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Chapter Author: Ronald C. Bodkin, Francine Chabot-Plante, Munir A. Sheikh

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RONALD G. BODKIN
University of Ottawa and Economic Council of Canada
FRANCINE CHABOT-PLANTE
Economic Council of Canada
MUNIR A. SHEIKH
Economic Council of Canada

Canadian Experience with Recent Inflation as Viewed through CANDIDE

In this paper, we employ a large-scale econometric model of the Canadian economy as a tool for studying the generation of inflation during the past fourteen years. Because ours is a medium-term model, we break this total span into three distinct subperiods: 1960–1965, 1965–1970, and 1970–1974. In our analysis we focus on

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the well-known construct of a "trade-off," or Phillips, curve, although our approach to this concept is in the context of our large-scale simultaneous equations model.[1] We shall not defend this construct, which has been the subject of a number of spirited exchanges in the literature in recent years. In any case, our goal in this paper is more modest: the objective is to see whether, and to what extent, the simple concept of a trade-off curve (based, of course, on certain hypotheses to be spelled out later on) remains a valid first approximation, in the context of a large-scale econometric model.[2] Of course, even if it is concluded that the results of an analysis of wage-price-unemployment behavior, in the context of a full model, can really be viewed, at least as a reasonable description, as a trade-off curve, this does not tell us anything directly about the Canadian economy. If the parent model is accepted as a tentatively validated approximation of the Canadian economy, then confidence would be strengthened in the trade-off curves that have been derived from such a model. However, it must be candidly admitted that the existence or nonexistence of such a trade-off curve has been derived from the basic equations of the model, and so this test of the existence of such a curve is really an indirect one. Accordingly, in this paper only an indirect contribution can be made to the debate on this subject.

In the first full section of this paper, we present an extremely brief introduction to CANDIDE Model 1.1. In section II, we analyze the period 1960–1965, utilizing heavily the concept of a trade-off curve as a theoretical simplification and as a basis for the presentation. In section III, we present similar analyses for 1965–1970, when inflationary pressures were much more pronounced in the North American economy. The analysis for 1970–1974 in section IV changes the emphasis of this study to the effects in Canada of price level developments in the United States; it will be recalled that this period includes the New Economic Policy, price controls and decontrols through the various phases of NEP, and worldwide food and oil shortages. In the concluding section, we present both our major conclusions and several caveats, attempting to distill one lesson for policy out of our study.

I. SUMMARY OF CANDIDE MODEL 1.1

CANDIDE Model 1.1 is the second generation of a large-scale model (roughly 2,050 equations for Model 1.1) of a national economy (i.e., a model with no explicit regional detail), fitted to annual data, with a medium-term outlook (for our purposes here, 5–10 years). The acronym represents (in English) *CAN*adian *D*isaggregated *I*nter-*D*epartmental *E*conometric (model or project).[3] In terms of the bare statistics, CANDIDE Model 1.1 has approximately 450 exogenous variables, 616 behavioral equations, 427 input-output identities, and over 1,000 ordinary identities.[4] The technique of parameter estimation was ordinary least squares, with variants such as polynomial (Almon) distributed lags utilized to deal with nondiscrete lag distributions and Hildreth-Lu (autoregressive) transformations employed to handle autocorrelated disturbances, particularly in the context of lagged dependent variables. In general, the sample period for Model 1.1 was 1955–1971, and the behavioral equations have been fitted to national accounts data and concepts that incorporate the 1972 revisions by Statistics Canada, which were important in scope and pronounced in magnitude.

Several striking features of the CANDIDE model may be briefly discussed. First, as the acronym implies, the model is disaggregated in a number of directions, which of course accounts for its large size. Although almost every sector of the model is disaggregated to some extent, the directions in which the disaggregation has been carried furthest include some of the categories of final demand expenditures, output originating (real gross domestic product) by industry, and the price level variables (the implicit deflators associated with the expenditure categories). Secondly, such a large system is obviously computer-oriented. The simultaneous core of CANDIDE Model 1.1 approximates some 1,500 nonlinear equations, and a model of this size would have been quite impossible to handle or even to manage before the age of the high-speed computer.[5]

A third characteristic is that the model is intended, as one might expect from the number of departments and agencies of the Government of Canada that had a hand in its construction,[6] to be a general-purpose one, onto which satellite models can be grafted as a particular need arises. Of course, there are limitations to this principle: the satellite model has to be broadly consistent with the basic model. In other words, CANDIDE is no panacea for all policy problems confronting Canadian government departments, as at times we have had to make quite clear to potential users of the model. In short, a model that is general purpose in nature should not be confused with that nonexistent entity, an all-purpose model.

A fourth striking feature of CANDIDE Model 1.1 is that, like

Model 1.0, it integrates two input-output submodels with conventional econometric modeling. (This has already been indicated in the equation counts above.) An input-output submodel is utilized in each of two places: on the real output side and also on the price side. The price-side I/O submodel will be discussed in the next paragraph. The real-side I/O submodel takes 169 categories of final demand by ultimate use and converts these time series (under the assumption of fixed coefficients) into a time series of final demands for the 105 commodities of the CANDIDE I/O classification. Then a rectangular input-output model is applied, yielding first estimates of gross output and (by another assumption of constant proportions) of value added originating in some sixty-three industries. These first estimates are then subjected to autoregressive correction equations, in order to obviate some of the rigidities entailed in the use of fixed coefficients estimated on the basis of data for a single year, 1961.[7]

Turning to the wage-price sectors of CANDIDE, we note that both wage and price formation (particularly the latter) are heavily cost-oriented. Wage formation takes place in twelve major industries of the Canadian economy. In three of these (manufacturing, construction, and transportation, storage, and communications), the key wage relationship is an industry variant of a wage adjustment function. Thus, a schematic wage adjustment function for these three industries would be:

$$\dot{w}_i = \alpha + \beta(1/U) + \gamma \dot{CPI} + \delta \dot{w}_{i_{US}} + \epsilon, \tag{1}$$

where the Greek letters are parameters, $\dot{w}_i$ is the rate of change of the wage rate in industry i, U is the rate of unemployment (as a proportion of the labor force), $\dot{CPI}$ is the rate of change of the consumer price index, $\dot{w}_{i_{US}}$ is the rate of change of wage rates in a corresponding U.S. industry, and ϵ is a random disturbance. In principle, the total wage bill in these three industries is equal to the product of the wage rate per man-hour multiplied by the total number of man-hours employed in the industry, although in practice inconsistencies in the data bases utilized forced us into ad hoc adjustment relationships. For the remaining nine major industries, the total wage bill (W_i) is explained directly. A typical wage bill function would be the following:

$$\log [W_i/0.5\,(CPI + CPI_{-1})] = \alpha' + \beta' X_i + \gamma' E_i + \epsilon', \tag{2}$$

where again the Greek letters are parameters, ϵ' is a random disturbance, X_i is the level of real domestic product originating in the ith industry, E_i is the level of industry employment (generally, but not always, in terms of man-hours), and CPI is as defined above. Note that the total wage bill has been deflated by the average of the current and the preceding year's consumer price index, on the view that a short lag characterizes this sort of relationship. It might be mentioned that the unemployment rate enters only one of the nine variants of equation 2. Hence it is not quite true to assert that the Phillips curve (relationship between the rate of change of wage rates and the level of the unemployment rate) is built right into all our wage formation equations, as D. J. Daly, our discussant, has asserted. On the other hand, it must be admitted that the model gives the Phillips curve (and the associated trade-off curve) every opportunity to make an appearance.

As noted above, industry price formation is strongly cost-oriented, with the principal explanatory variable being either unit labor costs or unit total costs (which include unit capital costs, or unincorporated business income per unit of real output, or both), depending upon the major industry under consideration. Denote the industry price level (the implicit deflator of real domestic product originating) by P_i, and unit labor costs or unit total costs by UC_i. Then the following is a schematic relationship explaining the determination of the price level of the ith industry's output:

$$P_i = \alpha'' + \beta'' UC_i + \gamma'' Z_i + \epsilon''. \tag{3}$$

Again, the Greek letters are parameters, ϵ'' is a stochastic disturbance, Z_i is (depending upon the industry under consideration) either a proxy variable for the direct effects of demand pressures or an indicator of price pressures from the corresponding U.S. industry. (In the case of the price level of mining output, both variants of Z_i appear.) In some major industries, UC_i appears as a distributed lag, rather than simply having a simultaneous influence.

Once the process of domestic industry price formation is complete, we can enter the price-side I/O submodel. (Other relevant independent variables are the prices of competing imports, which are essentially exogenous in CANDIDE Model 1.1, tax and subsidy rates, and several other minor determinants.) The I/O price-side submodel, which is one of pure cost-push, will generate estimates of (most of) the implicit deflators of the domestic final demand categories. Final estimates (in Model 1.1) are then obtained by subjecting these first estimates to an autoregressive correction procedure, analogously to what is done on the side of the estimates of real output by detailed industry emanating from the real-side I/O submodel. At the end of this process, some price-level aggregates are obtained by dividing the relevant current-dollar magnitudes by the appropriate constant-dollar values, which may be interpreted as taking a weighted average (with current weights) of the appropriate component deflators.

Finally, we may note, especially for an American audience, that the model of the U.S. economy that CANDIDE resembles most closely is Ross Preston's Wharton School annual and industry forecasting model.[8] This resemblance is closest with regard to the input-output aspects of the two models, as the CANDIDE treatment has been patterned on that pioneered by Preston. (Indeed, the principal difference between the CANDIDE input-output submodels and the Wharton ones is that a rectangular I/O subsystem is used in the former; and the more usual square system, in the latter.) Of course, there are some differences in the structures of the two models; for example, the links between monetary stocks and final demand functions are much more fully developed in the Wharton model. On the other hand, the foreign trade relationships are much more fully articulated in the CANDIDE models, which is hardly surprising in view of the much more open nature of the Canadian economy. It should be pointed out explicitly that this close resemblance is not accidental; as McCracken acknowledges,[9] the Wharton model was not only an inspiration to the CANDIDE model builders, but Ross Preston and Lawrence R. Klein gave useful counsel during the period of construction of the latter.

II. THE TRADE-OFF DURING 1960–1965

In this section, we take up two important issues:

First, in a directly estimated trade-off relationship, price changes can be derived as a function of the unemployment rate (and possibly some other variables). The unemployment rate is then modified exogenously to find the corresponding price changes, which trace out the trade-off curve. As Kaliski has pointed out,[10] "the several variables included in the wage and price equations can be said, with some exceptions, to be jointly determined in a larger system and thus to occur only in certain specific combinations of values. One cannot, in general, hold some of them constant and vary others." From another point of view, if such a trade-off exists at all, policymakers may want to find out whether or not it is independent of the policy instrument utilized.

The question is then, Can we derive the usual trade-off relationship between changes in prices and the rate of unemployment when we use a jointly determined larger system, such as the CANDIDE model? In a full-scale model we can only make autonomous changes in the exogenous variables or in the constant terms of the behavioral equations. We can then examine the resulting variations in both the unemployment rate and the rate of change of prices and thus derive our trade-off relationship, if it indeed exists.

Second, it is generally agreed that the openness of the Candian economy makes it more susceptible than most countries to foreign economic influences, especially those from the United States. In our trade-off framework, the second question that we want to study is, What happens to our trade-off relationships if we assume that the U.S. economy was experiencing more or less inflation than was actually the case during the sample period 1960–1965?

It is possible to study these issues on a year-to-year basis. Take, for example, some specific year. We have the unemployment rate for that year (*URATE* in the CANDIDE model) and the percent change over the past year in a price level, namely, the implicit deflator of gross national expenditure (*PGNE*), both taken from the *control solution* of the model. This gives us one point for our trade-off curve. Suppose now that we increase government expenditures in that year by a specific amount and obtain another *full-system dynamic solution* of the model. This solution will provide us with new numbers for the rates of inflation and unemployment for that year and hence another point for the supposed trade-off curve. By injecting various amounts of government expenditures into the system, we can generate as many points for our trade-off curve as we wish.

Instead of analyzing results on a year-to-year basis, we preferred to work with five-year averages. We could thus divide our sample period into two five-year subperiods, 1960–1965 and 1965–1970. Furthermore, we felt that five-year averages of the dependent variables that the model generates are more reliable than the simulated values for each year separately, for the simple reason that the impact of the misspecification of any equation (or group of equations) in the model is probably less for a five-year average.

To answer the two questions posed at the beginning of this section, the model was subjected to shocks by changing the following variables in various amounts:[11]

Government current expenditures (*GCURRK* in terms of model mnemonics), with a constant supply of high-powered money;

Government expenditure on fixed capital formation (*GFICAK*), with a constant supply of high-powered money;

Government transfer payments (*GTR*), with a constant supply of high-powered money;

Government current expenditures (*GCURRK*), with constant interest rates;

High-powered money (*MHPC*).

We were successful in deriving many trade-off curves with the CANDIDE model, consistent with our working hypotheses. It should be mentioned, however, before we present our results, that our model is neo-Keynesian in spirit, and hence it is not surprising that our findings agree broadly with the conclusions implicit in the IS-LM theoretical framework.

The Trade-off with Variations in Government Current Expenditure (with a Constant Supply of High-Powered Money)—GCURRK

To derive our trade-off relationship, we change *GCURRK*[12] by various amounts ranging from +$400 million to −$400 million constant dollars.[13] The results of this experiment are presented in Table 1. Notice that the results clearly indicate that an increase in the unemployment rate is associated with a decrease in the percent increase

TABLE 1 Trade-off under Fiscal Policy (Government Current Expenditure), 1960–1965

Change in *GCURRK* (millions of constant dollars)	*URATE*	Percent Change in *PGNE*
+400[a]	3.25	3.216
+300	3.76	2.877
+200	4.41	2.478
Control solution	5.61	2.002
−200	6.75	1.811
−300	7.31	1.752
−400	7.87	1.702

NOTE: For definition of variables, see text.
[a]We could not keep on injecting $400 million in 1964 and 1965 because the model fails to converge, as *URATE* becomes negative. Therefore, only $300 million are injected in those two years.

in *PGNE;* thus, there *does* exist a trade-off relationship, at least over this particular period.

However, according to the model, a lower *URATE* would not have meant too high a penalty in terms of higher price increases if the government had increased its expenditures on goods and services at that time. Nevertheless, lowering the price pressures, which were a problem only toward the end of that subperiod, would have been an expensive experiment. One can legitimately ask whether these quite optimistic results from the point of view of policymakers would have held, at least to the same degree, if some other fiscal tool had been used.

The Trade-off with Variations in Government Fixed Capital Formation (GFICAK)

According to our experiments, *GCURRK* appears to have been the most effective weapon for fighting unemployment. We have run a number of experiments with government expenditures on fixed capital formation (*GFICAK*) and government transfers (*GTR*). As we had expected, the structure of lags in the model implied by *GFICAK* and its more limited ramifications throughout the economy mean a smaller overall multiplier effect. The experiment with the most stimulation, injection of $400 million, brings mean *URATE* down to 4.33 percent, compared to 3.25 percent with *GCURRK* (Table 2). Again we find the existence of a trade-off rela-

TABLE 2 Trade-off under Fiscal Policy (Government Fixed Capital Formation), 1960–1965

Change in *GFICAK* (millions of constant dollars)	*URATE*	Percent Change in *PGNE*
+400	4.33	2.447
+300	4.66	2.309
+200	4.98	2.192
Control solution	5.61	2.002
−200	6.22	1.915
−300	6.53	1.896
−400	6.83	1.881

NOTE: For definition of variables, see text.

tionship. The slope of the trade-off curve that can be derived from this table, based on variations in *GFICAK*, is slightly flatter than that obtained from Table 1 with *GCURRK*.

The Trade-off with Variations in Government Transfer Payments (GTR)

Finally, we consider transfer payments from government to persons (*GTR*). Since *GTR* is in current dollars, we know that the changes in it are not directly comparable to those discussed above, which are in terms of constant dollars. It is thus not surprising to find a smaller overall effect when using this tool. The results of our various simulations are listed in Table 3. Again, the existence of a trade-off curve is evident, and this curve turns out to be reasonably close to the one derived for *GCURRK*, above. (Although the figures in Table 3 are closer to those in Table 2, plotting the curves on a graph makes it quite clear that the trade-off curve of this subsection is closer, over the relevant range, to that for *GCURRK* than for *GFICAK*.)

TABLE 3 Trade-off under Fiscal Policy (Government Transfer Payments), 1960–1965

Change in *GTR* (millions of constant dollars)	*URATE*	Percent Change in *PGNE*
+400	4.91	2.22
+300	5.09	2.162
+200	5.26	2.106
Control solution	5.61	2.002
−200	5.96	1.933
−300	6.13	1.918
−400	6.30	1.905

NOTE: For definition of variables, see text.

The Trade-off with Variations in Government Current Expenditures (with Constant Interest Rates)

In the previous simulations, we did not obtain the pure fiscal effect, in terms of the IS-LM framework, as the supply of high-powered money remained unchanged and interest rates increased. We now want to keep interest rates unchanged. This is done by making the monetary block exogenous, which means that the observed values of interest rates are used wherever they appear in the rest of the model.[14]

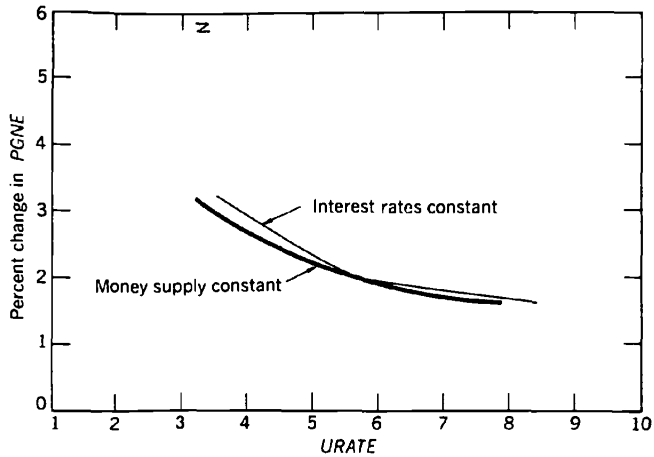
As expected, a comparison of tables 1 and 4 shows that a change of the same magnitude in *GCURRK* leads to a greater impact on *URATE* and *PGNE* if interest rates are kept constant by adjusting the money supply.[15] Any given injection, for example, is more helpful in reducing unemployment, but only at the expense, in the present case, of more inflation. Figure 1 illustrates the effect of keeping interest rates constant in the trade-off between inflation and unemployment. The values of *URATE* and the percent change in *PGNE* are almost similar in the two control solutions, one with and the other without an exogenous monetary block. Keeping interest rates constant slightly raises the trade-off relationship for ex-

TABLE 4 Trade-off under Pure Fiscal Policy (Interest Rates Held Constant), 1960-1965

Change in *GCURRK* (millions of constant dollars)	*URATE*	Percent Change in *PGNE*
+300[a]	3.58	3.264
+200	4.23	2.764
Control solution[b]	5.68	2.045
−200	7.01	1.815
−300	7.66	1.737
−400	8.30	1.671

NOTE: For definition of variables, see text.
[a]We could not run a simulation with +400 for the whole subperiod because *URATE* went below zero in some years and so the model could not converge.
[b]The control solution has slightly different values than in the preceding three tables (and also in Table 5, below), because, with the monetary block exogenous, we have, in effect, a slightly different model.

FIGURE 1 Trade-off under Fiscal Policy (Government Current Expenditure, GCURRK), 1960–1965



PGNE = GNE (gross national expenditures) deflator.
URATE = unemployment rate.

pansive fiscal policy, but hardly makes any difference for contractionary fiscal policy. This slight change under a stimulative fiscal policy probably occurs because, by holding our interest rates to their observed values and impeding any feedback from the real side of the economy, we may be breaking one of the corrective mechanisms which stabilize the economy under greater demand pressures.

The Trade-off with Variations in High-powered Money (MHPC)

Before launching into the analysis of monetary simulations, we must comment on the linkages between the monetary and real sectors in our model. Following neo-Keynesian tradition, the only such link we have is through interest rates: these are determined in the monetary block, and they enter as explanatory variables in the equations for investment, residential construction, discretionary savings, and some of the consumption categories. Monetary aggregates do not affect anything directly in the model except the complex of interest rates. Thus, given these tenuous links between the monetary and the real sectors and the fact that high-powered money is in current dollars, we generally expect a smaller overall effect for our monetary policy simulation.

A comparison of Table 5 with tables 1, 2 and 4 supports our assertion. However, the changes in *MHPC* have a greater impact than changes in *GTR*, as is obvious from a comparison of tables 3 and 5.[16]

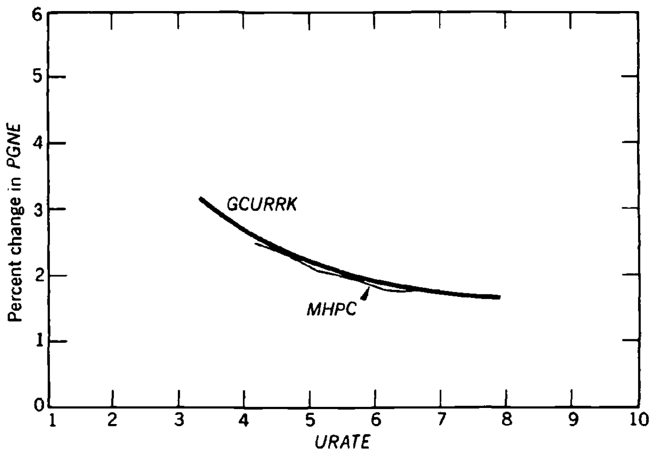
In Figure 2, we compare the trade-off curve derived from Table 5

TABLE 5 Trade-off under Monetary Policy, 1960-1965

Change in *MHPC* (millions of current dollars)	*URATE*	Percent Change in *PGNE*
+500	4.15	2.565
+400	4.47	2.403
+300	4.78	2.275
+200	5.07	2.170
Control solution	5.61	2.002
−200	6.10	1.870
−400	6.55	1.837

NOTE: For definition of variables, see text.

FIGURE 2 Comparison of Trade-offs under Fiscal (GCURRK) and Monetary (MHPC) Policies, 1960-1965



MHPC = high-powered money.

to the one derived by using *GCURRK* in Table 1. Our principal conclusion, at least for this historical period, is that the trade-off curve is relatively independent of the policy—monetary or fiscal—chosen to speed up or slow down the economy.

So far, our model corroborates the conclusions derived from the analysis of neo-Keynesian models, which is not surprising under our assumptions. To fight unemployment, fiscal policy is more effective. But the answer is less clear-cut on price stability. If we wish only to readjust our prices slightly, then monetary policy would do the job. Monetary policy alone will not be successful in achieving a drastic anti-inflationary goal, in the range of variations in the stock of money studied, under the assumptions of our model. We may add, however, that during this particular subperiod, inflation was not an acute problem.

The Trade-off with a Different Price Scenario for the United States, 1960-1965

For an analysis of the impact of U.S. inflation on the Canadian economy, we ask ourselves the following question: What would have happened to the trade-off relationships we derived earlier if the United States had been experiencing inflation at a rate higher than what was actually observed during this period (1960–1965)?

To study this issue, we made exogenous changes in all the prices paid (in U.S. dollars) for goods imported from the United States, which appear as exogenous variables in the model.[17] Assuming that Canada is a small country and hence a price taker in world markets and thus can sell its exports at exogenously determined prices, we change all the prices of goods exported to the United States and the rest of the world (exogenous in our model) by the same margin as the prices of imports from the United States.[18] Specifically, the observed rate of change of all these prices was increased by one percentage point[19] for all years from 1961 to 1965 with 1960 as the base year. A full-system solution of the CANDIDE model incorporating these changes gives us a new control solution and hence new control values of *URATE* and the rate of change of *PGNE* (again working with averages over the five-year subperiod).

Following the same procedure used earlier, we derive a new trade-off curve based on a higher rate of inflation in the United States. The trade-off relationship under this scenario (changes in *GCURRK*) is presented in Table 6. A comparison of this table with Table 1 reveals that a higher U.S. inflation leads to a lower unem-

TABLE 6 Trade-off with Higher U.S. Inflation, Using Fiscal Policy (GCURRK), 1960-1965

Change in *GCURRK* (millions of constant dollars)	*URATE*	Percent Change in *PGNE*
+300	3.41	3.72
+200	4.13	3.09
Control solution	5.37	2.52
−200	6.52	2.16
−300	7.08	2.02
−400	7.64	1.89

NOTE: For definition of variables, see text.

ployment rate in Canada, coupled with more inflation, according to the CANDIDE model. This latter result is consistent with what one would expect, given the extent of the dependence of the Canadian economy on its external environment. A variety of factors may be responsible for lowering the unemployment rate. For example, higher import prices could, among other things, make domestic goods more desirable relative to imported goods. The increase in demand for the former could lead to an increase in their production, consequently generating more employment in these industries.

Figure 3 illustrates much more clearly, however, the effect of additional U.S. inflation on the trade-off curve derived earlier for changes in *GCURRK*. We observe that higher U.S. inflation at an augmented rate of one percentage point per year shifts the entire trade-off curve upward, so that the annual rate of inflation projected by the model is increased between 0.2 and 0.7 percentage points, depending upon the particular rate of Canadian unemployment under consideration. The new curve is steeper, and so higher amounts of acceleration in the rate of inflation are associated with lower rates of unemployment. Alternatively, if the Canadian government wishes to hold the line at a given rate of increase of the price level, it has to allow for more unemployment at home to cope with the impact of higher U.S. inflation. This may imply roughly a one percentage point increase in the Canadian unemployment rate, as a crude approximation, although this may vary somewhat, depending upon the target rate of inflation selected.

Table 7 can be compared with Table 5 to analyze the impact of a higher rate of U.S. inflation on the trade-off relationship derived by permitting changes in monetary policy. From the table and the corresponding Figure 4, we can derive conclusions similar to those we presented above for *GCURRK*. Because of the differences in the

FIGURE 3 Shift of the Trade-off Curve Resulting from Higher U.S. Inflation under Fiscal Policy (GCURRK), 1960-1965

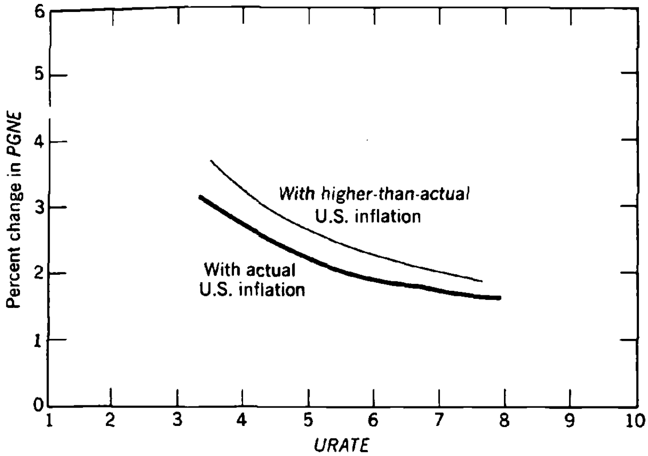


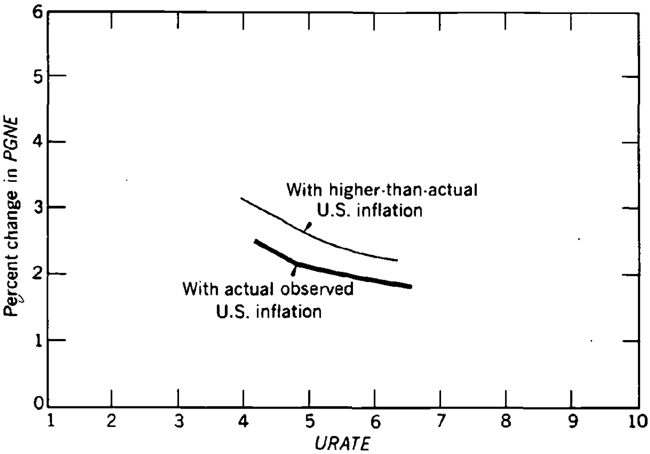
TABLE 7 Trade-off with Higher U.S. Inflation, Using Monetary Policy (MHPC), 1960–1965

Change in *MHPC* (millions of constant dollars)	*URATE*	Percent Change in *PGNE*
+500	3.89	3.18
+400	4.22	2.98
+300	4.53	2.83
+200	4.83	2.71
Control solution	5.36	2.52
−200	5.85	2.38
−400	6.29	2.27

NOTE: For definition of variables, see text.

effectiveness of these policy tools in our model, the magnitudes of the resulting changes are not directly comparable.

FIGURE 4 Shift of the Trade-off Curve Resulting from Higher U.S. Inflation under Monetary Policy (MHPC), 1960–1965



III. THE TRADE-OFF RELATIONSHIP DURING 1965–1970

Simulations for 1965–1970, when compared to those in the preceding section, permit us to analyze the question of the stability over time of our trade-off curves, following the literature on the Canadian trade-off curve. Working with the full model does not, however, allow us to be as explicit about the factors explaining the shift of the curve as with a small subsystem, even though such an analysis could be important for policy decisions. This is one price that must be paid for a more "realistic" analysis. The second issue considered in this section is the now familiar problem of analyzing the effects of changes in the U.S. environment on the Canadian trade-off curve for 1965–1970. Before proceeding, it is useful to recall that 1966 was a year of full employment for Canada and that inflation was emerging then as a real problem. Even though the rate of unemployment was increasing every year after 1966, inflation did not slow down. Thus, at the end of the 1960s, Canada was facing both a high unemployment rate and considerable inflation. It could thus be anticipated that the trade-off curve would shift up in 1965–1970 compared to 1960–1965.[20]

In Table 8 we list the trade-offs for 1965–1970 derived by utilizing both fiscal and monetary policies for this latter subperiod. A look at figures 5 and 6, which correspond to Table 8, clearly reveals an upward shift of the trade-off curves, whether fiscal or monetary policy is used. Hence a given rate of employment could be achieved only at the cost of higher inflation or, alternatively, a given rate of inflation could only be sustained by generating considerably more unemployment during 1965–1970 than during 1960–1965.

We are now in a position to consider another issue. We may ask about possible differences in cost in terms of additional inflation between the two subperiods, if the objective is to reduce the unemployment rate by a definite amount, e.g., one percentage point.

We turn first to the trade-off relationship derived on the basis of fiscal policy, using Figure 7, which is derived from Figure 5 as follows: In Figure 7, *A* and *B* are the respective trade-off curves for 1960–1965 and 1965–1970, and each passes through the origin at

TABLE 8 Trade-offs during 1965-1970

Fiscal Policy (Government Current Expenditures)			Monetary Policy		
Change in *GCURRK*, with High-Powered Money Held Constant (mill. constant dol.)	*URATE*	Percent Change in *PGNE*	Change in *MHPC* (mill. constant dol.)	*URATE*	Percent Change in *PGNE*
			+500	4.02	4.519
+400[a]	2.65	5.402	+400	4.20	4.439
+300	3.08	5.068	+300	4.38	4.370
+200	3.80	4.615	+200	4.55	4.309
Control solution	4.87	4.206		4.87	4.206
−200	5.86	3.923	−200	5.17	4.119
−300	6.34	3.802	−400	5.46	4.044
−400	6.82	3.690	−500	5.60	4.010

NOTE: For definition of variables, see text.

[a]Because 1966 was a full employment year, we could not inject $400 million in the first two years without running into convergence problems. Accordingly, we put in $300 million in 1965 and 1966 and $400 million from 1967 on.

the point of its control solution. The axes of Figure 7 thus represent *variations* in the unemployment rate ($\Delta URATE$) and in the percent rate of increase of prices [$\Delta(\%\Delta PGNE)$].

The relative positions of these two curves can now be used for a

FIGURE 5 Shift of the Trade-off Curve over Time under Fiscal Policy (GCURRK), 1960-1965 and 1965-1970

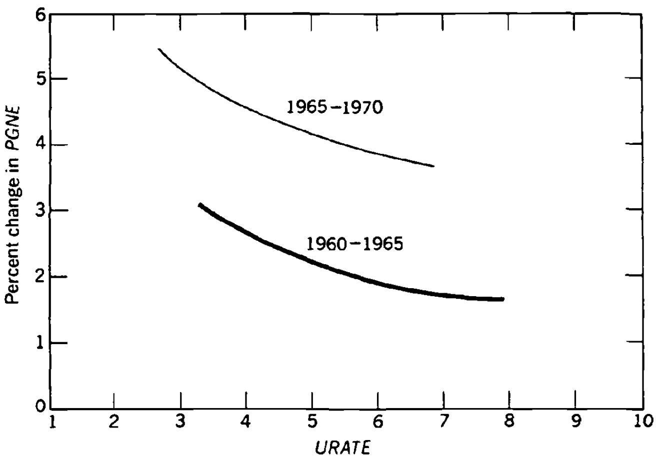


FIGURE 6 Shift of the Trade-off Curve over Time under Monetary Policy (MHPC), 1960-1965 and 1965-1970

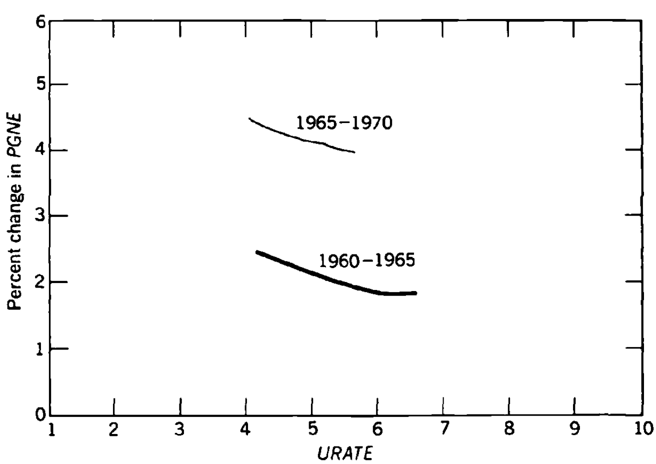
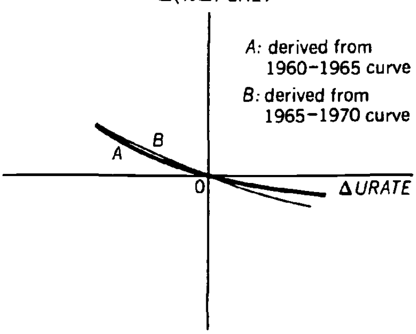


FIGURE 7 Comparison of Relative Costs of Inflation and Unemployment under Fiscal Policy, 1960–1965 and 1965–1970



Δ *URATE* = change over control solution value of *URATE*.
$\Delta(\%\Delta PGNE)$ = change over control solution value of percent change in PGNE.

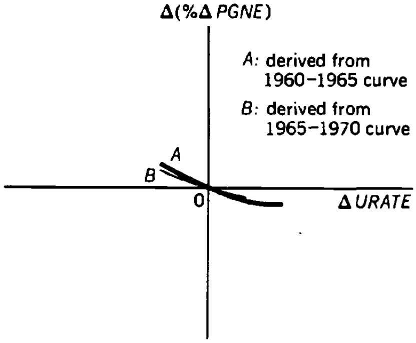
comparative analysis of the opportunity costs for the two subperiods. We notice that, to the left of the origin, the two curves can hardly be separated. Hence we can draw the conclusion that a given reduction in unemployment in both these subperiods could have been achieved at almost the same cost in terms of inflation. However, to the right of the origin, the slope of curve *A* is always flatter than that of curve *B*. This implies that the cost in terms of incremental unemployment of obtaining a reduction in inflation was higher in 1960–1965 than in 1965–1970.

Figure 8 is similarly derived from Figure 6, based on the trade-off curves using monetary policy. Again, curves *A* and *B* represent 1960–1965 and 1965–1970, respectively. Here the two curves appear largely to coincide throughout their full range.

To recapitulate, in the two subperiods examined, we found the trade-off curve to be shifting upward over time. An intuitive explanation of this shift is given in footnote 20. We also noticed that such a shift may involve as well a change in the opportunity cost of inflation in terms of unemployment.

Our treatment of the effects of changes in the external economic environment on the Canadian trade-off curves derived for 1965–1970 is similar to what we reported in the previous section for 1960–1965. We again worked with an accelerated rate of increase of U.S. prices equal to one percentage point annually. In Table 9, we

FIGURE 8 Comparison of Relative Costs of Inflation and Unemployment under Monetary Policy, 1960–1965 and 1965–1970



NOTE: Variables are defined in note to Figure 7.

TABLE 9 Trade-off with Assumed Higher U.S. Inflation during 1965–1970

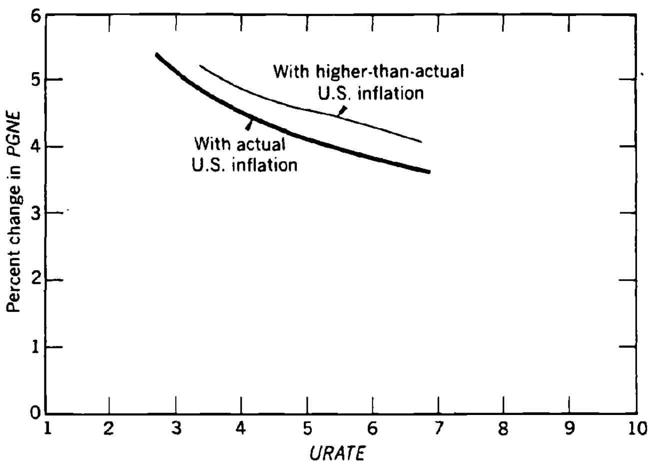
Fiscal Policy			Monetary Policy		
Change in *GCURRK* (millions of constant dollars)	*URATE*	Percent Change in *PGNE*	Change in *MHPC* (mil. constant dol.)	*URATE*	Percent Change in *PGNE*
			+500	3.84	5.02
+300[a]	3.31	5.27	+400	4.02	4.94
+200	3.61	5.13	+300	4.37	4.80
Control solution	4.69	4.69		4.69	4.69
−200	5.69	4.39	−200	4.99	4.59
−300	6.18	4.27	−400	5.28	4.52
−400	6.65	4.15			

NOTE: For definition of variables, see text.
[a] This represents an increase in *GCURRK* of $300 million in 1965 and 1969, $200 million in 1966–1968, and $400 million in 1970. For explanation, see Table 8, note a.

show the unemployment-inflation trade-offs for Canada for 1965–1970 under these assumptions, for both fiscal and monetary policies. If we compare these results with those of Table 8, we find essentially the same kinds of effects of higher U.S. inflation as were observed for 1960–1965. In particular, the new control solution produces a slightly better performance in terms of unemployment, but coupled with more inflation.

In Figure 9 we compare the trade-off curves based on fiscal

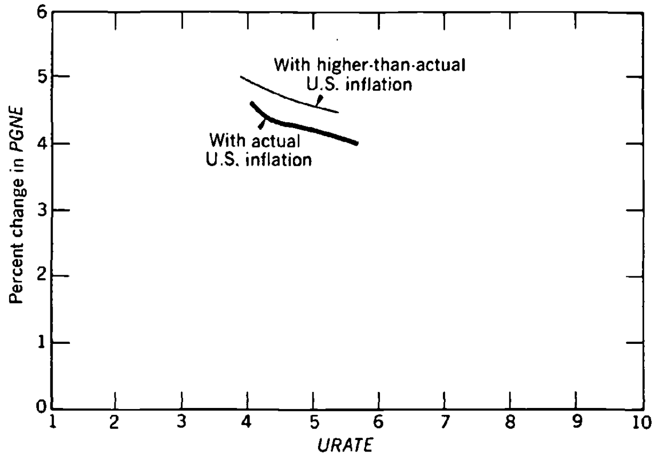
FIGURE 9 Shift of the Trade-off Curve Resulting from Higher U.S. Inflation under Fiscal Policy (GCURRK), 1965–1970



policy with and without increased rates of external inflation in the United States. In mild contrast to the 1960–1965 subperiod, the displacement is a largely parallel one, and an increase in U.S. inflation of one percentage point per year entails an increase in the annual rate of change of Canadian prices equal to four- to five-tenths of a percentage point, largely independent of the rate of unemployment, in the range studied. Similarly, the cost of insulating Canadian prices from additional external inflation is a considerably higher Canadian unemployment rate; due to the curvilinear nature of the trade-off curve, the required increment varies, depending upon the inflation target adopted.

Broadly similar conclusions may be drawn from Figure 10, in which we present the trade-off curves traced out by variations in monetary policy, with and without more rapid U.S. inflation.

FIGURE 10 **Shift of the Trade-off Curve Resulting from Higher U.S. Inflation under Monetary Policy (MHPC), 1965–1970**



IV. THE PERIOD OF THE NEW ECONOMIC POLICY AND ITS SUCCESSORS, 1970–1974

For 1960–1970, we have been interested in studying the behavior of a trade-off curve given different policy instruments, in testing the stability of the relationship over time, and finally, in raising questions about the impact of the external environment on our tentative conclusions. Since, in the 1970s, inflation has become such an important problem, we decided to devote a section to the effects of the U.S. price picture during 1970–1974 on Canadian economic performance. We not only wanted to know what our own price performance would have been if U.S. prices had increased by one more and one less percentage point than the actual rate, but we suspected that even a constant rate of growth instead of cyclical movements in the rate of price increase in the United States might have caused less harm to Canada.

In order to answer those questions, we first have had to forecast the subperiod 1970–1974 from the model. It is a forecast because the sample period covered by the model ends in 1971. Since data for 1972 were already known, and since we had preliminary figures for 1973 and for the first half of 1974, we decided to use a "tuned forecast"[21] of the period. The values for different variables generated by this forecast are used as a benchmark for the purpose of making comparisons with the results obtained with different scenarios.

To derive these alternative scenarios, we proceed as we did for the sample period, for the increase or reduction in the rate of change of U.S. prices by one percentage point. For the third scenario (the smoothed rate of inflation), the 1970 and 1974 levels of all U.S. prices (and the prices of Canadian exports) remain unchanged, but the price levels for the years in between are generated by applying the geometric average yearly growth rates of those prices during 1970–1974 to base-year (1970) prices. This gives us a group of smoothly increasing price series, in which each percentage yearly increase is constant. There are no longer leads and lags in the peaks of the rate of change of these prices. Of course, this is not to suggest that such a smooth movement of prices would be likely to take place, even in the absence of perverse policies. Nevertheless, such a polar case may be of interest in itself.

Higher Rate of U.S. Inflation

Inflation and Unemployment

Let us have a look first at the results of a higher rate of inflation in the United States. On average over the period, the mean percent change in *PGNE* (6.245) is higher than the control solution (6.057), and there is a decrease in *URATE* from 6.021 percent to 5.845. The bulk of the effect comes in the years 1971 and 1972, after which the economy seems to react very little. We admit that when these prices grow at a rate of 3 or 4 percent (as was the case during 1971 and 1972) the one-percentage-point increase would have more effect than when these prices are already increasing at a rate of 8 percent (as was the case near the end of the period 1970–1974).[22] Comparing the alternative scenario with the control solution, we observe that the mean level of *PGNE* increases by exactly one index point, from 1.479 to 1.489, and not more.

Wages and Industry Prices

Looking at the wage-price subsystem of the model, we find that total-economy wages (per man-hour) change from $4.059 as a subperiod average to $4.094. We expected large effects on Canadian wages and salaries in construction, transportation, and manufacturing industries because the equations for these variables in the model portray a considerable impact of U.S. wages on Canadian wages. On an average over the subperiod, wages per man-hour in construction, transportation, and manufacturing increase more rapidly—by 1.41, 1.74, and 0.14 percentage points,[23] respectively. In other industries, the results seem plausible.[24]

Since our industry prices depend primarily on unit labor costs (according to the model), it is not surprising to find patterns in industry prices analogous to those in industry wages. Thus, the implicit deflators of construction and transportation industries are considerably affected. They show a faster increase—3.06 and 1.98 percentage points, respectively. On the other hand, the deflator for manufacturing industry shows an increase of only 0.32 percentage points.

Foreign Trade

Terms of trade and income are two of the main factors influencing foreign trade. When we made autonomous increases in the prices of goods imported from the United States, we also changed all our export prices (see the discussion in section 2). Thus, there was hardly any change in the terms of trade between the United States and Canada. Furthermore, the U.S. GNP in constant dollars was not changed at all, and the Canadian GNP in constant dollars also is hardly changed in the present simulation. Hence it is not surprising to find that Canadian exports to the United States (in constant dollars) are not much affected on average over the subperiod. The same applies to Canadian imports from the United States.

Canadian exports to and imports from the rest of the world, in constant dollars, also show little change even though, on our assumption, Canadian prices rise relative to the prices of the rest of the world. Such a result can be expected if the goods imported into Canada from the United States and the rest of the world are not good substitutes and if there is little change in Canadian real income. Given virtually no change in these constant-dollar exports and imports, their value in current dollars increases by approximately the same proportion as the autonomous increase we introduced into the prices of goods exported and imported.

Real Growth and Expenditures

As already mentioned, constant-dollar GNP is hardly affected. Thus, the real growth of the economy does not change. Real disposable income, consumer expenditures, investment in machinery and equipment, and investment in nonresidential construction in constant dollars are also not much affected.

Investment in residential construction and the number of housing starts fall on average during the four years. We view this result with some apprehension because the housing starts equations have the variable *RTRB3M* – *RINDB*, which is the difference between the yield on three-month Treasury bills and the long-term industrial bond rate. This variable does not behave properly in the simulations.[25]

Lower Rate of U.S. Inflation

When we reduce U.S. inflation by one percentage point, we succeed in lowering our own average rate of price increases from 6.057 percent to 5.229 percent on the average while at the same time we do not have to pay for it by a higher unemployment rate. We even gain slightly in that respect in that *URATE* changes from 6.021 percent to 5.909 percent. Once again the average level of *PGNE* decreases by only slightly more than one index point: 1.464 instead of 1.479. Accordingly, the effect is not evenly spread throughout this particular subperiod. The main components of gross national expenditures[26] in constant dollars hardly change, except for investment in nonresidential construction, which shows an increase of 0.43 percent on average over the subperiod. Real disposable income, also, remains almost completely unchanged. Similarly, Canadian exports and imports in constant dollars do not show any significant changes.

The observations on wages in the case of higher U.S. inflation hold in reverse in the case of lower inflation. This symmetry is consistent with a priori reasoning, but the degree of responsiveness is not at all symmetrical. Industries such as agriculture and manufacturing, which did not show much increase in wages with higher U.S. inflation, now show a less rapid increase of almost two percentage points on average. On the other hand, financial services, public administration, and commercial business wages are less sensitive to an easing of U.S. inflation. For reasons given earlier, this asymmetry in the degree of responsiveness shows up in prices also.

Even Rate of U.S. Inflation

Simulating an even rate of inflation (as defined in the beginning of this section) was probably the most attractive experiment from the

Canadian point of view. It is very difficult to predict intuitively what overall effects an even rate would have for the Canadian economy. As for prices, the observed U.S. GNP deflator increased by 4.718 percent between 1970 and 1971, but then drastic anti-inflationary policies (such as wage and price controls) were successful in lowering it to about 3 percent. Inflation in the United States again increased sharply by the end of the subperiod 1970–1974. Thus, in general, if we transform the U.S. price series (and our export prices as discussed earlier), to incorporate an even rate of inflation, it will lower prices at the beginning of the period, raise them during the middle portion, and leave them nearly unchanged at the end. We expected other prices in the model to be affected similarly in this simulation.[27]

In this trial, we end up with the lowest unemployment rate (among our three simulations) and a lower average rate of price increase than the control solution. For 1970–1974, the unemployment rate decreased from an average of 6.02 percent to an average of 5.74, and the percent increase in the gross national expenditure (GNE) deflator decreased negligibly—from 6.05 percent to 6.02. Thus interestingly enough, simple elimination of the cyclical pattern of U.S. inflation, without even lowering the rate, improves the employment performance of the Canadian economy without any costs in terms of price performance. Indeed, we end up with a slightly lower level of the GNE deflator in 1974 even though, as expected, this level is higher than its level in the control solution for the middle years of the subperiod.

In general, wages per man-hour and industry prices show an increase relative to the control solution. This is not, however, true universally, as manufacturing wages and prices, for example, decline on average relative to control over the subperiod.

Canadian exports to the United States in real terms show an increase relative to control of 0.45 percent on average over the subperiod. This, coupled with the behavior of our transformed prices, increases the nominal value of Canadian exports to the United States during the middle years of the period 1970–1974. Even though exports to the United States, in real terms, show an increase in 1974 compared to the control solution, they show a decline in nominal terms because the decline of export prices relative to control in 1974 is sufficiently large to offset the increase in real terms. Again, in comparison to the control solution, exports to the rest of the world in real terms increase by 0.33 percent and, in nominal terms, exhibit the same behavior as exports to the United States.

On average over the subperiod, imports from the United States in real terms increase by 0.21 percent relative to the control solution. In nominal terms, they show an increase in 1971–1972, and almost no change in 1973–1974. Imports from the rest of the world are not affected much in real terms, but show a small nominal decline during 1972–1974.

Consistent with a reduction in unemployment rate, constant-dollar GNP compared to the control solution shows a slight increase —0.25 percent—on average over the subperiod. Real disposable income, consumer expenditures, and investment in machinery and equipment all show slight gains in real terms, but investment in nonresidential construction shows a slight decline. (Again we do not discuss investment in residential construction and housing starts, for reasons already mentioned.) In general, these gains in real terms without much reduction in price increases (and even with some increases in the middle of our subperiod) increase our major nominal aggregates such as disposable income, gross national product, corporate profits, and government revenues.

V. CONCLUDING REMARKS

The principal conclusions of this study may be stated briefly. In a medium-term context within the framework of the CANDIDE model, the trade-off curve does indeed exist: simulations of the model suggest that in a particular historical context with other relevant exogenous variables held constant, demand management policies can generate additional employment only at the expense of an acceleration in the rate of inflation. Alternatively, it can be said that demand contraction would have cut the rate of inflation only at the expense of some increase in the rate of unemployment. Under the regime of a fixed rate of foreign exchange (the only one studied), the trade-off curves derived from the simulations were relatively invariant to the type of demand management instrument (fiscal vis-à-vis monetary policy, or subvariants of fiscal policy) utilized. The curves were sensitive in the expected direction to the assumptions regarding U.S. inflation rates, although in the five-year subperiods analyzed there was far less than a full pass-through of an acceleration of the rate of U.S. inflation. Finally, as has been widely remarked, the trade-off curves derived in this study varied with the historical subperiod studied, and we obtained evidence of the recent upward shift (or shifts) in the Canadian trade-off curve, which has already been widely remarked in a number of discussions.

The caveats and qualifications of this study are less easy to present. A number of shortcuts and simplifying assumptions were utilized in our study, and we attempted to state all of them explicitly in our preceding discussion. Many of those simplifications are debatable ones and, accordingly, could be regarded as shortcomings of this study. Beyond those specific qualifications, we have the general issue of how well the Canadian economy is represented in CANDIDE Model 1.1. This is obviously not a subject that can be treated exhaustively in this discussion. In our forthcoming volume, in which we describe some of the details of CANDIDE Model 1.1, we present a number of points of self-criticism, and other members of the profession will doubtlessly add some other points as well. In our judgment, the CANDIDE model is reasonably well suited for this sort of exercise, even though we must candidly admit that the wage and price sectors are among the weakest portions of the overall model.[28]

Finally, we conclude by attempting to draw one tentative lesson for policy from our study. It will be recalled that a stabilization of the yearly rate of U.S. inflation at the geometric mean rate observed over the subperiod 1970–1974 had favorable effects on the Canadian economy, even though the subperiod mean rate of inflation remained unchanged. We guess that a parallel conclusion would hold for the U.S. economy itself. In other words, we think that the stop-go anti-inflation policy practiced in the United States during those past four years may have been harmful to the North American economies, as contrasted with a more evenhanded policy. (Of course, even for the Canadian economy, the degree of harm has probably been overstated by the polar case we have studied.) It must be admitted that that at the time we wrote our paper, this was little more than a conjecture for the much larger U.S. economy, although we hoped to get some enlightenment on this point at the conference itself.[29] But if this point is correct, it has an obvious and immediate application to demand management and other policies designed to counteract inflation.

NOTES

1. This approach is developed at some length in two of Bodkin's earlier papers: "Wage and Price Formation in Econometric Models," in N. Swan and D. Wilton, eds., *Inflation and the Canadian Experience* (Kingston, Ont.: Industrial Relations Centre of Queen's University, 1971), and "Wage and Price Formation in Selected Canadian Econometric Models," in Otto Eckstein, ed., *The*

Econometrics of Price Determination (Washington, D.C.: Board of Governors of the Federal Reserve System, 1972). As James Tobin indicated in his summary of the Federal Reserve conference (pp. 5–15), the bulk of the papers presented there either focused on or at least touched on the issue of the existence or nonexistence of a long-run trade-off curve in the context of a sophisticated full model of a developed economy.

2. In his comments on Bodkin's "Wage and Price Formation in Econometric Models," John A. Sawyer raised the issue of whether it was legitimate to take the wage and price relationships out of the full model context in which they were embedded (in Swan and Wilton, eds., *Inflation*, pp. 123–126). (He also questioned whether the trade-off relationship, even if it can be shown to exist, is the most useful piece of information that the model builder can give to the policymaker, but that is not our concern here.) In this paper, we have attempted to follow up on Sawyer's first question. In particular, we have tried to do what S. F. Kaliski recommended in a more recent study, although he himself did not carry out the suggested analysis [*The Trade-off between Inflation and Unemployment: Some Explorations of the Recent Evidence for Canada*, Special Study 22 for the Economic Council of Canada (Ottawa: Information Canada, 1972)]. Kaliski asserts: "General considerations suggest that the trade-off or wage-price-unemployment subsector ought to be part of a larger model of the economy" (p. 109). Although the optimum-sized model of the economy for this purpose is still a moot point, there appears to be agreement that it should be larger than the usual two- or three-equation subsystem used to generate the typical trade-off curve, if only because of the important endogeneity of the critical variable, the rate of unemployment.
3. Details of the structure of the model utilized in this study may be found in Ronald G. Bodkin and Stephen M. Tanny, eds., *CANDIDE Model 1.1*, CANDIDE Project Paper 18, Economic Council of Canada for the Interdepartmental Committee (Ottawa: Information Canada, 1975). A statement in some depth of the salient features of the parent CANDIDE Model 1.0 may be found in M. C. McCracken, *An Overview of CANDIDE Model 1.0*, CANDIDE Project Paper 1, published by the Economic Council of Canada for the Interdepartmental Committee (Ottawa: Information Canada, 1973). Further details of Model 1.0 may be found in CANDIDE Project papers 2 through 17, a few of which had not yet been published at the time this paper was written.
4. By comparison, CANDIDE Model 1.0 was somewhat smaller. It had 377 exogenous variables and roughly 1,525 equations, which could be classified into slightly less than 570 behavioral equations, roughly 400 input-output relationships, and roughly 560 ordinary identities.
5. CANDIDE Model 1.1 is block-recursive, with a small number of equations that can be solved prior to the simultaneous core of the model and a small number of equations that can be solved afterward. Within the set of anterior equations, we have a demographic submodel that generates estimates of the Canadian population, households, and major age-sex subgroups from such fundamental determinants as the overall fertility rate, marriage rates, death rates, and net immigration rates. (All these fundamental determinants, except the last, are exogenous in CANDIDE Model 1.1; through the net immigration rates, Canadian population is made responsive to economic conditions, albeit with a lag.) In between the anterior and posterior equations, we have the large simultaneous core, as mentioned in the text.

   The software employed to manage the computer files of the model and also to solve the set of nonlinear equations that constitutes the system could be the subject of a full discussion in itself. An introduction to the CANDIDE software may be found in McCracken, *An Overview*, App. A.

6. A brief history of the project may be found in "Foreword to the CANDIDE Model 1.0 Series of Project Papers," which appears in each of the first seventeen CANDIDE Project papers.
7. A summary description of the input-output aspects of CANDIDE Model 1.0 may be found in Ronald G. Bodkin, "The Use of Input-Output Techniques in a Large Scale Econometric Model of the Canadian Economy (CANDIDE)" (paper presented to Sixth International Conference on Input-Output Techniques, Vienna, Austria, April 1974). In turn, this paper was based on CANDIDE Project papers 8 and 12, in which the treatment employed is discussed in some detail. Finally, it must be mentioned that the CANDIDE input-output submodels reflect a heavy input of the labors of the Input-Output Research Division of Statistics Canada. These submodels are essentially a condensation of the large rectangular input-output system described in Statistics Canada (formerly Dominion Bureau of Statistics), *The Input-Output Structure of the Canadian Economy 1961*, Catalogue no. 15-501 Occasional (Ottawa: The Queen's Printer, 1969).
8. Ross S. Preston, *The Wharton Annual and Industry Forecasting Model*, Studies in Quantitative Economics, no. 7 (Philadelphia: University of Pennsylvania, Economics Research Unit, 1972).
9. McCracken, *An Overview*, p. xi.
10. Kaliski, *Trade-off between Inflation and Unemployment*, p. 5.
11. Another important dimension can be added to a study such as ours by also considering whether the exchange-rate regime in operation is fixed or floating. However, we left aside this interesting problem because we feel that the mechanism for determining the exchange rate when the rate floats is too weak in the present CANDIDE model to support such an exercise.
12. In our model, as *GCURRK* is an identity which sums its components, we have to vary all its components according to their relative weights as a mean in the subperiod in order to get an appropriate increase or decrease in *GCURRK*.
13. When we change government expenditures without modifying the supply of high-powered money (as in our first three experiments), we force interest rates to adjust accordingly. The subsequent change in the three-month Treasury bill rate and in all other interest rates linked to this key rate affects investment.
14. Another approach would have been not to hold the monetary block exogenous but to change the supply of high-powered money by a method of trial and error (which in the case of a big model like CANDIDE would be an extremely expensive exercise), until we are successful in keeping the interest rates approximately the same as in the control solution (but never exactly). It can be argued that the observed values of interest rates, which we use in our simulation, still differ from the values of these variables in the previous control solution. These two methods are not perfect substitutes because by keeping the monetary block exogenous we are breaking the normal feedback from the real sector to the monetary sector.
15. Even though we were sometimes successful in our efforts (especially in the case with the monetary block exogenous) to obtain a very low unemployment rate in our simulations, such calculations are, in part, only an academic exercise. We do not believe that Canada would have been successful in keeping its rate of unemployment from diverging from the U.S. rate by more than (say)

1.0 to 1.5 percent, and indeed a larger divergence has never been observed historically.

16. Both *MHPC* and *GTR* are in current dollars. Compared to *MHPC*, changes in *GTR* have relatively little effect in the model because the only channel through which they operate is changes in disposable income, and hence they have only an indirect effect on production.
17. Prices of imports from the United States *in Canadian dollars*, which are endogenous in our model, are simple functions of these exogenous prices and hence are automatically adjusted. Adjusting the exogenous import prices (in U.S. dollars) also changes the prices of competing imported commodities, which are an important determinant of the prices of domestically produced commodities in our price-side input-output submodel.
18. We agree that this is a gross simplification of the interrelationships between U.S. and Canadian prices. In the export of some commodities, such as oil, wheat and some raw materials, Canada probably has some market power in trade. However, in the absence of a known systematic relationship, this is probably the best assumption that can be made. We are thus positing a neutral change in North American markets, in which the prices of U.S. and Canadian exports increase more rapidly by the same number of percentage points on average over the subperiod. This assumption is made essentially for the convenience of the analysis.
19. This increase in price level would thus be cumulative over time. The 1961 increase in price over 1960 would thus be greater by one percentage point compared to historical levels. However, because we increase the 1962 price over the new 1961 price which has already been increased, the new 1962 price will be higher than the 1962 price by more than 1 percent; and indeed, it will be higher by approximately 2 percent. This cumulation of the effects of a higher rate of inflation continues, and has a compound interest effect.
20. In a simultaneous system, each dependent variable depends in general on the totality of the independent variables, and in a dynamic system the independent variables include those that are truly exogenous as well as the lagged values of the endogenous variables that constitute part of the system. Accordingly, at the highest level of generality, it is difficult to pinpoint causal relationships. Nevertheless, after using the model for some time and thus gaining a familiarity with its properties, we can make some more definite statements, provided the reader is willing to accept the results of educated intuition. It would appear that the upward shift of these trade-off curves between the two subperiods would in large part reflect a faster rate of inflation in the United States. (This point is illustrated immediately by a comparison of figures 3 and 4 with 5 and 6.) Secondly, the model has considerable inertia built into it, which reflects presumably similar dynamics in the Canadian economy itself. Once a pronounced movement of wages and prices gets under way, it will tend to perpetuate itself regardless of current economic conditions. This tendency of the model, together with the configuration of a high rate of price change and a low rate of unemployment at the beginning of the period, is a second aspect of a simple explanation of the upward shift in the trade-off curves between the two subperiods. [Footnote added, following critique of D. J. Daly at the conference.]
21. We feel that it is desirable to tune the forecast produced by a model if new information becomes available for some part of the forecast period. The process of tuning the model in the context of our discussion simply means that we do

not always take for granted all the forecasts produced by the model but rather make some adjustments to some of the equations of the model in light of the extra information available, so that the model generates forecasts closer to what is indicated by this new information.

22. A one-percentage-point increase in prices with a 4 percent rate of inflation amounts to a 25 percent increase in the rate of inflation, but compared to an 8 percent rate of inflation, it amounts to an increase of only 12.5 percent.

23. On a year-to-year basis, higher U.S. inflation has an almost negligible impact on wages in the construction industry in 1971 and 1972, but in 1973 and 1974 wages increase more rapidly—by 1.69 and 3.52 percentage points, respectively. This happens mainly because of the lag structure of the U.S. wage rate variable in the equation for construction industry wages. This variable appears to have a coefficient of 1.93 with a one-year lag and 0.68 with a two-year lag.

    The percentage-point figures for yearly acceleration in the wage increase in transportation are 1.39, 1.37, 1.88, and 2.27 for 1971–1974, respectively. The sum of the coefficients for the lag structure of the U.S. wage rate variable in this case is 0.643. But the variable that puts such considerable pressure on these wages to rise is the lagged consumer price index, which has a coefficient of 0.917. Such a structure allows us to get more than the one-percentage-point increase as early as the first year, and this effect continues to cumulate over the subsequent years.

    In the case of manufacturing, even though the lagged U.S. wage rate appears with a coefficient slightly greater than unity, we do not run into this cumulative process because the lagged dependent variable in this case appears with a negative coefficient (−0.2868) and, in addition, the reciprocal of the unemployment rate as an explanatory variable counteracts some of the pressure from higher U.S. wages.

24. Fishing, however, offers a strange pattern, and this holds for the three simulations and for prices in that industry also. However, this is a relatively small industry, and we need not worry too much about it.

25. Included in the model is a rule that does not allow *RTRB3M* to diverge too much from a corresponding U.S. interest rate. This condition was introduced as a check for our balance-of-payments constraints. When our rate is above the U.S. rate plus 0.5 percentage points, the former is set equal to this upper limit and when it is less than the U.S. rate, it is reset equal to the U.S. level; in each case, we correct for our supply of high-powered money accordingly. When the system is shocked, *RTRB3M* diverges widely, after a time, from the U.S. interest rate and hence is kept within the range arbitrarily. In the simulations, the effect showed up in 1973 and after. The same story repeats itself in other scenarios. However, *RINDB* fluctuates in the simulations, and thus the variable *RTRB3M* − *RINDB* creates distortions in the pattern of reactions.

26. Given our experience with the behavior of *RTRB3M* − *RINDB*, we are not analyzing the effects of this simulation on investment in residential construction and housing (see the preceding footnote).

27. Again, this is not to imply that prices in the United States, particularly prices of U.S. exports, would have behaved in this even fashion in the absence of the alternating patterns of controls and decontrols. (This point has particular force when it is recalled that U.S. export prices were generally not subject to regulation during the period of controls.) However, the examination of a polar case may still be of some interest.

28. As summarized in the two earlier Bodkin papers cited in note 1 above, this relative weakness of the wage-price subsystem is by no means unique to CANDIDE, but appears to characterize the current generation of econometric models almost universally.
29. See, in particular, the comparison papers by Marvin H. Kosters (Chapter 4 in this volume) and by Al-Samarrie, Kraft, and Roberts (Chapter 6). The stimulating Bosworth-Vroman paper (Chapter 3) indicates cogently, in our judgment, the limitations of a strictly empirical analysis of this unique historical experience.

COMMENTS

D. J. Daly

York University

I am glad to see a paper on the topic of recent inflation in Canada for three reasons. First, the subject is of considerable importance to economists, policymakers in government, decision makers in business, and the general public. Second, the paper reflects the use of a large econometric model of final demand, prices, employment, unemployment, and a substantial degree of industrial disaggregation. Finally, the senior author has published widely on applications of econometrics to wage-price and unemployment issues, and has widened his experience by two years in a senior operational role in the Economic Council of Canada.

Let me outline briefly what the authors have done in the paper. This is the first paper on a complete re-estimation of the Canadian CANDIDE model using annual data for 1955–1972. It is a 2,100-equation model with 450 exogenous variables, 625 behavioral equations, more than 400 input-output identities, and over 1,000 ordinary identities. It is thus a large computer-oriented, disaggregated, general-purpose model. It integrates input-output models of relative price determination and employment-output determination by industry. The model is neo-Keynesian and in the tradition of the Brookings and Wharton models for the United States.

In this paper, the authors use the model to simulate a Phillips-type trade-off curve for unemployment and price change. Simulations are made of alternative exogenous patterns on government expenditure change (current, fixed capital formation, and transfer payments) and monetary policy (constant interest rates and variations in high-powered money). The differences in the derived trade-off curves tend to be small, and the curves derived to be only marginally different from those obtained in earlier studies of smaller and simpler models. The authors also did simulations with alternative rates of price change in the United States, with results that indicate that this affected the derived Phillips curves for Canada.

In addition, simulations were made for three different time periods—1960–1965, 1965–1970, and 1970–1974. One important result from the subtime periods was that an outward shift of the Phillips curve was obtained for the 1965–1970 period compared to the previous five years. The authors suggested that the "simple elimination of the cyclical pattern of U.S. inflation, without even lowering the rate, improves the employment performance of the Canadian economy without any costs in terms of price performance."

Since a Phillips-curve relation was used in the specification and estimation of a number of the wage equations at the industry level, it is not surprising that it re-emerges in the aggregative simulations. It is surprising that so much effort went into such a simple point when there are other important topics needing study.

There are five areas that I would like to comment on, some of which relate to this particular Canadian model and the problems of analysis and policy in a small country, and others, to the broader family of models of this kind. A number of the comments raise points of a much broader nature than were covered within this particular conference paper.

My first concern relates to the incomplete documentation in the public domain on the CANDIDE model. The initial results were published two years ago, some of the staff studies related to Model 1.0 are still not published, and we now have the first paper on the next model. With a large, complex model, the sponsoring organization has a responsibility to make the basic information public more quickly than the Economic Council has been doing over the twelve years it has now been in operation. This is the advice I gave consistently when I was inside the organization, and I am now repeating the same advice outside. Ronald Bodkin has some responsibility in this area, and it is to be hoped that the performance on Model 1.1 will be better than it has been on 1.0.

The second question I wanted to raise concerns the stability of the input-output coefficients over time, a question that is relevant to the U.S. models also. Over the years, the assumptions that

Leontieff initially made of stability over time have been softened both in Preston's work for the United States and in the CANDIDE model used here. In the more detailed write-ups on the model (as set out in footnotes 3 and 7 of the paper) it is recognized that the coefficients of the industry technology matrix can change because of technological change, compositional shifts, relative price changes, and possible changes in taste. The procedures used make revisions to take account of changes in the shares of real GDP by industry, but the changes imply a continuation of past observed changes into the future.

What can we say about such procedures to extrapolate changes in the I/O coefficients over a twenty-year period? We do not have a test of this for Canada, but let me draw the attention of the model builders and the audience to a paper by Bea Vaccara and Nancy Simon done at an earlier conference of this body.[1] After standardizing for changes in final expenditures, they found significant changes in I/O coefficients over time, and later work reinforces the earlier results and suggests erratic, rather than systematic, changes in the coefficients. The changes for 1958–1963 are just as large as in their earlier study.

My own view is that the problems will be even *more* acute in Canada than these U.S. data suggest. The Canadian economy is much more open to international trade influences than the U.S. one, and exports and imports are much more important as demand and supply sources for such a small country. Cyclical changes in internationally traded goods are an integral part of the transmission of business cycles. Furthermore, over the period covered by the simulations, new elements have been introduced that were not present over the period used in estimating the model. For example, the Canadian dollar has appreciated about 8 percent since May 1970, and this has significantly affected the profit and price pictures in both export and import-competing industries. Since about 1967, the gap between the two countries in money and real weekly earnings in manufacturing that had persisted since 1900 has almost completely disappeared. This narrowing is partly the result of reductions in tariffs and of the Canada-U.S. trade arrangements. There is no reflection of an allowance for such structural changes in the discussions that I have yet seen on the CANDIDE models.

The third issue I raise concerns estimation procedures and applies to models of this kind, together with a number of the other papers presented at this conference. It relates to the implications of the collective bargaining process for wage settlements and the assumptions made in the basic structural equation estimations. The wage settlement process in unionized industries (covering about 20–25 percent of the Canadian labor force) involves a settlement frequently two or three years ahead, with a larger settlement in the first year. Thus, average hourly and weekly earnings in a particular year (or quarter) reflect developments not only in the current period, but one and two years earlier. The standard practice in estimating is to assume independence in the disturbances in the structural equations, and if estimates are made without allowing for intercorrelation between the independent variables and the residuals, the coefficients and *t* statistics will be biased. This statistical criticism by Rowley and Wilton of such Phillips-curve estimates made by Perry and Bodkin, Reuber, and others has not been met or mentioned in this paper. It would apply to estimates both of the levels and first differences in wages and to annual as well as quarterly estimates.

Fourth, I wish to point up the shift shown in the Phillips curve between 1960–1965 and 1965–1970. In Bodkin's earlier paper for the Economic Council of Canada, he had argued that the curve was fairly stable and could be used in policy discussions. This paper does not contain a reference to the earlier paper or an explanation of the shift in the second period. At the beginning of section III, it is stated that "working with the full model does not . . . allow us to be . . . explicit about the factors explaining the shift of the curve . . . , even though such an analysis could be important for policy decisions." If those involved in producing the model and the simulations cannot explain and defend the results, the outside professional is bound to be increasingly nervous about projecting the model into a situation of accelerated price developments, no matter what the ultimate or proximate factors in price inflation may be.

Let me just raise one more point. Anderson and Karnosky, in the first paper at this conference, provided a monetary interpretation of inflation. I have read about many past inflationary periods, but I cannot recall any in the industrialized countries which had not been preceded by a period of rapid monetary expansion. It may not be a sufficient interpretation of the last five years, as special circumstances of Vietnam, oil, food prices, and exchange rate changes have clearly been present. Anderson and Karnosky were concerned about a rate of monetary expansion of 6 percent in the United States. For Canada, over the three five-year periods used in the CANDIDE paper, the rates of monetary expansion have been 9.0, 10.25, and 16.4 percent per year compounded (based on an M_2 definition of money supply). These rates are well above the rates of increase in potential output estimated by CANDIDE and earlier methods used by the Economic Council of Canada.

May I suggest that there is a relevant domestic factor in the acceleration in the rate of increase in domestic prices in Canada over the period covered in this paper. More attention to the monetary implications of some of the earlier work by the ECC might have been very useful for government economic policy. The costs of looking at the rates of monetary growth over six- to nine-month periods (by any measure) would have been small, and I think it is undesirable for an agency to put all its eggs in one research basket.

NOTE

1. Bea Vaccara and Nancy Simon, "Factors Affecting the Postwar Industrial Composition of Real Product," in J. W. Kendrick, ed., *The Industrial Composition of Income and Product*, Studies in Income and Wealth 32 (New York: National Bureau of Economic Research, 1968), pp. 19–58.