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#13

THE PORTFOLIO EFFECT IN CANADIAN EXPORTS

by

Carl Prézeau

Faculté d'Administration,
Université de Sherbrooke.

May, 1973

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The views and opinions expressed in this report are those
of the author and are not necessarily endorsed by the
Department of Industry, Trade and Commerce.

"The Portfolio Effect in Canadian Exports"
by Professor Carl Prézeau, University of Sherbrooke

EXECUTIVE SUMMARY

- a) The purpose of the research project was to study on a historical basis, the problem of Canadian export diversification by using portfolio selection techniques developed in finance.

Using this financial analysis theory, Prézeau has confirmed the work of other investigators that trade with countries other than the USA has been an important factor in alternating the fluctuations in overall Canadian exports due to business cycle effects in the USA.

- b) The data used in this study were the quarterly series on Canadian exports (1965 to 1970) supplied by Statistics Canada and computer stored by the Financial Research Institute of McGill University. Correlation regression analysis was the basis of calculation.
- c) Prézeau has found that in effect there exists an important negative correlation between Canadian exports to other countries and Canadian exports to the U. S. (-0.3950) and that external trade to other countries has been an important factor in reducing the amplitude of Canadian fluctuations owing to the narrow commercial ties between the United States and Canada.
- d) In a second and third part of the study an ideal geographic diversification of exports and an ideal diversification of products is presented based on the historical average growth rate and the correlation coefficient between the different export outlets. Prézeau concludes that the global policy for the promotion of exports should take both axes of diversification into consideration.
- e) Relevance 3
Quality 1
Usefulness 1

THE PORTFOLIO EFFECT IN CANADIAN EXPORTS

By: Carl Prézeau

THE PORTFOLIO EFFECT IN CANADIAN EXPORTS*

BY

CARL PRÉZEAU

Canada's foreign trade is an important factor in managing the Canadian economy. Until 1971, the importance of this sector was analysed chiefly from the standpoint of relations between Canada and America as the United States has been Canada's largest customer and supplier since the postwar era. However, owing to the chronic deterioration of the American dollar, which has brought about drastic changes in United States trade policy, it has become increasingly necessary for Canada to consider greater diversification of its foreign trade.

The purpose of this booklet is to examine this problem of diversifying Canadian exports on a historical basis using portfolio techniques developed in finance. As a matter of fact, this sector is highly suited to the use of these techniques because:

- 1) the objectives of a long-term policy for diversification can be compared to those of portfolio management, as in both cases it is a matter of maximizing an output rate (growth in the case of

* Working paper on a study conducted in cooperation with Mr. Albény Nadeau, Assistant Professor in the Department of Finance of the University of Sherbrooke Faculty of Administration. This study was completely financed by a grant from the Federal Department of Industry, Trade and Commerce. The opinions expressed in this paper are those of the author only.

exports) while endeavouring to minimize fluctuations in that rate,

- 2) there are a large number of foreign markets other than the United States market,
- 3) there is statistical interdependence between those markets, and
- 4) in the long term, exports for various outlets can be divided up in accordance with an adequate distribution arrangement.

The existence of the four conditions mentioned above therefore makes possible elementary application of the standard formulation of a diversified portfolio problem.

It is a three-way application, viz.:

- a) a historical appraisal of the portfolio effect explaining the close connection between the Canadian and American economies through trade between Canada and the United States,
- b) a potential measurement of effective diversification through foreign markets, and
- c) a potential measurement of effective diversification by groups of products exported.

The data used in this document are the quarterly series on Canadian exports supplied by Statistics Canada and recorded in the memory of the computer belonging to the Financial Research Institute of McGill University. The programmes used in calculating the effective portfolios are those of the Dartmouth centre.

The average growth rate calculations were made as follows:

$$Y = a + bX$$

3

where Y = quarterly data

X = time.

We noticed a significant phenomenon of correlation between the annual series for the years 1950 to 1970, so we preferred to use the quarterly data for the years 1965 to 1970. In both instances, the minimum number of samples was 19--that number being strictly necessary to ensure the validity of the statistical tests. Moreover, we thought 20 quarters a maximum requirement since we did not have to consider the effect of the trade policies ^{the} of governments during that period on the basic trends in exports.

THE HISTORICAL AND GEOGRAPHICAL DIVERSIFICATION OF CANADIAN EXPORTS

Our interest in applying portfolio techniques in this field was roused by the conclusions of several studies showing the close relationship between the Canadian and United States economies.* Diagram No. I clearly shows that both economies fluctuate in the same direction at the same time.

DIAGRAM NO. I

GROSS NATIONAL PRODUCT IN CURRENT DOLLARS

CANADA AND THE UNITED STATES

Source: Business Cycles in Canada (November 1967), by Derek White

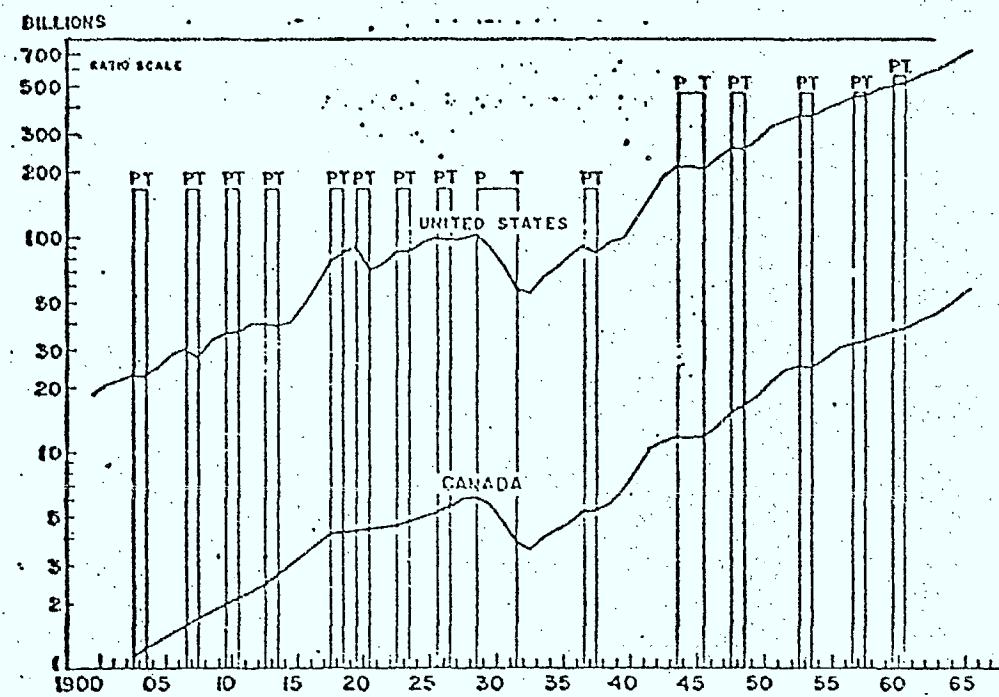
*White, Derek, Business Cycles in Canada (1967).

Brecher, I. and Reisman, S.S., Canada - United States Economic Relations (1957).

Rosenbluth, G., Changes in Canadian Sensitivity to United States Business Fluctuations (1957) - also, Changing Structural Factors in Canada's Cyclical Sensitivity (1958).

DIAGRAM NO. 1

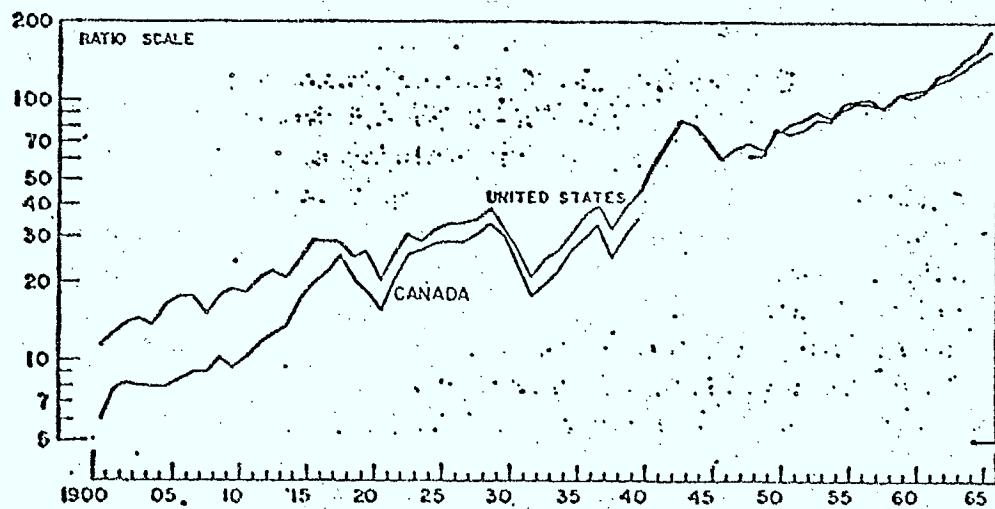
GROSS NATIONAL PRODUCT IN CURRENT DOLLARS
CANADA AND THE UNITED STATES



Source: Business Cycles in Canada (November 1967) by Derek White

DIAGRAM NO. 2

INDEX OF NON-AGRICULTURAL EXPORTS TO THE UNITED STATES AND AMERICAN
INDUSTRIAL PRODUCTION



Source: Business Cycles in Canada (November 1967), by Derek A. White.

These authors generally concluded that this close relationship is the outcome of the following factors:

- 1) the extent of the trade between these two countries (68% of Canadian exports go to the United States and 70% of Canadian imports come from the United States (Diagram No. II),
- 2) the high percentage of Canadian production in some sectors which goes for export, much of it bound for the United States,
- 3) the flow of capital between the two countries,
- 4) the predominant influence of American opinions and conjunctures on Canadian expectations,
- 5) the close link between Canadian and American Stock Exchanges.

DIAGRAM NO. II

Index of non-agricultural exports to the United States and American industrial production

Source: Business Cycles in Canada (November 1967), by Derek A. White.

Although we recognize the validity of those conclusions, we wonder whether Canada's trade policy as regards exports to other countries has not augmented that influence by ignoring the correlation effect that exists between this country and the United States.

A brief table of foreign markets follows.

CANADIAN EXPORTS IN 1971

\$17,704,000,000

(Breakdown by percentage)

United States	68%
Great Britain	8%

Other countries	7%
E.E.C.	6%
Japan	4%
Other Commonwealth countries	4%
South America	3%

White simply mentioned:

"More generally, although Canadian and U.S. fluctuations studied to coincide, a number of independent factors, and particularly the impact of overseas trade, insured that the path of aggregate activity in Canada was not completely identical to that in the United States. The relative importance assumed by such independent factors when U.S. recessions are mild as the postwar ones have been, appear to be the main reason why there is a low degree of rank correlation between the amplitudes of recent Canadian and U.S. contractions". (White, ibid., page 113-114)

Considering the extent of the trade with the United States (68% for exports in 1971), the effects of the American fluctuations via the trade factor are actually diminished only:

- a) if trade with the other countries is negatively correlated with Canadian trade with the United States, and
- b) if that negative correlation is substantial enough to have some influence.

As a matter of fact, the standard diversification model for reducing fluctuations is:

$$V(E_{EU A}) = P_{EU}^2 \sigma_{EU}^2 + 2P_{EU}P_A \sigma_{EUA} + P_A^2 \sigma_A^2$$

(V = variance, E = exports, EU = U.S., A = other countries and P = proportions.)

where $V(E_{EU A})$ is the variance in total Canadian exports, P_{EU} & P_A are the proportions of exports to each of the countries compared to the total exports, σ_{EU}^2 & σ_A^2 , the variances in

exports to each of the countries and $\sigma_{EU,A}$, the covariance between the two countries.

$$\text{But, } \sigma_{EU,A} = \rho \sigma_E \sigma_A$$

where ρ = the coefficient of correlation between E_{EU} and E_A , so obviously, Canadian fluctuations originating with those of the United States will be reduced if the term $\sigma_{EU,A}$ is negative and substantial. Both conditions are dependent on the value of ρ and its sign, with ρ able to vary between -1 and +1. In view of the ρ_{EU} value--about 68%--the ideal reduction would be produced with a ρ value of -1.

For the period 1965-1970, according to the quarterly data, the value of ρ was -0.3950, making it possible to join White in concluding that foreign trade with the other countries was an important factor in curtailing Canadian fluctuations arising out of the close commercial bond between the United States and Canada. On the other hand, if we compare the growth rate for exports to the United States with the growth rate for trade with the other countries, we find that it is very small--2.97%. The $\sigma_{EU} = .1605$ and the $\sigma_A = .0907$. If we include these results in the diversification model, we can see that if the coefficient of correlation were positive it would increase the total variance.

THE IDEAL GEOGRAPHICAL DIVERSIFICATION

Portfolio techniques are useful not as tools for describing the past so much as administrative methods for deciding on the course of action to be taken with respect to established aims. Now, as we have mentioned before, considering the importance of foreign trade in the managing of the Canadian economy, the opening up and expanding of foreign markets may depend solely /two fortunately quantifiable economic objectives, viz.: 7

- a) seeking an optimum growth rate while taking into account Canada's industrial potential, and
 - b) attempting to find an adequate level for fluctuations in this sector so as to control internal economic stability.

Evidently, these two objectives are fully compatible with the overall economic goals of Canadian society.

It therefore struck us as interesting to outline the ideal geographical distribution of the exports, taking into account the previously mentioned objectives. Table I presents eleven effective distribution schedules based on various possibilities for compromise between a desired growth rate and fluctuation level and provides a measurement of those various possibilities.

Analysis of this table shows that in no case should the United States have had the significance they did as foreign

TABLE I
IDEAL GEOGRAPHICAL DIVERSIFICATIONS FOR CANADIAN EXPORTS

TABLEAU I
DIVERSIFICATIONS GEOGRAPHIQUES IDEALES DES EXPORTATIONS CANADIENNES

<u>Liste des pays</u>	<u>Distribution</u>										
	1	2	3	4	5	6	7	8	9	10	11 (Pays i)
1 - Inde		52.87	35.40	26.53	20.18	9.99	6.90	3.96	2.25	1.05	
2 - Japon							7.65	17.63	18.58	17.57	15.97
3 - Australie									3.78	5.87	7.02
4 - Etats-Unis									7.79	12.69	15.42
5 - Royaume-Uni										7.17	11.19
6 - Belgique et Luxembourg					7.38	16.64	16.62	15.06	11.95	9.29	7.01
7 - France									5.07	7.51	8.83
8 - Allemagne de l'Ouest							3.29	5.41	5.30	4.84	4.30
9 - Italie				22.46	31.83	41.79	39.16	33.57	25.79	19.51	14.27
10 - Pays-Bas						8.07	8.75	8.43	6.95	5.53	4.26
11 - Norvège	100.0000	47.13	29.32	21.87	16.58	8.15	5.61	3.21	1.77		
12 - République de l'Afrique du Sud											4.36
13 - Vénézuela			35.28	29.14	24.04	15.37	12.02	8.47	5.50	3.64	2.29
14 - Mexique									4.28	5.27	5.33
Taux de croissance réalisable	0.2340	0.2138	0.1691	0.1445	0.1266	0.0976	0.0869	0.0755	0.0637	0.0520	0.0437
Variance	0.7785	0.3376	0.1477	0.0851	0.0514	0.0170	0.0103	0.0058	0.0033	0.0023	0.0020
Ecart-type	0.8823	0.5810	0.3843	0.2918	0.2268	0.1305	0.1014	0.0760	0.0575	0.0475	0.0452

TABLE I (Cont'd)

Realizable growth rate	
Variance	(For figures see text)
Standard deviation	

markets for Canada. In actual fact, from the historical data, Canada's main foreign outlets should have had the following breakdown for a growth rate of over 5%:

2 - Japan	16%
3 - Australia	7%
4 - United States	12%
5 - United Kingdom	7%
7 - Belgium and Luxemburg	7%
9 - West Germany	20%

These conclusions are arrived at from two main variables, viz.: the average historical growth rate and the coefficient of correlation between the various outlets. The value of those variables is given in tables II and III.

The effect of the growth rates for each outlet on the export growth rate can be explained by the following equation:

$$R_{ET} = \sum_{i=1}^n X_i R_i$$

where R_{ET} = growth rate for total exports

R_i = growth rate for each of the exports to a specific market, and

X_i = proportion of each of the markets in relation to the total exports.

TABLEAU II

TAUX MOYEN DE CROISSANCE PAR PAYS PAR TRIMESTREET LA VARIANCE DE CE TAUX

<u>Liste des pays</u>	<u>Croissance</u>	<u>Variance</u>
1 - Inde	0.1958	0.4979
2 - Japon	0.0511	0.0126
3 - Australie	0.0308	0.0307
4 - Etats-Unis	0.0297	0.0142
5 - Royaume-Uni	0.0243	0.0179
6 - Belgique et Luxembourg	0.0666	0.0283
7 - France	0.0318	0.0246
8 - Allemagne de l'Ouest	0.0527	0.0478
9 - Italie	0.0696	0.0140
10 - Pays-Bas	0.0648	0.0456
11 - Norvège	0.2340	0.7785
12 - République de l'Afrique du Sud	-0.0160	0.0151
13 - Vénézuéla	0.0885	0.0311
14 - Mexique	0.0478	0.0394

TABLEAU III
MATRICE DE CORRELATION ENTRE LES DIFFERENTS DEBOUCHES

	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12	Col. 13	Col. 14	Col. 15	Col. 16 *
1	1.0000	0.5943	-0.0351	-0.3373	0.1075	-0.1488	0.0237	0.0126	-0.2150	0.3515	0.1029	0.0290	-0.1352	0.0201	-0.2999	-0.3244
2	0.5943	1.0000	0.3261	-0.3816	0.3629	0.0632	-0.0855	-0.0956	-0.1171	0.3660	0.1981	0.0828	0.0783	0.0801	-0.1511	-0.1401
3	-0.0351	0.3261	1.0000	0.0151	0.2025	0.1602	-0.0326	-0.2122	0.2287	-0.0898	0.1876	0.1057	0.2337	0.1513	0.0301	0.1659
4	-0.3373	-0.3816	0.0151	1.0000	-0.0502	-0.0522	-0.2822	-0.0363	0.0891	-0.4842	0.0099	-0.3110	0.0971	-0.0079	0.0716	0.3420
5	0.1075	0.3629	0.2025	-0.0502	1.0000	0.6278	0.3034	0.4352	0.5644	0.3946	0.5180	0.4658	0.3337	0.1006	0.1429	-0.3327
6	-0.1488	0.0632	0.1602	-0.0522	0.6278	1.0000	0.5579	0.5644	0.9096	0.5438	0.7876	0.3456	0.4193	-0.0021	0.5587	-0.1872
7	0.0237	-0.0855	-0.0326	-0.2822	0.3834	0.5579	1.0000	0.3295	0.4998	0.4507	0.4352	0.2571	-0.0940	0.2572	0.2952	-0.4501
8	0.0126	-0.0956	-0.2122	-0.0363	0.4352	0.5644	0.3295	1.0000	0.5637	0.1630	0.2443	0.1465	0.2364	-0.1561	0.3576	-0.0115
9	-0.2150	-0.1171	0.2287	0.0891	0.5644	0.9096	0.4998	0.5637	1.0000	0.2876	0.6753	0.3815	0.4798	0.1057	0.5205	-0.1217
10	0.3515	0.3660	-0.0898	-0.4842	0.3946	0.5438	0.4507	0.1630	0.2876	1.0000	0.5017	0.3919	0.0105	-0.1007	0.0227	-0.4759
11	0.1029	0.1981	0.1876	0.0099	0.5180	0.7876	0.4352	0.2443	0.6753	0.5017	1.0000	0.1802	0.3335	0.0418	0.4943	-0.4105
12	0.0290	0.0828	0.1057	-0.3110	0.4658	0.3456	0.2571	0.1465	0.3815	0.3919	0.1802	1.0000	0.0877	0.0356	-0.0095	-0.3196
13	-0.1352	0.0783	0.2337	0.0971	0.3337	0.4193	-0.0940	0.2364	0.4798	0.0105	0.3335	0.0877	1.0000	0.2710	0.3504	0.1202
14	0.0201	0.0301	0.1513	-0.0079	0.1006	-0.0021	0.2572	-0.1561	0.1057	-0.1007	0.0418	0.0356	0.2710	1.0000	-0.1223	-0.1345
15	-0.2999	-0.1511	0.0301	0.0716	0.1429	0.5587	0.2952	0.3576	0.5202	0.0227	0.4943	-0.0095	0.3504	-0.1223	1.0000	-0.1298
16	-0.3244	-0.1401	0.1659	0.3420	-0.3327	-0.1872	-0.4501	-0.0115	-0.1217	-0.4759	-0.4105	-0.3196	0.1202	-0.1345	-0.1298	1.0000

* Index de la production industrielle américaine.

TABLE II
AVERAGE GROWTH RATE PER COUNTRY PER QUARTER
AND THE VARIANCE IN THAT RATE

<u>List of the countries</u>	<u>Growth</u>	<u>Variance</u>
1 - India		
2 - Japan		
3 - Australia		
4 - United States		
5 - United Kingdom		
6 - Belgium and Luxemburg		
7 - France		(For figures see text)
8 - West Germany		
9 - Italy		
10 - Netherlands		
11 - Norway		
12 - Republic of South Africa		
13 - Venezuela		
14 - Mexico		

TABLE III
MATRIX OF CORRELATION BETWEEN THE VARIOUS OUTLETS

Col. 1, etc.* (For figures see text)

*American industrial production index.

In other words, if there is a high growth rate in exports to a specific market, the growth rate for total exports will be higher if that market accounts for a big percentage of total exports, and vice versa. Thus the historical growth rate of Canadian exports has been primarily influenced by the growth rate of exports to the United States since they represent about 70% of all Canadian exports.

However, in practice, unlike a portfolio of Stock Exchange shares, effective geographical diversification cannot be achieved in the short- or medium-term because the exchange capacity of foreign markets other than the United States is necessarily limited. For instance, it is unfeasible to make a medium-term commercial realignment with West Germany to increase the exports to that country from \$319,000,000 to \$3,500,000,000 over a few years.

On the other hand, the advantage of finding out the various effective diversification profiles lies in the fact that they permit Canadian efforts to be better directed towards other foreign outlets. Hence, the efforts made by the Canadian government to develop trade with Japan and the Common Market countries can be regarded as valid, as long as the characteristics revealed by this text remain unchanged in the future.

THE IDEAL DIVERSIFICATION BY PRODUCTS

When diversification by markets is hard to achieve, it is advantageous to consider the possibilities of diversification by products. The same methodology was followed as in the foregoing sections. Thus, in Table IV, we provide the particulars on

- a) the historical growth rate for 24 groups of products, and
- b) the standard deviation for each.

Table V represents the matrix of correlation between the various products, including the American industrial production index.

To make it easier to evaluate overall policies, we used the Michael Boretsky classification* with a few variants. Boretsky, Michael - "Concerns about the present American position in international trade". Study paper - Department of Commerce, U.S.A.

The twenty-four products are accordingly regrouped as follows:

1 - Intensive-technology products, including:

- a) # 1 - aircraft parts
- b) # 4 - industrial equipment
- c) # 7 - chemical products
- d) # 8 - fertilizers.

The main criterion used by Boretsky for this group is the high level of scientific and technological expertise, research and development required by these products.

2 - Non-intensive-technology products:

- a) # 3 - manufactured products
- b) # 5 - other industrial equipment
- c) #11 - aluminium products
- d) #18 - newsprint
- e) #19 - other forest products.

3 - # 9 - products associated with the automobile.

4 - Raw materials

- a) # 2 - electricity
- b) # 6 - other metals and ores
- c) #10 - primary iron and steel
- d) #12 - copper, nickel and products
- e) #13 - oil and natural gas
- f) #14 - uranium ore
- g) #15 - lead, zinc and products
- h) #16 - wood
- i) #17 - paper pulp
- j) #20 - iron ore.

5 - Agricultural products

- a) #21 - wheat and flour
- b) #22 - oats
- c) #23 - other
- d) #24 - fish and products.

TABLEAU IV

TAUX DE CROISSANCE ET VARIANCE
PAR PRODUITS PAR TRIMESTRE

No. des produits	Titres	Taux	Variance
1	Pièces d'avion	-0.0018	0.0197
2	Électricité	0.1307	0.0578
3	Produits manufacturiers	0.0669	0.0368
4	Equipements industriels	0.0274	0.0151
5	Autres équipements industriels	0.0419	0.0267
6	Autres minéraux	0.0103	0.0083
7	Produits chimiques	0.0355	0.0198
8	Fertilisants	0.0471	0.0885
9	Produits reliés à l'auto	0.0550	0.0447
10	Fer et acier primaire	0.0250	0.0267
11	Produits de l'aluminium	0.0215	0.0370
12	Cuivre, nickel et produits	0.0473	0.0770
13	Plomb, zinc et produits	0.0505	0.0213
14	Pétrole et gaz naturel	0.0498	0.0069
15	Minerai d'uranium	0.1852	0.3893
16	Bois	0.0196	0.0215
17	Pâte à papier	0.0135	0.0119
18	Papiers journaux	0.0109	0.0049
19	Autres produits forestiers	0.0191	0.0061
20	Minerai de fer	0.3319	0.6527
21	Blé et produits	0.0897	0.0507
22	Avoine	0.4264	0.4960
23	Autres produits de ferme	0.0523	0.0288
24	Poissons et produits	0.0447	0.0346

TABLEAU V
MATRICE DE CORRELATION ENTRE LES DIFFERENTS PRODUITS

	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12	Col. 13	Col. 14	Col. 15	Col. 16	Col. 17	Col. 18	Col. 19	Col. 20	Col. 21	Col. 22	Col. 23	Col. 24
1	1.000	-0.512	-0.317	-0.042	-0.107	0.237	-0.379	0.184	0.590	0.423	0.245	0.450	-0.119	-0.350	-0.007	-0.094	-0.332	-0.391	-0.107	-0.060	-0.510	-0.243	-0.320	-0.282
2	-0.512	1.000	0.245	-0.020	-0.089	-0.499	0.270	0.069	-0.478	0.033	-0.411	-0.041	0.402	0.887	0.404	-0.239	0.030	-0.084	-0.169	-0.022	0.205	0.807	0.598	-0.049
3	-0.317	0.245	1.000	0.115	0.221	0.199	-0.293	-0.075	0.066	0.116	0.159	-0.419	0.490	0.137	-0.072	0.046	0.218	0.386	0.376	0.321	0.187	-0.019	0.424	0.495
4	-0.042	-0.020	0.115	1.000	0.314	0.159	-0.135	-0.036	-0.131	-0.096	0.244	0.020	0.406	-0.122	-0.205	0.076	0.167	0.119	0.436	0.293	0.302	0.025	-0.013	0.243
5	-0.107	-0.089	0.221	0.314	1.000	-0.179	0.323	0.248	0.169	-0.119	0.415	-0.211	-0.064	-0.150	0.282	0.091	0.498	0.301	-0.197	-0.226	-0.140	-0.341	0.087	-0.208
6	0.237	-0.499	0.199	0.159	-0.179	1.000	-0.356	-0.354	0.068	0.420	0.371	0.260	0.316	-0.508	-0.526	0.175	-0.121	0.236	0.646	0.608	0.341	-0.362	0.173	0.531
7	-0.379	0.270	-0.293	-0.135	0.323	-0.336	1.000	-0.116	-0.300	-0.183	0.003	-0.017	-0.190	0.325	0.471	0.421	0.487	0.136	-0.318	-0.165	-0.187	0.029	-0.073	-0.171
8	0.184	0.069	-0.075	-0.036	0.248	-0.354	-0.116	1.000	0.490	0.149	0.338	0.261	-0.306	-0.053	0.061	-0.300	0.227	0.108	-0.040	-0.538	-0.132	0.117	0.560	-0.667
9	0.590	-0.478	0.066	-0.131	0.169	0.068	-0.300	0.490	1.000	0.134	0.261	0.083	-0.294	-0.401	0.109	0.174	0.100	-0.020	0.106	-0.335	-0.391	-0.377	0.176	-0.381
10	0.423	0.033	0.116	-0.096	-0.119	0.420	-0.183	0.149	0.134	1.000	0.171	0.592	0.173	0.166	0.176	-0.134	0.062	-0.104	0.182	0.257	-0.020	0.061	0.213	-0.060
11	0.245	-0.411	0.159	0.244	0.415	0.371	0.003	0.338	0.261	0.171	1.000	0.149	0.107	-0.475	-0.276	0.124	0.364	0.503	0.225	0.121	-0.037	-0.356	0.015	-0.032
12	0.450	-0.041	-0.479	0.020	-0.211	0.260	-0.017	0.261	0.083	0.592	0.149	1.000	0.132	0.094	0.096	0.021	-0.105	-0.308	0.024	0.015	0.075	0.261	0.114	-0.465
13	-0.119	0.402	0.490	0.406	-0.084	0.316	-0.190	-0.306	-0.294	0.173	0.107	0.152	1.000	0.381	0.028	0.146	-0.063	-0.018	0.312	0.471	-0.292	0.388	0.221	0.439
14	-0.350	0.687	0.137	-0.122	-0.150	-0.508	0.325	-0.053	-0.401	0.166	-0.475	0.094	0.381	1.000	0.648	-0.020	0.084	-0.343	-0.338	-0.067	-0.030	0.714	0.432	-0.128
15	-0.007	0.404	-0.072	-0.205	0.282	-0.526	0.471	0.061	0.109	0.176	-0.276	0.096	0.028	0.648	1.000	0.289	0.402	-0.368	-0.495	-0.332	-0.383	0.201	0.165	-0.407
16	-0.094	-0.239	0.046	0.076	0.091	0.175	0.421	-0.300	0.174	-0.134	0.124	0.021	0.146	-0.020	0.289	1.000	0.539	0.085	0.184	0.140	-0.107	-0.264	-0.229	0.091
17	-0.332	0.030	0.218	0.167	0.498	-0.121	0.487	0.227	0.100	0.062	0.364	-0.105	-0.063	0.084	0.402	0.539	1.000	0.380	0.120	-0.078	0.000	-0.227	0.110	-0.033
18	-0.391	-0.084	0.386	0.119	0.301	0.236	0.136	0.108	-0.020	-0.204	0.503	-0.308	-0.018	-0.353	-0.368	0.085	0.380	1.000	0.504	0.407	0.389	-0.093	0.206	0.262
19	-0.197	-0.169	0.378	0.436	-0.197	0.646	-0.318	-0.040	0.106	0.182	0.225	0.024	0.312	-0.338	-0.495	0.184	0.120	0.504	1.000	0.576	0.566	-0.041	0.212	0.523
20	-0.060	-0.022	0.321	0.293	-0.226	0.608	-0.165	-0.538	-0.335	0.257	0.121	0.015	0.471	-0.067	-0.322	0.140	-0.078	0.407	0.576	1.000	0.466	0.287	-0.156	0.649
21	-0.510	0.205	0.187	0.302	-0.140	0.341	-0.187	-0.132	-0.381	-0.020	-0.037	0.075	0.292	-0.030	-0.383	-0.107	0.000	0.389	0.566	0.466	1.000	0.370	0.357	0.259
22	-0.243	0.807	-0.019	0.025	-0.341	-0.362	0.029	0.117	-0.377	0.061	-0.356	0.261	0.388	0.714	0.201	-0.264	-0.227	-0.093	-0.041	0.187	0.370	1.000	0.514	-0.200
23	-0.320	0.590	0.424	-0.013	0.087	-0.173	-0.073	0.560	0.176	0.213	0.015	0.114	0.221	0.432	0.165	-0.229	0.110	0.206	0.212	-0.156	0.357	0.513	1.000	-0.254
24	-0.282	-0.049	0.495	0.243	-0.208	0.531	-0.171	-0.687	-0.381	-0.060	-0.032	-0.465	0.439	-0.128	-0.407	0.081	-0.083	0.262	0.533	0.649	0.259	-0.200	-0.254	1.000

TABLE IV
GROWTH RATE AND VARIANCE
BY PRODUCTS PER QUARTER

Product No.	Titles	Rate	Variance
1	Aircraft parts	(For figures see text)	
2	Electricity		
3	Manufactured products		
4	Industrial equipment		
5	Other industrial equipment		
6	Other ores		
7	Chemical products		
8	Fertilizers		
9	Products associated with the automobile		
10	Primary iron and steel		
11	Aluminium products		
12	Copper, nickel and products		
13	Lead, zinc and products		
14	Oil and natural gas		
15	Uranium ore		
16	Wood		
17	Paper pulp		
18	Newsprint		
19	Other forest products		
20	Iron ore		
21	Wheat and products		
22	Oats		
23	Other farm products		
24	Fish and products		

TABLE V
MATRIX OF CORRELATION BETWEEN THE VARIOUS PRODUCTS

Column 1, Col. 2, etc.

(For details see text)

All these products account for 98% of the total exports. We have not included the exports associated with national defence(?) owing to the special nature of their transfer. Lastly, the breakdown for these groups of products in 1971 was as follows:

- 1) intensive-technology products - 10.70%
- 2) non-intensive-technology products - 39.25%
- 3) products associated with the automobile - 17.32%
- 4) raw materials - 23.76%
- 5) agricultural products - 8.96%

By consulting Table VI, which gives the various ideal distribution profiles, we find that in the case of Canada the rational profile is Distribution No. 15 which gives a growth rate of 6.15% with a minute variance of 0.15 or 1%. The breakdown by group of products, therefore, is:

a) intensive technology 10.90%

# 4	4.58%
7	4.98
8	1.34

b) non-intensive technology 23.55%

# 3	4.66%
5	3.94
11	1.43
18	5.71
19	7.81

c) products associated with the automobile # 9 3.11%

d) raw materials 47.25%

# 2	6.19%
6	3.07
10	3.24
12	1.93
13	6.25
14	18.91
15	1.20

TABLEAU VI

DIVERSIFICATION IDEALE DES EXPORTATIONS PAR PRODUIT

<u>Description</u>	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Pièces d'avion													5.56
2 Electricité	35.17	32.15	30.86	28.66	21.58	19.92	13.67	12.02	20.42	9.08	8.37	6.19	1.99
3 Produits manufacturiers		11.71	13.43	14.09	12.31	11.78	8.92	8.24	7.42	6.67	6.24	4.66	1.81
4 Équipements industriels									2.56	3.60	4.04	4.58	5.35
5 Autres équipements industriels							3.29	4.22	4.67	4.65	4.58	3.94	2.74
6 Autres minéraux												3.07	9.05
7 Produits chimiques							4.06	5.34	5.97	6.02	5.94	4.98	3.41
8 Fertilisants							1.19	1.47	1.61	1.58	1.55	1.34	
9 Produits reliés à l'auto		2.27	3.88	4.99	5.15	4.84	4.78	4.53	4.20	3.98	3.11	1.52	
10 Fer et acier primaire										1.27	1.88	3.24	5.17
11 Produits de l'aluminium										1.05	1.23	1.43	1.82
12 Cuivre, nickel et produits									1.61	1.77	1.84	1.93	1.87
13 Plomb, zinc et produits			4.15	8.00	8.65	9.02	9.16	8.87	8.30	7.92	6.25	3.24	
14 Pétrole et gaz naturel				12.76	16.38	23.37	25.11	25.24	24.01	23.13	18.91	11.01	
15 Minerai d'uranium	12.54	0.52	0.88	6.00	5.65	5.11	3.16	2.66	2.22	1.89	1.72	1.20	
16 Bois											1.40	2.34	3.85
17 Pâte à papier												2.84	6.18
18 Papiers journaux												5.71	15.91
19 Autres produits forestiers										3.88	5.00	7.81	12.60
20 Minerai de fer	19.68	14.07	12.92	11.44	7.77	6.92	3.96	3.23	2.59	2.16	1.93	1.28	
21 Blé et produits		9.84	10.87	11.36	10.36	10.07	8.46	7.96	7.32	6.58	6.18	4.86	2.21
22 Avoine	32.81	22.71	20.78	18.42	12.72	11.42	6.92	5.76	4.74	4.00	3.61	2.52	
23 Autres produits de ferme					3.86	4.60	5.91	6.23	6.19	5.84	5.61	4.56	2.59
24 Poissons et produits							3.25	3.82	4.04	3.94	3.85	3.24	2.09
Taux de croissance réalisable	0.2740	0.2198	0.2082	0.1926	0.1514	0.1405	0.1067	0.0967	0.0884	0.0803	0.0760	0.0615	0.0285
Variance	0.0930	0.0502	0.0431	0.0347	0.0173	0.0140	0.0060	0.0046	0.0036	0.0028	0.0025	0.0015	0.0008
Ecart-type	0.3050	0.2240	0.2076	0.1862	0.1314	0.1182	0.0778	0.0679	0.0600	0.0532	0.0497	0.0394	0.0281

TABLE VI
IDEAL DIVERSIFICATION OF EXPORTS BY PRODUCT

Description

- | | |
|---|------------------------|
| 1 - Aircraft parts | (For figures see text) |
| 2 - Electricity | |
| 3 - Manufactured products | |
| 4 - Industrial equipment | |
| 5 - Other industrial equipment | |
| 6 - Other ores | |
| 7 - Chemical products | |
| 8 - Fertilizers | |
| 9 - Products associated with the automobile | |
| 10- Primary iron and steel | |
| 11- Aluminium products | |
| 12- Copper, nickel and products | |
| 13- Lead, zinc and products | |
| 14- Oil and natural gas | |
| 15- Uranium ore | |
| 16- Wood | |
| 17- Paper pulp | |
| 18- Newsprint | |
| 19- Other forest products. | |
| 20- Iron ore | |
| 21- Wheat and products | |
| 22- Oats | |
| 23- Other farm products | |
| 24- Fish and products | |

Realizable growth rate

Variance

Standard deviation

16	2.34%
17	2.84
20	1.28
e) agricultural products	15.18%
# 21	4.86%
22	2.52
23	4.56
24	3.24.

Finally, if we take the historical variance in the exports, we can see that, for this same variance, Canada could have achieved a growth rate of 14%. On the other hand, the same limits in capacity can occur with the products as with the foreign markets. Consequently, any comprehensive export promotion policy would have to take the two ^{main} lines of diversification into consideration.

CONCLUSION

Use of portfolio techniques in this field therefore constitutes a valid source of information which will permit better guidance in efforts to promote exports towards achieving greater adequacy between the characteristics of the Canadian economy and the long-term economic objectives. Yet, though implementation looks easy from a historical basis, such is not the case with projection into the future. As a matter of fact, even when making the assumption that the coefficients of correlation will hold steady, the big job of estimating future growth rates and their variances still remains.

TECHNOLOGICAL INNOVATION STUDIES PROGRAM
PROGRAMME DES ETUDES SUR LES INNOVATIONS TECHNIQUES
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