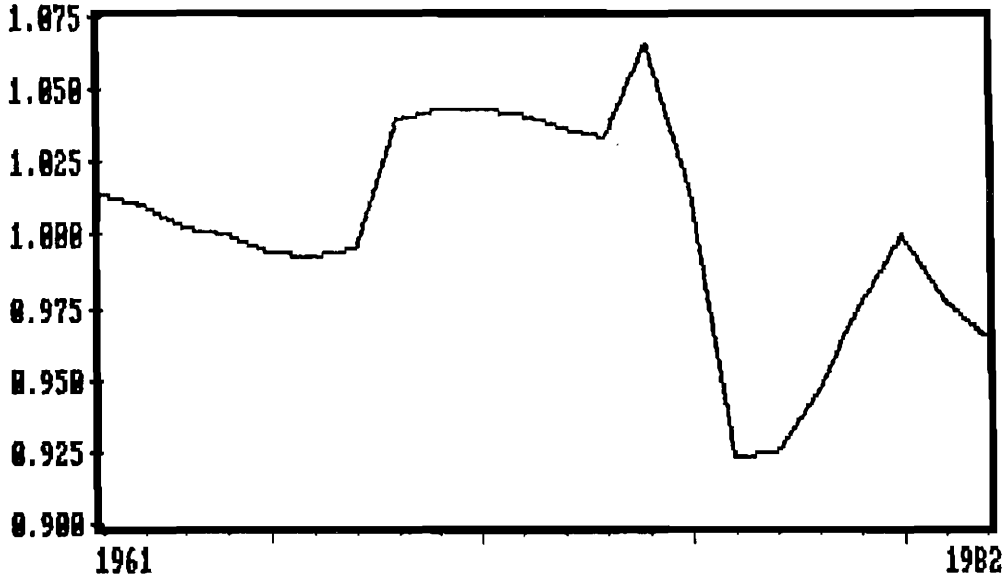


Chart 3

Price Adjusted Trade Weighted Exchange Rate (PATWER)

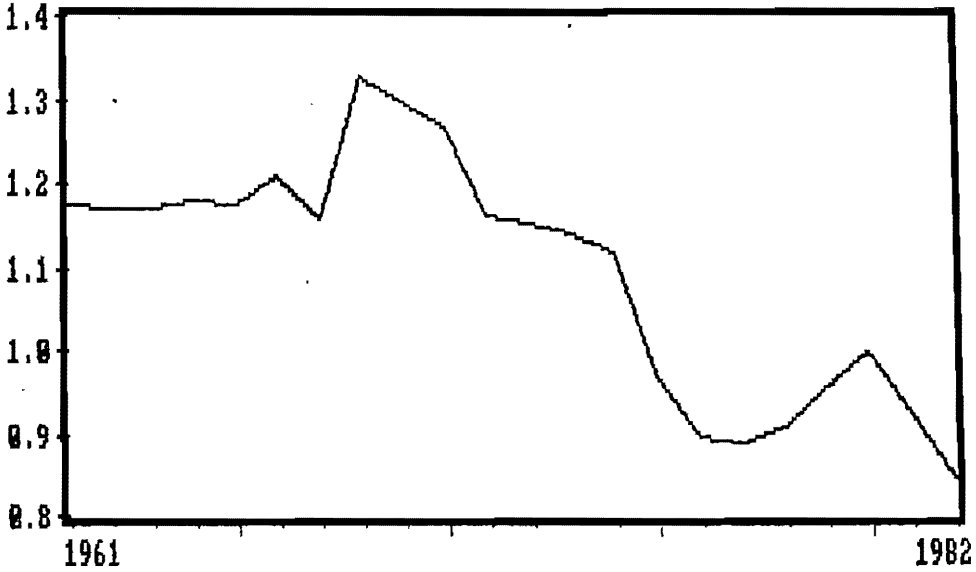


Chart 4

Index for Trade Effects (i_t)

Chart 5

index of prices (i_p)

Chart 6

index of relative prices (i_r)

Chart 7

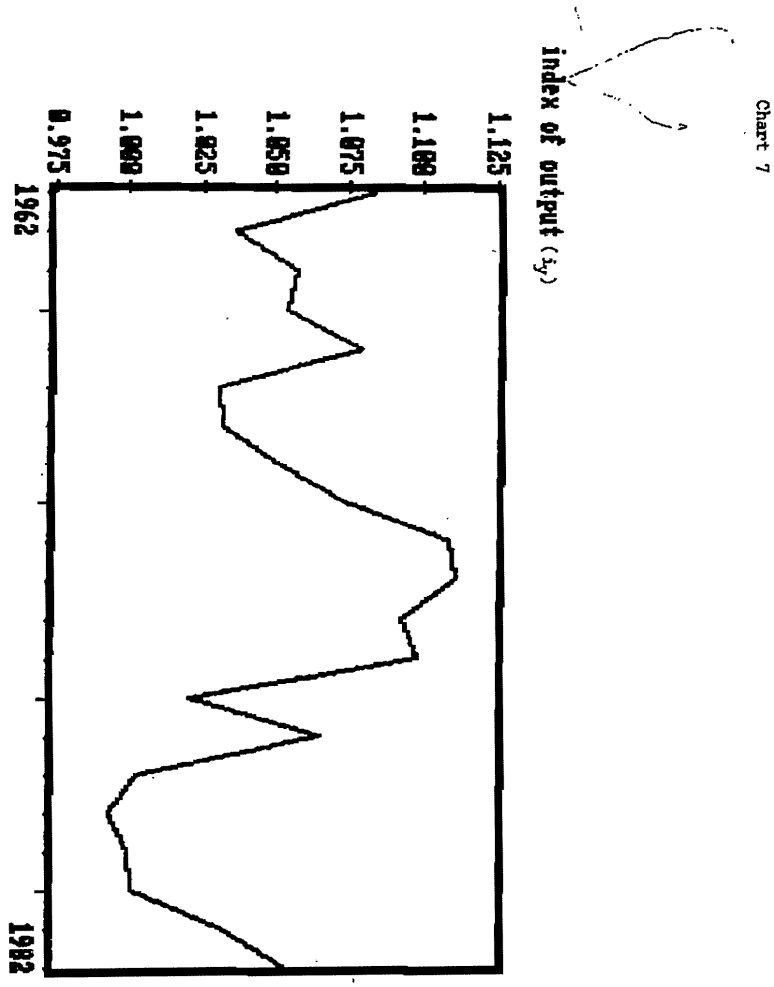


Chart 8 Alternative Exchange Rate Strategies

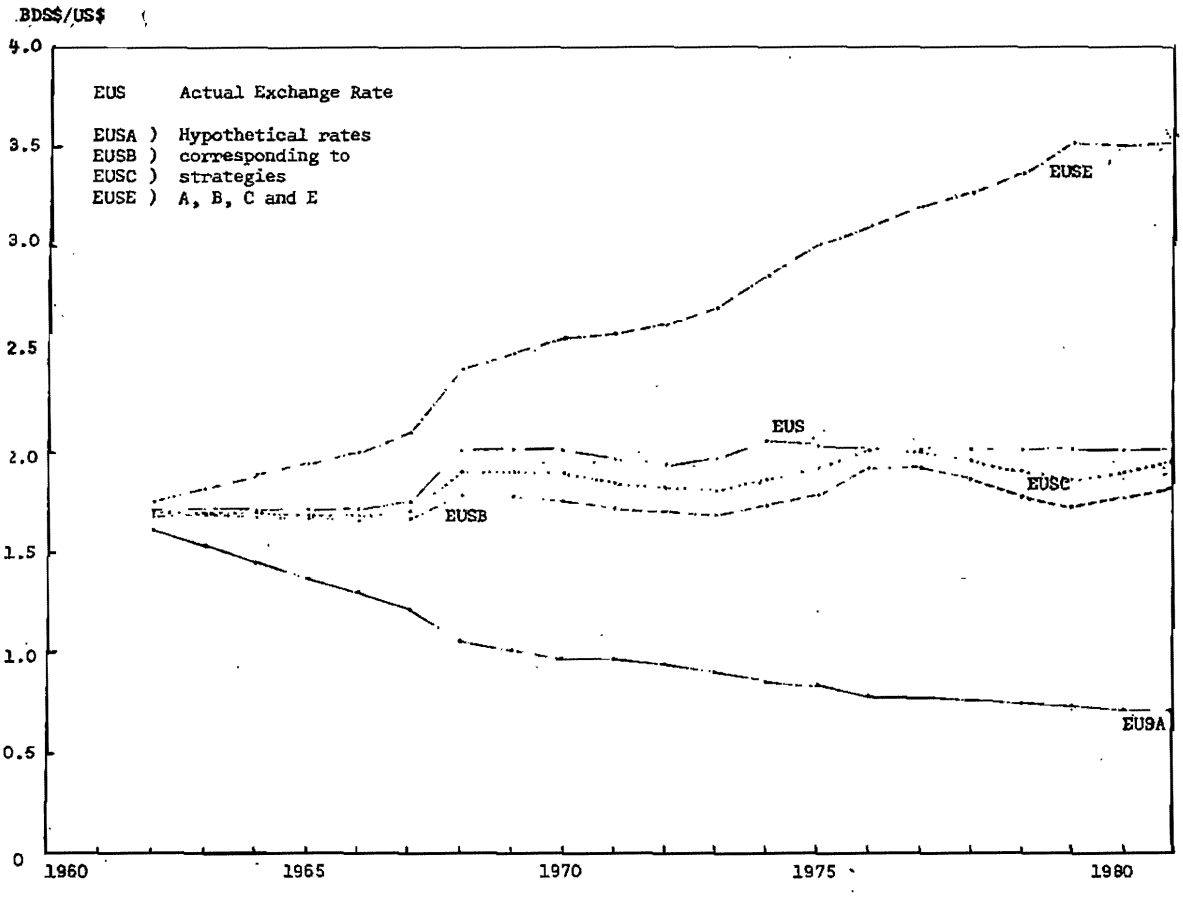
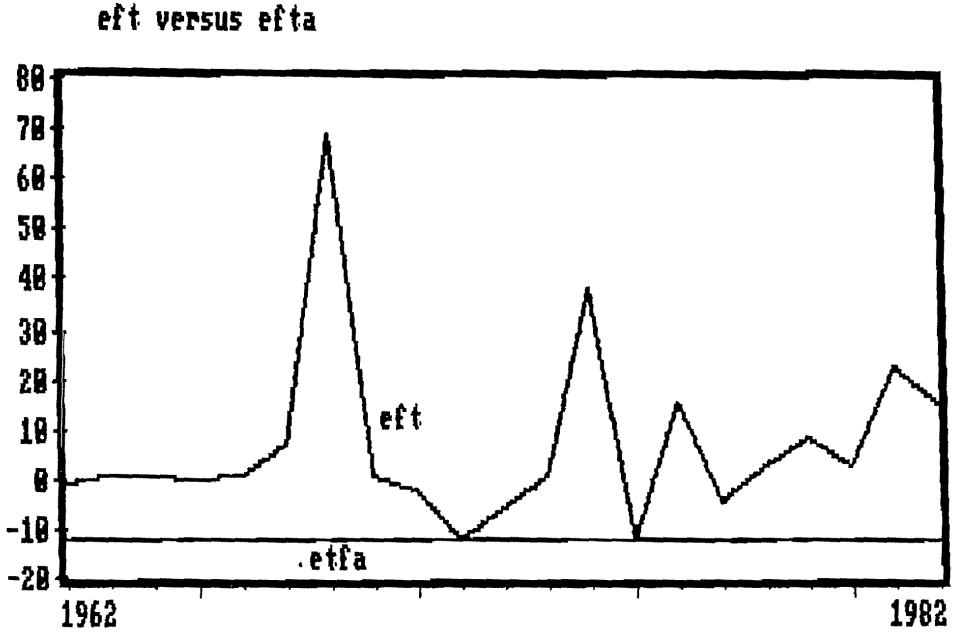


Chart 9

Trade Effects (First Strategy - A)



eft: Actual trade effects

efta: Trade effects of hypothetical strategy A

Chart 10

Price Effects (First Strategy)

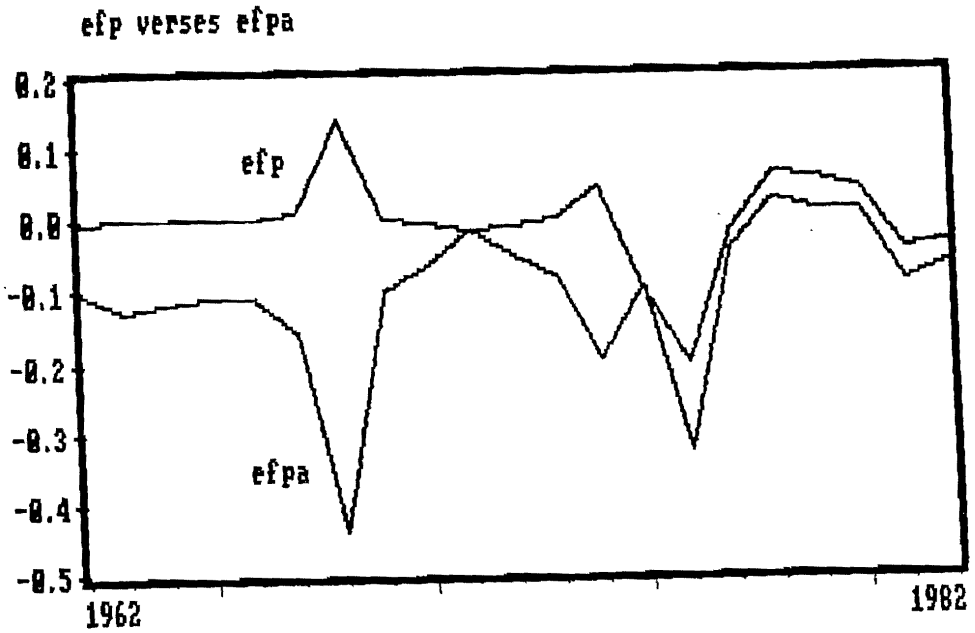


Chart 11

Real Exchange Rate Effects (First Strategy)

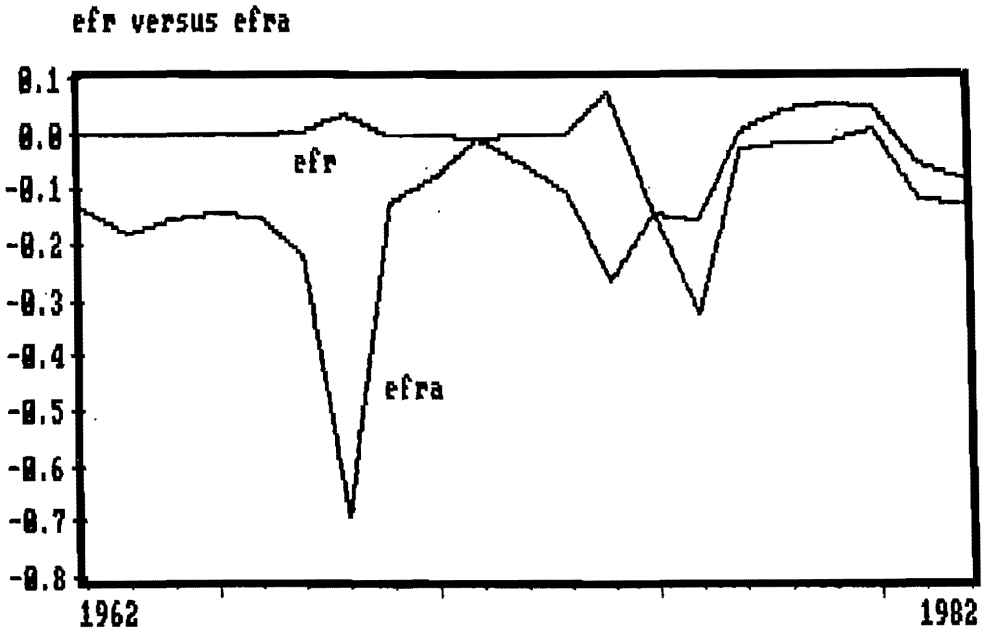


Chart 12

Growth Effects (First Strategy)

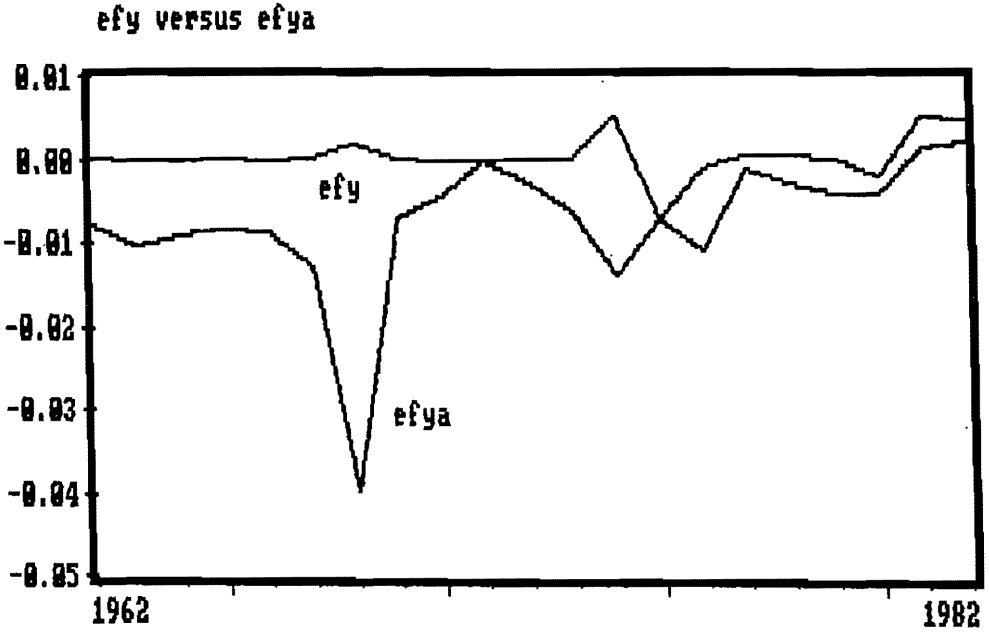


Chart 13

Price Effects (Second Strategy - B)

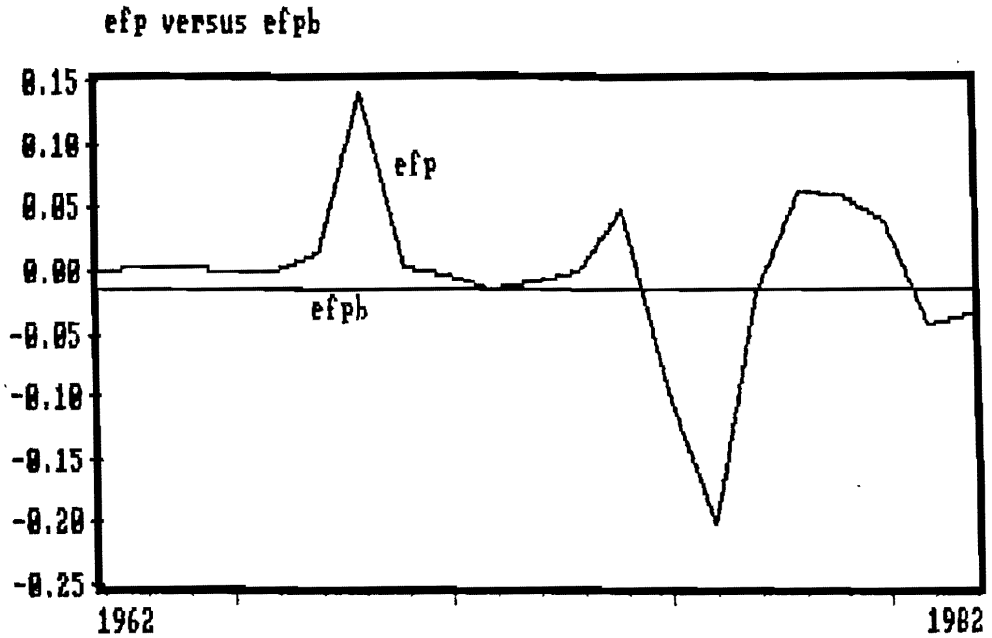


Chart 14

Trade Effects (Second Strategy)

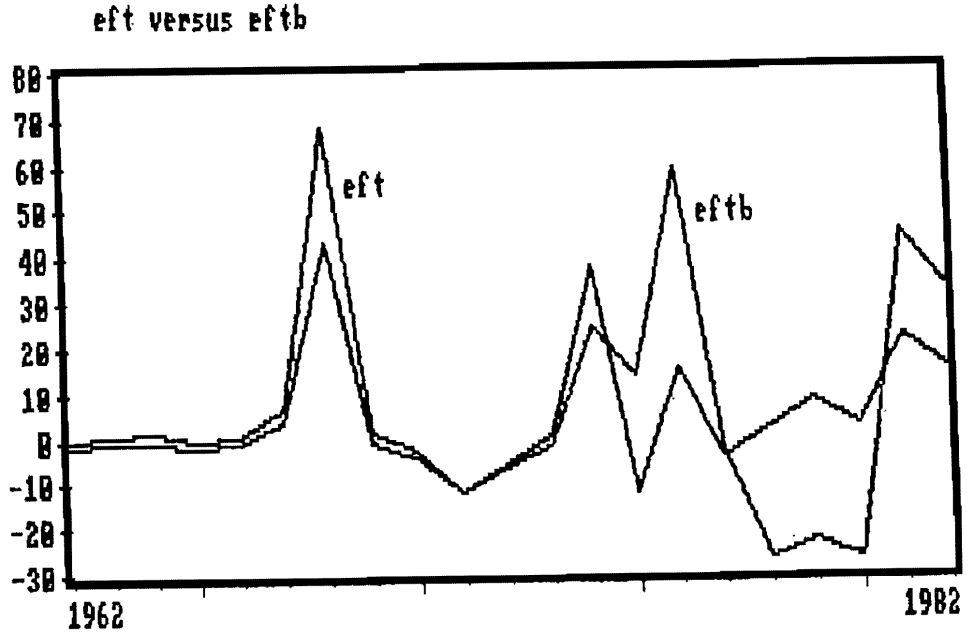


Chart 15

Real Exchange Rate Effects (Second Strategy)

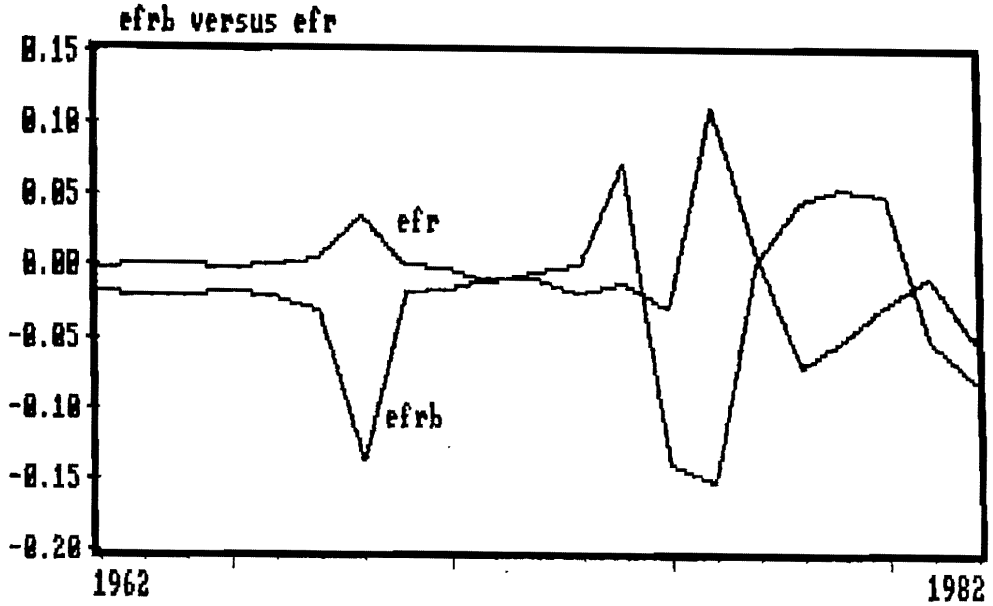


Chart 16

Growth Effects (Second Strategy)

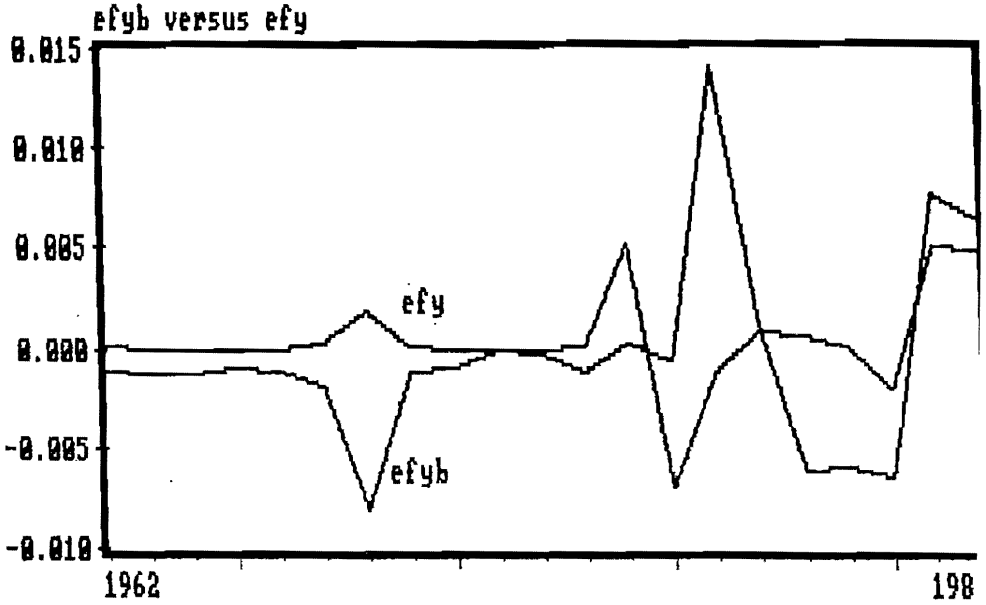


Chart 17

Trade Effects (Third Strategy - C)

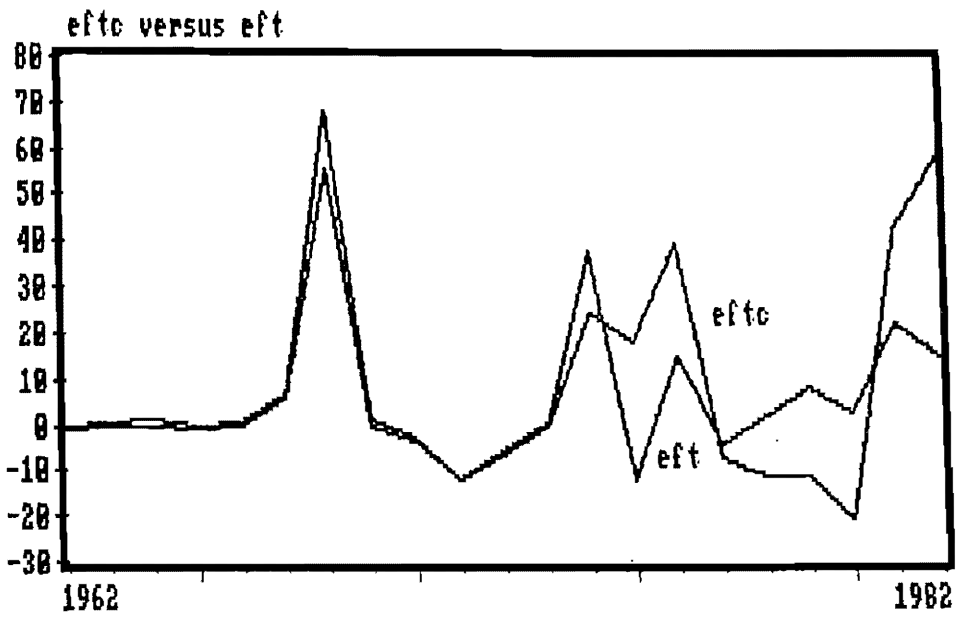


Chart 18

Price Effects (Third Strategy)

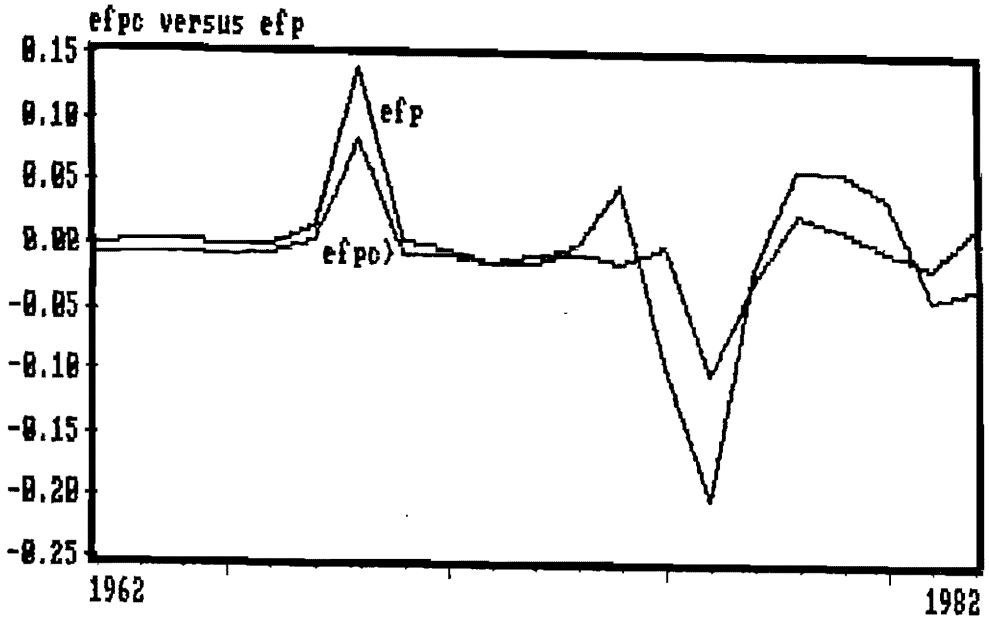


Chart 19

Real Exchange Rate Effects (Third Strategy)

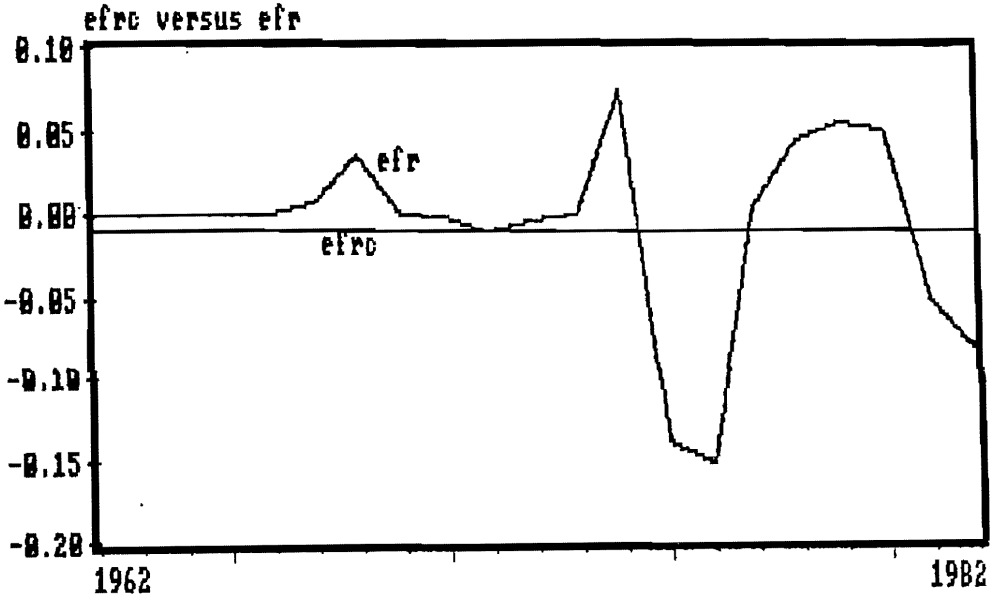


Chart 20

Growth Effects (Third Strategy)

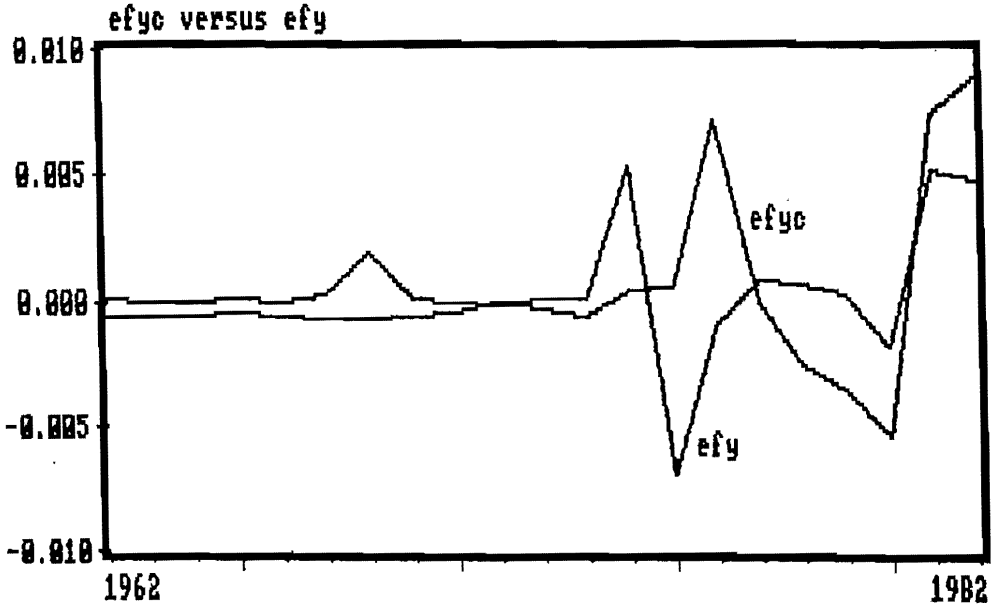


Chart 21

Trade Effects (Fourth Strategy - r)

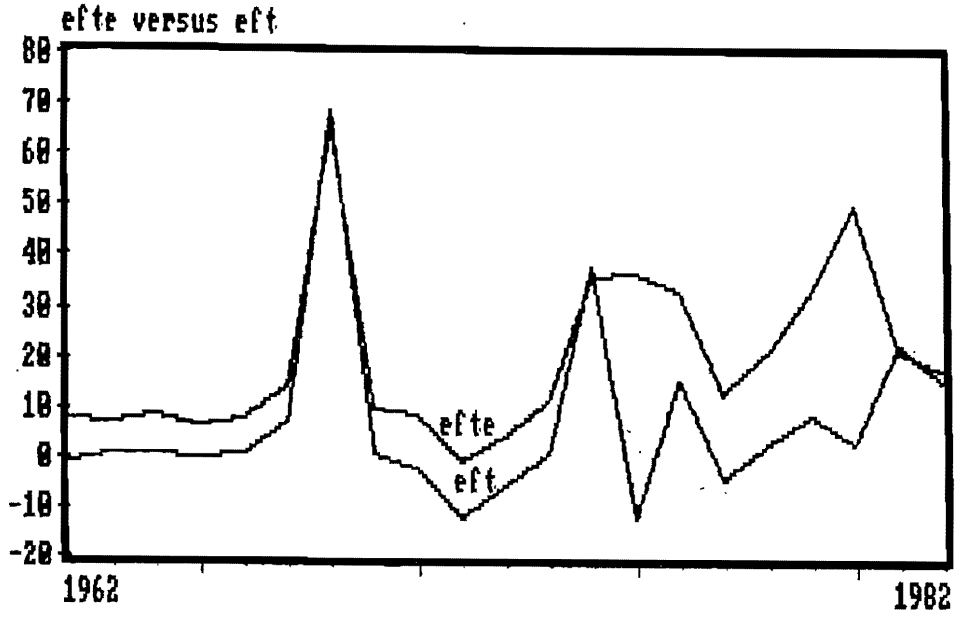


Chart 22

Price Effects (Fourth Strategy)

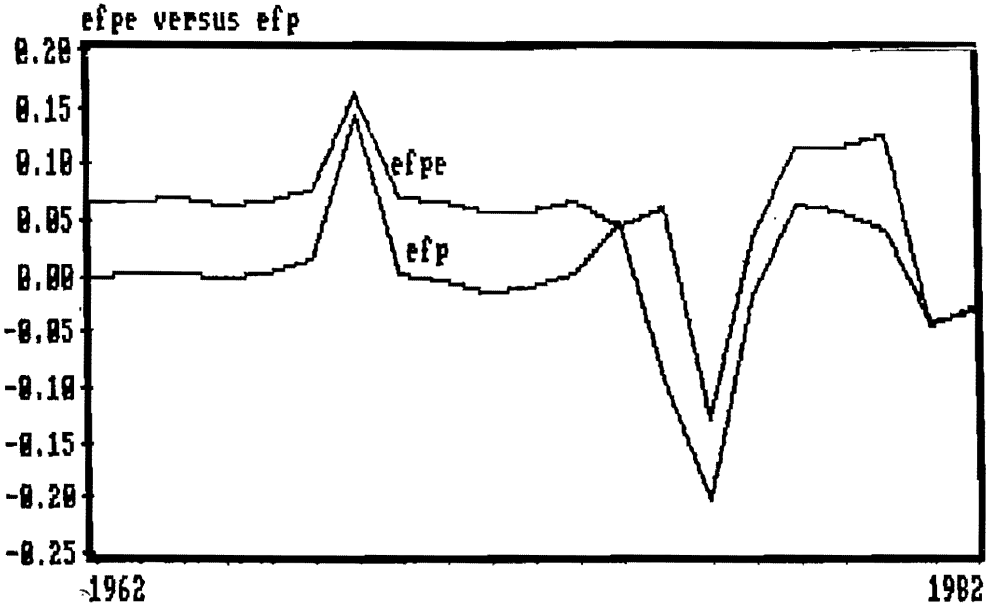


Chart 23

Real Exchange Rate Effects (Fourth Strategy)

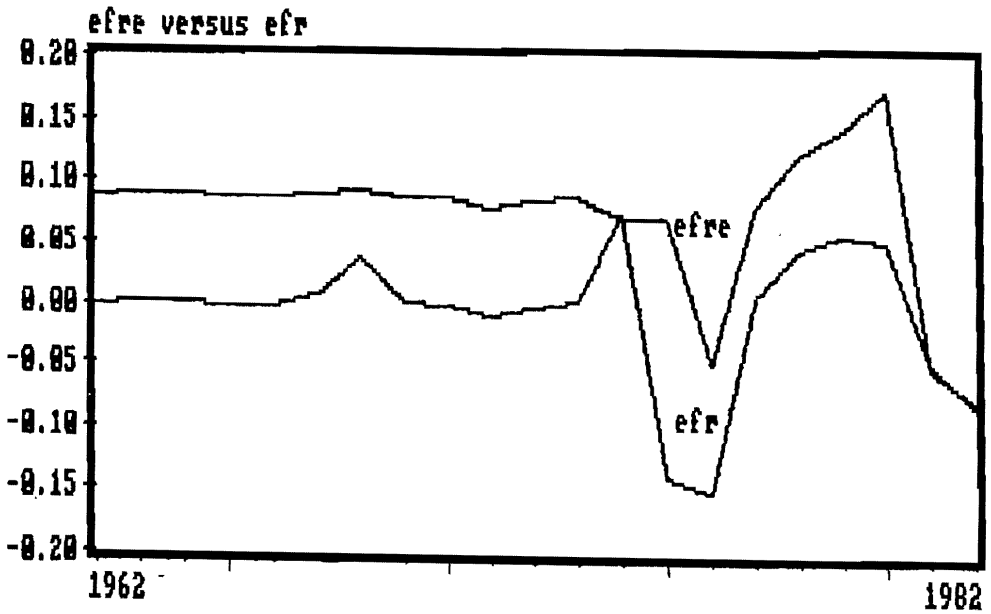


Chart 24

Growth Effects (Fourth Strategy)