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THE CANADIAN DOLLAR, 1971-76: AN EXPLORATORY INVESTIGATION OF SHORT RUN MOVEMENTS

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ABSTRACT

This paper examines the movement of the Canadian dollar over the 1971-76 period. Although Canadian prices increased substantially more than U.S. prices over this period, there was no tendency for a systematic depreciation of the Canadian dollar. To explain this phenomenon requires the introduction of other factors into the exchange rate equation. Among the variables that proved significant are the Canadian terms of trade, measures of long-term borrowing, the relative cyclical position of Canada and the United States, and the market's errors in forecasting the current account balance. When used together with relative prices, these variables track the movement of the Canadian dollar very satisfactorily over the period.

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1. INTRODUCTION

Most discussions of movements of exchange rates over the medium to long run begin with some variant of the purchasing power parity (PPP) type of analysis. An application of PPP to the movements of the Canadian dollar over the period 1971Q1-1976Q3[1] leads to a very puzzling result - over a period when prices in Canada increased about 15% more than prices in the United States (GNE deflators) the Canadian dollar showed no tendency to a systematic depreciation. (See Figures 1 and 2.) It is clear that other factors must have played an important role in explaining, first, why the Canadian dollar did not depreciate almost continuously over the 1972-1976 period, and, second, what caused the cyclical movements over the period. The aim of this paper is to specify these other factors and to show that they kept up the value of the Canadian dollar at a time when PPP considerations would have resulted in a substantial depreciation.

In Section 2 of this paper I set out a somewhat eclectic view of exchange rate determination. I begin with the Haas-Alexander model, and show its relationship to the Dornbusch version of the rational expectations model. In both of these models the expected exchange rate plays a crucial role and it is to the modelling of these expectations that I devote a great deal of attention. Included in the elements entering into the determination of the expected exchange rate are purchasing power parity, terms of trade, measures of long-term borrowing, the relative cyclical position of Canada and the United States, and the market's errors in forecasting the current account balance. Each of these factors enters the equation with a lag to reflect the notion that it is only when the announcement of monthly or quarterly data is made by the statistics-gathering agency that it can affect the market's perception of what is happening.

In order to model the errors in forecasting the current account balance it is necessary to develop an equation to explain the movements of the current account balance. A simple equation is presented in Section 3 in which the current account balance is regressed on measures of competitiveness, the terms of trade, and the relative cyclical position. Residuals from this equation are introduced as a regressor in the exchange rate equation. The various regression equations for the exchange rate are also presented in Section 3. In Section 4 I compare the coefficients across the two equations and draw some rather speculative conclusions from their relative magnitudes. Finally, in Section 5 I return to the questions posed at the beginning of this section and discuss in general terms the movements of the exchange rate over the 1971 to 1976 period.

2. THEORETICAL FRAMEWORK

Although there is a variety of theoretical models from which to choose[2] I shall use a variant of the Haas-Alexander portfolio balance model[3] as the starting point for the analysis. The Haas-Alexander model can be developed as follows:

$$ULS^*(\text{or } ULS^*/Scale) = a + b(RCAN-RUS) + cPFX - dPFXE$$

$$\Delta ULS = e(ULS^* - ULS_{-1})$$

$$\Delta ULS = - UBAL/PFX + FXO$$

where ULS*(ULS) is the desired (actual) stock of net short-term liabilities to foreigners

RCAN	is the Canadian interest rate
RUS	is the U.S. interest rate
PFX	is the spot rate (Canadian dollars per U.S. dollar)
PFXE	is the spot rate expected one period (three months) in the future
UBAL	is the basic balance surplus
FXO	is the change in Canadian reserves (intervention).

The desired stock of net short-term liabilities to foreigners is a function of the interest rate differential between Canada and the United States, the current spot rate and the expected spot rate. Actual liabilities are adjusted to the desired stock via the usual stock-adjustment model. The change in privately-held net short-term liabilities to foreigners (i.e. private short-term capital inflows) is by definition equal to the basic balance deficit plus the increase in Canadian reserves.[4]

Substituting, we get

$$PFX = - a/c + d/c\ PFXE - b/c(RCAN-RUS) + 1/c\ ULS_{-1} + 1/ec(FXO-UBAL/PFX)$$

Note that if d = c (as suggested by theory) and if complete adjustment occurs in the period of observation (e = 1 as suggested by Haas and Alexander), this equation becomes

$$PFX = - a/c + PFXE - b/c(RCAN-RUS) + 1/c\ ULS$$

Dornbusch[5] writes the spot rate equation as

$$\begin{aligned} PFX &= PFXE/(1+RCAN-RUS) \\ &\doteq PFXE(1-RCAN+RUS) \\ &\doteq PFXE - (RCAN-RUS) \text{ if } PFXE \doteq 1 \end{aligned}$$

In writing the equation in this way one must be careful to ensure that the same horizon holds for PFXE and the interest rates. The main point of difference between Haas-Alexander (H-A) and Dornbusch is the incorporation of the ULS term (or ULS_{-1} and FXO - UBAL/PFX) in H-A and the a priori imposition of a coefficient of unity on both b/c and d/c. These differences between the two theories can be subjected to empirical testing.

The crucial element in our treatment of PFX is the specification of PFXE. Rather than a simple autoregressive equation (including reserve change) as in H-A or simple purchasing power parity as in some versions of Dornbusch[6] we incorporate a large number of economic factors into PFXE. The basis of our treatment is the traditional purchasing power parity theory modified to take account of other factors, and the incorporation of some aspects of efficient market theory. Thus we include in PFXE the following:

(1) purchasing power parity
(2) relative cyclical position
(3) terms of trade
(4) long-term borrowing
(5) the error in forecasting the current account balance.

Each of these factors is entered with a lag to reflect the notion that it is only upon the announcement of the statistics by the data-gathering agency that the market changes its views of the evolution of the variables that enter into the determination of the exchange rate. I now turn to each of these factors in more detail.

In some very long run, if all other things were equal, one could argue that exchange rate movements should reflect differences in price movements between countries. This venerable theory of relative purchasing power parity (PPP) is still useful as a starting point for the analysis of expected exchange rates.[7] In a slightly different guise it turns up in discussions of competitiveness which is usually measured as the extent to which PPP is not achieved (although normally limited to the manufacturing sector). Even the earliest exponents of PPP recognized limitations to treating the exchange rate as being determined solely by PPP.[8] Of the qualifications they suggested, some focussed on the question of why actual exchange rates were not equal to equilibrium exchange rates whereas others dealt with factors that would affect the equilibrium rate itself. In the latter category the relevant ones for our purposes are continuing long-term capital movements and certain kinds of real changes in the economy.

The change in the equilibrium or long-run expected exchange rate is thus hypothesized to be a function of expected differential price movements between Canada and the rest of the world (principally the United States) over the relevant period, the change in the perceived long-run level of long-term borrowings abroad by provinces, municipalities, and corporations and perceived permanent real changes in the economy that impinge on the exchange rate. Long-term borrowing is important in that an increase in the continuing inflow of long-term capital implies, in the long run, an increase in the Canadian current account deficit which is consistent with an appreciation of the Canadian dollar. There are two main elements in the category of real changes to the economy. First, and more important, is the shift in the relative price of resources of which Canada is a major producer. These movements can be proxied either by Canada's own terms of trade figures or by the ratio of world raw materials prices to manufactures prices. The increase in the prices of Canadian resource exports is roughly equivalent in its effects on the exchange rate to an increase in demand by foreigners for Canadian goods in that there is a new higher equilibrium value for the Canadian dollar that will result in the same current account balance as the old exchange rate. The second aspect of real economic movements that might affect the equilibrium value of the Canadian dollar is the relative cyclical position of Canada and its trading partners. If the cycles were synchronized then this factor would have little effect. Even if the cycles were unsynchronized, to the extent that participants in the exchange market could "see through" the cycle there would be no effect on the equilibrium exchange rate. However, since business cycles tend to last for a period that is probably longer than the horizon for "fundamental analysis" of most participants in the exchange market, and since it may be difficult to disentangle cyclical effects from other real effects there is probably some adjustment of the equilibrium exchange rate over the cycle.

An alternative interpretation of the effect of the relative cyclical position is as follows. In theory, expected exchange rates are a function of the expected relative price levels and not the actual price levels but it is the latter that are used in the equation. The cyclical term may be proxying for the expected price inflation in the near future and thus plays an important role in the formation of the market's expectations of future exchange rate movements. For example, given current relative price levels, larger slack in Canada than in the United States might signal that Canadian inflation will be slowing relative to U.S. inflation and hence will tend to strengthen the Canadian dollar. Note that the sign on the relative cyclical variable is thus the reverse of that predicted by the simple monetarist approach to the balance of payments in which lower income in Canada (more slack) leads to a depreciation of the Canadian dollar.[9]

In the context of the framework outlined thus far, one can integrate the role of the announcement of the trade balance and/or current account into the analysis. The change in the equilibrium expected exchange rate is a function of perceived permanent changes in the factors underlying international transactions, especially PPP, demand factors (such as the world price of raw materials), long-term borrowing, and perhaps the relative business cycle position. The role of the announcement of, say, trade numbers, is to provide another piece of information to the market as to whether their assessment of underlying shifts was correct. For example, suppose the prices of Canada's exports of raw materials had risen on world markets as a result of an increase in world demand for these commodities. The effect of such a shift on the equilibrium exchange rate will depend on (a) the extent to which it is a relatively long-run change, (b) the effect of the change on the Canadian current account if the exchange rate remained unchanged, (c) the required shift of the exchange rate to wipe out the increase in the current account.[10] Even if the market were able to assess all these factors correctly, the Canadian dollar would temporarily appreciate to a position above the new equilibrium since there would be a transitory current account surplus because of the lags in adjustment to exchange rate changes. As the current account moved back to zero, the Canadian dollar would depreciate to its long run equilibrium, thereby yielding a capital gain to the short term speculators. To the extent that current account announcements are consistent with the expectations of the market, i.e. are anticipated, there will be no effect on the exchange rate. Indeed in the scenario outlined, there will be a declining although positive current account balance associated with a depreciating Canadian dollar. However, any trade numbers that are not consistent with expectations raise questions about whether the initial assessment was in error (any of items (a) to (c) above) or whether another shock had occurred that had not yet been perceived (e.g. a permanent shift in demand by Canadians for foreign goods). Given the errors in the statistics and given the randomness of any single month's numbers, a single unexpected data point is not likely to have very much effect on expectations (i.e. there is a high noise-to-signal ratio) whereas a series of such data points would undoubtedly bring about a revision in views.

Thus announcements about unanticipated changes in underlying factors (e.g. prices, discovery of exportable minerals, increase in gross borrowing requirements of provincial governments) can have a direct effect on expectations whereas announcements of outcomes (e.g. trade balances, basic balance) that are unanticipated have an indirect effect by requiring a re-examination of the market's assessment of the underlying factors. The way we introduce this element into the exchange rate determination equation is to enter the difference between the actual (announced) current account balance and that predicted by a simple equation. The latter explains the current account position by a distributed lag on competitiveness or the reciprocal of the real exchange rate (i.e. relative price levels deflated by the exchange rate), the terms of trade, and the relative cyclical position.

Turning to interest rate effects on the exchange rate, we can use theory to shed some light on the size of the coefficient of the interest rate differential term. Since we have treated PFXE thus far as the expected equilibrium exchange rate (based on the available information), the actual value of PFX will differ from PFXE by an amount that depends on the magnitude of the interest rate differential and the length of time the differential is expected to persist.11

Empirically it is very difficult to get a proxy for this latter consideration, and I therefore follow the usual practice and simply use the three-month interest rate differential. Note that one expects a coefficient of 0.25 times the average number of quarters the differential is expected to last as the appropriate coefficient on this variable.

3. EMPIRICAL RESULTS

The exchange rate equation discussed above can thus be written:

PFX = B0 + B1 * PPP(-1)

+ B2*BORR(-1) + B3*TOT(-1) + B4*CYC(-1)

+ B5*RESID(-1) + B6*ULS(-1) + B7*(FXO-UBAL/PFX)

+ B8*(R90-R90US) + B9*PFX(-1)

where PFX is the spot rate

PPP is the purchasing power parity variable

BORR is the long-term borrowing variable

TOT is the terms of trade variable

CYC is the cyclical variable

RESID is the residual from the current account equation

R90-R90US is the 90-day interest rate differential (Canadian finance paper minus U.S. commercial paper)

In the preferred equation we define the explanatory variables as follows:

PPP = PGNE/PGNEUS (scaled to equal unity in 1971Q1) where PGNE and PGNEUS and the GNP deflators.

BORR = NLTCF/YGNE where NLTCF equals the net long-term capital flows into Canada and YGNE is nominal GNP.

TOT = PX/PM (ratio of export to import prices)

CYC = RU-RUUS (Canadian minus U.S. unemployment rates)

We also tried other measures of prices as well as wage rates for PPP, the relative price of resources to manufactures for TOT, output gaps for CYC, and a number of other borrowing measures for BORR. Also, for reasons given in footnote 9, we introduced a measure of potential output into the equation.

The current account equation used to generate RESID is as follows:[12]

$$XBAL\$ = C0 + \sum_{0}^{7} C1i*(PPP/PFX)_{-i} + C2*TOT + C3*CYC$$

Here XBAL$ is determined by an eight quarter second-order Almon polynomial distributed lag on the competitiveness term and is also a function of current terms of trade and a cyclical variable. The latter are all defined in the same way as for the exchange rate equation. TOT is sometimes defined in terms of the ratio of the price of merchandise exports to that of merchandise imports and sometimes in terms of the prices of goods and services exports and imports. In some equations XBAL$ is scaled by YGNE. A variety of external balances were tried as the dependent variable.

The incorporation of the lagged dependent variable in the PFX equation appears at first glance to be inconsistent with the rational expectations approach taken thus far. This need not be the case, however. As I have argued elsewhere,[13] it is often difficult for the market to determine what it is that changes in variables are signalling. For example, increases in interest rates might reflect a temporary change in the level of the money supply, a permanent change in the level of the money supply, or a permanent change in the rate of growth of the money supply. Each of these would have a different effect on the time path of PFXE. Initially the market might not be sure which type of shock has occurred. As time passes, however, the market receives more information or is able to interpret the information received with greater assurance. Hence there may be delayed responses to changes as the nature of the change becomes more apparent to the market. A similar story could be told, for example, about terms of trade increases. At the time of the increase, it may not be possible to be certain whether it is temporary or permanent. If the increase does not reverse over time, the likelihood increases that it is a permanent change and hence the market will have a delayed response to the initial change.[14]

A less rational interpretation of the lagged dependent variable would focus on the elasticity of expectations of PFXE with respect to PFX. There might be an adaptive response of PFXE to PFX if beliefs about the future spot rate are not held with any strong conviction and are therefore easily revised in the light of spot rate developments.[15]

I begin with the results of the XBAL$ equation and go on to the PFX equation. In the next section I compare the coefficients across the two equations.

In Table 1 I present the results of a variety of XBAL$ equations. The number shown under COMP is the sum of the coefficients of the distributed lag on COMP. The t-statistics are shown in parentheses and that on COMP is the t-statistic of the sum of the coefficients. Since XBAL$ is measured at annual rates, coefficients are interpreted as the effect of a change in the exogenous variable on the current account balance at annual rates. Consider equation (1). Here COMP is based on the GNP deflator, TOT on the ratio of goods and services export price deflator to import price deflator, and CYC on the difference in unemployment rates. A 10% increase in the exchange rate (holding PGNE constant) will result in an improvement in the current account balance after 8 quarters of $3870 billion at annual rates (-42571(1/1.1 - 1)). To the extent that the change in the exchange rate results in an increase in PGNE the improvement in the current account will be lessened. There is no J-curve response in this equation although there are perverse movements in the first quarter in some of the other equations. An improvement of 10% in the terms of trade results in an increase in the current account surplus of $1483 million at annual rates. An attempt to introduce a lagged response to changes in the terms of trade change was unsuccessful, suggesting that the main effect of the terms of trade change was via price rather than via slow volume response.[16] The cyclical variable indicates that an increase of one percentage point in the Canadian unemployment rate or a reduction of one percentage in the U.S. unemployment rate leads to an improvement of about $746 million in the current account at annual rates. A one percentage point increase in the unemployment rate is consistent with about a 2 percent decline in output (Okun's law) or about $2825 million at the midpoint of the sample period. This implies a marginal response of net imports to GNP of 746/2825 or 26.4%, or slightly higher than the 25.4% average trade share in 1973Q4. The results thus provide a plausible representation of the factors driving the current account deficit. Note that with competitiveness and the terms of trade equal to unity and the relative cyclical position equal to zero the current account deficit would equal $940 million at annual rates, according to the equation.

In equation (2) the CPI's in Canada and the United States were used in COMP and in equation (3) relative wages were inserted.[17] Neither variable performed nearly as well as the GNP deflator, so that the latter was used in all the rest of the equations. In equation (4) the terms of trade defined in terms of the prices of merchandise exports and imports (i.e. excluding services and transfers) was used instead of the broader terms of trade notions, and in equation (5) the ratio of the price of raw materials to the price of world manufactures was used. The former performed somewhat better than the broader terms of trade and the latter somewhat worse but the differences are not great.

In equation (6) the cyclical variable is defined as the difference between the Canadian output gap (real GNE divided by its potential) and

U.S. output gap. Potential in each case is measured by a constant rate of growth of output as predicted by a logarithmic regression of real output on time over the period 1953 to 1973. This equation gives the best results of all those that were tried but we used equation (4) to define RESID in the PFX equation because of our concern that the results in (6) are sensitive to the rather arbitrary measurement of potential. To capture the notion that rates of potential growth might affect the current account we added the ratio of Canadian to U.S. potential output to equation (6). In the resulting equation (which is not shown in the table), the ratio of potential outputs had a t-statistic of only 0.8 and had a positive sign indicating a rather weak positive connection between the rate of potential growth in Canada and the Canadian current account surplus.

Equations (7), (8), and (9) present equations for XBAL$ over the period 1971-77 and for XBAL$/GNP over the periods 1971-77 and 1960-77. Comparing equation (8) with equation (7) we find that the former has a smaller coefficient on competitiveness, a larger J-curve effect, a smaller terms-of-trade effect, and about the same size cyclical effect. Extending the sample period (equation (9)), one gets smaller competitiveness, a larger J-curve effect and much worse summary statistics. Equations run over only the earlier part of the period (1960I-1970IV) tend to have the wrong sign on the terms of trade term. In experiments with different length of lag structure, the eight-quarter lag performs best for both XBAL$ and XBAL$/GNP equations for the 1971-1977 period.

Similar equations work quite well for the balance on trade and services (i.e. excluding transfers). However, when the merchandise trade balance alone is used as the dependent variable there is a sharp deterioration in the equation and the competitiveness variable becomes much smaller and much less significant. Further research will be required to explain this rather surprising result.

In Table 2 I present the results of the PFX equations. Since, in the Haas-Alexander PFX equation the coefficient on ULS(-1) and that on FXO-UBAL/PFX were almost identical, and since the coefficients were not significantly different in our equation we went immediately to a specification with current ULS. Equation (1) presents the results of the regression using PGNE in the PPP variable, a moving average of total net new issues by provinces, municipalities and corporations scaled by GNE in BORR, the broader definition of the terms of trade in TOT, and the unemployment rate differential in CYC. Since the ULS term is wrong-signed in equation (1) we dropped it in equation (2) with little effect on the other coefficients. The equilibrium effects from equation (2) are presented in (2E) and I now turn to a discussion of this equation as an example of the type of results obtained from these equations.

In equilibrium the effect of a 1% change in PPP is a 1.53% change in the exchange rate. This result is above the theoretically desirable response of unity. The distributed lag is such that 78% of the adjustment is completed in one year after the perception of the relative price change. The equilibrium multiplier on the BORR term is 1.77. This means that a perceived permanent increase in the net total new issues of provinces, municipalities, and corporations (a proxy for their financial requirements) on the order of 1% of GNP will lead to an appreciation of 1.77 cents in the Canadian dollar. That is, in 1974 values, if these borrowers needed another $1.5 billion in funds, the market would respond by assuming tht some fraction of this would be raised in foreign-pay issues; the resulting appreciation of 1.77 cents is required to achieve the offsetting increase in the current account deficit.

The equilibrium coefficient on the terms of trade variable is 1.23. Thus a 1% change in the terms of trade will result in a 1.23 cent appreciation of the Canadian dollar. The equilibrium multiplier on the cyclical variable is 0.037. A one percentage point increase in the unemployment rate in Canada or a one percentage point decrease in the U.S. unemployment rate would lead to a 3.7 cent appreciation of the Canadian dollar in the long run. As mentioned above, there are two interpretations for this variable. The first relates to the effect of the cycle on the current account balance and the market's assumption that the cyclical movement is permanent or its inability to see into the future to a period when the cyclical position will be reversed. The second (and our preferred) interpretation relates to the cyclical position as an indicator of future relative price inflation in the two countries.[18] Thus an increase in Canadian slack leads the market to expect an improvement in the Canadian inflation performance in the future.

The equilibrium effect of a change in the residual is -2.08 E-5. Thus a residual of $100 million at annual rates in the current account, i.e. an outcome that is $100 million better than predicted, will lead to an immediate appreciation of 0.065 cents in the Canadian dollar. If the current account residual then returns to zero, this effect will wear off gradually. However, a continuing residual of $100 million (as a result of a structural change, for example) will result in an appreciation of 0.21 cent in the Canadian dollar. A one percentage point increase in the short term interest rate in Canada results in an 0.81 cent appreciation of the Canadian dollar on impact and a 2.6 cent appreciation in equilibrium if the differential is held indefinitely. The large response probably signifies that a change in interest rate is interpreted as reflecting a long-run change in monetary policy.

Equations (3) and (3E) show that the Hildreth-Lu transformation for first-order autocorrelation has little effect on the coefficients and equilibrium multipliers. In equation (4) the lagged dependent variable is dropped. As expected the coefficients change a great deal and the SEE rises substantially.

A variety of other measures of long-term borrowing were tried out but none changed the equation to any great extent. Among the variables used were: (1) actual long-term capital flows, (2) long-term capital flows scaled by GNE, (3) net direct investment and the rest of long-term flows, entered separately and scaled by GNP. Equation (5) and (5E) present the results with actual long-term capital flows scaled by GNE as the borrowing variable and the narrower definition of the terms of trade as TOT. The price variable moves much closer to unity and the coefficients on the other variables fall somewhat.[19]

To evaluate the ability of equation (5) to track the movements of PFX over the sample period, we simulated the equation dynamically beginning in 1971Q1. The results are presented in Figure 3. The RMSE of the dynamic simulation is .00372 compared to .00440 for the RMSE of the residuals of the regression equation, also uncorrected for degrees of freedom. That is, the RMSE from the dynamic simulation is 85% that of the one-step-ahead forecast.

When the relative gap was used instead of the unemployment rate differential, the results deteriorated. The ratio of Canadian to U.S. potential output did not enter significantly. The CPI performed less well than the GNE deflator for which it was substituted. Nor did the ratio of M1's perform well. However, the ratio of M2's did enter significantly as shown in equations (6) and (6E) where PPP is represented by the ratio of the Canadian M2 to the American M2. Note that the cyclical variable becomes insignificant in this equation and the equilibrium response to the relative money supplies is substantially less than unity.[20]

4. COMPARISON OF THE TWO EQUATIONS

One can draw some (admittedly speculative) conclusions by comparing the equilibrium multipliers in the equations for XBAL$ and PFX. Our interpretation of the PFX eqution rests on the view that a permanent change in long-term borrowing or in the terms of trade is translated by the market into an exchange rate movement that will result in the basic balance returning to equilibrium. Thus an increase of $1 billion in long-term borrowing abroad will result in an exchange rate appreciation that will eventually lead to a deterioration in the current account of $1 billion. Similarly an exogenous terms of trade improvement will result in an appreciation that will bring the current account back to balance. We have two measures of the size of appreciation needed to offset a given borrowing or terms of trade change - the actual changes needed as determined in the XBAL$ equation (4) and the market's perception as shown for example, in the PFX equation (5).[21]

According to the XBAL$ equation, an improvement of 1% in the terms of trade will result in an offsetting appreciation of 0.28 % to bring the current account back to balance. In the PFX equation a 1% improvement in the terms of trade leads to a 0.65 cent appreciation of the Canadian dollar. It is not surprising that the market overestimated the importance of terms of trade changes. A priori one would have expected that the increase in raw materials price would result in an increase in the current account surplus both through the increase in the price of existing exports and through the increase in the volumes of raw materials exported. The latter effect turned out, in fact, to be much less significant than anticipated and hence the actual effect of the terms of trade was less than anticipated.

The direct effect on the current account of a 1% increase in unemployment, if maintained permanently, could be offset by a 1.73% appreciation (XBAL$ equation). In equilibrium such a change in unemployment leads to a 3.2 cent appreciation according to the PFX equation. This result is consistent with our earlier argument tht it is not just the direct effect of the unemployment rate that is the cause of the appreciation but the indirect effect via future reductions in inflation rates also play a role in affecting the market's expectations.

A permanent increase of \$1000 million in long-term capital inflows can be offset by an appreciation of about 2.5% according to the XBAL\$ equation, leaving the basic balance unchanged in the long run. In the PFX equation an increase of \$1000 million (at annual rates) in net long-term capital inflows (using the average sample period value of the GNP to scale the borrowing) leads to an appreciation of 0.57 cents. This rather substantial difference can be explained in either of two ways. First, the market recognizes that current borrowing implies interest payments in the future and hence does not respond as positively as might be anticipated. Second, the noise-to-signal ratio in the borrowing series is very high and therefore less attention is paid to it than otherwise might be expected. Finally, an increase of \$100 million in the current account balance that cannot be explained by the variables in the XBAL\$ equation can be offset by an appreciation of 0.25% according to the XBAL\$ equation. The perceived appreciation needed is 0.14 cent according to the PFX equation.

5. THE EXCHANGE RATE REVISITED

In the light of the above analysis we return to the questions posed in Section 1 of this paper, in particular how to explain the fact that the Canadian dollar did not depreciate over the period 1972 to 1976 when a substantial increase of Canadian prices relative to U.S. prices had occurred during that time. As is apparent from the theoretical and empirical discussion, it is our contention that factors such as long-term borrowing, terms of trade movements, and interest rate movements have moved in such a way as to offset the PPP movements for the period until 1976. It is clear from Figure 2 that the PPP variable by itself would have resulted in a gradual depreciation from 1972 through 1976 with a temporary appreciation in the second half of 1974. The movement of the terms of trade variable would cause a tendency to a sharp appreciation from 1972 through the middle of 1974 followed by a tendency mainly towards depreciation. The borrowing variable begins to have a major effect starting in 1975 when the provinces, municipalities and corporations increased their total financial requirements and long-term capital inflows rose sharply. The relative interest rate movement implied a depreciation from 1972 through the middle of 1973 followed by a strong appreciation especially in 1975 and most of 1976 followed by a depreciation toward the end of 1976.

Using the regression equation, one can decompose the movements of PFX since 1971Q2 into elements attributable to each of the explanatory variables. Because of the presence of the lagged dependent variable, the techniques underlying the decomposition are somewhat complex and are relegated to an appendix. In Figures 4a to 4f, I show the separate effect on PFX of the movement of each of the explanatory variables since 1971 Q2. Because of the importance of the initial conditions in understanding the meaning of Figure 4, it is worth pointing out that two of the explanatory variables, RESID(-1) and R90-R90US took on very unusual values in 1971 II, namely $947 million and -1.38 percentage points. Thus, for example, the contribution of any given interest rate differential is relative to the initial value of -1.38.

Turning to the results in Figures 4a-4f, one can see that PPP alone would have resulted in a depreciation of over 13 cents by 1976Q3 The increase in borrowing requirements implied an appreciation of almost 2 cents by the end of the period, and the terms of trade variable an appreciation of over 7 cents. The effect of the relative cyclical position changed from a tendency to mild appreciation in 1973 to a tendency to a substantial depreciation in 1975-76. The interest rate differential was worth about a 12 cent appreciation by the end of the period when compared to the very low value it took in 1971Q2. The residual implied about a 2 cent depreciation compared to the very large value it took at the beginning of the period. Finally, the effect of the initial position of PFX and the initial residual (see appendix for an explanation) was only 0.6 cents. Together these factors add to the 3.5 cent appreciation between 1971Q2 and 1976Q3.

FOOTNOTES

1. The time period of analysis begins two quarters after the exchange rate is allowed to float and ends with the Quebec election of 1976Q4.

2. For recent surveys see R. Dornbusch, "Monetary Policy Under Exchange Rate Flexibility", Federal Reserve Bank of Boston Conference on Managed Exchange Rate Flexibility (forthcoming 1979), and J.F.O. Bilson, "The Current Experience with Floating Exchange Rates: An Appraisal of the Monetary Approach", American Economic Review (May 1978), pp. 392-97.

3. R.D. Haas and W.E. Alexander, "A Model of Exchange Rates and Capital Flows: The Canadian Floating Rate Experience", Journal of Money, Credit and Banking (forthcoming, 1979).

4. The choice of short-term capital as the focus for analysis implies that long-term capital is determined in a different manner. In the Bank of Canada model, RDX2, which uses the Haas-Alexander equation to determine the exchange rate, thirteen equations are used to explain long-term capital movements.

5. R. Dornbusch, "Discussion", American Economic Review (June 1978), pp. 412-15.

6. See for example, R. Dornbusch, "Expectations and Exchange Rate Dynamics", Journal of Political Economy (December 1976), pp. 1161-76.

7. Note that there are strong arguments for preferring GDP price deflators or measures of unit labour cost to CPI indexes when constructing PPP indexes. See L.H. Officer, "The Purchasing-Power-Parity Theory of Exchange Rates: A Review Article", IMF Staff Papers (March 1976), pp. 1-60.

8. See Officer, *op. cit.*, pp. 8-10.

9. If, as Dornbusch has suggested to me, there are reasons for expecting a depreciation over time in the equilibrium exchange rate because Canadian growth might be import-biased, one would want to include a term for potential output as well as a term for the relative cyclical position in both the PFX equation and the current account equations.

10. For simplicity we are abstracting from all the induced income effects, etc. that such a rise in export prices would bring about.

11. The following argument assumes that, on average, the differential is zero. To the extent that the average differential is a non-zero constant, the argument can be recast in terms of the difference between the actual differential and the long-run

average differential.

12. Ideally one should not run a regression for the entire sample period to generate residuals. Instead one should run a separate regression for each quarter using only the data available up to that period.

13. C. Freedman, "Comments on Berner et al", Federal Reserve Bank of Boston Conference on Managed Exchange Rate Flexibility (forthcoming, 1979).

14. Ideally, we would like to incorporate different lagged responses to different explanatory variables since, presumably, the noise-to-signal ratio of changes differs among different variables. Degrees of freedom considerations prevent us from doing this.

15. See, for example, R. Dornbusch, "What Have We Learned from the Float" (mimeo, February 24, 1973), especially pp. 9-10.

16. See C. Freedman, "The Implications of a Change in Resource Prices: A Simulation Exercise" (mimeo, Bank of Canada, January, 1978) for further discussion of the absence of supply responses.

17. Clearly unit labour costs are more appropriate than wage rates, but the latter were more easily accessible.

18. An alternative measure of the difference in expected price inflation in the two countries is the differential in long-term interest rates. When this variable is added to the equation it has the correct sign (positive) but is insignificant (t of 0.6) and its introduction leaves the other coefficients virtually unchanged. Similarly, when the differential in medium-term (five-year) interest rates is added to the equation it is completely insignificant (t of 0.3) and results in very little change to the rest of the equation. Compare the results in J.A. Frankel, "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials", Seminar Discussion Paper No. 89, University of Michigan, August 1978.

19. A variety of other changes were made to equation (5) of Table 2 to see how robust the results were to changes in estimation techniques. Applying the Hildreth-Lu technique results in only small changes to the coefficients. Given the problem of having a lagged dependent variable in an equation with residual autocorrelation, I used the instrumental variables technique with the instrument applied to the lagged dependent variable. This resulted in somewhat smaller equilibrium multipliers, especially on PPP, and the wrong sign for the coefficient of RESID. First differencing the entire equation also leads to a reduction in the size of the equilibrium multipliers although all the signs remain unchanged.

20. The standard monetarist equation in which the logarithm of the exchange rate is regressed on the logarithm of the ratio of money supplies, the logarithm of the ratio of real incomes, the interest rate differential, and the lagged dependent variable always gives a significant negative sign on the interest rate differential, contrary to the theoretical model posited by the monetarists. Neither income nor money is significant in any of the equations.

21. Note the inconsistency between the argument that the market's views can differ from the actual multipliers and the incorporation of residuals from the XBAL$ equation into the PFX equation which implies that the market knows the actual multipliers.

APPENDIX

THE CALCULATION OF CONTRIBUTIONS TO THE CHANGE IN THE DEPENDENT VARIABLE

Assume an estimated equation of the form:

$$(1) \quad Y(t) = a + b*X(t) + c*Z(t) + d*Y(t-1) + u(t)$$

In a dynamic simulation starting from t equals 1 we replace the right-hand-side lagged dependent variable by its simulated value after the first period.

$$(2) \quad \hat{Y}(t) = a + b*X(t) + c*Z(t) + d*\hat{Y}(t-1) \qquad t > 1$$

For the first period, one uses actual Y(0) on the right hand side. Now we wish to explain Y(t) - Y(0) by movements of the explanatory variables.

From (1) we have

$$(3) \quad Y(0) = a + b*X(0) + c*Z(0) + d*Y(-1) + u(0)$$

Subtracting (3) from (2) we have

$$(4) \quad \hat{Y}(t) - Y(0) = b*[X(t)-X(0)] + c*[Z(t)-Z(0)]$$
$$+ d*\hat{Y}(t-1) - d*Y(-1) - u(0)$$
$$= b*[X(t)-X(0)] * c*[Z(t)-Z(0)]$$
$$+ d*[\hat{Y}(t-1)-Y(0)] + d*[Y(0)-Y(-1)] - u(0)$$

Recursively substituting we get

$$(5)\quad \hat{Y}(t) - Y(0) = b*[\sum_{0}^{t-1} d^{i}(X(t-i) - X(0))]$$

$$+ c*[\sum_{0}^{t-1} d^{i}(Z(t-i) - Z(0))]$$

$$+ \sum_{0}^{t-1} d^{i}[d*(Y(0) - Y(-1)) - u(0)]$$

The first term on the right hand side is the contribution of the movement in X to the movement of Y; the second term is the contribution of the movement of Z. The third term can be interpreted as the divergence of Y from its equilibrium in period 0. To the extent that earlier movements in X or Z had not completed their effect on Y by time 0 and to the extent there was an estimation residual in period 0 these ha to be taken into accunt in explaining differences from Y(0).

To compute the actual contributions we define variables CONTX, CONTZ, and CONTINITIAL defined as follows:

CONTX(t) = b*(X(t) - X(0)) + d*CONTX(t-1)

CONTZ(t) = c*(Z(t) - Z(0)) + d*CONTZ(t-1)

CONTINITIAL(t) = d*(Y(0) - Y(-1)) - u(0) + d*CONTINITIAL(t-1)

The values of CONTX, CONTZ, and CONTINITIAL are set equal to zero in period 0 and simulations begin in period 1. By construction the sum of these contributions will equal $\hat{Y}(t) - Y(0)$ in all periods.

FIGURE I

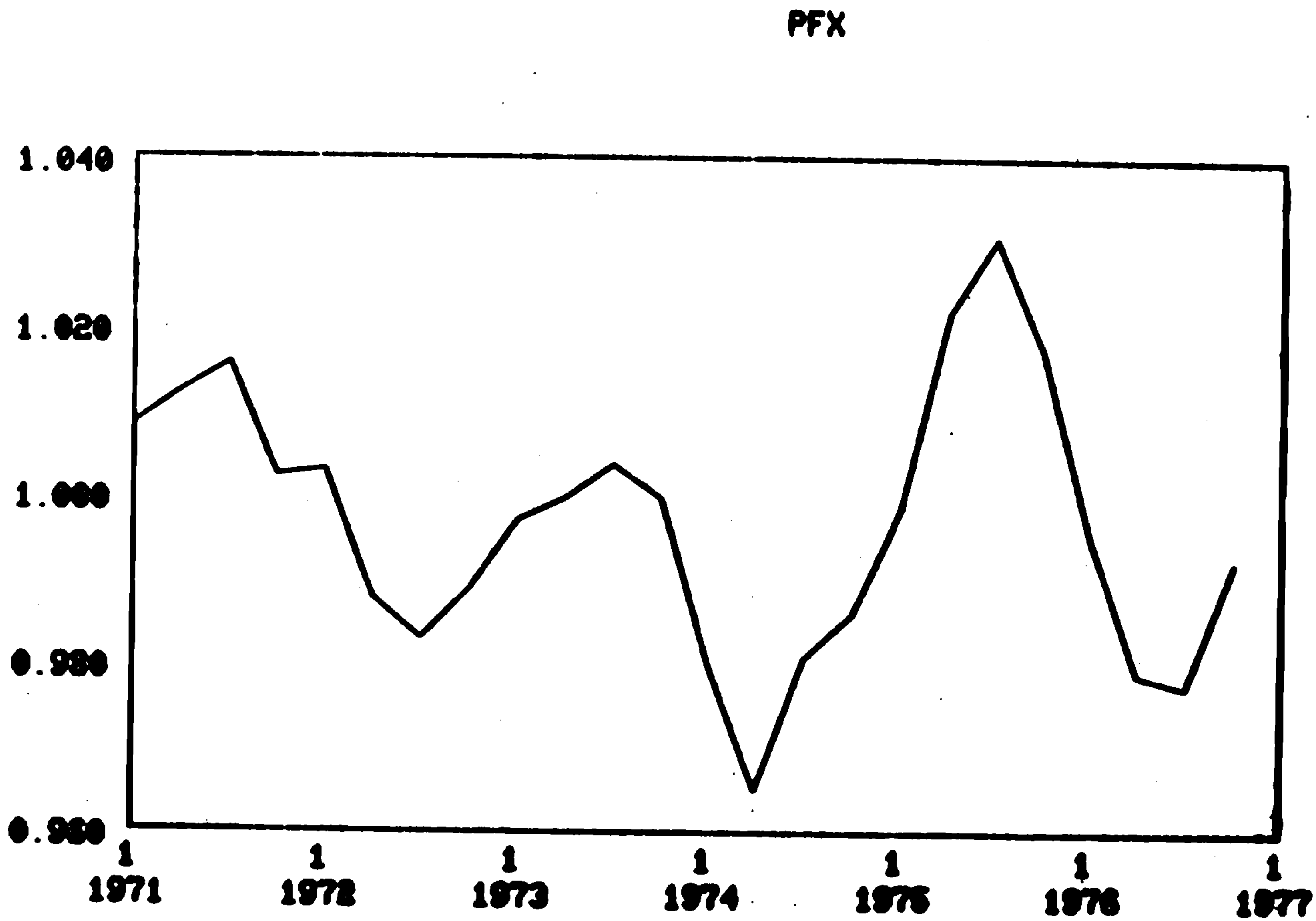
PFX
1.040
1.020
1.000
0.980
0.960
1
1971
1
1972
1
1973
1
1974
1
1975
1
1976
1
1977

FIGURE 2

PPP RATIO OF GNE PRICE DEFLATORS

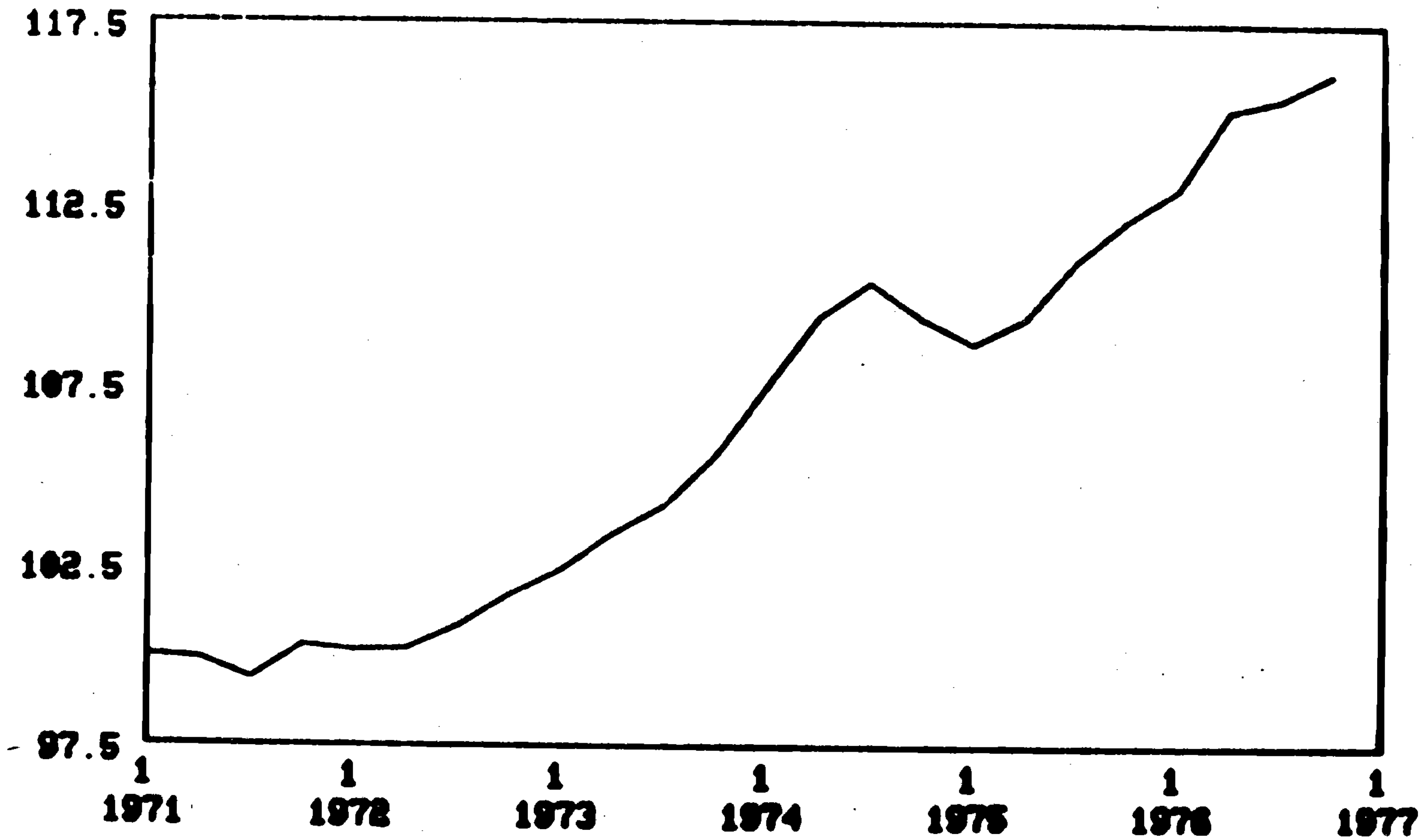

FIGURE 3

PFX ACTUAL VS SIMULATED

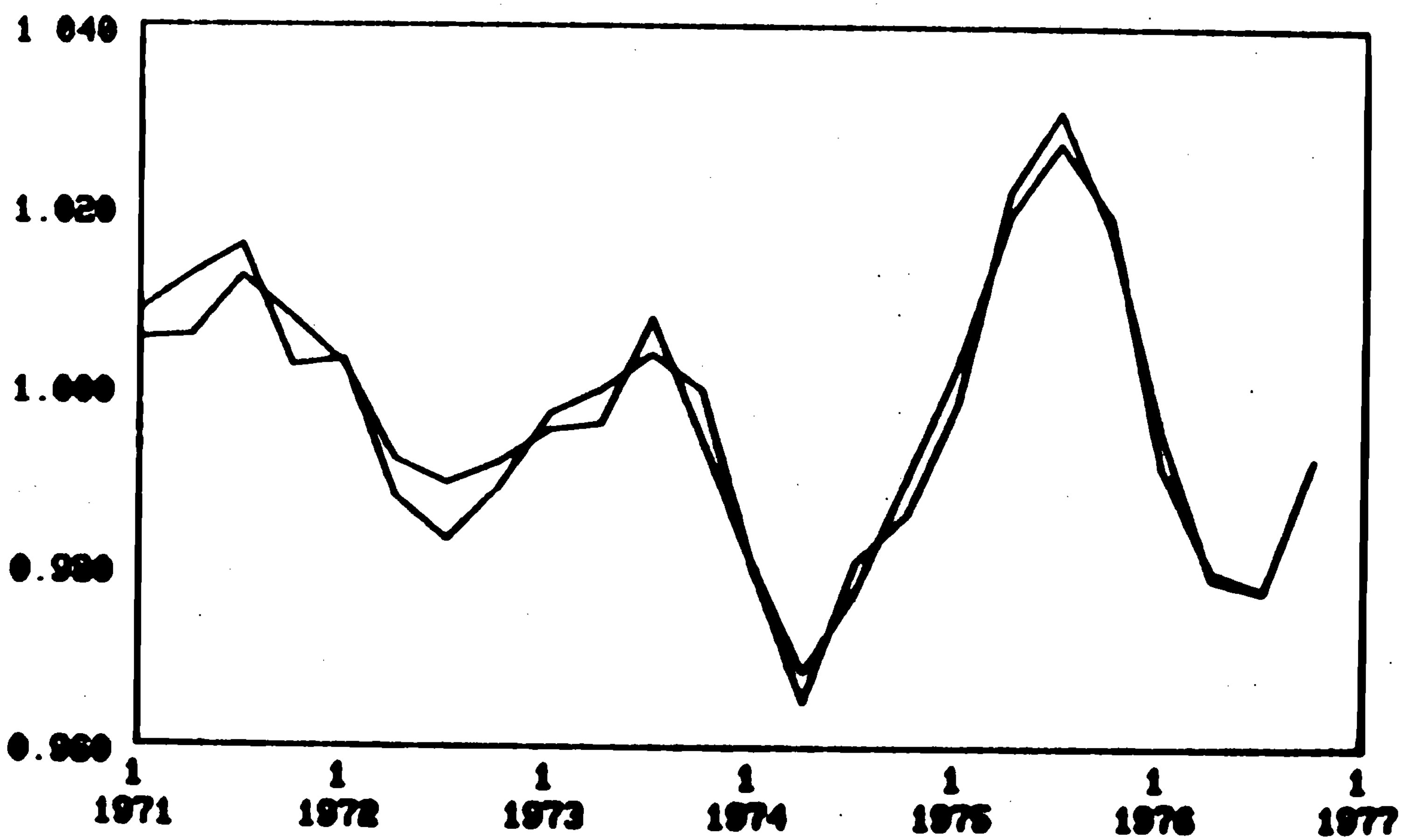

FIGURE 4a

CONTRIBUTION OF PPP

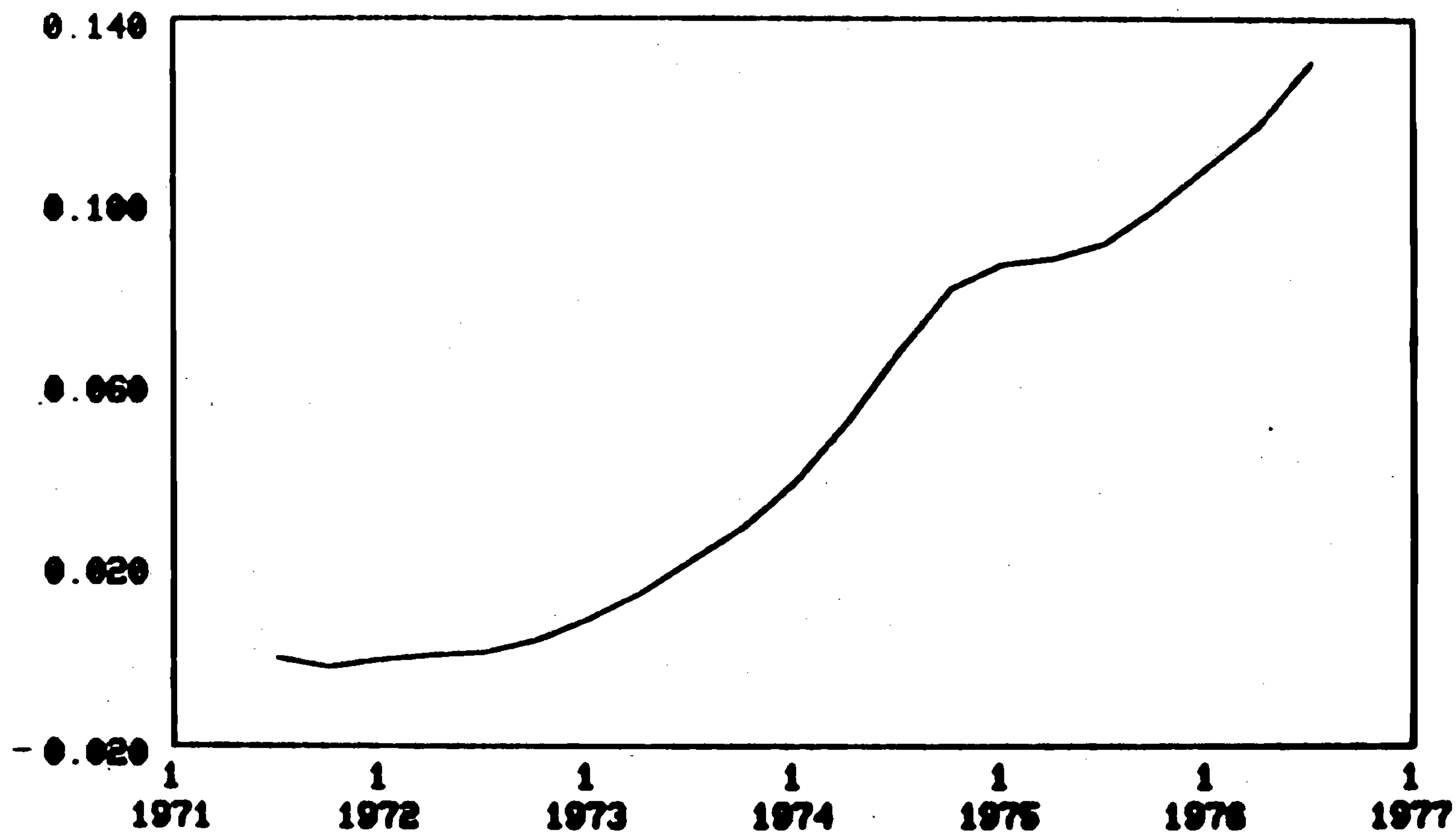

FIGURE 4b

CONTRIBUTION OF CAPITAL FLOWS

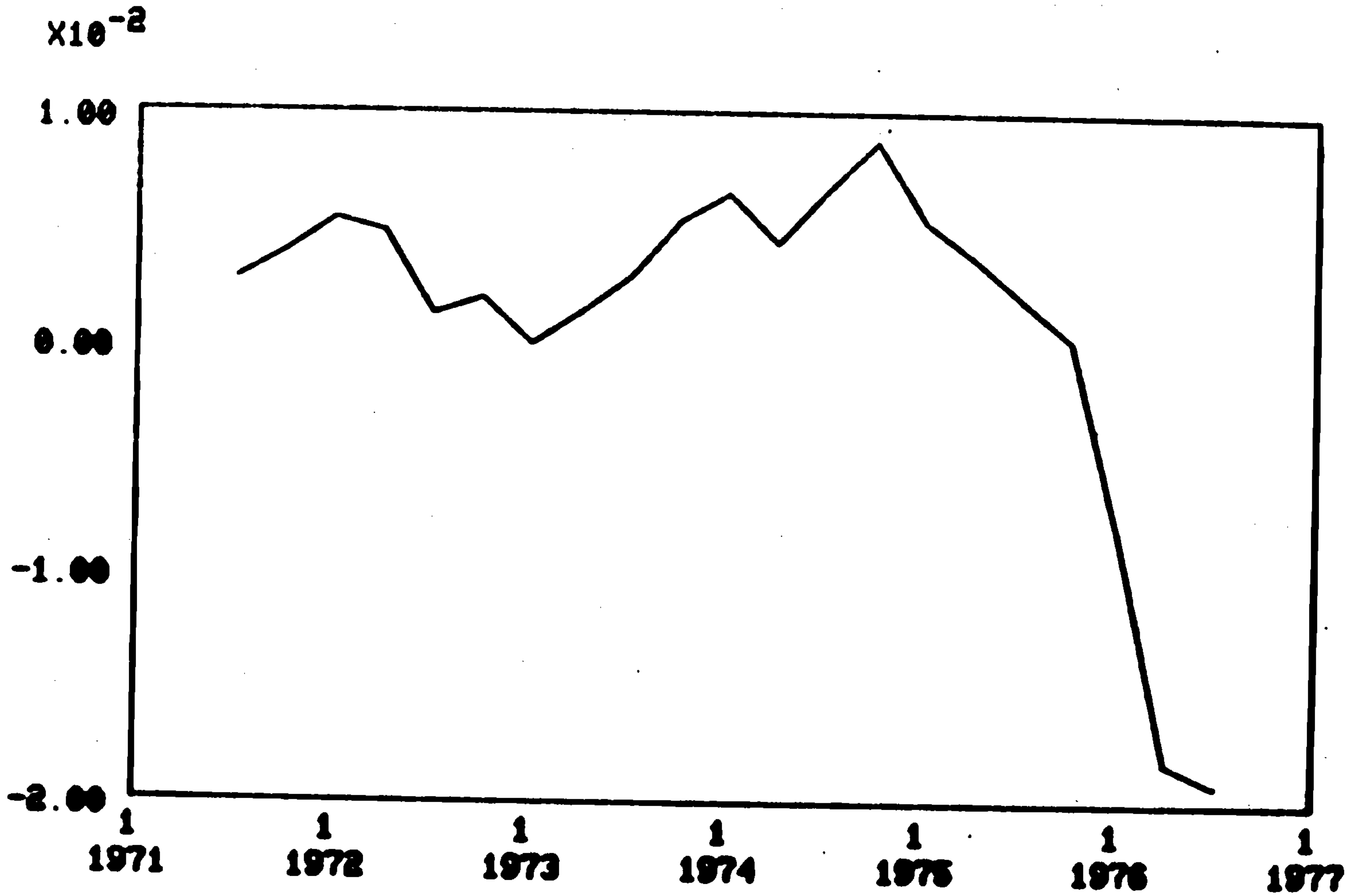

FIGURE 4c

CONTRIBUTION OF TERMS OF TRADE

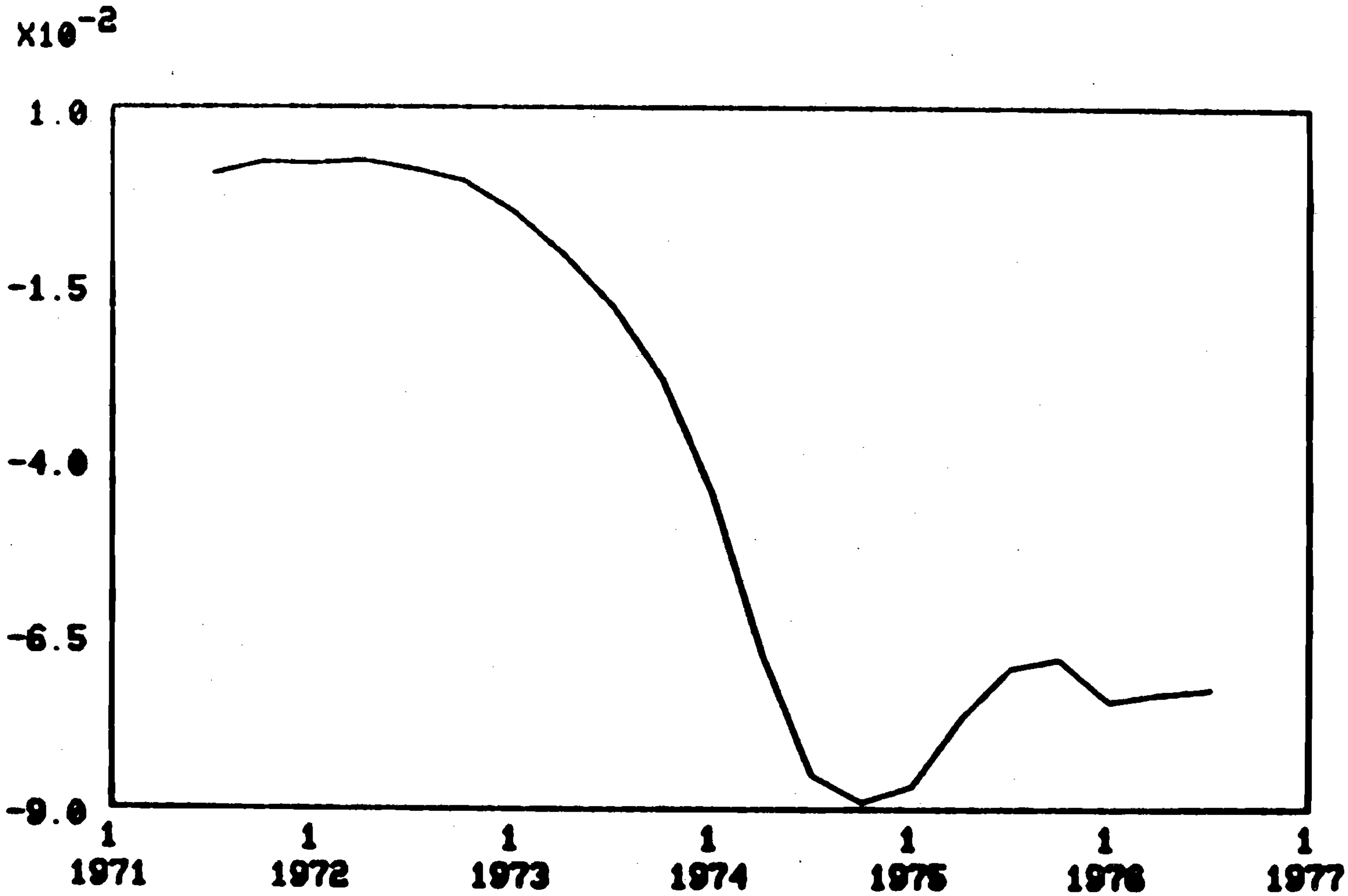

FIGURE 4d

CONTRIBUTION OF CYCLICAL VARIABLE

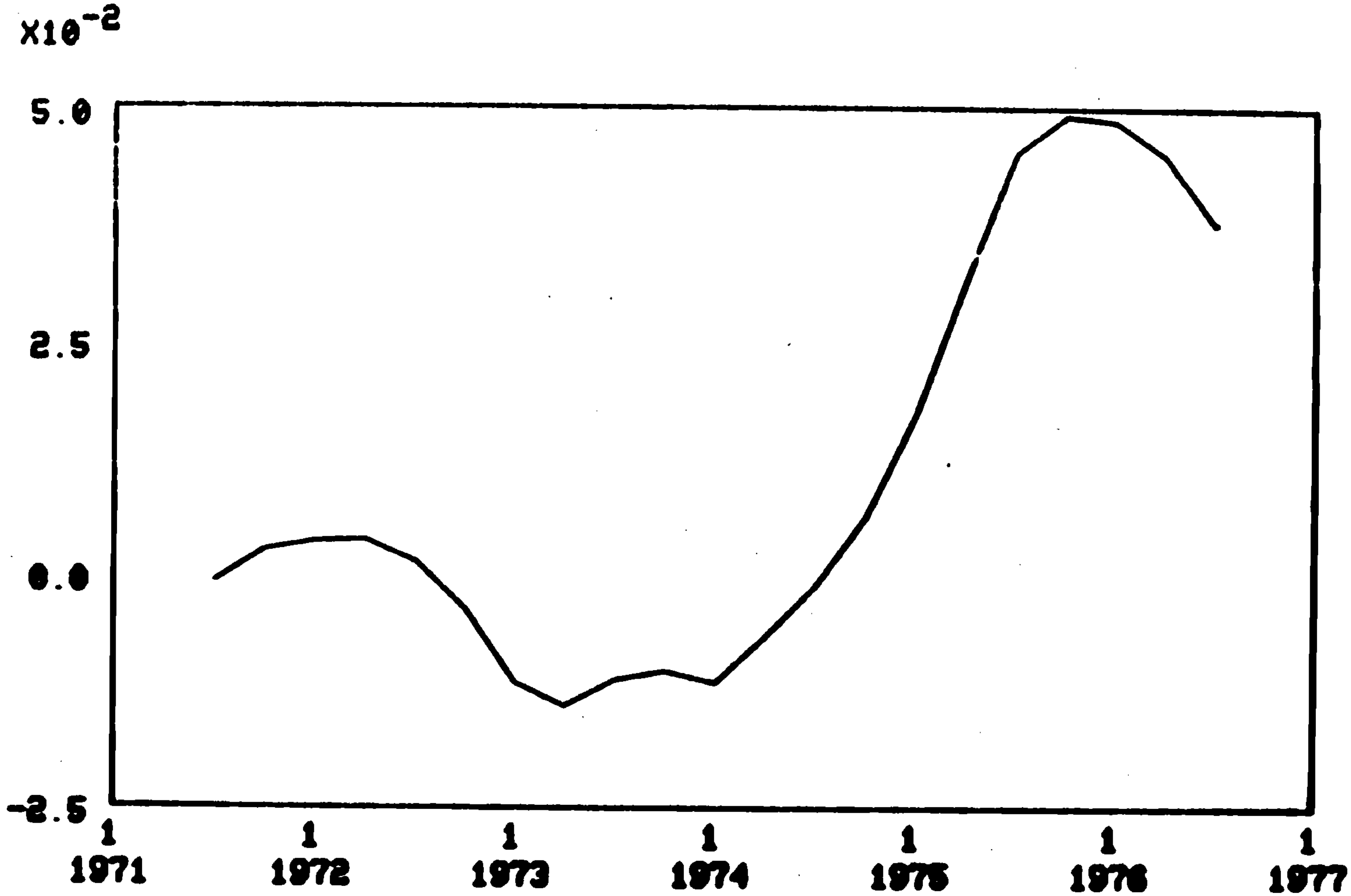

FIGURE 4e

CONTRIBUTION OF RESIDUALS FROM XBAL EQUATION

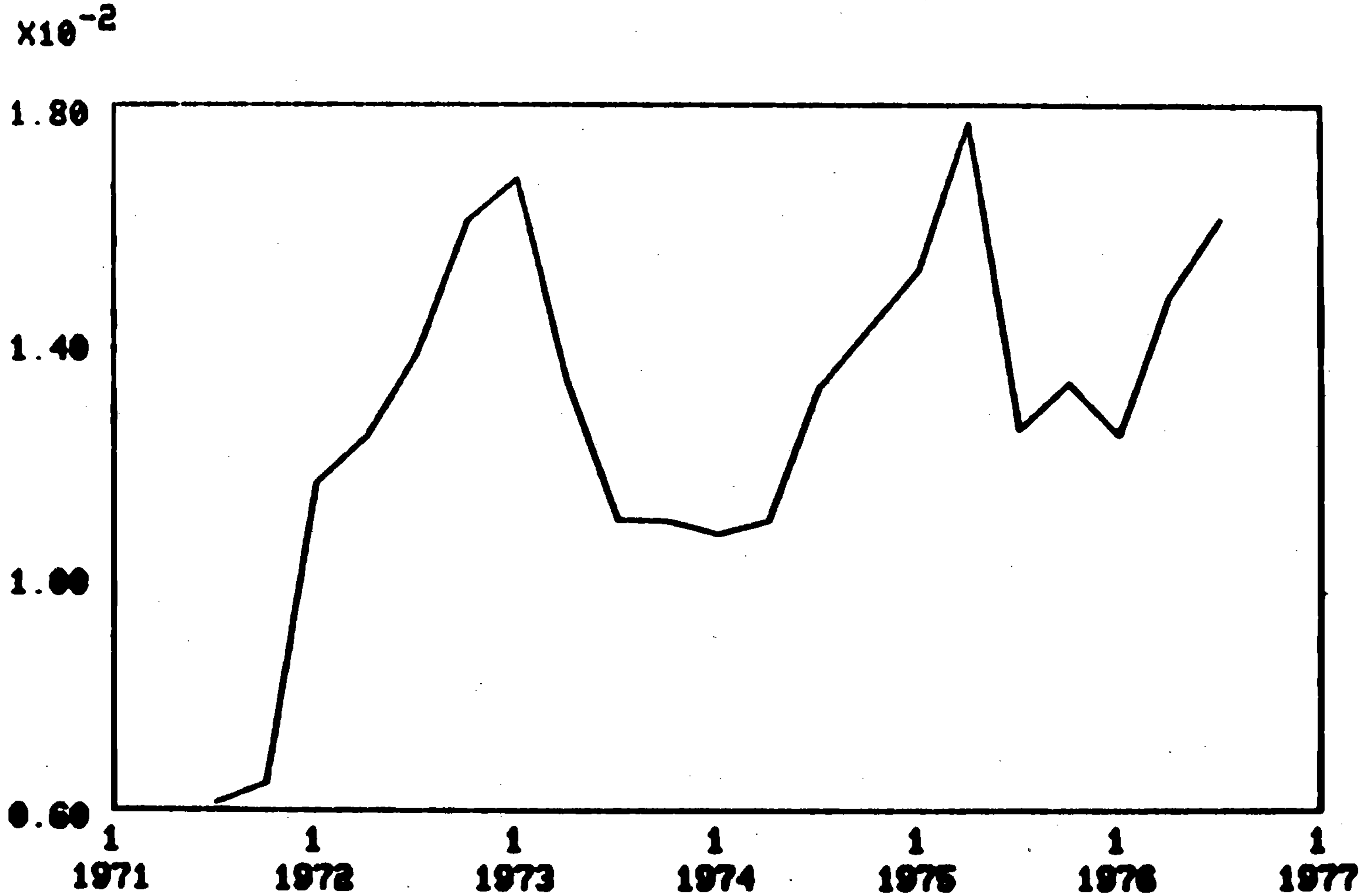

FIGURE 4f

CONTRIBUTION OF INTEREST RATE DIFFERENTIAL

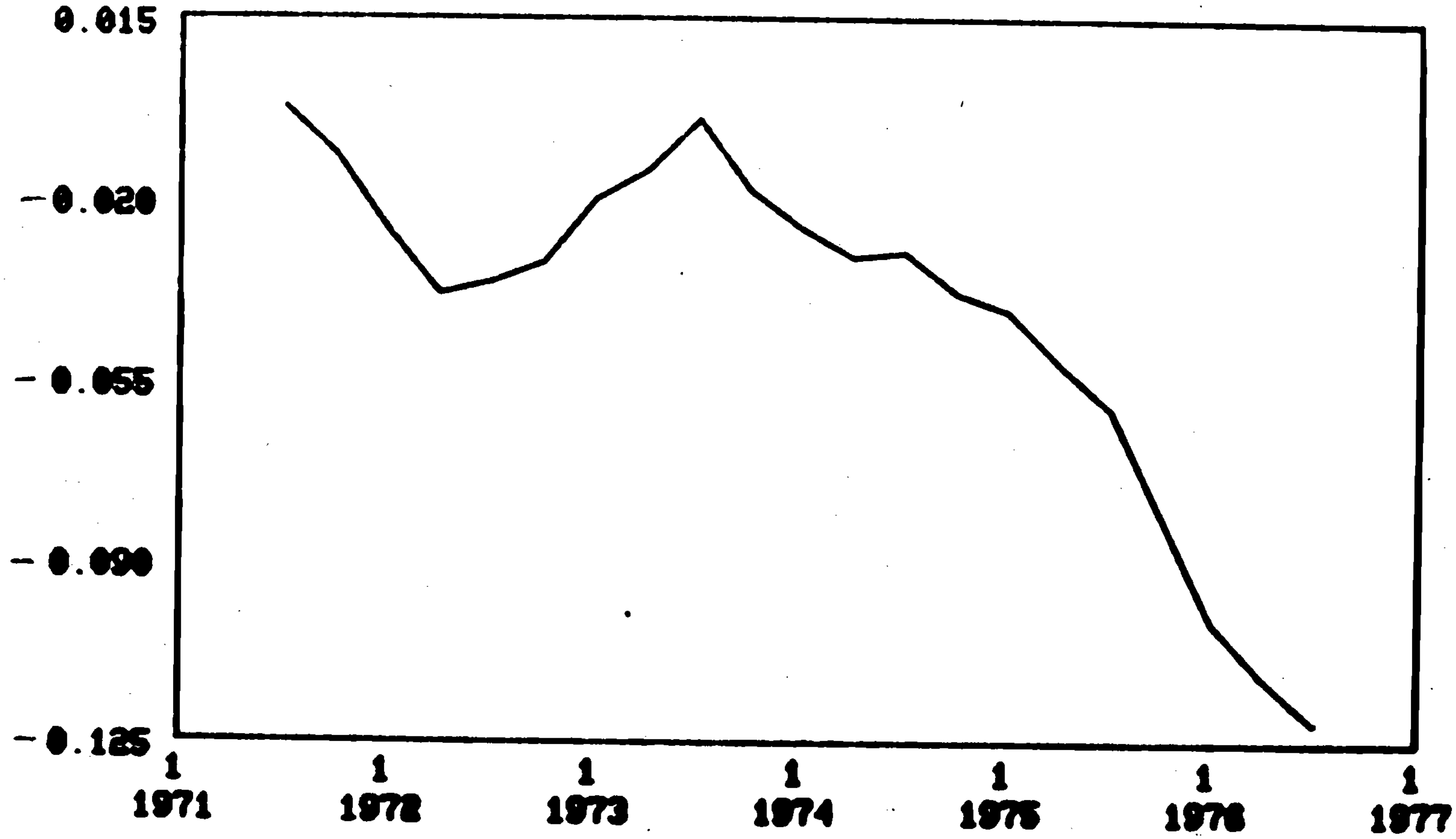

FIGURE 4g

TOTAL OF INDIVIDUAL CONTRIBUTIONS

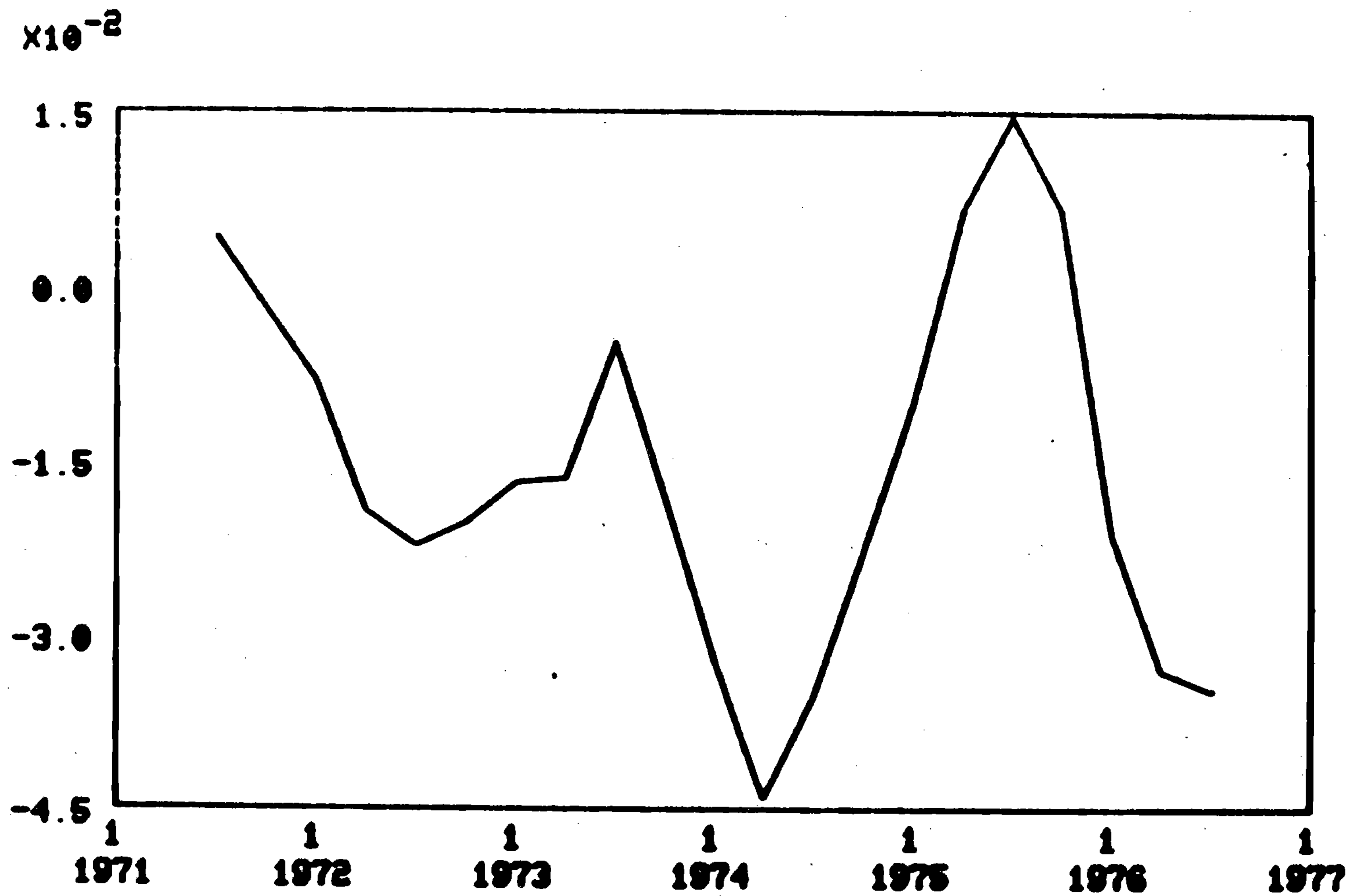

TABLE 1

CURRENT ACCOUNT EQUATIONS

	Dependent Variable	Period	C	COMP	TOT	CYC	RB2	DW	SEE
(1)	XBAL$	1971I-1976III	26,798 (5.9)	-42,571 (6.3)	14,833 (3.0)	746 (2.8)	.93	1.93	572
(2)	XBAL$	1971I-1976III	37,571 (3.7)	-51,913 (3.5)	13,422 (2.1)	2,076 (7.3)	.87	1.60	779
(3)	XBAL$	1971I-1976III	11,257 (3.3)	-23,771 (4.2)	11,141 (2.1)	1,633 (7.7)	.90	1.93	668
(4)	XBAL$	1971I-1976III	28,165 (6.4)	-40,506 (6.8)	11,404 (3.2)	699 (2.6)	.93	1.95	558
(5)	XBAL$	1971I-1976III	32,265 (6.4)	-35,251 (6.7)	2,615 (2.9)	554 (1.9)	.93	1.97	579
(6)	XBAL$	1971I-1976III	26,007 (7.2)	-42,444 (10.2)	16,431 (5.5)	-32,004 (4.1)	.95	2.11	474
(7)	XBAL$	1971I-1977IV	23,906 (8.9)	-33,620 ( )	8,765 (2.6)	922 (6.3)	.92	1.95	618.9
(8)	XBAL$/GNP	1971I-1977IV	0.127 (5.5)	-.1693 ( )	0.0366 (1.3)	0.0067 (5.3)	.83	1.42	0.0053
(9)	XBAL$/GNP	1960I-1977IV	0.068 (2.4)	-.1093 ( )	0.0338 (0.8)	0.0073 (5.2)	.50	0.66	0.0090

TABLE 2

PFX EQUATIONS

	C	PPP(-1)	BORR(-1)	TOT(-1)	CYC(-1)	RESID(-1)	R90-R90US	ULS	PFX(-1)	U(-1)	RB2	DW	$SEEx10^2$
(1)	.264 (1.4)	.403 (2.2)	-.573 (2.0)	-.349 (2.9)	-.015 (2.5)	-7.178 E-6 (2.0)	-.0081 (4.5)	-2.57 E-6 (0.6)	.706 (4.9)		.883	2.72	.555
(2)	.248 (1.4)	.482 (3.7)	-.557 (2.0)	-.386 (3.8)	-.012 (4.5)	-6.543 E-6 (2.0)	-.0081 (4.6)		.685 (5.0)		.887	2.76	.543
(2E)	.787	1.532	-1.771	-1.227	-.037	-2.080 E-5	-.026						
(3)	.206 (1.4)	.451 (4.5)	-.406 (1.8)	-.347 (4.4)	-.012 (6.4)	-6.128 E-6 (1.8)	-.0093 (6.6)		.711 (6.2)	-.504	.954	2.56	.483
(3E)	.714	1.563	-1.407	-1.202	-.042	-2.123 E-5	-.032						
(4)	1.124 (15.9)	.383 (1.9)	-.587 (1.3)	-.468 (2.9)	-.019 (5.4)	-4.590 E-6 (1.1)	-.0049 (1.9)				.715	1.93	.864
(5)	.210 (1.2)	.350 (3.7)	-.271 (2.1)	-.220 (4.1)	-.011 (4.1)	-4.649 E-6 (1.4)	-.0088 (5.4)		.662 (4.8)		.887	2.76	.545
(5E)	.622	1.035	-.801	-.651	-.032	-1.375 E-5	-.026						
(6)	.521 (2.7)	.251 (3.1)	-.551 (1.7)	-.346 (3.2)	-.003 (0.7)	-3.193 E-6 (0.9)	-.0070 (3.6)		.601 (4.1)		.867	2.40	.590
(6E)	1.305	.629	-1.380	-.867	-.008	-8.00 E-6	-.018						