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# The responsiveness of Canadian imports to income and price movements

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THE RESPONSIVENESS OF CANADIAN IMPORTS  
TO INCOME AND PRICE MOVEMENTS

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## INTRODUCTION

The key variables in international trade policy are imports and exports elasticities with respect to income and prices. Thus their estimation has drawn particular attention in the post war period.

Most of the studies gathered fruitful results in the sense that their estimates appeared with the a priori expected signs and magnitudes. However, opinions are not identical on the relevant importance of price and income elasticities. M. Kreinin (8) does not even attempt to compute income elasticities while H. Houthakker and S. Magee (5) claim that the latter are of stronger importance and their disparities between imports and exports are responsible, in the long run, for the performance of the Balance of Payment for several countries.

In the present work, estimates are presented of import demand functions, for Canada, a country with a widely open economy. It is understood that disaggregation of these estimates is extremely helpful for any meaningful commercial policy. For this reason income and price elasticity estimates are presented for eight categories of imported goods and for seventeen countries, which are among the major Canadian trade partners. Since the used data runs up to 1974 and alternative modern econometric techniques are employed, it is hoped that the set of estimates will be an efficient one and will provide an up-to-date view of the Canadian trade patterns.

## Methodology and Estimation by Commodity Class

It is widely accepted that imports demand is mainly a function of income and relative prices of the imported goods. Another factor which influences the volume of trade is the reserves held by a country in any form, but their statistical importance hasn't yet reached a consensus. The level of investment is parallel and can be incorporated into the income variable.

If the explicit form of imports demand function is an exponential one i.e.  $M_t = AY_t^a P_t^b e^{u_t}$  (1) where  $a = \frac{\frac{dm}{m}}{\frac{dx}{x}}$  and  $b = \frac{\frac{dm}{m}}{\frac{dp}{p}}$

We estimated the logarithm equivalent of (1) from time series data.

$\log M_{it} = \log A + a \log Y_{it} + b \log P_{it} + u_{it}$  (2) in which the elasticities come simply as coefficients of the independent variables.

$Y_t$  stands for Canadian G.N.P. in constant prices for the 1950-1974 period. Yearly data was chosen not to avoid the complexity of seasonal adjustment which is required for quarterly data but because it was felt that a twenty-five observations sample is not too small for a two explanatory variables regression. On top it is intuitively expected that the response of the volume of trade to income and price changes will be clearer in a one year period.

The variable used to approximate the price variable ( $P_t$ ) is the ratio of price of imports index to the wholesale price index for the same time period i.e.  $P_t = \frac{PI_t}{PWS_t}$  Whatever the difficulties

of this variable to capture the accurate price movements it has been of great use in almost every previous work in the field. However, alternative price proxies will be employed at a later stage.  $M_t$  is the value of imports in real terms.<sup>1</sup>

Total imports are split into eight categories by commodity class according to standard international trade classification to avoid "over-all" estimates, which are not useful for the exercise of the commercial policy and to provide a contrast between the one digit categories. It is however true that a more detailed disaggregation may provide additional light to the responsiveness of each individual commodity to the price and income movements but such a study would require a much more substantial labor input and adequate financing.

Table 1 reveals import demand elasticities for Canada.

Table 1

Estimates of elasticities of the demand for imports by Commodity Class.

	Income	Price	R <sup>2</sup>	W
Total imports	.6075 (5.66)	-3.79 (-2.81)	.86	.92
(0) Food	.5008 (6.71)	-3.06 (-2.96)	.91	1.16
(1) Beverages and tobacco	.5296 (5.25)	-4.14 (-3.69)	.89	.91
(2) Crude Materials	.3905 (5.85)	n.s.	.84	1.48
(3) Fuels	.5329 (13.30)	-2.29 (-4.16)	.97	1.32

(4) Animal and Vegetable oil	.4224 (7.39)	n.s.	.82	1.59
(5) Chemicals	.6444 (6.00)	-3.42 (-2.32)	.82	.92
(6) Manufactured goods	.5166 (6.77)	-3.02 (-3.13)	.91	1.14
(7) Machinery and transport equipment	.7293 (4.69)	-5.02 (-2.72)	.81	.94

T values in parenthesis.  
n.s. -nonstatistically significant estimate.

The results are absolutely in tune with the theory. Income elasticities are always positive and statistically significant at the 1% level and they range from .3905 for crude materials to .7243 for machinery and transport equipment. Price elasticities are always negative and in seven out of nine cases are statistically significant. Their values float between -2.29 for fuels and -5.02 for machinery and transport equipment.

Although the multiple determination coefficient ranges between relatively high limits, the Durbin-Watson criteria - which in the tables for the 5% level and for 25 observations and 2 explanatory variables has 1.21 and 1.55 lower and upper values respectively- is relatively low indicating a good possibility of serial correlation. To escape this problem the Hildreth - Lu iterative technique was employed. To avoid a possible convergence at a local rather than at a global minimum of the sum of squares, the  $\hat{u}_t$  of the residual of the relation  $u_t = \rho u_{t-1} + e_t$  was allowed to take values in the interval -.9 to .9 for .1 discreet changes. The estimates of these "corrected" regressions are presented on the following page.



Table 2

Estimates of elasticities of the demand for imports by  
commodity class corrected for autocorrelation.

	Income	Price	R <sup>2</sup>	W
Total imports	1.4757 (24.99)	-1.57 (-3.63)	.98	1.96
(0) Food	n.s.	n.s.	.96	1.18
(1) Beverages and Tobacco	1.3023 (23.61)	-2.59 (-6.93)	.98	1.77
(2) Crude materials	.8304 (10.79)	n.s.	.85	1.33
(3) Fuels	.2628 (4.38)	n.s.	.95	1.82
(4) Animal and vegetable oil	n.s.	n.s.	.65	2.00
(5) Chemicals	1.5197 (28.67)	-.81 (-2.10)	.98	1.70
(6) Manufactured goods	1.06 (13.29)	-1.65 (-2.81)	.94	1.68
(7) Machinery and transport equipment	1.99 (26.30)	-2.05 (-3.69)	.98	1.54

T values in parenthesis.

n.s. - nonstatistically significant.

While observing again the W values it is not clear if the problem of autocorrelation has been completely alleviated. It is however true that the "fitness" of the regression has been ameliorated as indicated by the R<sup>2</sup> values. The estimates are again compatible with the theory but now almost half of the price elasticities are not significant although they never appear with a wrong sign.



### Imports by Countries

The same analytical framework is now employed to Canadian imports from individual countries. Sixteen countries were chosen among the major Canadian commercial partners. Venezuela, an important importer, was excluded because a satisfactory export price index could not be established. Greece was introduced in the analysis due to the author's particular interest.

For each country the following three regressions were estimated by application of Ordinary Least Squares,

$$\log M_{it} = A + a_1 \log Y_t + b_1 \log P_{1t} + u_{it}$$

$$\log M_{it} = B + a_2 \log Y_t + c_2 \log P_{2t} + v_{it}$$

$$\log M_{it} = C + a_3 \log Y_t + b_3 \log P_{1t} + c_3 \log P_{2t} + e_{it}$$

where  $M_{it}$  is individual country's exports to Canada in constant prices (F.O.B.) for the 1950-1975 period.  $Y_t$  and  $P_{1t}$  are exactly the same variables ( $Y_t$  and  $P_t$  respectively) of the previous section while  $P_2$  is the ratio of the exports prices index of the exporting country to the Canadian imports price index. i.e.  $P_2 = \frac{P_{ex\ i}}{P_{im\ c}}$ .

Anyhow, both price variables incorporate the inflationary movements of these economies and also their exchange rate changes.

Table 3 reveals estimates of the above mentioned elasticities.

Table 3

Estimates of Elasticities of the Demand for imports by countries.

Imports from:	Income	P1	P2	R <sup>2</sup>	W
United Kingdom	.2857	-2.54		.78	.84
	(4.36)	(-2.78)			
	.1816		w.s.	.90	1.17
	(3.25)				
	.1801	w.s.	w.s.	.91	1.25
Japan	1.4225	-8.63		.71	.72
	(3.45)	(-2.02)			
	.9947		-9.12	.92	.73
	(3.04)		(-8.11)		
	.9612	-8.57	-9.12	.98	.96
	(2.14)	(-3.48)	(-9.99)		
Germany Fed.	1.0315	-5.67		.61	.42
	(3.63)	(2.01)			
	.8099				
	(1.98)		n.s.	.58	.49
	n.s.	n.s.	n.s.		
Italy	.9217	-5.87		.66	.59
	(4.17)	(-1.99)			
	.3705		-4.22		
	(2.12)		(-5.23)	.83	1.25
	3.2912	7.32	-4.53	.91	1.17
	(4.55)	(-9.97)	(-7.61)		
France	.8817	-6.00		.71	.59
	(4.59)	(-2.24)			
	.6591		w.s.	.86	1.08
	(5.07)				
	.6126	-2.01	w.s.	.89	1.09
	(4.46)	(2.27)			
Australia	.7955	-5.30		.78	.72
	(5.55)	(-2.65)			
	.7365		-1.76	.82	1.45
	(5.57)		(-3.59)		
	.5846	-4.52	-1.60	.86	1.46
	(4.60)	(-2.82)	(-3.72)		

Netherlands	.6640 (5.14)	-3.88 (-2.15)		.74	.58
	.4601 (3.59)		-4.09 (-3.87)	.81	.87
	.2719 (2.28)	-4.34 (-3.47)	-4.31 (5.00)	.88	.72
Belgium - Lux.	.4992 (6.30)	n.s.		.78	.97
	.4368 (5.19)		-1.16 (-2.34)	.80	1.47
	.3618 (4.04)	-1.85 (-2.01)	-1.19 (-2.52)	.83	1.27
Brazil	.3284 (5.81)	-2.62 (-3.39)		.81	.93
	.4597 (6.94)		w.s.	.73	1.28
	.3388 (4.96)	-2.56 (-3.10)	w.s.	.81	.91
Sweden	1.06 (4.30)	n.s.		.66	.89
	1.28 (5.92)		n.s.	.62	.91
	1.02 (4.12)	-7.19 (-1.99)	n.s.	.67	.91
Switzerland	.6231 (4.56)	-4.83 (-2.53)		.72	.60
	.6982 (4.54)		n.s.	.63	.84
	.3581 (2.31)	-6.41 (-3.59)	-1.58 (-2.69)	.79	.68

Norway	.5321 (4.13)	-3.18 (-6.11)		.95	.87
	.5918 (3.92)		-2.07 (-3.04)	.98	.85
	.4141 (3.41)	-1.98 (-2.55)	n.s.	.96	.90
India	.7112 (3.61)	-1.15 (-3.12)		.78	.99
	.6815 (9.17)		-2.32 (-3.21)	.81	1.02
	.4761 (3.31)	-2.78 (3.63)	-4.15 (-2.71)	.89	.97
South Africa	.6482 (4.15)	-3.12 (-2.87)		.81	1.09
	.5158 (6.21)		-3.19 (-2.22)	.83	1.12
	.4561 (5.38)	-2.27 (-3.12)	n.s.	.88	1.27
Denmark	1.04 (3.98)	n.s.		.61	.35
	1.22 (5.21)		n.s.	.57	.60
	.6170 (1.98)	-12.49 (-2.57)	-7.84 (2.10)	.68	.40
Greece	.8281 (5.07)	-8.62 (-3.75)		.79	.95
	1.1732 (6.34)		n.s.	.63	1.36
	.8504 (5.03)	-8.68 (-3.78)	n.s.	.80	1.09

T values in parenthesis.  
n.s. - not statistically significant  
w.s. - wrong sign

The income elasticity always comes out with reasonable magnitudes and it is statistically significant. It is interesting to note that imports from the United Kingdom are almost income inelastic due to the "ancient" political association between the United Kingdom and Canada, while on the other hand the relatively high income elasticity of Japanese exports reflects the trade expansion of this country.

$P_1$  was econometrically a more successful candidate than  $P_2$  since it came out with a wrong sign only once while it was not significant at the 5% level in four out of forty-eight regressions. The corresponding numbers for  $P_2$  are six and ten respectively. In many cases they reveal high price elastic imports.

In very many cases though, Durbin-Watson statistic appears very low confirming the presence of autocorrelation. To resolve this complexity the previously explained Hildreth-Lu method was applied to the data for the forty-eight regressions. Although  $R^2$  in almost every equation was very close to unity, the table with the results is not worthwhile to be reproduced in this paper, since the estimates are less compatible with the theory for a certain percentage of the countries examined.

## The Case of the U.S.A.

The most important commercial partner of Canada is the United States. Imports and exports among these countries account for three quarters of the total Canadian international trade. It is thus easily understood that a more analytical inspection of the parameters examined in this article is worthwhile since the knowledge of their exact, if possible, magnitude should be taken under serious consideration in any comprehensive economic policy with direct or indirect implications for the Balance of Payments.

The exchange rate of Canadian to U.S. dollars has not been kept constant in the post war period for various reasons. The movement of shortterm capital due to interest rates differentials is probably the main one. It is thus very reasonable to use a third price variable  $P_3$  which is simply the exchange rate of Canadian to the U.S. dollar. In the table presented below, every other variable is familiar to the reader. The estimation of the seven regressions - whose formulation needs not additional explanation - it is done by application of OLSQ.

Table 4

Estimates of Elasticities of the Demand for imports from the U.S.

Income	$P_1$	$P_2$	$P_3$	$R^2$	W
.5756 (5.17)	-4.23 (-3.01)			.80	.63



.7885 (7.99)		w.s.		.73	1.06
.7395 (7.59)			-1.66 (-2.20)	.73	.99
.5603 (4.38)	-4.41 (-2.62)	n.s.		.80	.58
.4958 (6.01)	-6.23 (-5.06)		-3.96 (-3.76)	.88	1.03
.8325 (8.42)		n.s.	-3.24 (-2.27)	.79	1.36
.5546 (5.63)	-4.37 (-3.92)	n.s.	-5.66 (-4.24)	.89	1.37

T values in parenthesis.  
n.s. - not statistically significant.  
w.s. - wrong sign.

The explanatory power of the regressions is fairly good. All income elasticity estimates are highly significant, lying in the .50 - .83 range. U.S. exports to Canada reveal considerable price elasticity ranging from -1.66 to -6.23 for the statistically significant estimates. Obviously correlation in the residuals exists for the first five lines.

Table 5 coincides conceptually with Table 4 but the estimates of Table 5 are calculated by application of the technique which is supposed to alleviate the problem of autocorrelation.

Table 5

Estimates of Elasticities of the Demand for Imports from the U.S.A. corrected for Autocorrelation.



Income	$R_1$	$P_2$	$P_3$	$R^2$	W
1.3709 (19.32)	-1.18 (-3.49)			.97	1.26
n.s.		n.s.		.96	.83
n.s.			n.s.	.97	.86
1.3063 (19.67)	-3.65 (-7.35)	-1.28 (-3.83)		.98	1.23
n.s.		n.s.	n.s.	.97	.85
1.3612 (13.56)	-.87 (-2.40)	-1.87 (-2.61)		.97	1.22
1.3899 (16.59)	-3.35 (-6.38)	-1.62 (-4.07)	-2.54 (-6.15)	.98	1.27

T values in parenthesis.  
n.s. - not statistically significant.

There are two main characteristics in the above results. Income elasticities are at least twice as high compared with the corresponding ones of Table 4. The three equations with no absolutely significant estimations are those in which autocorrelation could not be remedied.

## CONCLUSION

It was the intention of this paper to present a set of efficient and up-to-date estimates for income and price elasticities of the demand for imports. It is believed that this task was accomplished successfully. The problem of autocorrelation - inherent in series analyses - which diminishes the efficiency of the estimates was given considerable treatment. Here it is worthwhile to observe that the serial correlation of the residuals does not vanish completely the properties of the OLSQ estimates since no dependent variable is used as an explanatory one.

The variable with the best statistical performance is unquestionably the G.N.P. one. However, the magnitude of the income elasticity has an average lower than the unity for the regressions run "naively" by OLSQ and slightly higher than the unity for those "corrected" by a Cochrane-Orcutt technique.

It is true that the price variables are not always statistically significant. However, the magnitudes<sup>2</sup> of the estimates of the price elasticities are such as to suggest that Canadian imports are more price elastic than they are income elastic. This is equally true for imports by countries and for those classified by commodity categories. This high sensitivity of the volume of imports to the price changes should be kept steadily in the mind of the policy makers in a widely open economy with a "respectable" rate of inflation.

## Notes

- 1 Data for Gross National Income was obtained from United Nations Yearbook of National Account Statistics (various issues). Total imports as well as imports by countries and by Commodity Class were found in Statistics Canada Imports by Countries and in United Nations International Trade Statistics. In the latter were also found exports and imports price indexes of the countries included in the analysis and the exchange rates of their currency to the U.S. dollar. The Canadian wholesales price index was taken from United Nations Statistical Yearbook (various issues).
- 2 The high magnitude of the price elasticity estimates is justified by the fact that yearly data were used in the analysis and thus a fuller response of the volume of imports to the price changes was observed than the one when quarterly data are examined.

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