Working Paper 90-1/Document de travail 90-1

The Dynamic Effects of Exchange Rate Changes on Canada's Trade Balance, 1982-1987

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1982 - 1987

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December 1989

This paper was prepared for the
XXV Meeting of Technicians of Central Banks
of the American Continent,
Washington, D.C.,
October 17-21, 1988.

The authors would like to thank John Murray
for his helpful comments.
Any errors are the responsibility of the authors.

Abstract

Until recently, most of the analysis that the Bank of Canada has conducted on Canada's trade balance has been based on RDXF, a large macroeconomic model which contains a very detailed trade sector. However, experience has shown that a smaller, less disaggregated, trade model might be better suited for investigating some important analytical issues. A preliminary version of such a model is presented in this paper.

In spite of its small size, the model is able to incorporate many of the compositional and sectoral effects of the larger model and provides more realistic dynamic responses to various shocks. Non-linearity in the response of imports to changes in domestic demand and long lags associated with changes in competitiveness and real commodity prices are distinguishing features. The intra-sample fit and extra-sample forecast performance of the model are quite respectable, and the estimated parameter values appear to be reasonably stable over the sample period.

The paper presents a series of simulations designed to estimate the contribution of movements in the exchange rate and other variables to the evolution of the trade balance over the period 1982-1987. A similar decomposition is performed on export and import prices over the period 1986Q4-1988Q1.

Résumé

Jusqu'à récemment, la plupart des analyses de la balance commerciale canadienne effectuées à la Banque du Canada étaient fondées sur RDXF, un vaste modèle macroéconomique renfermant un secteur du commerce extérieur que formalisent un grand nombre d'équations. Toutefois, l'expérience a montré qu'un modèle de commerce extérieur plus petit et moins détaillé pourrait mieux convenir à l'étude de certaines questions importantes. Cette étude présente une version préliminaire d'un modèle de ce type.

Malgré sa petite taille, le modèle parvient à saisir un grand nombre des effets de composition et des effets sectoriels qu'on retrouve dans RDXF, et les réactions dynamiques à différents chocs y sont plus vraisemblables. Il se caractérise notamment par la non-linéarité de la réaction des importations à des modifications de la demande intérieure et par les longs décalages liés aux variations de la compétitivité ou des prix réels des produits de base. L'ajustement du modèle pour la période d'estimation et les prévisions effectuées au-delà de cette période sont d'une précision respectable, et les valeurs des paramètres estimés semblent assez stables sur l'ensemble de la période d'estimation.

L'étude décrit une série de simulations visant à estimer le rôle que les variations du taux de change et d'autres variables ont joué dans l'évolution de la balance commerciale entre 1982 et 1987 et dans la détermination des prix des exportations et des importations durant la période allant du dernier trimestre de 1986 au premier trimestre de 1988.

THE DYNAMIC EFFECTS OF EXCHANGE RATE CHANGES ON CANADA'S TRADE BALANCE 1982 - 1987

Until recently, most of the analysis that the Bank of Canada has conducted on exchange rate movements and Canada's balance of trade has been based on RDXF, a large macroeconomic model. This model contains a detailed trade sector designed to capture disaggregated sectoral developments as well as the effects of changes in the composition of demand on exports and imports. Although RDXF continues to play an important role in the International Department's research and forecasting activities, experience has shown that a smaller, less disaggregated, model might be better suited to some analytical issues. Moreover, questions have recently been raised regarding some of the dynamic properties of RDXF -- in particular the extremely short adjustment lags that are assigned to many of the export equations in the trade block.

In response to these concerns, we have constructed a smaller and more "transparent" model; one that tries to preserve the best features of RDXF, yet has properties that are more consistent with our views. If future tests indicate that the model is performing satisfactorily, it will be used in parallel with RDXF in our research work, and will serve as a basis for future revisions to RDXF.

A preliminary version of the new model is presented in this paper, with particular attention to the dynamics of exchange rate shocks, the predictive performance of the equations, and the results of stability tests. A series of simulations are presented, designed to estimate the contribution of movements in the exchange rate and other variables to the evolution of the trade balance over the period 1982-1987. A similar decomposition is performed on export and import prices over the period 1986Q4-1988Q1. Particular emphasis is given to the pass-

through effects of exchange rate changes, as the Canadian dollar experienced a significant appreciation through most of this period. In spite of this model's small size, it is able to incorporate many of the compositional and sectoral effects of the larger model and provides more realistic dynamic responses to changes in competitiveness and real commodity prices. The intrasample fit and extrasample forecast performance of the model are quite respectable, and the estimated parameter values appear to be reasonably stable over the sample period. The paper concludes with a short summary and suggestions for future research.

I. A Model of Canadian Trade

The notation that we use in our model is presented in Appendix 1; the identities and individual stochastic equations are shown in Appendix 2. The model comprises six stochastic equations. Two explain the price and volume of total exports (excluding crude oil, natural gas, wheat, office machines and equipment, and unallocated exports); two explain the price and volume of total imports (excluding crude oil, office machines and equipment and unallocated imports); and two explain the volumes of exports and imports of office machines and equipment.

Trade in crude oil, natural gas and wheat is treated as exogenous and is excluded from the model, since it is explained largely by supply factors and institutional arrangements. Unallocated exports and imports are also excluded, since they are relatively small and reflect for the most part unallocated balance of payments adjustments to customs data. Office machines and equipment, on the other hand, are included, but are estimated separately from other endogenous

imports and exports because their prices and volumes have exhibited extreme movements in recent periods. Rapid technological advances in computer equipment, by far the largest component of the offices machines and equipment category, have lowered the "quality-adjusted" prices of these products and have dramatically increased export and import volumes.

The model is fairly eclectic in its design, making use of both demand and supply elements to explain exports, and allowing international price discrimination to affect import prices in the short run. Competitiveness is measured as a ratio of adjusted domestic and foreign GDP deflators rather than as a ratio of export prices to adjusted foreign prices, which would capture only demand incentives. The trade-weighted activity and foreign price variables used in the model were drawn from the detailed disaggregated structure of RDXF. These weighted variables were introduced to ensure that composition effects, which exert an important influence on Canadian trade flows, were given adequate recognition. Most of the equations in the quarterly model were estimated over a sample period running from the early 1970's to 1987Q2.

A. Econometric Strategy

Our estimation strategy was based on a procedure popularized by Hendry[1]. According to this approach, one begins with a general representation that

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1. See, for instance, D.F. Hendry and J.F. Richard, "On the Formulation of Empirical Models in Dynamic Econometrics," Journal of Econometrics 20(1982):3-33.
D.F.Hendry, A.R. Pagan and J.D. Sargan, "Dynamic Specification," Handbook of Econometrics, Vol. 2, edited by Z. Griliches and M.D. Intriligator. Amsterdam: North-Holland, 1984.

includes lags on all the predetermined variables, gradually reducing the model to a more parsimonious representation by excluding insignificant coefficients. While satisfactory results were obtained for many of the model's variables, a problem arose with the influence of competitiveness: most of its long-run effect was felt on impact (i.e. only the contemporaneous variables were significant in the equations). Suspecting that this might have been caused by problems of multicollinearity, we decided to impose longer (and more realistic) lag lengths on the competitiveness variables. Freely estimated and constrained versions of the model were then compared on the basis of their explanatory power over the 1980-1987 period.

To improve the dynamics of the model, we replaced the free lags on the competitiveness variables with Almon lags of various lengths, while retaining a lagged dependent variable in each equation. Subsequent testing showed that long Almon lags were statistically significant and produced lower standard errors than regressions with shorter lag lengths. Therefore longer lags were incorporated in the final equations. Almon lags were also preferred to free lags on the real commodity price variable in the export volume equation. Although they were distorted by multicollinearity, parameter estimates from the regressions which were run on free lags indicated that higher real commodity prices had a sizable positive effect on export volumes. The Almon procedure allowed us to capture this in a more transparent manner and provided a better fit.

B. Import and Export Volumes

XGN and MGN represent endogenous exports and imports (excluding office machines and equipment). They are determined by three common factors: competitiveness (measured by an effective real exchange rate), activity (measured by trade-weighted averages of sectoral and aggregate demand variables), and capacity utilization rates[2]. In addition, real commodity prices are included in the export equations, and changes in aggregate demand are allowed to influence the level of imports.

Table 1 reports the long-run elasticity estimates for the volume equations, and Table 2 compares the elasticities with those from other models. With respect to activity and competitiveness, the long-run elasticities appear to fall within the range of previous estimates.

The XGN and MGN equations indicate that Canadian exports and imports are quite sensitive to changes in competitiveness and that the Marshall-Lerner condition is easily satisfied. Their response is gradual, however; three years are needed for 75 per cent of the long-run effect to be felt. Moreover, the largest incremental effects occur in the second and third years.

XGN reacts positively to a rise in real commodity prices. The latter could be seen as capturing aspects of international demand for raw materials that are not adequately accounted for in ACTX, the foreign activity variable included in the equation. In this case, one would expect XGN to respond quickly to

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2. In the case of exports, we used the capacity utilization rate in U.S. manufacturing as a proxy for excess demand (supply) in all foreign countries; in the import equations, we used the ratio of gross private business product to trend output in Canada.

TABLE 1

LONG-RUN ELASTICITIES FROM EXPORT AND IMPORT VOLUME EQUATIONS

	Activity	Capacity Utilization Rate	Real Prices	Competitiveness
XGN	1.1	0.4	0.6[1]	0.8
XOME	1.0c	-	-1.4[2]	1.0c
MGN	1.0	0.3	-	-1.1
MOME	0.9c	-	-1.5[3]	-0.9c

c: constrained elasticity

1. Price of raw materials (excluding wheat, crude oil and natural gas) relative to the price of finished goods in the United States (RPRIM).
2. Price of office machines and equipment relative to the GNE deflator in the United States.
3. Price of office machines and equipment relative to the GDP deflator in Canada.

TABLE 2

A COMPARISON OF LONG-RUN TRADE ELASTICITIES FOR CANADA

	Import Volumes		Export Volumes	
	Competitiveness	Activity	Competitiveness	Activity
O.E.C.D. Interlink (1987)[1]	-1.1	1.5	1.2	0.8
I.M.F World Trade Model (1988)[1]	-0.9	1.4	0.4	0.8
Bank of Canada RDXF(1988)[2]	-0.5	0.8[3]	0.7	1.7
Model used in this paper	-1.1	1.0[3]	0.8	1.1

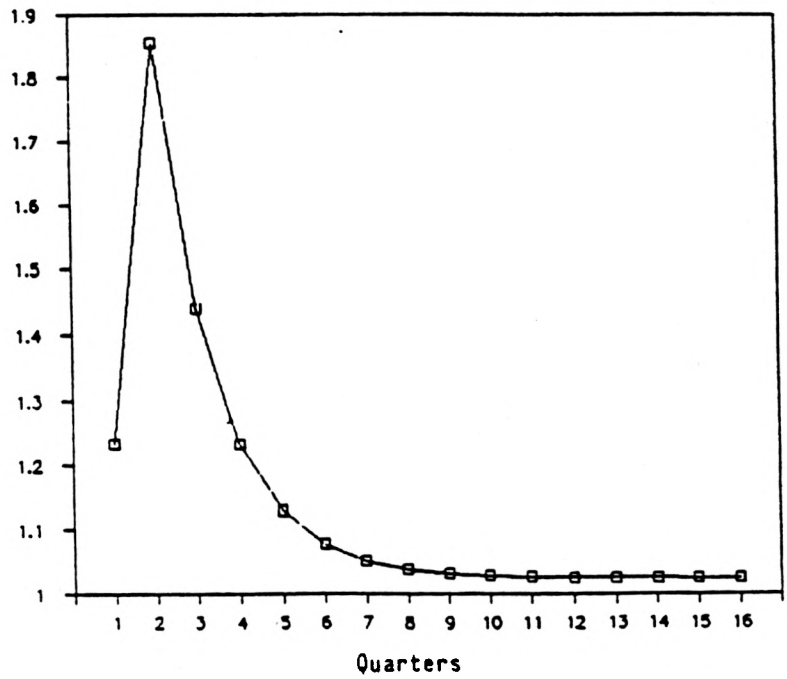
1. For manufactured goods.
2. All goods except crude oil, natural gas and wheat.
3. With capacity utilization remaining constant. The elasticities would be higher with endogenous capacity utilization.

changes in commodity prices. Alternatively, the relationship could represent a positive export supply response, which would likely involve longer lags. Since the adjustment of XGN to changes in real commodity prices is spread over 2 1/2 years in the model, the supply effects would appear to dominate.

The long-run elasticities on the activity variables for MGN and XGN are both about 1.0. Given the pro-cyclical behaviour of the trade-weighted demand components incorporated in the activity variables, these elasticities imply much higher elasticities relative to GDP. Capacity utilization rates in the United States and in Canada also exert a significant influence on export and import volumes, respectively. The non-linear response of imports to cyclical developments is further reinforced by a variable representing the trade-weighted growth of final domestic demand. Because of this "accelerator," a permanent shock to activity has a much larger effect on impact than it does in the long run (Chart 1), assuming unchanged capacity utilization.

CHART 1

RESPONSE OF IMPORT VOLUMES (MGN) TO A 1 PER CENT SHOCK ON ACTIVITY
(per cent)



Competitiveness and cyclical developments have presumably affected exports and imports of office machines and equipment (XOME and MOME), but their effects have been overshadowed by the response of XOME and MOME to the large drop in real computer prices noted earlier. As a result, we found it necessary to impose elasticity values on the competitiveness and activity variables similar to those estimated for XGN and MGN. Elasticities for the real price of office machines and equipment were then estimated freely. The estimated long-run values for XOME and MOME were -1.4 and -1.5, respectively.

C. Prices of Imports and Exports

Table 3 shows the impact and long-run elasticities for the two price equations, PXGN and PMGN. The long-run effects of changes in foreign prices and the (trade-weighted) nominal exchange rate on export and import prices are almost identical. However, import prices appear to respond much faster than export prices to exchange rate changes. As a consequence, exchange rate shocks have a significant effect on the terms of trade in the short run.

TABLE 3

ELASTICITIES IN EXPORT AND IMPORT PRICE EQUATIONS

	Foreign prices	Trade-weighted exchange rate	Normalized unit labour costs	Real "sensitive" prices[1]
PXGN				
-impact	0.3	0.3	0.1	0.1
-long-term	0.8	0.8	0.2	0.2
PMGN				
-impact	0.7	0.7	0.2	-
-long-term	0.9	0.9	-	-

1. Bank of Canada index of sensitive commodity prices, in U.S. dollars, relative to the wholesale price index for finished goods in the United States.

Although we might expect Canada to be a price-taker in most of its export and import markets, the long-run price pass-through from changes in exchange rates and foreign prices is less than one for both exports and imports. Evidently Canadian demand and supply are large enough relative to world demand and supply to exert a significant influence on the prices of certain products. This may be due to product differentiation or to the prevalence of oligopolistic market structures. Both PXGN and PMGN are influenced by normalized unit labour costs in Canada. The responsiveness of imports to domestic costs, and hence to domestic prices, is consistent with international price discrimination.[3] The response is temporary, however, suggesting that the ability of foreign exporters to act as discriminating monopolists is limited in the long run.

Canadian export prices are more sensitive to movements in spot commodity prices than are U.S. wholesale prices, which are used to construct the foreign price variable (PFORX) included in the PXGN equation. By incorporating an index of "sensitive" real commodity prices in this equation, the movement of export prices is accentuated whenever spot commodity prices change significantly. Its inclusion improves the fit of the PXGN equation.

D. Dynamics of Exchange Rate Effects

A permanent shock to the nominal and real trade-weighted exchange rates results in an initial deterioration of the trade balance, because PMGN adjusts

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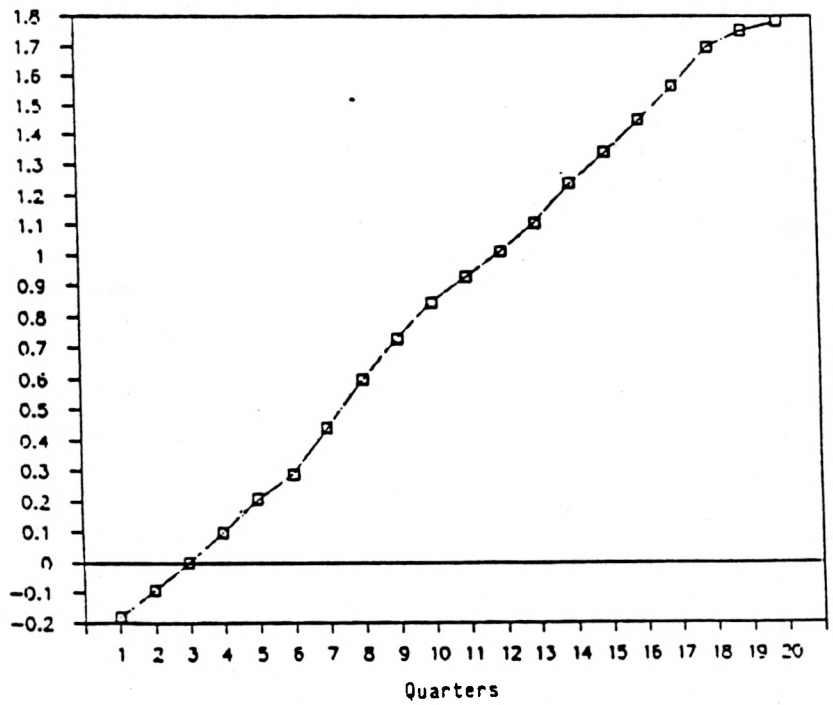
3. See R. Herd, Import and Export Price Equations for Manufactures, O.E.C.D. Working Papers, O.E.C.D. 1986. Herd estimated an elasticity of 0.36 for the Canadian import price for manufactures with respect to the Canadian demand deflator.

much faster than PXGN, and because export and import volumes respond very gradually to changes in competitiveness (Chart 2). Note that in this shock the prices of crude oil, natural gas, wheat and office machines and equipment are assumed to react immediately and completely to exchange rate changes (i.e. with a pass-through of 1.0), while the volumes of crude oil, natural gas and wheat are treated as exogenous. The J-curve effect lasts two quarters but is very small relative to the long-run effect, which moves in the opposite direction. The latter produces a $2 billion improvement in the trade balance for every 1 per cent increase in the exchange rate, assuming that domestic prices and demand are held constant and that higher export volumes do not require imported intermediate products. These induced effects would be expected to grow over time, however, and could reduce the long-run improvement in the trade balance by as much as 25 to 50 per cent.

CHART 2

EFFECTS ON THE TRADE BALANCE OF A 1 PER CENT DEPRECIATION OF THE TRADE-WEIGHTED NOMINAL AND REAL EXCHANGE RATES
(billions of dollars)



E. Performance of the Equations

Table 4 summarizes the predictive performance of the stochastic equations over the 1981-1987 period, while Charts 3 to 8 display the simulated and observed values. Overall, the predictive performance is quite good. The largest errors for export volumes occur in mid-1987, when automotive exports were depressed by exceptionally high inventories in the United States -- a special factor that cannot be captured by the model. The significant error observed on import volumes in 1987Q4 also reflects special factors (related to inventory accumulation in Canada) which caused the actual series to follow an erratic time path over this period (see Chart 4). Although the prediction errors in the price equations appear to be somewhat larger than those in the volume equations, the performance of PXGN and PMGN improves significantly over the 1985-87 period (see Charts 5 and 6). The volume equations for office machines and equipment have also managed to track the major movements in the data (Charts 7 and 8) and generally provide a good fit.

TABLE 4

ROOT-MEAN-SQUARE ERROR AS A PERCENTAGE OF THE PREDICTED VARIABLE

	1981Q1 - 1987Q4
PXGN	1.1
PMGN	2.0
XGN	3.0
MGN	2.7
XOME	14.0
MOME	4.9

CHART 3

TOTAL EXPORTS EXCLUDING CRUOE OIL, NATURAL GAS, WHEAT, OFFICE MACHINES AND EQUIPMENT ANO UNALLOCATEO EXPORTS (XGN)
(millions of 1981 dollars)

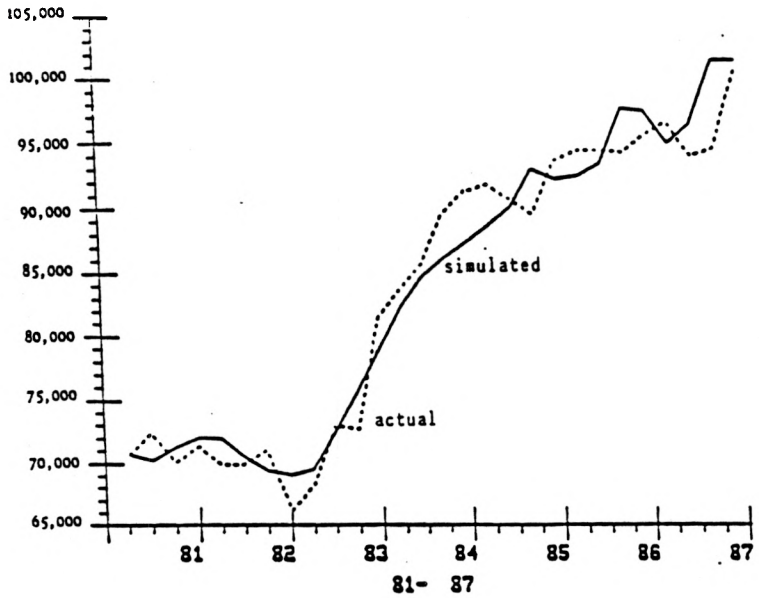


CHART 4

TOTAL IMPORTS EXCLUOING CRUOE OIL, OFFICE MACHINES ANO EQUIPMENT ANO UNALLOCATEO IMPORTS (MGN)
(millions of 1981 dollars)

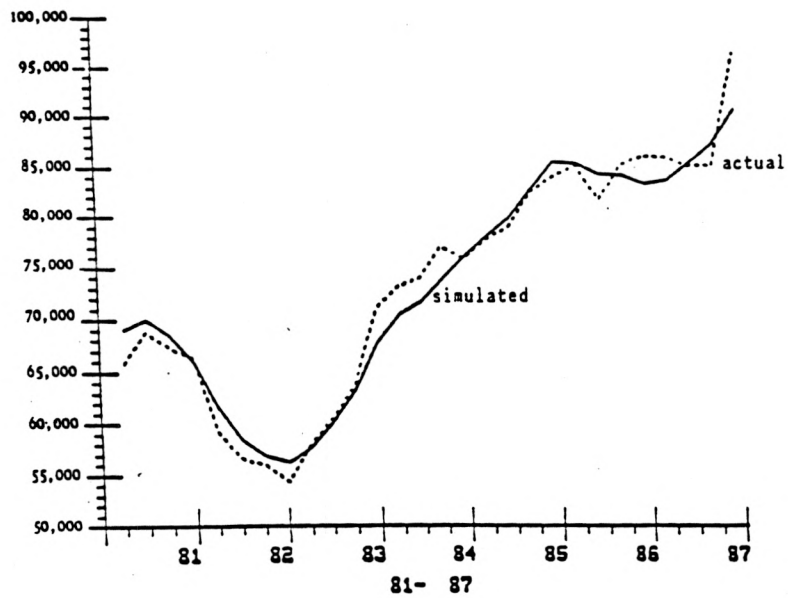


CHART 5

EXPORTS OFFICE MACHINES AND EQUIPMENT (XOME)
(millions of 1981 dollars)

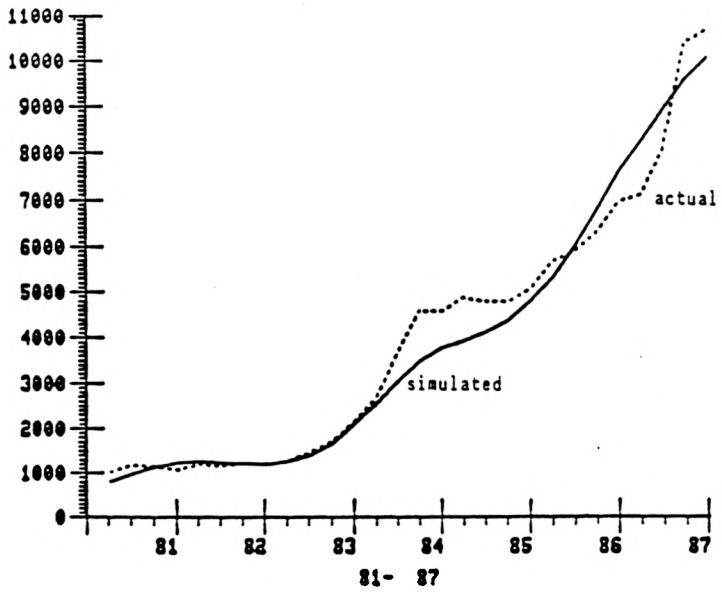


CHART 6

IMPORTS OF OFFICE MACHINES AND EQUIPMENT (MOME)
(millions of 1981 dollars)

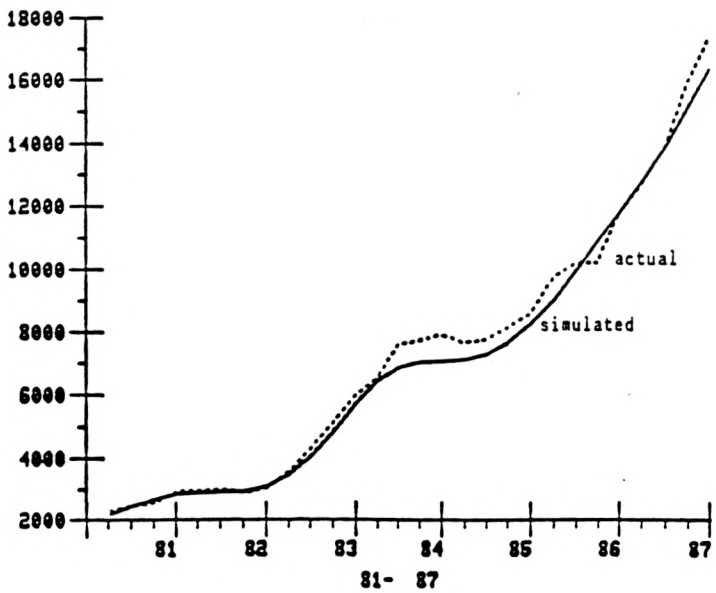


CHART 7

PRICE OF EXPORTS (PXGN)
(1981=1.0)

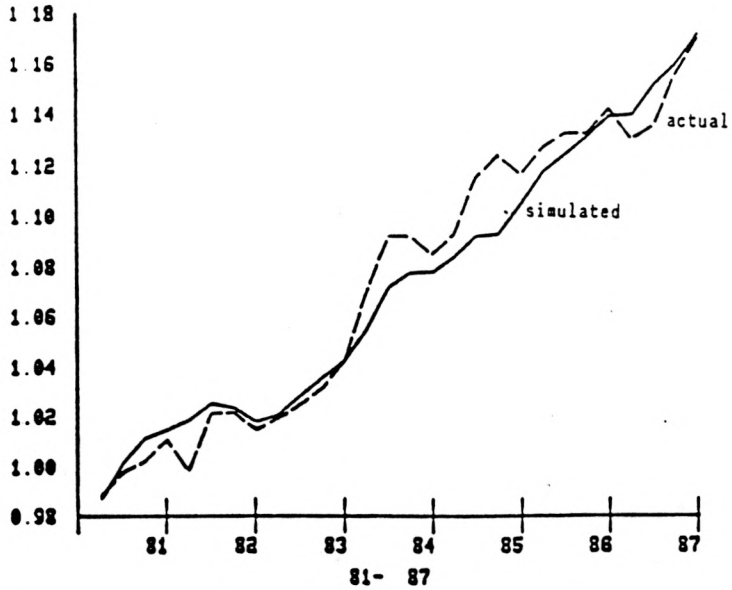
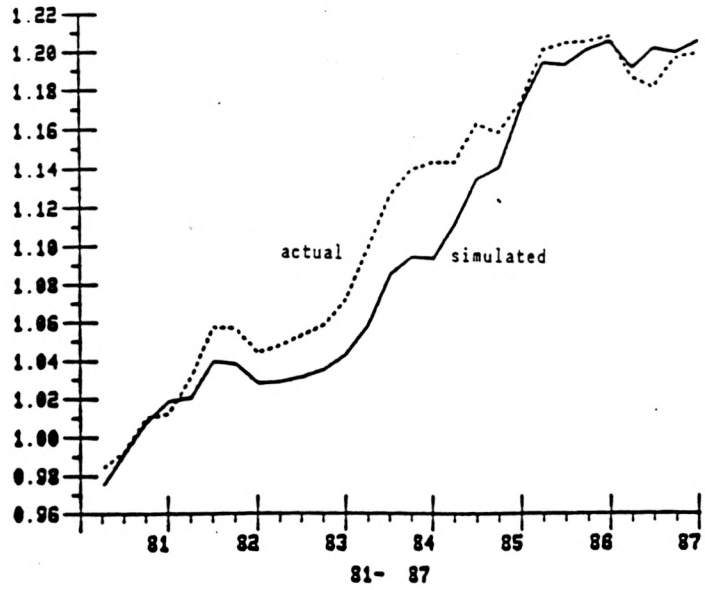


CHART 8

PRICE OF IMPORTS (PMGN)
(1981=1.0)



F. Stability Tests

Chow tests[4] were performed on each of the equations to check for any structural changes that might have occurred between the subperiod 1981Q1-1987Q2 and the rest of the sample period. The selection of these subperiods was somewhat arbitrary in that there was no a priori evidence of a structural break in 1981 or any other year. Table 5 summarizes the results of the tests.

None of the equations, except for MGN, showed any sign of structural change. The instability observed in the MGN equation appeared to be concentrated in the 1980-83 period. Tests based on dummy variables[5] indicated that the behaviour of imports in 1980Q3, 1981Q1, 1981Q3 and 1982Q1-1982Q4 differed significantly from the rest of the sample. There was no evidence of a structural break when a Chow test was run over the subperiods 1975Q1-1980Q2 and 1983Q3-1987Q2. Some of the instability uncovered in the intervening period was probably related to the deep recession experienced in Canada from mid-1981 to the end of 1982.

The tests reported above are too fragmentary to conclude that the model is completely free of instability. It is nevertheless encouraging to note that the parameters in the MGN and XGN equations remained relatively constant when either the last four years or the first three years of the estimation periods

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4. Each equation was first submitted to a Goldfeld-Quandt test to make sure the equation residuals were homoscedastic.

5. J.M. Dufour,"Variables binaires et tests prédictifs contre les changements structurels: une application à l'équation de St-Louis," L'Actualité Économique, Juillet-Septembre 1981.

TABLE 5

CHOW TESTS OF STRUCTURAL CHANGES

Equation	Period Tested	Test	Results
XGN	1971Q3-1980Q4 Against 1981Q1-1987Q2	$F = 0.94 < {}_{.05}F_{8,48} = 2.15$	Stability cannot be rejected
PXGN	1973Q3-1980Q4 Against 1981Q1-1987Q2	$F = 0.23 < {}_{.05}F_{4,48} = 2.58$	Stability cannot be rejected
XOME	1981Q2-1984Q3 Against 1984Q4-1987Q2	$F = 1.21 < {}_{.05}F_{11,9} = 3.11$	Stability cannot be rejected
MOME	1981Q2-1984Q3 Against 1984Q4-1987Q2	$F = 1.98 < {}_{.05}F_{11,9} = 3.11$	Stability cannot be rejected
PMGN	1973Q3-1980Q4 Against 1981Q1-1987Q2	$F = 1.93 < {}_{.05}F_{7,36} = 2.42$	Stability cannot be rejected
MGN	1975Q1-1980Q4 Against 1981Q1-1987Q2	$F = 4.42 > {}_{.05}F_{7,36} = 2.30$	Stability can be rejected
MGN	1980Q3-1983Q2 Against 1975Q1-1980Q2 And 1983Q3-1987Q2	$F = 3.09 > {}_{.05}F_{12,31} = 2.08$	Stability can be rejected
MGN	1975Q1-1980Q2 Against 1983Q3-1987Q2	$F = 1.44 < {}_{.05}F_{7,24} = 2.42$	Stability cannot be rejected

TABLE 6

LONG-RUN ELASTICITIES FOR XGN AND MGN OVER ALTERNATIVE SAMPLE PERIODS
(t-statistics in brackets)

	XGN			
	Activity	U.S. Capacity Utilization	Competitiveness	Real Commodity Prices
1971Q3-1987Q2	1.05 (6.8)	.39 (2.2)	.77 (3.8)	.57 (3.3)
1971Q3-1986Q2	1.07 (7.0)	.31 (1.7)	.76 (4.0)	.51 (3.1)
1971Q3-1985Q2	1.08 (7.0)	.30 (1.6)	.75 (3.8)	.50 (2.8)
1971Q3-1984Q2	1.01 (7.1)	.30 (1.8)	.80 (4.0)	.57 (3.1)
1972Q3-1987Q2	1.10 (7.1)	.43 (2.4)	.78 (4.0)	.80 (3.7)
1973Q3-1987Q2	1.19 (6.7)	.33 (1.6)	.75 (3.6)	1.11 (3.3)
1974Q3-1987Q2	.96 (4.1)	.68 (2.3)	.87 (3.7)	.29 (0.5)

	MGN			
	Activity	Growth in Domestic Demand*	Domestic Capacity Utilization	Competitiveness
1975Q1-1987Q2	1.02 (6.1)	.72 (3.5)	.26 (0.6)	-1.11 (-4.5)
1975Q1-1986Q2	.99 (6.0)	.72 (3.5)	.42 (0.9)	-1.04 (-4.4)
1975Q1-1985Q2	1.01 (5.7)	.71 (3.2)	.40 (0.8)	-1.06 (-4.2)
1975Q1-1984Q2	1.03 (5.3)	.73 (3.2)	.35 (0.6)	-1.10 (-3.7)
1976Q1-1987Q2	1.04 (5.0)	.63 (2.7)	.44 (0.9)	-1.06 (-4.4)
1977Q1-1987Q2	1.05 (5.6)	.62 (2.7)	.39 (1.0)	-1.00 (-4.8)
1978Q1-1987Q2	1.02 (5.3)	.66 (2.8)	.36 (0.9)	-0.90 (-3.7)

* Elasticity on impact.

were removed (Table 6). The parameter which appeared to be most sensitive to changes in the sample period was the one attached to real commodity prices: its statistical significance seems to depend importantly on the early 1970s, when commodity prices rose dramatically.

II. Estimates of Exchange Rate Effects

The following section describes a series of simulations run on the new model, designed to estimate the relative importance of movements in the exchange rates and other variables in the evolution of the trade balance and the determination of export and import prices.

A. The Trade Balance and the Canadian Dollar: 1982-1987

Table 7 presents the estimated contribution of changes in exchange rates and other variables to changes in the trade balance over the period 1982-1987.[6] The discussion that follows focuses on some of the more fundamental factors that have been at work: cyclical effects, movements in the terms of trade and real commodity prices, and changes in competitiveness. The influence of other factors, specific to wheat, crude oil and natural gas, is captured in a residual category, reported in the last column of Table 7. The latter also includes the effects of valuation adjustments, modelling errors related to annual changes in the trade components (see Chart 9), and unallocated exports and imports.

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6. Revisions to merchandise trade data from 1984 to 1987 were released after the work described in this section was completed. These revisions have not altered the profile of the trade balance or the properties of the model.

TABLE 7

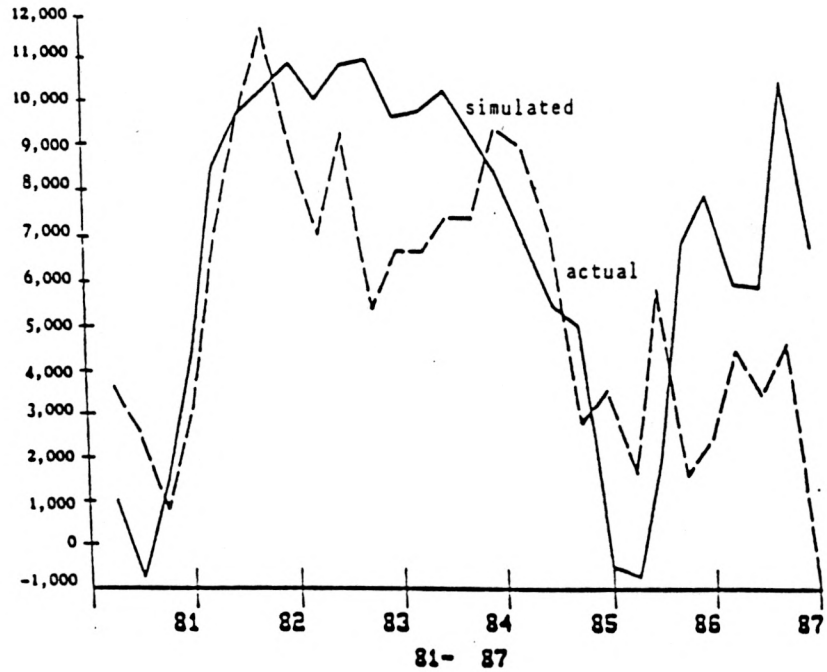
CONTRIBUTION TO CHANGES IN THE TRAOE BALANCE; 1982-1987
(billions of dollars)

	Actual Changes	Exchange Rate: Competitiveness	Exchange Rate: Terms of Trade	Activity	Real Commodity[1] Prices Through Export Supply	Raw Material Prices Through Terms of Trade	Office Machines and Equipment: Real Price Effects on Volumes	Office Machines and Equipment: Effects on Terms of Trade	Other Prices and Costs Through Terms of Trade	Other Factors
1982	10.4	1.6	-0.2	8.7	-0.9	0.4	-5.8	-	2.4	4.2
1983	-0.2	-1.2	0.4	3.0	-1.4	-0.2	-2.3	0.8	1.9	-1.2
1984	2.8	-3.0	-0.3	3.6	-0.5	0.7	-2.0	-0.4	1.6	3.1
1985	-3.3	-0.9	0.2	-3.4	0.5	-2.5	-0.3	0.2	0.7	2.2
1986	-6.5	3.6	-0.1	-1.5	-0.8	-4.7	-0.4	0.6	0.4	-3.6
1987	-	7.4	2.0	-3.9	-1.2	-0.5	-0.3	0.7	0.6	-4.8
Cumulative Effects										
1982-1984	13.0	-2.6	-0.1	15.3	-2.8	0.9	-10.1	0.4	5.9	6.1
1985-1987	-9.9	10.1	2.1	-8.8	-1.5	-7.7	-1.0	1.5	1.7	-6.2
1982-1987	3.0	7.5	2.0	6.5	-4.3	-6.8	-11.1	1.9	7.6	-0.1

1. Excluding wheat, crude oil and natural gas.

CHART 9

SIMULATED AND ACTUAL TRADE BALANCES
(EXCLUDING CRUDE OIL, NATURAL GAS AND WHEAT)
(millions of dollars)



1. Competitiveness and the Terms of Trade

Competitiveness effects helped to reduce Canada's trade surplus from 1983 to 1985, and to increase it in 1986 and 1987. As Table 8 illustrates, the negative contribution from 1983 to 1985 reflected two influences: (i) the diminishing positive effects of an earlier depreciation (1978Q1-1981Q1), and (ii) the increasingly large negative effects of a subsequent appreciation (1981Q2-1984Q1). This negative contribution gradually disappeared as the Canadian dollar weakened through 1985 and 1986. By 1987 the effects of the latest depreciation became more evident and Canada's improved competitive position had a strong

TABLE 8

DYNAMICS OF COMPETITIVENESS EFFECTS ON NET EXPORT VOLUMES
(billions of 1981 dollars)

	Depreciation 78Q1-81Q1	Appreciation 81Q2-84Q1	Depreciation 84Q2-86Q4	Appreciation 87Q1-87Q4	Total Effects
1981 Q1	7.3	-	-	-	7.3
Q2	8.0	-	-	-	8.0
Q3	8.2	-0.1	-	-	8.1
Q4	8.1	-0.2	-	-	7.9
1982 Q1	7.6	-0.4	-	-	7.2
Q2	7.0	-0.6	-	-	6.4
Q3	6.4	-0.9	-	-	5.5
Q4	5.7	-1.2	-	-	4.5
1983 Q1	5.2	-1.6	-	-	3.6
Q2	4.7	-2.1	-	-	2.6
Q3	4.2	-2.7	-	-	1.5
Q4	3.7	-3.4	-	-	0.3
1984 Q1	3.1	-4.2	-	-	-1.1
Q2	2.5	-4.8	-	-	-2.3
Q3	2.0	-5.3	0.2	-	-3.1
Q4	1.5	-5.7	0.4	-	-3.8
1985 Q1	1.1	-5.9	0.8	-	-4.0
Q2	0.8	-5.9	1.4	-	-3.7
Q3	0.5	-5.8	2.1	-	-3.2
Q4	0.4	-5.5	3.0	-	-2.1
1986 Q1	0.2	-5.0	4.2	-	-0.6
Q2	0.2	-4.5	5.6	-	1.3
Q3	0.2	-4.0	7.3	-	3.5
Q4	0.2	-3.4	9.1	-	5.9
1987 Q1	-	-2.8	10.8	-	8.0
Q2	-	-2.3	12.4	-0.2	9.9
Q3	-	-1.9	13.8	-0.4	11.5
Q4	-	-1.5	14.6	-0.7	12.4

positive impact on the trade balance; this effect was largely offset, however, by adverse transient factors which depressed automotive exports in the second and third quarters of 1987 and inflated imports in the fourth quarter.

The exchange rate also had a temporary effect on the trade balance through the terms of trade. Although on an average annual basis this effect was quite modest over the 1982-1986 period, a stronger Canadian dollar and an attendant improvement in the terms of trade increased the trade surplus by $2 billion in 1987. In future periods one would expect the trade balance to deteriorate, holding other factors constant, as the favourable terms of trade effect disappears along with the stimulus provided by the earlier real depreciation to net export volumes.

2. Cyclical Factors

Cyclical factors played an important role in the growth of the trade surplus between 1981 and 1984 and in its subsequent decline. The pro-cyclical behaviour of imports is particularly pronounced (see Chart 4), and explains most of the sharp improvement in the trade balance in 1982.

3. Real Commodity Prices and Export Volumes

Real commodity prices affect export supply with considerable lags. A downward trend in these prices from 1981 to 1986 depressed export volumes starting in 1982. The trade surplus narrowed by $4 1/2 billion between 1981 and 1987 as a result of this factor. Only in 1985 was the trade balance supported by rising commodity prices, owing to the effects of a temporary upswing from 1983Q1

to 1984Q2. Table 9 illustrates the dynamics of the price and quantity movements that were involved. Notice that during the first year following a shock, there was virtually no response.

4. Commodity Prices and the Terms of Trade

A decline in raw materials prices, particularly for energy, reduced the trade surplus considerably in 1985 and 1986. To a large extent this resulted from movements in international prices. Another important factor over the 1982-1987 period was the gradual downward adjustment of Canadian export prices on natural gas to levels that were more competitive in U.S. markets. This was made possible by a relaxation of Canadian regulations governing export pricing and by easier access to U.S. interstate pipelines, which allowed Canadian producers to make spot sales at prices lower than those on existing contracts. The resulting increase in competitiveness stimulated exports of Canadian natural gas and helped offset some of the negative terms-of-trade effects.

5. Office Machines and Equipment

Prices for exports and imports of office machines and equipment dropped by about two-thirds between 1981 and 1987, while volumes showed a sixfold increase over the same period. Since these products have a larger weight in imports than in exports, the net effect was to boost Canada's terms of trade and to reduce the volume of net exports. These price and quantity adjustments pushed the nominal deficit on trade in office machines and equipment to nearly $3 billion by 1987. While XOME and MOME were affected by global investment

TABLE 9

DYNAMICS OF REAL COMMODITY PRICE EFFECTS ON THE VOLUME OF EXPORTS
(billions of 1981 dollars)

	Increase 78Q1-80Q1	Decrease 80Q2-82Q4	Increase 83Q1-84Q2	Decrease 84Q3-86Q4	Increase 87Q1-87Q4	Total Effects
1981 Q1	0.8	-0.2	-	-	-	0.6
Q2	0.6	-0.4	-	-	-	0.2
Q3	0.4	-0.6	-	-	-	-0.2
Q4	0.2	-0.8	-	-	-	-0.6
1982 Q1	0.1	-1.0	-	-	-	-0.9
Q2	-	-1.3	-	-	-	-1.3
Q3	-	-1.5	-	-	-	-1.5
Q4	-	-1.9	-	-	-	-1.9
1983 Q1	-	-2.5	-	-	-	-2.5
Q2	-	-3.0	-	-	-	-3.0
Q3	-	-3.0	-	-	-	-3.0
Q4	-	-2.8	0.1	-	-	-2.7
1984 Q1	-	-2.2	0.2	-	-	-2.0
Q2	-	-1.6	0.4	-	-	-1.2
Q3	-	-1.0	0.8	-	-	-0.2
Q4	-	-0.5	1.0	-	-	0.5
1985 Q1	-	-0.2	1.0	-	-	0.8
Q2	-	-0.1	0.9	-	-	0.8
Q3	-	-	0.8	-0.1	-	0.7
Q4	-	-	0.5	-0.2	-	0.3
1986 Q1	-	-	0.3	-0.5	-	-0.2
Q2	-	-	0.2	-0.8	-	-0.6
Q3	-	-	0.1	-1.2	-	-1.1
Q4	-	-	-	-1.5	-	-1.5
1987 Q1	-	-	-	-1.8	-	-1.8
Q2	-	-	-	-2.0	-	-2.0
Q3	-	-	-	-2.0	-	-2.0
Q4	-	-	-	-1.6	-	-1.6

cycles and changes in competitiveness, the drop in the real price of computers clearly played a dominant role.

B. Trade Prices and the Canadian Dollar: 1986Q4-1988Q1

During the period 1986Q4-1988Q1, PMGN fell by 1.1 per cent, PXGN rose by 2.8 per cent, and the Canadian dollar appreciated by 5.3 per cent (on a trade-weighted basis). As Table 10 shows, this exchange rate change cut PMGN by 4 per cent. However, the decline was largely offset by a 2.4 per cent rise in foreign prices and a 4.2 per cent increase in Canadian unit labour costs, which raised PMGN by 1.7 per cent and 1.0 per cent, respectively. The net decline in predicted PMGN was 1.3 per cent, compared to an actual value of 1.1 per cent.

TABLE 10

SOURCES OF CHANGES IN TRADE PRICES FROM 1986Q4 TO 1988Q1

	Actual Growth	Predicted Growth	Contribution to Growth			
			Exchange Rate	Foreign Prices	Canadian Unit Labour Costs	Lagged Effects
PMGN	-1.1	-1.3	-4.0	1.7	1.0	-
Pass-through			0.8	0.7	0.2	
PXGN	2.8	3.4	-2.6	3.9	0.4	1.7
Pass-through			0.5	0.6*	0.1	

* Pass-through of U.S. wholesale prices.

According to the model, the appreciation of the Canadian dollar lowered PXGN by 2.6 per cent over the period. Despite this downward pressure, predicted PXGN rose by 3.4 per cent due to a 3.9 per cent increase attributable to higher

world prices and a 0.4 increase attributable to rising Canadian unit labour costs. In addition, the lagged effects of earlier price and cost increases and an exchange rate depreciation contributed a further 1.7 per cent to the rise in PXGN. These lagged effects reflect the relatively slow pass-through of movements in prices and exchange rates to PXGN. The remaining 0.6 per cent discrepancy between the actual and predicted values for PXGN represents the forecast error.

III. Conclusion

The model used in this paper has long-run elasticities that are broadly consistent with those in other models. Its distinguishing features are (i) its ability to capture demand composition effects in spite of its small size, and (ii) its dynamic responses to various shocks, particularly the non-linearity of the response of imports to changes in domestic demand and the long lags associated with changes in competitiveness. This last property deserves more study, since it is very important in shaping views on exchange rate effects over a time horizon of 2 to 3 years. If the response lags were found to be much shorter, as in previous models such as RDXF, the effect on trade volumes of the 1987Q1-1988Q2 appreciation of the Canadian dollar would be felt primarily in 1988. In contrast, with long lags, such as those imbedded in the present model, most of the effect would be delayed until 1989 and 1990. The consequences for the profile of output growth in Canada are significant.

APPENDIX 1

NOTATION

ACTM	Activity - imports. See Appendix 2
ACTX	Activity - exports. See Appendix 2
AGTWC	Canadian dollar exchange rate: trade-weighted index vis-à-vis the United States, the United Kingdom, Japan, West Germany and France
AGTWRC	Canadian dollar real exchange rate: ratio of a trade-weighted index of exchange rate-adjusted GDP deflators for the United States, the United Kingdom, Japan, West Germany and France to an index of GDP deflator for Canada
CAPUM2	Capacity utilization manufacturing - United States
CDMIS	Consumer expenditures on durable goods excluding motor vehicles and parts and household durables
CENERG	Consumer expenditures on gasoline, oil, grease, fuel oil, electricity and natural gas
CFOOD2	U.S. personal consumption expenditures on food
CHSHD	Consumer expenditures on household furniture and appliances
CMV	Consumer expenditures on motor vehicles and parts
CMVNA	Domestic consumption of North-American motor vehicles and parts
CMV2	U.S. consumption of motor vehicles and parts
CNDO	Consumer expenditures on non-durables excluding food and energy
CSD	Consumer expenditures on semi-durables
EMGRES	Unallocated imports
EXGRES	Unallocated exports
GNW	Total government non-wage expenditures
HSTA2	U.S. total housing starts
IME	Business investment in machinery and equipment
IME2	United States non-residential investment in producer's durable equipment
INRC	Business investment in non-residential construction
IPIE2	Index of industrial production - OECD Europe
IPIJ2	Index of industrial production - Japan
IPIUS2	U.S. industrial production index
IRC	Investment in residential construction (adjusted)
MCRPT	Imports of crude petroleum
MG	Imports of goods
MGN	Total imports excluding crude petroleum, office machines and equipment and unallocated imports. See Appendix 2
MOME	Imports of office machines and equipment
NPOPT	Total population (beginning-of-quarter figure)
PCPIF2	U.S. consumer price index for food
PFORM	Foreign price index for imports; see Appendix 2
PFORX	Foreign price index for exports; see Appendix 2
PFX	Spot exchange rate - Canadian dollars per U.S. dollar

PGDP	Price deflator for gross domestic product
PGNEFR	GDP deflator - France
PGNEG	GDP deflator - Germany
PGNEJ	GDP deflator - Japan
PGNEUK	GDP deflator - United Kingdom
PGNE2	United States - Implicit Price Deflator
PMCR2	U.S. refiners acquisition cost of imported crude oil
PMFFB2	Unit value index of U.S. imports - food, feed and beverages
PMGN	Price of total imports excluding crude petroleum, office machines and equipment and unallocated imports. See Appendix 2
PPRIM	Price of raw materials. See Appendix 2
PWCHM2	U.S. wholesale price index - chemicals and allied products
PWCOL2	U.S. wholesale price index - coal
PWELE2	U.S. wholesale price index - electric power
PWFF2	U.S. wholesale price index - farm products
PWLUM2	U.S. wholesale price index - lumber
PWMM2	U.S. wholesale price index - metals and minerals
PWPFG2	U.S. wholesale price index - finished goods
PWPI22	U.S. wholesale price index - intermediate goods
PWPI312	U.S. wholesale price index - consumer finished goods
PWPME2	U.S. wholesale price index - machinery and equipment
PWPP2	U.S. wholesale price index - pulp, paper and allied products
PWRPP2	U.S. wholesale price index - refined petroleum products
PWTE2	U.S. wholesale price index - transportation equipment
PXGN	Price of total exports excluding natural gas, crude petroleum, wheat, office machines and equipment and unallocated exports. See Appendix 2
RPRIM	Price of raw materials relative to finished goods. See Appendix 2
SCPI2	Sensitive commodity price index - U.S. dollars
UDPADJ	Real effective personal purchasing power
UFDD	Total final domestic demand
UGNE2	U.S. gross national expenditure
UGPP	Gross private business product (excluding agriculture and non-commercial business)
UGPPD	Trend output based on the production function with actual capital stock trend, trend employment ratio, actual population, trended weekly hours and trended total factor productivity
ULC	Normalized unit labour costs
ULC2	Index of normalized unit labour costs in the United States - non-farm business sector
XCF	Exports of chemicals and fertilizers
XG	Exports of goods
XGN	Total exports excluding natural gas, crude petroleum, wheat, office machines and equipment and unallocated exports. See Appendix 2
XMVP2	Exports of motor vehicles and parts to the United States
XMVP3	Exports of motor vehicles and parts to countries excluding the United States
XNG	Exports of natural gas

XOME	Exports of office machines and equipment
XOTHER	Exports of "other manufactured goods"
XPET	Exports of crude petroleum
XW	Exports of wheat
YFA	Accrued net income of farm operators from farm production (current dollars)

A P P E N D I X 2

A SMALL TRADE MODEL FOR CANADA

Convention

A $ suffix indicates current dollars. The operators JiA ( ) and JiD ( ) calculate respectively a moving average and a difference over i quarters. The operator JiW ( ) indicates distributed lags over i quarters.

Identities

All the components of ACTM, ACTX, PFORM, PFORX, PPRIM and RPRIM have been indexed to 1981=1.0.

```
MGN=   MG-MCRPT-MOME-EMGRES
XGN=   XG-XNG-XPET-XW-XOME-EXGRES
PXGN=  (XG$-XNG$-XPET$-XW$-XOME$-EXGRE$)/XGN
PMGN=  (MG$-MCRPT$-MOME$-EMGRE$)/MGN

ACTM=   .009*IRC+.009*INRC+.014*NPOPT+.053*UDPADJ
       +.011*YFA+.031*CHSHD+.051*CDMIS+.057*GNW
       +.066*XOTHER+.016*XCF+.302*IME+.121*CMVNA
       +.120*XMVP2+.002*XMVP3+.041*CMV+.030*CNDO
       +.040*CSD+.027*CENERG

ACTX=   .16*UGNE2+.07*IPIJ2+.11*IPIE2+.11*IME2
       +.24*IPIUS2+.01*HSTA2+.04*CFOOD2+.26*CMV2

PFORM=  .017*PWLUM2+.003*PWMM2+.042*PMFFB2
       +.042*PCPIF2+.211*PWPI22+.212*PWPME2
       +.311*PWTE2+.087*PWPI312+.022*PWCOL2
       +.046*(.130*PGNEFR+.189*PGNEG+.469*PGNEJ
       +.087*PGNEUK+.125*(PGDP/AGTWC))
       +.007*PMCR2

PFORX=  .8*(.034*PMCR2+.314*PWTE2+.086*PWFF2+.196*PWMM2
       +.062*PWCHM2+.063*PWLUM2+.116*PWPP2+.019*PWRPP2
       +.014*PWCOL2+.012*PWELE2+.083*(.747*ULC2+.032*PGNEFR
       +.056*PGNEG+.097*PGNEUK+.068*PGNEJ))
       +.2*(ULC/AGTWC)

PPRIM=  .143*PWFF2+.325*PWMM2+.104*PWCHM2+.105*PWLUM2
       +.192*PWPP2+.032*PWRPP2+.023*PWCOL2
       +.020*PWELE2+.056*PMCR2

RPRIM= PPRIM/PWPFG2
```

Stochastic Equations

All equations are in logarithmic form, so that their parameters represent elasticities, and all have been estimated by ordinary least squares. Student "t" statistic appears in brackets along with the estimated coefficient.

```
MGN=  5.535 + 0.511*ACTM + 1.441*J2A(J1D(.3*IME+.7*(UFDD-IME)))
      (5.65)  (6.05)       (3.54)

      +0.130*(UGPP/UGPPD) + J22W(AGTWRC) + 0.501*J1L(MGN)
      (0.56)                             (5.71)
```

T	JW(AGTWRC)	T	JW(AGTWRC)
0	-.011 (0.38)	-11	-.035 (3.21)
-1	-.022 (1.01)	-12	-.030 (3.09)
-2	-.030 (1.91)	-13	-.026 (2.99)
-3	-.036 (3.08)	-14	-.021 (2.90)
-4	-.041 (4.11)	-15	-.017 (2.83)
-5	-.044 (4.49)	-16	-.012 (2.77)
-6	-.045 (4.35)	-17	-.008 (2.72)
-7	-.045 (4.05)	-18	-.005 (2.68)
-8	-.044 (3.77)	-19	-.002 (2.64)
-9	-.041 (3.54)	-20	-.001 (2.60)
-10	-.038 (3.35)	-21	000 -
		SUM	-.554

$\bar{R}^2$ = .957 S.E.R. = .027 D.H. = -.979
Estimation period: 1975Q1 - 1987Q2

```
XGN =  8.058 + 0.748*ACTX + 0.281*CAPUM2 + J22W(AGTWRC)
       (7.01)  (6.79)       (2.18)

       +J11W(RPRIM) +0.288*J1L(XGN)
                    (2.80)
```

T	JW(AGTWRC)	T	JW(AGTWRC)
0	.003 (0.10)	-11	.036 (2.98)
-1	.016 (0.65)	-12	.032 (2.89)
-2	.026 (1.45)	-13	.028 (2.80)
-3	.034 (2.48)	-14	.023 (2.74)
-4	.040 (3.44)	-15	.018 (2.68)
-5	.043 (3.86)	-16	.013 (2.63)
-6	.046 (3.83)	-17	.009 (2.59)
-7	.046 (3.63)	-18	.005 (2.55)
-8	.045 (3.42)	-19	.003 (2.52)
-9	.043 (3.25)	-20	.001 (2.48)
-10	.040 (3.10)	-21	000 -
		SUM	.550

T	JW(RPRIM)	T	JW(RPRIM)

0	-.037 (0.26)	-6	.057 (1.47)
-1	.024 (0.37)	-7	.038 (1.39)
-2	.061 (2.88)	-8	.020 (1.33)
-3	.079 (2.62)	-9	.006 (1.29)
-4	.082 (1.89)	-10	000 -
-5	.073 (1.61)	SUM	.403

$\bar{R}^2$ = .982 S.E.R. = .029 D.H. = -1.88
Estimation period: 1971Q3 - 1987Q2

MOME = -.192 + .932*J1L(MOME) + (1-.932)*IME
(-.87) (9.17)

+(1-.932)*J13W(AGTWRC) + J8W(PMOME/PGDP)

T	JW(AGTWRC)	T	JW(AGTWRC)
0	-.05	-7	-.10
-1	-.05	-8	-.10
-2	-.05	-9	-.10
-3	-.10	-10	-.05
-4	-.10	-11	-.05
-5	-.10	-12	-.05
-6	-.10	SUM	-1.00

T	JW(PMOME/PGDP)	T	JW(PMOME/PGDP)
0	-.353 (-5.02)	-4	.131 (2.65)
-1	-.161 (-4.80)	-5	.134 (3.60)
-2	-.016 (-.43)	-6	.090 (3.23)
-3	.081 (1.65)	-7	-.002 (0.03)
		SUM	-.096

$\bar{R}^2$ = .993 S.E.R. = .046 D.W. = 2.28
Estimation period: 1981Q2 - 1987Q2

XOME= 0.268 + 0.746*J1L(XOME) + (1-.746)*IME2
(1.04) (4.90)

+(1-.746)*J13W(AGTWRC) + J8W(PMOME/(PGNE2*PFX))

T	JW(AGTWRC)	T	JW(AGTWRC)
0	.05	-7	.10
-1	.05	-8	.10
-2	.05	-9	.10
-3	.10	-10	.05
-4	.10	-11	.05
-5	.10	-12	.05
-6	.10	SUM	1.00

T	JW(PMOME/...)	T	JW(PMOME/...)
0	-.178 (1.19)	-4	-.084 (.80)
-1	-.200 (3.50)	-5	.011 (.13)
-2	-.189 (2.91)	-6	.135 (2.23)
-3	-.151 (1.53)	-7	.288 (2.45)
		SUM	-.365

$\bar{R}^2$= .989 S.E.R.= .077 D.W.= 1.52
Estimation period: 1981Q2 - 1987Q2

PXGN= -0.322 + 0.758*J1L(PXGN) + 0.344*(AGTWC*PFORX)
(8.67) (16.86) (3.28)

+ (1-.344-.758)*J1L(AGTWC*PFORX)

+ 0.060*(SCPI2/PGNE2)
(8.81)

$\bar{R}^2$= .999 S.E.R.= .010 D.W.= 1.95
Estimation period: 1973Q3 - 1987Q2

PMGN= -0.0020 + 0.684*(AGTWC*PFORM)
(.85) (11.98)

-0.617*J1L(AGTWC*PFORM)
(-8.71)

+ 0.426*J1D(J2A(ULC)) + 0.927*J1L(PMGN)
(3.22) (21.11)

$\bar{R}^2$= .999 S.E.R.= .008 D.H.= 1.19
Estimation period: 1973Q3 - 1987Q2

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