AN ANALYSIS OF AN INDEX OF INTERNATIONAL TRADE CONCENTRATION

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CHAPTER I

INTRODUCTION

The foreign trade of a nation holds some relationship to the power position of that nation in the world. The leaders of a country would be helped in their task if the economic impact of national power could be evaluated with scientific accuracy. A formal indicator of the significance of trade would help to answer the following questions: How can sovereign and independent nations exert or increase national power through economic means? What price in terms of depressed living standards must a country pay for an isolationist policy? What are the dangers inherent in doing too much business with one's neighbor? How far should a country sacrifice trade efficiency in order to diversify exports so that it may avoid political pressures from other countries? A possible answer to such questions has been suggested in the form of an index of trade concentration.

An index of trade concentration, as this term will be used in these pages, is a measure of the structure and direction of foreign trade. By foreign trade structure is meant the number of different products a country produces for foreign trade, and the relative importance of each product in that country's trade. Direction of trade refers to the number of other countries with which a nation trades and the relative importance of each of the trade flows. Changes in

structure or direction of a country's world trade may have a potential impact on the domestic economy and on the power position of the country. There may be many possible uses for a measure such as an index of trade concentration and the need for one is apparent.

This thesis will attempt a critical analysis of an index of international trade concentration originated in 1945 by A. O. Hirschman in his work, National Power and the Structure of Foreign Trade. No critical discussion of the index has come to the attention of the writer; such an investigation is necessary to develop and improve the index into a useful tool of inquiry. It is the purpose of this thesis to investigate the mathematical structure of the Hirschman index of trade concentration and to translate its implications into economic language. The thesis attempts to bring to light the inherent biases of the index so that interested users will be better able to evaluate it for their purposes.

This study is limited to the topic of concentration in foreign trade. The related area of domestic industrial concentration is not discussed. However, it should be noted that an index similar to Hirschman's has been created by Herfindahl for measurement of industrial concentration.[1] To include a discussion of industrial concentration would have necessarily involved several other topics such as cartels, which are beyond the scope of this thesis.

The index of trade concentration will be checked for its logical consistency through the use of mathematical methods. Hypothetical

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[1]Gideon Rosenbluth, "Measures of Concentration," Business Concentration and Price Policy, (Princeton, 1955), discusses Herfindahl's index. See page 60 of this work.

examples are applied to the index to test the results of variable changes according to logical expectations.

Chapter two is an inspection of the index of trade concentration as a statistical measure. The mechanics of the index are checked, its attributes are tested, and limits of the index are determined. The problems of applying available data to the index are discussed. Chapter three reviews the literature which has used the index of trade concentration. Information which will help to explain the causes or characteristics of foreign trade concentration are emphasized. Several applications of the index have been made and are discussed. Chapter four consists of conclusions of the thesis.

CHAPTER II

THE INDEX OF TRADE CONCENTRATION

The index of trade concentration was originated by A. O. Hirschman in 1945 and first appeared in his book, National Power and the Structure of Foreign Trade. Hirschman was analysing the pre-World War II actions of the German leaders. He wanted to show how the Germans had used economic policies to increase their political and national strength. He also emphasized that the economic power methods which they applied in their foreign trade could have been, and probably were, used by nations other than Germany. Hirschman felt that economic policies such as quotas or exchange controls as means to increase power have been much discussed; however, he believed that trade itself as a power tool has been neglected. The nature of a nation's international trade, the direction and structure of its trade with other countries, can be quantified and provide a meaningful instrument for policy purposes.

The most significant effect of international trade on the power of a nation is called by Hirschman the "influence" effect.[1] The country seeking power directs its trade so that the threat of stopping this trade would cause its trading partner to be more compliant with wishes, perhaps political wishes, of the power-seeking

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[1] Albert O. Hirschman, National Power and the Structure of Foreign Trade, (Berkeley, 1945), p. 16.

country. Some reasons why a country may be able to influence others are the following. 1) The country desiring an increase in its power position has chosen to trade with poorer countries whose gain from this trade is vital. 2) Export trade flowing from the power-manipulating country is concentrated on products which the dependent importing country greatly desires or considers essential for its national economy. 3) Not only essential exports are directed toward a dependent country, but the dominating nation also becomes the chief importer (if not the only one) of the leading exports of the dependent nation. This small trading partner may find it difficult to find new outlets for its export trade should the powerful country cut off this flow. The sales organization of the export country may have to be reconstructed and other trading partners may not be available to buy up additional large amounts of export products.

Hirschman suggests several trade policies that would increase a country's influence.[2] These policies would increase the weak partner's dependence on the power-seeking country through international trade.

If a country can increase its power situation by trading with poor or small countries in goods which are essential to them, Hirschman suggested that the position of these small or weak countries will reflect the attempt made to monopolize their trade. The index of trade concentration is the measure proposed to indicate how much one or a few big trading nations are succeeding in monopolizing smaller and weaker countries' trade.

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[2]See Hirschman, National Power and the Structure of Foreign Trade, page 34, for other policies suggested.

The Hirschman Index of Trade Concentration

The concentration of a nation's trade will depend on the number of countries included in this trade and the percentage of total trade each one of the trading countries holds.[3] The index of trade concentration must reflect both of these qualities. We shall now try to explain Hirschman's index of trade concentration in its mathematical entirety, using certain skimpy material from Hirschman's Appendix A,[4] and to see if the index actually does reflect both the qualities of unequal distribution and fewness.[5]

Hirschman states specifically that 1) "concentration of control over the foreign trade is a direct function of the relative inequality of distribution or dispersion."[6] The standard deviation being the accepted measure of dispersion, this statement means that C (concentration) increases as σ increases. The rationale of this latter statement may not be immediately apparent. The trade concentration will be highest when one or a few countries dominate a great deal of another country's trade. These few countries with extremely high trade volumes will cause the deviations from the

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[3]Hirschman, National Power and the Structure of Foreign Trade, p. 98.

[4]Ibid., pp. 157-160.

[5]Albert O. Hirschman, "The Paternity of an Index," American Economic Review, Vol. LIV, (September, 1964), p. 761.

[6]Hirschman, National Power and the Structure of Foreign Trade, p. 158.

mean used in computing the standard deviation to be great and in turn, the σ will have a larger value. Alternatively, of course, the σ will be smaller when deviations from the mean are not large, and concentration would be less if all trading partners held the same, or nearly the same, percentage of a country's trade.

Hirschman further states that 2) Concentration is a "reciprocal function of the number of importing and exporting countries."[7] If n stands for the number of countries, as n increases, C decreases. The reasoning behind this statement is easy to see. The more trading partners a country has, the less pronounced will be its dependence on any one or a few.

If the export trade of a country goes to n other countries, each of these trade volumes can be denoted by $a_1, a_2, \ldots, a_k, \ldots, a_n$, where a_k is a representative element in the series. The summation of all the a_k's equals A, the total export trade of the country. The notation is $\Sigma a_k = A$. Therefore, $\frac{a_k}{A}$ will be the percentage of total export trade for any one of a country's trading partners. (It should be noted here that concentration in exports is computed as a different series from the concentration of imports. These two should be kept separate.)

Given the notation of the series above, the index of trade concentration becomes,[8]

$$(1) \qquad C = \sqrt{\sum_{I=1}^{n} \left(\frac{a_k}{A} \cdot 100\right)^2} = \frac{100}{A}\sqrt{\Sigma a_k^2}$$

which is simply the square root of the sum of the percentages in the series.

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[7]Ibid., p. 158. [8]Ibid., p. 159.

Does this measure reflect the two characteristics proposed which such an index should reflect? In order to answer this question, the index is converted into another form through a series of mathematical manipulations. First a few preliminary explanations.

The arithmetic mean is defined by Hirschman as $\frac{A}{n}$. He does not discuss how he arrived at this measure, assuming that it is of common knowledge. The mean can, however, be determined by the application of expectation. The expected value of a random variable is the mean, or μ, the random variable in this case being the a_k's. So, $E(ak) = \mu$ and,

(2) $$E(a_k) = \Sigma\, a_k \left(\frac{1}{n}\right)$$

(3) $$= \frac{1}{n} \Sigma\, a_k$$

(4) $$= \frac{A}{n},$$

as the $\Sigma\, a_k$ has been defined as A. The term $\frac{1}{n}$ is the probability of any a_k occurring. Since there are n number of a_k's and the probability of any one of the a_k's is assumed to be equal, the probability of each is $\frac{1}{n}$.

It is helpful to extend the use of expectation to compute the variance for purposes of explanation of the index. The variance is defined in mathematical terms as the expected value of the random variable minus the mean, quantity squared or $E(a_k - \mu)^2 = \sigma^2$. And,

(5) $$E(a_k^2) = \Sigma\, a_k^2 \frac{1}{n}$$

(6) $$= \frac{1}{n} \Sigma\, a_k^2.$$

Applying the simplifying theprem for the variance used in mathematics,

(7) $$\sigma^2 = \frac{1}{n} \Sigma\, a_k^2 - \mu^2$$

and substituting $\frac{A}{n}$ for μ,

(8) $$\sigma^2 = \frac{1}{n} \Sigma\, a_k^2 - \left(\frac{A}{n}\right)^2$$

$$(9) \qquad \sigma^2 = \frac{1}{n}\left[\Sigma a_k^2 - \left(\frac{A^2}{n}\right)\right] .$$

The variance is,

$$(10) \qquad \sigma^2 = \frac{1}{n}\Sigma \left(a_k - \frac{A}{n}\right)^2 .$$

It is easy to see the relationship between σ^2 and σ by taking the square root of σ^2,

$$(11) \qquad \sigma = \sqrt{\frac{1}{n}\Sigma \left(a_k - \frac{A}{n}\right)^2}$$

$$(12) \qquad \sigma = \sqrt{\frac{\Sigma \left(a_k - \frac{A}{n}\right)^2}{n}} .$$

Thus we have developed the variance and standard deviation of the series of trade volumes from one country to other countries. Hirschman does not explain how he arrived at a standard deviation; perhaps the accepted formula in statistics was adapted using his particular notation. However, we have shown that the standard deviation can be formed using expectation procedure.

Hirschman, in order to show the relationship between the σ and C and to bring C into a different form to show the two necessary characteristics mentioned above, has performed a few operations on the σ. First, he squares σ and multiplies by n, which results in,

$$(13) \qquad n\sigma^2 = \Sigma \left(a_k - \frac{A}{n}\right)^2 = \Sigma a_k^2 - \frac{A^2}{n} ,$$

and dividing by $\frac{A^2}{n}$, and rearranging, results in,

$$(14) \qquad \frac{\sigma^2}{\frac{A^2}{n^2}} + 1 = \frac{n}{A^2} \cdot \Sigma a_k^2$$

This latter equation is equation (1) on page 159 of Hirschman's aforementioned work, National Power and the Structure of Foreign Trade.

It is helpful to retrace Hirschman's footsteps through all

the mathematical steps in order to see clearly the purpose of the manipulations. We will start with σ^2 which we have already derived (equation 10) and so we have only to multiply by n on the first step.

(10) $$\sigma^2 = \frac{1}{n} \Sigma \left(a_k - \frac{A}{n}\right)^2$$

Multiplying by n,

(15) $$n\sigma^2 = \Sigma \left(a_k - \frac{A}{n}\right)^2$$

(16) $$= \Sigma a_k^2 - \frac{A^2}{n}$$

and dividing by $\frac{A^2}{n}$, the equation becomes,

(17) $$\frac{n\sigma^2}{\frac{A^2}{n}} = \frac{\Sigma a_k^2}{\frac{A^2}{n}} - \frac{\frac{A^2}{n}}{\frac{A^2}{n}}$$

(18) $$= \frac{\Sigma a_k^2}{\frac{A^2}{n}} - 1$$

Moving all n's into the denominator on the left side and transposing -1 to the left side of the equation; also moving the n on the right side into the numerator, the equation becomes,

(19) $$\frac{\sigma^2}{\frac{A^2}{n^2}} + 1 = \frac{n \Sigma a_k^2}{A^2}$$

or,

(20) $$\frac{\sigma^2}{\frac{A^2}{n^2}} + 1 = \frac{n}{A^2} \Sigma a_k^2$$

This equation (20) is identical with Hirschman's equation (1) on page 159 of Appendix A of his work just mentioned. (See also equation 14 above.)

The coefficient of variation is defined as $v = \frac{\text{standard deviation}}{\text{mean}}$

or $v = \frac{\sigma}{\frac{A}{n}}$ and is used to compare the dispersion of different series having different arithmetic means. Using $v = \frac{\sigma}{\frac{A}{n}}$ and remembering that $C = \frac{100}{A}\sqrt{\Sigma a_k^2}$, Hirschman makes the statement that $v^2 + 1 = \frac{n}{100^2} \cdot C^2$. Is this equation true? The left-hand side of the equation becomes,

$$\frac{\sigma^2}{\frac{A^2}{n^2}} + 1$$

from the definition of v above. C^2, computed from the definition of C above, is $(\frac{100^2}{A^2} \Sigma a_k^2)$ so that,

(21) $$v^2 + 1 = \frac{n}{100^2} \cdot C^2$$

becomes

(22) $$\frac{\sigma^2}{\frac{A^2}{n^2}} + 1 = \frac{n}{100^2} \cdot \frac{100^2}{A^2} \Sigma a_k^2$$

Cancelling 100^2, the equation becomes

(23) $$\frac{\sigma^2}{\frac{A^2}{n^2}} + 1 = \frac{n}{A^2} \Sigma a_k^2$$

This equation (23) is identical to my equation (20) above and identical to Hirschman's equation (1). The equation (20) above we know to be true because it is simply the result of several operations on the standard deviation. Thus, the equation (24) below, used by Hirschman, is true.[9]

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[9] An error should be noted in Hirschman's National Power and the Structure of Foreign Trade at this point. This equation in his work at the bottom of page 159 reads,

$$v^2 + 1 = \frac{n}{100^2} \cdot C^n$$

It should read, $$v^2 + 1 = \frac{n}{100^2} \cdot C^2$$

(24) $$v^2 + 1 = \frac{n}{1002} \cdot C^2$$

We wish to isolate C in equation (24). This will result in a new form of the index of trade concentration and will more easily indicate if the index does reflect the two characteristics stated at the beginning of the chapter.

(24) $$v^2 + 1 = \frac{n}{1002} \cdot C^2$$

(25) $$(v^2 + 1)100^2 = nC^2$$

(26) $$\frac{100^2(v^2 + 1)}{n} = C^2$$

(27) $$C = 100\sqrt{\frac{v^2 + 1}{n}}$$

Equation (27) is the alternate form of the index that Hirschman suggests. How does this prove the existence of the two characteristics mentioned? Expand equation (27):

(27) $$C = 100\sqrt{\frac{v^2 + 1}{n}}$$

Substituting the definition of v and carrying out multiplication so that n is in the numerator,

(28) $$C = 100\sqrt{\frac{\frac{n^2\sigma^2}{A^2} + 1}{n}}$$

and further simplifying the fraction, the equation becomes,

(29) $$C = 100\sqrt{\frac{n\sigma^2}{A^2} + \frac{1}{n}}$$

Substituting $n^2\mu^2$ for A^2. (This is so because $\mu = \frac{A}{n}$ and so $A = n\mu$.)

(30) $$C = 100\sqrt{\frac{n\sigma^2}{n^2\mu^2} + \frac{1}{n}}$$

$$(31) \qquad C = 100 \sqrt{\frac{\sigma^2}{n\mu^2} + \frac{1}{n}}$$

Let us recall the two statements of characteristics which the index should show.

(a) As σ increases, C increases, and

(b) as n increases, C decreases.

Equation (31) places the information in a useable form. The standard deviation, being in the numerator, would cause the fraction $\frac{\sigma^2}{n\mu^2}$ to increase as σ increases, and thus C would increase also. Statement (a) is therefore true. The number n is in the denominator in both fractions, $\frac{\sigma^2}{n\mu^2}$ and $\frac{1}{n}$, and would cause the fractions to decrease in value as n increased; and thus C would decrease as n increases, fulfilling statement (b).

At first glance it appears that the index of trade concentration does indeed meet all requirements. However, looking again at equation (31) it must be noted that the term $\frac{\sigma^2}{n\mu^2}$ under the radical contains two elements besides n of which n is also a part; σ and μ both contain n. The result of an increase in n on concentration is now not nearly so clear-cut. An increase (decrease) in n would not leave μ unchanged unless A increased (decreased) proportionately. The effect of n on σ depends not only on the size of n, but also on each observation of trade volume as well as the total trade volume. Equation (29) restates the index in a form in which the μ is eliminated and the effect of n in the fraction $\frac{n\sigma^2}{A^2}$ under the radical has been reduced to its effect on σ^2.

Recalling equation (29),

$$(29) \qquad C = 100 \sqrt{\frac{n\sigma^2}{A^2} + \frac{1}{n}}$$

we need to discover the relative impact of a change in n on the left-hand and the right-hand fraction under the radical. The fact that n and σ^2 are in the numerator on the left will not necessarily be offset by the appearance of n in the denominator on the right. Will an increase in n result in a decrease in C as Hirschman prescribed?

In order to examine this problem, several examples were constructed using assumed numerical data. In these examples, I have tried to change some of the variables, (n, σ, A, μ) to see what would happen to concentration. The examples are simplified to facilitate the computation and do not propose to be realistic. It is felt they need not be empirically correct in order to show the effect of variable changes on concentration.

The Effects of Variable Changes on Concentration

Example One

Example one shows the method used in calculating the standard deviation and concentration. This example will be the basis for most comparisons which follow. If comparisons are not made with example one, they will be noted.

In example one, we are measuring the export concentration of a small and weak country we shall call Country X. (All examples will be concerned with export concentration, to ease possible confusion between exports and imports.) Country X has five trading partners to which it exports goods. A list of the trade with each of the countries follows:

Country X's trade with country a_1 = \$ 10
a_2 = 25
a_3 = 30

$$a_4 = 20$$
$$a_5 = 15$$

$$A = \$100 = \Sigma a_k$$

Total trade, A, is \$100, n is 5, and μ is 20. The standard deviation for this series is calculated using the formula,

(12)
$$\sigma = \sqrt{\frac{\Sigma(a_k - \frac{A}{n})^2}{n}}$$

$$= \sqrt{\frac{\Sigma(a_k - 20)^2}{5}}$$

$$= \sqrt{50}$$

$$\sigma \cong 7.07$$

Concentration is computed from the formula,

(29)
$$C = 100 \sqrt{\frac{\sigma^2 n}{A^2} + \frac{1}{n}}$$

$$= 100 \sqrt{\frac{250}{10,000} + \frac{1}{5}}$$

$$= 100 \sqrt{.025 + .20}$$

$$= \sqrt{.225 \cdot 10,000}$$

$$= \sqrt{2250}$$

$$C \cong 47.4$$

In example one, concentration is 47.4 and the standard deviation is 7.07.

Example Two

In example two, n was increased to see what would happen to C. In this case, total export trade, A, was held constant, with the result of decreasing the mean, μ. This means that trade would have to be shifted among the different trading partners. The series becomes,

$a_1 = \$\ 10$
$a_2 = 10$
$a_3 = 15$
$a_4 = 30$
$a_5 = 20$
$a_6 = 15$

$A = \$100$, $n = 6$.

The difference between the series of example one and two is that the $a_2 = 25$ in example one is divided into $a_2 = 10$ and $a_3 = 15$ in example two. The mean for this series is approximately 17. (It is exactly 16 2/3 or $\frac{100}{6}$. The result of this difference will be a slight overestimation of σ and C.) The standard deviation, calculated as in example one, of the series is approximately 6.85, which is a decrease from example one and concentration in example two is approximately 44.5, also a decrease from example one. The result of an increase in n is just as Hirschman suggests: a decrease in C as σ decreases, and a decrease in C as n increases.

Example Three

Example three shows the effect of an increase in n, however this time A is made to increase in proportion so that the mean remains unchanged (from example one). The series is shown here:

$a_1 = \$\ 10$
$a_2 = 25$
$a_3 = 30$

$a_4 = 20$
$a_5 = 15$
$a_6 = 20$

$A = \$120;\ n = 6;\ \frac{A}{n} = \mu = 20.$

The standard deviation for this example was approximately 6.5, which is less than in example one and concentration is approximately 43.3, which is also less than example one. It appears that as the mean remains unchanged; that is, as a country adds another trading partner to its list in which the amount of this trade is equal to the average of previous trade, concentration will be reduced as Hirschman proposes: as σ decreases, concentration decreases, and as n increases, concentration decreases.

Example Four

What happens to concentration if a trading partner is added in which the amount of trade is extremely high (or low) so that the mean will be altered and the standard deviation is sure to be especially increased? Example four deals with this question. One large trade amount is added to example one. The series is thus:

$a_1 = \$\ 10$
$a_2 = 25$
$a_3 = 30$
$a_4 = 20$
$a_5 = 15$
$a_6 = 50$

$A = \$150;\ n = 6;\ \frac{A}{n} = \mu = 25.$

The standard deviation for this series is approximately 13, which is nearly twice as large as in example one. Concentration in example four is approximately 46.3, which is just lower than in example one. The first of Hirschman's statements has been violated. Here, as a

country adds a trading partner, who takes a large amount of its growing export trade, dispersion has increased and yet the index of trade concentration has decreased, moving in opposite directions instead of in the same direction. The suggestion from this example is that the index of trade concentration may be weighted in favor of n; as n is increased, C will tend to decrease, no matter what happens to the dispersion or σ. The policy implication is that if a country desires to decrease trade concentration, the main concern will be to find new trading partners. Trying to keep the amount in dollars sent to this new trading partner equal to the average of trade so that dispersion will be decreased is not necessary since we have just seen that even if the standard deviation increases, concentration may decrease.

Example Five

It should be noted here, before we elaborate the point just made, that it <u>is</u> possible to decrease C without increasing n by manipulating trade amounts among trading partners already established so that all are closer to the average. In this case, dispersion is decreased. Example five illustrates this possibility. The a_k series becomes:

$$\begin{aligned} a_1 &= \$\ 15 \\ a_2 &= \quad 20 \\ a_3 &= \quad 30 \\ a_4 &= \quad 20 \\ a_5 &= \quad 15 \end{aligned}$$

$$A = \$100; \quad n = 5; \quad \frac{A}{n} = \mu = 20.$$

The standard deviation for this series is approximately 5.5, which is less than example one and concentration is approximately 46.4, which is also lower than in example one.

The example raises the following question: Will it be preferable

to focus efforts of reducing trade concentration on acquiring new outlets or equalize the trade with the old ones? It would appear that amounts of trade are established over a period of many years and it would be difficult to change and redirect these amounts at will. Hirschman also suggests that this is the case.[10] However, it may also be difficult to find new trading partners. A more definite answer to this question requires an investigation of broad policy considerations which goes beyond the scope of this paper.

Example Six

Two examples were constructed which aimed to see further what happens to C as n is increased in such a way that dispersion is increased. Both examples reinforce the suggestion that the index is weighted in favor of an increase in n. In example six, three large amounts of trade were added to the original situation. The series is:

$$
\begin{aligned}
a_1 &= \$\ 10 \\
a_2 &= \quad 25 \\
a_3 &= \quad 30 \\
a_4 &= \quad 20 \\
a_5 &= \quad 15 \\
a_6 &= \quad 50 \\
a_7 &= \quad 50 \\
a_8 &= \quad 40
\end{aligned}
$$

$$A = \$240; \quad n = 8; \quad \frac{A}{n} = \mu = 30$$

The standard deviation is approximately 14.3, which is at least twice that of example one. Concentration is approximately 39.2, which is less than in example one.

Example Seven

Example seven adds three very small a_k's to the series:

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[10]Ibid., p. 30.

$a_1 = \$ 10$
$a_2 = 25$
$a_3 = 30$
$a_4 = 20$
$a_5 = 15$
$a_6 = 10$
$a_7 = 5$
$a_8 = 5$

$A = \$120; \quad n = 8; \quad \frac{A}{n} = \mu = 15$

The standard deviation for example seven is approximately 8.7, which is more than the 7.07 of example one. Concentration is reduced to approximately 40.8, which is less than the 47.4 of example one.

We can now make the following statement: Whenever a country adds new trading partners to its established trade pattern, the index of trade concentration is likely to fall regardless of the size of the new trade flow. If the new trade flow is similar in magnitude to the existing average, the concentration will drop together with the rate of dispersion (example 3). If, however, the new trade is far higher than the established average (example 6) or far lower than this average (example 7) the dispersion rate will increase, but the concentration rate will decrease, probably to a lesser degree. The impact of dispersion in the formula of trade concentration is not, in its present form, sufficient to change the direction of concentration caused by the change in the number of trading partners.

Example Eight

We have shown so far that C is a function of n, leaving σ in a subordinate role. Is it possible to increase σ sufficiently to raise C in spite of an increase of n? Example eight shows such manipulation of trade figures and the addition of one a_k:

$$
\begin{aligned}
a_1 &= \$\ 5 \\
a_2 &= \quad 5 \\
a_3 &= \quad 5 \\
a_4 &= \quad 5 \\
a_5 &= \quad 50 \\
a_6 &= \quad 50
\end{aligned}
$$

$$A = \$120; \quad n = 6; \quad \frac{A}{n} = \mu = 20$$

The standard deviation is a very large 21.2, about three times example one. Concentration has increased to about 59.5. The example shows that it is possible to increase C and σ and n at one time, but the manipulation of trade figures necessary to produce this result is rather far-fetched.

Example Nine

Suppose that a country has the situation in example eight above. An additional trading partner will create example nine:

$$
\begin{aligned}
a_1 &= \$\ 5 \\
a_2 &= \quad 5 \\
a_3 &= \quad 5 \\
a_4 &= \quad 5 \\
a_5 &= \quad 50 \\
a_6 &= \quad 50 \\
a_7 &= \quad 55
\end{aligned}
$$

$$A = \$175; \quad n = 7; \quad \frac{A}{n} = \mu = 25$$

The standard deviation in example nine has increased, when compared to example eight, to about 23.2, and yet the concentration has decreased from 59.5 in example eight to approximately 51.5 in example nine above.

The answer to the question posed at the beginning of this section concerning the effect of an increase in n on the equation (29)

$$C = 100 \sqrt{\frac{n\sigma^2}{A^2} + \frac{1}{n}} \tag{29}$$

where n is in both the numerator and denominator, can now be answered

with greater confidence. The effect of n in the term $\frac{1}{n}$ apparently offsets the effect of n in the term $\frac{n\sigma^2}{A^2}$; as n increases, concentration decreases. In fact, the examples in this section found that the effect of an increase in n tended to offset even an increase in σ . The result contradicts Hirschman's statement that σ and C increase together. The index of trade concentration is weighted in favor of n.

A Comparison of Two Forms of the Index

The index of trade concentration has been used above in two very different forms, the second of which was derived by a series of mathematical manipulations. Are these two forms producing the same result? To answer this question we compute the index using both forms and compare the results. The a_k series of data of example one is used to make this comparison. We start with the original form of the index:

(1) $$C = \frac{100}{A}\sqrt{\Sigma a_k^2}$$

Applying the series $a_1 = 10$; $a_2 = 25$; $a_3 = 30$; $a_4 = 20$; $a_5 = 15$ to the equation, it becomes,

$$C = \frac{100}{100}\sqrt{100 + 625 + 900 + 400 + 225}$$

(X) $$C = \sqrt{2250}$$

The second form of the index was,

(27) $$C = 100\sqrt{\frac{v^2 + 1}{n}}$$

we substituted the definition, $v = \frac{\sigma}{\frac{A}{n}}$, into this form. We

then simplified the equation into the form,

(29) $$C = 100\sqrt{\frac{n\sigma^2}{A^2} + \frac{1}{n}}$$

to calculate C for the various examples. The same series as above is used to calculate concentration. (The variance has already been computed to be 50. See example one.)

$$C = 100\sqrt{\frac{5 \cdot 50}{10{,}000} + \frac{1}{5}}$$

$$= 100\sqrt{.025 + .20}$$

$$= \sqrt{.225 \cdot 10{,}000}$$

(Y) $$C = \sqrt{2250}$$

Equation (X) is equal to equation (Y) which shows that these two indices are equal.

The Limits of the Index of Trade Concentration

The index of trade concentration will have a maximum and minimum limit. The upper limit would approach 100 if the trade of a country goes to only one other country. The computation would be:

$$\frac{a_k}{A} = 100\% \text{ of trade.}$$

In this case, a_k will equal A, so that the formula for concentration would become:

$$C = \sqrt{100^2} = 100.$$

The lower limit could conceivably become zero if a country trades with an infinite number of countries, each with an infinitely small share of that country's trade. But for all practical purposes,

the lower limit of such an index will not be zero. In fact, all countries concentrate the bulk of their foreign trade on a very limited number of other nations; therefore, a low level of concentration will remain far from being zero. Only relative, not absolute concentration is of really practical significance.

The lower limit of C will be found by the following reasoning. Suppose all the a_k's are equal, or:

$$a_1 = a_2 = a_k = \ldots = a_n.$$

Then the concentration formula can be written,

$$C = \frac{100}{A} \sqrt{na_k^2}$$

$$= \frac{100a_k}{A} \sqrt{n}$$

and A can be written na_k since all a_k's are equal,

$$= \frac{100a_k}{na_k} \sqrt{n}$$

$$C = \frac{100}{n} \sqrt{n}$$

The minimum value for the index will be found by $C = \frac{100}{\sqrt{n}}$.

Commodity and Geographic Concentration

The index of trade concentration can be applied to several different series of data. So far in the discussion, the index has been applied to only one of these series. We have referred only to export trade, but more explicitly, we have talked about export trade to the various other countries, or trading partners. This is called the geographic concentration of trade; it shows with how many countries one nation trades and the share of total exports each of the trading

partners holds. The geographic concentration can also be computed for imports. This index reflects the number of countries a nation buys from and the relative distribution of total imports of these purchases.

The index may also be applied to a series of data which is called the commodity concentration of trade. A series of this kind would be based on commodity groups and their relative importance for a country's exports (or imports). The grouping of these commodities is subject to some arbitrary classifications. The actual commodity classification for the determination of a concentration ratio encounters considerable practical difficulties. These will be discussed below. The same rationale, however, applies to both the geographic and commodity concentration. The commodity concentration focuses on the number of different commodities exported (imported) and the percent of total exports (imports) contained in each commodity group. Again, commodity exports and imports are computed in separate series.

Variations of the Hirschman Index

The index of trade concentration appears in the literature in two other different approaches. They may be dealt with easily as they are merely changes in notation and can be reduced to Hirschman's exact form, with one small exception.

Michael Michaely[11] uses a more explicit notation than Hirschman when he distinguishes between exports and imports and also between

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[11]Michael Michaely, Concentration in International Trade, (Amsterdam, 1962), p. 8. and p. 19.

geographic and commodity concentration. The index of commodity concentration of exports of country j, to be denoted by C_{jx}, is defined as,

$$C_{jx} = 100 \sqrt{\Sigma\left(\frac{X_{ij}}{X_{\cdot j}}\right)^2}$$

where X_{ij} stands for the X_i series, or value of country j's exports of commodity i to the rest of the world, and $X_{\cdot j}$ stands for total value of country j's exports to the rest of the world. Taking $X_{\cdot j}$ out of the radical, the result looks distinctly like Hirschman's,

$$C_{jx} = \frac{100}{X_{\cdot j}} \sqrt{\Sigma(X_{ij})^2}$$

where X_{ij} equals the a_k and $X_{\cdot j}$ equal A. It should be noted, however, that Hirschman's a_k's were dealing in countries and the X_{ij}'s are products. Michaely uses the notation M for imports and the commodity concentration index becomes,

$$C_{jm} = 100 \sqrt{\Sigma\left(\frac{M_{ij}}{M_{\cdot j}}\right)^2}$$

where;

C_{jm} = commodity concentration of country j in imports

M_{ij} = value of import trade in product i

$M_{\cdot j}$ = total imports.

Again, the same approach is used by Michaely in notation for geographic concentration of trade. The geographic concentration of trade in exports looks like,

$$G_{jx} = 100 \sqrt{\Sigma\left(\frac{X_{sj}}{X_{\cdot j}}\right)^2}$$

where;

G_{jx} = geographic concentration of country j in exports

X_{sj} = the value of export trade to country s by country j

$X_{\cdot j}$ = total exports of country j.

And lastly, the import geographic concentration of trade becomes:

$$G_{jm} = 100 \sqrt{\Sigma\left(\frac{M_{sj}}{M_{\cdot j}}\right)^2}$$

Benton F. Massell[12] is interested in the export commodity and geographic concentration index but makes no difference in notation between them. He does not multiply the radical by 100 as do Hirschman and Michaely. The result of this is that the index is always 100 times smaller. That is, a representative index would be .242 rather than 24.2 for Hirschman or Michaely. The maximum value for the index will be 1 rather than 100 and the minimum value will be $\frac{1}{\sqrt{n}}$ rather than $\frac{100}{\sqrt{n}}$. Massell's index is written;

$$C = \sqrt{\Sigma\left(\frac{x_i}{x}\right)^2}$$

where x_i is the value of exports of commodity i in the specified time and $x = \Sigma x_i$. All of these indices will yield the same result as long as it is remembered that Massell leaves off the 100.

Data Restraints to the Index

One of the main difficulties in the use of a statistical measure such as the index of trade concentration, is the analysis of available data. Are needed data available and reliable and

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[12] Benton F. Massell, "Export Concentration and Fluctuations in Export Earnings," American Economic Review, (March, 1964), p. 52.

especially are they comparable between countries? In recent years, due to the efforts of the United Nations, World Bank, and IMF, the collection of data has become more methodical and the index has become more practical to use, especially the commodity concentration index.

In 1945, Hirschman,[13] computed only the geographic concentration index, using the publication, International Trade Statistics, of The League of Nations. The main difficulty encountered by Hirschman is the problem of the category "other countries." This residual category remains a problem today since there appears to be no statistical source which is inclusive of all trading partners. In the countries for which Hirschman computed the index, the "other country" category amounted to not more than 5% of total trade, so he arbitrarily assumed that this 5% would be divided into a number of countries, each holding .5% of the total.[14] In this case, then, there would be 10 countries, each with .5% of trade and $10 \cdot .5\%$ would be added to the sum of the squares of the other percentages. If this "other country" trade were 4.5% of total trade, $9 \cdot .5^2$ would be added. Michaely has considered the "other countries" category as one single unit if the group is of minor importance, but if the percentage of total trade held by this group is judged significant, he excludes it altogether from the calculations.[15]

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[13]Hirschman, National Power and the Structure of Foreign Trade, p. 100.

[14]Ibid.

[15]Michaely, Concentration in International Trade, p. 18.

Another difficulty encountered in the compilation of data for the geographic concentration index is the appropriate definition of a country. In an age of revolution, it is often difficult to determine the geographic and political boundaries of countries. For the purpose of gathering trade statistics, a country is defined by its customs area rather than by its geographic frontiers.[16]

In recent years, the prime source of information for the calculation of geographic concentration has been the publication, Direction of International Trade, a joint publication of the United Nations, the International Monetary Fund, and the International Bank for Reconstruction and Development.[17] This publication reproduces monthly and annually, export and import trade statistics in terms of United States dollars. The trading partners of each country are listed along with the value of trade with each of them. This source presents up to date information, but the problem of the "other countries" category is not eliminated.

Hirschman did not attempt to actually calculate the commodity concentration index. "Although this type of concentration has definite meaning, it is awkward to deal with statistically because of the difficulty of defining a commodity or a product."[18] To simplify and standardize commodity grouping, the United Nations initiated in 1950 the Standard International Trade Classification

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[16]United Nations, Yearbook of International Trade Statistics, (New York, 1962), p. 6.

[17]Michaely, Concentration in International Trade, uses this publication for his calculations. See page 18 of his book.

[18]Hirschman, National Power and the Structure of Foreign Trade, p. 106.

(SITC), "in order to have available data in internationally comparable categories suitable for the economic analysis of trade."[19] The SITC divides all commodities that are traded internationally into ten sections:

0 Food and Live Animals
1 Beverages and Tobacco
2 Crude Materials, inedible, except Fuels
3 Mineral Fuels, Lubricants and related Materials
4 Animal and Vegetable Oils and Fats
5 Chemicals
6 Manufactured Goods classified chiefly by Material
7 Machinery and Transport Equipment
8 Miscellaneous Manufactured Articles
9 Commodities and Transactions not classified according to kind.

This very general 10-section (one-digit code) is further subdivided into 56 divisions (two-digit code), 177 groups (three-digit code), and 625 items (five-digit code).[20] Most United Nation countries are now complying with the SITC classification.

While some major problems inherent in the use of the commodity concentration index have been tackled, still many remain. The fact that commodity categories are subdivided presents a problem. When commodity groups are kept broad enough to permit a small number of n notations to remain manageable, each broad group may represent an average of unrelated commodities. As each group is split to improve the homogeneity of each subgroup, n rises without any change in total trade; the standard deviation rises as averaged data are separated. In this case, as groups are subdivided, there is no unique determination of the concentration index.

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[19] U. N., Yearbook of International Trade Statistics, 1962, p.5.

[20] United Nations, Standard International Trade Classification, Revised, (New York, 1961), p. vi.

An example will help to clarify the problem. We will take for an example a hypothetical extreme case of dispersion in commodity classification subgroups. We shall assume that the commodity classification scheme has only two groups, (instead of 10 as does the SITC); these will be denoted by group X and Y. Group X shall represent industrial goods and group Y shall represent foodstuffs. To further simplify, the value of total exports of the country in question is exactly $100. The country exports $70 worth of goods in group X (70% of total export trade) and $30 in group Y (30% of export trade). Further, it happens that all of the $70 in group X represents sales in only one product, 50 HP engines, and the $30 represents sales of rice. Now, group X is further divided into 5 subgroups, of which 50 HP engines is one subgroup. And group Y is divided into 3 subgroups, of which rice is one subgroup. The n has increased from 2 to 8, but in 6 of the 8 new subgroups, there is no trade at all. In this case the dispersion has risen sharply. What does happen to $\bar{\sigma}$ and C as groups are subdivided? Before the division, the $\bar{\sigma}$ was calculated to be 20 and C was 74. Group X then became:

$$
\begin{aligned}
X_1 &= \$70 \\
X_2 &= 0 \\
X_3 &= 0 \\
X_4 &= 0 \\
X_5 &= 0 \\
\hline
&\$70
\end{aligned}
$$

Y became:

$$
\begin{aligned}
Y_1 &= \$30 \\
Y_2 &= 0 \\
Y_3 &= 0 \\
\hline
&\$30
\end{aligned}
$$

$A = \$100$; $n = 8$; $\frac{A}{n} = \mu = \$12.5$. The standard deviation of this new classification has increased to 24 and the concentration ratio has increased to 76.

This example shows that there will be no unique determination of the concentration index as commodity groups are subdivided because of differences in dispersion in subgroups. It should be noted that the effect of subdividing may have other results than those of the example. It is possible that C may decrease as groups are subdivided. A country that is highly diversified in a group, but only trades in that one group, will decrease its concentration ratio as groups become more and more subdivided. It is therefore easy to see that the problem of choosing a commodity classification scheme becomes difficult. The three-digit SITC code was chosen most often as being manageable enough (keeping n small) and yet inclusive enough.[21]

We also need to consider how well the commodity classifications have been selected. It is assumed that the subdivisions are made equally fine in all sections, divisions, groups, and items. If they are not, countries who have traded more in a classification where the divisions were not so fine would have an upward biased concentration over countries who traded in very finely subdivided groups. The problem of the "other commodities" category has to be considered as before. One way of overcoming the difficulty of the "other commodities" category would be the elimination from the index of all

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[21]Michaely, Concentration in International Trade, p. 7, and Massell, "Export Concentration and Fluctuations in Export Earnings," AER, p. 53.

groups with less than 5% of export trade. The impact of such a procedure on the index is small and the usability would not be harmed in any appreciable way.

Summary

This chapter has examined the index of trade concentration in its mathematical entirety. The index in its simple form,

$$C = \frac{100}{A}\sqrt{\Sigma a_k^2} \tag{1}$$

would cause one to ask why square and then take the square root. However this form was shown to be equal to another form,

$$C = 100\sqrt{\frac{v^2 + 1}{n}} \tag{27}$$

which is related to the standard deviation and coefficient of variation, which reflect dispersion. The index was also examined to see if it increased as σ increased and decreased as n increased, as Hirschman suggested it would. It was found that the index was weighted in favor of the increase in n and that for the most part, C would decrease as n increased no matter what happened to σ. Other notations of Hirschman's index were discussed and it was found that all were replicas of Hirschman with inconsequential variations. No apparent attempt has been made to compensate for the weight put on the increase in n and its implications. The maximum and minimum limit of the index was determined and the possible use of the data was discussed.

CHAPTER III

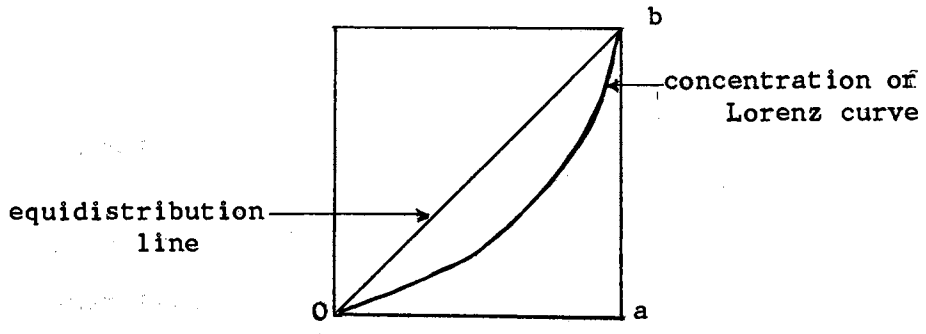
APPLICATIONS OF THE INDEX IN THE LITERATURE

Several other writers have seen a need for an index of trade concentration in some broader context. Their contribution will now be discussed.

Gini

Long before Hirschman, the idea of a concentration ratio was discussed by Corrado Gini, the Italian statistician. At that time, 1914, the Lorenz curve was the best known measure of concentration. In such a graphical description, the vertical distance between the equidistribution line and the concentration curve was the meaningful variable. Figure one shows a Lorenz curve representing trade concentration.

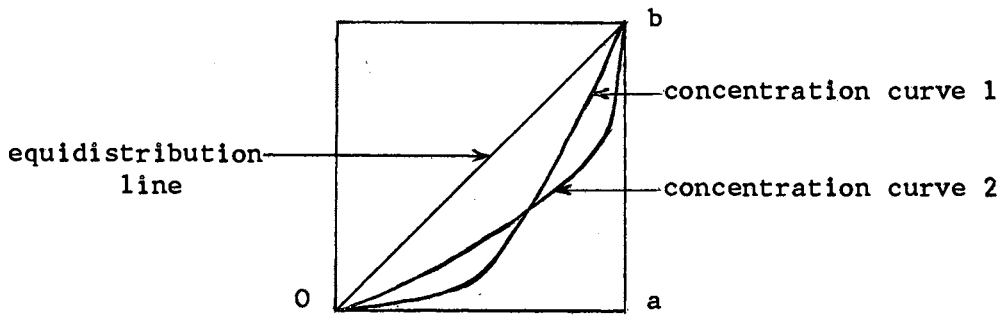
Figure 1.



Gini points out that this measure has a basic weakness when working with concentration curves of different shapes which may even cross

each other.[1] It is then difficult to tell which curve represents the higher concentration. This becomes important when comparing two or more different groups with different shapes of distribution of data. In the context of this thesis, his comments are relevant because the distribution of foreign trade data will surely be different for each country for which the concentration ratio is computed, causing a possible crossing of the concentration curves. Figure two shows this relationship.

Figure 2.



The problem is solved, according to Gini, when the area between the concentration curve and the equidistribution line is considered instead of the vertical distance. He proposed a concentration ratio which would indicate the concentration area of different curves, regardless of whether they crossed or not.

The ratio was equal to the area between the equal-distribution line and the concentration curve divided by the area of the triangle O-a-b. Concentration would increase as the concentration curve filled more and more of the area bounded by O-a-b. The concentration ratio is at a minimum when the concentration curve is equal

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[1]Corrado Gini, "Sulla misura della concentrazione e sulla variabilità dei caratteri," Atti del R. Istituto Veneto di Scienze, Lettere e Arti, Vol. LXXIV, Part II, p. 1230.

to O-b and at a maximum when it is equal to O-a-b. In the first case, the ratio would be zero and in the latter, it would be one. Gini, thus made it possible to compare any two or more patterns of distribution of data for concentration using the Lorenz curve, the result of which is a concentration ratio.

The Lorenz curve measures the inequality in the size of trade volumes from (to) other countries. Hirschman felt a measure of concentration should reflect not only the inequality in trade volumes, but the number of trading partners. We have seen in the preceding chapter that the index Hirschman prescribed as an alternative indeed reflects the number of trading partners.

Hirschman and Michaely

The writers who have followed Hirschman have used his index of trade concentration without much critical comment. They have frequently incorporated the index as one of two or more variables, intended to reflect the economic position of a country, with hopes of finding some significant relationship. These writers have tried to test the relevance of the index of trade concentration. Their studies are of interest, not only for the empirical information and analysis, but for their approach to questions of a more basic nature. They shed light on possible causes for concentration, and investigate the relative importance of exports vs. imports in concentration.

Hirschman computed the geographic index of concentration for 44 countries that he considered small and weak.[2] Michaely computed

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[2]Hirschman, National Power and the Structure of Foreign Trade, p. 101.

the geographic concentration index and the commodity concentration index for 44 countries, however, he did not pick the same countries that Hirschman examined.[3] Hirschman found that the geographic concentration was higher in exports than in imports. Thirty-nine of the 44 countries Hirschman examined had a higher concentration in exports than in imports.

Michaely used data from 1954, which are nearly 20 years later than those used by Hirschman; the previous pattern was reaffirmed. However, Michaely's study does not significantly support the earlier study since he found that only slightly more than half of the countries had higher geographic concentration in exports than in imports. Two reasons may explain the difference. First, the countries used were not the same, and secondly, in the years since Hirschman's study was made, the concentration of exports may have been declining as a result of deliberate diversification.

Both studies found, however, that the range of values for export concentration was much wider than for import concentration. When export concentration was high, the difference between export and import concentration was great; a low export concentration was not matched by an equally low import concentration.

Hirschman did not compute a commodity concentration index, as has been mentioned, but he had much to say about the relationship between geographic and commodity concentration. He suggested that it was logical for a country to export a few main products that it has specialized in producing and to import large quantities of finished products, raw materials, or food. If the statement is correct,

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[3]Michaely, Concentration in International Trade, p. 11.

commodity concentration will be higher for exports than for imports We may assume that a country will produce for export primarily those goods in which it has a comparative advantage. The country buys from other nations those goods which they are better able to produce. With many countries specializing in different export products, each country will import a larger variety of goods than it exports, causing the export concentration to be higher than import concentration.

Hirschman claims that there is a positive correlation between geographic and commodity concentration. This may be contrary to one's first logical view,

> that specialization of a country's production for exports upon one or a very few commodities would permit this country to supply the whole world with these commodities. On the other hand, it would seem natural that if a country trades mostly with another single country it would have a comparative advantage in a large number of products and would therefore have rather diversified exports. It would follow, then, that a dependence of exports upon one product would be tempered by a large geographical spread of exports, whereas a dependence of exports upon one country would be somewhat compensated by a diversified structure of the commodity-composition of exports.[4]

We have shown, however, that there is a positive correlation between geographic and commodity concentration, not a negative one. How can this be explained? Hirschman suggested this relationship can best be explained by taking into account the large differences in industrialization and in size of the countries involved. As a country becomes more and more industrialized, it acquires new trading partners in each step of the industrialization process without losing its old trading partners.

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[4]Hirschman, National Power and the Structure of Foreign Trade, p. 107.

It appears that the exports of an industrial country are more diversified than those of a primary-producing country, therefore concentration in commodities and in countries will move in the same direction. If a small country produces only a few staple products for export, it may not be able to fill the demand of even one large country and yet it might be supplied with goods from many other countries. Thus, the size of a country may be helpful in explaining the relationship between geographic and commodity concentration. Hirschman points out that the positive correlation between geographic and commodity concentration caused the pattern of world trade to be determined by only a few countries trading few products. The availability of alternative markets for world trade will, therefore, be severely limited. This will allow much opportunity for the exercise of economic pressures by the great trading nations.

Michaely was particularly interested in the causes of concentration. These became more evident as the indices of concentration were calculated. In addition to the reasons offered by Hirschman for the positive correlation of commodity and geographic concentration, Michaely suggested some other explanations. Hirschman had stated this positive relationship is partially determined by the degree of industrialization of a country. Michaely suggested that if a country has arrangements for trading with only one or very few trading partners, then it will have less opportunity for exporting a variety of goods. But, if a country has trade connections with many nations, chances for finding outlets for a variety of goods are much better. Reasons for maintaining trade connections with

one or many countries are various. This may be due to conscious government political action or it may be due to cultural and geographical proximity.

Michaely computed the index of commodity concentration, and he arrived at much the same results that Hirschman proposed without computation. In 39 of the 44 countries examined, concentration in exports was higher than in imports.[5] He found that there was a much larger variation in the degree of commodity concentration of exports than of imports. More specifically, the coefficients of commodity concentration ranged from 16.9 to 98.8.[6] The range for import concentration for the countries examined varied from 15.6 to 30.5, with one exception, the Netherlands Antilles, which had an import concentration ratio of 83. Whether the ratio of exports over imports was high or low, then, depended more on exports than on imports.

What are some of the causes for variation in export commodity concentration? The immediate suggestion made by Michaely was the degree of development of the economies in the various countries as expressed by the level of per-capita income of the countries. The more developed an economy becomes, the more varied its production is expected to be. The more varied the production, the more

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[5]Note the coincidence in results between Hirschman and Michaely. Both found concentration higher in exports than in imports in 39 of 44 countries examined. However, they were examining different countries. Also, Hirschman was computing geographic concentration while Michaely was computing commodity concentration.

[6]Michaely was using the SITC three-digit code, which at that time had 150 groups. (It now has 177). The limits to the index of commodity concentration become $\frac{100}{\sqrt{150}}$ or 8.2 as a minimum and 100 as a maximum.

diversified will be the country's exports. Industrialization increases with development and leads to product diversification at home and in export trade. It may be difficult to distinguish between a developed and an industrialized country, especially since it is probable that economic development is enhanced as increased industrialization takes place.

The location of the country is another possible explanation for the degree of export commodity concentration. Nearness of a country to the great trading centers of the world will help to diversify its exports because it will be better able to find buyers for many products. The prime example would be export concentration in the countries in Europe. Europe is the major world trading area and the exports of these countries are diversified; thus the export concentration index is low. The difficulty here is that these countries are also some of the most developed and industrialized in the world. However, it does seem reasonable that location may be significant because the transportation costs are an important variable for the feasibility of exports in many product lines.

The size of the country and its per-capita income should also be mentioned. A larger country has more opportunity to vary its production because it is likely to own a greater variety of economic resources. With a more varied production, we may assume that exports will be more diversified.

The relationship between the commodity concentration of exports and imports was also discussed by Michaely. It might be expected that the correlation between the export and import concentration is positive, that the indices move in the same direction. The opposite can be argued in the following terms. If a country exports

only very few products, it would surely desire a variety of products from other countries. Michaely offers several reasons why the relationship is positive. First, it is possible that a country imports raw materials in order to export the finished product. Next, there may be some factor common to both exports and imports which cause them to be affected equally. Such a factor might be the distance to major trading areas. The transportation costs would apply equally to both exports and imports. Lastly, the economic development of a country may cause export and import concentration to move in the same direction. An underdeveloped country will export very few goods, perhaps only a few primary products, but it is also too poor to buy a lot of goods abroad. It is able to buy not only few imports, but imports of limited variety.

Massell

Massell has further explored the relationship between export commodity concentration and development.[7] He was interested in the relationship between export concentration and the fluctuations in the export earnings of various countries. He suggested that the instability or fluctuation a country notices in its export earnings may be traceable to a lack of diversification of products made for export. The countries which have been particularly concerned about the instability in their export earnings have been those newly developing countries that produce mostly one or a few primary products. The export earnings of these countries help them to buy much needed

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[7] Massell, "Export Concentration and Fluctuations in Export Earnings," AER, p. 47.

capital-goods to further their ecomomic development. If export earning instability is indeed caused by high export concentration, then a relatively simple policy of more diversification in export products would help to smooth out the instabilities. It is just this relationship that Massell wished to test. He has attempted, therefore, to find an important use for the index of trade concentration.

The results of Massell's study rejected his hypothesis that export earnings' instability was caused by high commodity concentration of exports. He used regression analysis with the commodity concentration index as the independent variable and an index of export earnings' instability as the dependent variable to estimate the relationship between concentration and instability. No significant relationship was found, so he added another variable, the index of geographical concentration of exports. Massell found that, given the amount of geographic concentration, the relationship between commodity concentration of exports and instability of export earnings was only slightly more positive than the correlation without geographical concentration. These results were contrary to his expectations. The following considerations might explain his result.

The first clue may be in the differences between the various products for export. Some products are more subject to changes in the demand schedule due to changes in expectations or other reasons. And some products are more subject to changes in the supply schedule due to plant disease or weather. Those countries who produce the goods with more volatility in demand or supply may have a higher instability in export earnings which could not be explained by differences in commodity concentration. Massell suggests another

reason why the relationship between concentration and instability may be a weak one. Different commodities may not be independent for statistical purposes. If the cross elasticity of demand of two products is high,

> a shift in the demand for one is likely to be accompained by a comparable shift in the 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.[8]

Having to abandon his original hypothesis, Massell examined an alternative. Instability of export earnings results from a high concentration of primary goods for export as opposed to industrial goods, rather than from a high commodity concentration of exports. He found, however, that instability of export earnings did not occur solely in primary-producing countries; industrial countries encountered the same difficulty.

One must conclude from Massell's study that the index of commodity concentration for exports cannot be used to explain export earnings instabilities. A simple policy of diversification of products for export will not smooth out instabilities on any general scale. A shift toward the production of industrial goods for export will not reduce instabilities since industrial countries experience instability as readily as do primary-producing countries. Those underdeveloped countries showing the most concern about instability of export earnings do so simply because they are poorer and feel fluctuations more readily than richer, more developed countries. The instability of export earnings must be caused by

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[8]Ibid., p. 58.

some variable other than the degree of commodity concentration. As a matter of common observation, we might suggest that export instability is a result of the fact that foreign markets are a marginal area of penetration; they exhibit demand increases during cyclical expansion and the converse during recession periods.

Coppock

One other author has attempted to use the index of trade concentration to help explain international economic instability. Coppock's book is broader in scope than Massell's article. He is interested in many possible explanations of instability, of which the geographic and commodity concentration indices are just two of nearly forty.[9] Coppock was especially hoping to shed enough light on the economic instability of the world in order to propose policy measures for mitigating it.

Coppock chose export proceeds as the major variable which represents the principal economic benefit the exporting countries receive from their foreign trade relations. An index of export instability was applied to the export proceeds data. The result was an instability coefficient for each country which was part of his sample. In order to account for the differences in instability among the various countries, Coppock used single and multiple correlation analysis to explain the relationship between each of the possible explanatory variables and the index of export instability. The indices of commodity and geographic concentration of exports

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[9] Joseph D. Coppock, International Economic Instability, (New York, 1962), p. 80.

were correlated with the index of export instabilty, and in both the single and multiple correlation analyses, Coppock found a very insignificant relationship. These results concur with those of Massell, even though the methodology used was not similar.

Tinbergen

The index of trade concentration may be helpful in explaining the flow of foreign trade between countries. This use of the index is found in the appendix of a recent study by Tinbergen.[10] Tinbergen suggests, within a much broader framework, that there are three major forces today which are shaping our world economy -- communism, economic development, and the passing of colonialism. In the discussion of development, Tinbergen became concerned with the effects of less-than-free trade policies upon the speed of development. He concluded that, given certain conditions, free trade was agreeable with the optimal well-being of the world. He lists several of these conditions: temporary subsidies should be given to young industries which have not yet achieved full capacity production; provision for retraining and relocating workers in declining industries should be made; subsidies for vital industries need to be considered. Tinbergen wanted to know whether the actual trade flows between countries deviated very much from the optimal or theoretical trade flows. The most significant determinants of optimum trade flow used by Tinbergen were the economic sizes of the pairs of countries examined and their

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[10]Jan Tinbergen, Shaping the World Economy, (New York, 1962), p. 7.

geographical separation.[11] Economic size was expressed by the GNP, both of the exporting and the importing country. Transportation costs were used as the measure of geographic separation; they operated in a negative way as distance between countries increased. A negative deviation of the actual from the optimal trade flow meant that a country may be discriminated against by importing countries. Developing countries in this case would be trading less than enough for necessary economic expansion.

Tinbergen calculated the optimal trade flows, using in one instance the index of commodity concentration as an additional explanatory variable. He found a negative sign to the coefficient, associated with the index, which means that an increase in commodity concentration would lead to a smaller flow of exports. The problem encountered here is the evident interrelationship of the variables involved. Development, or lack of development, is one of the major causes of concentration. Since the flow of trade is measured at least in part by the GNP, one would surely suspect that changes in concentration would affect the flow of trade. If concentration increased, the flow of trade would decrease. The effect of the index of trade concentration on the explanation of differences in world trade flows can not be evaluated successfully due to the interrelatedness of the variables.

Summary

In this chapter we have reviewed several studies using the index

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[11] Ibid., p. 60.

of trade concentration. It was found that the most significant discovery has been a rather thorough discussion of the probable determinants of concentration, the relationship between export and import concentration, and the relationship between commodity and geographic concentration. A difficulty arises in the discussion of the causes of concentration because of the high degree of interrelatedness of the variables. The level of development may well be the most significant determinant of concentration, but how can one distinguish development from the degree of industrialization? The size and location of a country is a major determinant of its level of development or industrialization. It is easy to see that there will be no simple policy implications for countries wanting to reduce concentration.

CHAPTER IV

CONCLUSIONS

The study has shown the desirability of an international trade concentration index which will reflect the true picture of a country's international economic position. Leaders of nations would like to know the potential impact of their policy decisions; an index of international trade concentration would help indicate increases or decreases in a country's power position as a result of its foreign trade practices.

The Hirschman index of international trade concentration is the only one available at present. It is not adequate as this study has shown, for the following reasons: a) The exact causes of concentration have not yet been isolated in sufficient detail. The tendency for interaction between possible causes of concentration further complicates the matter. b) The problem of selecting and weighting the available data has not been adequately solved to allow the index to be used with confidence.

This study discovered a bias built into the mathematics of the index which emphasizes the importance of the mere number of trading partners or commodities far beyond their relative impact on a nation's foreign trade. The concentration index will decrease as new trading partners or new commodities are added regardless of their share in the country's total foreign trade.

The different forms of the index which have been found in the literature in more recent years do not differ in substance although there are slight distinctions in mathematical appearance. So far in the literature, there has been no apparent attempt to correct the inherent biases of the index.

The simplest form of the index of international trade concentration used by Hirschman is in fact the equivalent of his more complicated mathematical presentation. The simple form is easier to apply to the data. The latter form shows more clearly the effect of changes in dispersion or number of entries in the data used.

Because of all the obstacles encountered, both in the formulation of the index itself and in the difficulties of selecting the most appropriate data for the index, the actual application of this device has been limited to purely experimental studies. So far, no significant role for the index has been found by writers on this subject.

Finally, in order to construct an index that could be used for policy purposes with confidence, it will be necessary to: a) learn more about the forces which dominate independent economic decision making in a nation's economy, and b) find a more suitable [illegible] mathematical expression of the proper weight of each of these forces.

BIBLIOGRAPHY

Coppock, Joseph David. International Economic Instability. New York: Mc Graw-Hill Book Company, Inc., 1962.

Gini, Corrado. "Sulla misura della concentrazione e sulla variabilita dei caratteri." Atti del R. Instituto Veneto di Scienze, Lettere e Arti, Vol. LXXIV, Part II (1913-1914), 1229-1233.

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

_____. "The Commodity Structure of World Trade." Quarterly Journal of Economics, Vol. 57 (1942-1943), 565-595.

_____. "The Paternity of an Index." The American Economic Review, Vol. LIV (September, 1964), 761.

Kindleberger, Charles P. Foreign Trade and the National Economy. New Haven and London: Yale University Press, 1962.

Massell, Benton F. "Export Concentration and Fluctuations in Export Earnings: A Cross-Section Analysis." The American Economic Review, Vol. LIV (March, 1964), 47-63.

Michaely, Michael. Concentration in International Trade. Amsterdam: North-Holland Publishing Company, 1962.

_____. "Concentration of Exports and Imports: An International Comparison." Economic Journal, Vol. 68 (December, 1958), 722-736.

_____. "The Shares of Countries in World Trade." Review of Economics and Statistics, Vol. 42 (1960), 307-317.

Robinson, Joan. "Beggar-My-Neighbor Remedies for Unemployment." Readings in the Theory of International Trade. Philadelphia: The Blakiston Company, 1949, 393-407.

Rosenbluth, Gideon. "Measures of Concentration." Business Concentration and Price Policy. Princeton: Princeton University Press, 1955.

Tinbergen, Jan. Shaping the World Economy. New York: The Twentieth Century Fund, 1962.

Trenton, Rudolph W. "National Independence and Economic Self-Sufficiency." Current Economic Comment, Vol. 18 (November, 1956), 3-14.

United Nations. Direction of International Trade. New York: United Nations Statistical Office, United Nations Statistical Papers, Series T.

_____. Standard International Trade Classification, Revised. New York: United Nations Statistical Office, United Nations Statistical Papers, Series M, No. 34, 1961.

_____. Yearbook of International Trade Statistics, 1962. New York: United Nations Statistical Office, 1964.

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