MEMORANDUM
RM-3432-PR
MARCH 1963

EXPORT CONCENTRATION AND FLUCTUATIONS IN EXPORT EARNINGS: A CROSS-SECTION ANALYSIS

Benton F. Massell

PREPARED FOR:
UNITED STATES AIR FORCE PROJECT RAND

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PREFACE

This Project RAND Memorandum contains an empirical analysis of the relationship between the fluctuations of a country's export earnings and the concentration of its exports. It is a result of continuing RAND studies dealing with economic problems in the less-developed areas, and is intended to shed light on the merits of diversification as a deliberate policy to reduce the amplitude of annual fluctuations in export earnings. A related study just published assesses the Soviet claim that the USSR provides a stabler market than the industrial countries of the West for the primary-product exports of the less-developed countries: RAND RM-3341-PR, The USSR and the West as Markets for Primary Products: Stability, Growth, and Size, by Egon Neuberger.

The present Memorandum is expected to be of interest to economists and economic planners as well as to those concerned with relations with the less-developed countries and with U.S. foreign aid programs.

The author is indebted to RAND colleagues Richard C. Kao, Andrew W. Marshall, and Egon Neuberger for a number of helpful comments and suggestions. But the views expressed here and the conclusions arrived at are the author's.

SUMMARY

It is frequently asserted that the severe fluctuations in export earnings experienced by many countries are largely attributable to the concentration of these countries on a narrow range of products for export, and that these fluctuations would be reduced by a policy of diversification. The present study attempts to determine empirically the extent to which intercountry variation in the instability of export earnings can be explained by the degree of export concentration.

In a sample of 36 countries, regression analysis is used to estimate the relationship between the instability of a country's export earnings (dependent variable) and the commodity concentration of its exports (independent variable). Other independent variables are successively introduced: (1) the geographical concentration of exports and (2) the ratio of primary-product exports to total exports.

The data indicate a significant but weak net relationship between export-earnings instability and the commodity concentration of exports; and only a marginally stronger net relationship between instability and the primary-product ratio. Much of the intercountry variation in export-earnings instability fails to be explained by the independent variables considered. One can conclude that in general neither diversification nor industrialization is likely to reduce greatly the amplitude of fluctuations in a country's export earnings.

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I. INTRODUCTION

In recent years there has been considerable discussion of the problem of fluctuations in commodity markets and the impact of these fluctuations on countries producing primary products.[1] The newly developing countries, in particular, all of whom are heavily dependent upon earnings from the sale of primary commodities to finance much-needed capital goods imports, have evidenced substantial concern with the instability of their export proceeds.[2] In large part, this concern derives from the fact that commodity prices -- and, consequently, foreign exchange earnings -- have often exhibited a tendency towards secular decline; but in part it stems also from the shorter-run fluctuations around the trend.[3]

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[1] See, for example, United Nations, Department of Economic Affairs, Instability in Export Markets of Underdeveloped Countries, 1952; United Nations, Department of Economic Affairs, Commodity Trade and Economic Development, 1954; United Nations, Department of Economic Affairs, Measures for International Economic Instability, 1951; United Nations, Commission on International Commodity Trade, Report of 8th Session, May 1960; United Nations, Economic and Social Council, Economic Commission for Africa, International Action for Commodity Stabilization and the Role of Africa, E/CN. 14/68, November 1960; United Nations, Economic and Social Council, Impact of Fluctuations in Economic Activity in Industrial Countries on International Commodity Trade, New York, 1960; Guy Benveniste and William E. Moran, Jr., African Development - A Test for International Cooperation, Stanford, Stanford Research Institute, 1960, Ch. VI; Carnegie Endowment for International Peace, "International Commodity Problems," International Conciliation, September 1959.

[2] See United Nations, Economic and Social Council, Official Records, Twenty-Eighth Session, July 1959; United Nations, Commission on International Trade, Eighth Session, Summary Record, July 1960.

[3] Given the prices paid for imports, the trend in export proceeds determines the long-run gains that accrue to a country from international trade, and hence is an important determinant of the secular rise in the country's material welfare. Nevertheless, whatever the trend in export earnings may be, there are obvious advantages in reducing fluctuations around this trend. Uncertainty and unreliability of annual foreign exchange earnings may well create complexities in development planning. Furthermore, fluctuations in exchange proceeds tend periodically to exert strains on the balance of payments, possibly resulting alternatively in inflationary and deflationary pressures on the economy.

The problem is especially acute if the country is heavily dependent on foreign trade as a source of income, for violent fluctuations in the value of exports may then mean equally severe fluctuations in the value of total output. In several African countries exports comprise better than 40 per cent of national income -- for example, Mauritania (52.3 per cent), Congo (48.3 per cent), and Federation of Rhodesia and Nyasaland (45.5 per cent).[1]

One way to mitigate the impact of market instability on individual primary producers in a particular country is for the government to establish some degree of unilateral control over export proceeds, as exemplified by the Marketing Boards in West Africa.[2] While such action may help stabilize individuals' earnings,[3] the country as a whole is still fully exposed to the market forces. As an alternative, various measures have been tried on an international basis -- such as buffer stock schemes and commodity agreements -- but, while these devices provide some degree of relief in the short run, they can hardly be regarded as a lasting solution to the problem. A longer-run solution must involve taking steps designed to eliminate or reduce the source of the fluctuations.

To a considerable extent, the source of fluctuations in export proceeds -- at least, from the standpoint of a single country -- is often believed to be concentration on an unnecessarily narrow range of products for export. There are many examples of so-called "one crop economies," such as Ghana (cocoa), Mauritius

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[1] Benveniste and Moran, op. cit., p. 117; and United Nations, Department of Economic and Social Affairs, Economic Survey of Africa Since 1950, E/CN. 14/28, New York, 1959, pp. 15 and 175.

[2] See P. T. Bauer, West African Trade: A Study of Competition, Oligopoly, and Monopoly in a Changing Economy, New York, Cambridge University Press, 1954.

[3] Or may not, depending on the sources of the fluctuations and the methods employed by the stabilization authorities. For example, an attempt to stabilize prices may result in a further destabilization of income in the event of sufficiently large fluctuations in volume, opposite in direction to the fluctuations in prices.

(sugar), and Sudan (cotton). It is sometimes argued that if these economies were to diversify their exports, their export earnings would exhibit a greater degree of stability over time.[1,2]

In the present study an attempt is made to determine whether diversification is likely to provide a greatly increased measure of stability in export earnings.[3] This is done by examining empirically, in a sample of 36 countries, the extent to which fluctuations in a country's export earnings tend to be associated with concentration of the country's exports. A linear regression model is used which expresses export instability, the dependent variable, as a function of several independent variables. Section II considers the definition and measurement of an index of instability, while Section III develops an index of concentration. The empirical results are presented in Section IV, and some conclusions, suggested by these results, in Section V.

It is worth noting that a statistical study such as the present one has certain limitations. Aside from the usual qualifications which necessarily attach to the conclusions of any study based on regression analysis, there is a further qualification which stems from the uniqueness of countries and of commodities -- or,

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[1] "Fluctuations in proceeds from particular exports are more serious if the country concerned cannot rely on an averaging of the price movements of many different types of goods," United Nations, Commodity Trade and Economic Development, op. cit., p. 9. See also Arnold Rivkin, Africa and the West, Elements of Free-World Policy, New York, Praeger, 1962; United Nations, International Action for Commodity Stabilization and the Role of Africa, op. cit.; Benveniste and Moran, op. cit.

[2] The United Nations has noted, "A high degree of specialization is often a result of small 'economic size,' and is accompanied by a high degree of dependence on foreign trade, so that fluctuations in export proceeds have a devastating effect on the domestic economy." Commodity Trade and Economic Development, op. cit., p. 10.

[3] Appendix A considers the relationship between instability and concentration in the context of a mathematical model.

more precisely, from the uniqueness of the particular choice confronting any country. Whatever the observable statistical relationship between concentration and instability in a cross-section of countries, a single country may rightly feel that its own position is sufficiently atypical to make these results of little interest. Thus, Ghana's decision whether or not to produce coffee in addition to cocoa should be based on the relationship between coffee and cocoa prices (among other things), rather than on generalizations based on aggregates of countries and of commodities.

Nevertheless, there is reason to believe that the conclusions presented in the following pages may provide general guidelines of some use in development planning by yielding a better understanding of certain fundamental economic relationships. Moreover, if the results cannot be given prescriptive value, perhaps they can at least explain existing intercountry disparities.

II. THE MEASUREMENT OF EXPORT RECEIPT INSTABILITY

The observable changes over time in the value of exports result from the interaction of a variety of market forces, both on the supply and the demand sides. It is an arbitrary, but nevertheless convenient, procedure to distinguish between long-run forces, which can be said to determine the trend, and short-run forces, which can be viewed as determining fluctuations around the trend.[1] If a measure of instability is used which does not distinguish between the two sets of forces, then a country with a rapid secular increase (or decrease) in its export earnings will exhibit greater instability than a country whose export earnings are secularly unchanging. For our purposes, this result would be undesirable. It appears more appropriate to measure annual fluctuations not around the mean but around the trend.

One way to do this is to fit a regression line to export earnings expressed as a function of time, and then measure exports as deviations from this estimated trend. Thus, we can write

$$Z_t = \beta_0 + \beta_1 t \ , \qquad (1)$$

where Z = export earnings, t = time, and where the β's can be estimated by least squares.[2]

Using equation (1), the linear time trend was estimated for each of the 36 countries in our sample for the period 1948-1959, with Z defined as the money value (in current monetary units) of the earnings received by the country from the sale of all merchandise

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[1] It should be noted that intra-year fluctuations, which are appreciable in some cases, are not considered in this study.

[2] In using equation (1) it is assumed that the trend can most appropriately be approximated by a linear function of time. In fact, an exponential trend was also fitted to the data, but inspection of the residuals suggested that the linear trend provided a better fit.

exports.[1] The trend coefficients, β_1, together with the respective correlation coefficients, r, are presented in Table 1. The β_1's range from .159 for Japan to -.019 for Argentina, the only country in the sample with a negative rate of growth for the period.[2]

As an index of instability two measures, both trend-corrected, appear equally satisfactory. One is the standard error of estimate (square root of the unexplained variance), divided by the mean of the observations. This measure, which we shall term the "normalized standard error," is a pure number and is thus independent of the over-all level, or of the rate of growth, of a country's exports. We can write this variable,

$$I = \frac{\sqrt{\frac{\Sigma(u_t)^2}{n}}}{\bar{Z}} \qquad (2)$$

where $u_t = Z_t - (\beta_0 + \beta_1 t)$, n = the number of years in the series, and $\bar{Z} = \frac{\Sigma Z_t}{n}$.

Alternatively, we can use the average annual percentage rate of change in the value of exports, also trend-corrected, as given by:[3]

$$I^* = \frac{\Sigma w_t'}{n} \quad , \qquad (3)$$

where:

$$w_t = \frac{|u_{t+1} - u_t|}{\text{max. } [Z_t, Z_{t+1}]} \qquad (4)$$

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[1] 1948 was chosen as the initial year in the belief that it represented the first "normal" postwar year. All the data used in this study were obtained from United Nations, Department of Economic and Social Affairs, Yearbook of International Trade Statistics - 1959, Volume 1, New York, 1961.

[2] In fact, the UAR also had a negative rate of growth, but this rounded off to zero for three decimal places.

[3] I* is also a pure number.

Table 1

AVERAGE RATES OF GROWTH AND TIME COEFFICIENTS OF CORRELATION FOR 36 COUNTRIES

Country	Average Rate of Growth β_1	Correlation Coefficient r
Japan	.159	.991
Austria	.157	.988
Finland	.10[illegible]	.921
Netherlands	.108	.987
France	.107	.940
Trinided and Tobago	.105	.986
Iceland	.096	.954
Italy	.096	.967
Malta	.092	.903
Norway	.082	.931
Sweden	.078	.925
El Salvador	.076	.986
Cyprus	.073	.836
Ireland	.073	.941
Belgium	.056	.[illegible]35
Thailand	.066	.870
Mauritius	.059	.875
Nigeria	.058	.897
United Kingdom	.057	.953
Portugal	.057	.983
New Zealand	.051	.831
Ghana	.052	.789
Dominican Republic	.050	.851
Philippines	.049	.895
Canada	.047	.943
United States	.047	.944
Australia	.040	.841
Panama	.039	.947
Colombia	.038	.958
Ceylon	.034	.654
Burma	.032	.627
Malaya	.023	.266
India	.013	.380
Brazil	.003	.030
United Arab Republic	-.000	-.004
Argentina	-.019	-.463

In the subsequent analysis we shall use both measures.

The variables I and I* were computed for each country and are presented in Table 2, Columns 2 and 3, respectively. With the exception of Malaya (I = .284), the values of I are relatively uniformly distributed between .057 (Canada) and .184 (Colombia). There seems to be a tendency for the countries commonly regarded as "underdeveloped" to have a larger value of I than the more economically advanced nations, although it is noteworthy that some underdeveloped countries have quite low values of I -- for example, Trinidad (.060) and Panama (.082).

Turning to I*, the values range from .051 (United Kingdom) to .202 (Malaya). For most countries, the value of I* corresponds rather closely to that of I, but there are notable exceptions to this, for example, Malaya and Colombia. Spearman's Rank Correlation Coefficient was computed to test the significance of the country rankings according to the two indexes and was found to equal .718, with standard error .17, which is significant at the .01 level. The two measures of export instability are, of course, conceptually quite distinct; where I* is a measure more of year-to-year changes, I is a measure of the variation of the series as a whole around the trend line. Either measure is influenced by the appropriateness, for a particular country, of fitting a linear time trend, but a poor fit would affect I more than I*.

Table 2

TWO MEASURES OF INSTABILITY OF EXPORT RECEIPTS
IN A SAMPLE OF 36 COUNTRIES

Country	Ratio of Standard Error of Estimate to Mean I	Average Annual Percentage Rate of Change, Trend-Corrected I*
Malaya	.284	.202
Colombia	.184	.096
Australia	.166	.160
Cyprus	.164	.123
Finland	.163	.135
Malta	.152	.176
Argentina	.150	.150
Burma	.138	.110
Ghana	.136	.133
France	.134	.121
Ceylon	.132	.099
Thailand	.129	.112
Brazil	.125	.101
United Arab Republic	.123	.096
Nigeria	.118	.094
Mauritius	.113	.104
Norway	.111	.111
Sweden	.111	.096
India	.108	.097
Dominican Republic	.108	.123
El Salvador	.106	.086
Iceland	.103	.140
Portugal	.103	.104
Japan	.101	.105
United States	.099	.105
Belgium-Luxembourg	.097	.100
New Zealand	.095	.083
Ireland	.091	.073
Italy	.087	.078
Philippines	.085	.121
Austria	.084	.091
Panama	.082	.087
United Kingdom	.063	.051
Netherlands	.061	.052
Trinidad and Tobago	.060	.057
Canada	.057	.060

III. A MEASURE OF EXPORT CONCENTRATION

One measure of export concentration, recently used by M. Michaely,[1] is the Gini coefficient, written

$$C = \sqrt{\Sigma (x_i/x)^2} \qquad (5)$$

where x_i = the value of exports of commodity i in some specified year,[2] and $x = \Sigma x_i$. If a country that produces a given number of products for export divides its resources more evenly among these products, this will result in a reduction in C. C will also be reduced if the country produces an additional product for export provided that:

$$0 < \sum_{i=1}^{m} d_i \leq p_i' \leq p_i \leq 1, \text{ all } i, \qquad (6)$$

where p_i = the proportion of the economy's resources initially devoted to the production for export of commodity i, p_i' = the proportion after a new commodity has been added, and $d_i = p_i - p_i'$. (See Appendix B for a more detailed discussion.)

As Michaely has pointed out, the value of C depends in an important way on what commodity classification scheme is employed. In particular, C will be higher the greater the level of aggregation over commodities, for at a higher level of aggregation products which are relatively dissimilar are classified together. Thus, a country all of whose exports fall within a single large group, but are highly diversified within this group, may have a value of C

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[1] M. Michaely, "Concentration of Exports and Imports: An International Comparison," The Economic Journal, Volume XXVIII, No. 272 (December 1958), pp. 722-736.

[2] In most cases, 1959 data were used in this study; where 1959 data were unavailable or incomplete, 1958 data were used.

higher than that of another country which is virtually a one-crop economy, but which produces also some product in a different group. A corresponding problem obviously arises if a highly disaggregated classificatory scheme is used. We have chosen, consequently, to compute C for the 36 countries in the sample on the basis of two classification schemes, differing in the level of aggregation involved: (1) on the basis of the Standard International Trade Classification (SITC) one-digit industries, and (2) on the basis of the SITC three-digit industries -- denoted C_1 and C_3 respectively.[1]

We computed both measures of concentration for the group of 36 countries. The values of C_3 appear in Table 3, Column 2. These values range all the way from .160 (United States) to .991 (Mauritius). With few exceptions, the less-developed countries tend to have higher values of C_3, as one would expect.

For comparison we present in Table 4, together with our own values of C_3, those obtained by Michaely for many of the same countries, based on 1954 exports.[2] As one can see, Michaely's figures tend to correspond fairly well with ours, although he obtains higher values of C_3 for 19 of the 28 countries compared. The difference between the two sets of figures may be due to any of three factors: (1) To some extent, the structure of exports of several of the countries may have altered in the interval 1954 to 1959. (2) The country methods of reporting the data, while supposedly standardized, may have been changed during this interval; for example, reporting exports in greater detail in more recent years would tend to make our C_3 lower than Michaely's. (3) Perhaps, also, differences in

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[1] Another problem is the appropriateness of the SITC commodity breakdown to the analysis presented here. For example, if industrial products are classified more finely than agricultural commodities, primary-product exporting countries will be biased towards greater concentration.

[2] Michaely (op. cit.) computed C for the SITC three-digit classification only.

Table 3

MEASURES OF EXPORT CONCENTRATION IN A SAMPLE OF 36 COUNTRIES

Country	C_3	C_2	P[a]	G[b]
Mauritius	.991	1.000	1.000	.847
Trinidad and Tobago	.810	.826	.972	.461
Colombia	.780	.811	.981	.705
Panama	.740	.961	1.000	.967
Iceland	.715	.780	.998	.322
El Salvador	.704	.762	.956	.483
Ghana	.704	.733	.911	.393
Malaya	.607	.784	.845	.347
Burma	.691	.831	.967	.330
United Arab Republic	.685	.729	.885	.284
Ceylon	.649	.723	.985	.390
Brazil	.568	.777	.978	.465
Thailand	.490	.691	.981	.324
Dominican Republic	.490	.888	1.000	.593
Cyprus	.455	.665	.963	.454
New Zealand	.449	.691	.968	.619
Nigeria	.439	.646	.982	.571
Malta	.425	.581	.781	.500
Australia	.427	.609	.875	.387
Philippines	.414	.675	.959	.611
Finland	.373	.590	.496	.336
Ireland	.365	.633	.686	.814
Argentina	.303	.729	.952	.340
India	.280	.538	.565	.347
Belgium-Luxembourg	.264	.600	.165	.328
Sweden	.252	.522	.372	.291
Austria	.242	.529	.279	.252
Portugal	.237	.453	.540	.284
Norway	.233	.493	.402	.321
Canada	.227	.486	.547	.601
Japan	.215	.527	.120	.351
France	.214	.448	.240	.280
Italy	.207	.429	.305	.270
United Kingdom	.195	.521	.132	.212
Netherlands	.170	.486	.469	.334
United States	.160	.431	.357	.292

Notes:

[a] P is a measure of a country's concentration on primary products, see p. 14 below.

[b] G is a measure of a country's geographical concentration of exports, see p. 16 below.

Table 1

A COMPARISON OF EXPORT CONCENTRATION AS MEASURED IN THIS STUDY AND AS MEASURED BY M. MICHAELY

Country	C_3 (Massell)	C_3 (Michaely)	G[a] (Massell)	G[a] (Michaely)
Mauritius	.991	.988	.847	.776
Trinidad and Tobago	.810	.727	.461	.500
Colombia	.780	.840	.705	.798
Panama	.740	.628	.967	.955
Iceland	.715	.803	.322	.291
Ghana	.704	.835	.393	.479
Malaya[b]	.697	.498	.347	.260
Burma	.691	.744	.330	.476
United Arab Republic	.685	.842	.264	.260
Brazil	.668	.612	.465	.415
Thailand	.490	.683	.324	.435
Nigeria	.439	.493	.571	.740
Australia	.427	.508	.387	.412
Finland	.373	.381	.336	.340
Ireland	.365	.383	.814	.807
Argentina	.303	.306	.340	.321
Belgium-Luxembourg	.264	.255	.328	.284
Sweden	.258	.291	.291	.284
Austria	.248	.277	.352	.318
Portugal	.237	.247	.285	.274
Norway	.233	.255	.321	.280
Canada	.227	.249	.601	.639
Japan	.215	.248	.354	.240
France	.214	.180	.280	.216
Italy	.207	.205	.270	.211
United Kingdom	.195	.192	.212	.187
Netherlands	.170	.169	.334	.270
United States	.160	.188	.292	.279

Note:

[a]G is a measure of a country's geographical concentration of exports, see p. 16 below.

[b]Michaely's figures include Singapore.

Sources:

Massell, see p. 11 above and Table 3; Michaely, see M. Michaely, "Concentration of Exports and Imports: An International Comparison," The Economic Journal, Vol. XXVIII, No. 272 (December 1958), pp. 722-736.

processing the published data may have accounted for some of the discrepancy.

In Column 3 of Table 3 are shown the values of C_1. One can see that, from the definition of the C indexes, the following inequality must hold for any country:

$$C_1 \geq C_3 \ . \qquad (7)$$

C_1 tends to be appreciably larger than C_3, reflecting the difference in aggregation. C_1 ranges from .420 (Netherlands) to 1.000 (Mauritius).

IV. EMPIRICAL RESULTS

To estimate the relationship between the instability and concentration of exports, regression analysis was used, with I and I*, alternatively, as dependent variables, and C_1 and C_3 as independent variables. The regression equations are written:

$$I = a_{io} + a_{ic} C_i \tag{8}$$

$$I^* = a^*_{io} + a^*_{ic} C_i \tag{9}$$

where i = 1, 3.

The entire sample of 36 countries was used to estimate the coefficients in (9), but for (8) Malaya was deleted, as the value of I for this country was sufficiently greater than the next highest value to suggest that it might represent a special case which it was safer to omit.[1]

The estimated regression coefficients for C_1 and C_3 are presented in Table 5, on page 20, with the standard errors in parentheses beneath their respective coefficients. With a one-tailed test, none of the slope coefficients is significant at the .05 level.

Before concluding that the insignificance of the simple regressions implies the rejection of the hypothesized relationship, let us add an additional variable to the model. We begin by noting that concentration can refer not only to the commodity composition of a country's exports but also to the geographical composition of established markets for these products. A country whose exports were destined principally for only one or two countries would be termed highly concentrated in the latter sense; diversification would involve seeking a greater variety of markets or spreading

[1] See Table 2 for the range of values of I.

exports more evenly over existing markets.

To measure the geographical concentration of exports, we turn again to the Gini coefficient, as given by

$$G = \sqrt{\Sigma (Y_i/Y)^2} \qquad (10)$$

where Y_i = exports to country i, and $Y = \Sigma Y_i$. The values of G for the 36 countries appear in Table 3, Column 5. These values range from .212 (United Kingdom) to .967 (Panama). In Table 4, above, the values of G are compared with those obtained by Michaely.[1] For 10 of the 28 countries compared, Michaely arrives at a higher value of G.

One could argue that, if geographical concentration indicates the absence of flexibility, then this variable might be expected to be positively correlated with instability. On the other hand, it is quite possible that countries whose exports are highly concentrated geographically tend to have more effective methods of smoothing out the fluctuations in export receipts, perhaps because bilateral commodity arrangements may be more prevalent in such cases. Those countries in the sample with high values of G tend to ship a major part of their exports to the United States or the United Kingdom. In many cases, it is likely that some form of commodity agreement between the exporting and importing countries tends to reduce fluctuations in export receipts. Perhaps the dominant trading partner in these cases either pegs the price of the staple exports or else imports a guaranteed amount, in either case insulating the exporter from the full impact of market forces.

By adding the new variable, the regression equations can be rewritten,

$$I = \gamma_{io} + \gamma_{ic} C_i + \gamma_{ig} G \ , \qquad (11)$$

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[1] Michaely, op. cit. The measure G was also computed by Albert Hirschman, National Power and the Structure of Foreign Trade, Berkeley and Los Angeles, University of California Press, 1945.

and

$$I^* = \gamma^*_{io} + \gamma^*_{ic} C_i + \gamma^*_{ig} G \ . \qquad (12)$$

The estimated regression coefficients are presented in Table 5 on page 20.

Turning first to the regressions on I, we see that both γ_{1c} and γ_{3c} are significant at the .05 level, with a one-tailed test. Further, the γ_{ig}, though insignificant at the .05 level with a two-tailed test, are both negative. Thus, the results suggest that I, while not simply correlated with either C_1 or C_3, is correlated with each of these two variables net of geographical concentration. In other words, given the degree of geographical concentration of a country's exports, the instability of its export receipts is positively correlated with commodity concentration. As indicated in Table 5 by the F-ratio[1] (or by the value of the Coefficient of Determination, R^2), a greater proportion of the intercountry variation in I is explained by employing C_3 and G, rather than C_1 and G, as the pair of independent variables, although even with the former pair nearly 90 per cent of the variation remains unexplained. The partial correlation coefficient between I and C_3 is .338, while that between I and C_1 is .300.

With I* as the dependent variable, Table 5 shows results similar to those just discussed. However, the only significant regression coefficient is γ^*_{3c}, and the γ^*'s are slightly lower in value than the γ's. The F-ratio is also lower, suggesting that the independent variables provide a better explanation of intercountry variation in I than in I*.

The low correlation between instability and concentration seems to contradict established doctrine,[2] and thus merits further attention. To some extent, the low correlation may result from large differences in the volatility of different commodities. Some products -- notably primary products -- are subject to large shifts in the demand schedule because of changes in expectation or because of the cyclical character of industrial activity in the more mature economies, while other products have a relatively stable demand pattern. Moreover, products

[1] Neither value of F is significant at the .95 level.

[2] See Section I.

differ in the extent to which they are subject to fluctuations on the supply side -- for example, some primary products are affected by the weather or by the incidence of various types of plant disease. The over-all result is that the extent of fluctuations in price and in volume traded -- and in the product of the two -- differs markedly from one product to another. In the context of the present inquiry, this means that countries that specialize in the more volatile products will tend to show a more marked instability of export revenues, for a given concentration of exports, than economies whose exports consist primarily of the more stable products. But, to the extent that one would expect a systematic relationship between concentration of exports and volatility of the goods exported, this relationship should strengthen the positive correlation between instability and concentration. Primary products can be expected to be more volatile than manufactured goods and the exports of primary producing countries are typically more highly concentrated than those of industrial economies.[1] However, if the disparity in the instability of earnings from the sale of different products is sufficiently great then, while the regression line will have a positive slope, there will nevertheless be considerable scatter around the line -- and this is in fact what has been observed.

Another point, though, should be considered. As the model in Appendix A suggests, the rationale for diversification is based on the assumption of statistical independence between annual changes in earnings from the export of any two products. But if the cross elasticity of demand for two commodities is high, then a shift in the demand for one is likely to be accompanied by a comparable shift in demand for the other, and the proceeds from the two products will tend to be intercorrelated. If the intercorrelation is sufficiently great, the value of diversification will be greatly reduced. Of course, shifts in the demand schedule account for only part of the fluctuations in export earnings; another part is due to shifts

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[1] See p. 21; also, cf. Michaely, op. cit.

in the supply curve, and there is less reason to expect a high degree of correlation between the supply schedules of different products.[1] Thus one can expect some random element to be present in the determination of export earnings from the production of different commodities.

While we cannot investigate here the statistical independence among products, it is of some interest to examine briefly the price changes for a selected group of commodities for the period 1950-1958, shown in Table 6 on page 23. We see that four commodities reached a high in 1951, three in 1954, one each in 1955 and 1959, and one both in 1953 and in 1955; while two reached lows in 1950, one each in 1953 and 1954, two in 1956, and four in 1958. While there is apparently some intercorrelation among the time paths, this intercorrelation is far from perfect.

Nevertheless, there may be some merit in examining an alternative hypothesis: that fluctuations in export earnings result not from high export concentration, as defined by the Gini coefficient, but from concentration on the export of primary products, as opposed to industrial goods. This might be the case if intercorrelation between the earnings time paths of two primary products tends to exceed that between the earnings time paths of two industrial goods, or of an industrial good and a primary product, perhaps because of a similarity in the market forces affecting many internationally traded primary products.

To measure the extent of a country's concentration on primary products, we have used the ratio, P, of primary-product exports to total exports, where primary products were defined as SITC Groups 0 to 4. This variable, which we shall term the primary-product ratio, was computed for the sample of countries and is shown in Column 4 of Table 3. The values range from .120 for Japan to 1.000 for several countries.

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[1] Although a drought will result in reduced production of most agricultural commodities.

Table 5

RELATIONSHIP BETWEEN EXPORT INSTABILITY AND CONCENTRATION

Equation number in the text	Dependent Variable	Independent Variables; Regression Coefficients (standard errors in parentheses) C_2	C_1	P	G	Coefficient of Determination[a] R^2	F-ratio[b]
(8)	I	.037 (.032)				.030	3.0*
(8)	I		.043 (.032)			.046	1.59
(11)	I	.055 (.027)			-.043 (.033)	.117	2.12
(11)	I		.073 (.041)		-.046 (.036)	.093	1.64
(13)	I			.052 (.019)	-.056 (.032)	.201	4.03
(9)	I*	.050 (.041)				.033	1.15
(9)	I*		.058 (.042)			.038	1.35
(12)	I*	.046 (.027)			-.053 (.034)	.100	1.82
(12)	I*		.056 (.038)		-.046 (.033)	.078	1.35
(14)	I*			.048 (.019)	-.067 (.033)	.172	3.42

Notes:

[a]The coefficient of determination is the proportion of the total variance of the dependent variable which is 'explained' by the regression.

[b]The F ratio is given by: $F = R^2(n-k-1)/(1-R^2)k$, where n is the number of observations in the sample and k is the number of independent variables. The only values of F significant at the .05 level are those for equations (13) and (14).

The regression equations can now be written

$$I = \xi_o + \xi_p P + \xi_g G \tag{13}$$

and

$$I^* = \xi^*_o + \xi^*_p P + \xi^*_g G \tag{14}$$

The coefficients appear in Table 5.

Using a one-tailed test, one finds a significant correlation at the .05 level between either I or I* and P, net of G.[1] An increase in P by 20 percentage points, given the value of G, is associated with a 1 per cent rise in either I or I*, indicating that P explains only a small part of the variation among countries in export instability. As indicated by the F-ratio, the pair of variables, P and G, provide a better explanation of variation in I than in I*.

The partial correlation coefficient between I and P, in equation (13), is .445 compared with a value of .338 between I and C_3 in equation (11). This suggests that P provides a better explanation than C_3 (which, in turn, is better than C_1) of the variation in I. Inspection of the F-ratios confirms that the pair of variables, P and G, provides the best explanation of inter-country variation in either I or I*. In both cases, F is significant at the .95 level.

An attempt to include both P and either C_3 or C_1 as independent variables yielded no significant results, possibly because of multicollinearity. In fact, it can be observed that C_3, C_1, and P all appear to be intercorrelated, thus indicating that primary-producing countries tend to have more highly concentrated exports.

While the low correlation between I and either C index is not at all what one would expect, the weak relationship between I and P is, perhaps, even more surprising. These results suggest that we must reject the view that fluctuations in export earnings affect only the primary-producing countries; apparently the industrial

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[1] With I as dependent variable, G is also significantly negative at the .05 level, using a two-tailed test. A simple regression of I or I* against either P or G fails, however, to be significant.

countries share this instability in nearly the same measure. One should note, though, that some commodities are now subject to control, so that the statistical results reflect, in part, these institutional arrangements. The low degree of correlation between I and any of the independent variables must not be interpreted as suggesting that the commodity stabilization schemes now in effect are gratuitous; indeed, in may be that the partial success of these schemes has contributed to the low observed correlations. Fluctuations in the export earnings of primary producing countries might have been considerably worse in the absence of these commodity control arrangements.[1]

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[1] This is particularly so if -- as seems likely -- the most volatile commodities are the ones which have been made subject to international agreements.

Table 6

EXAMPLES OF FLUCTUATIONS IN COMMODITY PRICE INDEXES

Commodity	Price Index (January-June 1950 = 100)								
	1950	1951	1952	1953	1954	1955	1956	1957	1958
Cocoa	132	135	135	141	220[a]	141	103[b]	117	167
Coffee	106	113	113	121	165[a]	119	122	119	102[b]
Tea	99	91	83	91	125[a]	105	104	90	81[b]
Cotton	123	201[a]	141	100	112	102	93	92	88[b]
Wool	123	149[a]	95	110	96	80	85	94	66[b]
Rubber	172	268[a]	147	103[b]	105	174	148	135	122
Tobacco	100	104	111	113[a]	109	113[a]	91[b]	99	99
Copper	111[b]	130	163	160	158	223[a]	209	139	125
Tin	125	180[a]	161	122	120[b]	124	132	126	122
Manganese	104[b]	125	144	161	145	151	155	175[a]	174

Notes:

[a] High for period.

[b] Low for period.

Source:

United Nations, Department of Economic and Social Affairs, Economic Survey of Africa Since 1950, E/CN. 14/20, New York, 1959, p. 181.

V. CONCLUSIONS

Several points appear to follow from the preceding analysis. First, it is clear that the relationship between instability of export earnings and concentration of exports is a tenuous one indeed.[1] As the degree of concentration of a country's exports explains such a small proportion of the intercountry variation in export instability, one would not expect a policy aimed at diversification generally to result in a marked reduction in fluctuations -- although such a policy may well be effective in certain individual cases.

As the relationship between instability and the primary-product ratio is also relatively weak, this investigation gives little support for industrialization as a method of reducing export instability. But the fact that neither diversification nor the degree of industrialization appears to explain much of the variation in export instability has other implications. Why, one might ask, do the primary-producing countries typically exhibit so much concern with the problem of instability if, as the data indicate, the industrialized countries have been subject to export fluctuations to nearly the same extent? One reason may be that primary-producing countries tend also to be low-income countries and are consequently more disturbed by fluctuations than wealthier countries. In this case, it is not only instability but poverty that is responsible for the problem. Or, put differently, while the underdeveloped countries may not be subject to a much greater degree of instability in export earnings, the disutility of this instability may be appreciably greater.

Second, primary-producing countries tend to depend more heavily on exports as a source of income than do industrialized countries, so that a given degree of export instability has a greater impact on the economy of a primary-producing country.[2] Thus, what may be

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[1] Moreover, the results suggest that the observed relationship between instability and concentration may result from (1) the relationship between instability and the primary-product ratio together with (2) the tendency for primary-producing countries to have highly concentrated exports.

[2] See p. 2 above.

required is not diversification of exports but reduced dependence on exports.

Finally, fluctuations in commodity prices may have a real cost to primary producers quite apart from the visible effect on annual earnings. To some extent, perhaps, the producers have responded to price changes by means of offsetting changes in volume offered for sale.[1] Thus a rise in price may have been met by a fall in volume, and a fall in price by an increase in volume. We shall not examine here whether this seems to be the case, but will merely note that, in instances where this may have occurred, the primary-producing countries have achieved greater revenue stability, but at a cost. However, diversification would presumably not reduce this cost for the individual producer.

We conclude by noting that it is unlikely that either instability of export earnings or the disutility arising from such instability will be eliminated by simple policies, such as producing a wider range of exports. To the extent that the disutility created by fluctuations in exports is intensified by the low incomes of the primary-producing countries, the problem is basically a manifestation of poverty and, as such, will be eliminated or reduced as the country achieves economic development.

The general case for diversification (or, indeed, for industrialization) as a cure for fluctuations in export earnings receives little support from this investigation. For a given country, however, there may be some gain in choosing a particular product that will help reduce the fluctuations in its exports receipts. And of course diversification may be beneficial in other ways, for example, in providing the economy with greater flexibility in adapting the structure of its production to changes in market conditions.

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[1] See United Nations, Special Study on Economic Conditions in Non-Self-Governing Territories, New York, 1960, Sales No. 60, VI. B.3.

Appendix A

SOME THEORETICAL ASPECTS OF THE RELATIONSHIP BETWEEN CONCENTRATION OF EXPORTS AND INSTABILITY OF EXPORT RECEIPTS

It may be helpful to illustrate by means of a mathematical model why diversification of exports should be expected to result in a reduction in the variation in year-to-year values of export receipts. This follows, subject to certain assumptions, from some rather elementary mathematical principles. Let

$$Z = \Sigma a_i q_i \ , \tag{15}$$

where the q_i are independent and normally distributed random variables, with non-negative means, μ_i, and standard deviations, σ_i, and where

$$\Sigma \ a_i = 1, \tag{16}$$

and

$$a_i \geq 0, \text{ for all } i. \tag{17}$$

Then Z is also a normally distributed random variable, with mean, μ_z, and standard deviation, σ_z, given by

$$\mu_z = \Sigma \ a_i \mu_i \tag{18}$$

and

$$\sigma_z = \sqrt{\Sigma \ a_i^2 \ \sigma_i^2} \tag{19}$$

Now, define

$$v_i = \frac{\sigma_i}{\mu_i} \ , \tag{20}$$

and assume that

$$v_i = v_j \tag{21}$$

for all i and j.

Then,

$$v_z = \frac{\sqrt{\Sigma\, a_i^2\, \sigma_i^2}}{\Sigma\, a_i\, \mu_i} \tag{22}$$

$$= \frac{\sqrt{\Sigma_j\, a_i^2\, \sigma_j^2\, (\mu_i/\mu_j)^2}}{\Sigma\, a_i\, \mu_i}$$

Simplifying,

$$v_z = \frac{\sqrt{\Sigma\, (a_i \mu_i)^2}}{\Sigma\, a_i\, \mu_i}\; v_j \,. \tag{23}$$

Now,

$$v_z < v_j \tag{24}$$

if

$$\frac{\sqrt{\Sigma\, (a_i \mu_i)^2}}{\Sigma\, a_i \mu_i} < 1 \,, \tag{25}$$

or if

$$\Sigma (a_i\, \mu_i)^2 < (\Sigma\, a_i\, \mu_i)^2 \,. \tag{26}$$

But by expanding the right side of inequality (26), we have

$$(\Sigma\, a_i\, \mu_i)^2 = \Sigma\, (a_i\, \mu_i)^2 + \sum_{\substack{i,\, j \\ i \neq j}} a_i a_j \mu_i \mu_j > \Sigma\, (a_i \mu_i)^2 \tag{27}$$

if, for at least one pair of i, j, $i \neq j$, a_i, a_j, μ_i, $\mu_j > 0$.

Now, consider q_i to be the annual value of export receipts that a country could earn by devoting all of the resources in its export sector to the production of commodity i. The mean of such values over a number of years would then be μ_i, and the standard deviation σ_i. If the proportion of the country's export resources used to produce

commodity i is represented by a_i, then the annual value of export earnings from the sale of this commodity would be $a_i q_i$, with mean $a_i \mu_i$ and standard deviation $a_i \sigma_i$.[1] The variable, z, then, is the annual value of receipts from the sale of all exports. If all of the individual coefficients of variation v_i were equal, then the country could obtain a lower over-all coefficient of variation v_z, by allocating its export resources over a number of commodities. In particular, it can be seen that the ratio, v_z/v_i, depends only on the value of C*, where

$$C^* = \frac{\sqrt{\Sigma (a_i \mu_i)^2}}{\Sigma a_i \mu_i} \quad . \tag{28}$$

Now, let $z_i = a_i q_i$ be the actual receipts from the export of commodity i. Then,

$$\mu_{z_i} = a_i \mu_i \quad , \tag{29}$$

and C* can be rewritten:

$$C^* = \frac{\sqrt{\Sigma \mu_{z_i}^2}}{\mu_z} \tag{30}$$

$$= \sqrt{\Sigma (\mu_{z_i}/\mu_z)^2}$$

The ratio, μ_{z_i}/μ_z, is the ratio of the average earnings from commodity i to the average value of total export earnings, and thus corresponds closely to the ratio x_i/x used in calculating C.

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[1] This assumes that resources are equally efficient in the production of any commodity.

Appendix B

CONDITIONS UNDER WHICH AN INCREASE IN THE NUMBER OF COMMODITIES EXPORTED WILL REDUCE THE MEASURE C

Let: x_i = exports of commodity i initially, i=1,...,m, and

x_i' = exports of commodity i after a new product has been added, i=1,...m, m+1

And assume: $x = \sum_{i=1}^{m} x_i = \sum_{i=1}^{m+1} x_i'$

Now, define:

$$\left\{ \begin{array}{l} p_i = x_i/x \\ p_i' = x_i'/x \\ d_i = p_i - p_i' \end{array} \right. \tag{31}$$

such that:

$$0 \leq \sum_{i=1}^{m} d_i \leq p_i' \leq p_i \leq 1, \text{ all } i, \tag{32}$$

and:

$$0 < \Sigma d_i < p_i' < p_i, \text{ at least one } i. \tag{33}$$

Squaring (31) we have:

$$p_i^2 = (p_i')^2 + d_i^2 + 2 p_i' d_i \tag{34}$$

Summing over i,

$$\sum_{i=1}^{m} p_i^2 = \sum_{i=1}^{m} (p_i')^2 + \sum_{i=1}^{m} d_i^2 + 2 \sum_{i=1}^{m} p_i' d_i . \tag{35}$$

But,

$$\left(\sum_{i=1}^{m} d_i \right)^2 = \sum_{i=1}^{m} d_i^2 + 2 \sum_{i,j=1}^{m} d_i d_j . \tag{36}$$

Substituting (36) into (35),

$$\sum_i p_i^2 = \sum_i (p_i')^2 + \left(\sum_i d_i\right)^2 + 2\left[\sum_i p_i' d_i - \sum_{i,j} d_i d_j\right] . \qquad (37)$$

Now,

$$C = \sqrt{\sum_{i=1}^{m} p_i^2} \qquad (38)$$

and

$$C_{m+1} = \sqrt{\sum_{i=1}^{m+1} (p_i')^2} \qquad (39)$$

It follows that $C_{m+1} < C_m$ if

$$\sum_{i=1}^{m+1} (p_i')^2 < \sum_{i=1}^{m} p_i^2 , \qquad (40)$$

or if

$$\sum_{i=1}^{m} (p_i')^2 + \left(\sum_{i=1}^{m} d_i\right)^2 < \sum_{i=1}^{m} p_i^2 . \qquad (41)$$

From (37) we see that inequality (41) holds if:

$$\left[\sum_i p_i' d_i - \sum_{i,j} d_i d_j\right] > 0 . \qquad (42)$$

But,

$$\left[\sum_i p_i' d_i - \sum_{i,j} d_i d_j\right] = \sum_i \left[d_i \left(p_i' - \sum_j d_j\right)\right] . \qquad (43)$$

Thus $C_{m+1} < C_m$ if:

$$p_i' > \sum_j d_j \text{ , all } i \text{, and the inequality holds for at least one } i. \qquad (44)$$

But from (32) and (33) we know this to be the case. In fact, it is not necessary to assume that $\Sigma d_i < p_i' < p_i$, for if $\Sigma d_i = p_i'$, for all i, then all the p_i' would be equal, and $p_i' < p_i$ for all i. The assumption, $0 < \Sigma d_i$, merely avoids a trivial solution.

BIBLIOGRAPHY

Bauer, P. T., West African Trade: A Study of Competition, Oligopoly, and Monopoly in a Changing Economy, New York, Cambridge University Press, 1954.

Benveniste, Guy, and William E. Moran, Jr., African Development - A Test for International Cooperation, Stanford, Stanford Research Institute, 1960.

Carnegie Endowment for International Peace, "International Commodity Problems," International Conciliation, September 1959.

Dixon, W. J., and F. J. Massey, Jr., Introduction to Statistical Analysis, New York, McGraw-Hill, 1957.

Hirschman, Albert, National Power and the Structure of Foreign Trade, Berkeley and Los Angeles, University of California Press, 1945.

Michaely, M., "Concentration of Exports and Imports: An International Comparison," The Economic Journal, Volume XXVIII, No. 272, December 1958.

Rivkin, Arnold, Africa and the West, Elements of Free-World Policy, New York, Praeger, 1962.

United Nations, Commodity Trade and Economic Development, 1954.

-----, Special Study on Economic Conditions in Non-Self-Governing Territories, New York, 1960, Sales No. 60. VI. B. 3.

-----, Commission on International Commodity Trade, Report of 8th Session, May 1960.

-----, Commission on International Trade, Eighth Session, Summary Record, July 1960.

-----, Department of Economic Affairs, Instability in Export Markets of Underdeveloped Countries, 1952.

-----, Department of Economic Affairs, Measures for International Economic Instability, 1951.

-----, Department of Economic and Social Affairs, Economic Survey of Africa Since 1950, E/CN. 14/28, New York, 1959.

-----, Department of Economic and Social Affairs, Yearbook of International Trade Statistics - 1959, Volume I, New York, 1961.

-----, Economic and Social Council, Official Records, Twenty-Eighth Session, July 1959.

-----, Economic and Social Council, Impact of Fluctuations in Economic Activity in Industrial Countries on International Commodity Trade, New York, 1960.

-----, Economic Commission for Africa, International Action for Commodity Stabilization and the Role of Africa, E/CN. 14/68, November 1960.