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I

INTRODUCTION

It is a commonplace that, when it comes to the interpretation of economic history or the discussion of practical economic policy, the data do not speak for themselves. They must be organised in terms of some sort of theoretical structure. All too often that structure is an informal one, rather than being an explicit model, but there is nevertheless much to be said for discussing practical matters in terms of a fully articulated model. If policy debates are cast in such terms, it becomes much easier to recognise the extent to which differences of opinion arise from ideological considerations on the one hand, and from disagreements about the logic of economic theory or about simple matters of fact on the other.

There already exist many formal econometric models that can be used in such discussions, but these models are typically large and cumbersome. Their mechanics are extremely difficult to understand, even for those who are actively engaged in building and maintaining them, let alone for anyone else. There is frequently a "small model" underlying such large models. We often hear one block of equations being referred to as "The IS block", and another as "The LM block", when attempts are made ot describe such large scale systems, but we seldom come across attempts to formulate and test explicitly the small model whose existence is implicit in such a description. However, over the last seven or eight years, one of us has been involved in a number of attempts to construct macroeconomic models that are both small scale enough to be readily comprehensible, and

sufficiently relevant empirically to withstand econometric testing. (See e.g., Laidler (1973), Laidler and O'Shea (1980), Laidler and Bentley (1981).)

It goes without saying that a small scale model can deal only with a few phenomena. The models under discussion here have focussed on what one might reasonably refer to the central issues of short run macroeconomics. They have dealt with the interaction of inflation and output (and therefore, indirectly, unemployment), as well as with the influence of the quantity of money and various fiscal variables on these policy targets. Some of the work in question has dealt only with these factors, and hence data drawn from the relatively "closed" United States economy have been used in empirical tests. (Laidler (1973), Laidler and Bentley (1981).)

It is by now well established that closed economy macroeconomics, no matter how relevant it might be (or perhaps might have been before the end of the Bretton-Woods System) to the United States, must be applied with the greatest care to more open economies. At the very least the exchange rate and the balance of payments are variables of key importance in any open economy. The model developed by Laidler and O'Shea (1980), dealing as it does with the United Kingdom, recognises this fact and pays particular attention to these variables while still dealing with interactions among output, prices, and monetary and fiscal policy variables. Spinelli (1980) has shown that the very same structure seems to fit Italian data rather well, with only minimal modification, and in this paper we deal with yet a third attempt to confront the framework in question with empirical evidence. In the pages that

follow we shall give an account of our attempts to test it against data from Canada.

This application to Canadian data is interesting for a number of reasons. First, it represents an attempt of a type not too often encountered in applied economics at replicating an empirical experiment. A model that purports to show how monetary and fiscal policy influence real income and prices in an open economy, originally developed using United Kingdom data, is confronted with evidence that did not influence its initial construction. Thus, as with Spinelli's work applying the model to Italy, so here we have something akin to a true test of the model in question. Second, and perhaps more important, the U.K. and Italian data against which the model has earlier been tested are drawn from fixed exchange rate periods. In both of these cases, it turned out to be impossible to use the model to deal with data drawn from the 1970s, when the world economy was operating a system of flexible exchange rates and when the international monetary system was in much turmoil. Canada operated a flexible exchange rate during the period 1954-1962, at a time when the world economy was relatively tranquil. Thus Canadian data present us with the opportunity to discover the extent to which it was the existence of exchange rate flexibility per se that undermined the model in the cases of the U.K. and Italy in the 1970s and how much it was the general state of upheaval in the world economy that accounted for the difficulties in question.

As we shall see, it does turn out to be necessary to modify the model to get it to perform well in the face of Canadian data, even for the 1950s and 1960s, thus confirming that the nature of the exchange

rate regime is an important matter in determining the way in which monetary and fiscal policy interact with prices and output in an open economy. We shall also see that further problems arise when attempts are made to model the early 1970s in the case of Canada, even after the model has apparently been adapted successfully to deal with exchange rate flexibility per se although these extra problems are relatively minor. Thus our results suggest that the simple adoption of exchange rate flexibility is the main source of our difficulty (and everyone else's) in dealing with data generated by the United Kingdom and Italy in the 1970s. Further comments on this conclusion will be more readily comprehensible when the model and the results of testing it have been presented, and it is to this task that we now turn.

II

THE BASIC MODEL

Detailed descriptions of the basic framework that generated the results to be presented below, and of its analytic properties, are already available in Laidler and O'Shea (1980) and Spinelli (1980) and there is no need to repeat all the relevant analysis here. Nevertheless it will be convenient if we first of all set out the model as it was used in those two papers. The reader may then make up his own mind about how basic are the modifications which we have made to it in order to deal with data generated under a flexible exchange rate regime.

The basic model is in the tradition of open economy monetarism and was designed to cope with data generated under fixed exchange rates. Thus the interaction of the balance of payments with the supply and demand for money, and the interaction of actual and expected inflation rates with fluctuations in real income, are its key ingredients. The model is log. linear in form, and may be set out as follows.

$$y = \alpha_1(m_s - m_d)_{-1} + \alpha_2(\pi + e + a - p)_{-1} + \alpha_3 t_{-1} + \alpha_4 g \qquad (1)$$

$$\Delta r = \gamma_1(m_s - m_d)_{-1} + \gamma_2(\pi + e + a - p)_{-1} \qquad (2)$$

$$m_d = \delta_o + \delta_1 y^* + p \qquad (3)$$

$$\Delta p = \beta y_{-1} + (p^e - p)_{-1} \qquad (4)$$

$$(p^e - p) = \varepsilon_1 \Delta\pi + \varepsilon_2(\pi + e + a - p) \qquad (5)$$

$$\Delta m_s = (1 - \mu)\Delta c + \mu\Delta r \qquad (6)$$

$$y^* = \Theta_o + \theta_1 \tau \qquad (7)$$

The variables used above are all, with the exception of τ (time) logarithms, and are defined as follows: y the transitory component of the log. of real income; m_s the log. of the nominal money supply; m_d the log. of the long-run quantity of nominal money demanded; π the log. of the price level ruling in the world economy; e the log. of exchange rate or price of foreign currency; p the log. of the domestic price level; p^e the value that the log. of the domestic price level is expected to take next period; t the deviation of the log. of the economy's average tax rate from trend; g the deviation of the log. of government expenditure

from trend; r the log. stock of foreign exchange reserves; y* the permanent component of the log. of income; $\not{c}$ the log. of domestic credit extended by the consolidated banking system; and a a constant to be described below.

Equation (1) may be regarded as a reduced form of an income expenditure system that tells us that deviations of output from its "permanent" level (or "natural" level, the concepts are interchangeable in this model) depend upon the size of any difference between the supply of money on the one hand and the long run demand for money on the other, the deviation of domestic prices from some equilibrium value relative to world prices and the exchange rates (with units of measurement chosen so that the equilibrium value of that relative price term is zero) and the deviation of the tax rate and government expenditure from trend. In fact, equation (1) is a log. linear approximation to the following, more conventionally expressed, relationship, where capital letters are used to indicate the natural values of the relevant variables, with C being real consumption, I investment, and X net exports. The approximation in question is obtained by linearising the logarithmic form of the relationship about the steady state values of the logarithms of the variables following a procedure set out in Wymer (1976).

$$Y = (C + I + X) + G = k\left[\frac{M_s}{M_d}\cdot\alpha_1^1 \cdot \frac{\Pi}{P} E^{\alpha_2^1} \cdot T^{\alpha_3^1}\right]_{-1} Y^* + G \qquad (8)$$

The parameters of equation (1) bear the following relationships to those of equation (8) $\alpha_1 = k\alpha_1^1$, $\alpha_2 = k\alpha_2^1$, $\alpha_3 = k\alpha_3^1$, $\alpha_4 = 1 - k$.

It is worth noting two points explicitly here. First, to enter fiscal policy variables as deviations from trend, as we have done here, while making permanent, or steady state, income solely a function of time imposes long-run crowding out of fiscal policy on the behaviour of the model, while leaving short-run crowding out open as an empirical matter. Second, the relative price level term includes a constant "a": in our empirical work, prices and the exchange rate are measured as index numbers with a base of 1970=1 so their logs. are zero in that year, and the constant a is thus a measure of the proportion by which the home currency, in this case the Canadian dollar, was undervalued in 1970.

Equation (2) is an equation that determines the balance of official settlements concept of the balance of payments and makes it depend upon the excess supply of money, as well as upon relative price levels and the exchange rate. Equation (3) tells us that the long run demand for real money balances depends upon permanent income, and omits an opportunity cost argument. This last omission might disturb some readers, but the following points should be noted. First, and most important, because this is a model in which the economy is allowed to be "off" its long run demand for money function, to leave an interest rate out of this relationship does not, as it would in a conventional IS-LM framework, ensure that only money matters as far as the determination of real income and prices is concerned. Second, some preliminary work carried out using ordinary least squares on equation (1) suggests that to add an interest rate to the demand for money function makes no important difference to the results obtained for other parameters

of the system, a conclusion that receives further support from the work of Laidler and Bentley (1981) on United States data. Third, and of considerable importance, the omission of interest rates from the model enables us to keep the structure simple. Were such a variable included, the model would have to be extended in order to cope with its determination, and that would be no easy matter. Finally, in omitting the interest rate from our model, we do not imply that that variable is unimportant in the transmission mechanism of monetary policy. The model may be interpreted as ignoring interest rate variations, not because they do not matter, but because they are an intermediate step in that mechanism. Equation (4) is a conventional expectations augmented Phillips curve while equation (5) tells us that inflation expectations depend both upon the rate of inflation ruling in the world economy, and on the deviation of the domestic price level from its long-run equilibrium level. Equation (6) is a standard log. linear approximation to the money supply identity while equation (7) defines the permanent, or natural, component of the logarithm of income as being given by a simple time trend.

The only differences between the model set out above and that fitted already by Laidler and O'Shea, and Spinelli to U.K. and Italian data lie in some minor adjustments to equations (2) and (6) that were made to adapt the textbook money supply identity to the accounting conventions actually used in generating U.K. and Italian balance of payments data. The model was further modified in both studies in the following ways in the light of empirical results. In the case of the U.K. the parameter α_1 turned out to be zero, indicating that the only measurable effects of monetary policy in that country over the period

studied were on the balance of payments, while the parameter ε_1 was estimated so close to unity that it was constrained to take that value; in the case of Italy the role of relative price levels in the output equation turned out to be better determined if the term was entered unlagged, while the "catch up" parameter ε_2 in the inflation expectations equation turned out to be zero and ε_1 took a unit value as in the British case, indicating that the Italian price level had never deviated far enough from equilibrium vis-à-vis the rest of the world for a catch up effect to be measurable. This result contrasted with the U.K. case where the 1967 devaluation caused a major shock to this relationship whose subsequent influence on inflation was, statistically speaking, well determined.

Unlike the U.K. and Italy, Canada operated a flexible exchange rate regime for much of the period 1954-1970, and so the question must arise as to whether the framework set out here needs any modification in the light of this fact. This is, of course, an empirical question. The exchange rate appears on the right-hand side of three of our equations and there is nothing in the pure logic of our model to stop us treating it "as if" an exogenous variable for estimation purposes. Even so, it is one thing to say that it is logically possible to formulate the model in this way, but quite another to say that the procedure will yield sensible results, and as we shall see in a moment, it emphatically did not in this case. Before turning to this, and other, aspects of our empirical work, however, we must first of all say something about the data we have used.

III

THE DATA

The data from which our empirical results are derived are straightforward enough and are listed in Appendix A. The output variable upon which y and y* are based is real gross domestic product. The price variable is the consumer price index, chosen because it is the index most readily comparable with the data upon which our world price level variable is based. The latter variable is a GNP weighted geometric average of the consumer or retail price indices of sixteen other countries, while the exchange rate, defined as the domestic currency price of foreign currency, is a similarly weighted index of the individual exchange rates on the same sixteen countries. A considerable amount of effort was devoted at an early stage of our work to investigating whether or not the use of trade weights would make any difference to the outcome of experiments involving these "world economy" variables. In the case of Canada the choice between GNP and trade weights makes virtually no difference to the series, since with either set of weights United States' data dominate the index.

The government expenditure and tax variables which we use appertain to federal, provincial and local government activities. As with the output series, they represent deviations of the logs. of the variables in question from trends fitted by ordinary least squares to the original data. Care was taken to ensure that time patterns of these series were not heavily dependent on the choice of years over which the original trends were fitted. They do not seem to be, and in every case the

variables used in our study are deviations from a log. linear trend fitted to the period 1952-1975.

Our money supply series is for a "broad" M3 definition of money, and this choice was made for three reasons. First, and least important, broad money variables were used by Laidler and O'Shea in dealing with Britain and Spinelli in dealing with Italy, and there seemed to be some point in maintaining this practice to facilitate comparisons among the modelling exercises in question. Second, and crucially, as we have already noted, our model's demand for money function contains no opportunity cost variable. We believe that the demand for a broad definition of money, encompassing as it does many interest-bearing assets, is relatively insensitive to this omission, and preliminary experiments with ordinary least squares confirmed that the addition of an interest rate variable to the demand for money equation used in this model made an at best marginal improvement to its explanatory power. Laidler and Bentley (1981) have investigated this same question in the course of their work on the U.S. economy with a closed economy version of this type of model, and their results further confirm this conclusion. Third, ours is an open economy model that seeks to exploit the basic balance sheet identities of the banking system. It is easier to do this when a broad definition of money is utilized, given the way in which published data are put together.

As it is, it is precisely when we come to deal with these balance sheet identities that our data are less than straightforward. In the simple textbook open economy monetary model, an equation such as (2) determines the balance on official settlements concept of the balance

of payments, and this in turn is usually treated as identical with the change in the banking system's holdings of foreign exchange reserves. In the real world, a number of problems intrude to make matters more complex. First, official borrowing and lending overseas is an alternative to reserve movements as a means of financing payments inbalances, and second, the domestic currency value of foreign exchange reserves varies as a result of exchange rate changes.

Our solution to the accounting difficulties posed by these facts is essentially the same as that adopted by Jonson (1976) and followed by Laidler and O'Shea. Our "reserve" series is constructed by starting in a benchmark year and then adding to the value of reserves observed in that year the current Canadian dollar value of the balance of official settlements concept of the balance of payments observed in the next and each successive year. This practice ensures that the proportional change in reserves variable on the left-hand side of equation (2) is appropriately measured. The money supply identity, to which equation (6) is a log. linear approximation, is then preserved by subtracting our reserves variable from the money supply to generate a series for domestic credit. The latter variable is treated as exogenous in our model, and all changes in foreign exchange reserves arising from exchange rate changes that were at any time permitted to influence the money supply rather than the net worth of the banking system are hence included in it. They are thus treated as exogenous, as we believe they should be. The money stock, domestic credit, and reserves figures are end period statistics, as they should be, given the timing of the flow data in our model.

The only other variable used in our empirical work is the deviation of the logarithm of U.S. real GNP from trend. This variable was introduced into our work at a rather late stage, and its role is best discussed in the context of the relevant empirical results. Suffice it to say for the moment that this variable was generated in exactly the same way as the Canadian output and fiscal variables by fitting a log. linear trend to real GNP data for the period 1952-1975, and taking deviations from that trend.

IV

A TEST OF THE BASIC MODEL

We now turn to a discussion of the results generated by our attempts to fit the model described in Section II above, to annual data on the Canadian economy for the period 1954-1970. Implicit in the model's structure are a number of constraints on parameter values both within and across equations. Therefore, as in virtually all our empirical work, we used full information maximum likelihood techniques to fit the model as a whole, employing programs originally developed by Dr. Clifford Wymer.

The model as actually estimated is obtained by substituting equations (3) and (5) in the relevant places, and because equation (7) determining "permanent" income as a time trend was estimated first and the relevant variable entered as exogenously measured, consists of four equations.

These are:

$$y = (\alpha_1\delta_o + \alpha_2 a) + \alpha_1(m_s - p - \delta_1 y^*)_{-1} + \alpha_2(\pi + e - p)_{-1} + \alpha_3 t + \alpha_4 g \qquad (i)$$

$$\Delta r = (\gamma_1\delta_o + \gamma_2 a) + \gamma_1(m_s - p - \delta_1 y^*)_{-1}$$

$$+ \gamma_2(\pi + e - p)_{-1} \qquad \text{(ii)}$$

$$\Delta p. = \beta y_{-1} + \varepsilon_1\Delta\pi + \varepsilon_2(\pi + e - p) + \varepsilon_2 a \qquad \text{(iv)}$$

$$\Delta m_s = (1 - \mu)\Delta c + \mu\Delta r \qquad (6)$$

Table 1 presents the results of estimating this model (using annual Canadian data for the period 1954-1970). It presents a set of parameter estimates for the model with the figures in brackets underneath the parameters being asymptotic standard errors. These are the results obtained when the same form of the model as fitted by Laidler and O'Shea to United Kingdom data was used. That model, set out above, clearly does not perform in a satisfactory way, thus suggesting strongly that simply to treat Canada "as if" it were a fixed exchange rate economy that had a large number of "exogenous" exchange rate changes over the period in question will not do. Note in particular that the parameters of the demand for money function are nonsense, and that only the parameters α_2 and α_4 are of the correct sign at conventional levels of statistical significance as far as equation (1) is concerned. As to the Phillips Curve, the parameter ε_1, which ought not to be different from unity, clearly is, while the balance of payments equation fails completely. All in all, the attempt to replicate the results obtained by Laidler and O'Shea and Spinelli using Canadian data fails miserably.

TABLE 1

PARAMETER ESTIMATES BASED ON THE ORIGINAL MODEL
1954-1970

δ_o	14.445 (72.330)	β	0.162 (0.061)
δ_1	-3.450 (20.946)	ε_1	0.492 (0.120)
α_1	-0.023 (0.115)	ε_2	0.152 (0.044)
α_2	0.556 (0.141)	γ_1	0.022 (0.108)
α_3	-0.118 (0.075)	γ_2	-0.173 (0.559)
α_4	0.462 (0.129)	a	0.146 (0.026)
		μ	0.122 (0.009)

V

MODIFYING THE MODEL

This failure of our first attempt to replicate U.K. and Italian results using Canadian data is perhaps not all that surprising, because in estimating our model we have treated years of flexible and fixed exchange rates identically. That is to say the results presented in Table 1 are, among other things, based upon the hypothesis that the exchange rate regime makes no difference to the behavior of the economy, and this is a dubious hypothesis to say the least. As we shall now show, some rather simple modifications to the model, designed to account for the differences between fixed and flexible exchange rate regimes, lead to a remarkable improvement in its empirical performance.

We made two changes to the structure of the model in order to deal with the flexible exchange rate years. The first of these involved the hypothesis that, under a fixed exchange rate, inflation expectations are given by equation (5) but that under a flexible rate, they could usefully be modelled as depending solely on domestic factors. We took the lagged value of the domestic inflation rate as an appropriate variable to use here. According to the monetarist style analysis from which our model is derived, inflation in an open economy is determined abroad if the economy operates a fixed exchange rate, and

at home if it operates a flexible rate. This is a plausible, and indeed obvious, modification to make to our basic model. Thus equation (5) was modified to take the form

$$p^e - p = \varepsilon_1((1 - D)\Delta\pi + D\Delta p) + (1 - D)\varepsilon_2(\pi + e + a - p) \qquad (5')$$

where D is a dummy variable taking the value one when a flexible exchange rate regime was in place and zero when the exchange rate was fixed. We investigated this equation's properties by substituting it into equation (4) the Phillips curve, and estimating the resulting expression with ordinary least squares. This investigation confirmed that the formulation was not obviously inappropriate, that the parameter ε_1 was roughly equal to unity, and that the Phillips curve equation's performance was indeed improved by switching between expectations proxies as the exchange rate regime changed. As we shall note below, the first two of these three conclusions hold up well when the question is estimated as part of the complete system, while the third finds a certian amount of marginal support as well.

If the level of the exchange rate cannot be treated as an exogenous variable when rates are flexible, then at such times one's first inclination would be to treat it as the appropriate dependent variable for an equation such as (2). Unfortunately, though textbook models can and do take it that reserve changes are equal to zero when the exchange rate is flexible, the real world does not behave in that way. Here therefore we followed Girton and Roper (1977), in arguing that pressure on

the foreign exchange market can manifest itself both in reserve losses and exchange depreciation. They further argue that it is appropriate to define a variable called "exchange market pressure" (EMP) as the sum of the change in log. of reserves and the change in the log. of the exchange rate, and we used such a variable as the dependent variable of equation (2) for both fixed and flexible exchange rate periods, thus:

$$EMP \equiv \Delta r - \Delta e = \gamma_1(m_s - m_d)_{-1} + \gamma_2(\pi + e + a - p) \qquad (2')$$

Girton and Roper treat exchange market pressure as the simple sum of the percentage change in the exchange rate and the percentage change in reserves, but, because we could think of no compelling a priori reason why this should be the case in the context of our model, we experimented extensively with versions of our model which allowed exchange market pressure to be a weighted sum of the two variables, with the weights in question being estimated as part of the model. It turned out that the data seldom rejected the hypothesis of equal weights, and that the results for other parameters in the system were not affected in any important, or statistically significant, way by what we did here. Thus the results we actually present are in fact based upon this simplifying, and as it turned out, innocuous assumption.

When equation (2) is modified in the way just described, it becomes a moot point as to whether the model is still "complete". As far as the fixed exchange rate regime is concerned, it certainly is, because exchange rate changes were to all intents and purposes zero during the 1963-1969 period - the one exception being provided by the influence of the British devaluation of 1967, but that was clearly

exogenous. For flexible rate years the question is more open. Certainly the float of the 1954-1962 period was not a clean one, and it is arguable that, with exchange market pressure in any year being determined by an equation such as (2'), the authorities decided in each instance how much of that pressure to absorb by reserve changes and how much by an exchange rate change. This in effect is to argue that this division is the result of a decision exogenous to the model. However, it is natural to ask whether or not there might not exist some systematic principles underlying such a decision that could be captured in a well determined policy reaction function.

We did expend a considerable amount of energy investigating this matter, but to no avail. Thus, the empirical results that we present below are to be interpreted, depending on the taste of the reader, either as resting on the hypothesis that during the floating rate period, the division of exchange market pressure between reserves and exchange rate changes was at the exogenous discretion of the authorities, or that it was determined by an as yet undiscovered policy reaction function. Those who choose the latter alternative will, of course, be more skeptical about the results that we present than those willing to accept the former. They will also note that our treatment of domestic credit expansion as an exogenous variable, independent of the fiscal variables, is a further symptom of our inability to find a simple way of rendering monetary policy endogenous in this model.

The two modifications we have just described proved sufficient to enable the model to generate sensible estimates for most parameters, with the bulk of the improvement arising from the introduction of exchange market pressure as the dependent variable in equation (5). Nevertheless, the parameter ε_2, representing what we have termed the "catch up" factor in inflation expectations under fixed exchange rates, remained essentially equal to zero in all these experiments, seldom becoming larger than 0.1, and always being considerably smaller than its standard error once exchange market pressure became the dependent variable of equation (2). Thus, at this stage the parameter in question was dropped from the model although it was from time to time reintroduced in subsequent work in order to ensure that its absence was not affecting the outcome of the experiments in question. These spot checks confirmed our earlier decision to exclude it. The reader might note that in having expectations solely determined by past domestic inflation under flexible rates, our model rules out the exchange rate from playing a role in the transmission mechanism of domestic monetary policy to inflation under flexible rates. We will return to this matter below in Section VI.

As did Laidler and O'Shea in dealing with U.K. data, so we too attempted to add a number of other variables to various equations of our model in order to check the robustness of our results. In particular we added lagged domestic transitory income to the output equation (to pick up potential multiplier effects) and to the exchange market pressure equation (to pick up propensity to import effects). We also added U.S. transitory income to these two equations to pick up any

direct links between U.S. income fluctuations and Canadian output and exchange market pressure. By and large, the addition and subtraction of various permutations and combinations of these variables did not disturb the estimates we obtained for the other parameters of the model, the exception here being the fiscal policy parameters α_3 and α_4 whose statistical significance is higher when the various lagged income variables are omitted from equation (1), the problem here obviously being one of multicollinearity.

Be that as it may, lagged domestic income turned out to be potentially important in the output equations, but not in the balance of payments, while lagged U.S. income turned out to influence significantly only the balance of payments. The parameters of these variables are α_5 and γ_4 respectively and estimates of them appear in Table 2. The two variables in question are highly correlated with one another, of course, and the reader might note that, because the programmes used to estimate the model do not tell us anything about the serial correlation properties of the residuals generated by the model, the presence of lagged transitory income in equation (1) might simply be picking up first order serial correlation in the residuals from that equation. It is worth repeating, therefore, that nothing of any importance as far as the rest of the model is concerned hinges upon the presence of these variables, so that the reader who is suspicious of the role that they are playing should not discount the rest of our results for this reason.

The results presented in Table 2 largely speak for themselves. The demand for money function is well determined with a priori reasonable estimate of the income elasticity of demand for money. The parameter α_1 satisfies tests based on conventional levels of statistical significance and this result suggests that monetary disequilibrium has exerted a systematic influence on domestic output,

TABLE 2

PARAMETER ESTIMATES BASED ON THE MODIFIED MODEL
1954-1970

δ_o	-1.657 (0.628)	β	0.122 (0.055)
δ_1	1.212 (0.170)	ε_1	1.016 (0.079)
α_1	0.276 (0.135)	ε_2	-- --
α_2	0.522 (0.141)	γ_1	-0.529 (0.299)
α_3	-0.216 (0.087)	γ_2	-0.149 (0.388)
α_4	0.275 (0.131)	γ_4	0.983 (0.540)
α_5	0.417 (0.142)	a	0.088 (0.026)
		μ	0.157 (.007)

while an important role for fiscal policy in influencing output is confirmed by the statistical significance of the parameters α_3 and α_4. The level of prices in Canada relative to that in the rest of the world also displays a well determined influence on output. Excess demand systematically influences inflation, while the expected rate of inflation influences current inflation with the theoretically predicted unit coefficient.

The weakest equation of the model is that dealing with exchange market pressure, for although domestic monetary disequilibrium does produce a correctly signed though not too well determined effect here, the relative price level term takes a negative sign, albeit not significantly so. Although this result does not contradict anything in economic theory, it does differ from the well determined positive influence that Laidler and O'Shea found for the U.K. This absence of a relative price level effect in the balance of payments is not a characteristic only of the results presented here but turned up in all our experiments with various forms of the model and presents an as yet unresolved puzzle that merits further investigation. Spinelli encountered similar problems, though not so acutely, in the case of Italy.

Of the variables added to our basic model, the only one whose presence creates something of a problem of interpretation is United States' transitory income. This variable is on the margin of significance in the exchange market pressure equation but was never significant to the output equation. If this variable was capturing a simple Keynesian marginal propensity of the U.S. to import Canadian goods, one would have expected it to appear in both equations. Our tentative

suggestion is that it is standing, instead, as a proxy for the influence of U.S. monetary disequilibrium on the capital account of the balance of payments, but we have not as yet carried out any work to check this conjecture. It should be noted that the coefficient μ which measures the share of "reserves" in the assets that match the money supply is of an appropriate order of magnitude. Moreover the estimate of "a" suggests that the Canadian dollar was undervalued by a little under 9% in 1970. Given that Canada had not by then imported much of the Vietnam War inflation from the United States, but was in that year forced by balance of payments pressures to float the dollar (upwards) this estimate is not obviously wrong, though one might argue that, if anything, it somewhat exaggerates the degree of overvaluation ruling at the time.

Perhaps the most striking thing about the results presented in Table 2 is the way in which relatively small modifications to the original model, introduced in order to cope with exchange rate flexibility, cause the results to fall into line. Indeed, given the well determined effects of the quantity of money on domestic output, and the sensible estimate of the income elasticity of demand for money, it is possible to make the case that the framework under test here actually fits the Canadian data rather better than it does the United Kingdom data in terms of which it was first developed by Laidler and O'Shea. They could find no well determined effect of money on domestic output, and their estimate of the permanent income elasticity of demand for money was implausibly low.

However, the question must naturally arise as to whether this relatively good performance is merely accidental or rather will it hold up in the face of further modifications to the model. We shall now turn to discussing some further experiments which we carried out with our model, and as the reader will see, our basic results do hold up quite well in the face of such further testing.

VI

FURTHER TESTS

It is often remarked that the nature of the inflation-unemployment trade off in an open economy is crucially different given the nature of the exchange rate regime, and our model provides a vehicle, even though a crude one, for investigating this question. As we have already noted, one characteristic of the model which generated the results presented in Table 2 is that the expected inflation rate is proxied by lagged world inflation under a fixed exchange rate, and lagged domestic inflation under a flexible exchange rate, To see how important this modification actually was to the outcome of our empirical work, we tried the experiment of using each proxy in turn for the entire sample period, Here the results were indecisive, and therefore disappointing. Neither of these two variants of the model gave results that were quite as well determined as those presented in Table 2 but the deterioration in the model's overall performance was on the whole trivial. In particular the coefficient ε_1 remained equal to unity and well determined in either case, and although the statistical significance of the parameter β linking excess demand to

inflation did fall off notably, the rest of the model remained essentially unchanged. Indeed the deterioration of β was the only characteristic of the results that could be used to defend the propositon that it is important to model inflation expectations separately for fixed and flexible exchange rate periods. We must conclude therefore that both the world and Canadian economies were too tranquil in the 1954-1970 period to generate data that would enable us to get a sharp test of the importance of this matter.

In order to check into these issues further, another experiment was carried out. Instead of forcing the parameter on world inflation under fixed rates and domestic inflation under flexible rates to be the same, they were estimated separately. The relevant results are given in Table 3, where fixed rates and ε_1 is attached to lagged world inflation under fixed rates and ε_3 to lagged domestic inflation under flexible rates. The reader will see that the unit coefficient on expected inflation that appears in Table 2 is the result of averaging two components, the new ε_1 which is slightly greater than unity, and ε_3 which is markedly below unity. He will also see that the rest of the model is insensitive to this modification, A further probe involved modelling the expected inflation rate under flexible rates not just by lagged domestic inflation, but rather by the outcome of applying the error-learning hypothesis to past domestic inflation rates. The results of doing this were not impressive. The error-learning parameter took a point estimate of .350, but its standard error was so large that it could not be concluded that it differed either from zero or one. All in all, the most striking feature of this test and of that reported in Table 3

TABLE 3

FURTHER MODIFICATIONS TO THE MODEL

δ_o	-1.679 (0.553)	β	0.204 (0.043)
δ_1	1.216 (0.149)	ε_1	1.306 (0.081)
α_1	0.306 (0.129)	ε_3	0.622 (0.084)
α_2	0.604 (0.137)	γ_1	-0.656 (0.324)
α_3	-0.217 (0.083)	γ_2	0.359 (0.440)
α_4	0.265 (0.127)	γ_4	0.937 (0.572)
α_5	0.427 (0.142)	μ	0.156 (0.007)
		a	0.081 (0.025)

is not the evidence it generated about "new" parameters, but rather the way in which it showed that the estimates of the other parameters of the model were robust in the face of the changes made to the model's price determination equations.

In addition to those described in Tables 1, 2 and 3, a large number of other permutations and combinations of experiments were performed with the various specifications of the model using data for 1954-1970. In particular much fruitless time and effort was put into testing various policy reaction functions designed to make exchange rate changes endogenous to the model. None of this work added anything startling, either for or against the model, to the results already presented. The reader may take it that, as far as the period 1954-1970 is concerned the results set out in Tables 2 and 3 are representative to those obtained and robust in the face of many small modifications to the model.

As we noted in the introduction to this paper, one of the objects of our work was to see whether the 1970s differed from earlier times in being a flexible exchange rate period, or whether the general instability of the world economy over that period was also a factor underlying the difficulties encountered by Laidler and O'Shea and Spinelli in extending their work on the U.K. and Italy beyond 1970. Hence we also put some effort into extending our Canadian model's period of application to encompass the flexible exchange rate years 1971-1975. We found this quite a difficult task, and were never able to do so entirely satisfactorily.

Tables 4 and 5 present results for the forms of the model earlier presented in Tables 2 and 3 respectively, but with these extra five years of data added. These results are typical of those we obtained. Although certain aspects of our earlier results proved quite robust, particularly as far as the output equation and the demand for money are concerned, other aspects did not. The intercept of the demand for money function, and the "undervaluation" parameter "a" are essentially undetermined. Since these parameters turn up in the intercepts of equations (i) and (ii) (see pp. 13-14 above), this indicates that at least one of these equations is incapable of dealing with data drawn from the 1970s. In this respect our model as specified is obviously inadequate. It might be noted that our estimate of ε_3 is not different from 1.0 when the new data are added and to this extent the model's performance is improved by their addition. Also, the improvement in the model's performance, brought about by splitting the expectations variable between fixed and flexible rate periods, which was only marginal for the 1954-1970 period, was more marked for the longer period as results not reported in detail here showed. However, against this improvement must be offset the poor performance of the parameter β as displayed in Tables 4 and 5, not to mention the fact that the parameter γ_2 becomes almost significantly negative in sign.

As we noted above (p. 20), one characteristic of the flexible exchange rate version of our model is troublesome. It makes inflation expectations depend solely upon the past behaviour of the domestic price level, and therefore eliminates any possibility of a line of transmission running between domestic monetary policy and prices by way of the exchange rate. As the reader will easily see, if we were to use equation 5 as

TABLE 4

MODEL AS PRESENTED IN TABLE 2, ESTIMATED FOR 1954-1975

δ_o	7.116 (656.581)	β	0.090 (0.061)
δ_1	1.197 (0.109)	ε_1	1.113 (0.061)
α_1	0.249 (0.094)	ε_3	-
α_2	0.416 (0.105)	γ_1	-0.574 (0.304)
α_3	-0.137 (0.064)	γ_2	-0.950 (0.495)
α_4	0.212 (0.107)	γ_4	1.942 (0.709)
α_5	0.264 (0.107)	μ	0.114 (0.007)
		a	5.329 (394.519)

TABLE 5

MODEL AS PRESENTED IN TABLE 3 ESTIMATED

FOR 1954-1975

δ_o	3.507 (195.841)	β	0.083 (0.070)
δ_1	1.201 (0.112)	ε_1	1.093 (0.145)
α_1	0.248 (0.094)	ε_3	1.118 (0.073)
α_2	0.419 (0.106)	γ_1	-0.561 (0.304)
α_3	-0.138 (0.064)	γ_2	-0.935 (0.495)
α_4	0.215 (0.108)	γ_4	1.984 (0.715)
α_5	0.261 (0.107)	μ	0.114 (0.007)
		a	3.110 (116.500)

an expectations formula for flexible exchange rate periods this particular problem would not arise. Then, monetary disequilibrium would influence exchange market pressure, and to the extent that this pressure manifested itself in an exchange rate change, it would also influence domestic prices by way of the "catch-up" term in the expression determining inflation expectations. The results presented in Table 1 suggest that this form of the model might be worth trying.

Table 6 presents the results of estimating our model, modifed to use equation 5 for both fixed and flexible rate periods for the years 1954-1970 and 1954-1975. These results are in some respects more satisfactory than those already described and in some ways less so. To begin with, note that certain characteristics of the model's performance are robust in the face of this change. The output equation continues to perform well - with the exception of a fall off in the statistical significance of the parameter α_1 for the shorter time period. On the other hand, the parameter β, which links the inflation rate to excess demand retains its significance in this experiment even when the years 1971-75 are added to the sample. Moreover, although γ_2 remains negative in this formulation of the model, there is no longer any difficulty in estimating the parameters δ_0 and "a" for the longer period. The inclusion of the latter parameter in a third equation apparently enables it to be estimated with a fair degree of precision.

The key problem with the results set out in table 6 lies with the parameter ε_1 which is systematically estimated at less than unity, as it was in table 1. A number of comments may be made about this result. To begin with, on the basis of results presented earlier, one might have thought that this estimate was produced solely by data generated during flexible

TABLE 6

VERSION OF THE MODEL WITH INFLATION EXPECTATIONS MODELLED ACCORDING TO EQUATION 5

	1954-1970	1954-1975
δ_o	-3.305 (1.772)	-2.463 (0.889)
δ_1	1.718 (0.552)	1.480 (0.269)
α_1	0.168 (0.105)	0.149 (0.073)
α_2	0.824 (0.132)	0.539 (0.103)
α_3	-0.295 (0.070)	-0.171 (0.055)
α_4	0.369 (0.106)	0.312 (0.087)
α_5	0.372 (0.140)	0.273 (0.100)
β	0.132 (0.041)	0.194 (0.065)
ε_1	0.580 (0.118)	0.509 (0.121)
ε_2	0.113 (0.029)	0.168 (0.048)
γ_1	-0.295 (0.210)	-0.445 (0.253)
γ_2	-0.892 (0.517)	-1.272 (0.613)
γ_4	1.461 (0.613)	1.780 (0.697)
a	0.125 (0.023)	0.130 (0.023)
μ	0.155 (0.007)	0.119 (0.007)

exchange rate periods. However we did try a number of experiments in which ε_1 was estimated as a separate parameter for fixed and flexible exchange rate periods, and this turned out not to be the case. To use equation 5 to model expectations during the flexible exchange rate years makes sufficient difference to the quantitative estimates of the other parameters of the model as to yield an estimate of significantly below unity for ε_1 for the fixed rate period too. It should also be pointed out that we attempted to apply the error learning hypothesis to the world inflation rate, to see if the low parameter estimate of ε_1 reported in table 6 was the result of inflation expectations responding with a distributed lag to changes in the world inflation rate. This experiment was to no avail, because the error learning coefficient was found to be not different from unity in this case while ε_1 remained well below that value.

The time periods 1954-1970 and 1954-1975 are both characterised by rising inflation in the world economy. It is, therefore, by no means impossible to take the position that our estimate of the parameter ε_1 might indeed give a true measure of the link between actual world inflation and expected world inflation during those periods. Perhaps agents did indeed systematically expect the world inflation rate to fall below recently experienced values over the years in question. However to accept this interpretation of our results is to argue that the estimate of ε_1 does not represent a structural parameter describing an aspect of the Canadian economy so much as it represents an ex post statistical description of the relationship between the actual and expected value of the world inflation rate over a particular time period.

It is thus to argue that the formulation of the model upon which the results presented in table 6 are based is only partly satisfactory. All in all then, the particular modification to our model whose results we have just described cannot be regarded as any more satisfactory than earlier formulations.

VII

CONCLUSIONS

By no means all of the empirical results that we have presented, or referred to, in this paper have been successful and clearcut, but it is important to maintain a certain sense of proportion here. The broad aim of the study reported in this paper was to replicate, if possible, an experiment first carried out using United Kingdom data (Laidler and O'Shea) and later Italian data (Spinelli) with information gathered from a third economy, Canada, and covering the same time period as those originally used. In this not unimportant respect our study has been in good successful measure. Once certain simple modifications were made to the basic model, which amounted to little more than recognising that, under a flexible exchange rate regime, the exchange rate cannot be treated as an exogenous variable, results at least qualitatively like those obtained elsewhere were found to hold for Canada.

A model that attributes output fluctuations mainly to variations in the quantity of money and fiscal policy does seem to account rather well for Canadian experience and indeed in this respect the model performs better better for Canada than the U.K. Moreover, output fluctuations in their turn do appear to have a systematic effect on the domestic inflation rate, once due allowance is made for "expectations". Monetary factors

also turn out to have an albeit not too well determined effect on the behaviour of the foreign exchange market. Though perhaps none of these conclusions is startling, it is nevertheless notable that so simple a model as the one we have used here can account for data on such variables drawn from three separate economies (or four if one counts the closed economy Laidler-Bentley version of the model that been used on United States data).

By no means all of our results have been positive, but even negative or indecisive results can be instructive. We expended a good deal of effort on investigating the way in which the foreign exchange rate regime has impinged upon the interaction of output and prices in Canada, but the results we have obtained here cannot be regarded as being more than suggestive. Our initial hypothesis was that to allow foreign inflation to influence domestic inflation under fixed rates but not under flexible rates would permit a more satisfactory explanations of the relevant data. The results we obtained here were, unfortunately, disappointing. They were consistent with this hypothesis, but, particularly for the 1954-1970 period the improvement in our model's performance which arose from the modification in question was trivial. Moreover we have seen that to use the original "world inflation plus a catch-up" hypothesis, as used by Laidler and O'Shea, to capture inflation expectations throughout the sample period enables us to produce results that in some respects are satisfactory and in some respects are not.

In the light of these indecisive results it is hard to resist the conclusion that our, admittedly rudimentary, efforts at modelling the

formation of inflation expectations in an open economy under alternative exchange rate regimes have been inadequate. Of course the whole of the literature on the "rational expectations" hypothesis tells us that the next step in such an investigation ought to involve incorporation of information about the conduct of policy into the formation of expectations. Our inability, noted above, to find any simple policy reaction function which could be incorporated in our model, however, has precluded us from making even any preliminary investigation along these lines.

One reason for using Canadian data in order to test the model underlying this paper was that this might permit us to isolate the effects of exchange rate flexibility per se on the model's performance from those of the instability in the international economy that so dominates the data drawn from the early 1970s. In this respect our results are of some interest, because although the addition of the years 1971-75 to our sample did increase the difficulties we encountered in our empirical work, this addition stopped far short of destroying the model's viability as it had done in the case of Laidler and O'Shea's work on the United Kingdom. In some formulations of the model the difficulties we encountered were confined to estimating a couple of intercept terms, and in one formulation - whose results are set out in table 6 - extending the sample period created no difficulties that were not already present in the short period results. All this suggests that the structure of the model we have been testing is rather robust both with respect to changes in the exchange rate regime, and with respect to changes in the stability of the world economy.

Certainly our model proved more robust in this respect than we initially expected. Nevertheless, we did, as we have already pointed out, run into difficulties, particulary as far as modelling inflation expectations are concerned. In this respect our exercise has been relatively unsuccessful. However, it is eay enough to suggest further lines of enquiry that would be worth pursuing and which might solve these problems.

First, we have already noted that the modelling of the policy formation process needs to be carried out successfully if further progress is to be made in dealing with expectations. Perhaps just as important is the matter of dealing with the influence of the rest of the world on the home economy. In the exercises we have described in this paper, that "rest of the world" has been described by a price level variable and a United States real income variable, both of which have been treated as exogenous. Obviously, these variables are themselves generated by economic processes in the rest of the world which could themselves be modelled along the lines which we have followed in dealing with the home country Canada. It would be an interesting endeavour, though be no means an easy one, to build a "rest of the world" model that could be linked through the exchange market pressure equation, and perhaps the expectations equation as well, to a home country model such as we have described here.

To sum up, then. Some of the key characteristics of the model under test in this paper have survived confrontation with data from yet another country and with data generated under a flexible exchange

rate, and this is not an unimportant result. In some respects, however, notably in the treatment of inflation expectations, our model has proved fragile and clearly needs further, perhaps quite extensive work. Thus, though we hope that the results we have described in this paper are interesting, they should be regarded as the the outcome of work still in progress rather than of work which purports to provide a definitive account of the interaction of prices output the exchange rate and the balance of payments in the post-Korean-war Canadian economy.

DATA 1952-1975

	Real GDP $ Billion	Consumer Prices 1970 = 100	World Prices 1970 = 100	Exchange Rate $/FCU 1975 = 100
1952	31.84	69.5	64.5	96.8
1953	33.46	68.9	65.0	97.1
1954	33.57	69.3	65.5	96.2
1955	36.93	69.4	65.7	97.3
1956	40.65	70.5	67.0	97.1
1957	41.38	72.7	68.7	94.3
1958	41.63	74.7	71.0	94.7
1959	43.48	75.5	71.9	92.5
1960	44.75	76.4	73.2	93.4
1961	45.84	77.2	74.2	97.9
1962	49.14	78.1	76.0	103.5
1963	51.83	79.4	77.9	104.6
1964	55.25	80.9	79.6	104.6
1965	59.05	82.8	81.8	104.6
1966	63.75	85.9	84.6	104.6
1967	66.06	89.0	87.0	104.5
1968	69.30	92.6	90.4	103.3
1969	73.12	96.8	94.7	103.2
1970	75.43	100.0	100.0	100.0
1971	80.53	102.8	104.9	97.5
1972	86.01	107.8	109.5	99.7
1973	94.76	115.9	117.7	106.2
1974	102.85	128.6	132.5	102.3
1975	105.87	142.5	145.8	107.6

DATA 1952-1975

	Money Supply $ Cdn. Bill.	Reserves $ Cdn. Bill.	Domestic Credit $ Cdn. Bill.	Real Govt. Exp. $ Cdn. Bill.	Taxes as a proportion of GDP
1952	9.26			5.21	.176
1953	9.32	1.75	7.57	5.55	.174
1954	10.14	1.88	8.26	5.52	.161
1955	10.88	1.38	9.50	5.82	.164
1956	11.19	1.88	9.31	6.28	.172
1957	11.50	1.77	9.73	6.29	.166
1958	12.93	1.89	11.04	6.50	.137
1959	12.79	1.87	10.92	6.59	.149
1960	13.40	1.47	11.57	6.91	.146
1961	14.58	2.13	12.45	7.24	.164
1962	15.12	2.28	12.84	7.59	.168
1963	16.15	2.42	13.73	7.81	.166
1964	17.35	2.78	14.57	8.29	.179
1965	19.34	2.94	16.40	8.88	.187
1966	20.58	2.59	17.99	9.96	.199
1967	23.68	2.60	21.08	10.96	.202
1968	27.19	2.96	24.23	11.92	.209
1969	27.91	3.02	24.89	12.75	.224
1970	31.16	4.56	26.60	14.46	.221
1971	36.35	5.33	31.02	15.49	.214
1972	41.42	5.55	35.87	16.31	.207
1973	49.03	5.08	43.95	17.22	.205
1974	57.44	5.10	52.34	18.68	.212
1975	67.38	4.70	62.68	20.16	.172

DATA SOURCES

Real GDP	International Financial Statistics. May 1977, line 99b deflated by Consumer prices.
Consumer Prices	International Financial Statistics. May 1977, line 64, rebased on 1970 = 100.
World Prices	A GDP weighted average of the Consumer Price index of sixteen Industrial Countries: Australia; Austria; Belgium; Denmark; France; Ireland; Italy; Japan; Netherlands; New Zealand; Norway; South Africa; Sweden; Switzerland; United States; West Germany. Data from International Financial Statistics, May 1977.
Exchange Rate	A GDP weighted average of the Canadian dollar price of the currencies of sixteen Industrial Countries as listed above. Data from International Financial Statistics, May 1977.
Money Supply	Currency plus privately held Canadian Dollar deposits at Chartered Banks. End of period. Source: Bank of Canada mimeo.
Reserves	1953 Canadian Dollar value of Official International Reserves. Thereafter the series is generated by adding Series for "Net Official Monetary Movements". (CANSIM No. B50212) net of any allocation of Special Drawing Rights (CANSIM No. D50210).

Domestic Credit	Money Supply - Reserves, as defined above.
Real Government Expenditures	Outlays of Federal, Provincial, and Local Governments for currently produced goods and services. 1952-1970 National Income and Expenditure Accts. 1926-1974 (13-531). 1971-1975 National Income and Expenditure Accts. 1978 4th Quarter
Taxes as a Proportion of GDP	Total Federal, Provincial and Local Government revenue minus current transfers divided by GDP. Data from National Income Expenditure Accounts, as above.

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