RICE UNIVERSITY

ECONOMIC EFFICIENCY IN THE MANUFACTURING SECTOR--

AN INTER-REGIONAL COMPARISON:

BRAZIL, 1970

by

Manoel Bosco de Almeida

A THESIS SUBMITTED
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE

DOCTOR OF PHILOSOPHY

APPROVED, THESIS COMMITTEE:

Donald L. Huddle
Donald L. Huddle
Professor of Economics
Chairman

Gordon W. Smith
Gordon W. Smith
Associate Professor of Economics

Robert H. Dix
Robert H. Dix
Professor of Political Science

HOUSTON, TEXAS

July 1980

ABSTRACT

ECONOMIC EFFICIENCY IN THE MANUFACTURING SECTOR--
AN INTER-REGIONAL COMPARISON:
BRAZIL, 1970

by

Manoel Bosco de Almeida

This dissertation is an attempt to measure the economic efficiency of Brazil's manufacturing sector at the two-digit level of aggregation and lower. More specifically, we investigate some of the reasons for the sizeable differences in labor productivity between the manufacturing sectors of the Northeast and the South of Brazil. We investigate how the observed differences in average labor productivity between the two regions could be explained by differences in the capital/labor ratio and economies of scale. The question we ask is: what would the Northeast's level of average labor productivity have been if either this region's capital/labor ratio and/or the average plant size were the same as the South's.

One point of time, 1970, is chosen since it is the most recent year for which complete data are available.

First, we estimate the effect of capital/labor ratio differences on productivity differences. For this estimation, a production function was specified. The quality of the data

and the limited number of observations per sector and branch restricted our choice to the CES production function. Information on the Northeast's relative capital/labor ratio and relative factor prices was sufficient to estimate the parameters of this function.

The results on the Northeast's relative efficiency, defined as the ratio of the Northeast's hypothetical labor productivity to the South's actual level, show that the capital/labor ratio by itself did not explain the observed differences in average labor productivity either at the two-digit or lower level of aggregation. Adjustment for the level of capacity utilization and/or changes in the values of the elasticity of substitution did not change this outcome much.

Next, the Northeast's relative efficiency was adjusted for economies of scale. This measure was called the Northeast's adjusted relative efficiency. This adjustment indicated increasing returns to scale for some sectors and constant returns to scale for others. In either case, however, the unexplained residuals remained large for the majority of sectors.

Of the two adjustments, the K/L ratio accounted for the major increase in ratio efficiency and perhaps would be more effective in reducing the sizeable across-region differences in labor productivity than would increasing the scale of plants. This suggests that medium- and small-scale plants might play a more effective role in the North-east's economic development. Data and time limitations prevented any further analysis of this or other relevant issues.

ACKNOWLEDGEMENT

Many individuals have contributed to the completion of this dissertation. Special thanks go to Professor Donald Huddle, the chairman of the dissertation committee. His comments, suggestions and friendly criticisms, much improved the content and form of the dissertation as did those of Professor Gordon Smith. Professor Robert Dix's comments were also helpful.

I am also indebted to my friends at the Universidade Federal do Ceará, Brazil, for their helping hands and constant incentives, particularly Professors Hamilton Silva, Ricardo Regis Duarte, and Francisco Soares. Thanks also go to Professors Werner Baer of the University of Illinois, David Denslow, Jr. of the University of Florida and Peter Eaton of the University of Kansas. They were encouraging and kind in giving me help when needed. Professor Rogerio Sanson of the Universidade Federal de Pernambuco, Brazil, was generous in taking his time to send some needed material. Norma Maria Collares collected most of the data used in the dissertation. I must thank both for their help. Any shortcomings or errors, of course, are my own.

My Ph.D. program at Rice University would not have been possible without the financial support of the Universidade

Federal do Ceará, the United States Agency for International Development and the Coordenacão do Aperfeicoamento do Pessoal de Nivel Superior (CAPES).

Finally, to my wife, Odirene, I owe the greatest debt. Her patience, cooperation, and constant encouragement can never be overemphasized.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Most studies on labor productivity differences have involved international comparisons. Our interest, however, is centered on productivity differences in a regional framework. More specifically, we intend to investigate some of the reasons for the sizeable differences in labor productivity between the manufacturing sectors of the Northeast and the South of Brazil.

I.1 - Relevance of the Study

The serious problem of regional imbalances in Brazil[1] seems worse when the South[2] is compared to the Northeast. For example, the proportion of the Northeast's "per capita" income was 40.2 and 29.6 per cent of that of the whole of Brazil and the South, respectively, in 1970. More important is the fact that relatively low "per capita" income in the Northeast has been observed for decades. The seriousness of this problem has been for a long time the subject of country-wide discussion.[3] As a result, several steps have been taken, mainly by the Federal Government since the '50's, to reduce or avoid widening of the gap between the Northeast and the rest of the country. Among these, the most important ones have been the creation of BNB (Bank of Northeast of Brazil) and SUDENE (Superintendencia Regional de Desenvolvimento Economico do Nordeste). Both institutions have contributed to the industrialization drive that has been taking place in that region since 1962 under the well known fiscal incentives mechanism for regional industrialization.[4]

We were at first tempted to include in our study an evaluation of the results of these fiscal incentives, but did not because of the time that would be involved in such an investigation. The importance of the across-region differences in industrial labor productivity on the standard of living cannot be overemphasized, since in 1969 the share of the industrial product of the regional internal income was only 11.5 per cent. A higher Northeast industrial labor productivity is a relevant objective since: first, the Northeast's labor productivity is much lower than the South's; second, the region's share of industrial output has to increase if development is to take place.[5] A study of the Northeast's relative industrial productivity can contribute to the understanding of the region's economic problems.

1.2 - Productivity Differences and Objective of the Study

We found empirically that interregional differences in labor productivity in Brazil's manufacturing sector, mainly between the Northeast and the South regions, were substantial in 1970.

Data in Table I indicate that Northeast labor productivity was on the average only 49.3 per cent of the South's level. This percentage is lower for the Rubber, Pharmaceuticals, Cosmetics and Transportation sectors. On the other hand, a higher percentage is found for the Chemical, Non-Metallic and Clothing sectors.

A striking feature of the data in Table I, with minor exceptions, is that variation in relative productivity among sectors of the Northeast is not substantial. In fact, the estimated standard deviation was only 12.5 per cent, which indicates that a high (low) productivity sector in one region tends to be also a high (low) productivity sector in the other. Though the interregional differences in labor productivity between developed and underdeveloped countries (see column 4 of Table 1 for the discrepancy between Colombia's and the United States' labor productivity as estimated by R. R. Nelson)[6] are larger than those observed in Brazil, it is evident that the differences in the average labor productivity between the Northeast and the South are substantial.

Factors l·ke labor skill, management effort, market size, economies of scale, capital/labor ratio, etc., are among the most important in the current literature on labor productivity. For the Grupo de Trabalho para o Desenvolvimento do Nordeste (GTDN),[7] for example, low capital

TABLE I

LABOR PRODUCTIVITY, NORTHEAST AND COLOMBIA'S

RELATIVE LABOR PRODUCTIVITY

(CR $1.000,00)

Sectors	Labor Productivity (q) (1970)		(a)/(b)	Colombia's Relative Productivity (1) (1958)
	NE (a)	South (b)		
Non-Metallic	8.683	12.885	.674	.128
Metallurgy	9.576	18.019	.531	.146
Machinery	9.817	17.105	.574	.127
Electrical Material	10.526	20.824	.505	.211
Transportation Equipment	7.562	22.791	.332	.097
Lumber	4.878	8.714	.560	.158
Furniture	6.399	11.093	.577	.132
Paper and Cardboard	6.667	16.107	.414	.190
Rubber	7.993	28.461	.281	.232
Hides and Skins	5.490	13.212	.415	.254
Chemicals	31.942	43.959	.727	.170
Pharmaceuticals	14.147	52.277	.271	-
Cosmetics	18.984	49.982	.380	-
Plastics	9.897	18.024	.549	-
Textiles	6.658	11.559	.576	.365
Clothing and Footwear	5.923	8.473	.699	.162
Food	9.191	20.133	.456	.196
Beverages	9.829	20.319	.484	-
Tobacco	25.445	55.401	.459	.427
Printing	7.178	17.544	.409	.153
Miscellaneous	7.237	14.804	.489	-

Source: Industrial Census - 1970
(-) No data are available.
(1) See R. R. Nelson , <u>et al</u>., <u>op. cit</u>., pp. 116-119, Tables 22 and 23.

intensiveness, indirectly measured by the ratio of Horsepower to labor was the main reason for the low level of labor productivity in the Northeast manufacturing sector. Economies of scale, external economies, among other factors, were also considered important. In this study, however, we will restrict ourselves to the capital/labor ratio and economies of scale factors.[8]

We have decided on a broader coverage of industrial sectors (two digit level of aggregation) and their component branches (lower level of aggregation) subject to data availability in Brazil's Industrial Census. Thus, restrictions, i.e., the direction of our study to the particular question of the capital/labor ratio and the related problem of economies of scale, was coupled with a greater coverage in terms of industrial sectors and branches in both regions.

Previous studies have already laid down an appropriate technique for quantifying the hypothetical (or real) gain in labor productivity where either the capital/labor ratio, economies of scale, or both, are taken into account. The first and most famous study in this field was made by Arrow et al.,[9] followed by K. C. Clague[10] and R. Nelson,[11] among others. In the first, the United States labor productivity was compared to Japan; in the second, to Peru, and in the third, to Colombia. All these studies, like many others, have relied upon the specification of a C. E. S. production function assumed to be homogeneous of degree one and to be common for both countries in each study.[12]

The influence of the capital/labor ratio on labor productivity is, in general, taken to be an important explanatory variable. It is worth mentioning that, in the literature on economic development, much ink and thought have been spent on the important question of the appropriate choice of technology in the LDC's.[13] Generally, the argument is that the choice of capital-intensive technology is more appropriate, not only for increasing labor productivity in a static framework, but also in a dynamic setting where reinvestment of profits is considered a strategic variable for inducing rapid and sustained economic growth.[14] One should also not forget the importance of the capital/labor ratio in relation to labor productivity in the more general context of the neo-classical theory of production.[15] In this case, for a linear homogeneous production function, labor productivity can be expressed as a function of the capital/labor ratio. Differentials in labor productivity either across countries or regions, should, in fact, be explained by differences in capital/labor ratio. Jorgenson and Griliches[16] have already stated that if ". . . quantities of input are measured accurately, growth in total output is largely explained by growth in total input."[17] By the same token, the level of labor productivity as well as productivity differentials should also be wholly explainable by the capital/labor ratio if both inputs are measured accurately.

1.3 - Approach of the Study

The study will be descriptive in method and static in character. One point of time, 1970, is chosen since it is the most recent year for which complete data are available. Analytically, heavy use will be made of the neo-classical theory of production. In particular, output will be assumed to be produced with two inputs, capital and labor, and a common C. E. S. production function will also be assumed for both regions for a given industrial sector (henceforth named only sector). Thus, interregional differences in labor productivity will be explained by differences in capital/labor ratio.

The assumption of a C. E. S. production function, though more general than the Cobb-Douglas, is a limitation of the study. First, it is assumed, i.e., not empirically verified. Second, it constrains the elasticity of substitution to be constant along an isoquant. A more general production function, without this restriction would be more desirable. However, our data which include two observations for each sector and branch, preclude this approach. The deficiencies in the data are further limitations to bear in mind when interpreting the empirical results of this study.

Fortunately, the significance of these limitations on the quality of our empirical results about the role of factor proportions on productivity differentials can be determined by assuming alternative values of both capital/labor ratios and the elasticity of substitution. Obviously, the less sensitive the results to our alternative assumption, the more reliable will be our conclusion.

Once the factor proportion question has been examined, we analyze the importance of economies of scale on the across-region differences in labor productivity. This involves the estimation of the elasticity of labor productivity in relation to the average plant size and compares ours with independent estimates of the economies of scale parameters.

Chapter II discusses the technique for estimating both the elasticity of substitution and the efficiency parameter. These two estimates are essential in determining the role of factor proportions on productivity differentials. Chapter III discusses the coverage of our study in terms of industrial sectors and branches as well as the variables and definitions to be used. Chapter IV estimates both regions' capital stock. Chapter V discusses the South's relative capital cost, since no data on either capital stock or cost of capital are available in Brazil's 1970 industrial census. Both sets of estimates are necessary to estimate the elasticity of substitution and the efficiency parameter. Chapter VI presents and discusses data on regional average wage rates, factor prices and factor proportions. It examines whether factor combinations are consistent with the cost minimization hypothesis in Chapter II. Chapter VII estimates the elasticity of substitution, the efficiency parameter and the Northeast's relative efficiency. Also this chapter discusses the sensitivity of the results on the Northeast's relative efficiency for different assumptions of the elasticity of substitution and capital/labor ratios. Chapter VIII examines the effect of economies of scale on the Northeast's relative efficiency as well as the sensitivity of these results to alternative estimates of the economies of scale parameter. Finally, Chapter IX provides some concluding remarks about the empirical results and their relevance for the interpretation of the across-region differences in labor productivity.

FOOTNOTES FOR CHAPTER I

[1]For a brief analysis of regional imbalances in Brazil, between the North, Northeast and the Center-South of Brazil, see Roberto C. de Albuquerque and Clovis C. de Albuquerque, *Desenvolvimento Regional no Brasil* - (IPEA, serie estudos para planejamento, n. 6, Rio de Janeiro, 1976).

[2]It should be noted that in this study, the South-region is to be understood the South and the Southeast of Brazil as defined by FIBGE.

[3]The literature on the Northeast region and its backwardness is quite large. Here we will mention only a few. See for example "Uma Politica de Desenvolvimento Economico para o Nordeste." GTDN-(Grupo de Trabalho para o Desenvolvimento do Nordeste) in *Formacão Economica do Brasil - a experiencia da industrializacão*. Série ANPEC, Flavio R. Versiani and José R. M. de Barros: editors (Edicão Saraiva, São Paulo, 1977), pp. 293-338; Stefan H. Robock, *Brazil's Developing Northeast: A study of regional planning and foreign aid* (The Brookings Institution, Washington, D. C., 1963); C. Furtado, *Diagnosis of the Brazilian Crisis* (University of California Press, Berkley, 1965) among others.

[4]About the fiscal incentives see A. O. Hirschman, "Industrial Development in the Brazilian Northeast and the Tax Credit Scheme of Article 34-38," *The Journal of Development Studies*, vol. 5, no. 1, October 1968, pp. 5-28; David E. Goodman and others, "Fiscal Incentives for the Industrialization of the Northeast of Brazil and the Choices of Techniques," *Brazilian Economic Studies*, vol. 1, no. 1, 1975, pp. 201-226; David E. Goodman and Roberto C. de Albuquerque, *Incentivos á Industrializacão e Desenvolvimento do Nordeste* (IPEA, colecao relatorio de pesquisa no. 20, Rio de Janeiro, 1974) among others.

[5]The important influence of capital accumulation on economic development was neatly summarized by A. W. Lewis, "Economic Development with Unlimited Supply of Labor," in *Manchester School of Economics and Social Studies*, vol. 22, no. 2, May 1954, pp. 139-191. Note also that, an earlier study on the Northeast economy, had identified two basic reasons for that region's relative degree of backwardness: first, relative shortage of agricultural land; second, low level of capital accumulation. As such, growth of industrial

investment was set as the first target (out of four) to be achieved if the regional imbalance was to be reduced. See "Uma Politica de Desenvolvimento para o Nordeste," op cit., p. 299.

[6]Richard R. Nelson and others, Structural Change in a Developing Economy - Colombia's problems and prospects (Princeton University Press, New Jersey, 1971), pp. 116-119.

[7]See GTDN, op. cit., p. 301.

[8]For a treatment of the influence of market size and economies of scale as well as other factors, see, for example, Marvin Frankel, "Anglo-American Productivity Differences: Their Magnitude and Some Causes," in American Economic Review, vol. XLV, no. 2, May 1955, pp. 94-112. For the role of management effort see F. Harbison, "Entrepreneurial Organization as a Factor in Economic Development," Quarterly Journal of Economic, vol. LXX, no. 3, August 1956, pp. 364-379.

[9]K. Arrow et al., "Capital - Labor Substitution and Economic Efficiency," Review of Economic and Statistics, vol. XLIII, no. 3, August 1961, pp. 225-250.

[10]K. C. Clague, Economic Efficiency in Peru and United States, Unpublished PhD Dissertation (Harvard University, 1965), pp. 1-197.

[11]R. R. Nelson and others, op. cit., pp. 90-127.

[12]Hardin & Strassman have worked along the same line when comparing U. S. vs. Mexico labor productivity, but they have used a Cobb-Douglas specification of production function; see, Einar Hardin & W. P. Strassman, "La Productividad Industrial y la Intensidad de Capital de Mexico y los Estados-Unidos," El Trimestre Economico, vol. XXXV, no. 137, Jan./March 1968, pp. 51-62.

[13]For a fairly recent discussion of this question, see Lawrence J. White, "The Evidence on Appropriate Factor Proportions for Manufacturing in Less Developed Countries: A Survey," Economic Development and Cultural Change, vol. 27, no. 1, October 1978, pp. 27-60. Also for a brief review of a discussion of investment criteria see, Gerald Meir, Leading Issues in Economic Development: Studies in International Poverty 2nd. edition (Oxford University Press, New York, 1970), Ch. VI, section VI.B.

[14]Galenson and Liebenstein have an earlier paper stating that since the difference between the wage bill and the value added is bound to be greater in plants and/or industries utilizing capital intensive technology, the capital-labor ratio should be maximized. See W. Galenson and H. Liebenstein "Investment Criteria, Productivity and Economic Development," Quarterly Journal of Economic, vol. LXIX, no. 3, August 1955, pp. 343-370. Note also that not much different was Hirschman's hypothesis about the relation of labor productivity to process-oriented versus product-oriented industries. Here it stated that because of some technical characteristics of the process-oriented industries, like machine-paced operations, greater ease of coordination of labor effort, rigidly compelled sequences of operations etc., labor productivity would be higher in the process oriented-industries than in the product-oriented industries. A. O. Hirschman, The Strategy of Economic Development, 4th edition (Yale University Press, 1963), Ch. 8. Many authors have challenged the view that capital-labor ratio can be more important factor explaining labor productivity. See, for example, H. Liebenstein, "Allocative Efficiency vs. X-Efficiency," American Economic Review, vol. LVI, no. 3; June 1966, pp. 392-415; see also P. W. Strassman, Technological Change and Economic Development (Cornell University Press, Ithaca, 1968), Ch. 3, and R. R. Nelson and others, op. cit., pp. 103-127.

[15]In chapter II, the relation of labor productivity to capital-labor ratio will be made more clear.

[16]D. W. Jorgenson and Z. Griliches, "The Explanation of Productivity Change," Review of Economic Studies, vol. XXXIV, no. 3, July 1967, pp. 249-284.

[17]Ibid., op. cit., p. 249.

CHAPTER II

CONCEPT AND MEASUREMENT TECHNIQUES OF RELATIVE EFFICIENCY

II.1 - The Purpose of the Chapter

This chapter discusses the concept of relative efficiency, the theoretical techniques involved in its measurement and its relation to the elasticity of substitution. We will use two distinct, but inter-related levels: graphical and algebraic.

II.11 - The Concept of Relative Efficiency

Assuming that capital and labor are the only inputs in the production process, it is reasonable to say that one firm is more efficient than another if, by using the same factor proportions, it succeeds in producing a higher level of output per units of inputs. This concept would not change if 3 or more imputs were assumed, but the complexity of the model and its empirical testing would be increased.[1]

Consider a firm in two regions - The South and the Northeast, employing two factors - capital and labor - under conditions of constant returns to scale. Let isoquant SS on Diagram I represent the alternative combinations used to produce a unit of output in the South region. Alternatively, let the Northeast region be represented by the NN isoquant.

Let points A and B on the OS ray represent the two regions' actual factor combinations used to produce unit output. Assume also that in the South this unit output is produced efficiently. It is then clear that Northeast is less efficient than the South since it uses more of both

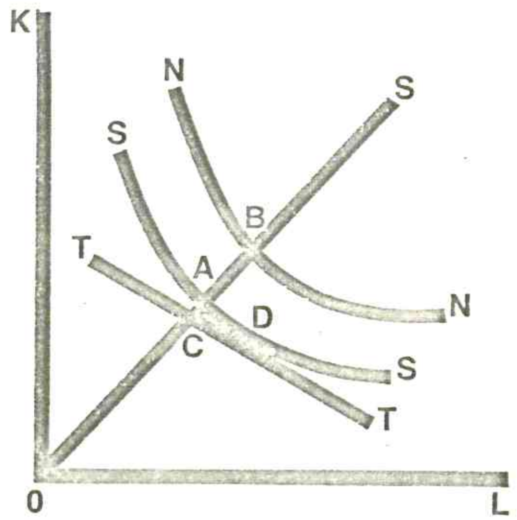


Diagram I

inputs - capital and labor - to produce that same unit of output. In the South, only a fraction OA/OB of both inputs is used. This ratio OA/OB is the measure of Northeast relative efficiency.

This measure of relative efficiency, as indicated by Farrel[2] and Yotopoulos and Nugent,[3] is a measure of technical efficiency since it measures only the ability of a given industry to produce the maximum level of output from a given level of input utilization. It does not say anything about the best (most efficient) level of input combinations.

Assume that the tangent at D,TT, in Diagram I, is the South industry isocost line, and that it intersects the OS ray at point C. In this case, the industry in the South, though technically efficient, is price inefficient. The ratio OC/OA measures the extent to which the South's industry is price inefficient,[4] and the ratio OC/OB measures Northeast relative economic efficiency.[5]

Unfortunately, in empirical studies it is seldom possible to distinguish these two types of "efficiency."[6] The measure or price efficiency is complex: first, it is difficult to identify equilibrium prices; second, the measure of price efficiency is sensitive to the slope of the isoquant at point D and its curvature from D to A. Finally, as indicated by O. Lange,[7] for less developed countries, it is often more desirable to increase production capacity than to worry about the subtlety of "high grade efficiency."[8] Technical efficiency, i.e., the success in producing the maximum with a given factor combination, can be more relevant to economic policy makers. In empirical studies, however, actual factor prices are typically assumed to be equilibrium prices. Thus, by assumption, the ratio OA/OB is a measure of economic efficiency. Deviations of actual prices from the assumed equilibrium conditions are not known. Since the available data on this question are inadequate, we must use more caution in the analysis of empirical results.[9]

An additional problem is that neither SS isoquant, NN isoquants nor Points D and B in Diagram I are known. The Northeast relative efficiency cannot be determined since points A and E (assumed to represent each region actual factor combination) in Diagram I are not strictly comparable. Fortunately, by specifying a neo-classical production function assumed to be identical, except for the efficiency parameter, for each industry in both regions, both isoquants NN and SS and the Northeast relative efficiency can be determined.

For purpose of exposition, assume a linear, homogeneous production function of the general form

$Y = f(K,L)$ (1) such that $\frac{\partial Y}{\partial K}, \frac{\partial Y}{\partial L} > 0$, $\frac{\partial^2 Y}{\partial L^2}$ $\frac{\partial^2 Y}{\partial K^2} < 0$

and $\frac{\partial^2 Y}{\partial K\,\partial L} > 0$.[10]

Since (1) is homogeneous of degree one, it can be written as $Y/L = f(K/L)$ or, in a more concise form, $q = f(k)$, $f' > 0$ and $f'' < 0$. The functional relation between q and k is graphically shown in Diagram II.

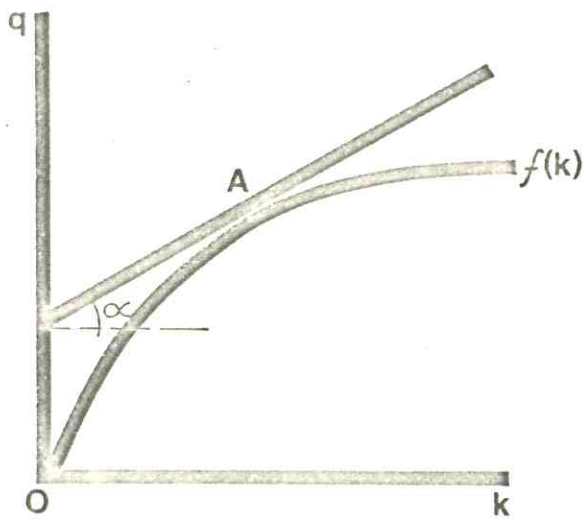


Diagram II

Observation on any ordered pair, say (qo, ko), identifies a point on the function (point A). The slope of a tangent to that point (tg α) is equal to the rate of return on capital, since the model implies that r = f'(k) where r and f'(k) are the rate of return on capital and the marginal productivity of capital, respectively. So, observation on the rate of return on capital enables us to identify the slope and the elasticity of the function at point A.[11] This information, also enables us to estimate the effect on output per worker as we change the capital/labor ratio for small changes in (k) (see Diagram II). For large changes we cannot base our estimate on labor productivity changes on only r_o. The linear extrapolation will not give reliable results since, as the capital/labor ratio increases, the concavity of

$f(k)$ may change significantly. Thus, we need some information on the concavity of the function, i.e., on the rate of diminishing returns which determines the degree of gain or loss in efficiency as the Northeast increases its capital/labor ratio. The rate of diminishing returns may be determined by the elasticity of substitution of capital for labor since from (1) it can be shown that

$$\sigma = -\frac{f'(k)[f(k) - kf'(k)]}{kf(k)f''(k)} \quad (2)$$

Thus $f''(k) = -\frac{f'(k)[f(k) - kf'(k)]}{kf(k)\sigma}$ (3) which indicates that concavity of $f(k)$ is a function of σ, k and $f'(k)$. We know that the expression in brackets in equation (3) is positive, so $f''(k)$ is negative as it should be from the assumption on the shape of the production function. Now we investigate how the concavity of the function changes as the elasticity changes. Taking the derivative of $f''(k)$ in relation to σ we find that $\frac{df''(k)}{d\sigma} > 0$, i.e., as the elasticity of substitution increases, the concavity of the function diminishes, i.e., the rate of diminishing returns decreases. This relation between σ and the rate of diminishing returns can be seen more clearly through analysis of the variation in the elasticity of the function as the capital/labor ratio changes. Taking the derivative of S_{K0} in relation to the capital/labor ratio we obtain:

(4) $$\frac{dS_K}{d(K/L)} = \left(\frac{f_K}{f_L}\frac{K}{L}\right)\frac{dS_K}{d_K} + \frac{f_K}{f_K}(1 - S_K) + (1 - S_K)K/L$$

$$\left(\frac{df_K/f_L}{d_K}\right)$$

Thus

(4.a) $$\frac{dS_K}{d(K/L)} + \left(\frac{f_K}{f_L}\frac{K}{L}\right)\frac{dS_K}{d(K/L)} = \frac{f_K}{f_L}(1 - S_K)K/L$$

$$\frac{d(f_K/f_L)}{d(K/L)}$$

but

$$\frac{f_K}{f_L} - K/L = \frac{S_K}{1-S_K} = \frac{f_K}{f_L}$$

then

(4.b) $$\frac{dS_K}{d(K/L)}\frac{S_K}{1-S_K} + 1 = \frac{f_K}{f_L}(1 - S_K) + (1 - S_K)K/L\frac{d(f_K/f_L)}{d(K/L)}$$

but $\frac{S_K}{1-S_K} + 1 = \frac{1}{1-S_K}$ then substituting in (4.b)

$$\frac{dS_K}{d(K/L)}\frac{1}{1-S_K} = \frac{f_K}{f_L}(1 - S_K) + (1 - S_K)K/L\frac{d(f_K/f_L)}{d(K/L)}$$

Let's take $(1 - S_K)K/L\frac{d(f_K/f_L)}{d(K/L)}$

then multiplying and dividing by f_K/f_L we get

$$(1 - S_K)\ \frac{f_K}{f_L}\ \left(\frac{K/L}{f_K/f_L}\right)\ \frac{d(f_K/f_L)}{d(k/L)} = (1 - S_K)\ \frac{f_K}{f_L}\ (-1/\sigma)$$

then

$$\text{(4.c)}\qquad \frac{dS_K}{d(k/L)}\ \frac{1}{1 - S_K} = \left[\frac{f_K}{f_L}\ (1 - S_K)\right]\ (1 - 1/\sigma)$$

which after some algebraic manipulation becomes[12]

$$\text{(5)}\qquad \frac{dS_K}{d(K/L)} = S_K(1 - S_K)\left(\frac{\sigma - 1}{\sigma}\right)L/K$$

finally

$$\text{(6)}\qquad \frac{d\log S_K}{d\log_{(K/L)}} = (1 - S_K)\left(\frac{\sigma - 1}{\sigma}\right)$$

i.e., the elasticity of the capital share of value added in relation to the capital/labor ratio is a function of the elasticity of substitution. Since the capital share of value added identifies the elasticity of the function with respect to K/L at that point, we know from equation (6) that as K/L increases, the elasticity of the function decreases, as does the rate of diminishing returns.

Assuming that the elasticity of substitution is constant along a given isoquant, then, if we know a point in the f(k) curve, the slope at that point, and the elasticity of substitution, the related isoquant can be specified. Conversely, if the capital/labor ratios and relative factor prices in the South and Northeast are known and a given production function is specified the regional isoquants can be drawn. Finally, assuming also that the specified form of the production function is common to both regions, both isoquants can be compared and Northeast relative efficiency determined.

II.3 - Northeast Relative Efficiency

Let the rays OS and ON in Diagram III represent capital/labor ratios in the South and Northeast, respectively. Point A represents Northeast's unit output (Y_n) associated with the level of labor (L_1) and capital (K_1). Similarly, point C stands for the South's unit output (Y_2) where (K_2) and (L_2) are that region's level of inputs utilization.

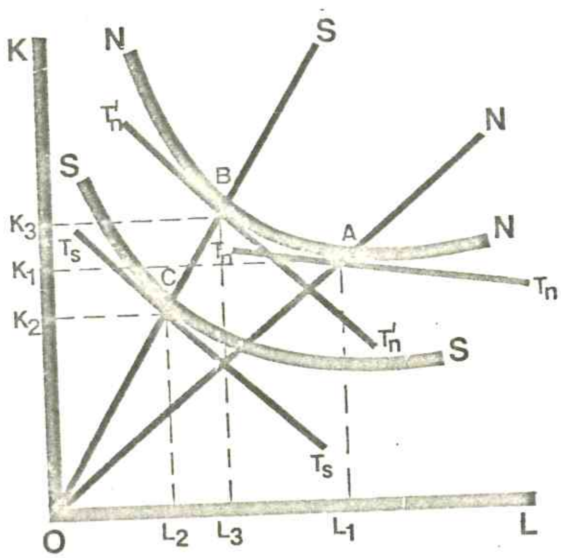


Diagram III

From empirical data we can estimate regional labor productivity. Northeast relative labor productivity is given by the ratio of the South to the Northeast level of employment (L_2/L_1). To the extent that L_2 is different from L_1, regional labor productivity will not be equal. By hypothesis, the higher the capital/labor ratio, the higher the labor productivity. Thus, if the observed differences in regional capital/labor ratios are reduced, the across region differences in labor productivity should also be reduced.

The importance of the capital/labor ratio in explaining regional differences in labor productivity can be seen if we hypothetically increase Northeast capital/labor ratio to the South's level. Graphically, this can be visualized by drawing an isoquant from point A, which will intersect the OS ray at point B. (Such derivation presents no problem once a production function has been specified.) Consider now the downward sloping lines T_sT_s and T_nT_n, tangents at points C and A, respectively, which represent the relative input prices in both regions. Their tangency at points C and A assumes that entrepreneurs are cost minimizers; i.e., each region factor combination is optimal for that region's factor prices. Under the cost minimization assumption it follows that the line $T_n^{'}T_n^{'}$ must be parallel to T_sT_s, i.e., as the Northeast region moves from A to B, it changes its relative input combinations since it faces different factor prices.

At point B Northeast unit output is produced with the hypothetical level of labor (L_3) and capital (K_3). That region's hypothetical labor productivity is given by (Y_n/L_3), and the ratio L_2/L_3 is the measure of Northeast relative efficiency which is equal to the ratio OB/OC. Point B represents the capital/labor ratio required to produce unit output with the South's factor proportion and the Northeast level of efficiency.

It can be shown that Northeast relative efficiency is equal to the product of the hypothetical to the actual Northeast relative labor productivity, i.e., $L_2/L_3 = (L_1/L_3)\ (L_2/L_1)$.

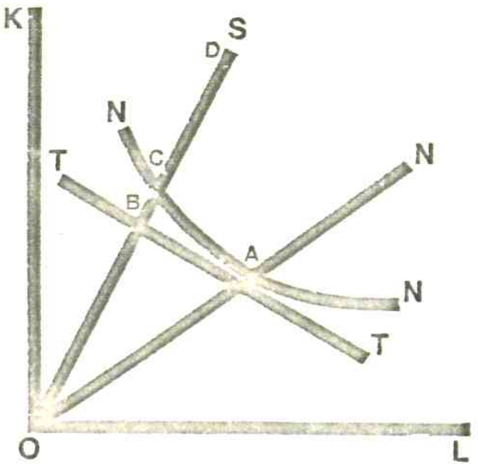
This equality shows that if (L_1/L_3) equals unity then $L_2/L_3 = L_2/L_1$, i.e., no gain in Northeast relative efficiency is observed as that region increases its capital/labor ratio. For any value of L_1/L_3 except one, Northeast relative efficiency will differ from relative productivity. More specifically, if that ratio is greater than one, relative efficiency would increase as movement along isoquant NN takes place from A to B. The reverse would be true if the ratio L_1/L_3 is less than one.

II.4 - The Elasticity of Substitution and Relative Efficiency

Hypothetical labor productivity will be equal to, greater or less than unity depending upon whether L_3 is equal to, greater or less than L_1. The movement from L_1 to L_3 in Diagram III obviously implies a substitution of capital for labor. The ease or difficulty in which this substitution takes place is directly related to the magnitude of the elasticity of substitution (σ) which is assumed to be constant along a given isoquant. The greater this elasticity, the greater will be the reduction in Northeast level of employment, and so the greater will be the gain in Northeast labor productivity as that region increases its capital/labor ratio.

As has been proved elsehwere,[13] the elasticity of substitution has a range of variation (from o to ∞). In Diagram IV, this range is graphically shown. There we can see that if $\sigma = 0$, there will be no factor substitution as

Diagram IV



a movement from A to D takes place. In this case, there will be no gain in labor productivity or in relative efficiency.[14] The opposite occurs if $\sigma = \infty$.

This range of variation of σ enables us to deduce the upper and lower limits of the hypothetical level of employment L_3 (see Diagram III) as capital is substituted for labor. If $\sigma = 0$, the level of hypothetical employment L_3 will coincide with the level of actual employment (L_1) in the Northeast. Thus, at D, we have the lower limit of factor substitution. Similarly, at B we have the upper limit. In this case, the specific point of intersection of the straight line isoquant with the OS ray depends on the relative factor prices prevailing in the Northeast, since relative factor productivities do not change along segment AB. More specifically, if $\sigma = \infty$, the slope of the Northeast isoquant will be equal to the slope of TT (see Diagram IV) which is equal to relative factor prices. Thus, the specific locus of point B in Diagram IV will depend on the relative factor prices prevailing in the Northeast. Point B theoretically could lie either to the left or to the right of point A on Diagram I, or just on it. Obviously, the location of the intersection point between the Northeast isoquant and the OS ray is relevant since this point will correspond to a specific level of hypothetical employment L_3.

This is not surprising, since, as we know, the gain (loss) in efficiency will depend upon the rate of diminishing returns, i.e., the degree of convexity of the isoquant. The rate can be measured by the elasticity of substitution of capital for labor which determines how the convexity of the isoquant changes as the capital/labor ratio changes. The greater the rate of diminishing returns, i.e., the lower the elasticity of substitution, the less will be the gain in efficiency for the Northeast as it moves from point A to B in Diagram III.[15] Thus, it is important to know the magnitude of σ in order to avoid bias in the empirical estimation of relative efficiency. The procedures for estimating σ and Northeast relative efficiency are discussed below.

II.5 - Relative Efficiency: an Algebraic Treatment

As indicated in section II.2, specification of a production function is a required step if we want to know what the Northeast capital/labor ratio will be at point B on Diagram III.

Two point observations (Northeast and South) for each industry restrict the form of production function. Thus, in choosing between the more general variable elasticity of substitution and the constant elasticity types of production function, we select the second.

This choice poses two limitations. The first is the fact that the CES production function, though allowing the elasticity to differ from unity requires it to be constant along a given isoquant, meaning that the elasticity of substitution, σ is invariant to changes in the capital/labor ratio. In other words, it restricts σ to change only in response to changes in technology. If, in fact, σ varies with changes in factor proportions, then the role of technical change is being overstated as indicated by Brown.[16]

This restriction would be avoided if a more general production function were used. However, data availability prevented this, and a more general production function would impose restrictions of its own which would not satisfy neoclassical criteria and have ". . . asymptotes which are difficult to measure."[17]

The second restriction is the necessary assumption under the CES framework that factor proportions are independent of plant size.[18] This assumption ensures that we will be working with a homothetic production function and both isoquants SS and NN in Diagram V will be parallel to each other. This means that from any given ray, say OS, from the origin the slopes of both isoquants will be equal. Thus, tangents T_sT_s and T_nT_n are parallel to each other.

The assumption--homotheticity--has been the object of wide criticism, since factor proportions, both from a theoretical and empirical point of view, are expected to be positively associated with plant size. In other words, it is expected that the larger the plant size, the greater will be the capital/labor ratio. Though this association may exist, its significance is yet to be empirically determined.[19]

Lack of data on capital per establishment and per size group prevented an empirical test of this issue.

The CES production function is written in the form:

$$Y = A[(1-d)L^{-c} + dK^{-c}]^{-1/c} \qquad (1)$$

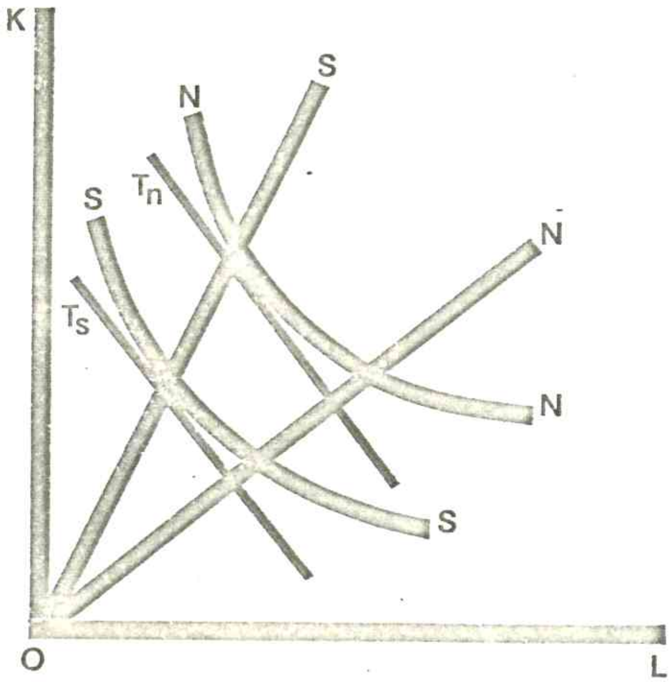


Diagram V

where Y = output

K = capital

L = labor

A = efficiency parameter

d = the distribution parameter

c = the substitution parameter

Following previous works in this field[20] we assume that both regions production functions are, except for the efficiency parameter A, identical. In other words, technological progress is neutral; i.e., it affects both capital and labor equally. This assumption is debatable, but data problems rule out any empirical evidence in its support.[21]

From equation (1) it can be shown that the marginal rate of technical substitution (MRTS) is equal to $\frac{w}{r} = (\frac{1-d}{d})(K/L)^{1+c}$ (2) where r and w stand for the price of capital and labor respectively. Multiplying both sides of equation (2) by L/K we get $\frac{wL}{rK} = (\frac{1-d}{d})(K/L)^{c}$ (3) which shows the relative factor share to be a function of d and the capital/labor ratio.

From (2) we can also see that

$k = K/L = [\frac{w}{r}\ (\frac{d}{1-d})]^{\sigma}$ (4) where $\sigma = \frac{1}{1-c}$. Data on K for both regions would permit expressing the relative factor intensities by $\frac{k_1}{k_2} = [\frac{(w/r)_1}{(w/r)_2}]^{\sigma}$ (5) where the subscripts 1 and 2 here and henceforth represent Northeast and South regions, respectively.

From equation (5) we can estimate σ.[22] Through equations (3) and (4) we can alternatively estimate d.[23] In each case the estimates are independent of the efficiency parameter A, i.e., both d and σ do not change as the efficiency parameter varies between regions.

The independence of d in relation to the efficiency parameter has the very convenient property of being estimated through data referring to either region. This property is a logical conclusion from the homotheticity assumption which implies that both c and d are constant between regions for a given industry. Conversely, the empirical values of d_1 and d_2, where 1 and 2 refer to Northeast and South respectively, provide a test on the neutrality assumption of the C. E. S.

Once d and σ are estimated the efficiency parameter can be determined. Let $Y_1 = A_1[(1-d)L_1^{-c} + dK_1^{-c}]^{-1/c}$ (1.a) and $Y2 = A_2[(1-d)L_2^{-c} + dK_2^{-c}]^{-1/c}$ (1.b) which stand for the regional production functions.[24] Relative efficiency can be estimated by the ratio A_1/A_2 since by assumption $Y_1 = Y_2$. However, drawing upon our previous graphical analysis,

$$Y3 = A_3[(1-d)L_3^{-c} + dK_3^{-c}]^{-1/c}$$

stand for the hypothetical level output at point C in Diagram I.

Obviously $Y_1 = Y_3$ and by assumption $A_1 = A_3$, thus

$$[(1-d)L_1^{-c} + dK_1^{-c}]^{-1/c} = [(1-d)L_3^{-c} + dK_3^{-c}]^{-1/c} \quad (6)$$

Dividing and multiplying the left and right hand side of (6) by L_1 and L_3 respectively, we get

$$L_1[(1-d) + dk_1^{-c}]^{-1/c} = L_3[(1-d) + dk_3^{-c}]^{-1/c}$$

Also by assumption $Y_2 = Y_1$. Then, $Y_2 = Y_3$. More important yet, at A and C in Diagram III, $k_3 = k_2$. Replacing k_2 for k_3 in the above equality

$$L_1[(1-d) + dk_1^{-c}]^{-1/c} = L_3[(1-d) + dk_2^{-c}]^{-1/c}$$

It then follows that $J = L_1/L_3 = [\frac{(1-d) + dk_2^{-c}}{(1-d) + dk_1^{-c}}]^{-1/c}$ (7)

where J is the correction factor for the across region differences in the capital/labor ratio. In other words, J is equal to one plus the percentage change in Northeast average labor productivity as that region moves from A to B in Diagram III. Also, it can be shown that Northeast relative efficiency is equal to the product of J to the Northeast relative productivity, i.e., $L_2/L_3 = (L_2/L_1)J$.

Equation (7) contains only known terms. Hence J can be estimated and so can be the hypothetical level of employment L_3. It remains to be shown that A_1/A_2 is equal to L_2/L_3.

We already know that $Y_2 = Y_3$ then:

$$A_2[(1-d) + dk_2^{-c}]^{-1/c} L_2 = A_3[(1-d) + dk_3^{-c}]^{-1/c} L_3$$

By assumption $A_1 = A_3$ then

$$A_2[(1-d) + dk_2^{-c}]^{-1/c} L_2 = A_1[(1-d) + dk_3^{-c}]^{-1/c} L_3$$

As already shown, $k_3 = k_2$ then

$$[(1-d) + dk_2^{-c}]^{-1/c} = [(1-d) + dk_3^{-c}]^{-1/c}$$

Thus it follows that $A_2L_2 = A_1L_3$ and $A_1/A_2 = L_2/L_3$.

Let us now determine the range of variation of J within the range of σ. First assume $\sigma = 0$. Then c approaches ∞, since $\sigma = 1/1+c$. Substituting this value of c in equation (7)

$$L_1/L_3 = J = [\frac{(1-d) + d}{(1-d) + d}] = 1 \quad (7.a)$$

in other words, $L_1 = L_3$ as we have discussed before.

Assume now that $\sigma = \infty$. Here, $c = -1$. Again, substituting this value of c in (7) we get

$$L_1/L_3 = J = [\frac{(1-d) + dk_2}{(1-d) + dk_1}] \quad (7.b)$$

Thus the gain in Northeast relative efficiency will be mainly determined by the across regions differences in capital/labor ratios.[25]

We have explored Northeast relative efficiency by assuming that the Northeast capital/labor ratio is increased to the South's level. An interesting alternative question relates to the reduction of the South's level to the Northeast level, i.e., instead of deriving an isoquant for the Northeast we derive one for the South passing through points C and D. See Diagram VI.

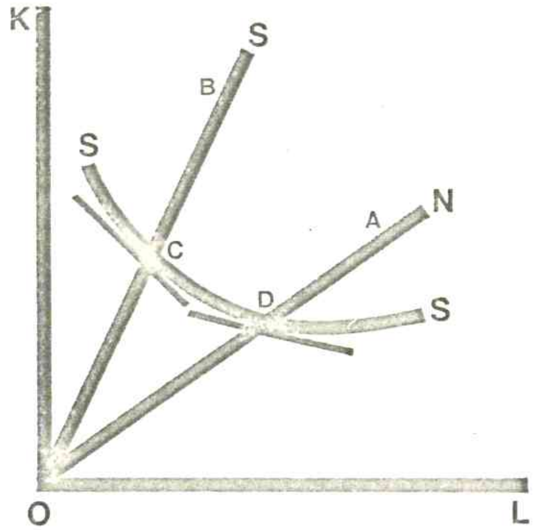


Diagram VI

Our results will not change since the CES has the symmetry property. The symmetry property states that the empirical results for Northeast relative efficiency do not change if either the capital/labor ratio is decreased from C to D or if it is increased from A to B in Diagram VI.

Algebraically this can be shown as follows. We know that

$$Y_2 = A_2[(1-d) + k_2^{-c}]^{-1/c} L_2 \text{ and } Y_4 = A_4[(1-d) + k^{-c}]^{-1/c} L_4$$

and since Y_2 and Y_4 (South's unit output at D) are on the same isoquant then

$$A_2[(1-d) + dk_2^{-c}]^{-1/c} L_2 = A_4[(1-d) + dk_4^{-c}]^{-1/c} L_4$$

which can still be further simplified into

$$[(1-d) + dk_2^{-c}]^{-1/c} L_2 = [(1-d) + dk_1^{-c}]^{-1/c} L_4 \text{ since}$$

$A_2 = A_4$ and $k_4 = k_1$. Then

$$L_4/L_2 = \left[\frac{(1-d) + dk_2^{-c}}{(1-d) + dk_1^{-c}}\right]^{-1/c} = J$$

The Northeast relative efficiency is given by

$$L_4/L_1 = (L_4/L_2)(L_2/L_1) = (L_2/L_1)\ J = L_2/L_3.$$

FOOTNOTES TO CHAPTER II

[1]For a generalization of this concept of relative efficiency see M. J. Farrel, "The Measurement of Productive Efficiency," in Journal of the Royal Statistical Society, Series A (General), Part III, vol. 120, 1957, pp. 256-258.

[2]M. J. Farrel, op. cit., p. 254.

[3]Pan A. Yotopoulos and Jeffrey B. Nugent, Economic of Development -- Empirical Investigations (New York, Harper and Row, 1976), ch. 5, pp. 72-73.

[4]Note that the unit cost at C is lower than at A.

[5]This ratio is equal to the product of the technical to the price efficiency, i.e., $OC/OB = (OA/OB)(OC/OA)$. Farrell denominated this ratio as the overall efficiency. M. J. Farrel, op. cit., p. 255.

[6]Studies for the agricultural sector have attempted to distinguish these two "efficiencies." See for example, L. J. Lau and P. A. Yotopoulos, "A Test of Relative Efficiency and Application to Indian Agriculture," American Economic Review, vol. LIX, n. 1, March 1971, pp. 94-108.

[7]Oskar Lange, in Gerald Meir (2nd edition) Leading Issues in Economic Development, op. cit., ch. X, sec. X.B.2.

[8]Ibid., p. 699. J. S. Farrel, also argued that price efficiency is not necessarily desirable because a firm's best policy can be to operate at a higher than the optimum level of production or because input prices can be adjusted to past and future prices. M. J. Farrel, op. cit., p. 260-261.

[9]Griliches and Ringstaad have argued that the assumption of perfect competition need not seriously affect the validity of the empirical results based upon them. Z. Griliches and V. Ringstaad, Economies of Scale and the Form of the Production Function (North-Holland Publishing Co., Amsterdam, 1971), p. 11.

[10]Here we closely follow the discussion developed by Richard R. Nelson and others, Structural Change in a Developing Economy--Colombia's Problems and Prospects (Princeton

University Press, New Jersey, 1971), pp. 91-102.

[11] Note that observation on the capital share on output (s_k) also enables us to identify the slope and the elasticity of the function since:

$$S_K = \frac{f'(k)k}{f(k)}$$

[12] Note that

$$\frac{f_K}{f_L}(1-S_K) = \frac{f_K}{f_L}\left(\frac{f_K K + f_L L}{Q} - \frac{f_K K}{Q}\right)$$

$$= \frac{f_K}{f_L}\left[\frac{f_K K}{Q} + \frac{f_L L}{Q} - \frac{f_K K}{Q}\right]$$

Then

$$\frac{f_K}{f_L}(1-S_K) = \frac{f_K}{f_L}\,\frac{f_L L}{Q} = \frac{f_K L}{Q} = \frac{L}{K}\,\frac{K f_K}{Q} = L/K\ SK$$

Finally

$$\frac{dS_K}{dK/L}\left(\frac{1}{1-S_K}\right) = L/K\ S_K\left(\frac{\sigma-1}{\sigma}\right)$$

and

$$\frac{dS_K}{dK/L} = (1-S_K)\ L/K\ S_K\left(\frac{\sigma-1}{\sigma}\right)$$

equation (5) in the text follows immediately. For this proof, I am indebted to Professor Ricardo R. S. Dúarte of Universidade Federal do Ceará.

[13]See K. J. Arrow, et. al., "Capital-Labor Substitution and Economic Efficiency," Review of Economic and Statistics, vol. XLIII, n. 3, August 1961, pp. 225-250.

[14]More specifically, since $L_2/L_3 = (L_1/L_3)(L_2/L_1)$, then $L_2/L_3 = L_2/L_1$, i.e., labor productivity remains unchanged. From another point of view, we see that since as capital increases, output and labor inputs remain unchanged, obviously labor productivity will not change either.

[15]"Perhaps the easiest way to rationalize this intuitively is to recall that the more easily substitutable are factors for each other, the more similar they are from an economic point of view. If σ is low, then the factors are dissimilar. This implies that when σ is low, diminishing returns to labor set in more rapidly for an increase in R than when σ is at higher level." See Murray Brown, On the Theory and Measurement of Technological Change (Cambridge University Press, Cambridge, England, 1966), p. 48.

[16]About this point and the related question of the constancy of σ, Brown has stated that ". . . this is an a priori specification, we really do not know whether the elasticity should vary when factor proportions change. If the true structure prescribes a variable elasticity due to changes in factor proportions and we claim that the elasticity is changing for technological reasons, then we are ascribing to technological change more than is due to it." See M. Brown, op. cit., p. 60.

[17]See Murray Brown, op. cit., p. 60.

[18]The question of plant size, its definition and measurement will be discussed in Ch. VIII.

[19]It should be noted that if there is a significant positive association between average plant size and capital/labor ratio, this association is not necessarily common for all sectors and branches. V. Walmsley, for example, observed that when size class was associated with horse-power per worker, for only half of Brazil's industrial sectors a significant association was found. His study was based on 1959 industrial census. See Vernon T. Walmsley, Os determinantes da Produtividade Média do Trabalho, na Industria de Transformacão do Brasil, unpublished Master's Thesis, Universidade Federal dé Pernambuco Recife, 1975, pp. 1-65. On the other hand, two alternative studies for India's manufacturing sector have produced conflicting

evidence on this issue. See J. C. Sandesara, "Scale and Technology in India Industry," Bulletin--Oxford University Institute of Economics and Statistics, vol. 28, n. 3, August 1966, pp. 181-198; and B. V. Mehta, "Size and Capital Intensity in India Industry," Ibid., vol. 31, n. 3, August 1969, pp. 189-204. Also data on capital/labor ratio per size group for the Norwegian manufacturing sector indicate that, for most of the sectors, that ratio is quite stable for the different size groups. See Griliches and Ringstaad, op. cit., p. 42.

[20]See Arrow, et. al., op. cit., and Christopher K. Clague, Economic Efficiency in Peru and the United States, unpublished Ph.D. Dissertation (Harvard University, 1965), pp. 1-197.

[21]In Chapter VII, sec. VII.1, we return to this question.

[22]Estimation of σ through equation (5) was previously made by I. Kravis, "Relative Income Shares in Fact and Theory," American Economic Review, vol. XLIX, n. 5, December 1959, pp. 917-949. Later it was used by Arrow, et al., op. cit., C. K. Clague, op. cit. and John Kendrick, in his comments on R. M. Solow's paper, "Capital, Labor and Income in Manufacturing," The Behavior of Income Shares (National Bureau of Economic Research--NBER, Princeton University Press, Princeton, 1964), vol. 27, pp. 140-142.

[23]Equation (4) is more frequently used in empirical studies. The d value is very sensitive to the measure of the variables, since d is not invariant to the units on which the variables on equation (3) and (4) are measured. However, equation (3) had the very convenient property of being estimated through factor shares and not relative factor prices as in (4). This property, it seems to us, makes the estimation through equation (3) more reliable.

[24]For a similar algebraic treatment see K. C. Clague, op. cit., pp. 6-11.

[25]In Chapter VII.4 we return to this question.

CHAPTER III

EMPIRICAL PROCEDURES AND PROBLEMS

III.1 - Introduction

The inadequacy of available data will be one of the main factors limiting the robustness of the empirical results of this dissertation. From the outset, then, it is important to understand the types of data used, their sources and some of their limitations. In this chapter we begin with a discussion of the data coverage by states and regions and by industrial sectors and branches. Next we examine some of the variables and definitions to be used in this study. Finally, the question of the measurement of capital is briefly treated.

III.2 - Coverage of the Study

Brazil's Industrial Census publishes data for: a) the total of all establishments in the manufacturing sector; b) the set of those establishments with 5 or more employees and/or value of production greater than 640 times the highest minimum wage in 1970; c) the complement of set b or b + c = a.

In (a) and, to a lesser extent, in (c) the available information is rather meager. Set (c) does not have information on horse-power, size groups or other relevant data. Thus, the aggregation of (b) to (c) is not feasible for some information we need. Consequently, we have chosen to work with set (b) since it has both information on size-group by sector and good coverage of total production and employment in the manufacturing sector.[1]

Within set (b), figures for levels of aggregation lower than the two digit-level are limited to wages, output, and number of workers and the distribution of these variables by size-class is not available. More important, figures on industrial branches (lower than the two digit level) are not complete for every state. For some branches in some states no production occurs. For others the number of establishments is so small that, to avoid possible revelation of information on particular individual establishments, no production figures are published.[2] Thus, for some branches, information on a state level is unobtainable. Since data on the manufacturing sector is available only at the state and national level, a list of those branches having the necessary information for all states in both regions is needed.

Our procedure was to select all industrial branches with complete information for all states, because we want to test our hypothesis at less than the two-digit level, so that the sensitivity of σ and J to changes in the level of aggregation can be seen.[3] Our first attempt involved the selection of five states in each region.[4] This proved too restrictive since a large number of industrial branches had to be excluded because of lack of adequate data. A second alternative selected only three states for each region: São Paulo, Minas Gerais, and Rio Grande do Sul in the South and Ceará, Pernambuco, and Bahia in the Northeast. This proved better, since it allowed the inclusion of a larger number of industrial branches, increasing our coverage of industrial activities. Moreover, by increasing the number of industrial branches, we also managed to increase the number of industrial sectors that could be studied at a finer level of aggregation.[5] Matching industrial branches by state level also ensures a greater degree of homogeneity in industrial sectors and in final products between both regions. Finally, the chosen states represent the most advanced ones in both regions,[6] particularly the Northeast. Here, the industrialization drive that took place in the sixties as a result of the "34/18" fiscal incentives mechanism is concentrated heavily in the three states chosen.[7] SUDENE's data indicate that 70 per cent of the total number of projects and 73 per cent of total investments are concentrated in Ceará, Pernambuco, and Bahia. Though there are no data on projects and investments by industrial sector and state, the last columns of Table I confirm the importance of these states and of the selected classifications.

TABLE I

DISTRIBUTION OF THE TOTAL NUMBER OF PROJECTS AND TOTAL INVESTMENT

States	Total no. of projects	Investment %	Distribution of Total Investment (%)			
			Capital goods	Inter-mediary goods	Durable consump. goods	Other consump. goods
Maranhão	10	1.9	--	2.5	--	1.4
Piaui	11	0.7	--	0.4	--	1.1
Ceará	92	8.2	10.5	4.5	16.1	13.9
R. G. do Norte	32	5.3	--	3.5	0.1	13.2
Paraiba	65	7.4	6.8	7.0	5.6	9.3
Pernambuco	192	32.4	27.4	28.0	57.9	33.6
Alagoas	21	5.8	16.0	7.8	0.9	1.0
Sergipe	12	1.6	--	0.9	--	4.3
Bahia	124	32.7	35.5	41.6	18.6	16.0
Minas Gerais	22	4.0	3.8	3.7	0.8	6.2
TOTAL	581	100	100	100	100	100

Source: David E. Goodman and Roberto C. de Albuquerque (Incentivos à Industrialização e Desenvolvimento do Nordeste - (IPEA, Colecão relatórios de Pesquisa - n. 20, Rio de Janeiro, 1974), Tabelas IX.27 IX.28 - pp. 283-284.

One serious question we must ask is: to what extent does the choice of these states, leaving out others, deprive our analysis of its "regional" aspect? Fortunately, not significantly, as Table II shows.

Table II shows the relative weights of the selected states in total regional number of establishments and labor, and in output and wage bill for both regions. First, the relative weights of the selected states for both regions are generally high. For only Lumber, Furniture (output variable) and Hides and Skin (labor variable) are the weights lower than 60 per cent. In the Northeast this occurs in the Hides and Skins and Food sectors when the number of establishments is considered. Second, the relative weights tend to be higher in the Northeast (above 80 per cent for most sectors) than in the South (above 70 per cent).[8] For both regions, these weights are generally higher for output and labor than for establishment and wage bill.

The relatively high weights for both regions and for most of the sectors, whatever the variable, indicate that the procedure we have followed maintains the intended regional character of our study.

TABLE II

RELATIVE WEIGHT OF THE SELECTED STATES ON THE TOTAL REGIONAL

ESTABLISHMENTS, OUTPUT, LABOR AND WAGES (1970)

Sectors	NORTHEAST				SOUTH			
	E 1	Y 2	L 3	W 4	E 1	Y 2	L 3	W 4
Non-Metallic	0.65	0.82	0.75	0.85	0.70	0.76	0.71	0.74
Metallurgy	0.79	0.83	0.81	0.83	0.78	0.79	0.82	0.82
Machinery	0.77	0.92	0.87	0.98	0.78	0.82	0.79	0.80
Electrical Material	0.95	1.00	0.99	0.99	0.80	0.87	0.82	0.83
Transportation Equipment	0.78	0.94	0.91	0.96	0.74	0.87	0.83	0.86
Lumber*	0.65	0.80	0.76	0.86	0.65	0.67	0.66	0.69
Furniture	0.70	0.87	0.80	0.87	0.66	0.56	0.60	0.71
Paper and Cardboard	0.80	0.88	0.92	0.92	0.70	0.73	0.67	0.73
Rubber	0.76	0.83	0.83	0.87	0.74	0.92	0.88	0.91
Hides and Skins	0.57	0.60	0.63	0.64	0.86	0.73	0.57	0.73
Chemicals	0.60	0.87	0.84	0.94	0.71	0.71	0.71	0.71
Pharmaceuticals	0.81	0.82	0.79	0.88	0.63	0.69	0.66	0.72
Cosmetics	0.64	0.81	0.74	0.77	0.63	0.76	0.61	0.69
Plastics	0.75	0.79	0.76	0.79	0.80	0.71	0.76	0.77
Textiles	0.64	0.63	0.63	0.69	0.83	0.78	0.75	0.79
Clothing and Footwear	0.76	0.64	0.70	0.71	0.80	0.81	0.80	0.81
Food	0.58	0.68	0.66	0.69	0.68	0.76	0.69	0.74
Beverages	0.61	0.91	0.84	0.93	0.74	0.69	0.63	0.62
Tobacco	1.00	1.00	1.00	1.00	0.73	0.71	0.65	0.62
Printing	0.65	0.75	0.66	0.75	0.67	0.64	0.61	0.65
Miscellaneous	0.82	0.88	0.88	0.92	0.74	0.81	0.79	0.80

TABLE II (continued)

Source: Industrial Census.

* For this sector Paraná was included in the South.

1 Establishments

2 Output

3 Labor

4 Wage

III.3 - Variables and Definition

III.3.1 - Labor and Wage Data

Data on labor give information on the number of production workers, total employees at the end of the year, and monthly average employment. The use of total employees instead of production workers alone, allows for the substitution of managerial effort for labor.[9] For a given industry, the ratio of production workers to total employees will be higher in the Northeast, indicating that capital is substituted for labor more intensively in the South. Consideration of production workers alone may give a distorted view of the differential in labor productivity between regions since the proportion of production workers to total employees is not the same in both regions.

The monthly average number of workers gives a better idea of the actual movement of the labor force in the manufacturing sector than the level of employment at the end of the year, since variations in the level of employment during the year are included. However, since the corresponding data on wages are not available, this classification was not considered. Thus, total number of employees at the end of the year was the measure of labor used.

It is known that the use of the stock of labor for productivity analysis assumes implicitly that the flow of labor services is proportional to labor stock. This assumption, as indicated by Jorgenson and Griliches,[10] is incorrect since it does not take into account the number of hours effectively worked nor the intensiveness of the effort. Figures on effective hours of work are not available in the Industrial Census. However, through the so-called "2/3 law," the Ministry of Labor has information on the weekly average of hours worked by total employees in each industrial sector.[11]

Our procedure was to take the arithmetic mean of the three states in the South and two states in the Northeast: Pernambuco and Ceará. This presents no problem since interstate variation in man-hours is insignificant.[12] The average number of hours worked per year was obtained by multiplying the weekly average by 52, i.e., the total number of weeks per year. No attempt was made to correct the figures on labor stock either for nonhomogeneity between region or for the intensiveness of the labor effort.

Data on wages refer to the total wage bill which includes payments to owners or partners working in the establishment, production workers and administrative personnel. Since data on the labor force were converted into a flow of hours effectively worked, wage data were divided by that flow for each industrial sector. Thus, the price of labor services is given in terms of the average wage per man/hour.

III.3.2 - Productivity

Brazil's industrial census does not have direct information on value added. This is usually obtained by subtracting the Miscellaneous expenses from the Value of Industrial Transformation (VTI - the difference between the total value of production and expenditure of raw materials, intermediate inputs, fuel and lubrificants, electric power, and taxes).[13] Thus, our measure of labor productivity is the ratio of value added gross of depreciation to the yearly flow of labor services.

Since the present study refers to regions of the same country, correction for the exchange rate and, to some extent, for price variations is not required. These two features reduce the bias in the estimation of the elasticity of substitution, since, as indicated by Arrow et al., under or overevaluation of exchange rates and regional differentials on prices are sources of bias in the estimation of the elasticity of substitution.[14]

No attempt was made to correct for possible quality differentials in product composition, or for differences in product mix between regions for a given industry, since this would be difficult, if not impossible, to do. First, the degree of arbitrariness introduced in the attempt to make the correction would defeat its own purpose. Second, inter-regional variation in the quality of product tends to be smaller than that, for example, between developed and less-developed countries. In some cases, the across-region differences in product mix are quite insignificant. Third, the procedure we have followed in the choice of the states ensures that the degree of homogeneity in terms of product composition for a given industry is maximized since only the more developed states in each region were selected. Moreover, product-mix is less heterogeneous at the regional than at the state level since, as indicated by Nerlove,[15] specialization of industrial activity is more likely to occur at the state than at the regional level. The selection of industrial branches that are common to all selected states reinforces this claim. However, it is clear that product mix is not necessarily homogeneous across regions even at the branch level, since aggregation of different industrial activities, and so of products, persists. At the sector level, this is even more valid, and for Chemical Products, Mechanics, Metallurgy and Transport Equipment differences in product composition can be significant.[16] Finally, in so far as quality differences are related to prices, inter-regional differences in product quality will be expressed as inter-regional differences in product prices.[17]

III.4 - Capital Input

In measuring capital we must pay attention to changes in machines which, since they usually embody technological advances, make them more productive than older models. In other words, new capital tends to be "more" capital.[18] Capital valuation based on capital book value and/or gross investment in the absence of a quality index can underestimate real capital input. New capital can also be "less" capital if the rate of inflation is higher than the rate of technical advances embodied in new machines.[19] Quality changes, as indicated by Deninson,[20] are of two different kinds: one enhances the productivity power of new machines in relation to older ones; the other reduces the cost of producing new machines. If lower production costs generally mean lower acquisition costs, it is difficult to identify new machines as, in reality, "more" capital. Of the three alternative methods of measuring capital suggested by Deninson, the original cost approach is favored.[21] This approach, though more limited than the others, is more often used in empirical studies. Briefly, it takes book value as the measure of capital stock. It is this approach that we will follow.

Another question concerning capital input is the use of capital stock versus the use of the flow of capital services in production studies. The first approach is favored by Griliches[22] and the second by Vernon Smith.[23] If the flow of capital services is proportional to the capital stock, either use would be correct. If not, it seems clear that the flow approach is more appropriate. The difficulty lies obtaining an adequate measure of the flow of capital services. Usually, arbitrary assumptions about depreciation, obsolescence, premium rates, etc., have to be made because of unavailable or inappropriate data.

In this study, the flow approach is followed since it is more consistent with our treatment of labor input. However, inadequate data forced us to assume that the flow of capital services is equal to the depreciation of fixed capital.[24] Depreciation will be estimated by the straight-line method on the assumption that the average life of fixed assets is ten years in both regions.[25] The arbitrariness of this assumption was caused by lack of adequate data on actual flow of replacement cost. However, if actual useful life of fixed capital in both regions is approximately equal, i.e., ten years, no bias will be introduced in our estimation of σ and J, since what matters is the across-region differences in capital/labor ratio (see section II.5). It could be argued, however, that since the wage rate is generally lower in the Northeast, fixed capital would tend to be used longer, and, at first, it would seem more reasonable to assume a lower rate of depreciation for this region than for the South. However, there are mechanisms which, by inducing the Northeast to depreciate capital more rapidly than South, have partly offset the low wage effect. First, lower capital cost, because of SUDENE's fiscal incentives to capital formation in the Northeast,[26] leads firms to accelerate depreciation charges by replacing old equipment. Second, accelerated depreciation on fixed capital of national origin is allowed for all firms in both regions, and since the proportion of this equipment is higher in the Northeast so will be the replacement charges. Both low capital cost and accelerated depreciation, to a large extent, offset the Northeast's lower labor cost. Therefore, our assumption of equal depreciation charges seems reasonable.

FOOTNOTES FOR CHAPTER III

[1]The deleted information corresponding to set (c) is insignificant. On the average, the proportion of set (c) on the total (i.e., set a) in terms of VTI, is .961 and .986 for the Northeast and the South, respectively.

[2]At two digit level this problem does not arise.

[3]It is worth noting that some authors have indicated that the elasticity of substitution tends to be lower at finer level of aggregation. Granted this, the sensitivity of the regional level of efficiency to changes in the capital/labor ratio would be lower as the level of aggregation goes down. On the other hand, it is worthwhile to investigate how relative productivity, factor intensities and factor prices change as the level of aggregation changes.

[4]São Paulo, Guanabara, Rio de Janeiro, Minas Gerais and Rio Grande do Sul for the South and Ceará, Rio Grande do Norte, Paraiba, Pernambuco and Bahia for the Northeast.

[5]Even here 5 sectors have to be dropped: Paper and Cardboard, Hides and Skins, Perfumes, Plastics and Tobacco.

[6]This deserves a qualification since the value of industrial output was greater for the Guanabara state than for either Minas Gerais or Rio Grande do Sul. However, the industrial structure was more diversified for the two latter states than for the former.

[7]The denomination 34/18 represents the numbers of the principal articles of the basic laws that approved the first two SUDENE's Master Plans. It refers to the art. 34 - Law 3595 - 12.14.61 and to the art. 18 - Law 4239 - 06.27.63.

[8]Since the weight of the Wood sector in the South is too low, data on the Parana state were included. Unless otherwise stated, both Northeast (NE) and South (SO) refer to these states only.

[9]As indicated by Harbinson and Fleming, capital intensiveness is associated positively with managerial effort, i.e., as the capital/labor ratio increases labor is replaced by managerial effort. See F. W. Harbinson, op. cit., pp. 365-374, and, M. C. Fleming, "Inter-Firm Differences in Productivity and their Relation to Occupational Structure and Size of Firm," The Manchester School of Economics and Social Studies, vol. 38, n. 3, Sept. 1970, pp. 223-245.

[10]See D. Jorgenson and Z. Griliches, "Explanation of Productivity Change," Review of Economic Studies, vol. XXXIV, n. 3, July 1967, pp. 249-283.

[11]The 4.923/65 Law requires that industrial and non-industrial establishments fill out a questionnaire by the 15th of each month, when the information is given to the Ministry of Labor. See, Ministerio do Trabalho e Prevedincia Social, DNMO, Mercado de Trabalho - Composicão e Distribuicão da Mão de Obra, 1970.

[12]The non-significance of the variation was checked by looking at the data on the average hours worked in the Southern states and in the two Northeastern states. The results were the same as in similar data for 1969.

[13]This procedure is widely used in Brazilian economic literature. See among others, E. L. Bacha, M. de Matos e R. L. Modenesi, Encargos Trabalhistas e Absorcão de Mão de Obra, (IPEA: Colecão Relatorios de Pesquisa - n. 12, Rio de Janeiro, 1972), p. 116, Footnote n. 1 to Table III. 10.

[14]See Arrow et al., op. cit., pp. 383-87.

[15]See Nerlove, "Recent Empirical Studies of the CES and Related Production Functions," in The Theory and Empirical Analysis of Production, ed. M. Brown. (National Bureau of Economic Research-NBER, New York, 1967) vol. 31, p. 70.

[16]The data on output by state and sector do indicate that the difference in the structure of production is greater for these sectors. See FIBGE - Industrial Census.

[17]K. Clague has assumed that ". . . the quality of the workmanship bears a fixed relationship to the price of product," op. cit., p. 23.

[18]See R. Nelson, "Aggregate Production Function and Medium Range Growth Projections," American Economic Review, vol. LIV, n. 5 (September 1964), pp. 575-606, and Nancy Ruggles, "Concepts of Real Capital Stock and Services," in Output, Input and Productivity Measurement (NBER, Princeton University Press, 1961), vol. 25, pp. 387-403.

[19]Zvi Griliches, "Production Functions in Manufacturing: Some Preliminary Results," in The Theory and Empirical Analysis of Production, ed. M. Brown, (NBER, New York, 1967) vol. 31, pp. 275-322, and J. R. Moroney, The Structure of Production in American Manufacturing (The University of North Carolina Press, Chapel Hill, 1972), Ch. 2, p. 21.

[20]Edward F. Denison, "Theoretical Aspects of Quality Change, Capital Consumption and Net Capital Formation," in Problems of Capital Formation (NBER, Princeton University Press, Princeton, 1957), vol. 19, pp. 215-261. See also R. and Nancy Ruggles, op. cit., pp. 388-390.

[21]See E. F. Denison, op. cit., pp. 222-227.

[22]Z. Griliches, op. cit., pp. 280-281.

[23]This author's basic argument is that the concept of capital flow is difficult and unlikely to be related to any observable experience. See Vernon L. Smith, Investment and Production (Harvard University Press, 1961), Ch. 1, p. 4.

[24]Assumption of depreciation charges as a "proxy" for capital services was made by others: Z. Griliches, loc. cit., Z. Griliches and V. Ringstaad, op. cit., pp. 12-140.

[25]This procedure consists merely in scaling down the original capital stock data. Since the scalar transformation is the same for both regions, it makes no difference in terms of empirical results whether the capital stock or our assumed flow of capital services is assumed. However, by using the flow concept, we introduce a degree of flexibility to our study since the scalar transformation can be assumed to differ between the regions. Thus the sensitivity of σ and J to different flow of capital services can be obtained. Obviously, this flexibility is not present in the capital stock approach.

[26]Capital costs will be discussed in Ch. V.

APPENDIX TO CHAPTER III

INDUSTRIAL SECTORS AND INDUSTRIAL BRANCHES

Throughout this study tables and references to sectors and their sub-divisions will often be made. Thus an indexation at this stage can prove to be helpful. The indices and their respective sectors and branches are shown below:

No. of order	Sectors and Branches
01*	Non Metallic Mineral
24**	Grinding and preparation of stones for construction (marble, slate, etc.)
25	Stone grinding
30	Quicklime
31	Slaked lime
32	Clay products-excluding ceramics
34	Ceramic products
43	Cement products
02*	Metallurgy
63	Ironworks (Siderurgic Products)
73	Primary Metallurgy of Non-Ferrous Metals, including precious metals
85	Metallic structures
91	Tin products (including print works)

94	Metallic tanks and recipients, excluding tin cans
03*	<u>Mechanic</u>
117	Machine tools, industrial apparates, parts and accessories
137	Machine maintenance and repair; industrial and agricultural equipment
04*	<u>Electric Communication Equipment</u>
173	Machine maintenance and repair; electronic and communication equipment
05*	<u>Transportation Equipment</u>
186	Motor vehicles and parts and accessories
06*	<u>Lumber</u>
204**	Log slicing
205	Lumber milling
209	Wood structure products and carpentry products
07*	<u>Furniture</u>
233**	Wood, wicker and reed furniture
234	Wood, wicker and reed furniture for home use
08*	<u>Paper and Cardboard</u>
09*	<u>Rubber</u>
279	Pneumatic tire reconditioning
10*	<u>Hides and Skins</u>

11*	<u>Chemicals</u>
320	Crude animal and vegetable oils, fats and waxes (excluding food products)
12*	<u>Pharmaceuticals</u>
13*	<u>Soap, Perfume and Candles</u>
14*	<u>Plastics</u>
15**	Textiles
382	Spinning and weaving
405	Ropery, bag, net and drapery products
16*	<u>Shoes and Clothing</u>
414**	Undergarments
416	Women undergarments
417	Men and boys' clothes
426**	Footwear
427	Shoes, excluding sport shoes
17*	<u>Food</u>
437**	Food processing
438	Cereals, coffee and similar products
440	Coffee toasting and grinding
446	Canned and dehydrated fruits, vegetables and sweets excluding candies and condiments
453	Meat processing from slaughterhouse to preparation of canned meat
461	Dairy products, excluding ice cream

464	Cane sugar refining
472	Bakery products
474	Biscuits and crackers
477*	Other food products
478	Edible oils of animal or vegetable origin, cocoa butter
484	Animal rations
18*	<u>Beverages</u>
490	Alcoholic beverages
499	Soft drinks
19*	<u>Tobacco</u>
20*	<u>Printing</u>
512	Edition and printing of books, periodicals and manuals
21*	<u>Miscellaneous</u>
557	Other miscellaneous products

* Industrial sectors, two digit level.

** Industrial branches, four digit level. The unstarred branches are all six digit level.

CHAPTER IV

CAPITAL STOCK

IV.1 - The Purpose of the Chapter

Data on capital stock at both the sector and branch level are required to proceed with the analysis of Northeast relative efficiency.[1] The purpose of this chapter is to estimate capital stock in each region and to consider bias in the estimates. The related question of bias in our estimates of depreciation allowances, and in capacity utilization are also considered.

IV.2 - Estimation of Capital Stock at Sectoral Level[2]

Data on the value of capital stock at either the national or regional level are not directly available from Brazil's 1970 Industrial Census. Data on 1959 capital stock and on the flow of gross investment in the 1962-1970 period, however, are available and allow us to estimate the 1970 capital stock.[3] Since these sets of data differ, it is convenient to treat the data on 1959 capital stock first, and then to treat the flow of gross investment which must be added annually to the 1959 capital stock to yield the desired capital stock figures for the year 1970.

IV.2.1 - The 1959 Capital Stock

Brazil's industrial census provides information on the book value of capital at both the national and state level for 1959. This information covers all establishments in each industrial sector and represents an historical flow of yearly gross investment at annual current prices. This historical data poses some problems since data on Brazil's capital stock, beginning in 1939, were uncorrected for price changes and depreciation. In order to correct the 1959 capital stock for both price changes and depreciation[4] from the year 1939, we have followed the approach used by R. Bonelli[5] which consists basically in the estimation of price deflators for each industrial sector. Bonelli's procedure in its basic features is explained below.[6]

The historical data on capital can be written as

$$PK = \sum_{i=T}^{T-J} P_i \Delta K_i \qquad (1)$$

where T and J refer to the terminal (1959) and initial (1939)[7] period, respectively. K_i is the gross investment at the i^{th} year (for $i \leq T$) and P_i and P_T the price level at the i^{th} year and terminal year, respectively.[8]

Similarly, the capital stock net of depreciation can be written as

$$P_T K' = \sum_{i=T}^{T-J} P_T \Delta K_i + P_T K_{T-J-1} \qquad (2)$$

where K_{T-J-1} is the initial capital stock in the T-J-1 period, and the prime (') refers to net capital stock.

Dividing equation (2) by (1) one obtains

$$P_T K' = PK \frac{\sum_{i=T}^{T-J} P_T \Delta K_i' + P_T K'_{T-J-1}}{\sum_{i=T}^{T-J} P_i \Delta K_i} \qquad (3)$$

Neither the flow of gross investment ($P_i K_i$) through time nor data on capital-output ratio (β) was available. Output data, however, was available. Bonelli's approach was to assume that both ICOR and average capital-output ratio were constant,[9] allowing the specification of the flow of gross investment through time and so its adjustment for price changes and depreciation.

Empirical studies on the average capital/output ratio (β) have indicated this ratio to be fairly stable through time.[10] Several reasons can explain this relative stability. First, capital stock does not change rapidly since net investment is, in general, a small proportion of capital stock and the actual replacement proportion is even smaller. Second, capital productivity does not fall in proportion to an increase in the average life of equipment. Finally, as new equipment (gross investment)[11] is added, output is also expected to increase. The relative proportion of this increase to capital formation depends upon the productivity of new capital and its price relative to the price output. If both prices move in the same direction and approximately in the same proportion, no big change in the capital/output ratio will occur as a result of additions to the capital stock. Thus, barring changes in capacity utilization between points of time, the capital/output ratio is not expected to show large variations in its magnitude.[12]

Data on the average capital/output ratio (β) for Brazil, as estimated by R. Bonelli[13] for the years 1959 and 1970, indicate that the (β) coefficient has been fairly stable. As shown in Table I, on the average, the percentage change in (β) in that period was only 2 per cent. At the sector level, some degree of variation can be observed. However, in only one sector--Miscellaneous--was the change higher than 20 per cent in the 1959-1970 period. (See Table I, column 3.) This fairly stable pattern of the average capital/output ratio is more evident at a higher level of aggregation, as revealed by Werner Baer's estimates.[14] As shown in Table II, the change in the value of (β) was rather low. Though Baer's and Bonelli's estimates are not strictly comparable,[15] they tend to support the "stability" assumption. Thus, Bonelli's assumption of a constant (β) over the 1939-1959 period is warranted.

Once (β) is assumed constant, we can write

$$P_i K_i = \beta P_i \Delta Y_i + \beta d P_i Y_{i-1} \qquad (4)$$

TABLE I

AVERAGE CAPITAL/OUTPUT RATIOS: BRAZIL (1959-70)

Sectors	1959	1970	Relative Variation (%)
Non-Metallic	1.83	1.92	+ 5
Metallurgy	1.89	1.98	+ 5
Machinery	2.08	2.05	- 2
Electrical Material	1.42	1.27	-11
Transportation Equipment	1.94	1.75	-10
Lumber	2.23	2.32	+ 4
Furniture	1.34	1.54	+15
Paper and Cardboard	1.93	2.23	+16
Rubber	1.19	1.05	-12
Hides and Skin	2.59	2.70	+ 4
Chemicals	2.20	2.18	- 1
Pharmaceutical	1.09	1.00	- 8
Cosmetics	1.30	1.21	- 7
Plastics	1.68	1.58	- 6
Textiles	2.51	2.85	+14
Clothing and Shoes	1.14	1.28	+12
Food	2.44	2.49	+ 2
Beverages	2.79	2.99	+ 7
Tobacco	1.32	1.26	- 5
Printing	1.99	2.08	+ 5
Miscellaneous	1.34	1.72	+28
Total	2.01	1.98	- 2

Source: R. Bonelli, op. cit., p. 198.

TABLE II

AVERAGE CAPITAL/OUTPUT RATIOS--BRAZIL

	1945-52	1953-56	1957-60	1947-60
Current Prices	2.52	2.67	2.19	2.45
Constant Prices	2.15	2.48	2.10	2.23

Source: W. Baer, Industrialization and Economic Development, *op. cit.*, p. 130.

where Y_i is the level of output in the i^{th} period and d is the annual rate of depreciation.

Similarly $P_T \Delta K_i' = \beta P_T \Delta Y_i$ (5)

and $P_T K_{T-J-1}' = \beta P_T Y_{T-J-1}$ (6)

Making the necessary substitutions in equation (3) we have

$$P_T K' = PK \frac{\beta P_T \sum_{i=T}^{T-J} \Delta Y_i + \beta P_T Y_{T-J-1}}{\beta \sum_{i=T}^{T-J} P_i \Delta Y_i + d\beta \sum_{i=T}^{T-J} P_i Y_{i-1}} \qquad (7)$$

Assuming now that the rate of output growth is constant in a given period of time[16] we have

$$Y_T = Y_i (1+r)^{T-i}$$

and $\Delta Y_T = \Delta Y_i (1+r)^{T-i}$

where r is the annual average rate of output growth. Substituting the value of Y_i and ΔY_i in (7) and cancelling out (β) we obtain

$$P_T K' = PK \frac{\Delta Y_T \sum_{i=T}^{T-J} \frac{1}{(1+r)^{T-1}} + Y_{T-J-1}}{\Delta Y_T \sum_{i=T}^{T-J} \frac{1}{(1+r)^{T-i}} \cdot \frac{P_i}{P_T} + dY_T \sum_{i=T-1}^{T-J-1} \frac{1}{(1+r)^{T-i}} \cdot \frac{P_i}{P_T}} \qquad (8)$$

or $P_T K' = \alpha(PK)$ where (α) is the price deflator.[17]

Bonelli's deflators and the 1959 corrected capital stock at 1959 prices for the Northeast and the South are shown in Table III. As the data show, industrial structure[18] diverges between both regions. Though both regions' industrial structure is concentrated in the Textile and Food sectors (columns 4 and 5 of Table III), this concentration is even more pronounced in the Northeast. In fact, while 31 per cent of the South's capital stock was concentrated in those two sectors, the corresponding figure for the Northeast was 67 per cent. This divergent pattern on the regional industrial structure is also evident in sectors like Metallurgy, Machinery, Electrical Equipment, and Transportation Equipment.

IV.2.2 The 1970 Capital Stock

The estimation of the 1970 capital stock has to rely on gross investment for each year during the 1959-1970 period, which is available from the FIBGE-DEICOM annual industrial survey.[19] These data, however, pose some problems. First, they are not strictly comparable to the Industrial Census data[20] and the divergence in coverage is not equal for both regions. Second, gross investment for the 1960, 1961 years is missing. Third, the investment and also the 1959 capital stock data, are expressed in current prices. To deal with these problems, the following steps were taken:

a) Adjustment for Coverage

Assuming that the coverage level of DEICOM output data holds equally for the investment data, we estimated the

TABLE III

DEFLATORS, REGIONAL CAPITAL STOCK AND ITS STRUCTURE--1959

(CR $1.000 of 1959)

Sectors	Deflators (1)	Capital Stock		Structure	
		NE	South	NE	South
Non-Metallic	1.99	3.316	29.295	.066	.052
Metallurgy	2.06	1.267	55.319	.025	.099
Machinery	1.68	118	25.560	.002	.046
Electrical Material	1.77	70	21.583	.001	.039
Transportation Equipment	1.69	232	59.177	.005	.106
Lumber	2.15	892	10.834	.018	.019
Furniture	2.20	510	7.515	.010	.013
Paper and Cardboard	2.15	848	14.396	.017	.026
Rubber	2.06	172	9.653	.003	.017
Hides and Skins	3.02	902	7.397	.018	.013
Chemicals	2.13 (Chemicals, Pharmaceuticals, Cosmetics, Plastics)	4.956	54.876	.099	.098
Pharmaceuticals		95	7.224	.002	.013
Cosmetics		541	3.387	.011	.006
Plastics		8	3.179	0	.006
Textiles	2.46	13.383	77.137	.268	.138
Clothing and Footwear	2.43	650	11.291	.013	.020
Food	2.39	20.414	97.770	.409	.175
Beverages	2.45	2.160	18.818	.043	.034
Tobacco	2.76	937	3.568	.019	.006
Printing	2.29	1.159	13.705	.023	.024
Miscellaneous	2.10	138	6.401	.003	.011
TOTAL	2.21	49.931	559.091	100	100

Source: Industrial Census, 1960--FIBGE

1) From Bonelli, op. cit., p. 196.

proportion of VTI (Value of Industrial Transformation)[21] of those establishments with five or more employees, etc., (set b) on the total VTI (set c, as defined in sect. III.1) by region and sector (data not shown). Then the investment figures were adjusted upward or downward depending upon whether that proportion was greater or smaller than 90 per cent.[22]

b) Gross Investment for 1960 and 1961

To cope with the fact that data on gross investment were missing for 1960 and 1961, the average rate of output growth was estimated for 1959-1962. Then, assuming that the rate of growth of capital was proportional to that of output, gross investment for each sector and region for both years was computed.[23]

c) The Use of Price Deflators

Finally, the nominal data on capital and investment were adjusted to 1970 constant prices by applying implicit deflators of gross capital formation from the national accounts.[24] This series of price deflators (1959 to 1970) was not complete since the index for 1970 was missing. To fill this gap, the 1970 general index of producer goods was used.[25]

The completion of these steps yielded our estimate of the 1970 capital stock for both regions. Algebraically, our adjusted capital stock is written as:

$$\overline{K}_{70} = \overline{K}_{59} + \sum_{i=60}^{69} \overline{I}_i$$

where the bar stands for capital and investment at constant prices.[26]

Data on Table IV, columns 1 and 2, show each region's 1970 capital stock at 1970 prices. Before elaborating on these data, however, two questions have yet to be considered. The first concerns the influence of the 1958 drought and its effect upon our estimates of the Northeast 1970 capital stock. The second relates to depreciation charges in the 1959-1970 period.

IV.3 - The 1958 Drought in the Northeast and the New Estimates of Capital Stock

The Northeast 1970 capital stock may have been overestimated due to the recurring drought phenomenon in that region.[27] Drought was particularly serious in 1958, and sharply reduced agricultural production while creating mass unemployment. Sales and output of sectors dependent on inputs from the agricultural sector were affected adversely.

As shown in Table III, column 4, the Northeast industrial structure was heavily oriented toward production of consumer goods in 1959. In sectors such as Food and Textiles,

TABLE IV

REGIONAL CAPITAL STOCK AND ITS STRUCTURE--1970

(CR $1.000,00 of 1970)

Sectors	Capital Stock		Structure	
	NE	South	NE	South
Non-Metallic	454.22 (489.644)*	2.879.138	.090	.051
Metallurgy	215.577	8.259.687	.043	.146
Machinery	31.973	2.749.698	.006	.049
Electrical Material	85.642	2.793.913	.017	.049
Transportation Equipment	74.686	7.266.073	.015	.128
Lumber	73.965(79.447)*	1.605.164	.015	.028
Furniture	95.622(100.294)*	779.671	.019	.014
Paper and Cardboard	60.542	1.403.851	.012	.028
Rubber	16.661	1.029.524	.003	.018
Hides and Skins	44.128(53.569)*	630.349	.009	.011
Chemicals	982.380	5.388.053	.194	.095
Pharmaceuticals	12.000	769.275	.002	.014
Cosmetics	44.590	352.169	.009	.006
Plastics	21.621	566.515	.004	.010
Textiles	880.709(1.137.780)*	6.998.334	.174	.124
Clothing and Footwear	64.800(69.939)*	1.077.385	.013	.019
Food	1.414.748(1.796.591)*	7.991.238	.280	.141
Beverages	224.770(259.526)*	1.589.109	.044	.028
Tobacco	93.395	384.813	.018	.007
Printing	147.203(159.206)*	1.306.349	.029	.023
Miscellaneous	12.574	683.002	.002	.012
TOTAL	5.052.138	56.503.310	100	100

Source: Table I and FIBGE-DEICOM--1962-1969. *Unadjusted for the 1958 drought.

dependence on inputs from the agricultural sector was particularly great, and, in 1959, because of adverse climatic conditions and raw material shortages,[28] there was a sharp reduction in agricultural products.[29] Aggregate demand for industrial products was also adversely affected, and the whole productive system of the region was disrupted by the drought phenomenon.[30] Income levels fell as did the demand for consumer goods such as clothing, beverages, food products and others.

To the extent that the 1959 production level was below "normal," our estimates of capital stock for those sectors were overestimated. This estimation bias is inherent in the procedure we have followed in estimating the 1960-61 gross investment level. If we assume that the 1962 production level was "normal," it is clear that our estimated rate of output growth for the 1959-62 period is overestimated. As a check on this, data on 1958 value added was taken from S. Robock.[31] After these data were transformed into 1959 VTI figures, new rates of output growth were estimated. As expected, these new rates were lower than our previous estimates in nine of the eleven sectors, and the capital stock for nine sectors was adjusted downward.[32] The adjusted results are shown in Table IV.

Comparing both regions' capital stock in 1959 and 1970, it can be seen that some structural change did occur. This change is more visible in the Northeast where a significant decrease in the share of the Textile and Food sectors is observed. The most conspicuous growth sectors were the Chemical and Metallurgy sectors. For the South and the remaining sectors in the Northeast, the changes were not substantial.

IV.4 - Depreciation

No allowance for depreciation was made in the estimation of the 1970 capital stock in section IV.2.2. Therefore, the value of the 1970 capital stock could be an overestimation.[33] Since data on actual depreciation are not available, we could have assumed either a rate of depreciation equal to 5 per cent of yearly gross output or to 29 per cent of yearly gross investment. Even though both procedures are used on data in national accounts,[34] neither will be used. First, in Ch. III (sec. III.4) we assumed an average life of 10 years for fixed capital. There we argued that the assumption of an equal depreciation rate was a better approximation of the actual pattern of replacement charges in both regions. It was also argued that, since it is the across-region differences in the capital/labor ratio that really matter, for our purposes any question dealing with the actual span of useful life of fixed capital is not substantive. Second, the actual depreciation rate is not known and, since it is likely to differ among sectors, it is doubtful if any gain in accuracy could be achieved by actually depreciating each year's flow of gross investment in the 1959-1970 period. Moreover, differences in the rate of depreciation at the plant level tend to offset each other with aggregation and in inter-regional comparison. Third, statistical data on capital stock, unlike that on labor and output, are usually poor. Not that statistics on output and labor are totally accurate or free of conceptual difficulties, but only that, as indicated by both T. Barna[35] and J. R. Hicks,[36] these difficulties are less important than those related to the measurement of capital. Thus, it can be argued that data on capital or gross investment are usually biased. Though the direction of this bias is not known, it is likely that in our case it is downward since:

i) Our deflators, as well as Bonelli's, were derived from national account data and refer to the gross capital formation of both government and private sectors. In the latter, investment in the agriculture and service sectors is included. If the price change for the industry sector is greater than for the other two sectors, underestimation of 1970 capital stock can happen. Though we do not have any information on the movement of capital price by sector of the economy, it is likely that the price of equipment and machinery has risen more rapidly for the industrial sector than for the agriculture and service sectors.

ii) Underreporting can be frequent in stating capital expenditures.

iii) As indicated by Kuznets,[37] considerable additions to capital stock are not included in census data since they are produced within the firm. These additions, he argued, are more important at the early stages of economic development than later.

Though we cannot determine the magnitude of the underestimation bias, it is great enough to assume both regions' capital stock as net of depreciation.[38] This assumption, however, is more apt for the South than for the Northeast since the Northeast's capital/output ratios, even when adjusted for capacity utilization, tend to be higher than either the South's or SUDENE's weighted average ratios (see Table V).[39]

IV.5 - Investment for Modernization and Accumulated Depreciation in the Northeast

Increase in the Northeast capital stock is partly due to SUDENE's fiscal incentives, many for modernizing existing plants. Not all modernization can be accounted for by replacement, since some investment for modernization can be used to expand existing facilities.[40] Unfortunately, there

TABLE V

AVERAGE CAPITAL/OUTPUT RATIOS

Sectors	NE[1]	South[1]	NE[1] (*)	South[1] (*)	SUDENE'S[2]
Non-Metallic	2.36	1.94	2.17	1.75	2.82
Metallurgy	2.57	2.28	2.13	2.01	3.72
Machinery	1.06	1.20	.79	.98	1.81
Electrical Material	1.93	1.51	1.29	1.22	1.29
Transportation Equipment	3.38	2.53	1.18	1.20	1.49
Lumber	3.20	2.94	2.50	2.53	1.88
Furniture	3.40	1.47	2.35	1.26	1.15
Paper and Cardboard	4.57	2.03	3.84	1.87	2.35
Rubber	2.89	1.37	2.25	1.30	1.37
Hides and Skins	6.40	3.94	4.35	3.39	1.55
Chemicals	3.33	1.92	2.70	1.71	3.68
Pharmaceutical	1.74	.75	1.36	.64	.89
Perfume and Soap	2.79	.71	2.37	.58	.66
Plastics	2.42	1.03	1.89	.84	1.34
Textiles	5.57	2.69	3.90	2.42	2.66
Clothing and Shoes	1.39	1.11	1.26	.92	.68
Food	3.53	2.45	2.43	1.96	1.79
Beverages	2.89	3.03	2.22	2.60	2.82
Tobacco	1.05	1.05	.84	.87	.78
Printing	4.19	1.52	3.26	1.31	1.55
Miscellaneous	1.64	1.03	1.28	1.57	1.38

1) Source: Table IV and Industrial Census.

2) Source: Goodman and Cavalcante, <u>op. cit</u>., Tables IX.14 and IX.15, pp. 249-251.

* K/Y are adjusted for capacity utilization level.

is no breakdown of the modernization figures and the realized investment data refer to total investment (i.e., includes working capital) for plants already in operation by December 1968.[41] Finally, all states in the region are covered.

To deal with these problems, the following steps were taken: a) since there is no sectoral data on the actual (even planned) proportion of working capital to total capital, this latter figure was assumed to be equal to fixed investment in modernization projects. We defend this assumption on the ground that actual investment began to come on stream only after 1967: b) the spatial distribution of planned new and modernization investments indicates that an average of 71 per cent of total modernization investment was to be invested in Ceará, Pernambuco and Bahia.[42] Since no comparable data exist for actual investment, the planned proportion was assumed to hold sectorially for actual investment. Briefly, steps (a) and (b) were applied to the data on actual investment for modernization by sector. The resulting figures correspond to the actual fixed investment in modernization projects in the states of Ceará, Pernambuco, and Bahia. Finally, since not all investment can be accounted for by replacement and addition to capital stock is not available, 50 per cent of the estimated actual fixed investment for modernization was assumed to be actual replacement charges. For the Textile sector, however, investment in modernization was accounted for by actual depreciation charges.

Tables VI and VII show the age composition of capital in the Textile sector at two points in time. Both the age composition of equipment and the number of machines were substantially reduced in the 1959-1969 period. The reduction in the number of looms was greater than in the number of spindles, 51 and 36.5 per cent respectively. Moreover, if in 1959, 61.7 and 86.6 per cent of spindles and looms, respectively, were older than 15 years, by 1969 those figures were reduced to approximately 36.5 and 34.4 per cent. Both reductions in the number and in the average age of machines indicate that the Textile sector has been rapidly modernizing.[43] Thus, our assumption about replacement costs is accurate and reasonable.

As it happened, the assumed depreciation charges for most of the sectors were insignificant, either in absolute terms or as a proportion of each sector's capital stock (data not shown). This outcome, however, was not true for the Non-Metallic and Textile sectors. Since these two sectors alone accounted for 51 per cent of the total realized investment for modernization projects, depreciation of their capital stock was included.[44] For the remaining sectors, this was not included.[45]

TABLE VI

TEXTILE SECTOR--AVERAGE AGE OF EQUIPMENT

(1959)

Average Age in Years	Spindles in Operation Number	%	Looms in Operation Number	%
Less than 15	245.930	38.3	3.016	13.4
From 15 to 30	48.500	7.5	1.201	5.4
More than 30	347.876	54.2	18.259	81.2
Total	642.306	100.0	22.476	100.0

Source: Pesquisa sobre a Industria Textil do Nordeste, op. cit., p. 46.

TABLE VII

TEXTILE SECTOR--AVERAGE AGE OF EQUIPMENT

(1969)

Average Age in Years	Spindles in Operation Number	%	Looms in Operation Number	%
Less than 10	168.323	38.8	4.027	36.5
From 10 to 19	106.896	24.7	3.202	29.1
From 19 to 30	75.400	17.4	.319	2.9
More than 30	82.565	19.1	3.468	31.5
Total	433.184	100.0	11.016	100.0

Source: Pesquisa sobre a Industria Textil do Nordeste, _op. cit._, p. 46.

IV.6 - Capital Stock at Lower Levels of Aggregation

No information on capital stock, investment, or even horse-power is available at a more disaggregated level in Brazil's 1970 Industrial Census. Therefore, sectoral capital/output ratios were assumed for component branches. By estimating each branch's output proportion on the sectoral output level, each branch capital stock was estimated, i.e.,

$$K_{ij} = K_i \left[\frac{VAB_{ij}}{VAB_i}\right] = \left[\frac{K_i}{VAB_i}\right] VAB_{ij} = \left(\frac{K_i}{Y_i}\right) Y_{ij}$$

where K_{ij} is the j^{th} branch capital stock in the i^{th} sector, similarly for VAB_{ij}.

Measurement errors were likely for these estimates. Capital/output ratios, though admittedly fairly stable for a given sector through time, are not necessarily stable among other sectors. Unfortunately, the direction and magnitude of this bias is difficult to ascertain. Since such errors occurred in both regions, they tend to be offsetting. (The results on K_{ij} are not shown.)

IV.7 - Level of Capacity Utilization

It is usually asserted that capital in use, rather than capital in place, is the relevant variable to consider in productivity studies. Since capital services were not appropriately measured, we should account for capacity utilization differentials, since unequal levels of capacity utilization between regions for a given sector would weaken the proportionality assumption between capital stock and the flow of capital services.[46] Fortunately, data on capital utilization are available.[47]

Table VIII indicates that capacity utilization levels vary between regions for a given sector and among sectors for a given region. It shows that for all sectors, except Non-Metallic, Cosmetics and Clothing, the degree of excess capacity is higher in the Northeast. The across region differences in capital utilization, however, is not great. As shown in column 3, for only two sectors--Transportation Equipment and Textiles--the Northeast level of excess capital is 20 per cent higher than in the South. Nonetheless, it is clear that the flow of capital service is not proportional to the level of capital stock. This lack of proportionality is more pronounced in the Northeast than in the South either because of the Northeast's lower level of capacity utilization or because of its higher within-sector variations. Thus, since capital in use, rather than capital in place, is the important variable to consider in productivity studies, adjustment for the level of capacity utilization is desirable.[48] The same is true for the flow of capital services.

TABLE VIII

CAPACITY UTILIZATION LEVEL[(a)]

Sectors	NE (a)(1)	South (b)(2)	(a)/(b)
Non-Metallic	92	90	102
Metallurgy	83	88	94
Machinery	75	82	91
Electrical Material	67	81	83
Transportation Equipment	35	82	43
Lumber	78*	86*	91
Furniture	69	86*	80
Paper and Cardboard	84	92	91
Rubber	78	95	82
Hides and Skins	68	86*	79
Chemicals	81	89	91
Pharmaceuticals	78*	85	92
Cosmetics	85	82	104
Plastics	78*	82	95
Textile	70**	90	78
Clothing and Footwear	91	83	110
Food	69	80***	86
Beverage	77	86	89
Tobacco	80	83	96
Printing	78*	86*	91
Miscellaneous	78*	86*	97
Total	78	86	91

Sources: 1) <u>Revista Economica</u>, <u>op. cit</u>., Table 7, p. 84.
2) <u>Conjuntura Economica</u>, <u>op. cit</u>., Table VI, p. 68.

a) The figures refer to an unweighted average of quarterly data on Capacity Utilization.

*) Total Manufacturing level of Capacity Utilization was used for these sectors since sectoral information was missing.

TABLE VIII

(continued)

** This figure is a weighted average of Textile and Fiber processing. The weights were 2 and 1 respectively.

*** This figure refers to the broader classification "Consumer Goods" since information on this sector was missing. See "18ª Sondagem Conjuntural," op. cit., Table VII, p. 69.

Capacity utilization levels are lower in the Northeast because: first, the 1970 drought in the Northeast adversely affected some sectors. This impact is more strongly felt in the group of consumer goods industries and in those industries (e.g., Textiles and Food) dependent for inputs on the agricultural sector. Second, for sectors such as Electrical Material and Transportation Equipment, it was probably difficult to produce at a higher level of capacity. Poor management combined with low level of labor skill were bottlenecks in new Northeast industrial ventures.

Data in Table IX show the annual average rate of growth of capital stock for the 1959-1970 period for both regions. Though, on the average, regional growth rates were equal, they differed sharply at the sectoral level. This discrepancy was pronounced both between regions as well as among sectors for the same region. For the Northeast, the rate of growth varied from a minimum of 2 per cent for Hides and Skins to a maximum of 38 per cent for the Plastics sector. The rate of growth was also high (31%) for the Electrical Material sector. In the South, on the other hand, the range of variation was narrower since the minimum and maximum rates were 6.5 and 14 per cent, respectively, for the Food and Plastics sectors.

Contrasting the rate of growth of Northeast capital stock with its level of capacity utilization, we see that the higher the level of excess capacity, the higher the rate of

TABLE IX

ANNUAL AVERAGE RATES OF CAPITAL GROWTH*--1959/1970

Sectors	NE	South
Non-Metallic	.112	.082
Metallurgy	.131	.120
Machinery	.174	.090
Electrical Material	.311	.107
Transportation Equipment	.189	.102
Lumber	.066	.072
Furniture	.098	.086
Paper and Cardboard	.052	.081
Rubber	.080	.089
Hides and Skins	.018	.067
Chemicals	.145	.081
Pharmaceuticals	.104	.089
Cosmetics	.066	.087
Plastics	.383	.136
Textile	.045	.074
Clothing and Footwear	.083	.079
Food	.049	.065
Beverage	.087	.068
Tobacco	.083	.090
Printing	.105	.079
Miscellaneous	.075	.089
	.84	.84

Sources: Tables III and IV

*: $r = \ln(K_1/K_o)/n$

growth of capital stock (particularly for the Machinery, and Electrical Material, Transportation Equipment, Perfume and Plastics sectors). In the South, this inference is less warranted, since both sectoral growth rates and level of capacity utilization varied little. Given the South's far smaller rate of growth in capital, it is reasonable that the intense recent industrialization in the Northeast has been an important explanatory variable for its level of excess capacity.

The fiscal incentives scheme in the Northeast may well have induced Northeast entrepreneurs to overestimate their capital needs either because of low capital costs or anticipation of a rise in future demand (building ahead). This explanation is restricted to only a share of the regional capital stock which, though large for a few sectors, was not sizeable for the majority. A more general explanation has been that the region's permanent (not circumstantial, e.g., the 1970 drought) low level of per capita income[49] has had inhibiting effect on the expansion of regional demand for manufacturing goods and so on the increase of the level of capital utilization.

IV.8 - Conclusion

The estimation of capital stock relied on 1959 data, book value of capital stock, and on the flow of gross investment thereafter and, admittedly, could be underestimated. Since the magnitude of the bias is not known, capital stock was treated as net of accumulated depreciation. This procedure was likely to be more apt for the South: first, capital/output ratios were generally higher in the Northeast than in the South; second, modernization of existing plants through SUDENE's fiscal incentives was high in the Northeast. Therefore, allowances for accumulated depreciation were made for the Northeast, which with two exceptions, Non-Metallic and Textiles, was insignificant.

Data on capital stock and capacity utilization were not available at the branch level. Therefore, we assumed the capital/output ratio and the level of capacity utilization to be the same at sector and branch level. The estimated capital stock at the lower than two level aggregation was also treated as net of accumulated depreciation. Finally, across region differences in capacity utilization for most of the sectors were lower in the Northeast. However, for only two sectors--Transportation Equipment and Textiles--was the Northeast's level of excess capacity 20 per cent higher than in the South. Adverse effects, both in demand and supply, of the 1970 drought, poor management and skills were possible explanations.

APPENDIX TO CHAPTER IV

ADJUSTMENTS OF THE NORTHEAST CAPITAL STOCK

Correcting the overestimation bias in the Northeast capital stock due to the drought phenomenon meant estimation of new rates of output growth for the 1957-1962 period. Intermediate steps necessary for this calculation were: first, since no data on 1958 VTI was available, the value added had to be transformed into VTI figures. To do this, the 1958 value added was first converted into value added at 1959 prices and then multiplied by the 1959 ratio of VTI to value added, assuming that this ratio remained constant in that period. Second, the average 1949-1958 sectoral rate of output (VTI) growth was estimated. Assuming that these rates remained constant, the 1959 VTI (presumably free of the adverse effect of the drought) was then estimated. The final step was to estimate the new rates of output (VTI) growth for the 1959-1962 period, and, from them, the adjusted flow of gross investment for 1960 and 1961.

Table IV shows substantial reductions in capital stock for some sectors. These reductions might have been greater if data on 1957 VTI had been available, because the 1958 output level was also probably affected by the drought. This immediate effect tended to be greater in those states more directly affected by drought, i.e., Ceará and Pernambuco. Thus, measured capital stock could still be an overestimation.

Finally, out of eleven sectors considered, adjustments were made for nine. The data we used show only twelve sectors and one of them, Metals, was likely to include the Metallurgy, Machinery, Electrical Material and Transportation Equipment sectors in the 1959 and 1970 FIBGE classification. Because of the low weight of these sectors on regional industrial structure, (see Table I) and because they were unlikely to be affected by drought (at least on the supply side) they were not considered. Two of the remaining eleven, Paper and Cardboard, and Chemicals, did not show any reduction in the output (VTI) rate of growth, i.e., their rate of growth in the 1949-1959 period was greater than in the 1949-1958 period, which was not true for the remaining nine sectors.

FOOTNOTES TO CHAPTER IV

[1]See equations 4 and 5 in Ch. II.

[2]Data on capital stock and on gross investment are available only for the industrial sectors.

[3]It should be noted that data on both capital stock in 1959 and on gross investment are given by state. For estimating regional data an unweighted sum was computed.

[4]The question related to quality change was briefly treated before. See Ch. III, sec. III.4.

[5]R. Bonelli, *Tecnologia e Crescimento Industrial: A experiencia brasileira nos anos 60* (IPEA, serie monografica, n. 25, Rio de Janeiro, 1976).

[6]For a full acount of the approach, see R. Bonelli, *op. cit.*, pp. 189-193.

[7]There is nothing in Bonelli's work which explains why 1939 was chosen as the terminal year. We can only suggest that availability of data on output restricted his choice. In fact, the output index Bonelli used was available only after 1939. Moreover, it is not unreasonable to assume that the useful life of capital stock is equal to or even lower than twenty years. For the data on output index see F. G. Loeb, "Número Indices de Desenvolvimento Fisico da Producão Industrial, 1939-1940," *Revista Brasileira de Economia*, year 7, n. 1, March 1953. Table II, pp. 31-66.

[8]Both P_i and P_T are price indices of the fixed gross fixed capital formation.

[9]Similar procedure was used before by A. Fishlow, "Origens e Consequencias da Substituicão de Importacão no Brasil," in *Formacão Economica do Brasil*, *op. cit.*, pp. 41-63.

[10]See E. Domar, "The Capital-Output Ratio in the United States; Its Variation and Stability," in *Theory of Capital--* I.E.A., D. C. Hague ed. (St. Martin's Press, New York, 1961), pp. 95-117, and S. Kuznets, "Quantitative Aspects of the Economic Growth of Nations v. Capital Formation Proportions:

International Comparisons for Recent Years," in Economic Development and Cultural Change, vol. 8, no. 4, part II, July 1961, pp. 1-124. See pp. 16-33 in particular.

[11]It is important to consider gross instead of net investment, since new equipment, whether for replacement or in addition to existing capital stock, is, generally, more efficient than older equipment. As stated by E. Domar, "One would prefer some net figures to gross, but working with net investment and net stock of capital in the conventional sense one loses sight of gross investment as a major vehicle of technological progress." E. Domar, op. cit., p. 99.

[12]S. Kuznets, for example, has found that for some countries, i.e., the United States, Britain, Japan, the ". . . average ratio of total capital to total output declined roughly a fifth over the long period between a half and a full century . . . ." S. Kuznets, Postwar Economic Growth--Four Lectures (The Belknap Press of Harvard University Press, Cambridge, Mass., 1964), p. 40.

[13]R. Bonelli, op. cit., p. 198.

[14]W. Baer, Industrialization and Economic Development in Brazil (Richard D. Irwin, Inc., Homewood, Ill., 1965), p. 130.

[15]W. Baer's data refer to the whole economy and are derived from national account data on gross fixed capital formation and gross domestic product. Bonelli's data refer to the ratio of gross fixed capital to gross output.

[16]Bonelli argued that this assumption was used more for simplification purposes since it allows the use of ". . . annual average rates of growth through decades instead of the corresponding individual rates." R. Bonelli, op. cit., p. 190.

[17]The estimated deflators refer to Brazil's industrial sectors, and we have used them for correcting regional data on capital book value.

[18]By "structure" we mean the percentage distribution of the region's capital stock by sectors.

[19]Producão Industrial--1966, 1967, 1968, 1969--FIBGE-DEICOM, Rio de Janeiro.

[20]The DEICOM data are based on a sample of establishments which covers approximately 90 per cent of industrial production. The Industrial Census, on the other hand, covers all establishments with 5 or more employees and/or value of production greater than 640 times the highest minimum wage prevailing in the country in 1970 (set b as defined in sec. III.1).

[21]For the definition of VTI, see Ch. III, sec. III.3.2.

[22]Except for the Lumber, Furniture, and Hides and Skins sectors in the Northeast only, the proportion was systematically greater than 90 per cent. Thus, with the above exceptions, both investment flows were adjusted upward. For these three sectors, a downward adjustment was made.

[23]By output, we mean VTI here.

[24]See Conjuntura Economica, vol. 25, n. 9, September, 1971. National Accounts--Updating, Tables 2 and 14, pp. 92-97.

[25]This index has 1969 as base year, and it is available only after that year. It is weighted average of the indices of motor vehicles machinery and equipment, and others. See Conjuntura Economica, vol. 26, n. 2, February, 1972, p. 185.

[26]As can be noted from the algebraic expression, our capital stock estimates are one year lagged. On the one hand, this approach is warranted since this year's investment usually does not add to current capacity. On the other hand, the choice of the time lag is arbitrary, because the actual lag can be higher than one year and can vary from sector to sector.

[27]For an excellent description of the drought phenomenon in the Northeast, see A. O. Hirschman, Journeys Toward Progress (The Twentieth Century Fund, New York, 1963), Ch. pp. 58-72.

[28]For an underdeveloped region like the Northeast, were appropriately high inventories of raw material are the exception rather than the rule, a poor year in the production of raw material will significantly affect the coming year's industrial activities in those sectors linked to the primary sector.

[29]Production of cotton seeds was most affected.

[30]For an excellent analysis of the disruptive effect of the drought phenomenon on the region's social economic system, see "Grupo de Trabalho para o Desenvolvimento do Nordeste" (G.T.D.N.), op. cit., pp. 313-325.

[31]See Stefan H. Robock, op. cit., p. 52.

[32]The criterion for making this adjustment is discussed in the Appendix to this chapter. There we discuss: a) the rationale for working with eleven sectors only; b) the transformation of value added in VTI figures.

[33]Note that the 1959 capital stock is net of accumulated depreciation.

[34]As a matter of fact, the last procedure is used more often in the Brazilian economic literature. See O. Reboucas, op. cit., p. 65, and Jorge Jatobá, Politica de Precos, Mudánca de Tecnologia e Absorcão de Mão de Obra (PIMES--Universidade Federal de Pernambuco, 1977), pp. 161-162. (This work is a translation of Jatoba's Ph.D. dissertation, Vanderbilt, 1974, pp. 1-185.)

[35]See T. Barna, "On Measuring Capital," in The Theory of Capital--I.E.A., op. cit., pp. 75-94.

[36]J. R. Hicks, "The Measurement of Capital in the Relation to the Measurement of Other Economic Aggregates," in The Theory of Capital, I.E.A., op. cit., pp. 18-31.

[37]S. Kuznets, Economic Growth and Structure--Selected Essays (W. W. Norton & Company, Inc., New York, 1965), p. 34.

[38]A similar procedure was followed by R. Bonelli in his treatment of Brazil's capital stock. R. Bonelli, op. cit., p. 195.

[39]The level of capacity utilization will be discussed in the next section. Figures for capital-output ratios of new and modernization projects, as well as the corresponding planned investment, are available in Goodman and Cavalcante, op. cit., Ch. IX, Tables IX.14 and IX.15, pp. 249-251. The weights are given by the proportion of each category of planned investment on the total investment.

[40]Even here, however, it is hard to visualize an old factory undergoing substantial modernization on top of old equipment. Basically, the modernization drive, whenever substantial, does imply the replacement of at least part of

the equipment. Thus, data on realized modernization investment do reveal indirectly the magnitude of the accumulated depreciation.

[41]These figures were adjusted to 1970 constant prices. For primary data on realized modernization investment, see Goodman and Cavalcante, op. cit., Ch. XII.

[42]Ibid., p. 283, Table IX.

[43]Both BNB and SUDENE financing provided strong incentives for managers to buy new, and scrap old, equipment. In general, the program demanded the replacement of old equipment for two reasons. First, modernization was not meant to increase capacity. Second, the replaced machinery could not be resold to other plants; i.e., it had to be literally scrapped. See, Pesquisa sobre a Industria Textil do Nordeste (MINTER-SUDENE, Recife, 1971), pp. 25-29. A similar program for the South was not available. As indicated by Bergsman, the decrease in that region's average equipment life for the Textile sector was achieved more through new plants than modernization of old ones. See Joel Bergsman, Brazil--Industrialization and Trade Policies (Oxford University Press, New York, 1970), p. 137.

[44]The depreciated figures for both sectors are 422.732 and 732.754 thousands of CR$ at 1970 prices for the Non-Metallic and Textiles sectors, respectively.

[45]Similar figures were not available for the South. We decided that this fact poses no particular problem, since the South's capital/output ratio can be considered fairly low. First, the observed ratios for the South are systematically lower than Northeast's. Second, they are, in general, lower (though by a small amount) than Bonelli's (see Table I). The same is true if we compare these estimates with those by W. Baer (see Table II). Third, if S. Kuznets' low limit of 3 to 1 for capital/output ratio is chosen as a basis of comparison, the South's estimates look even lower. For the Northeast, in four sectors, Hides and Skins, Paper and Cardboard, Textiles, and Printing, the capital/output ratios are higher than 3 to 1.

[46]It should be noted that by assuming a straight line depreciation and equal life for capital in both regions, this proportionality assumption was implicity made.

[47]For complete information on the procedure and its limitations, see, for the South, "18ª Sondagem Conjuntural," in Conjuntura Economica, vol. 25, n. 3, 1971, pp. 68-75. For the Northeast, see "Sondagem Conjuntural na Industria de Transformacão," in Revista Economica, II (7) Jan./March, pp. 73-90.

[48]This question will be further discussed in Ch. VIII.

[49]It is interesting to note that Northeast per capita income was 60 per cent lower than the national figure, the South's level was 35 per cent higher. Moreover, as argued in SUDENE's IV Master Plan, the regional income was not only low but also poorly distributed. See on this, Goodman and Cavalcante, op. cit., p. 177.

CHAPTER V

RATES OF RETURN AND THE COST OF CAPITAL

V.1 - Introduction

The "computation of the cost of capital is a very tricky business."[1] This is so partly because there is no explicit transaction cost between the sale and purchase of capital services.[2] There would be no difficulty if all capital units were rented instead of owned, the rental rate being a good measure of capital price. Since all units are not rented, an alternative measure has to be found.

In empirical studies, the gross rate of return has been the most common measure of capital cost.[3] However, measurement errors, lack of adequate data, and problems of definition of capital rentals, make empirical estimates of gross rates of return an unreliable "proxy" of capital cost. In Brazil these problems are compounded because there have been changes in economic structure, creating measurement errors, especially in the rate of return. In this chapter we develop an alternative "proxy" for relative capital cost. First, we discuss the gross rate of return, as well as the reasons for rejecting such estimates as "proxies" for capital cost. Second, an alternative "proxy" for relative capital cost, based on the proportion of subsided capital in Northeast capital stock is discussed. Finally, we deal with the importance of internal and outside financing.

V.2 - An Inter-Regional Comparison of Rates of Return on Fixed Capital

From a theoretical point of view, rates of return on capital[4] should be higher in the Northeast than in the South, since the capital/labor ratio is expected to be lower in the less developed regions than in more developed ones.[5]

Our empirical results, however, are not consistent with this hypothesis. Data in Table I show that, except for the Machinery and Rubber sectors, rates of return are higher in the South. Moreover, the across-region differences are higher than 50 per cent for most of the sectors (see Column 3). For instance, for ten of twenty-one sectors, the rates of return in the South are up to two times greater than in the Northeast. For the Printing and Plastics sectors this differential is more than three. In the remaining sectors, the across-region differences are equal to or 50 per cent greater in the South. These rather large differences in rates of return are not likely to be explained by differences in capital/labor ratios because, if this was the case, both capital/labor ratios and wage rates would be higher in the Northeast than in the South.

TABLE I

RATES OF RETURN--1970

(%)

Sectors	NE (1)	South (2)	(2)/(1) (3)	(2)/(1)* (4)
Non-Metallic	31(29)**	35	1.129	1.154
Metallurgy	24	30	1.250	1.119
Machinery	46	48	1.043	.954
Electrical Material	27	45	1.667	1.379
Transportation Equipment	14	26	1.857	.823
Lumber	14	21	1.500	1.360
Furniture	18	40	2.222	1.782
Paper and Cardboard	11	31	2.818	2.564
Rubber	22	57	2.591	2.127
Hides and Skins	07	16	2.286	1.807
Chemicals	21	42	2.000	1.821
Pharmaceuticals	40	111	2.775	2.553
Cosmetics	30	121	4.033	4.180
Plastics	24	71	2.958	2.814
Textiles	12(10)**	24	2.000	1.560
Clothing and Footwear	46	56	1.217	1.141
Food	21	32	1.524	1.314
Beverages	20	24	1.200	1.068
Tobacco	83	84	1.012	.975
Printing	11	37	3.364	3.061
Miscellaneous	38	64	1.684	1.633

Sources: Industrial Census, 1970 and Table II, Ch. IV.

* Here the Northeast rates of return were adjusted for the level of capacity utilization.

** Rate of return estimated with non-depreciated capital stock.

As we show in Chapter VI, this is not true. Thus, factors other than capital/labor ratios, which include measurement errors, capacity utilization, product-mix differentials, and degree of monopoly, may also partly explain these differences in rates of return.

Consider first capacity utilization. At less than full capacity, the marginal physical productivity of both capital and labor is adversely affected,[6] as are the rates of return. Since the average level of capacity utilization is lower in the Northeast than in the South, the low absolute value of the Northeast's rates of return can be partly explained by this. To check this, we first divided the Northeast level of capacity utilization by the South's level by sector and then multiplied this by the South's relative rates of return (see column 3).[7] The adjusted South's relative rates of return are shown in column 4: little is changed. For three sectors only--Transportation, Hides and Skins and Textiles--was the hypothetical gain (loss) in the Northeast's (South's) relative rates of return above 20%. Even here, the differentials between both regions remained high.

Considering the product mix argument, and assuming that different products sell for different prices, price indices on industrial products, if available by region, would provide an empirical test of this hypothesis. Since such data are not available,[8] an alternative test is to investigate whether aggregation of data has any bearing on the observed across-region differences in rates of return.[9] Data in Table II show that for only six branches out of forty-six did Northeast rates of return become higher than in the South. For the remaining branches the changes were not substantial. Exceptions to this are found in the Metallurgy, Electrical Material and Transportation sectors. This is not surprising, since it is in these sectors that product mix differences can be more important. Heavy machinery, appliances, electrical motors, vehicles, and their parts, for example, are produced in the South only. Moreover, except for the Metallurgy sector, the branches covered are not representative of these sectors' output since only two branches in the Electrical Material and one branch in the Transportation sector were covered by our data. This can also be said about the Lumber, Textile and Printing sectors. On the other hand, for those sectors where product mix differentials are presumably not significant, such as the Non-Metallic, Furniture, Clothing and Food sectors, not much change is observed between sectors and their respective branches. There is, therefore, some indication that differences in product-mix between regions explain part of the across-region differences in rates of return.

TABLE II

GROSS RATES OF RETURN--1970*

(%)

Branches	NE (1)	South (2)	(2)/(1)
24	35	28	.80
25	26	30	1.154
30	35	42	1.20
31	52	34	.654
32	23	33	1.435
34	30	30	1.000
43	23	28	1.217
63	26	33	1.269
73	30	29	.967
85	21	22	1.048
91	28	23	.821
94	27	26	.963
117	45	46	1.022
137	43	21	.488
173	9	10	1.111
186	15	26	1.733
204	17	22	1.294
205	16	34	2.125
209	14	9	.643
233	18	37	2.055
234	17	36	2.118
279	20	51	2.550
320	21	44	2.095
382	8	23	2.875
405	9	24	2.667

TABLE II (continued)

Branches	NE (1)	South (2)	(2)/(1)
414	48	57	1.187
416	49	58	1.184
417	47	56	1.255
426	42	52	1.238
427	33	53	1.606
437	23	34	1.478
438	18	35	1.944
440	23	31	1.348
446	17	32	1.882
453	23	31	1.348
461	15	35	2.333
464	15	31	2.067
472	23	34	1.478
474	24	33	1.375
477	23	32	1.391
478	25	34	1.360
484	17	31	1.823
490	20	28	1.400
499	16	22	1.375
512	7	38	5.428
557	33	61	1.848

Sources: Industrial Census--1970

(*) In the case of the Non-Metallic and Textile sectors their capital stock and their component branch capital stock are net of depreciation.

Consider next measurement errors in capital stock. The relatively high across-region differences in gross rates of return, both at the two-and less-than-two digit level of aggregation, are a possible indication that the Northeast's capital stock could be relatively overestimated. But, as is argued in Chapter IV, section IV.4, this is not likely to be correct. Consider Martone's estimates,[10] which are based upon income tax on fixed capital and pre-tax profits for the 1972 fiscal year. These data indicate that (see Table III) except for Cosmetics, Pharmaceuticals, and Textile sectors, the rates of return are systematically higher in the South (see column 3). Thus, whatever the errors in our measure of capital stock, the across-region differences in rates of return are largely independent of the particular method or source of data for estimating regional capital stock and gross rate of return.

For B. S. Minhas,[11] the low yields on capital stock in less-developed countries or regions are fundamentally related to lower efficiency in use of inputs, which is consistent with the low labor productivity in the Northeast. Whatever the case, rates of return are lower in the Northeast.

The high observed differences in rates of return indicate that it is not appropriate to consider these rates as a "proxy" for capital cost, since it is unlikely that capital cost differs that much between regions. Thus, an

TABLE III

RATES OF RETURN, 1972

(%)

Sectors	NE (1)	South (2)	(2)/(1)
Non-Metallic	12	34	2.833
Metallurgy	12	32	2.667
Machinery	23	67	2.913
Electrical Material	48	63	1.312
Transportation Equipment	5	50	10.00
Lumber	34	60	1.765
Furniture	53	95	1.792
Paper and Cardboard	19	28	1.474
Rubber	47	56	1.191
Hides and Skins	46	77	1.674
Chemicals	24	30	1.250
Pharmaceuticals	62	54	.871
Cosmetics	126	99	.786
Plastics	30	62	2.067
Textiles	38	36	.947
Clothing and Footwear	72	88	1.222
Food	25	34	1.360
Beverages	11	44	4.000
Tobacco	52	187	3.596
Printing	39	52	1.333
Miscellaneous	56	80	1.428

Source: Celso Martone, op. cit., Table II.5, p. 79.

alternative measure of relative capital cost, discussed below, is desirable.

V.3 - An Alternative Measure of Capital Cost

As argued by Miller and Modigliani ". . . under conditions of perfect certainty, the assumption on which most of Neo-Classical theory has been developed, the concept of the cost of capital presents no particular difficulty. It is simply the market rate of interest."[12] Assuming perfect certainty to prevail in both regions, the market rate of interest for each region could then be taken as a measure of capital cost. In this case, it could be assumed that capital cost would be equal (or approximately so) for both regions since lending rates on borrowed capital differ little between regions.[13] This assumption is incorrect: first, current gross investment in Brazil is partly financed by internal funds; second, the main source of credit for Brazil's private manufacturing sector is official banks, which have subsidized rates of interest.[14] Thus, capital costs can differ between regions due to different proportions of these credits in total gross investment in each region. Third, and most important, SUDENE's fiscal incentives to the Northeast are substantial.[15] Since fiscal incentives are not available to the South, capital costs become unequal between the two regions. Of the three reasons, only the third poses a substantial threat to our assumption of equal capital cost in both regions. In what follows, we deal first with SUDENE's fiscal incentives and then with the role of internal funds and official banks.

V.3.1 - SUDENE's Fiscal Incentives and the Northeast's Relative Capital Cost

Our main contention is that, if it were not for SUDENE's fiscal incentives, \$1.00's worth of capital in the South would approximately equal \$1.00's worth in the Northeast. SUDENE's incentives, however, by providing free funds to firms in the Northeast, reduce the actual cost. The divergence in the capital costs between the regions will depend on the proportion of SUDENE's funds in the total investment. The higher that proportion the lower will be the cost of capital in the Northeast.

The ratio of \$1.00's worth of capital (assumed proxy for the capital cost in the South) to the adjusted \$1.00's worth in the Northeast will be our new "proxy" of relative capital cost.[16] This measure of relative capital cost is not problem-free. First, no data on the proportion of SUDENE's capital funds to realized[17] investment are available. If this proportion differs between realized and planned investment, Northeast capital cost will have a bias, which cannot be determined. Second, realized, rather than planned investment was considered, and in general, realized investment is higher. If the difference is met by the entrepreneur's own capital,[18] underestimation of capital price occurs. Third, no data on realized investment and on the proportion of SUDENE's incentives on fixed capital are available for lower than two-digit level of aggregation. Thus, the two-digit level will be assumed to hold over the subdivisions (branches) of industrial sectors. If SUDENE's incentives were channeled to some specific branches, their cost estimates would be biased upward, and underestimation would occur for the remaining branches of the sector.

The procedure used to estimate the Northeast's capital cost was as follows. First, we estimated realized fixed capital investment through SUDENE's fiscal incentives. Total figures on new and modernization projects were multiplied by 68 and 63 per cent respectively, to obtain the fixed investment component of the total.[19] Second, fixed realized investment in 1968 for the whole region was assumed to be equal to 1969 realized investment in Ceará, Pernambuco and Bahia.[20] Third, the fixed capital thus obtained was multiplied by the share of SUDENE's financing in the total planned (not realized) investment,[21] which gives us the total fixed capital invested with zero cost. Finally, this figure was subtracted from and then divided by our estimates of 1970 capital stock.[22] Thus, the reciprocal of the actual proportion of capital subsidy in Northeast for the 1970 capital stock can be written as

$$X' = K^i_{70} - \{[K^i_N\ (1-K_{wN}) + K^i_M\ (1-K_{wM})]\ X\}\ /\ K^i_{70}$$

where

K^i_{70} is the i^{th} sector capital stock,

K^i_N is the i^{th} sector realized investment on new projects,

K^i_M ibid., for modernization projects,

X is the share of SUDENE's financing in the total planned investment,

$K_{wN,M}$ are respective fractions of working capital on SUDENE's total realized investment.

Data in Table IV, column 1, show the proportion of subsidies in the total planned investment under SUDENE's fiscal incentives mechanism. Column 2 shows the realized investment in fixed capital under SUDENE's fiscal incentives program. In column 3, we find the reciprocal of the actual proportion of SUDENE's subsidy X' in the Northeast's 1970 capital stock by sector. Finally, column 4 shows our proxy for the South's relative capital cost.

Column 4 shows that for only six sectors, Metallurgy, Machinery, Transportation, Electrical Material, Plastics and Clothing, was the South's capital cost equal to, or higher than 30 per cent of that in the Northeast, and for only two

TABLE IV

SUDENE'S INCENTIVES, REALIZED INVESTMENT AND

RELATIVE CAPITAL COST--1970

Sectors	X*	Fixed Realized Investment CR $1.000,00	X'*	1/X'
	1	2	3	4
Non-Metallic	41	167.077	85	1.176
Metallurgy	36	192.564	68	1.470
Machinery	53	13.161	77	1.299
Electrical Material	43	57.831	71	1.409
Transportation Equipment	48	77.815	57**	1.754
Lumber	42	21.640	88	1.136
Furniture	50	1.450	99	1.010
Paper and Cardboard	51	5.690	95	1.052
Rubber	39	5.803	87	1.149
Hides and Skins	46	6.579	93	1.075
Chemicals	39	208.359	92	1.087
Pharmaceuticals	55	-	100	1.00
Cosmetics	43	-	100	1.00
Plastics	40	15.993	70	1.428
Textiles	32	148.135	94	1.064
Clothing and Footwear	51	36.548	72	1.389
Food	42	39.489	99	1.010
Beverages	33	-	100	1.010
Tobacco	25	5.477	98	1.020
Printing	39	1.451	100	1.00
Miscellaneous	51	811	97	1.031
TOTAL	40	1.005.873	-	-

Sources: 1) Table II in Ch. V; 2) Goodman and Cavalcante, op. cit., Table IX.3, pp. 224-225.

*) See definition in the text.

**) For this sector, data on "planned inevestment was used.

sectors, Non-Metallic and Lumber, was the South's capital cost higher than 12 per cent of that in the Northeast. Among these sectors, a heavier dependence on SUDENE's funds is found for Transportation, Plastics and Electrical Materials. For the remaining sector, the difference in capital cost is lower than 10 per cent, and for some sectors, for example, Beverages and Food, that difference is either absent or insignificant. This fact indicates that the importance of SUDENE's funds in lowering the cost of capital in the Northeast depends not only on the amount of the funds, but also on the sector's capital stock.[23] Thus, our X' figures are systematically lower than X, as can be seen by comparison of columns 1 and 3 in Table IV. Finally, by contrasting the results in Table IV, column 4, with those in Table I, column 3, we can see that the across-region difference is not as large as the rates of return. For this reason, also because of the independence of these estimates of capital rentals, we have taken the data in column 4 as a proxy for relative capital cost.

V.3.2 - <u>The Role of Internal Funds and Official Bank Financing in the South Relative Capital Cost</u>

As argued in section V.3, a large part of current gross investment in Brazil is financed by internal funds and by credit from official banks. In this section we show that this basically does not affect our estimates of the South's relative capital cost.

First, consider the question of internal funds. Data on retained earnings and gross fixed investment in Brazil's private industry for the 1953-1960 period[24] indicate that the proportion of retained earnings to fixed investment varied from 46 to 88 per cent between 1953 and 1960. The simple average for the entire 1953-1960 period was 61 per cent and 75 per cent for the 1958-1960 period. Though these figures indicate the importance of self-financing in Brazil's fixed investment, they could underestimate the actual proportion between internal funds and fixed investment since depreciation allowances are not included.

The proportion of depreciation in total investment (fixed plus working capital) has been estimated to be 6.8 per cent for the 1959-1962 period in Brazil's private manufacturing sector.[25] This figure, however, is underestimated. First, as argued by D. Huddle,[26] it is computed as a proportion of capital book value at historical cost of acquisition. Second, as a ratio of depreciation changes to total capital, it underestimates the importance of depreciation for fixed capital formation. Thus, on both counts, the 6.8 per cent figure is downward biased.

As discussed in Chapter III, section IV, data on actual depreciation charges are not available. Since we assumed an average life of 10 years for capital stock, we will assume here that depreciation of fixed capital is 10 per cent per year. Adding this figure to the simple averages, we have estimated that the per cent of self financing on gross fixed capital formation will be increased to 71 and 85 per cent for the 1953-1960 and 1958-1960 periods, respectively. In either case, a significant share of Brazil's private manufacturing gross fixed capital is internally financed. This becomes even more important after 1964 when fixed asset revaluation was included.[27] This revaluation is linked to changes in price level and is determined by the monetary correction index on government bonds,[28] as fixed by the Ministry of Planning. Thus, the relative importance of asset revaluation is equal for all regions and is at least in the 1964-1970 period, decreasing.

Addition of monetary correction to Brazil's average that we have computed will make our figures on the proportion of self financing unduly high. Thus, as a gross approximation to actual proportions, we will assume that 75 per cent of fixed capital is internally financed in Brazil. This figure, as indicated elsewhere,[29] is not uncommon in developed countries.

The high proportion of self financing in Brazil's private manufacturing sector indicates that little weight for the purpose of determining capital cost can be attached to external funds. Thus, to the extent that both the proportion and the cost of internal funds are the same in both regions, outside financing and the structure of interest rates will not impair our findings on the South's relative capital cost.

Let us consider the cost of internal funds. In general, internal funds, mainly own capital, are not costless since there is an opportunity cost of investing these funds in the firm. Assuming this is true, we can take the opportunity cost of capital on internal funds as approximate to the rates of interest on exchange bills paid to investors. The bill of exchange has low risk and offers a sure net gain over inflation.

Data from Banco Central indicate that the average monthly rate of interest paid to the investor (saver) was 2.16 and 2.10 per cent for the South and Northeast, respectively.[30] Thus, no great difference is observed in opportunity cost between both regions. A similar conclusion, using a different approach, was reached by Bacha.[31]

Consider now the proportion of self-financing. We first assume that the South's per cent proportion is equal (or approximately so) to Brazil's proportion, since we have no specific data for that region.[32] For the Northeast, use will be made of SUDENE's 1969 field survey of the new and modernization projects already in operation by December 1968.[33]

Table V shows the data on self-financing for both total projects (new and modernization) and modernization projects only. These data are divided into own capital, asset revaluation, and retained earnings proportion on fixed capital financing,[34] and refer to the 1966-68 period. First, the proportion of self-financing is high for both total and modernization projects but is decreasing. This is explained basically by the reduction in the share of asset revaluation (reflecting a decrease in monetary correction), since the share of own assets and retained earnings are approximately constant. If we assume the proportion of self-financing for modernization projects as an indicator of that region's manufacturing sector's actual proportion,[35] we can conclude that there is not much difference in the self-financing proportion between the Northeast and the South. More disaggregated data would be necessary for a more definite conclusion.

If across-region differences in self-financing are not a source of unequal capital cost between the regions, the composition of outside funds can be. SUDENE's fiscal incentives are such a source, as are the loans to both regions' manufacturing sectors by official banks. In the latter case, the region with a greater proportion of subsidized credits will have a lower capital cost in relation to the other region. Thus, it is relevant to know if one region has benefited more

TABLE V

SOURCES OF INVESTMENT FUNDS AS A PROPORTION OF FIXED CAPITAL FINANCING--SUDENE'S TOTAL AND MODERNIZATION PROJECTS

Source	Total Projects			Modernization Projects		
	1966	1967	1968	1966	1967	1968
Own Resources	.357	.344	.320	.339	.336	.338
Asset Revaluation	.264	.230	.186	.407	.342	.312
Retained Earnings	.040	.047	.049	.055	.047	.050
TOTAL	.661	.621	.556	.801	.725	.700

Source: Resultados do Programa de Industrializacão, _op. cit._, Statistical Appendix, Table I.

than another in terms of subsidized credits from the official banks.

The most important official bank is the BNDE (National Economic Development Bank) because of its predominant role as a source of credit for Brazil's private manufacturing sectors.[36] Given the predominance of the South's manufacturing sector, it is certain that this region gets the larger share of the absolute value of credit from the bank. However, it is not certain that the proportion of credit to each region's capital stock will differ much between the regions. To check this, we considered the flow of credit from BNDE to Brazil's manufacturing sector in 1965-69, as available in Bacha's study,[37] and found no information on the distribution of credits by region. Fortunately, a recent study on the origins of regional inequality in Brazil[38] gives the distribution of BNDE credit by states and by regions. Though this information is complete for the South, for the Northeast, it is available only for Pernambuco and Bahia. We then added the information for each of the states (three) in the South and in the Northeast and, considered the total regional percentage, a procedure posing no particular problem. This is true because the difference between the percentage of both Pernambuco and Bahia from that of the Northeast is not large, and, Ceará is likely to be the most important recipient of BNDE's credits after those two states.

Once these steps were taken, the distribution by region and year, of BNDE credit to the manufacturing sector was calculated. Finally, the yearly flow of credit by region was added. This total volume of credit by region in the 1965-69 period is shown in Table VI.

As indicated in Table VI, the volume of credit to the South was eleven times greater than that of the Northeast. This pattern of distribution is basically determined by the FRE (Fundo de Reparelhamento Economico) credit distribution, since for both FIPEME (Fundo de Financiamento para a Pequena e Media Industria-Operacões Diretas) and Repasses[39] the share is even larger. For FINAME (Agencia Especial de Financiamento Industrial), the South's share is only seven times greater than the Northeast's.

The large share of BNDE funds accruing to the South does not mean that the proportion of BNDE's credit for 1970 capital stock is higher in the South than in the Northeast. On the contrary, that proportion is similar for both regions, 5.5 and 7.4 per cent for the South and Northeast, respectively. This result allows us to draw two important conclusions: First, subsidized credits from BNDE do not distort our measure of relative capital cost. Second, since BNDE is by far the most important credit institution for Brazil's manufacturing sector, the low observed proportions indicate that outside financing is not an important source of funds

TABLE VI

BNDE--DISTRIBUTION OF OPERATIONS BY SOURCES* (1965-69)

(CR $1.000,00--at 1970 prices)

Sources	Northeast	South
FRE	265.071	2.951.043
FINAME	97.021	765.472
FIPEME	8.226	442.419
REPASSES	5.420	104.080
TOTAL	375.739	4.263.014

Sources: E. Bacha and others, Análise Governamental, op. cit., Table I.3, p. 31

Efeitos Espaciais, op. cit., Tables 4.10, 4.13, 4.14, 4.20, pp. 190-205.

(*) We have excluded other sources which are not directly involved in financing capital formation. For the excluded sources and their amount see E. Bacha, Análise Governamental, op. cit., pp. 32-57.

for fixed investment. It is true that there are alternative sources of subsidized capital in Brazil, a typical example being the BNB (Bank of Northeast Brazil), the second most important development bank in the country. Since its area of influence is restricted to the Northeast, any influence it can have is to increase the South's relative capital cost. In other words, our figures, as shown in Table IV, could be underestimated, which may not be important. First, the proportion of BNB credit in the total capital (BNB finances both fixed and working capital) in SUDENE's survey, was around 5.5 per cent for all the years considered, for both total and modernization projects. Second, in the South, there are also alternative sources of subsidized credit such as the BRDE (Banco Regional de Desenvolvimento Economico) for the states of Rio Grande do Sul, Santa Catarina, and Paraná, and the BDMG (Banco de Desenvolvimento de Minas Gerais). Third, the BNB influence on Northeast's capital cost can just offset that region's disadvantages in terms of, say, transportation cost of equipment. In other words, since most of Northeast's equipment and machinery are imported from the South, transportation costs can make the same equipment cost more for the Northeast than for the South. Obviously, all these arguments are not enough to prove that other elements not considered are irrelevant in terms of regional capital cost. But they do indicate that the omission of these other elements may have no noticeable effect on our results.[40]

V.4 - Conclusion

Our main objective was to measure capital cost to obtain empirical measures of σ and J. First, we investigated the possibility of taking the gross rates of return by region and sector as "proxies" of capital cost. Measurement errors, market imperfections, and also the large across-region differences observed in those rates indicated that these estimates would be unreliable. An alternative measure (proxy) equal to the ratio of \$1.00's worth of capital to the adjusted \$1.00's worth in the Northeast was estimated. This measure, however, was not free of limitations, and we discussed some of these. Finally, we examined the influence of the structure of financing (internal vs. outside funds) of fixed capital through interest rate charges as a measure of relative capital cost. Our evidence shows that SUDENE's fiscal incentives were the one most important reason for lower capital cost in the Northeast compared to the South.

FOOTNOTES TO CHAPTER V

[1] J. R. Moroney, _op. cit_., p. 56. Difficulty in estimating rates of return was also stressed by Minhas. He stated that, "It is hard to overstress the inevitable inaccuracy of any estimates of return to capital. Since such estimates call not only for technical competence, but also good judgement, any claims to a large degree of objectivity are bound to be pedantic. "B. S. Minhas, _An International Comparison of Factor Costs and Factor Use_ (North-Holland Publishing Co., Amsterdam, 1963), Ch. 5, p. 55.

[2] On this question see T. Barna, "On Measuring Capital," in _Theory of Capital_, _op. cit_., pp. 75-76. See also Jorgenson and Griliches, _op. cit_., pp. 254-257, among others.

[3] See, for example, Jorgenson and Griliches, _op. cit_., 254-257; Arrow _et al_., _op. cit_., p. 235; J. R. Moroney, _op. cit_., pp. 56-60. See also F. Modigliani and M. H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," _American Economic Review_, vol. 48, n. 3, June 1958, pp. 261-297.

[4] Rates of return are defined to be equal to the ratio of property income (output less the total wage bill) to capital stock.

[5] For a discussion of this point, see Arrow, _et. al_., _op. cit._, p. 229; R. R. Nelson and others, _op. cit_., pp. 99-103, and Paul Samuelson, "The Surrogate Production Function," in _Review of Economic and Statistics_, vol. XXIX, n. 3, June 1962, pp. 193-206.

[6] See, on this, Lester C. Thurow, "Desequilibrium and the Marginal Productivity of Capital and Labor," _Review of Economics and Statistics_, vol. 50, n. 1, February 1968, pp. 23-31.

[7] In this procedure, we are implicitly assuming the South's actual level of capacity utilization as full capacity.

[8] There are data on price indices for agricultural products, more specifically, on price received by farmers at the state level. This is also true for the cost of living, but data up to 1970 were published only for the Southern states. See, for example, _Conjuntura Economica_, vol. 26, February 1972, pp. 206-216.

[9]Though information at the branch level is still reasonably aggregated, it is likely to minimize the product mix differences between regions. This effect is more pronounced when we consider the fact that only corresponding branches are taken into account, i.e., non-common regional branches are excluded.

[10]Unlike our study, his estimates refer to the whole region, i.e., all states in each region were included. However, for the South, he distinguished between S. Paulo and the remaining states in that region. To get around this problem, we have taken a weighted average of South (excluding S. Paulo) and S. Paulo rates of return. The weights were given by S. Paulo's proportion on the South's total (i.e., including S. Paulo) output. For original data, see Celso Martone," Efeitos Alocativos da Concessão de Incentivos Fiscais," in O Imposto sobre a Renda das Empresas ed. Fernando Resende (IPEA, Rio de Janeiro, 1975), pp. 53-94.

[11]B. S. Minhas, An International Comparison, op. cit., pp. 89-91.

[12]M. H. Miller and F. Modigliani, "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-57," American Economic Review, vol. 56, n. 3, June 1966, pp. 333-391.

[13]Commercial banks not only do not finance fixed capital, but their lending policies are set homogeneously throughout the country. Investment banks, which concentrate on financing consumer durable goods and working capital, act similarly. Though their lending rates for working capital can vary between regions, this does not affect our capital cost, since we are considering fixed capital only. It remains to be said that interest charges from commercial and investment banks are difficult to obtain. See, on this, Donald Syvrud, "Estrutura e Politica de Juros no Brasil," Revista Brasileira de Economia, vol. 26, n. 1, Jan./March 1972, pp. 117-139.

[14]The BNDE (National Bank of Economic Development) at the national level and the regional banks of development at regional and state levels are the main institutions financing fixed capital formation in Brazil. See, on this, Edmar L. Bacha and others, Análise Governamental de Projetos de Investimentos no Brasil: Procedimentos e Recomendacões (IPEA--Relatorio de Pesquisa, n. 1, Rio de Janeiro, 1971), pp. 23-89. Note that the BNDE has a unique lending rate for a given class of industrial project for the whole country. For the BNDE rates of interest, see, for example, Conjuntura Economica, vol. 27, June 1973, pp. 90-103.

[15]As a matter of fact, it is not all clear that SUDENE's funds are costless to the entrepreneur. Transaction costs are incurred by the entrepreneur applying for those funds. For some sources on the fiscal incentives mechanism and on the cost of capital (zero cost), see footnote 4, Ch. 1.

[16]This measure is what matters for our purposes.

[17]Realized investment refers here to those sets of projects approved by SUDENE and already in operation in December 1968. Planned investment refers to all projects approved even if not yet realized. See Goodman and Cavalcante, op. cit., Ch. 12, Table XIII.1, p. 346.

[18]This is possible since: first, inflation makes the planned investment fall short of actual needs; second, though the firms can reapply to SUDENE for more funds to offset changes in price levels, the process for receiving the needed additional capital is slow-moving. Thus, in between, entrepreneurs have to increase their share of own capital for maintaining their investment schedule.

[19]These percentages were obtained by considering the proportion of working capital to total capital, as shown by SUDENE's survey. See, Resultados do Programa de Industrialização até 1968 (Minter-SUDENE, Recife, 1972), Statistical Appendix, Table 1.

[20]This procedure differs from the one used in sec. IV.4. This change, however, has no noticeable effect on the results on the Northeast relative efficiency.

[21]Data on these proportions are available only for planned investment. See Goodman and Cavalcante, op. cit., Ch. IX, Table IX.3.

[22]As in the previous treatment of depreciation charges, the data on realized investment were adjusted to 1970 constant prices (see footnote 41 in Ch. IV).

[23]Contrasting the Machinery and Food sectors, for example makes this point more clear.

[24]The data on retained earnings and gross fixed investment are from D. L. Huddle, "Post-war Brazilian Industrialization: Growth Patterns, Inflation and Sources of Stagnation," in Eric N. Blaklanoff ed. The Shaping of Modern Brazil (Louisiana State University Press, Baton Rouge. 1969), p. 103.

[25] Our source was D. L. Huddle, Inflationary Financing, Industrial Expansion and the Gains from Development in Brazil. (Program of Development Studies--Rice University, 1975), paper n. 60, Table 1, p. 5.

[26] Ibid., pp. 5-7.

[27] See, on this, W. L. Ness, "Financial Markets, Innovation as Development Strategy: Initial Results from the Brazilian Experience," Economic Development and Cultural Change, vol. 22, n. 3, April 1974, pp. 453-472.

[28] For a discussion of government bonds in Brazil (ORTN) and monetary correction, see D. E. Syvrud, Foundations of Brazilian Economic Growth (Hoover Institution Press, Stanford, 1974), Ch. V.

[29] See Baasch and Kybal, Capital Markets in Latin America, as mentioned in D. L. Huddle, Inflationary Financing, op. cit. p. 5.

[30] These are monthly data and refer to the capitals of the states, only. Unlike the South, in the Northeast, the data cover only Recife. A simple average of both regions interest rates was computed. The maturity period of the bill of exchange was one year. The data refer to 1972 since there were no data for 1970 and 1971. See, Boletim do Banco Central, vol. 8, August 1973, p. 24.

[31] E. Bacha concluded that the opportunity cost for the manufacturing sector for both the Northeast and Brazil was equal to 15 per cent. His conclusion was based on data on gross rates of return. For Brazil, the data was based on the 500 largest corporations (including government corporations), and for the Northeast, they were based on SUDENE's new projects. See E. L. Bacha and others, op. cit., Part II, Ch. 1.

[32] This assumption is not as arbitrary as it may appear. First, a large proportion of Brazil's capital stock is concentrated in the South (see sec. IV.2.2). Second, the weight of this region in Brazil's manufacturing sector is high by any indicator.

[33] See Resultados do Programa de Industrializacão, op. cit., Statistical Appendix, Table 1.

[34] Proportions on fixed capital financing were obtained by excluding the proportion of short term financing on total financing. For primary data, see Resultados do programa de Industrializacão, op. cit., Statistical Appendix, Table III. Note that the data refer to the whole Northeast region.

[35] This assumption is not unreasonable since modernization projects are more representative of those plants that did not receive fiscal incentives from SUDENE.

[36] For a brief discussion of both regional and state development banks, see E. L. Bacha and others, op. cit., pp. 41-70.

[37] Ibid.

[38] Efeitos Espaciais da Politica Nacional de Desenvolvimento Industrial--unpublished monograph (Universidade Federal de Pernambuco, Recife, 1978), pp. 175-212.

[39] Repasses refers to BNDE funds (mainly from FIPEME) allocated to other official credit institutions. For a brief treatment of the so-called BNDE "system," see Efeitos Espaciais, op. cit., pp. 175-205.

[40] We have to note that we are referring in this section only to the aggregate manufacturing sector. This clearly limits us on the alternative sources of financing since as indicated by D. L. Huddle, the distribution of credit within the manufacturing sector for the 1954-64 period was uneven. However, his data refer to the whole of Brazil and no information by region is available. See D. L. Huddle, Inflationary Financing, op. cit., pp. 8-15.

CHAPTER VI

AN INTER-REGIONAL COMPARISON OF AVERAGE WAGES, FACTOR PRICES AND FACTOR PROPORTIONS

VI.1 - Introduction

From a microeconomic point of view, factor proportions under competitive conditions vary directly with relative factor prices (wage/capital cost). This follows from the basic principle that an entrepreneur faced with a set of factor prices and a set of "hypothetical" technological choices (ideally represented by an isoquant in the input space) achieves cost minimization by substituting a factor whose price has declined. If entrepreneurs in both regions are cost minimizers, across-region differences and capital/labor ratios will vary directly with inter-regional variation in relative factor prices. In this chapter we ask whether actual data on factor proportions and relative factor prices by region confirm the cost minimization hypothesis. First, we present and discuss the wage rate data and the inter-regional variation in factor prices and factor proportions. Second, we discuss the apparent inconsistencies in some sectors and branches.

VI.2 - Factor Prices and Factor Proportions

Empirical studies have indicated that average wages tend to be lower in a less developed region than in a more developed region (and country). This pattern is, in general, confirmed by our data on wage rates for both Northeast and South. As shown in Table I, on the average, the wage rates in the South are 55 per cent higher than in the Northeast.[1] At the sectoral level, the only exception to the average was the Chemical sector.[2] Variation (dispersion) around the mean was not significantly different between regions.[3] Table I (columns 1 and 2) also indicates that relatively high wage industries in the South are also relatively high wage industries in the Northeast. In fact, the standard deviations of the Northeast relative wage was only .16. This figure is reduced to .11 if the Northeast relative wage for the Chemical sector is excluded.

At a lower level of aggregation (see Table II), the picture changes very little. In only one branch (24) is the Northeast wage significantly higher than in the South, and in only two (173 and 499) are the Northeast and South wage level approximately equal. For the remaining branches, differences across regions in wage levels are substantial (see Table II, column 3). If inter-industry differences in relative wages are in general high, so are

TABLE I

WAGE DATA AND RELATIVE FACTORS PRICE

(CR $1.00)

Sectors	Wage Rate (1)		W_1/W_2	W_1/W_2 Prod. Workers	Relative Factor Prices (2)	Relative Wage in U. S. A. (3)
	W_1	W_2				
Non-Metallic	1.03	1.63	.629	.617	.740	.83
Metallurgy	1.45	2.22	.651	.612	.958	.88
Machinery	2.02	2.86	.705	.685	.916	.90
Electrical Material	2.05	2.62	.780	.603	1.099	.92
Transportation Equipment	1.62	3.25	.499	.476	.875	.93
Lumber	1.01	1.30	.788	.780	.884	.56
Furniture	1.00	1.83	.546	.599	.552	.77
Paper and Cardboard	1.22	2.28	.536	.489	.565	.98
Rubber	1.26	2.39	.527	.479	.606	.92
Hides and Skins	1.22	1.88	.644	.764	.693	.86
Chemicals	3.83	3.34	1.146	.573	1.246	.97
Pharmaceuticals	1.67	3.40	.491	.586	.492	**
Cosmetics	1.15	2.62	.440	.405	.440	**
Plastics	1.67	1.91	.875	.743	1.250	.92

TABLE I (continued)

Sectors	Wage Rate (1) W_1	Wage Rate (1) W_2	W_1/W_2	W_1/W_2 Prod. Workers	Relative Factor Prices (2)	Relative Wage in U. S. A. (3)
Textiles	1.22	1.66	.731	.714	.778	.79
Clothing and Footwear	.85	1.30	.649	.599	.902	.77
Food	.95	1.61	.590	.612	.596	.78}
Beverages	1.68	2.23	.756	.772	.756	
Tobacco	1.41	2.71	.520	.540	.531	1.24
Printing	1.67	3.11	.538	.522	.538	.87
Miscellaneous	1.10	2.01	.547	.510	.564	.79
Total	1.48*	2.29*				

Sources: 1) FIBGE Industrial Census, 1970.
2) DNMO-FIBGE--Mercado de Trabalho--Composicão e Distribuicão de Mão de Obra.
3) Table IV, Ch. V.

1) Average wage per man/hour
2) Relative here and henceforth is to be understood as the ratio of Northeast relative factors price (or whatever variable is considered) to the South relative factors price.

* $\overline{W} = \sum_{i=1}^{n} Wi/n$ where n = number of sectors

** There are no corresponding data.

3) Source: J. R. Moroney, op. cit., Table 6.1, p. 132.

TABLE II

WAGE DATA AND RELATIVE FACTORS PRICE*

(CR $1.00)

Branches	Wage Rate		W_1/W_2	W_1/W_2 Prod. Workers	Relative Factor Prices
	W_1	W_2			
24	3.668	1.622	2.261	2.223	2.260
25	1.108	1.680	.660	.689	.776
30	.412	1.313	.314	.392	.369
31	.397	1.538	.258	.291	.304
32	.292	.615	.475	.484	.558
34	1.070	1.645	.651	.610	.765
43	1.135	1.464	.775	.668	.912
63	1.685	2.400	.702	.604	1.032
73	1.579	2.372	.666	.753	.979
85	1.678	2.411	.696	.634	1.024
91	1.378	2.085	.661	.606	.972
94	1.056	1.863	.567	.578	.833
117	2.346	3.075	.763	.654	.991
137	2.042	3.089	.661	.756	.859
173	3.735	3.871	.965	1.099	1.359
186	2.173	3.364	.646	.638	1.133
204	.954	1.077	.886	.873	1.006
205	.780	1.013	.770	.772	.875
209	.948	1.574	.603	.614	.685
233	.973	1.513	.643	.621	.649
234	.924	1.455	.635	.617	.641
279	1.251	1.551	.806	.770	.926
320	1.479	1.699	.870	.769	.946

TABLE II (continued)

Branches	Wage Rate		W_1/W_2	W_1/W_2 Prod. Workers	Relative Factor Prices
	W_1	W_2			
382	1.306	1.623	.804	.789	.856
405	1.134	1.584	.716	.634	.761
414	.868	1.345	.645	.588	.896
416	.654	1.348	.485	.338	.673
417	.881	1.318	.668	.664	.928
426	.806	1.240	.650	.639	.902
427	.755	1.233	.612	.571	.850
437	.839	1.563	.536	.507	.542
438	.731	1.244	.588	.521	.593
440	.892	1.580	.565	.607	.571
446	.703	1.449	.485	.471	.490
453	.861	1.580	.545	.593	.550
461	1.491	1.542	.967	.806	.976
464	1.081	1.826	.558	.551	.563
472	.764	1.105	.691	.729	.698
474	.888	1.522	.583	.568	.589
477	1.179	2.043	.577	.635	.583
478	1.269	2.245	.577	.656	.583
484	1.087	1.925	.565	.573	.571
490	1.019	1.146	.889	.747	.889
499	2.199	2.123	1.036	.927	1.036
512	2.147	4.047	.530	.477	.530
557	1.655	1.988	.833	.586	.858

Sources: See Table I.

* See footnotes to Table 1.

the differences for inter-branches of different industries. This is not necessarily true, however, for inter-branch differences within the same industry.

It is interesting to point out that, except for the Non-Metallic sector, inter-branch variations in relative wages are not significant. This is particularly true for the Metallurgy, Lumber, Clothing and Food sectors. Thus, within-branch stability in relative wages seems to indicate that there is a tendency for wage levels to remain fixed in the Northeast and the South. In other words, inter-branch proportionality in wage rates across regions seems to remain steady. A direct implication of this is that differences in labor market conditions between regions remain quite stable at the branch level. To a lesser extent, this holds true when the absolute level of wages at the sectoral level is compared to that of its component branches. In other words, labor market conditions at the sectoral level do not seem to depart from those prevailing at a lower level of aggregation.[4]

A second feature of the data in Table I and II is the high across-region differences in Brazilian nominal wage rates. Differences in nominal wage rates between countries have been observed to be high, but across-regions, the opposite is usually true.[5] Data on inter-regional wages for the United States, for example, show (see column 6 of Table I) that, except for the Lumber sector, nominal wage differentials are generally lower than between the Northeast and the South in Brazil.[6] Still narrower differentials were found by Griliches for manufacturing in Norway.[7]

We wish to comment on the large differences found in the average wage level in Brazil, since these reflect differences in industrial structure and in competitive conditions. Differences in average wages in Brazil can be the result of regional skill mix, average labor productivity and institutional factors, all dealt with briefly below.

First, the minimum wage in 1970 was 20 per cent lower in the Northeast than in the South. Though the actual differences in wages in Brazil are larger, it is likely that the across region differences in wage rates would be smaller if the minimum wage were the same for both regions. Second, as discussed in Chapter I (see sec. I, Table I), labor productivity is systematically lower in the Northeast than in the South. For some sectors like Transportation Equipment, Pharmaceuticals and Cosmetics, the Northeast's labor productivity was 62 per cent lower than the South's. However, as we compare the relative wage and relative productivity data, we see that the Northeast's relative wage is not as low as the Northeast's relative productivity[8] for any sector. This indicates that either the Northeast's average wage is set above its average productivity, or that the opposite is true for the South. In either case, labor productivity explains little of the Northeast's low relative wage.[9] The skill-mix argument, based upon the average years of schooling[10] for the Northeast and the South, as estimated by Sahota and Rocca,[11] also seems irrelevant (see Table III). The average years of schooling are, except for the Plastics sector, systematically lower in the Northeast than in the South. Moreover, the observed differences in the years of Northeast relative schooling are lower than the differences in the Northeast relative average wage.

The highest difference in average years of schooling was observed for the Paper and Textile sectors. While for the Paper sector, wage differences are greater than suggested by skill differences,[12] the opposite is true for the Textiles. For the remaining sectors, average years of schooling differences are lower than wage differences. For some sectors like Plastics, Transportation Equipment and Pharmaceuticals, average years of schooling are much lower. Thus, there is not a close positive association between wage and skill differences, and, at a more aggregated level for the manufacturing sector, the association was not verified.[13]

TABLE III

AVERAGE YEARS OF SCHOOLING AND NORTHEAST RELATIVE

QUALITY-BASED INDEX

(1971-1972)

Sectors	Average years of schooling NE (a)	Average years of schooling South (b)	(a) / (b)	Northeast Relative Quality-based Index
Non-Metallic	2.86	3.96	.722	.928
Metallurgy	3.18	4.32	.736	.922
Machinery	4.37	4.75	.920	.965
Electrical Material	4.37	4.75	.920	.965
Transportation Equipment	3.74	5.04	.742	.917
Lumber	2.92	3.50	.834	.957
Furniture	3.09	4.03	.767	.936
Paper and Cardboard	3.23	4.69	.689	.900
Rubber	3.69	4.53	.814	1.172
Hides and Skins	3.12	3.96	.788	.938
Chemicals	5.67	5.77	.983	.992
Pharmaceuticals	5.67	5.77	.983	.992
Cosmetics	5.67	5.77	.983	.992
Plastics	4.80	4.51	1.064	1.014
Textiles	2.81	4.04	.695	.908
Clothing and Footwear	3.58	4.28	.836	.944
Food	3.56	4.07	.875	.966
Beverages	3.15	3.73	.844	.953
Tobacco	3.49	4.63	.754	.918
Printing	5.02	5.52	.909	.967
Miscellaneous	-	-	-	-

Source: 1) G. S. Sahota and C. A. Rocca, op. cit., Table A1, p. 106.

(-) Not available.

Sahota and Rocca have also computed a "quality-based" index for the labor force in the South and the Northeast.[14] Drawing upon their results, we computed the Northeast's relative "quality-based" index, and found that the observed inter-regional variation for skill was even narrower than before (see column 4, Table III). For two sectors, Rubber and Plastics, the index was higher in the Northeast than in the South. For the remaining sectors, "the quality-based" index was only slightly lower in the Northeast. In fact, for most of the sectors, the Northeast's "quality-based" index was only 5 per cent lower than the South's. Assuming that the "quality-based" index is a better indicator of labor skill than the average years of schooling, the inability of skill mix to explain average wage differences in Brazil is evident.[15]

Though years of schooling are often used as a proxy for skill level, on the job training, i.e., years of experience, can be more important in determining the wage level. Data on average monthly wage by length of time in the firm, as computed by Macedo[16] (see Table IV), indicate that both the average wage and the inter-regional wage differential increase as the length of time in the firm increases. If we assume that on the job training is positively associated with the length of time spent by a worker in the firm, we can say that informal education is a relevant factor in

TABLE IV

BRAZIL: AVERAGE MONTHLY WAGE IN THE INDUSTRIAL SECTOR OF DIFFERENT STATES, CLASSIFIED BY LENGTH OF SERVICE IN THE FIRM--1965 - CR$

	Length of service in the firms (years)						
	<1	1-3	4-8	9-14	15-19	20-29	30 & up
São Paulo	82.7	99.1	127.7	127.1	142.5	154.0	196.5
Minas Gerais	66.7	80.4	97.1	107.7	109.9	119.3	95.3
R. G. do Sul	65.0	74.9	86.9	101.9	107.6	103.3	156.0
Pernambuco	64.1	72.1	72.2	67.0	74.6	75.1	106.5
Bahia	57.0	75.6	75.6	85.8	93.0	56.9	116.1

Source: R. Macedo, op. cit., Table 4.4, p. 145.

explaining across-region differences in wage rates. However, more data and in-depth research on this topic would be necessary to arrive at a more definite conclusion.

The weakness of the skill-mix hypothesis is even more evident if we consider the data on average wage rate for production workers only (see column 4 of Tables I and II). We see that, for most sectors and branches, the across-region differences are still larger than when total employees' average wages are considered. Though the differences between both sets of relative wages are not large, they reinforce the basic fact that labor cost in the Northeast is much lower than in the South.

If, from a macroeconomic point of view, lower labor costs in one region or country means this region has more labor relative to demand than in another, from a microeconomic point of view, this should indicate a more intensive use of labor relative to capital in this region than in the other. In fact, in Moroney's study,[17] wage rate differentials were related to capital/labor differentials between regions. This is a proper approach only where capital price differences across regions do not exist, or are insignificant. As discussed in Chapter V, capital prices do differ between the Northeast and South, and, contrary to expectations, they have been generally lower in the Northeast.

The extent to which lower capital prices in the Northeast will more than offset that regions's initial labor cost advantage will depend upon the difference between wages and capital prices regionally. More specifically, the Northeast factor price ratio $(w/r)_1$ will tend to be lower than in the South unless capital prices are so low in the Northeast as to more than offset its initial labor cost advantage.

For only three sectors--Chemicals, Electrical Material and Plastics--is the relative factor cost ratio higher than unity.[18] However, for only the last two did lower capital prices in the Northeast more than offset the lower labor cost. For the Chemical sector, labor cost was higher in the Northeast than in the South. For three others--Machinery, Metallurgy and Clothing--the Northeast's relative factor cost approaches unity while low capital cost in the Northeast explains this for the last two sectors; for the Machinery sector, low wage differences also account for this. For the remaining sectors the Northeast's relative factor cost is much lower than unity (30 per cent or more).

At the branch level, the picture changes little. As shown in column 5 of Table II, the Northeast's relative factor costs are greater than the South's for only 7 of 46 branches, and in only three of these is relative factor cost significantly greater than unity (branches 24, 173 and 186). Higher relative wages in the Northeast, on the other hand, explain why relative factor costs are higher there in two branches (24 and 499). For the remaining branches (5), the Northeast's lower capital price is the main reason for the higher relative cost.

Except for these seven branches, relative factor costs are systematically lower in the Northeast. They are lower for the Food, Non-Metallic and Furniture sectors and higher for the Metallurgy, Machinery, Textile and Clothing sectors. Again, low capital price is the main explanatory variable, except for the Textile sector, where the low wage differential is more important.

If relative factor prices are any guide to entrepreneurs' choice of technology, the Northeast's capital/labor ratio should be, with but two exceptions at the sector level and five exceptions at the branch level, consistently lower than the South's. This is, generally, true.

For 15 of 21 sectors (see Table V), the capital/labor ratios are lower in the Northeast than in the South. Moreover, except for the Non-Metallic, Paper, Clothing and Miscellaneous sectors, the across-region differences in capital/labor ratios are substantial (equal to or more than 34 per cent). For those four sectors, those differences, though smaller, are still substantial. On the other hand, for six sectors--Furniture, Chemical, Cosmetics,

TABLE V

CAPITAL/LABOR RATIOS AND NORTHEAST RELATIVE FACTOR PROPORTIONS (CR $1.000,00)

Sectors	Capital/Labor Ratios		NE Relative Factor Proportions	
	NE (a)	South (b)	(a)/(b)	(k_1/k_2) *
Non-Metallic	.720	.990	.727	.738
Metallurgy	.996	1.595	.625	.589
Machinery	.420	.816	.515	.471
Electrical Material	.820	1.242	.660	.546
Transportation Equipment	1.040	2.360	.441	.193
Lumber	.596	1.016	.586	.532
Furniture	.842	.653	1.288	1.033
Paper and Cardboard	1.144	1.279	.894	.816
Rubber	1.025	1.526	.672	.551
Hides and Skins	1.049	2.065	.682	.539
Chemicals	4.221	3.329	1.268	1.154
Pharmaceuticals	.975	1.542	.632	.580
Cosmetics	2.102	1.407	1.493	1.548
Plastics	.992	.732	1.356	1.290
Textiles	1.340	1.227	1.092	.848
Clothing and Footwear	.340	.378	.876	.961
Food	1.247	1.924	.647	.559
Beverages	1.123	2.465	.456	.408
Tobacco	1.216	2.383	.510	.492
Printing	1.263	1.073	1.177	1.067
Miscellaneous	.476	.614	.775	.703

Sources: 1) Table IV in Ch. IV.
2) FIBGE-Censo Industrial, 1970.
3) Table VIII in Ch. IV.
*) Relative capital labor ratio adjusted for capacity utlization level.

Plastics, Textiles and Printing, the capital/labor ratio is higher in the Northeast than in the South. This is unexpected for only four sectors, since for the Chemical and Plastic sectors, the Northeast's relative factor cost was higher than unity. For these two sectors, the Northeast's relative capital/labor ratios are consistent with relative prices.

For the Furniture, Cosmetics, Textile and Printing sectors, the entrepreneurs' actual factor combinations appear paradoxical since relative factor prices indicate that lower capital/labor ratios should prevail. This is more puzzling if we consider again the sectors' respective relative factor costs, since, except for the Textile sector, the Northeast's relative factor prices are approximately half of that of the South. Thus, for these sectors the entrepreneur's choice of technology is clearly inconsistent. The same problem occurs in the Electrical Equipment sector, where, though the capital/labor ratio is lower than in the South, relative factor cost is not and, more puzzling yet, there is a substantial capital subsidy.

Data in Table VI (see column 3) indicate that for twelve branches, the capital/labor ratio is higher in the Northeast than in the South. In only two branches are relative factor prices higher in the Northeast. Thus,

TABLE VI

CAPITAL/LABOR RATIOS AND NORTHEAST RELATIVE

FACTOR PROPORTIONS

(CR $1.00)

Branches	Capital/Labor Ratio		NE Relative Factor Proportions	
	NE (a)	South (b)	(a)/(b)	(k1/k2)u
24	3.410	.758	4.499	4.598
25	.572	.796	.718	.735
30	.310	.467	.664	.679
31	.304	1.175	.259	.264
32	.162	.219	.740	.756
34	.703	.727	.967	.989
43	.528	.656	.805	.823
63	1.246	2.293	.543	.512
73	1.396	1.527	.914	.862
85	.883	1.128	.783	.738
91	1.293	1.142	1.137	1.072
94	.832	.966	.836	.788
117	.379	.822	.460	.421
137	.381	.505	.754	.690
173	.887	.477	1.858	1.537
186	1.512	2.481	.609	.270
204	.663	.886	.749	.679
205	.495	.550	.900	.816
209	.527	1.601	.329	.299
233	.852	.491	1.737	1.393
234	.735	.455	1.613	1.294
279	.840	.547	1.535	1.261
320	1.710	2.497	.685	.623

TABLE VI (continued)

Branches	Capital/Labor Ratio NE (a)	Capital/Labor Ratio South (b)	NE Relative Factor Proportions (a)/(b)	NE Relative Factor Proportions (k1/k2)u
382	.980	1.158	.846	.658
405	.886	1.102	.804	.626
414	.367	.405	.906	.993
416	.152	.450	.339	.371
417	.361	.405	.892	.988
426	.272	.331	.824	.903
427	.191	.317	.602	.660
437	1.532	2.450	.625	.539
438	.598	1.832	.326	.282
440	2.520	2.967	.849	.732
446	.504	1.657	.304	.262
453	2.684	1.480	1.814	1.565
461	1.030	2.712	.380	.328
464	.736	1.811	.406	.350
472	1.396	1.141	1.223	1.055
474	1.696	1.277	1.328	1.145
477	2.290	2.916	.785	.677
478	3.582	3.275	1.094	.943
484	1.634	3.110	.525	.453
490	.679	1.767	.384	.344
499	1.199	1.939	.618	.554
512	1.461	1.454	1.005	.912
577	.576	.570	1.011	.917

Sources: See Table V.

for ten branches, capital/labor ratios are higher in the Northeast though factor costs are not. The opposite happens for five branches for which capital/labor ratios in the Northeast are lower than in the South though factor costs are not. In other words, in 15 branches out of 46, relative factor proportions are not consistent with relative price ratios. The apparent paradoxes occur more frequently in the Food, Metallurgy, and Furniture sectors (with four, three, and two apparent paradoxes, respectively).[19] On the other hand, except for the Furniture sector, there was no paradox at the branch and sector levels. The opposite, i.e., the occurrence of paradoxical observations at the branch level, and not at the sectoral level, such as in the Food and Metallurgy sectors, was more frequent. The occurrence of paradoxical observations at both levels of aggregation indicated that the number of both sectors and branches to be covered had to be reduced. The ones dropped will be discussed in the next section.

VI.3 - Paradoxical Sectors and Branches

As noted, capital/labor ratios were higher for some sectors in the Northeast than in the South in spite of lower relative factor costs. Moreover, relative factor cost was higher for some Northeast sectors while the capital/labor ratio was lower. In both situations, factor combinations, are inconsistent with the cost minimization hypothesis. In this section, we attempt to explain this phenomenon.

Consider first those paradoxes where relative factor cost was higher in the Northeast than in the South, while the capital/labor ratios were lower. It is our judgement that most of the paradoxes are more apparent than real. Measurement errors in the cost of capital can be one main explanation, since labor cost was much lower in the Northeast than in the South. First, each sector's capital cost was assumed to prevail for its component branches. SUDENE's fiscal incentives, however, are not necessarily equal for each project within a given sector, nor is each plant necessarily a recipient of SUDENE's funds. In other words, capital cost at the sectoral level may differ from the capital cost for some of its component branches. Second, except for the branch Motor Vehicles and Parts (186) in the Transportation Equipment sector, and for the Electrical Materials sector, the Northeast's relative factor cost in only slightly[20] higher than unity. These observations are consistent with the proposition that measurement errors could be the main source of the apparent paradox.

Consider now those sectors and branches where the Northeast capital/labor ratios were higher than in the South, but where that region's relative factor costs were lower. Unlike the earlier case,[21] measurement errors in the capital and labor variables are less likely to explain these paradoxes. First, measurement errors, if present, are common to both regions since the sources of data and the procedure for estimating both capital stock and labor were common to both. To the extent that the direction of the bias is the same in both regions, they could offset each other. Thus, capital/labor ratios would be less plagued by measurement errors than capital prices.[22] Second, this is also true for labor input. Thus, we can say that even if some bias is present in our estimated capital/labor ratios, it is certainly less significant than that found in the measure of capital price.

Granted this, higher capital/labor ratios in the Northeast, when not matched by higher relative factor costs, indicate that factor combinations are inconsistent. For consistency, capital/labor ratios in the Northeast must be higher (lower) whenever factor costs are higher (lower) than in the South. Graphically (see Diagram I), the Northeast's actual factor combination is at point C instead of A where Northeast relative factor cost ratio is tangent to that region's isoquant (NN).

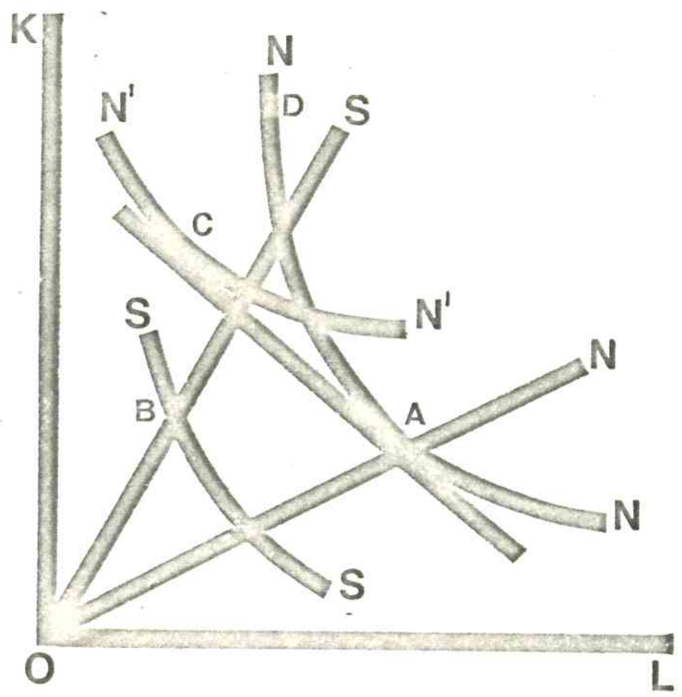


Diagram I

Across-region differences in capacity utilization could explain this. To the extent that an increase (decrease) in the level of capacity utilization implies a proportional increase (decrease) in the level of employment, capital/labor ratios will increase (decrease) whenever adjustment in capital stock for capacity utilization is made. Obviously, if regional levels of capacity utilization differ, the relative capital/labor ratio will be changed accordingly. As shown in Ch. IV, section IV, except for the Non-Metallic and Clothing sectors, capacity utilization levels have been systematically lower in the Northeast. Thus, Northeast capital/labor ratios will decrease for most of the sectors when adjustment for capacity is made.

Data in Tables V and VI, column 4, indicate that the adjustment for capacity utilization (though Northeast relative capital/labor ratios did decrease for most sectors and branches) was not sufficient to eliminate all inconsistencies. In fact, in only one sector, Textiles, and three branches, did adjustment for capacity utilization imply a "flipping over" of the relative capital/labor ratio. Moreover, though paradoxes remain for other sectors and branches, for some they were substantially reduced. The two paradoxes for the Furniture sector and the branch Bakery products (472) in the Food sector are more apparent than real since, after adjustment, Northeast captial/labor ratios were only slightly higher than the South's ratios. We are now left with two inconsistencies at the sector level--Printing and Cosmetics--and six at the branch level.[23] These inconsistencies can be explained (or rationalized) by one or more of the following: first, they could happen if both regions' production functions are not equal. Assume that the Northeast's isoquant is given by N'N'. If this is the case, there would be no inconsistent factor combination pattern. The assumption of different production functions, implicitly assumed in N'N' isoquant, would be most damaging to our study since the distribution parameter and/or elasticity of substitution would vary between regions. Thus, the estimation of the efficiency parameter would be wrong. More important, as indicated by R. Robinson,[24] if production functions were to differ, much of the analytical power of our theoretical framework would be lost, since any discrepancy in regional labor productivity could be inputed to "different" production functions.

A second rationale for the apparent inconsistency could be non-cost minimization behavior. Though production functions are actually equal, say SS and NN in Diagram I, "irrational" entrepreneurs in the Northeast[25] could disregard factor price signals. In this case, the actual Northeast factor combination would be depicted by point D instead of C on Diagram I. A capital subsidy for the Northeast makes this explanation more plausible. However, except for the branch, Tin Products (91) in the Metallurgy sector, the South's relative capital cost was approximately equal to unity.[26] Thus, if irrationality" is the explanation, SUDENE's incentives are not to be blamed.

Third, the industrialization drive in each region could also be an explanation. Strong industrialization incentives, gaining even greater strength after 1965,[27] existed in the South since World War II. In the Northeast, however, the industrialization drive began only in 1962, with greater thrust after 1967.[28] The average age of capital stock will, therefore, probably differ between the regions. Moreover, since industrial investment is not evenly distributed among industrial sectors, the relative "youth" of these in the Northeast could be even more pronounced. Thus, it is possible that the higher capital/labor ratio in the Northeast can be explained by one or any combination of the following: a) inflation in the price of capital goods so that a given machine was more expensive in the Northeast than in the South at the time of purchase; b) limited factor substitutability coupled with a higher wage-rent ratio in the Northeast at the time of plant construction during earlier periods of major investment; c) capital-using technological progress, giving rise to a higher optimum capital intensity, ceteris-paribus.[29]

To test the relevance of the age structure argument, we computed the ratios of the 1959 capital stock and of the realized investment in the 1967-69 period[30] to the 1970 capital stock. These two ratios do not convey the same information: the higher the first ratio, the older will be the average structure of capital stock, and the opposite is true for the second ratio.[31] Thus, a one-way view of average age structure, as data in Table VII indicate, can be misleading. Consider the Metallurgy sector, where, at one point, the table indicates that the average age structure of capital stock in both regions was about the same, then, at a second point, that the Northeast's average structure is lower than the South's. The same is true for the Pharmaceuticals and Miscellaneous sectors. If we had considered the second ratio only, we would have concluded that capital stock is "older" in the Northeast than in the South for the Printing and Furniture sectors and about the same age for the Chemical sector. Obviously, the opposite is true. These facts indicate that use of both ratios either as complementary or as alternative sources of information on average age structure is more relevant than if either one of these ratios were considered alone.

Combining both facts, we conclude that, except for the Rubber, Hides and Skins, Cosmetics, Textiles and Tobacco sectors, capital stock is "younger" in the Northeast than in the South. For the Food sector, equality seems to prevail. Thus, while the youth vs. maturity argument is no justification for the paradox in the Cosmetics sector, it can be useful in explaining the paradox for the Furniture and Printing sectors[32] where

TABLE VII

AGE COMPOSITION OF CAPITAL STOCK

(%)

Sectors	Northeast		South	
	a	b	a	b
Non-Metallic	29	53	41	18
Metallurgy	24	38	27	17
Machinery	15	47	37	35
Electrical Material	3	49	31	21
Transportation Equipment	12	27	33	20
Lumber	45	37	45	12
Furniture	20	11	38	9
Paper and Cardboard	57	21	41	15
Rubber	41	19	38	31
Hides and Skins	72	9	47	9
Chemicals	20	18	41	18
Pharmaceuticals	32	31	37	14
Cosmetics	48	17	38	24
Plastics	2	62	22	29
Textiles	51	11	44	11
Clothing and Footwear	42	34	42	13
Food	46	14	49	12
Beverages	33	21	47	10
Tobacco	41	16	37	14
Printing	29	7	42	16
Miscellaneous	44	20	37	14

Sources: 1) FIBGE-DEICOM, Producão Industrial, 1967-69
2) CH. IV, Tables III-IV
a) Ratio of the 1959 to 1970 capital stock
b) Ratio of 1967, 1968, 1969 investment to 1970 capital stock.

the ratio of the 1959 to the 1970 capital stock is much lower in the Northeast. Moreover, the capital/labor ratios for both sectors are not substantially higher in the Northeast; in fact, only 3 and 7 per cent higher for the Furniture and Printing sectors, respectively.

At the branch level, the maturity argument could be more useful if we had more disaggregated data on capital stock. Assuming that what is true for each industrial sector is true for its component branches, let us compare the paradoxes at the branch level with the data on the age structure of capital stock. For only one branch, Tin Products (91) in the Metallurgy sector, is it possible that "age structure" can partially explain the observed inconsistency. First, capital stock is "younger" in the Northeast than in the South for the Metallurgy sector. Second, the Northeast's relative capital/labor ratio for that branch (91) is not much higher than unity.[33] This is not true for the other branches either because the capital stock was not "younger" in the Northeast than in the South (Rubber and Food Sectors) and/or the Northeast relative capital/labor ratios were substantially greater than unity (equal to or greater than 30 per cent--see Table VI). In summary, the age structure of capital stock can be a valid explanation of the observed paradoxes at both sector and branch level when: one, the capital stock in the Northeast is younger than in the South; two, the Northeast capital/labor ratios are not substantially greater than unity. It should be noted, however, that though the "age structure" argument can explain some of the paradoxes, it cannot reverse them.[34] The same is true for those paradoxes we have considered more apparent than real because of possible measurement errors in capital stock.

VI.4 - Conclusion

Both the Northeast's relative factor cost and the relative capital/labor ratios were estimated and discussed in this chapter. First, since those differences were large, we discussed the across-region differences in wage rates. Also, we discussed briefly to what extent minimum wage, average labor productivity and skill mix could explain the large wage differences in Brazil. We indicated that, except for the minimum wage, which varies between regions, labor productivity and skill mix did not explain much of the observed wage differences. Moreover, the large differences in wage rates in Brazil increased when only the average wage of production workers was considered. This reinforces the basic observation that labor cost is much lower in the Northeast than in the South. Lower labor cost in the Northeast, other factors being equal, implies the use of more labor-intensive technology in the Northeast than in the South.

For some sectors, however, capital cost was also lower in the Northeast, making it clear that the Northeast's factor cost was not necessarily lower than the South's. On the other hand, estimation of the capital/labor ratios has indicated that this was not always the case since, for a few sectors and branches, the capital/labor ratio in the Northeast was higher than in the South. Comparing Northeast relative factor costs and relative capital/labor ratios, inconsistencies termed paradoxes turned up, i.e., factor combination was not consistent with factor costs. We argued that some of the paradoxes were more apparent than real. Apparent or real, the inconsistent observations have been deleted since they do not fit our analytical framework.

APPENDIX TO CHAPTER VI

As Table I shows, the Chemical sector wage pattern in the Northeast is unique. If, on the one hand, in this sector, the total employees' average wage is higher for the Northeast, on the other, it is lower when production workers are considered. Moreover, the discrepancy between the two is substantial (total employees' relative wage is 50 per cent higher than the production workers' relative wage). In this appendix, we will explain this.

Our initial hypothesis is that the observed wage pattern for the Chemical sector in the Northeast can be explained by the share of non-production workers in the state of Bahia on the total wage bill. In other words, if Bahia is excluded, the Northeast's wage rate will be lower than the South's, in both labor classifications. Furthermore, the discrepancy between the two in the Northeast's relative wage will be sharply reduced.

Data on the average wage per man hour in Table VIII confirm our hypothesis. First, the total employees' average wage for Bahia is approximately four times greater than the corresponding wage for Pernambuco and Ceará. This is not true when production workers' average wage is considered. Second, the Northeast's total employees' average wage is more than two times greater than that region's average, when Bahia is excluded. Again, for production workers, the discrepancy is much smaller (less than 10 per cent). Thus, the upward bias in Northeast's total employees' average wage is explained by Bahia's non-production workers' average wage. In columns 3 and 4 of Table VIII, we can see that the proportion of non-production workers to total employees is not much different among the three states. Looking at this proportion in terms of wage bills, a different picture emerges. That proportion is only 20 per cent in Bahia, while in Ceará and Pernambuco, it is 62 and 68 per cent, respectively. It is obvious that the discrepancy between production workers and the wage bill in Bahia is significant: 50 per cent. This poses a new question: namely, why is the non-production workers' bill in Bahia so high? An hypothesis can be raised pertaining to the weight of state enterprises (e.g., oil industries) and multinational corporations in Bahia for the Chemical sector. Those enterprises are not absent in the South, but their weight in Bahia's Chemical sector is likely to be greater. Obviously, to be able to reach a more definitive conclusion, more detailed information on that sector's labor force and wage bill would be necessary. However, the wage rate for the branch Crude Oil and Vegetable Oil

TABLE VIII

AVERAGE WAGE* AND PROPORTION OF PRODUCTION WORKERS ON TOTAL LABOR

FORCE AND WAGE BILL: NORTHEAST 1970

States	Av. Wage--CR $ 1.00		Proportion of	
	Total Employees (TE)	Production Workers (PW)	PW/TE	PW Wage Bill / TE Wage Bill
Ceará	1.733	1.379	.78	.62
Pernambuco	1.695	1.491	.78	.68
Bahia	6.209	1.655	.70	.20
Average**	3.88 (1.714)	1.573 (1.435)	.75 (.78)	.20 (.65)

Source: FIBGE--Industrial Census--1970

* Average Wage per man/hour
** Northeast average wage
( ) Northeast average--Bahia excluded

(n. 320) shown in Table II, supports our hypothesis. For this branch, the wage rate is lower in the Northeast in both labor classifications. Moreover, the discrepancy between both in the Northeast's relative wage is small.

FOOTNOTES TO CHAPTER VI

[1]"Average" means the simple arithmetic mean of all sectors combined.

[2]The Northeast's Chemical sector wage rate is discussed in the Appendix to this chapter.

[3]The standard deviations of wage rates were .638 and .653 for the Northeast and South, respectively.

[4]An exception to this, however, can be found in the Non-Metallic sector. The sharp discrepancy observed in the Electrical Material and Transportation Equipment, mainly in the Northeast, does not contradict our conclusion, since only one observation at the branch level is available for each of those sectors.

[5]See, for example, the results on Colombia's relative wage rate (U. S. = 100) in R. R. Nelson and others, op. cit., p. 85. See also Arrow, et al., op. cit., pp. 248-250.

[6]Moroney's data on wage rates refer to the South, New England, and the rest of the U. S. The relative wage of the South is considered here. See J. R. Moroney, op. cit., p. 132.

[7]On the average, the geometric averages of wage rate per hour (in Kroner) were 7.44, 6.63 and 6.49 for the Oslo region, Region I and Region II, respectively. See A. Griliches and V. Ringstaad, op. cit., p. 46.

[8]Data on Colombia's relative wage and relative labor productivity (U. S. = 100) show the opposite. Colombian relative wages are, in general, lower than the relative productivity. See R. R. Nelson and others, op. cit., p. 85.

[9]A previous study by P. Baltar on wage and productivity in Brazil's manufacturing sector did come to the same conclusion. See Paulo E. A. Baltar, Salário e Produtividade na Estrutura Industrial de 1970, paper presented in the V National meeting of Brazilian Economic Association--ANPEC (Rio de Janeiro, 1978), pp. 1-71.

[10] We will assume that the average years of schooling is a "proxy" for labor skill. It is worth mentioning at this point that in empirical studies, either on labor productivity or human capital, years of schooling (formal education) are usually taken as a "proxy" for labor skill. See, for example, R. R. Nelson, op. cit., pp. 163-168. Moreover, J. J. Sena has concluded that Brazil's manufacturing sector, years of schooling were a relevant variable in explaining inter-industry variation in wage rates. See J. J. Sena, "Analise dos diferenciais de Salarios entre os Diversos Ramos da Industria Brasileira," Estudos APEC--A Economia Brasileira e suas Perspectivas (Rio de Janeiro, 1976) as mentioned in Paulo V. da Cunha and R. Bonelli. "Estrutura de Salários Industriais no Brasil," paper presented at the V National meeting of Brazilian Economic Association--ANPEC, vol. 2 (Rio de Janeiro, 1978), pp. 13-14.

[11] The data on mean years of schooling are taken from G. Sahota and C. Rocca. Unfortunately, it is not clear what classification of labor was used. There is no indication whether it was production workers or total employees. See Gian S. Sahota and Carlos A. Rocca, Investment and Growth (mimeographed) Fundacão Instituto de Pesquisas Economicas FIPE (Universidade dé São Paulo, São Paulo, 1976), p. 125.

[12] Moroney rejected the hypothesis of skill differences explaining wage differences for the United States on the simple ground that the observed differences in wage rates were ". . . larger than most authorities would be willing to attribute to interregional labor quality differences." J. R. Moroney, op. cit., p. 131. As we have shown, wage differences in Brazil are higher than those in the United States.

[13] Considering each sector as an independent unit of observation, we regressed the wage rate differences on the skill differences. The result was

$$(w_1/w_2) = .706 + \underset{(.108)}{.207}\,X \qquad R^2 = .11$$

where X is the Northeast relative average years of schooling. As the result indicates, though the slope coefficient is significant, the fit is rather poor. Here and henceforth, we consider a slope coefficient as significant if it is ". . . more than two times the standard deviation, . . ." as previously done by Z. Griliches and V. Ringstaad, op. cit., p. 47.

[14]The "quality-based index was estimated through the relation

$$l_i = \frac{1 + v_i P_{h,i} h_i}{w_i}$$

where v_i = rate of return on schooling; P_{hi} = cost of year of schooling; h_i = mean years of schooling and w_i = wage rate for the education level. See Sahota and Rocca, op. cit., p. 106.

[15]Regression of wage differentials on the Northeast relative "quality-based" index was not good. The fit was poor, and the coefficient was not significantly different from zero.

[16]Macedo's data refer to the total manufacturing sector, and to total employees, See Roberto B. M. Macedo, Models of the Demand for Labor and the Problem of Labor Absorption in the Brazilian Manufacturing Sector, Ph.D. dissertation (Harvard University, 1974), pp. 141-152.

[17]J. R. Moroney, op. cit., pp. 130-136.

[18]We will use relative factor cost to mean the Northeast's relative factor prices divided by their corresponding term in the South.

[19]The other sectors, each with just one paradoxical observation, are: Transportation Equipment, Lumber, Rubber, Beverages, Printing, and Miscellaneous.

[20]In this Chapter by "slightly," we mean a difference equal to or lower than 5 per cent.

[21]The cases where the Northeast's relative factor costs were higher than unit.

[22]In the preceding case of higher relative factor costs in the Northeast, we have noted that capital prices in that region were lower than or at most equal to, the South. Had we assumed that higher capital price in the Northeast was the case, no paradox would have existed

because of relative factor cost. This would not be true, however, for the capital/labor ratio, i.e., "induced" paradoxes.

[23]The branches Tin products in the Metallurgy sector (n. 91), Wicker and Reed Furniture and Wood, Wicker and Reed Furniture for home use (ns. 233 and 234, respectively) in the Furniture sector, Pneumatic Tire Reconditioning (n. 279) in the Rubber sector, Meat Processing and Biscuits and Crackers (ns. 453 and 474, respectively) in the Food sector.

[24]Rommey Robinson, "Factor Proportions and Comparative Advantage. Part I," Quarterly Journal of Economics, vol. 70, n. 2, May 1956, pp. 181-197. Robinson has stated that "If different production functions are admitted, then the theory confronted with evidence of trade contrary to that indicated by factor supplies could always take refuge in the plea: different production function." Ibid., p. 173.

[25]At this point, it is worth mentioning that we are implicitly assuming that the South's entrepreneur is "rational." Two reasons can be given for this: first, there is no strong capital incentive in this region as in the Northeast; second, there is no paradox in the South.

[26]For the Tin branch (n. 91) the South's relative cost was equal to 1.47. For the remaining inconsistencies at branch level (see footnote n. 22 for the specific branches), that cost was equal to 1.010. For the inconsistencies at sector level (Cosmetics and Printing sectors), the South's relative capital cost was equal to 1.00. Capital cost is discussed in Ch. V, sec. V.3.1.

[27]For Brazil's industrialization process, see Joel Bergsman, op. cit., pp. 239-280.

[28]See, for example, Goodman and Cavalcante, op. cit., Ch. IX-XII.

[29]These points were raised before by Moroney, op. cit., pp. 132-136. It is also interesting to note that the maturity argument is similar in many respects to the Best vs. Average practice argument as developed by W. E. G. Salter, Productivity and Technical Change (Cambridge University Press, Cambridge, 1969), Ch. IV.

[30]The choice of these three years is partially based upon the fact that actual investment in the Northeast through SUDENE's incentives was more significant in this period. On this, see Goodman and Cavalcante, op. cit., Ch. IX.

[31]We implicitly assume that the distribution of the gross investment as a proportion of capital stock is uniform (or approximately so) in both regions.

[32]Though, as we have noted, there were no inconsistencies for the Chemical and Plastics sectors, no explanation was given for the observed higher capital/labor ratios in the Northeast for those two sectors. Now, with data on age composition, we can argue that differences in age structure can be an explanation. This is particularly true for the Plastic sector.

[33]Only seven per cent higher.

[34]This follows from the fact that we have no quantitative method based on "age structure" for adjusting the observed capital/labor ratios.

CHAPTER VII

THE ELASTICITY OF SUBSTITUTION AND THE NORTHEAST'S RELATIVE EFFICIENCY

VII.1 - The Purpose of the Chapter

Chapter I showed that labor productivity in the Northeast was systematically lower than in the South; in fact, for some sectors (Rubber and Perfumes), the South's productivity level was three times higher. Though many factors explain such differentials, our focus was on the inter-regional capital/labor ratio differentials for each sector. We asked what would happen to Northeast's relative labor productivity if its sectoral capital/labor ratio were raised to the South's level. We have called this new hypothetical productivity the Northeast's relative efficiency.

If inter-country or inter-regional productivity differentials "reflect" (sic) differences in the capital/labor ratio, most, if not all, of the observed productivity differential should disappear as capital/labor ratios are equalized, as indicated by R. Nelson.[1] Different studies have shown that, more often than not, inter-country differences in capital/labor ratios have systematically failed to explain international differences in labor productivity. The purpose of this chapter is to show whether or not our results support this conclusion. First, we will deal with elasticity of substitution (σ) estimates at two levels of aggregation. Second, the efficiency parameter (J) and the Northeast's relative efficiency will be estimated and analyzed.

VII.2 - The Elasticity of Substitution (σ): Some Preliminary Remarks and Empirical Results

The ease (or difficulty) with which capital can be substituted for labor as relative prices change is given by the magnitude of the elasticity of substitution. The greater (smaller) this elasticity, the greater (smaller) the possibility of factor substitution will be. In the limit, factor substitution is not at all possible if $\sigma = 0$ and unlimited if $\sigma = \infty$. Empirically, however, different studies indicate that a value of σ around unity is more likely.

Unfortunately, estimates of σ vary significantly in different studies, and this is also true even when the same country, the same time and same production function specifications are considered.[2] Obviously, the particular model used and measurement errors in the variables have a lot to do with this, and it is far from settled in the literature what the appropriate magnitude of the elasticity of substitution is.[3]

For some authors, Eisner among them, the actual possibility of substituting capital for labor is narrow.[4] He considers that ". . . the elasticity of substitution between capital and labor is both very low (nearer to zero than to one) and variable, getting lower as the capital/labor ratio is pushed to the point when the marginal net product of capital would become zero or negative."[5] Others, like Griliches, suggest that σ estimates do not depart significantly from unity.[6] In fact, an estimate of σ about unity is generally the case for cross-section studies and, in time series studies, it is less than unity.[7]

Eisner's comments raise another important question concerning the elasticity of substitution, namely, its variability along a given isoquant. Most empirical studies, however, relied upon the C. E. S., or the Cobb-Douglas, specification of production function for estimating σ and in both specifications σ is assumed to be constant. Lately this restrictive aspect of C. E. S. (a more general production function specification of which the Cobb-Douglas and Leontief type production functions are particular cases) has come under attack, and less restrictive approaches such as the V. E. S. and Trans-log production functions are gaining ground.[8] Data problems, however, pose serious limitations on the use of a more general production function specification, and it is not surprising that the simple Cobb-Douglas, and/or the still-simpler productivity wage relationship, abound in the literature.[9] Moreover, whatever the generality of a given production function specification, bold assumptions about output and factor markets have to be made. On the other hand, as indicated by Christensen and others,[10] the C. E. S. approach is a suitable approximation to the actual production function whenever only one output and two inputs are taken into consideration. For more than one output and more than two inputs, the C. E. S. becomes overly restrictive and an alternative, such as the Trans-log production function, should replace it. However, as Griliches and Ringstaad point out, more generality in the production function specification also usually means greater constraints on the variables going into the model, thus making it less useful.[11]

However, matters are not settled by specifying a C. E. S. production function, since the estimation procedure is not unique. First there is the straightforward method of regressing labor productivity on wage data. This method is most appealing because it does not require information on capital and price of capital data, but it is plagued by a host of problems, both theoretical and econometric. With a more direct method of estimation through an approximate (Kmenta) C. E. S. the results of σ improve, the closer the elasticity is to unity. As the elasticity departs from unity, the usefulness of that approximation is reduced.[12] In general, the availability of data determines the approach used, which is true in this study. An insufficient number of observations for each sector and its component branches forced us to use a deterministic model. More specifically, since each sector or branch has only two point observations, the only approach suitable for our data was the use of equation (5), which was derived from the assumption of a common production function and neutral technological progress in both regions. Thus, two weaknesses are inherent in our approach to measuring the elasticity of substitution. First, no statistical testing can be done, in our judgement, a most serious limitation. Second, equation (5) is very sensitive to changes in the data. Not that other measures of σ within the C. E. S. framework are not sensitive to changes in the data, but ours can be more so under some circumstances.[13] To see this more clearly, let us write equation (5) again:

$$\frac{k_1}{k_2} = \left[\frac{(w/r)_1}{(w/r)_2}\right]^{\sigma} \qquad (5)$$

Applying logarithms to equation (5), we obtain

$$\sigma = \frac{l_n(a)}{l_n(b)} \qquad (5.a)$$

where a = relative capital labor ratio

b = relative factor prices

Equation (5.a) indicates that the magnitude of σ is extremely sensitive to measurement errors in (a) and (b). First, whenever (a) is greater (smaller) and (b) smaller (greater) than unity, σ will be negative.[14] This would be true in all "paradoxical" sectors and branches had we attempted to measure their respective elasticity of substitution. Second, as long as (b) approaches unity and (a) does not, the magnitude of the elasticity becomes unrealistically high. Third, if (a) approaches unity and (b) does not, then the elasticity will approach zero. In spite of these drawbacks, however, our approach has some positive aspects. For instance, whenever inter-regional or inter-country differences in capital/labor ratios and factor costs are large,[15] estimates of σ using equation (5) have proved to be similar to alternative σ estimates using a more "rigorous" approach.

The need for large differences among variables is not a peculiarity of equation (5), but our approach requires larger differences because of the limitation of two point observations. Cross-country studies are more appropriate than cross-region studies, since differences in the variables are likely to be larger in the former.[16] However, the assumption of a common production function and neutral technological progress is less tenable between countries.

Second, equation (5) can be shown to have some nice properties. To do this, let us specify a more general C. E. S. production function where constant returns to scale and neutral technological progress are not assumed, i.e.,

$$Y = A\ [dK^{-c} + (1-d)L^{-c}]^{-v/c} \qquad (1)$$

where v represents the degree of economies of scale. (Other parameters were defined in Chapter II.)

Differentiating in relation to K and L, we have

$$f_L = v\ A\ (1-d)L^{-(c+1)}\ [\theta]^{-v/c-1}$$

$$f_K = v\ A\ (1-d)K^{-(c+1)}\ [\theta]^{-v/c-1}$$

where $\theta = [dK^{-c} + (1-d)L^{-c}]$.

Dividing f_L by f_K the marginal rate of technical substitution is obtained, i.e.,

$$MRTS = \frac{f_L}{f_K} = (\frac{1-d}{d})[\frac{K}{L}]^{c+1} \qquad (2)$$

Let us now assume two different production functions for the Northeast and the South respectively. It is immediately clear that both regions MRTS will be

$$MRTS_1 = (\frac{1-d_1}{d_1})(^K/_L)_1^{c_1+1} \qquad (2.a)$$

$$MRTS_2 = (\frac{1-d_2}{d_2})(\frac{K}{L})_2^{c_2+1} \qquad (2.b)$$

Assuming equilibrium conditions to prevail, equations (2.a) and (2.b) can be written as

$$(w/r)_1 = (\frac{1-d_1}{d_1})[\frac{K}{L}]^{c_1+1} \qquad (2.a)'$$

$$(w/r)_2 = (\frac{1-d_2}{d_2})[\frac{K}{L}]^{c_2+1} \qquad (2.a)'$$

Dividing equations (2.a)' by (2.b)' and, after substitution, we get

$$\frac{(w/r)_1}{(w/r)_2} = \frac{(\frac{1-d_1}{d_1})(k_1)^{c_1+1}}{(\frac{1-d_2}{d_2})(k_2)^{c_2+1}} \qquad (3)$$

or

$$\frac{k_1}{k_2} = \frac{(\frac{1-d_1}{d_1})(\frac{w}{r})_1^{\sigma_1}}{(\frac{1-d_2}{d_2})(\frac{w}{r})_2^{\sigma_2}} \qquad (4)$$

Finally, if a common production function is assumed for both regions as well as the existence of neutral technological progress, then

$$\frac{k_1}{k_2} = [\frac{(w/r)_1}{(w/r)_2}]^{\sigma} \qquad (5)$$

which is our approach to measuring the elasticity of substitution.

Some important features of this equation are: first, it is independent of economies of scale; in other words, the assumption of constant returns to scale does not introduce any bias in our estimates of σ. This is not true, however, for the assumption of common production functions and neutral technological progress, and any departure from these assumptions can bias our results. Second, estimates of σ are independent of product prices; thus, price differentials between regions do not bias our results.[17] Third, estimates of σ are independent of the efficiency parameter; i.e., across-region differences in A do not affect them. Fourth, equations (2.a) and (2.b) and, therefore also equation (5), are not dependent on the assumption of profit maximization. An assumption about cost minimization is required, but, as indicated by Moroney, the cost minimization assumption is less restrictive than the profit maximization, since ". . . a variety of 'satisficing' and 'sales maximizing' hypotheses concerning the optimum choice of inputs . . ."[18] is compatible with the former but not the latter. Finally, since a cross-region comparison is made, measurement errors in the variables may, to some extent, offset each other, thus reducing the bias in our estimates.[19]

Let us now consider our empirical results on σ. As shown in Table I, except for the Metallurgy, Machinery, Transportation Equipment, and Lumber sectors, the σ estimates look quite reasonable. For six sectors they are less than unity (significantly so for the Paper sector); for three, they are not very different from unity, and for the remaining sectors (three), they are greater than unity. Though estimates of σ above unity (three or more times greater than unity) are within the theoretical range of variation of σ, empirically, they are dubious.[20] Thus, the high estimates of σ will be rejected on the ground that they are upward biased. This, unfortunately, restricts our analysis of relative efficiency to only twelve sectors out of twenty-one.

How do our estimates of σ compare to alternative estimates pertaining to the Brazilian economy? (See Table I columns 2.4.) First, note that all three alternative estimates of the elasticity of substitution refer to cross-section studies either for Brazil (Macedo's and Luques') or to the Northeast (Jatoba's). Second, Macedo[21] and Jatoba[22] used an identical method of estimation where the elasticity of substitution was obtained by regressing labor productivity on average wage rates. In Luque's[23] study, an approximate

TABLE I

CROSS-SECTION ESTIMATES OF ELASTICITIES OF SUBSTITUTION[1]

Sectors	This Study (1970)	Macedo (1969) (2)	Luque (1970) (3)	Jatobá (1969) (4)
Non-Metallic	1.069	.81	1.147	1.69
Metallurgy	10.972	.84	.734	.57
Machinery	7.584	1.08	.360	1.06
Transportation Equipment	6.159	1.13	.448	1.17
Lumber	4.317	1.02	1.870	1.08
Paper and Cardboard	.197	.97	.555	.21
Rubber	.795	1.16	1.251	1.07
Hides and Skins	1.043	.82	.400	.96
Chemicals	1.081	.70	.709	.60
Pharmaceuticals	.646	1.34	*	*
Plastics	1.363	1.25	.705	*
Clothing and Footwear	1.281	1.05	.274	1.25
Food	.337	.96	.954	.62
Beverages	2.808	1.66	.747	1.41
Tobacco	1.061	1.26	.863	1.25
Miscellaneous	.446	*	*	*

1) Those sectors where $\sigma < 0$ were deleted.

2) Roberto B. M. Macedo, op. cit., Table 3.1, p. 72.

3) Carlos A. Luque, op cit., Table V, p. 31

4) Jorge Jatobá, op. cit., Table 21, p. 83.

* Estimates of σ were missing.

(Kmenta) C.E.S. was used, and electricity consumption was taken to be a proxy for the flow of capital services. Third, Luque and Jatobá worked with data on total employees while Macedo used production workers only. This brief description does not make a judgement about each alternative estimate but it does point up that estimates of σ in Table I may well not be strictly comparable. However, if σ estimates are to bear any relation to actual factor substitution, their magnitude should not differ significantly, since all approaches attempt to measure the same parameter. However, as the data in Table I indicate, variations in σ for a given sector is large,[24] and especially so in the Metallurgy, Machinery, Transportation Equipment and Lumber sectors. This variation is reduced if either Macedo's and Jatobá's, or Jatobá's and our estimates are compared. In the first pair the estimates are reasonably close in eight sectors; in the latter, they are also close, but only for six sectors. There is no a priori reason for this, and no attempt at explanation will be made.

The last chapter stressed that the response of factor proportions to factor price changes was stronger at the branch than at the sector level. Hence, the elasticity of substitution estimates should be higher at the branch than at sectoral level.[25] Data in Table II seem to confirm this, particularly for the Clothing, Non-Metallic, and Food

TABLE II

CROSS-SECTION ESTIMATES OF THE ELASTICITY OF SUBSTITUTION

Branches	This Study (σ)	Branches	This Study (σ)
24	1.537	382	1.075
25	1.300	405	.799
30	.410	414	.906
31	1.136	416	2.739
32	.518	417	1.527
34	.123	426	1.892
43	2.348	427	3.122
63	-	437	.766
73	4.262	438	2.145
85	-	440	.291
91	-	446	1.668
94	.986	453	-
117	83.751	461	40.523
137	1.853	464	1.569
173	2.019	472	-
204	-	474	-
205	.794	477	.448
209	2.933	478	-
233	-	484	1.147
234	-	490	8.173
279	-	499	-
320	6.850	512	-
		557	-

(-) For these branches $\sigma < 0$.

sectors' component branches. For other branches, though the σ estimates are close to unity (or even greater than unity), we cannot tell much about them since estimates at the sectoral level are missing. Again, for some branches in the Textile and Metallurgy sectors (see Table II), σ estimates are unacceptably high, and we drop these branches.[26] Finally, there is some linkage between high (low) magnitudes of elasticity at both levels of aggregation, especially for the Metallurgy, Transportation Equipment, and Beverages sectors. For the Clothing sector, this linkage does not happen (see Table I, column I and Table II).

The correspondence between σ estimates for a given sector at both levels of aggregation is not surprising. First, no direct estimates of capital stock and capital price at branch level were made. Those figures were either indirectly derived from two digit level data (capital stock) or assumed to be equal to sector figures (capital price). Second, as discussed in section VI.2, wage rates at both levels of aggregation were not much different. Thus, correspondence between both σ estimates is, to some extent, expected. On the other hand, for example, in the Clothing sector, sensitivity of equation (5) to values of the variables can be the explanation for the differences between the estimates for both levels of aggregation for a given sector.

VII.3 - Relative Efficiency

The J parameter determines to what extent the Northeast's relative efficiency will be increased as its capital/labor ratio attains the South's level.[27] The greater the value of this parameter, the greater will be the gain in Northeast's relative efficiency as its capital/labor ratio increases.

Table III shows the efficiency parameter and the Northeast's relative efficiency in columns 1 and 2, respectively. For only two sectors, Chemicals and Plastics, is the efficiency parameter smaller than unity. This is consistent with the finding that capital/labor ratios for these two sectors are higher in the Northeast than in the South. For the remaining sectors, the magnitude of J varies from approximately one in the Paper, Clothing and Miscellaneous sectors to 1.37 and 1.44 in the Tobacco and Beverage sectors. This wide variation in the magnitude of J is largely explained by inter-industry differences in production functions and relative capital/labor ratios.

Where J is approximately equal to one, labor productivity is increased little if that region's capital/labor ratio is increased. This insensitivity of labor productivity to changes in the capital endowment per worker is the result of either a low value of σ and/or small differences in regional capital/labor ratios. Low values of σ are the main

TABLE III

EFFICIENCY PARAMETER, RELATIVE EFFICIENCY, PERCENTAGE CHANGE

IN CAPITAL/LABOR RATIO AND UNEXPLAINED RESIDUALS

Sectors	J	Northeast Relative Efficiency	% Change in k_1	Unexplained Residual (%)	Implicit Capital Share (%)
Non-Metallic	1.129	.760	38.0	40.4	34
Paper and Cardboard	1.04	.431	11.8	56.9	34
Rubber	1.170	.331	48.9	66.9	37
Hides and Skins	1.221	.507	46.5	49.3	48
Chemicals	.888	.645	-21.1	35.5	53
Pharmaceuticals	1.169	.316	58.1	68.4	29
Plastics	.918	.367	-26.2	63.3	31
Clothing and Footwear	1.030	.720	11.2	28.0	27
Food	1.273	.581	54.3	41.9	50
Beverages	1.439	.696	119.5	30.4	37
Tobacco	1.366	.627	96.0	37.3	38
Miscellaneous	1.070	.523	29.0	47.7	24

reason for the low value of J in the Paper and Miscellaneous sectors, while small differentials in the capital/labor ratio explain the outcome in the Clothing sector. At the other extreme, the high value of J for the Tobacco sector is largely explainable by the high differential in the capital/labor ratio. For the Beverage sector, the explanation is less simple since both the capital/labor ratio and the σ value are very high. Thus, we cannot say that the relatively high sensitivity of the Northeast's labor productivity is wholly explained by the high value of σ; this is also true for the capital/labor ratio differential.[28]

Whatever the magnitude of J, however, the Northeast's relative efficiency remains substantially lower than the South's (see column 2). In other words, capital/labor differences are not the only distinguishing feature across regions.[29] To clarify this point, we estimated the percentage increase in the Northeast's capital/labor ratio that would have taken place had that region increased its capital/labor ratio up to the South's level (see column 3). Contrasting columns 1 and 3, one can see the wide discrepancy between the hypothetical percentage increase in labor productivity (J-1) and the increase of the capital/labor ratio.[30] This discrepancy is wider for the Non-Metallic, Miscellaneous and Beverages sectors, and not surprisingly, becomes smaller as the across-region difference in capital/labor ratios goes down. This was the case, for example, in the Paper and Clothing sectors. Smaller discrepancies between both increases, however, do not necessarily mean a sharp reduction in productivity differentials, as substantiated by the data in Table III, mainly column 4.

As the cross-region difference in product-mix becomes lower, more significant gains in labor productivity result from a higher capital/labor ratio. Data in Table IV partially confirm this. The magnitude of J, also the gain in productivity, is for some branches, higher than that observed at the two digit level. In fact, gains in productivity above 70 per cent are observed in three branches: two in the Food sector and one in the Non-Metallic sector. In three branches, two in Food and one Lumber, the percentage increase in Northeast's productivity is higher than the percentage increase observed at the more aggregate level. If the percentage increase in labor productivity was large for these six branches, their corresponding percentage increase in capital/labor ratios was even larger. Data in column 3 indicate that the percentage increase ranged from 146 to 260 per cent for the branches Cane Sugar Refinery (464) and Slaked Lime (31), respectively. This wide discrepancy was general for all branches. Again, the across-region differences in the capital/labor ratio and the magnitude of σ are the most important reasons for the inter-branch variation

TABLE IV

EFFICIENCY PARAMETER, RELATIVE EFFICIENCY, PERCENTAGE CHANGE IN CAPITAL/LABOR RATIO AND UNEXPLAINED RESIDUALS

Branches	J	Northeast Relative Efficiency	% Change in k_1	Unexplained Residual (%)	Implicit Capital Share %
24	.566	7.752	-79.7	-	
25	1.109	.616	29.2	38.4	37
30	1.142	.414	39.8	58.6	36
31	1.749	.217	260.1	78.3	29
32	1.092	.476	25.9	52.4	35
34	1.011	.858	03.8	14.2	29
43	1.066	.705	15.5	29.5	42
94	1.064	.758	16.1	24.2	40
137	1.038	.898	32.5	10.2	12
173	.925	.947	-20.9	5.3	35
205	1.038	.582	11.1	41.8	32
209	1.584	.910	203.8	9.0	29
382	1.071	.413	12.3	58.7	58
405	1.095	.385	18.2	61.5	52
414	1.023	.731	10.3	26.9	22
416	1.232	.436	196.0	56.4	12
417	1.023	.734	12.2	26.6	22
426	1.040	.688	21.7	31.2	19
427	1.094	.524	66.0	47.6	20
437	1.342	.599	59.9	40.1	57
438	1.793	.419	206.3	58.1	38
440	1.120	.708	18.0	29.2	66
446	1.757	.414	228.8	58.6	33
464	1.509	.427	146.0	57.3	35
477	1.163	.663	27.4	33.7	59
484	1.479	.501	90.3	49.9	53

in the magnitude of J. Whatever this magnitude, Northeast relative efficiency remained lower than in the South throughout.

The over-all failure of the capital/labor increase to account for across-region differences in labor productivity indicates that other factors besides capital endowment per worker are important in explaining labor productivity differentials. This is especially true for those sectors and branches where the capital/labor ratios were higher in the Northeast than in the South, but where the average labor productivity was not, as in the Chemical sector.

In summary, we have found that: first, across-region differences in labor productivity generally cannot be explained by capital/labor ratio differentials; second, the magnitude of J varies considerably among sectors and branches; finally, this variance is positively associated with both the magnitude of σ and the across-region discrepancy in the capital/labor ratio. This last point raises the important question of the extent to which our negative result is influenced by measurement errors in both capital stock and the elasticity of substitution. To this issue, and to the more general question of J sensitivity to measurement errors and production function specifications, we now turn.

VII.4 - Sensitivity Analysis

The effects of change in the variables and parameters on the size of the efficiency parameter can be seen more clearly through the algebraic expression derived in chapter II, equation 7, and reproduced here.

$$J = \left[\frac{(1-d) + dk_2^{-c}}{(1-d) + dk_1^{-c}}\right]^{-1/c} \qquad (II.7)$$

From this equation, we see that J estimates can be biased if: a) the distribution parameter is biased; b) the assumption of constant returns to scale is not warranted; c) σ estimates are biased; d) there are measurement errors in k_1 and/or k_2. Thus, a host of problems besieges our estimation of J and, therefore, of relative efficiency. We will deal with them separately for the sake of clarity.

Consider first the problem posed by the distribution parameter. Two sources bias our estimates of J. First, the distribution parameter is highly sensitive to the units of measurement of k and w. Brown and Cani[31] and M. Brown[32] have made clear that variance of the units of measurement was a price that had to be paid for the use of the C. E. S. production function. This sensitivity of d to units of measurement is easily seen through equation (4) in Ch. II, here repeated.

$$k = \left(\frac{w}{r}\ \frac{d}{1-d}\right)^{\sigma} \qquad (II.4)$$

From this equation, it is clear that as the unit of measurement changes so will the magnitude of (d) since only the absolute values of k and w are considered. At first glance, this fact would appear to constitute a major drawback to our procedure in estimating J. Fortunately, this is not true. Empirically we have observed that even though d did change as alternative units of measurement were used, the J parameter remained unchanged.[33]

Though J is not affected by changes in the magnitude of (d), it is important to notice that little, if any, meaning can be attached to its magnitude as an estimate of factor shares in total income.

In Chapter II we assumed that differences in efficiency between regions were neutral, i.e., that the marginal rate of substitution between capital and labor was the same at points C and B (see Diagram I). In other words, we assumed, a priori, that the distribution parameters and the σ estimates were equal in both regions. Violation of the neutrality assumption, as indicated by M. Brown, implies variation between regions of either the distribution or the substitution parameter.[34] Assume that non-neutral (capital using) technological progress has taken place in the South. (This is depicted by the dotted isoquant on Diagram I.) If this

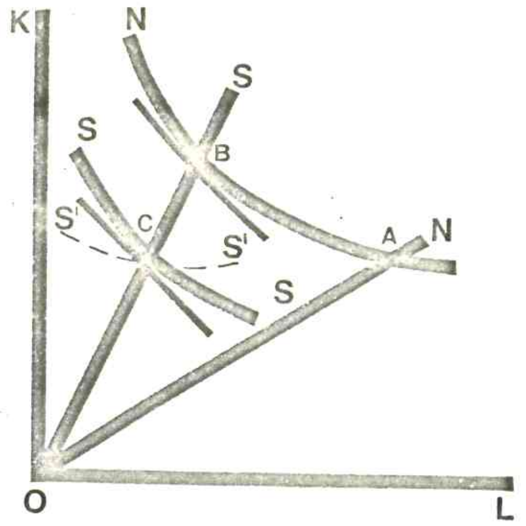


Diagram I

is the case, i.e., $d_2 > d_1$ two different, but interrelated, questions arise.[35] First, what would be the bias in the measure of relative efficiency and, second, what are the errors in cross-section studies when the neutrality assumption is violated. The answer to the first question is that our J estimate is not affected if $d_2 \neq d_1$. This is easily understood if we review our derivation of J in Chapter II, where J was derived by making the assumption that, as the Northeast increases its capital/labor ratio, it does so by moving along its own isoquant from E to point B (see Diagram 1 in that chapter). Basically then, it is only the shape of the NN isoquant that matters in the derivation of J and not that of the South's production function (SS, S'S', or whatever it may be). More generally, it does not matter (as far as the measure of J is concerned) if either d or σ varies between regions. Thus, the J estimate is not dependent on the assumption of neutral technological progress. Matters could stop here if the J estimates were not an intermediate step in the estimation of the Northeast's relative efficiency. (The expression "relative" here makes a lot of difference.) This brings us to the second question related to errors in cross-section studies when the neutrality assumption is violated. Though the J estimate is not dependent on the neutrality assumption, <u>comparisons</u> are dependent in cross-section studies. Basically, non-neutrality between regions (or countries) means that at the points of <u>comparison</u> (points B and C on Diagram I or over the whole NN isoquant) regional relative factor productivities are not equal. Both regions would have different production functions, and so NN and S'S' isoquants would not be strictly comparable. In this sense, our J estimate, though a measure of the hypothetical gain in the Northeast's labor productivity as that region's capital/labor increases, would give an incorrect indication of the power of differences in the capital/labor ratio to explain differentials in labor productivity. As clarification of this, consider the hypothesis that a capital-using technology is employed in the South while a labor-using one is found in the Northeast (respectively S'S' and NN in Diagram 1.) Granted this, capital productivity in the South is higher than in the Northeast, and the same may be true of labor productivity. If this is the case, under no condition will equality in the regional capital/labor ratio imply equality in labor productivity. As indicated by Leontief,[36] this is not to say that capital is not an important factor in boosting labor productivity but that ". . . the implicit assumption that relative (author's emphasis) productivity of capital and labor--if compared industry by industry--is the same here and abroad"[37] is incorrect and misleading. It is incorrect because non-neutrality violates this assumption. It is misleading because it implies that the capital/labor ratio should be increased when other factors which were to be assumed constant were actually more important in explaining labor productivity.[38] Given the importance of this issue, it is worth asking if our assumption of neutrality is warranted.

In their pioneering study, Arrow et. al.,[39] have argued that differences in production are concentrated in the efficiency parameter. This assumption, they argued, was more sensible than the alternative hypothesis that differences in efficiency were concentrated either on labor or capital inputs. Their rationale was that for observations that are close in time, "one can assume access to approximately the same body of technical knowledge."[40] At the regional level, this assumption is more tenable, since as argued by Solow,[41] technology among regions is more homogeneous than among countries.

For the Northeast and South of Brazil, the assumption of identical technology is still less arbitrary. First, only three states by region, with a common set of identical branches, were chosen. Second, for both regions, it can be said that the pool of technology was the same, since equipment and machinery were bought in the South of Brazil, United States, and Western Europe. Third, though the age composition of capital differs between regions, their capital stock is relatively modern. Finally, as indicated by Solow[42] and Salter,[43] if it is empirically observed that $d_2 \neq d_1$, the question remains of the extent to which this difference is a result of "different" production functions, or of "adaptation to differing price structures."[44] Obviously, a more definite conclusion on this issue would have to rely upon a more specific investigation of each region's production function. Since our two point observation on d would not permit meaningful statistical testing, we maintain the neutrality assumption as it is.

For our next step, we investigate the sensitivity of J to changes in the magnitude of σ, and from across-region differences in capital/labor ratios. The J value is sensitive to these factors and, to the extent that there are errors in the measurement of the capital stock, and biases in the estimation of σ, our conclusions on the role of capital becomes less defensible.

We begin by considering how J varies as both the capital/labor ratio differentials and σ vary. A short-cut to this, is to consider capital stock data after adjusting for capacity utilization. By affecting regional capital/labor ratios, this adjustment will also affect the magnitude of σ, and so of J.[45]

Table V shows the new value of σ and J in columns 1 and 2 respectively.[46] As expected, except for the Non-Metallic and Clothing sectors where capacity utilization is higher in the Northeast, the value of σ increases. This increase is substantial for some sectors such as Hides and Skins, and Food and Beverages. For other sectors, the changes, though smaller, are still significant.[47]

If the changes in σ are significant throughout, the opposite is generally true for the J parameter. The gain or loss in productivity due to higher or lower values of J can be seen in column 5, where the ratio of the adjusted J_u to the unadjusted J is shown. These data show that for Non-Metallic, Clothing and Printing, the adjustment for capacity utilization actually decreases the Northeast's relative efficiency. For others, the gain in Northeast productivity is positive but small. In both cases, gain and loss in productivity are rather insignificant when compared to the observed changes in σ or in the capital/labor ratio differentials (see columns 3 and 4 of Table V, chapter VI).

TABLE V

CROSS-SECTION ESTIMATES OF THE ELASTICITY OF SUBSTITUTION, EFFICIENCY PARAMETER, RELATIVE EFFICIENCY AND UNEXPLAINED RESIDUALS - *

Sectors	$\sigma\mu$	J_u**	Northeast Relative Efficiency	Unexplained Residual (%)	J_u/J
Non-Metallic	.996	1.112	.749	.394	.985
Paper and Cardboard	.356	1.081	.447	.553	1.039
Rubber	1.188	1.245	.352	.648	1.063
Hides and Skins	1.684	1.324	.550	.450	1.084
Pharmaceuticals	.767	1.174	.318	.682	1.004
Textiles	.655	1.070	.616	.462	-
Clothing and Footwear	.389	1.008	.705	.295	.978
Food	1.125	1.323	.604	.396	1.039
Beverages	3.203	1.448	.700	.300	1.006
Tobacco	1.120	1.340	.615	.385	.981
Miscellaneous	.616	1.083	.529	.471	1.012

* In this table, regional capital/labor ratios were adjusted for differences in capacity utilization.

(-) There was no value for J.

** Since $k_1 > k_2$ for the Chemical and Plastic sectors, and J and Ju are both less than unity, we decided to drop these sectors.

At the branch level (see Table VI), the picture changes little. An appropriate contrast between this Table and Table II in this chapter gives an indication of the change in values of σ. The same picture for the capital/labor differentials is obtained by contrasting columns 3 and 4 in Table VI in Chapter VI.

Up to now we have been considering the adjustment for capacity utilization as a simple exercise in analyzing the sensitivity of J to across-region differences in capital/labor ratios and to changes in them. The scope of this adjustment is broader, however. To the extent that capital in use is more relevant than capital in place for productivity and growth analysis, hypothetical gains (losses) in productivity should be evaluated by using adjusted capital data.

Consider graphically what actually occurs when adjustment for capacity utilization is made. In Diagram II, NN and

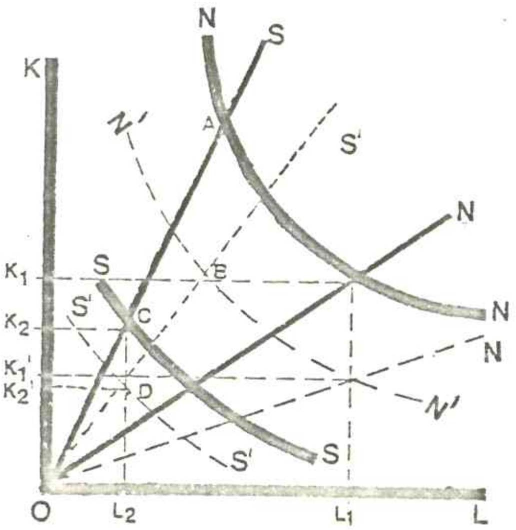


Diagram II

TABLE VI

CROSS-SECTION ESTIMATES OF THE ELASTICITY OF SUBSTITUTION,

RELATIVE EFFICIENCY AND UNEXPLAINED RESIDUAL*

Branches	σu	Ju**	Northeast Relative Efficiency	Unexplained Residual (%)
25	1.213	1.094	.624	37.6
30	.388	1.125	.421	57.9
31	1.117	1.682	.225	77.5
32	.480	1.079	.481	51.9
34	.041	1.003	.864	13.6
43	2.107	1.055	.713	28.7
94	1.307	1.077	.767	23.3
137	2.439	1.041	.900	10.0
205	1.528	1.065	.597	40.3
209	3.191	1.560	.896	10.4
382	2.684	1.162	.381	61.9
405	1.719	1.185	.355	64.5
414	.064	1.001	.716	28.4
416	2.506	1.186	.420	58.0
417	.301	1.005	.718	28.2
426	.995	1.018	.674	32.6
427	2.555	1.068	.511	48.9
437	1.008	1.409	.629	37.1
438	2.429	1.765	.413	58.7
440	.555	1.216	.769	23.1
446	1.876	1.711	.403	59.7
464	1.826	1.498	.423	57.7
477	.722	1.240	.707	29.3
478	.108	1.035	.797	20.3
484	1.410	1.527	.517	48.3
512	.145	1.027	.325	67.5
557	.568	1.018	.662	33.8

* See footnotes to Table V. **Ibid.

SS represent Northeast and South isoquants, respectively. OS and ON rays refer to each region's unadjusted capital labor ratios. Assume that adjustment for capacity utilization is made. Then capital stock in both regions is reduced, from K_1 to K_1' in the Northeast and from K_2 to K_2' in the South. Labor inputs on the other hand, are not reduced. Thus, actual capital/labor ratios in both regions are given by ON' and OS', respectively. To the extent that the capacity utilization level is higher in the South, the reduction in the capital/labor ratio will be greater in the Northeast. In other words, the downward shift in the Northeast isoquant will be greater than in the South, thus reducing the distance between both isoquants (N'N' and S'S', respectively).[48] Actually, our J's ratios in column 5 of both Tables V and VI are a numerical indication of this proportional shift, i.e., of the gain or loss in the Northeast's relative efficiency.

If we assume that the hypothetical gain (loss) in the Northeast's relative efficiency is appropriately measured by J_u in Tables V and VI, how much more have we explained by the across-region differences in capital/labor ratios? Not much; the Northeast's relative efficiency remains lower than the South's. We have gained by slightly increasing the coverage of sectors and branches (the Textile sector and the branches 478 in the Food sector, and 512 and 557 in the Printing and Miscellaneous sectors).

Our analysis of J's senstivity is not terribly enlightening, since a) it was based on values of σ estimated through equation (5) which is very sensitive to measurement errors; b) both σ and capital/labor ratios have changed; thus, the direct influence of σ on the magnitude of J could not be ascertained. To determine the importance of these criticisms, we assumed three alternative values of σ: first, we assumed the values of σ estimated by Moroney[49] for the United States; second, we set σ equal to 1.2 and 2.0.

The choice of those values of σ, though arbitrary, has some rationale. In the first place, since Moroney's estimates are, in general, lower than unity (see column 1 of Table VII), higher than unity values of σ allow for a better perception of J's sensitivity to σ. In this case, a value of σ = 2 can be understood as the upper limit and Moroney's as the lower one. In between we set σ = 1.2, thus getting a more complete look at this matter. Second, when σ is assumed constant for all sectors, inter-sectors variation in the magnitude of J is accounted for by the differences in capital/labor ratio, emphasizing its importance.

We want to stress the following: a) only the adjusted capital/labor ratio for capacity utlization is used; b) all sectors and branches where the Northeast's $(K/L)_1$ are lower than the South's are considered; c) our procedure to estimate d is changed; d) since there is no alternative σ estimate at the branch level, sectoral estimates were assumed for the component branches. The rationale for using adjusted capital data only is implicit in our previous discussion (see pages 196-198. The second and third points are discussed below.

We saw in the previous chapter that some of the paradoxical observations at both sector and branch level were the result of higher relative factor costs in the North-east and not of higher capital/labor ratios. Since estimation of J is independent of factor costs, those sectors and branches need not be excluded from our analysis if arbitrary values are assumed. The same is true for those cases where the estimates of σ were too high to be acceptable. In what follows, these two sets of sectors and branches will be included, thus increasing the coverage of our study.

The reasons for changing our estimation procedure of the distribution parameter are two fold. First, since our new J estimates will be independent of factor costs so should be our estimate of d. As we recall from Chapter II, two equations were available for the estimation of d. In the second, equation (4) which we have used, data on factor costs are necessary.[50] In the first, equation (3), they are not, since relative factor shares are substituted for factor costs for consistency. Second, since in equation (3) data on factor costs are not required, and relative factor shares are independent of the units of measurement, the second procedure is less sensitive to a change in measurement units.[51] This is a "gain" in one sense, but also a "relative" loss, since, by changing d values, we cannot, strictly speaking, compare old and new results. In what follows we consider the new results only.[52]

Data in Tables VII and VIII show the new values of J and the Northeast's relative efficiency at both levels of aggregation. There are two separate ways to analyze these data. While in the first we investigate the J sensitivity for changes in both σ and d, capital/labor ratio constant, in the second, σ is constant and, capital/labor ratios and d change.[53] Obviously, both are relevant.

Using the first procedure, we find that variation in the value of σ, except for Tobacco, is substantial. The corresponding changes in the value of J, however, are not. Comparing the data in columns 2, 3 and 4 confirms this. For example, in the Machinery sector, as the value of σ changed from .150 to 1.2 (a 800% increase), the corresponding J value changed from 1.12 to 1.46, a 30% increase. For other sectors, the change in J's values is relatively smaller. Therefore, changes in the value of σ, do not have a noticeable effect on J's value, i.e., on the Northeast's relative efficiency. A detailed analysis of all sectors and branches reveals the same pattern. Thus, our conclusion that across-region differences in K/L do not explain general

TABLE VII

ELASTICITY OF SUBSTITUTION, ALTERNATIVE ESTIMATES OF J

AND NORTHEAST RELATIVE EFFICIENCY

Sectors	σ^*	Efficiency Parameter J_1 (1)	J_2 (2)	J_3 (3)	NE Relative Efficiency (1)	(2)	(3)
Non-Metallic	.982	1.217	1.219	1.223	.820	.822	.824
Metallurgy	.593	1.364	1.403	1.417	.724	.745	.752
Machinery	.150	1.123	1.462	1.497	.644	.839	.859
Electrical Material	.552	1.320	1.380	1.401	.667	.697	.707
Transportation Equipment	.692	1.868	2.277	2.538	.620	.756	.843
Lumber	.825	1.323	1.348	1.371	.741	.755	.768
Paper and Cardboard	.276	1.110	1.110	1.112	.459	.459	.460
Rubber	.772	1.454	1.452	1.501	.408	.416	.422
Hides and Skins	.775	1.302	1.331	1.352	.540	.552	.561
Pharmaceuticals	.764	1.449	1.471	1.486	.393	.399	.403
Textiles	.609	1.096	1.099	1.100	.631	.633	.634
Clothing and Footwear	.759	1.026	1.026	1.026	.717	.717	.717
Food	.538 }	1.483	1.537	1.554	.676	.701	.709
Beverages		1.530	1.694	1.748	.740	.820	.846
Tobacco	1.963**	1.889	1.875	1.890	.867	.861	.867
Miscellaneous	.554	1.230	1.247	1.253	.601	.610	.613

TABLE VII (continued)

* Moroney's estimates--see J. R. Moroney, _op. cit._, Table 3.1, p. 57.

** From R. Solow, _op. cit._, Table 2, p. 113. There was no estimate for this sector in Moroney's work.

1) Values associated with Moroney's estimates of σ.

2) Values associated with σ = 1, 2.

3) Values associated with σ = 2,0.

TABLE VIII*

ALTERNATIVE ESTIMATES OF J AND NORTHEAST

RELATIVE EFFICIENCY

Branches	Efficiency Parameter			NE Relative Efficiency		
	J_1 (1)	J_2 (2)	J_3 (3)	(1)	(2)	(3)
25	1.191	1.193	1.197	.813	.815	.817
30	1.306	1.309	1.315	.618	.619	.622
31	2.887	2.960	3.078	1.097	1.125	1.170
32	1.169	1.171	1.175	.608	.609	.611
34	1.004	1.004	1.004	.870	.870	.870
43	1.001	1.102	1.104	.828	.829	.830
63	1.500	1.568	1.593	.714	.746	.758
73	1.113	1.114	1.115	.893	.893	.894
85	1.165	1.177	1.181	.807	.816	.818
94	1.171	1.177	1.179	.835	.839	.841
117	1.100	1.460	1.192	.640	.850	.876
137	1.093	1.185	2.193	.945	1.025	1.031
186	1.797	2.047	2.193	.827	.942	1.009
204	1.227	1.236	1.244	.876	.882	.888
205	1.106	1.108	1.110	.620	.621	.623
209	1.638	1.753	1.863	.942	1.008	1.071
320	1.388	1.404	1.414	.558	.564	.568
382	1.155	1.174	1.181	.512	.520	.523
405	1.196	1.220	1.231	.503	.514	.518
414	1.005	1.005	1.005	.718	.718	.718
416	1.642	1.742	1.812	.581	.617	.641
417	1.015	1.015	1.015	.725	.725	.725
426	1.062	1.062	1.063	.703	.703	.703
427	1.202	1.214	1.223	.576	.582	.586

TABLE VIII* (continued)

Branches	Efficiency Parameter			NE Relative Efficiency		
	J_1 (1)	J_2 (2)	J_3 (3)	(1)	(2)	(3)
437	1.603	1.657	1.671	.714	.739	.745
438	1.782	2.180	2.315	.417	.510	.542
440	1.304	1.312	1.314	.824	.829	.832
446	1.730	2.164	2.320	.408	.511	.547
461	1.552	1.813	1.907	.430	.502	.528
464	1.522	1.746	1.826	.431	.494	.517
477	1.362	1.379	1.384	.776	.786	.789
478	1.052	1.052	1.052	.810	.810	.810
484	1.666	1.786	1.821	.563	.604	.616
490	1.628	1.880	1.965	.646	.746	.780
499	1.272	1.330	1.349	.820	.858	.870
512	1.030	1.030	1.030	.409	.409	.409
557	1.047	1.048	1.048	.680	.681	.681

*See Footnotes to Table VII.

productivity differences is further substantiated. In fact, in no sector did the Northeast's labor productivity become higher than that of the South. Even for $\sigma = 2$, the unexplained residuals (not shown) remain substantial. For some branches, the residuals become somewhat lower (or even disappear). However, for the majority, the residuals remain high and, for some, even higher than observed at the two digit level. In other words, disaggregation is not usually an explanation for poor results.

How do J values change as capital/labor ratios change? As the capital/labor differential increases, other things being equal the J value will also increase.[54] In other words, the greater the increase in the Northeast's capital/labor ratio, the greater will be the regional gain in labor productivity. A detailed comparison of across-sector values of J, say for $\sigma = 1.2$ with the Northeast's relative capital/labor ratio (see column 4, Table V in Chapter VI), shows the expected results. For the Machinery and Transportation sectors, for example, the Northeast's relative capital/labor ratios were .471 and .193, respectively. Clearly, the hypothetical increase in the Northeast's capital/labor ratio will be higher in the second sector than in the first. J values, on the other hand, were 1.462 and 2.777 for the Machinery and Transportation sectors, respectively (see column 4 of Table VII): i.e., the hypothetical gain in the

Northeast's relative efficiency is substantially higher in the first sector.

This positive association is expected since, if by increasing the capital/labor ratios, no gain in labor productivity is achieved, no increase in that ratio should take place from the start. Thus, the question is not about the existence of "gains" derived from more investment in capital stock, but about the magnitude of these gains compared to the effect of increasing capital intensity. Our results and those of others[55] indicate that these gains are not substantial and thus, an emphasis on capital investment is not always advisable. However, by assuming constant returns to scale, we may have underestimated the actual gains in labor productivity. This is an empirical question with which we deal in the next chapter.

The main conclusion of this chapter is that though σ and J are positively associated, the hypothetical gain in the Northeast's average labor productivity is not very sensitive to changes in the values of σ. Our sensitivity analysis, where alternative values of σ were assumed, made this clear. More important than the value of σ are the across-region differences in capital/labor ratios. Inter-sectoral variation of capital/labor ratio σ assumed constant for all sectors, or comparison of J's values for the adjusted and unadjusted capital stock for capacity utilization can show this. Thus, measurement errors in σ do not seriously impair our results for J. In other words, in spite of the sensitivity of equation (5) to the values of variables, we can conclude that capital/labor ratio differentials did not explain the observed across-region differences in average labor productivity. The unexplained residuals, though somewhat lower at the branch level, generally remained high. The next chapter will investigate whether these residuals can be totally or partially explained by a scale factor.

FOOTNOTES TO CHAPTER VII

[1]R. Nelson stated that if different countries or regions are employing the same neo-classicial production function, and competitive conditions in the input markets are assumed, "inter-country productivity differences thus reflect differences in factor proportions used by the representative firms." R. R. Nelson and others, op. cit., pp. 91-92.

[2]See, for example, estimates for R. Solow, "Capital, Labor and Income in Manufacturing," The Behavior of Income Shares--Selected Theoretical and Empirical Issues--NBER (Princeton University Press, Princeton, 1964), op. cit., pp. 101-128, and J. R. Moroney, op. cit., pp. 57-59.

[3]For an earlier review of many empirical studies on σ estimates, see M. Nerlove, op. cit., pp. 55-121.

[4]R. Eisner, Comments on Solow's paper, in The Behavior of Income Shares, op. cit., pp. 128-137.

[5]Ibid., p. 137.

[6]Z. Griliches, "Production Functions in Manufacturing . . ." op. cit., pp. 290-297, and Griliches and Ringstaad, op. cit., pp. 9-10.

[7]I. Nadire, for example, has stated that "The only tentative conclusion is that most of the time series estimates of σ are below unit, while the cross section estimates are generally higher than the time-series estimates and close to unit," pp. 1151-1153. See I. Nadiri, "Some Approaches to the Theory and Measurement of Total Factor Productivity: A Survey," Journal of Economic Literature, vol. 8, n. 4, December 1970, pp. 1137-1177.

[8]For the V. E. S. approach, see, for example, C. A. Knox Lovell, "Capacity Utilization and Production Functions in Post-War American Manufacturing," Quarterly Economic Journal, vol. 82, n. 2, May 1968, pp. 219-239. For the Trans-log, see Lauris R. Christensen, Dale W. Jorgenson and L. J. Lau, "Transcendental Logarithmic Production Function." Review of Economic and Statistics, vol. LV, n. 1, Feb. 1973, pp. 28-45.

[9]See Yhi-Min Ho, The Production Structure of the Manufacturing Sector and Its Distribution Implication: The Case of Taiwan (Rice University--PDS, 1976), Paper no. 78, pp. 1-32, among others.

[10]Lauris R. Christensen and others, op. cit., pp. 28-30.

[11]Griliches and Ringstaad for example, stated that in a model where ". . . we have more than two factors of production we need more constraints on the variables in addition to constant output to define the elasticity of substitution between two factors. Depending on the constraints introduced one can get a number of different elasticities of substitution. None can be said to "correct." They are all useful, but useful for answering different questions," op. cit., p. 6.

[12]Ibid., pp. 8-9.

[13]About the sensitivity of the C. E. S. parameters to changes in the data, I. Nadiri has stated that "The empirical evidence seems to indicate that the parameters of the C. E. S. production function are highly sensitive to slight changes in the data, measurement of the variables and methods of estimation," I. Nadiri, op. cit., p. 1151.

[14]A negative σ is considered a "non-sense" result. This conclusion follows immediately from the fact that, by assumption, the factor marginal physical productivities are positive. In other words, an industry (i.e., a firm written at large) always operates in the so-called economic region of production. If this is not the case, $\sigma < 0$ can happen. As a matter of fact, the possibilities of values of σ less than zero arise under the V. E. S. production function specification as indicated by A. C. Knox Lovell, op. cit., pp. 221-226. On the other hand, Borts and Mishan raised the point that factor marginal productivity, mainly capital, can be actually negative. The rationale for this is that, in the short run (the case of all cross-section studies), the firm cannot dispose of the excess capacity it finds itself with. Thus, involuntarily, capital is used uneconomically. See George H. Borts and E. J. Mishan, "Exploring the Uneconomic Region of the Production Function," Review of Economic Studies, vol. 29, n. 81, October 1962, pp. 300-312.

[15]For alternative estimates of σ for the United States economy, see M. Nerlove, op. cit., pp. 60-65. See also Table I in this chapter.

[16] Obviously, the existence of fiscal incentives in the Northeast makes things worse for us. In other words, inter-region variation in relative factor prices are narrowed down so ln(b) approaches zero while ln(a) does not.

[17] As indicated by Nerlove and Arrow, et. al., these biases can be quite serious. See M. Nerlove, op. cit., pp. 72-74; Arrow, et. al., op. cit., p. 337.

[18] J. R. Moroney, op. cit., p. 48.

[19] It is worth mentioning that equation (5) is true by definition. To see this, let us rewrite equation (5) as

$$\ln(k_1/k_2) = \sigma \ln\left(\frac{w_1/r_1}{w_2/r_2}\right) \text{ or}$$

$$\frac{\ln(k_1) - \ln(k_2)}{\ln(w_1/r_1) - \ln(w_2/r_2)} \simeq \frac{d\ln(k)}{d\ln(w/r)} = \frac{dk}{k} \div \frac{w/r}{d(w/r)} = \sigma$$

Thus, the estimates of σ in this particular case are independent of any assumption or specification about production function form.

[20] These high values of σ can be more a numerical artifact than an indication of actual technical possibilities of factor substitution. As a matter of fact, what has happened is that the across region difference in relative factor costs is small, while the differences in regional capital/labor ratio are not. From another point of view, the high magnitude of σ could be explained in terms of the Best vs. Average practice argument. Equation (5) shows that if the ratio of new to total plants is higher in the Northeast, and if new plants have a higher capital/labor ratio than older plants, other things being equal, the estimate will be upward biased. For more on this, see Raford Boddy in Comments to M. Nerlove's paper in M. Brown, ed., op. cit., pp. 127-133.

[21] Roberto B. M. Macedo, op. cit., Table 3.1, p. 72.

[22] Jorge Jatobá, op. cit., Table 21, p. 83.

[23]Carlos Antonio Luque, Elasticidade de Escala e Taxa Efetiva de Incentivos a Exportacão, unpublished Master's thesis (Universidade de São Paulo, São Paulo, 1976), Table V, p. 31

[24]It should be noted that differences in σ for different estimates is the rule rather than the exception. See M. Nerlove, op. cit., pp. 60-65; and R. Macedo, op. cit., p. 72.

[25]An opposite point of view was advanced by Solow. See R. Solow, op. cit., p. 118.

[26]These branches were: ns. 73, 117, 320, 427, 261 and 490, respectively Primary Metallurgy of Non-Ferrous Metals, Machine Tools, Crude Animal and Vegetable Oils, Shoes (excluding sport shoes), Dairy Products (excluding ice cream) and Alcoholic Beverages.

[27]As discussed in Chapter II, the J parameter is derived under the assumption of a common C. E. S. production function for both regions. This parameter will be greater than unit whenever the capital/labor ratio is lower in the Northeast. It will be less than unit, otherwise.

[28]Further discussion of J's sensitivity to σ and k_1/k_2 values will be postponed until the next section.

[29]That capital/labor ratio differences across-regions or countries should be the only distinguishing differences was indicated by R. Nelson. He stated that, "In a way, this is too strict. Several of the papers admit the possibility of total factor productivity differences across nations. But this is brought in as an empirical fact of life, not as something intrinsic to the basic model." R. Nelson and others, op. cit., p. 92.

[30]It can be shown that, for a homogeneous function of first degree the per cent increase in labor productivity is equal to the percentage increase in capital/labor ratio times the capital's share in output. In other words,

$$\left(\frac{\Delta Y}{Y} - \frac{\Delta L}{L}\right) = b\left(\frac{\Delta K}{K} - \frac{\Delta L}{L}\right)$$

where b = capital share in output. As a corollary, our results on J, and the percentage change in the capital/labor ratio, yields an implicit value of b. These values are shown in column 5 of Tables III and IV.

[31]Murray Brown and John S. Cani, "Technological Change and the Distribution of Income," International Economic Review, vol. 4, n. 3, September 1963, pp. 289-309

[32]M. Brown, On the Theory and Measurement of Technological Change, op. cit., Ch. 9, pp. 131-132.

[33]We have expressed the capital and wage variables in CR $1.000,00 and CR $1.00, and the observed change in the magnitude of d was substantial. The magnitude of, J however, did not change. It can be proved that J is not affected by changes in d. Consider equation (4) and (7)

$$k = \left(\frac{d}{1-d}\,\frac{w}{r}\right)^{\sigma} \qquad (4)$$

$$J = \left[\frac{(1-d) + dk_2^{-c}}{(1-d) + dk_1^{-c}}\right]^{-1/c} \qquad (7)$$

Let α be a scalar such that $\alpha \geq 1$. Multiplying k and w in (4) by α we obtain

$$\alpha k = \left(\frac{d}{1-d}\,\frac{\alpha W}{r}\right)^{\sigma}$$

Applying log and taking the value of d we have that

$$d = \frac{b}{10^{-\beta c} + b}$$

where $b = 10^{a}$ and $a = \log \frac{k}{(w/r)^{\sigma}}/\sigma$

$$c = 1-\sigma/\sigma$$
$$\beta = \log \alpha$$

Substituting the value of d in (7) we have

$$J = \left[\frac{1 - \frac{b}{10^{-\beta c} + b} + \frac{b}{10^{-\beta c} + b} (\alpha k_2)^{-c}}{1 - \frac{b}{10^{-\beta c} + b} + \frac{b}{10^{-\beta c} + b} (\alpha k_1)^{-c}} \right]^{-1/c}$$

or

$$J = \left[\frac{10^{-\beta c} + b 10^{-\beta c} k_2^{-c}}{10^{-\beta c} + b 10^{-\beta c} k_1^{-c}} \right]^{-1/c} \rightarrow$$

$$J = \left[\frac{1 + bk_2^{-c}}{1 + bk_1^{-c}} \right]^{-1/c}$$

which indicates that J's value is independent of the unit of measurement of k and w. (This proof was suggested to us by Prof. Francisco de A. Soares--Universidade Federal do Ceará). On the other hand, this conclusion is consistent with the observation made by Brown and Cani that the sensitivity of d to units of measurement poses no problem if we stick to one unit of measurement throughout. See Brown and Cani, op. cit., p. 293.

[34]M. Brown stated that ". . . non-neutral changes are associated with variations in k, the capital intensity parameter, or σ, elasticity of substitution." M. Brown, op. cit., p. 55.

[35]Note that in equilibrium

$$\frac{w}{r} = \left(\frac{1-d}{d}\right) \left(\frac{K}{L}\right)^{1+c}$$

Thus, changes in d, ceteris paribus, imply changes in the equilibrium condition.

[36]W. W. Leontief, "Domestic Production and Foreign Trade: The American Capital Position Re-examined," in J. Bhagwati (ed.), International Trade (Penguin Books Ltd., Harmondsworth, 1972), pp. 93-139.

[37]W. W. Leontief, op. cit., p. 127.

[38]As noted by Solow, "The source of productivity differentials might be almost anything--differences in effective production functions, differences in product-mix, differences in the age, sex or educational composition of the labor force." R. Solow, op. cit., p. 115.

[39]Arrow, et al., op. cit., pp. 232-233.

[40]Ibid., p. 226.

[41]Solow argued that, "The point of analyzing interregional cross section is the chance that technology is more homogeneous across such regions than across countries at widely different levels of development." R. Solow, op. cit., p. 118.

[42]R. Solow, op. cit.

[43]E. G. Salter, op. cit., Chs. 2-3.

[44]R. Solow, op. cit., p. 118.

[45]Whenever the capacity utilization level is lower in the Northeast than in the South, the across-region differences in capital/labor ratio and the magnitude of σ will be increased.

[46]The missing sectors in this table are those which presented either a negative σ or a too-big value of σ. The same applies to the data on Industrial branches in the following table.

[47]By "significant," we mean that the ratio of the deviations of σ_u from σ to the standard deviation of σ was equal to or greater than 15 per cent. The only sector with a lower percentage was the Tobacco sector.

[48]It should be stressed here that we are not comparing isoquants NN or N'N' (or SS and S'S'). This comparison is not appropriate, since, in general, the distribution parameter's at points A and B are not the same. By assumption, the opposite is true at points B and D.

[49]Moroney's σ are cross-section estimates and are basically derived from the same cost minimization approach we have used. See, J. R. Moroney, op. cit., p. 57.

[50]For convenience, we repeat here both equations:

$$\frac{wL}{rK} = \left(\frac{1-d}{d}\right)\left(\frac{K}{L}\right)^{c} \qquad (3) \text{ and}$$

$$\frac{K}{L} = \left[\frac{w}{r}\left(\frac{d}{1-d}\right)\right]^{\sigma} \qquad (4)$$

[51]If we had assumed a Cobb-Douglas specification, factors share on output would be equal to d and (1-d) for the labor and capital input, respectively. Since a C. E. S. specification was used, this equality will not hold whenever $\sigma \neq 1$.

[52]At first sight, one would be tempted to compare J_u with, say, J_1, and input the differences in J to changes in d. This is wrong, since both d and σ have been changed.

[53]It should be noted that, in the case of Moroney's σ estimate, everything changes. As such, the second method will not be applied for this case.

[54]This is true whenever $\sigma > 0$. See equation (7) in Ch. II.

[55]The persistence of unexplained residuals was found by Arrow, et. al., op. cit., pp. 242-243; R. Nelson and others, op. cit., pp. 98-103, to mention only a few. On the other hand, the low sensitivity of J to changes in value of σ and the opposite to changes in differences in capital/labor ratios was first analysed by R. Nelson in "The CES Production Function and Economic Growth Projections," in Review of Economic and Statistics, vol. 47, n. 3, August 1965, pp. 326-328. In this paper, R. Nelson analyzed the question by considering different points of time. Obviously, this conclusion applies with equal force to cross-section studies, which he has done when comparing U. S. and Colombian manufacturing sectors. See R. Nelson and others, op. cit., pp. 98-99. Nelson's conclusion has led Z. Griliches to consider the elasticity of substitution as a second order parameter in the ". . . estimation and analysis of courses of productivity growth . . . ." Z. Griliches in M. Brown, ed., op. cit., p. 285. Along the same line, but less forceful, was M. Nerlove's position, see Ibid., pp. 55-58.

CHAPTER VIII

ADJUSTMENT FOR ECONOMIES OF SCALE

VIII.1 - Introduction

In the previous chapter, a CES production function with constant returns to scale was assumed. In this chapter, this assumption is relaxed because labor productivity can, and often does, have a positive association with average plant size. If this association is significant, the across-region differences in average plant size can be as important as the capital labor ratio in explaining inter-regional differences in labor productivity. Fortunately, we can adjust for economies of scale. In this chapter, we first discuss the rationale and the analytical procedure used to make this adjustment and then their influence on the Northeast's relative efficiency.

VIII.2 - Adjustment for Economies of Scale

Empirically, average plant size can differ between regions. Let us assume it does and ask what change in the Northeast's relative efficiency would occur, allowing for economies of scale. In other words, what would be the effect on our estimates of the Northeast's relative efficiency if the average plant size in both regions is standardized. In this study, average plant size is defined as the average number of workers per establishment (L/E).[1] We also need to develop an analytical (algebraic) expression through which the adjustment factor for economies of scale could be estimated. Before developing this expression, let us briefly give a graphical illustration of the scale argument.

Consider diagram I. On the abcissa is the average number of workers per establishment ($\overline{L}$), and, on the ordinate, the average capital per establishment ($\overline{K}$). The rays OS and ON are, as before, the regional capital/labor ratios. The same is true for the isoquants SS and NN.

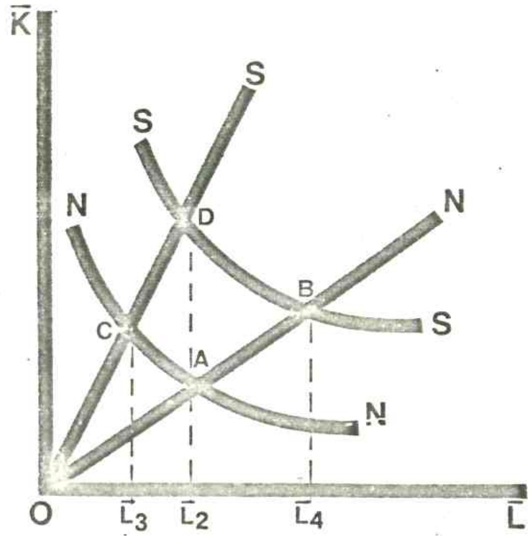


Diagram I

These isoquants, however, are not unit isoquants, and, in fact, the output level is assumed to be higher in the South (point D), than in the Northeast (point C), though both regions have the same capital/labor ratios. This equality of capital/labor ratios, is the result of the hypothetical movement along isoquant NN from point A to point C, as discussed in Ch. II. Thus, at C, both the Northeast average plant size $(\bar{L}_3)$[2] and average labor productivity (q_3) are hypothetical figures. This is not true for the South's $(\bar{L}_2)$ and q_2 figures. Alternatively, by the symmetry property of the CES production function, we could have assumed that the South's capital/labor ratio was reduced from OS to ON as that region moved downward along isoquant SS. In either case, average plant size differs between regions.[3]

To the extent that increasing returns to scale prevail, standardization of regional average plant size can positively affect the Northeast's hypothetical gain in labor productivity. Thus, an adjustment for differences in average plant size across regions is desirable. Assume that the Northeast's hypothetical average plant size is adjusted upward. Graphically, this adjustment is made by moving along OS from point C to D. By doing so, capital and labor are proportionally increased so that no change in the Northeast's hypothetical capital/labor ratio takes place. This is an important result, for it indicates that, unless there are increasing returns to scale, no hypothetical gain in the Northeast's labor productivity will be observed.[4]

Assume that increasing returns to scale do prevail. In this case, the adjusted Northeast hypothetical labor productivity at D, (q^*) will be higher than the hypothetical labor productivity at C, (q_3)[5]. On the other hand, q^*/q_3 is equal to one plus the percentage increase in labor productivity after allowing for adjustment for economies of scale. This size elasticity of labor productivity (g) which was assumed to be constant across size group and states by region is defined by

$$g = dq/_q \div d\bar{L}/\bar{L} =$$

$$d\log q/d \log \bar{L} \simeq (\log q^* - \log q_3)/(\log \bar{L}_2 - \log \bar{L}_3)^{6}$$

thus, $g \simeq \log (q^*/q_3)/\log(\bar{L}_2/\bar{L}_3)$, or, alternatively,

$\log (q^*/q_3) \simeq g \log (\bar{L}_2/\bar{L}_3) \simeq g \log(\bar{L}_2 J/\bar{L}_1)$ where $\bar{L}_2 J/\bar{L}_1$ is the ratio of actual average plant size in the South to the hypothetical average plant size in the Northeast.[7] Since q^* is unknown, the ratio q^*/q_3 cannot be estimated directly. However, once the size elasticity g and the ratio $\bar{L}_2 J/\bar{L}_1$ are estimated, this ratio can be determined. This ratio q^*/q_3 is the "correction factor" for economies of scale.[8]

The product of the correction factor q^*/q_3 to the Northeast's relative efficiency q_3/q_2 is equal to the adjusted Northeast relative efficiency (q^*/q_2). More clearly, $q^*/q_2 = (q_3/q_2)(q^*/q_3)$. Finally, note that, since $q_3/q_2 = J(q_1/q_2)$, it will follow that $q^*/q_2 = J(q_1/q_2)(q^*/q_3)$. In other words, as far as q^*/q_2 is concerned, it does not matter whether we first correct the Northeast's relative productivity for the across-region differences in capital/labor ratios, and then adjust this result for economies of scale, or if the reverse procedure is followed.

VIII.3 - The Size Elasticity of Labor Productivity (g)

Though we have made use of the size elasticity of labor productivity, we have not yet discussed the procedure for its estimation. Basically, g is estimated by regressing labor productivity on average plant size. The regression will be made in logarithmic form; there are two reasons for this double log transformation of the variables. First, the estimate of the size elasticity of labor productivity is directly given by the coefficient of the independent variable.[9] Second, both the symmetry of the distribution and the homoscedasticity of the disturbance term can be improved compared with that of the distribution of the actual values of the variables.[10] Thus, for any given industry, an equation of the form $\overline{q}_{ij} = a + gS_{ij}$ will be fitted, where $\overline{q}$ and S refer to the natural logs of labor productivity and average plant size, respectively, and the subscripts i and j to the i^{th} industry and j^{th} size class.[11]

The remaining question regarding estimation procedures for economies of scale refers to the appropriate definition of average plant size. Since there is no ideal measure of average plant size, data availability and the purpose of the study determine which particular measure to use.[12]

Griliches and Ringstaad[13] have argued that the level of output is more likely to be affected by transitory variation than are labor and employment. Therefore, the use of the total number of workers is more appropriate as the size measure, because the possibility of correlation between the error terms and the independent variables becomes less serious. Also, if the number of workers divided by the number of establishments (L/E) is taken as an explanatory variable, the more likely will this measure be "predetermined" and the less likely will it be affected by any kind of transitory variation, since in the short run, fluctuations in the level of employment and in the number of establishments is less significant than in the level of output.

K. Clague[14] discussed two alternative definitions: average number of workers per establishment (L/E) and factory output per establishment (Y/E). He did not consider the (Y/E) measure to be appropriate, since output levels may vary from country to country or among regions due only to more efficient use of available resources rather than because of the absolute level of resource utilization.[15] Possible covariation between factory output and labor productivity can also result in an upward bias in the g estimate. Conversely, errors in the measurement of labor can result in negative covariation and so underestimate g. Given these reasons, Clague took the geometric mean of both estimates as the appropriate measure of the size elasticity of labor productivity.[16]

In this study, we will take the geometric mean of two distinct estimates of (g), which will refer to the same definition of average plant size (L/E) and to two alternative grouping of data: Output (Y) and Labor (L). Contrary to Clague's[17] arguments, positive covariation between average plant size and average labor productivity is more likely to occur on either the (Y/E) or (L/E) definition, since both measures tend to increase with plant size. Furthermore, to the extent that the two measures of plant size are intercorrelated, there is not much to choose from between either definition of average plant size.[18] The same is not true with different groupings of data, since, as indicated by Johnston, two markedly different patterns of the relation between the average labor productivity and the average plant size can emerge whether the Output (Y) and the Labor (L) classifications are considered.[19] Therefore, it is advisable in empirical work, whenever data and sufficient number of observations are available, that both size classifications (groupings) be used.

The remaining problem is to decide which definition of labor to use, i.e., total labor or production workers only. As pointed out by Clague, the first definition of labor is bound to introduce a downward bias in the estimation of g, since the ratio of production workers to total employed labor decreases as plant size increases.[20] This supposition can be justified by the assumption advanced by Fleming[21] and Harbison,[22] among others, that as plant size increases so does the degree of technological sophistication as well as the managerial effort necessary to run a factory. There is a tendency for substitution of managerial and technical personnel for unskilled labor. Obviously, the utilization of total labor as a measure avoids this problem and is also consistent with our measure of labor productivity, and of relative efficiency.

VIII.4 - Average Plant Size Estimates[23]

Data in Table I, columns 1 and 2, show actual average plant size for the Northeast and the South, respectively. As the data indicate, for six sectors, average plant size is larger in the Northeast, and, in only one sector (Textiles), are they about equal. Of these two measures, however, only the South's are relevant for our purposes, since the Northeast's measure refers to point A, rather than point C, in Diagram I. This fact poses an empirical problem, since the average plant size at C ($\overline{L}_1/J$) depends upon the magnitude of J, which is sensitive to both σ and the across-region differences in capital/labor ratios. In other words, there is not a unique estimate of J, and it is hard to determine which estimate of J is more adequate. Thus, we decided to use two alternative values of J: one associated with Moroney's σ estimates, the other, with the assumed value of $\sigma = 1, 2$. First, under both estimates, we increase the number of sectors to be analyzed, since by assuming independent values of σ, information on relative factor prices are not needed to estimate J[24]. Second, these J estimates are related to capital/labor ratios adjusted for capacity utilization. This adjustment, we argued before (sec. VII.4), is relevant in estimating the Northeast's relative efficiency. Third, the assumed values for σ, Moroney's estimates and $\sigma = 1, 2$, allows for a wide

TABLE I

AVERAGES AND HYPOTHETICAL AVERAGE PLANT SIZE (1970)

Sectors	$\bar{L}_1$ (1)	$\bar{L}_2$ (2)	$\bar{L}_1^*$ (3)	(2)/(3) (4)	$\bar{L}_1^{**}/J$ (5)	(2)/(5) (6)
Non-Metallic	18.778	28.447	15.430	1.844	15.404	1.847
Metallurgy	46.000	54.172	33.724	1.606	32.787	1.652
Machinery	30.415	51.886	27.080	1.916	20.804	2.494
Electrical Material	79.604	71.325	60.306	1.183	57.684	1.236
Transportation Equipment	38.487	100.069	20.603	4.857	16.902	5.920
Lumber	15.283	19.994	11.552	1.731	11.337	1.764
Furniture	17.105	19.289	-	-	-	-
Paper and Cardboard	68.448	63.338	61.665	1.027	61.664	1.027
Rubber	12.893	56.610	8.867	6.384	8.700	1.507
Hides and Skins	32.179	26.291	24.715	1.064	24.176	1.087
Chemicals	53.050	55.981	-	-	-	-
Pharmaceuticals	23.238	81.207	16.037	5.064	15.797	5.141
Cosmetics	15.018	38.066	-	-	-	-
Plastics	30.033	38.897	-	-	-	-
Textiles	77.777	77.519	70.964	1.092	70.771	1.095
Clothing and Footwear	33.149	31.696	32.309	.981	32.309	.981
Food	25.481	18.107	17.182	1.054	16.578	1.092
Beverages	36.569	25.172	23.901	1.053	30.627	.821
Tobacco	129.259	161.707	68.427	2.363	68.938	2.346
Printing	25.495	-	-	-	-	-
Miscellaneous	13.960	32.531	11.349	2.866	11.195	2.966

TABLE I (continued)

Source: FIBGE--Industrial Census--1970

* The J values are associated with Moroney's σ estimates (see Chapter VII, Table VII, column 1).

** The J values are associated with $\sigma = 1.2$ (see Chapter VII, Table VII, column 2).

\- For these sectors there is no estimate of J.

variation in the value of σ for most sectors. Thus, there is room for change in J, and so in the measure of hypothetical average plant size.

The Northeast's hypothetical average plant size, associated with Moroney's σ estimates, and the South's relative average plant size (the ratio of the South's to the Northeast's hypothetical average plant size) are shown in columns 3 and 4, respectively, of Table I. Similar figures associated with σ = 1, 2 are shown in columns 5 and 6, respectively. As indicated, for most sectors, no big differences are observed between the two alternative estimates of the Northeast's hypothetical average plant size. In fact, in only three sectors, Machinery, Transportation Equipment and Beverages, are those differences larger than 10 per cent. This also applies to the two alternative estimates of the South's relative plant size.

Contrasting the South's average with the Northeast hypothetical average plant size,[25] we notice that in only one sector, Clothing, is the average plant size in the South smaller than in the Northeast. On the other hand, for four sectors, Paper, Hides and Skins, Textiles, and Beverages, the average sizes are approximately equal in both regions. While, for these four sectors, gains in the Northeast's relative position will be insignificant whatever the intensity of increasing returns to scale, for the Clothing sector, that relative position will actually become worse.[26] In the remaining sectors, chances are that the unexplained residuals will be reduced.

When the alternative measure of the Northeast's average plant size (J's associated with $\sigma = 1,2$) is considered (see column 5), we see that, except for the Beverage sector, the previous results on the South's relative average size remain basically the same. Thus, under this alternative measure of the Northeast's average size, it can happen that, for two sectors, Clothing and Beverage, the Northeast's relative efficiency can actually deteriorate as economies of scale are allowed for. Obviously this result, and also any possible improvement for the other sectors, will depend on the size and magnitude of the coefficient (g).

VIII.5 - The Size Elasticity of Labor Productivity (g) and the Adjusted Northeast Relative Efficiency (q^*/q_2)

As discussed in section VIII.3, the "g" estimates are obtained by regressing average labor productivity on average plant size, where size classes are considered as individual observations. The emphasis on "average" is not misplaced since size class data are one-way classified. In this case, working within group (class) "average" is a necessary condition to obtain unbiased estimates of "g."[27] If, on the one hand, ordinary least square estimates of "g" are unbiased, on the other, they are non-efficient.

As explained by Cramer[28] and Kmenta,[29] the loss of efficiency in grouped data occurs because within-group variation in the variables is lost. This loss is more serious in a one-way classification than in the two-way classified group data. Since our data are one-way classified, the loss of efficiency in our "g" estimates can be serious.[30]

Fortunately, as shown by Cramer,[31] the loss of efficiency is minimized if the between-group (between-class) variation of the regressand is maximized. In the limit no efficiency will be lost if the within-group variation in the regressand (average size) is null. In this respect, it is relevant to raise some additional points about the procedure which we used to estimate "g."

First, our regressand average size (L/E) is unlikely to show large variation within each size class. This is even more evident if we consider that we have not "lumped together" the regional data in each size class. In other words, our procedure is one of viewing each size class in each state as an independent observation. Obviously, this not only increases our number of observations and thus our degrees of freedom,[32] it also reduces the within-group variation in average plant size. On the other hand, this procedure can increase the between-class variation which as already explained, is important in improving the efficiency of the "g" estimate.

Regressing labor productivity on average plant size under the labor classification yielded poor results. First, the explanatory power of the regression model was low. Second, for some sectors, not enough observations were available. On both counts, the effect of economies of scale on labor productivity could not be investigated for a large number of sectors. Estimating "g" under the output classification did not improve the results. Both are shown in Table II.

The exclusion of a relatively large number of sectors was judged an unnecessary limitation in our investigation of economies of scale, since the same kind of information was available for the South. Thus, we decided to make an alternative estimate of "g," using the South's data.

As in the Northeast, regressing labor productivity on average plant size under the labor classification did not prove to be a good procedure. Again, either the coefficients were not significant or the goodness of fit was rather poor.[33] Both problems occurred for fourteen out of twenty sectors.[34] Fortunately, under the output classification, the coefficients were statically significant and

TABLE II

ALTERNATIVE ESTIMATES OF (g)--NORTHEAST (1970)

Sectors	Labor Classification		Output Classification	
	g	R^{2*}	g	R^{2*}
Non-Metallic	.479 (.081)	.707	.563 (.081)	.374
Metallurgy	.253 (.090)	.368	.415 (.063)	.699
Machinery	**		.301 (.131)	.261
Electrical Material	-	-	.365 (.209)	.185
Lumber	.316 (.085)	.584	.453 (.175)	.364
Beverages	.214 (.141)	.106	.386 (.117)	.397

Source: FIBGE--Industrial Census--1970.

* All R^2 are adjusted for degrees of freedom.

** Results were very poor.

\- There were not enough observations.

the goodness of fit high. (See specification I in Table III.) Only this classification will be used in our estimates of "g," a choice which poses two problems. First, as argued by Johnston,[35] the "g" estimates under the output classification can overestimate the size elasticity of labor productivity. This is partially confirmed in Table II, where the "g" estimates under the labor classification are systematically lower than under the output classification. Moreover, the differences between both estimates are quite large, varying from 18 to 93 per cent for the Non-Metallic and Metallurgy sectors, respectively. The same pattern, in fact even more pronounced, is observed for the two alternative estimates of "g" for the South. Second, working with the output classification, some degree of "efficiency" may be lost in our estimates, since the size classification is not made in terms of the regressand. Empirically this did not happen. For the Northeast, for only one sector (Clothing) did the standard deviation of the estimate increase from one to the other classification. In two sectors it decreased, and, in the remaining one (Non-Metallic), it remained constant. For the South, no change was observed. Thus, loss in efficiency does not seem to be a problem.

To face the overestimation bias, we made two alternative estimates under the output classification. In the

TABLE III

ALTERNATIVE ESTIMATES OF (g)--SOUTH (1970)

Sectors	Specifications					
	I		II		III	
	g	R^{2*}	g	R^{2*}	g	R^{2*}
Non-Metallic	.562 (.034)	.938	.424 (.055)	.762	.306 (.030)	.848
Metallurgy	.407 (.043)	.817	.240 (.023)	.840	.193 (.016)	.865
Machinery	.279 (.047)	.633	.170 (.027)	.657	.151 (.020)	.733
Electrical Material	.344 (.053)	.668	.190 (.028)	.687	.164 (.021)	.748
Transportation Equipment	.412 (.045)	.799	.227 (.032)	.714	.190 (.022)	.784
Lumber	.453 (.045)	.805	.415 (.057)	.681	.316 (.029)	.831
Paper and Cardboard	.348 (.064)	.587	.687 (.030)	.687	.169 (.023)	.730
Rubber	.394 (.084)	.487	.232 (.048)	.569	.193 (.034)	.645
Hides and Skins	.398 (.218)	.114	.190 (.030)	.681	.166 (.022)	.756
Pharmaceuticals	.602 (.138)	.619	.259 (.085)	.428	.213 (.068)	.446

TABLE III (continued)

Sectors	Specifications					
	I		II		III	
	g	R^{2*}	g	R^{2*}	g	R^{2*}
Textiles	.269 (.054)	.543	.144 (.027)	.578	.133 (.021)	.654
Clothing and Footwear	.224 (.055)	.460	.158 (.037)	.488	.138 (.030)	.524
Food	.385 (.100)	.407	.275 (.057)	.528	.241 (.034)	.705
Beverages	.322 (.130)	.244	.168 (.090)	.136	.187 (.065)	.312
Tobacco	-	-	-	-	-	-
Miscellaneous	.499 (.076)	.709	.342 (.054)	.696	.267 (.030)	.817

See footnotes to Table II.

first, we weighted the average plant size by each size class share on industry output. In the second, the average size was weighted by each size class share on the industry labor force.[36] For brevity, let us call these alternative specifications II and III, respectively, and the results obtained by simply regressing labor productivity on average plant size, specification I. The results are shown in Table III.

The first important feature of our results has to do with the comparisons of "g" estimates for the South and Northeast. (See the "g" estimates for the output classification in Table II and specification I in Table III.) We see that not much difference can be found in the size of the coefficient estimates of "g" and in their corresponding standard deviation. The same is not true for the Labor classification.[37] Thus, it may happen that, by working with the output classification and the South's data to estimate "g," no serious distortion will be introduced in our adjustment of the Northeast's relative efficiency for economies of scale.

The second feature, as seen in Table III, is that the results vary substantially from one specification to the other. In the first place, the coefficient estimates of g are significantly higher for specification I than for the two alternatives. In the last two specifications, the estimated coefficients are higher in the first than in the second. In the second place, the goodness of fit is, in general, better for specification III. In fact, for only two sectors, Non-Metallic and Food, is the goodness of fit better in specification I. In the third place, the standard deviations, though, in general, quite low in whatever specification model we look at, are lower for specification III. Comparison of the standard deviations with the size of the corresponding coefficients shows that, for any of the alternative specifications, the standard deviations are more than twice as great as the estimated coefficient of "g." Thus, we can conclude that the estimated coefficients are significant.

Having discussed these features, we must choose which "g" estimates to use in our investigation of economies of scale. Our choice was the estimates of "g" under the specifications I and III, since they correspond to the highest and lowest values of "g." Though this choice is rather arbitrary, some facts deserve comment: first, little can be gained by comparing the alternative hypothetical gain in the Northeast's labor productivity through the "g" estimates under specifications II and III, since the discrepancy between them is not substantial; second, the results for specification III look better since the goodness of fit is, generally, higher and the standard deviation lower than in the other two; third, the "g" estimates of the first specification are generally much higher than in the alternative specifications; fourth, since we have used the output classification, they can overestimate the actual labor productivity elasticity. Thus, comparison between both estimates (the highest and the lowest) can give us some indication of the importance of economies of scale for the Northeast's level of labor productivity.

The correction factor q^*/q_3 corresponding to both estimates of (g) and to the J's associated with Moroney's estimates are shown in columns 1 and 2, respectively, of Table IV. Similar figures for the J's associated with $\sigma = 1, 2$ are shown in columns 3 and 4, respectively. As the data indicate, the correction factor is not sensitive to these two alternative measures of the Northeast's hypothetical average plant size. When the (g) estimates under specification I are considered, the difference in the magnitude of the correction factor q^*/q_3 between the two alternative measures is largest for the Transportation Equipment, Beverages sectors (8 per cent), and Machinery sectors (7 per cent).[38] For the remaining sectors, these differences are still less significant. Under specification III, these differences are even smaller: 5 per cent for the Beverage sector and 4 per cent for the Machinery and

TABLE IV

ALTERNATIVE "CORRECTION FACTORS" (1970)

Sectors	q^*/q_3			
	(1)	(2)	(3)	(4)
Non-Metallic	1.410	1.206	1.412	1.206
Metallurgy	1.213	1.096	1.227	1.020
Machinery	1.199	1.103	1.290	1.148
Electrical Material	1.059	1.028	1.075	1.035
Transportation Equipment	1.917	1.350	2.080	1.402
Lumber	1.282	1.189	1.293	1.196
Paper and Cardboard	1.009	1.004	1.099	1.004
Rubber	2.076	1.430	2.091	1.435
Hides and Skins	1.025	1.010	1.034	1.014
Pharmaceuticals	2.655	1.413	2.679	1.417
Textiles	1.024	1.012	1.025	1.012
Clothing	.966	.997	.996	.997
Food	1.020	1.013	1.034	1.021
Beverages	1.017	1.010	.938	.964
Miscellaneous	1.691	1.325	1.703	1.329

1) Specification I "g" estimates and the South's relative average plant size (see column 4 of Table I) were used.

2) Specification III "g" estimates and the South's relative average plant size (see column 4 of Table I).

3) Specification I "g" estimates and the South's relative average plant size (see column 6 of Table I).

4) Specification III "g" estimates and the South's relative average plant size (see column 6 of Table I).

Transportation Equipment sectors. For the remaining sectors, the differences are equal to, or less than, 3 per cent. Therefore, we decided to work only with the correction factors estimated through the J's associated with Moroney's σ estimates, from now on referred to as specification I and III, respectively.

As expected, the hypothetical gain in labor productivity is systematically higher for specification I than for specification III. The discrepancy between both results becomes greater, the larger the South's relative average plant size. Here, it is likely that the hypothetical gain in productivity can be overestimated for some sectors like Transportation Equipment, Rubber, Pharmaceuticals and Miscellaneous sectors. This overestimation bias is stronger under specification I than under specification III. In the first case, the hypothetical gain in labor productivity, due to economies of scale for those four sectors, is over 70 per cent. Under specification III, those "gains," though sharply reduced, remain quite high (around 40 per cent). The opposite is true when the South's relative average plant size approaches unity, since the hypothetical gain in labor productivity under both "correction factors" specifications is small (lower than 6 per cent) and the differences between them are still lower (less than 4 per cent). Thus, in this latter case under rather than overestimation is more likely.

Biases in the "correction factors" estimates will obviously adversely affect the empirical results on the adjusted Northeast relative efficiency (q^*/q_2). To cope with this, we consider it appropriate to compare our estimates of the scale parameter with alternatives[39] and, also, to investigate how these alternative estimates will affect the results on (q^*/q_2).

Two independent estimates by sector of the economies of scale parameter are shown in Table V. The first (column 1) refers to the United States Manufacturing sector, as estimated by Moroney.[40] The second estimates refer to Brazil's Manufacturing sector, as estimated by A. Luque.[41] Both are cross-section estimates, and states were used as units of observation. Cobb-Douglas and C. E. S. (Kmenta approximation) production function specifications were used by Moroney[42] and A. Luque,[43] respectively.

For the United States, increasing returns to scale are found in only five sectors: two at $P \leq .01$ (Food-Beverages and Printing) and three at $P \leq .05$ (Furniture, Chemicals and Miscellaneous).[44] For the remaining sectors, constant returns to scale prevail. For Brazil, on the other hand, constant returns to scale is true for only two sectors, Food and Beverages, and, in only one sector, decreasing returns to scale occur.[45] Finally, for only four sectors, Non-Metallic, Hides and Skins, Food and Beverages,

TABLE V

ECONOMIES OF SCALE PARAMETERS: UNITED STATES

(1957) AND BRAZIL (1970)

Sectors	Moroney's Estimates (1)	Luque's Estimates (2)
Non-Metallic	1.028	1.055
Metallurgy	1.020	1.218
Machinery	1.026	1.129
Electrical Material	1.027	1.246
Transportation Equipment	.999	1.210
Lumber	1.016	1.221
Paper and Cardboard	.998	1.157
Rubber	.934	1.125
Hides and Skins	1.008	1.080
Pharmaceuticals	1.091	1.201
Textiles	1.010	.846
Clothing and Footwear	1.049	1.143
Food	1.070	1.037
Beverages	1.070	1.092
Miscellaneous	1.057	1.115

1) J. R. Moroney, op. cit., Table 2.1, p. 24.

2) A. C. Luque, op. cit., Table VI, p. 35.

are Luque's and Moroney's estimates approximately equal and, for only one sector, Textiles, are Luque's estimates lower than Moroney's.

Contrasting these alternative estimates with the "correction factors" in columns 1 and 2 in Table IV, we see that in the Non-Metallic, Transportation Equipment, Rubber, Pharmaceuticals, and Miscellaneous sectors, our estimates tend to overestimate the economies of scale parameter. This overestimation bias is stronger for specification I than for specification III. For the remaining sectors, the discrepancies in the magnitude of that parameter among the alternative estimates are less significant (equal to or less than 10 per cent). Thus, underestimation of the economies of scale parameter is a less likely event than is overestimation.

In conclusion: first, specification I estimates are less reliable than specification III estimates; second, even for specification III, overestimation of the economies of scale parameter for some sectors is likely to occur. To deal with this bias, we decided to estimate the adjusted Northeast relative efficiency (q^*/q_2) for two alternative estimates of the economies of scale parameter: specification III and Luque's estimates respectively. Luque's estimates are lower than ours for those sectors where overestimation is likely to occur, but, unlike Moroney's, they are slightly higher than ours for the remaining sectors.[46] Thus, by this procedure we reduce the overestimation bias on the one hand, and on the other, we allow for increasing returns to scale for sectors such as Clothing.

Our estimates, Luque's, and Moroney's are not strictly comparable. First, except for "g," our estimates, cannot be considered statistically significant. Second, Luque's estimates, unlike ours, are independent of any definition of average plant size, and, for that matter, of the South's relative average plant size, which ours are not. Given these factors, we considered it appropriate to follow a procedure different from the one developed in section VIII.2 to estimate (q^*/q_2) when using Luque's estimates. This alternative procedure is fairly simple and consists of estimating a different value for J under conditions of increasing, decreasing, and constant returns to scale. This is simply obtained by rewriting equation (7) in Chapter II as

$$J = \left[\frac{(1-d) + dk_2^{-c}}{(1-d) + dk_1^{-c}}\right]^{-v/c} \qquad (7)$$

where v is the economies of scale parameter.[47]

Estimates of (q^*/q_2) for ours and Luque's economies of scale are shown in columns 1 and 2, respectively of Table VI. As expected, the (q^*/q_2) figures in column 1 are

TABLE VI

ADJUSTED NORTHEAST RELATIVE EFFICIENCY (q^*/q_2) AND THE HYPOTHETICAL

GAIN IN NORTHEAST RELATIVE EFFICIENCY

Sectors	q^*/q_2		q_3/q_2	(1)/(3)	(2)/(3)
	(1)	(2)	(3)	(4)	(5)
Non-Metallic	.989	.832	.820	1.206	1.015
Metallurgy	.793	.775	.724	1.095	1.098
Machinery	.710	.654	.644	1.102	1.015
Electrical Material	.686	.714	.667	1.028	1.070
Transportation Equipment	.837	.707	.620	1.350	1.140
Lumber	.881	.790	.741	1.189	1.065
Paper and Cardboard	.461	.467	.459	1.04	1.017
Rubber	.583	.429	.408	1.428	1.050
Hides and Skins	.545	.552	.540	1.010	1.022
Pharmaceuticals	.555	.424	.393	1.412	1.079
Textiles	.638	.622	.631	1.011	1.014
Clothing and Footwear	.715	.719	.717	1.00	1.00
Food	.685	.686	.676	1.013	1.014
Beverages	.747	.770	.740	1.010	1.040
Miscellaneous	.796	.615	.601	1.324	1.023

1) Obtained through specification III (g) estimates and the South's relative average plant size.
2) Obtained through Luque's estimates of economies of scale parameters and equation(7)
3) Northeast relative efficiency--source: Ch. VII, Table VII.

substantially greater than those in column 2 (greater than 18 per cent) for the Non-Metallic, Transportation Equipment, Rubber, Pharmaceuticals and Miscellaneous sectors. For the remaining sectors, the discrepancies between our estimates and Luque's are smaller. In either case, relative efficiency, except for the Non-Metallic sector, remained lower in the Northeast. In fact, only for the Non-Metallic sector would the Northeast's efficiency approach the South's, if both the capital/labor ratio and the Northeast's average plant size were increased. This, however, does not hold if Luque's estimates are considered (see column 2). On the other hand, for only two sectors, Transportation Equipment and Lumber (see column 2), are the differences in efficiency between the two regions lower than 16 per cent. For the remaining sectors, these differences are greater than 20 per cent, which indicates that both capital/labor ratio and economies of scale do not explain the across-region differences in average labor productivity.

Consider now the hypothetical gain in relative efficiency due only to economies of scale. To clarify, we repeated in column 3 the Northeast's relative efficiency (q_3/q_2) as estimated in Ch. VII, by hypothetically increasing the Northeast's capital/labor ratio up to the South's level. In columns 4 and 5, on the other hand, we showed the ratios of the adjusted (q^*/q_3), columns 1 and 2, respectively, to the unadjusted (q_3/q_2) Northeast relative efficiency. For seven sectors, the percentage hypothetical gain in efficiency due to economies of scale is equal to, or greater than, 10 per cent (see column 4). For the Transportation Equipment, Rubber and Miscellaneous sectors, that gain is greater than 30 per cent. On the other hand, if Luque's estimates of the economies of scale parameters are considered (see column 5), only for the Metallurgy sector is the hypothetical gain equal to 10 per cent, and for the Textile sector, decreasing, rather than increasing, returns to scale occur.

The large differences between the results in columns 4 and 5, mainly for the Non-Metallic, Transportation Equipment, Rubber, Pharmaceuticals, and Miscellaneous sectors, indicate that our results on the economies of scale parameter should be viewed with caution since they could well be overestimated. For the remaining sectors, such bias is less likely.

Finally, it is interesting to note that the percentage proportions of the adjusted (q^*/q_2) to unadjusted (q_3/q_2) Northeast relative efficiency is, on both estimates of (q^*/q_2), consistently larger for the Metallurgy, Machinery, Transportation Equipment, Lumber, and Pharmaceuticals sectors than for the remaining ones.[48] The process-oriented character of these sectors explains this result. For the remaining sectors it appears that the Northeast's relative efficiency, and for that matter, labor productivity, will not be substantially affected by increasing that region's average plant size. In other words, for most sectors, scale of the plant is not an important factor in explaining the observed across-region differences in relative efficiency. Moreover, even when the hypothetical gains due to economies of scale are large, such as in the Transportation Equipment, Rubber and Miscellaneous sectors, the across-region differences in efficiency remain large.

VIII.6 - Conclusion

A positive association between average plant size and average labor productivity can be one factor explaining across-region differences in relative efficiency. In this chapter, the rationale and procedure for adjusting relative efficiency for economies of scale were discussed.

Actual average plant size for both regions was defined as the ratio of total employees to the total number of establishments ($\overline{L}$) per sector, and the Northeast's hypothetical average plant size was given by ($\overline{L}_1/J$), which is sensitive to the efficiency parameter. Two measures were made of ($\overline{L}_1/J$): one associated with Moroney's σ

estimates and the other with the assumption that $\sigma = 1.2$. Thus, two measures of the South's relative plant size were obtained ($\bar{L}_2 J/\bar{L}_1$). The "g" estimates, on the other hand, were found by regressing average labor productivity on actual average plant size by sector, where each size group was considered as an individual observation. Since two alternative classifications of size group were available (Labor and Output), two alternative estimates of "g" were made. The regressions first attempted for the Northeast for both classifications gave rather poor statistical results for the majority of sectors. For the South's data, however, this was true only for the labor classification.

Since the "g" estimates under the output classification can be overestimated (see sec. VIII.3), we specified two alternative regression models: in the first, the independent variable (S_i) was weighted by each size group share of each sector and state level of employment; in the second, output shares were used as weights. Only the second alternative, which we have called specification III, was selected. Finally, the "correction factors" associated with both the (g) estimates and the two alternative measures of the South's relative average plant size were estimated. We found no significant differences between the "correction factors" estimated through either of the alternative measures of the South's relative average plant size. Since this was not true for the alternative (g) estimates, we selected the "correction factors" associated with both (g) estimates and the South's relative average plant size associated with Moroney's σ estimates.

For seven sectors (see Table IV, columns 3 and 4), the results under specification I were substantially higher than under specification III. In particular, for four sectors, Transportation Equipment, Rubber, Pharmaceuticals and Miscellaneous, the suggested gain in the Northeast's relative efficiency due to economies of scale was rather high (over 70 per cent). For the remaining sectors, there was not much difference between both "correction factors" estimates, and the suggested hypothetical gain was low. These results are a possible indication that both over-and under-estimation could be present. To check this, two independent estimates of the economies of scale parameters were shown: one estimated by Moroney and the other by Luque, for the United States' and Brazil's manufacturing sectors, respectively. Comparing their estimates with ours we concluded that some of our results, mainly under specification I, were overestimated, but that the underestimation bias was less likely. Since the indication of upward bias was stronger for the "correction factors" under specifications I and III, only the second was used for estimating the adjusted Northeast relative efficiency (q^*/q_2).

The same estimation was made by using Luque's economies of scale parameters.

For eight sectors (see Table VI, columns 4 and 5), the differences between the results on the hypothetical gain in the Northeast's relative efficiency due to economies of scale was small. For these sectors, except Metallurgy, constant, rather than increasing, returns to scale prevailed. For the remaining seven sectors, on the other hand, the differences between both estimates were rather high, reaching the highest level for the Non-Metallic and Miscellaneous sectors. Thus, for these seven sectors and also for Metallurgy, the hypothetical gain in the Northeast's relative efficiency due to economies of scale is high under either estimate of (q^*/q_2). Obviously, they are much higher if our estimates of the economies of scale parameters, rather than Luque's, are considered. This divergency suggests that caution is advisable when choosing one of the two estimates as an indication of the hypothetical gain which may occur as average plant size in the Northeast's manufacturing sector is increased. We must remember that, for seven sectors, constant returns to scale prevail, and also, the hypothetical increases in average plant size (see Table I, column d) were much higher than the corresponding gain in efficiency. All these facts show that large-scale plants are not the solution for low efficiency in the Northeast.

FOOTNOTES TO CHAPTER VIII

[1]This definition, like any other, has its positive and negative aspects. Later in this chapter we will deal with some of these.

[2]Note that $\overline{L}_3 = L_3/E = (L_1/E)(L_3/L_1) = \overline{L}_1/J$.

[3]In this case, the South's hypothetical average plant size is

$$\overline{L}_4 = L_4/E = (L_2/E)(L_4/L_2) = \overline{L}_2 J/E$$

since

$$L_4/L_2 = L_3/L_1 = J.$$

[4]It is true that the absolute value of Northeast's output would be increased by this adjustment, but not its labor productivity. It can be also seen that if across-region differences in capital/labor ratios and average plant size were "all that matter" at C labor productivity would be equal in both regions.

[5]Note that q_3 is the hypothetical level of Northeast labor productivity associated with correction for differences in capital/labor ratio only. On the other hand, q^* is the hypothetical level associated with both adjustments, i.e., capital/labor ratio and average plant size.

[6]Note that $d\overline{L}/\overline{L}$, i.e., the percentage change in average plant size takes place along ray OS. Thus, both capital and labor are increased proportionately.

[7]This treatment of economies of scale was first developed by K. C. Clague, La Eficiencia Economica en el Peru y los Estados Unidos, unpublished monography (Harvard University, 1966), pp. 9-12.

[8] The alternative method for scale adjustment can be summarized as follows: consider

$$g \simeq \log q^* - \log q_3 / \log \bar{L}_2 - \log \bar{L}_3$$

multiplying both numerator and denominator by (-1) we have

$$g \simeq \log q_3 - \log q^* / \log \bar{L}_3 - \log \bar{L}_2 .$$

The size elasticity of productivity is invariant if we assume that the South increases or the Northeast decreases its average plant size. In this latter case we would have:

$$\log (q_3/q^*) \simeq g \log (\bar{L}_1 J/\bar{L}_2) \simeq g \text{ Log } (\bar{L}_1/\bar{L}_2 J).$$

[9] This convenient aspect, as indicated by Johnston, makes the use of double-log transformation common in econometric studies. See J. Johnston, Econometric Methods, 2nd edition (McGraw Hill Book Co., New York, 1972), Ch. 3, pp. 51-52.

[10] The effect of log transformation on distribution is briefly treated by F. E. Croxton and D. J. Cowden, Practical Business Statistics, 3rd edition (Prentice Hall, Inc., Englewood Cliff, N. J., 1960), Ch. 18, pp. 260-263. On the question of homocedasticity see D. J. Smith and others, "The Measurement of Firm Size: Theory and Evidence for the United States and United Kingdom." Review of Economic and Statistics, vol. LVIII, n. 1, Feb. 1975, pp. 111-114.

[11] Since data on individual plants are not available, class size will be considered as the unit of observation.

[12] See, on this, S. S. Shalit and U. Sankar, "The Measurement of Firm Size," Review of Economic and Statistics, vol. LIX, n. 3, Aug. 1977, pp. 290-298. For a discussion of alternative definitions of plant size, see also Bela Balassa, "Economies of Scale in the European Common Market," Economia Internazionale, vol. XIV, n. 2, March 1961, pp. 199-213.

[13]Griliches and Ringstaad, op. cit., p. 12. These authors have also noted that the labor measure ". . . is also more convenient for a form of estimation based on grouping into employment size categories . . . which reduces significantly the endogeinity problem." Ibid., loc. cit.

[14]K. C. Clague, Economic Efficiency . . . , op. cit., pp. 36-37.

[15]Suppose we have two given plants with the same level of resources employment but with different production levels. Obviously, the one with greater output level would be larger than the other.

[16]For further discussion of the (L/E) and (Y/E) measures, see Bela Balassa, op. cit., pp. 203-206, and M. Frankel, op. cit., pp. 108-109.

[17]K. C. Clague, Economic Efficiency . . . , op. cit., pp. 40-41.

[18]For further discussion about the intercorrelation between different measures of plant size, see David J. Smith and others, loc. cit.

[19]See J. Johnston, Statistical Cost Analysis (McGraw Hill Co., Inc., New York, 1960), Ch. 3, pp. 111-130.

[20]Note that if, as the average plant size increases, the output is increased pari passu with a reduction in labor force, regressing average labor productivity on average plant size can, in this case, underestimate the size elasticity of labor productivity.

[21]M. C. Fleming, op. cit., pp. 223-228.

[22]F. Harbison, op. cit., pp. 365-374.

[23]In this section we will deal only with more aggregated data, since we do not have size class classification for a lower level of aggregation.

[24]As we have seen (sec. VI.3), most of the observed paradoxical observations were due to the low across-region differences in relative factor prices rather than to a higher capital/labor ratio in the Northeast.

[25] Hypothetical average plant size associated with Moroney's estimates.

[26] This conclusion will be reversed if, instead of increasing, we have decreasing returns to scale.

[27] See, on this, Y. Haitovsky, "Unbiased Multiple Coefficients Estimated from One Way Classification Tables when the Cross Classifications Are Unknown," Journal of the American Statistical Association, vol. 61, n. 315, June 1966, pp. 720-728. See also, J. Kmenta, Elements of Econometrics (The MacMillan Company, New York, 1971), pp. 320-329.

[28] J. S. Cramer, "Efficient Grouping, Regression and Correlation in Engel Curve Analysis," Journal of the American Statistical Association, vol. 59, n. 305, March 1964, pp. 223-250.

[29] J. Kmenta, op. cit., pp. 322-329.

[30] The loss of efficiency can be overcome if another method, rather than O. L. S. is used. See, on this, J. Kmenta, op. cit., pp. 322-329. See also, J. Johnston, Econometric Methods, op. cit., pp. 228-238.

[31] J. S. Cramer, op. cit., pp. 236-239.

[32] Actually, if we had aggregated regional data, we would not have enough observations to estimate "g."

[33] R^2 adjusted for degree of freedom less than 10 per cent.

[34] For one sector (Tobacco), there were not enough observations. For the remaining six sectors, the results are:

Sectors	(g)	R^2
Non-Metallic	.174 (.085)	.135
Metallurgy	.184 (.046)	.413
Transportation	.129 (.055)	.209
Rubber	.139 (.073)	.148
Cosmetics	.301 (.079)	.475
Printing	.187 (.065)	.299

Note that the latter two results are not relevant to our purpose since they correspond to what we have called paradoxical observations in Ch. VI, sec. VI.3.

[35] J. Johnston, Statistical Cost Analysis, op. cit., pp. 111-130.

[36] The two regressions equations are respectively:

$$q = \alpha_o \left[\frac{VAB_i}{VAB} \left(\frac{L}{E}\right)_i \right]^g$$

$$q = \alpha'_o \left[\frac{L_i}{L} \left(\frac{L}{E}\right)_i \right]^{g'}$$

where

VAB_i = the i^{th} size class output level in a given sector and state. Similarly for L_i.

VAB = each state output in a given sector. Similarly for L.

[37] Compare the results on footnote 34 with these, corresponding to specification I in Table III.

[38] As we noted before, the discrepancy between the two alternative measures of the Northeast's hypothetical average plant size was largest for these three sectors.

[39] It should be noted that the "correction factors" are equal to one plus the scale parameters.

[40] J. R. Moroney, op. cit., p. 24.

[41] A. C. Luque, op. cit., p. 35. Luque has two estimates for the scale elasticity. In the first, he did not allow for external economies; in the second, he did. Sectoral value added for each state was used as a proxy for external economies. We chose Luque's second estimate, though the difference between them was not significant.

[42] For the actual specification, see J. R. Moroney, op. cit., p. 20.

[43] See A. C. Luque, op. cit., p. 23.

[44] See J. R. Moroney, op. cit., p. 25.

[45] For the Tobacco sector, the economies of scale parameter was also significantly greater than unity. For this sector, and also for the others, the significance level was 10 per cent. See, A. C. Luque, op. cit., p. 34.

[46] The Textiles sector is an exception, since decreasing returns to scale are indicated in Luque's estimates. In ours, on the other hand, constant returns to scale seem to be the case.

[47] To be consistent with our procedure in Ch. VII, Moroney's estimates and capital/labor ratios are assumed to be adjusted for capacity utilization.

[48] These sectors' hypothetical gains are much higher under our estimates than under Luque's, varying from 20 per cent for the Non-Metallic to approximately 42 per cent for Rubber and Pharmaceuticals. For Transportation and Miscellaneous sectors, this percentage would have been 35 and 32 per cent, respectively. These high percentages indicate that our estimates could have been overestimated.

CHAPTER IX

CONCLUSIONS

IX.1 Introduction

This study has concentrated on the analysis of across-region differences in average labor productivity in Brazil's manufacturing sector at the two-digit level of aggregation and lower. Basically, we have investigated how the observed differences could be explained by differences in capital/labor ratios and economies of scale.

IX.2 - Summary and Conclusions

Adjustments for capital/labor ratios and/or economies of scale did not, for most sectors, explain all of the differences in labor productivity between the Northeast and the South of Brazil. The contribution of each of these two factors varies among sectors, and that of capital/labor ratio is, in general, higher than that of economies of scale. At the branch level, adjustment for capital/labor ratios was also made, and many differences in labor productivity were left unexplained.

The fact that differences in capital/labor ratios do not explain differences in labor productivity is not new.

Earlier, Arrow et al.,[1] Clague,[2] and Nelson,[3] among others, reached the same conclusion. The innovative features of the present study were that similar results were found in a regional context, both alternative values of σ were assumed, and capacity utilization level was included. Another important aspect of this study was the comparison of the hypothetical percentage increase in the capital/labor ratio with that in labor productivity. This revealed that increases in capital/labor ratios at both levels of aggregation were much larger than those in labor productivity.

The analytical framework for dealing with capital/labor ratio differences and economies of scale was discussed in Chapters II and VIII.

Since data on both capital stock and capital price were unavailable, this information had to be computed. Capital stock was computed by using 1959 book value information and the flow of gross investment thereafter. The estimated capital stock was assumed to be net of accumulated depreciation since, as discussed in section IV.4, census data are likely to underestimate actual capital formation. However, indirect evidence on actual replacement charges, through investment in modernization projects, was available for the Northeast. Half of this investment was assumed to be equal to actual replacement charges. The assumed depreciation charges were insignificant, either in absolute terms, or as a proportion of each sector's capital stock. This, however, was not true for the Non-Metallic and Textile sectors, and depreciation charges were included for these two.

Measurement errors, market imperfections, and the large across-region differences in rates of return precluded their use as proxies for capital prices. Therefore, an alternative measure of the South's relative capital price was computed (see sec. V.3.1). We found that capital cost was lower in the Northeast than in the South[5] because SUDENE's fiscal incentives artificially lowered it. Moreover, the composition of financing (internal vs. external funds; see sec. V.3.2) of fixed capital indicated that SUDENE's fiscal incentives were the most important factor accounting for the observed across-region differences in capital cost.

Labor costs (average wage rates) were discussed in Chapter VI, as were relative factor costs and relative factor proportions. Labor costs, with several exceptions, were consistently lower in the Northeast than in the South. However, because of the lower capital cost, relative factor cost was not always lower in the Northeast. Capital/labor ratios were also not always lower in the Northeast. Thus, for 5 out of 21 sectors and 15 out of 46 branches, factor combinations were inconsistent with factor price signals.

We attempted to rationalize these inconsistencies (see sec. VI.3). In some cases, capacity utilization (discussed in Chapter IV, section IV.6) explained them.[6] In others, we argued that either one or any combination of the following: limited factor substitutability, age composition of capital stock by region and non-cost minimization, could be explanatory factors.

The elasticity of substitution (σ) and the efficiency parameter (J) were estimated in Chapter VII. The elasticity of substitution (σ) estimates were obtained through equation (5).[7] These estimates are sensitive to the values of the the variables since, for each sector or industrial branch, only two observations either on relative capital/labor ratios or relative factor prices are available. In spite of this limitation, the estimation procedure has some positive aspects, i.e., independence of: i) assumption of profit maximization, ii) economies of scale parameter, iii) prices of output. Moreover, comparison with alternative estimates (see Table I, Ch. VII) for the Brazilian manufacturing sector indicated that, for some sectors, our estimates were quite robust.

Comparison of the σ estimates at both sector and branch levels indicated that the values of σ tended to be slightly higher in the branches. More important, there was correspondence between estimates for a given sector and its component branches. (This was not true for between-sector estimates.)

The Northeast's relative efficiency was estimated in section VII.3. Though σ and J are positively associated, this association was not strong either at the sector or branch level. Alternative values of σ were assumed, ranging from lower than unity (Moroney's estimates) to σ = 2. In between we set σ = 1,2. The changes in the values of J, given such a large change in σ, were small. Therefore, we concluded that measurement errors in σ are not a serious drawback to our empirical results which indicated that across-region differences in capital/labor ratios did not explain many of the differences in labor productivity.

Finally, in Chapter VIII we investigated the extent to which economies of scale could reduce the unexplained residuals. First, the sensitivity of the results to alternative measures of the South's relative plant size and for different specifications of the simple regression equation, was assumed. Second, two independent estimates of the economies of scale parameters, one for the United States (Moroney's), and the other for Brazil (Luque's) were considered. Comparison of these estimates with each other and with ours indicated that ours could have been upward-biased for some sectors, since differences between ours and the two alternative estimates were the highest. This upward bias suggests caution in accepting some of our estimates. Therefore, we used two estimates of the economies of scale parameters (ours and Luque's) for adjusting the Northeast's relative efficiency (q_3/q_2) for economies of scale.

Under both estimates, relative efficiency, except for the non-Metallic sector (for our estimates only), remained lower in the Northeast. On the other hand, for only two sectors, Transportation Equipment and Lumber (for our estimates only), are the differences in efficiency between the two regions lower than 16 per cent. For the remaining sectors, and for all sectors in Luque's estimates, these differences were larger than 20 per cent.

IX.3 - Implications for Policy

Low capital intensiveness was considered by the GTDN[8] (see Ch. 1.2) to have been the main reason for the low level of labor productivity in the Northeast's manufacturing sector, with economies of scale also being an important factor. Our results do not substantiate this claim. An increase in the capital/labor ratio and/or in the average plant size did not make up for the across-region differences in labor productivity. This is more relevant since both regions' capital stock was adjusted for capacity utilization.

The magnitude of the unexplained residuals, however, varies greatly among sectors. So does the role of the capital/labor ratio and scale of the plant in reducing the differences in labor productivity between the two regions. These variations can be revealing in terms of policy implications.

In Table I we repeat the data on the Northeast's relative productivity (q_1/q_2), relative efficiency (q_3/q_2), and the adjusted relative efficiency (q^*/q_2) in columns 1, 2 and 3, respectively. The increase in the Northeast's relative labor productivity explained by capital/labor ratios and economies of scale is shown in columns 4 and 5, respectively. This is obtained by subtracting: first, column 2 from column 1, second, column 3 from column 2. The addition of these two increases is the explained residual. In column 6 we show the unexplained residuals (100 minus the adjusted efficiency).

For one sector, Non-Metallic, the unexplained residuals approach zero and, for two others, Transportation Equipment and Lumber, they are very low. Thus, for these three sectors, both capital/labor ratio and scale seem to be most effective in reducing the across-region differences in labor productivity. To a lesser extent, the same can be said for the Metallurgy, Electrical Material, Beverages and Miscellaneous sectors since their level of unexplained residuals is

TABLE I

NORTHEAST RELATIVE LABOR PRODUCTIVITY AND FACTORS EXPLAINING IT

Sectors	Northeast			Residuals		
				Explained by		
	Relative Labor Productivity (1)	Relative Efficiency (2)	Adjusted Relative Efficiency (3)	Capital Labor Ratio (4)*	Economies of Scale (5)*	Unexplained (6)*
Non-Metallic	.674	.820	.989	.146	.169	.011
Metallurgy	.531	.724	.793	.193	.069	.207
Machinery	.574	.644	.710	.070	.066	.290
Electrical Material	.505	.667	.686	.162	.017	.314
Transportation Equipment	.332	.620	.837	.288	.217	.163
Lumber	.560	.741	.881	.188	.140	.119
Paper and Cardboard	.414	.459	.461	.045	.002	.539
Rubber	.281	.408	.583	.127	.175	.417
Hides and Skins	.415	.540	.545	.125	.005	.455
Pharmaceuticals	.271	.393	.555	.366	.162	.445
Textiles	.576	.631	.638	.055	.007	.362
Clothing	.699	.717	.715	.018	-.002	.285
Food	.456	.676	.685	.220	.009	.315
Beverages	.484	.740	.747	.256	.007	.253
Miscellaneous	.489	.601	.796	.112	.195	.204

1) Source: Chapter I, Table I.
2) Source: Chapter VII, Table VII.
3) Source: Chapter VIII, Table VI.
*) See text.

relatively low and the explained residuals are fairly large. For the remaining eight sectors, this is not true, since either the unexplained residuals are fairly large and/or the explained residuals are fairly low, as in the Machinery, Paper, Textiles and Clothing sectors. For the Rubber and Pharmaceuticals sectors, on the other hand, the explained residuals are large,[9] but so are the unexplained ones. The low level of the Northeast's relative labor productivity (see column 1) for these two sectors partly explains this. The same is also true, to some extent, for the Hides and Skins and Food sectors. In summary, capital-intensiveness and scale of the plant were important factors in reducing the sizeable across-region differences in labor productivity in seven sectors, whereas for the remaining eight sectors emphasis on the capital/labor ratio and scale of the plant did not explain much.

Another implication for policy to be drawn from our empirical results concerns the relative importance of the capital/labor ratio and economies of scale in explaining the differences in labor productivity. As the data show (see columns 4 and 5), for three sectors only, Non-Metallic Rubber and Miscellaneous, does the scale factor seem more important than the capital/labor ratio. For the remaining twelve sectors, either both factors seem to be equally important, as for the Machinery, Paper, Textiles and Clothing sectors, or the capital/labor ratio factor seems to be crucial. For the eight sectors,[10] medium and small-scale plants could have great relevance. First, they can use fairly modern technology without excessive investment in capital per worker. This is relevant since if, on one hand, the increases in the Northeast's relative labor productivity due to the capital/labor ratio may be fairly large, on the other, the corresponding increases in those ratios are much higher. In other words, the increase in Northeast's labor productivity has to be weighted against its investment cost. Second, smaller scale plants usually require a lower level of management effort and labor skill, both scarce in this region. Moreoever, medium-and small-scale plants can mean more job opportunities and a more widespread increase in labor productivity. This does not imply that an across-the-board emphasis on small-and/or medium-scale plants over large-scale and up-to-date technology is recommended. It only indicates that, for those eight sectors, medium-and-small-scale plants might be efficient units of production in the Northeast, and could make an important contribution to the region's growth.

IX.4 - Limitations of the Study and Some Suggestions for Additional Research

The limitations of this study are many, and we will classify them in two groups. In the first are the assumptions about competitive conditions, neutrality of technological progress, and the a priori specification of a C. E. S. production function. In the second, are factors such as management, labor skill, and others which are likely to differ between the two regions, and were not treated in our study. Since our focus was on the role of the capital/labor ratio and economies of scale in explaining the across-region differences in labor productivity these other factors are only briefly mentioned as relevant topics for further research.

Let us consider the first group of limitations. Competitive conditions in both input and output markets and also an identical C. E. S. production function (except for the efficiency parameter) were assumed to prevail in both regions. Both assumptions, it could be argued, impose serious limitations on our results. First, competitive conditions seldom prevail in the real world, and less so in regions where rapid industrialization and structural changes are taking place. Absence of competitive conditions, on the other hand, is damaging to the related maintained hypothesis of cost minimization. Second, it is debatable that the elasticity of substitution remains constant along a given isoquant. Third, production functions may differ between regions.

Non-cost minimization is most damaging to the estimation of the elasticity of substitution. However, as we have seen, our results are not sensitive to the magnitude of σ. Thus, even if entrepreneurs are not cost minimizers, our conclusion suffers little, if any, damage. The same reasoning applies to the assumption of a constant σ, and we can argue along with both Griliches[11] and Nelson[12] that σ is a second order parameter in the determination of average labor productivity, as sensitivity analysis has confirmed. In spite of this, it is likely that specification of a more general production function would yield different results from ours. Whether a more general production function would increase the role of both capital/labor ratio and scale in explaining the differences in labor productivity is an empirical question. Limitations of our data precluded a more general approach.

Non-identical production functions for a given sector or branch in both regions can be damaging; i.e., comparison of points A and B in Diagram I (see Ch. II) would be misleading. If we assume, for example, that capital is more productive in the South than in the Northeast, there would be no reason to expect that, as the Northeast hypothetically increases its capital/labor ratio up to the South's level, its efficiency would be equalized at that level. This is also true for the efficiency of labor.

The claim of "different" production functions, however, could justify virtually everything. Without empirical evidence to support this claim, the assumption of identical production functions is a more reasonable one for the researcher. Moreover, as we have argued, for two regions such as the South and Northeast of Brazil undergoing rapid industralization at the same time, it is more likely that the production functions for each sector or branch in both regions would be identical, except for the efficiency parameter.[13] Nonetheless, across-region differences in average age of plants and in the craft sector, by industry, lend some support to the "different" production function argument. These differences, mainly in the craft sector, probably explain some of the differences in average labor productivity.[14]

Consider next the second group of limitations. The sizeable unexplained residuals for the majority of the sectors suggest that factors other than capital/labor ratios and economies of scale are relevant in explaining the differences in labor productivity, and their exclusion is a limitation of this study.

Better management is more efficient in: i) combining factors of production; ii) choosing technology; iii) setting the scale of the plant; iv) adjusting the level of production to changes in demand; v) procuring raw materials, replacement parts and financing. Better management is generally reflected in lower unit cost of production. Assuming that management quality is higher in the South than in the Northeast, the low level of the efficiency of the Northeast can be partially explained by its shortage of management skill.[15]

Average years of schooling did not differ much between the Northeast and the South. Still lower were the across-region differences in the "quality-based" index in education (see sec. VI.2). Thus, skill differences may have a lesser importance in explaining the differences in labor productivity. However, we have also seen (sec. VI.2) that average nominal wage rate tends to increase with the length of time in the firm. Thus, if formal education does not mean large differences in skill between the two regions, informal education, i.e., on the job training, can be important. The comparatively recent industrialization drive in the Northeast has brought fewer opportunities for on the job training, and, hence, the fitness of labor for industrial work may be higher in the South. The low level of integration of the Northeast's manufacturing sector, its dependence on inputs from the South, its limited access to national and international markets and its low level of income indicate that external economies favor its plants less than the South's. Both skill differences and external economies probably also account for part of the large unexplained residuals.

Another interesting topic in this area is the possible role that product mix differences and oligopolistic practices in fixing the price of final products could have on the interregional differences in average labor productivity. Though our results at the branch level did not indicate that lower levels of aggregation were associated with smaller differences in average labor productivity, it might happen that, for a given product (identical or approximately so in both regions), productivity differences are smaller than our data have indicated. This could also be true for oligopolistic practices, since part of the higher value added in the South can be explained, not by higher efficiency, but by higher output prices.

FOOTNOTES TO CHAPTER IX

1 Arrow *et al.*, *op. cit.*, pp. 242-243.

2 K. C. Clague, *op. cit.*, pp. 124-132.

3 R. R. Nelson, and others, *op. cit.*, pp. 98-103.

4 For the Textiles sector, investment in modernization was equated to actual depreciation charges.

5 Sector estimates of the South's relative capital cost were assumed for each sector's component branches, since we have no data at branch level on SUDENE's fiscal incentives.

6 By "explained" here, we mean that across-region differences in capacity utilization "flipped over" the relative capital/labor ratio.

7 See Ch. II, sec. II.5.

8 GTDN, *op. cit.*, p. 301.

9 We view the results for the Rubber sector with skepticism. A large proportion of this sector's output is accounted by the branch Pneumatic Tire Reconditioning (58 per cent, a similar figure for the South is only 4 per cent). This activity is generally labor intensive and, from a technical point of view, is unlikely to have conditions for a large increase in both capital/labor ratio and scale.

10 Metallurgy, Electrical Material, Transportation Equipment, Lumber, Hides and Skins, Pharmaceuticals, Food and Beverages.

11 Z. Griliches, in M. Brown ed., *op. cit.*, p. 285.

12 R. R. Nelson, "The C. E. S. Production Function and Growth Projections," *op. cit.*, pp. 326-328.

13 Note that the selected states by region are the ones with a higher pace of industrialization by region. Moreover, this assumption is fairly common in the literature even when different countries at different stages of

development are considered. See Arrow et al., op. cit., pp. 232-233; K. C. Clague, op. cit., pp. 5-9; R. Nelson and others, op. cit., pp. 91-92, among others. Moreover, as indicated by R. Solow, "The point of analysing interregional cross-sections is the chance that technology is much more homogeneous across regions than across countries at widely different levels of development." R. Solow, op. cit., p. 118.

[14] Nelson, for example, has argued that "dualism" in industrial structure in less developed countries where new technology (according to the technological lead, product cycle theories) is introduced at a slower pace than in the developed countries, is a key factor explaining international differences in average labor productivity. He even states that the greater the weight of the craft sector, the lower the average labor productivity of a given country. His argument can be translated with less impact into a regional framework. See R. R. Nelson and others, op. cit., pp. 103-127.

[15] It has been argued that management quality and size are positively associated. If so, our adjustment for economies of scale may have included some of the differences in management quality between the regions. Also, those estimates would be an overestimation of the scale effect on labor productivity. See C. Clague, Economic Efficiency in Peru and the United States, op. cit., pp. 130-131.

REFERENCES

Albuquerque, R. C. de. and Albuquerque, C. C. de. Desenvolvimento Regional no Brasil--Série Estudos para Planejamento. Rio de Janeiro: IPEA, 1976, no. 6.

Arrow, Kenneth, J., Chenery, H. B., Minhas, B. S., and Solow, R. M., "Capital-Labor Substitution and Economic Efficiency." Review of Economics and Statistics, 43 (August 1961): 225-50.

Bacha, E. L.; Mata, M. da; and Modenesi, R. L. Encargos Trabalhistas e Absorcão de Mão de Obra. Colecão Relatórios de Pesquisa. Rio de Janeiro: IPEA, 1972, no. 12.

Bacha, E. L.; Araujo, A. B.; Mata, M. da.; and Modenesi, R. L. Análisé Governamental de Projetos de Investimento no Brasil: Procedimentos e Recomendacões: Colecao Relatorios de Pesquisa. Rio de Janeiro: IPEA, 1971. no. 1.

Baer, W. Industrialization and Economic Development in Brazil. Homewood, Ill.: Richard D. Irwin, Inc., 1965.

Balassa, B. "Economies of Scale in the European Common Market," Economia Internazionale, XIV (March 1961), pp. 199-213.

Baltar, Paulo Eduardo de Andrade. "Salario e Produtividade na Estrutura Industrial de 1970," Rio de Janeiro: V National Meeting of Brazilian Economic Association--ANPEC (December 1978) (Mimeographed).

Banco Central do Brasil. Various issues. Boletim do Banco Central do Brasil. Brasilia.

Banco, do Nordeste do Brasil (BNB). "Sondagema Conjuntural na Industria de Transformacão," Revista Economica, 2 (Jan.-March 1971), pp. 73-90.

Barna, T. "On Measuring Capital," in The Theory of Capital, ed. D. C. Hague. New York: St. Martin's Press, Inc., 1961, pp. 75-94.

Boddy, R. "Recent Empirical Studies of the CES and Related Production Functions: Comment," In The Theory and Empirical Analysis of Production, ed. M. Brown, New York: National Bureau of Economic Research, 1967, pp. 127-133.

Bonelli, Regis. Tecnologia e Crescimento Industrial: a experiencia brazileira nos anos 60. Série Monografica. Rio de Janeiro: IPEA, 1976, no. 25.

Borts, H. and Mishan, E. J., "Exploring the Uneconomic Region of the Production Function," Review of Economic Studies, 29 (October 1962), pp. 300-312.

Brown, Murray. On the Theory and Measurement of Technological. Change. Cambridge, Eng.: Cambridge University Press, 1966.

Christensen, L. R.: Jorgenson, D. W.; Lau, L. J. "Transcendental Logarithmic Production Function," Review of Economic and Statistics, 55 (February 1973), pp. 28-45.

Clague, K. C. Economic Efficiency in Peru and the United States. Ph.D. Dissertation, Harvard University, 1965.

________. La Eficiencia Economica en el Peru y los Estados Unidos. Unpublished Monograph: Harvard University, 1966. (Mimeographed.)

Cramer, J. S. "Efficient Grouping, Regression and Correlation in Engel Curve Analysis," Journal of the American Statistical Association, 59 (March 1964), pp. 223-250.

Croxton, F. E. and Cowden, D. J. Practical Business Statistics, 3rd edition, Englewoods Cliffs, N. Jersey: Prentice-Hall, Inc., 1960.

Cunha, Paulo, V. da and Bonelli R. "Estrutura de Salários Industriais no Brasil," Rio de Janeiro: V National Meeting of Brazilian Economic Association - ANPEC (December 1978). (Mimeographed.)

Denison, Edward F. "Theoretical Aspects of Quality Change, Capital Consumption and Net Capital Formation," in Problems of Capital Formation--Concepts, Measurement, and Controlling Factors. Princeton: National Bureau of Economic Research, 1957, pp. 215-61.

Departmento Nacional de Mão de Obra (DNMO). Mercado de Trabalho - Composicão e Distribuicão da Mão de Obra. Ministério do Trabalho e Previdencia Social, 1969, 1970.

Domar, E. "The Capital--Output Ratio in the United States, Its Variation and Stability," in Theory of Capital. Ed. D. C. Hague. New York: St. Martin's Press, 1961, pp. 95-117.

Eisner, R. "Capital, Labor and Income in Manufacturing: Comment," in The Behavior of Income Shares--Selected Theoretical and Empirical Issues. Princeton: National Bureau of Economic Research, 1964, pp. 128-137.

Farrel, M. J. "The Measurement of Productive Efficiency," in Journal of the Royal Statistical Society, Series A (General), 120, Part III (1957), pp. 256-58.

Fishow, A. "Origens e Consequencias da Substituicão de Importacão no Brasil," in Formacão Economica do Brasil: A Experiencia da Indústrializacão. eds. Flavio R. Versiani and José R. M. de Barros, São Paulo: Edicão Saraiva (1977), pp. 41-63.

Fleming, M. C. "Inter-Firm Differences in Productivity and their Relation to Occupational Structure and Size of Firm," The Manchester School of Economics and Social Studies, 38 (September 1970), pp. 223-245.

Frankel, Marvin. "Anglo-American Productivity Differences: Their Magnitude and Some Causes," American Economic Review, 45 (May 1955), pp. 94-112.

Fundacão Getulio Vargas. Various Issues. Conjuntura Economica. Rio de Janeiro.

Fundacão Instituto Brasileiro de Geografia e Estatistica (FIBGE). Censo Industrial 1970. Rio de Janeiro, 1974.

________. Producão Industrial, 1962-1969. Rio de Janeiro: FIBGE/DEICOM.

Furtado, C. Diagnosis of the Brazilian Crisis, Berkeley: University of California Press, 1965.

Galenson, W. and Liebenstein, H. "Investment Criteria, Productivity and Economic Development," Quarterly Journal of Economic, 69 (August 1955), pp. 343-370.

Goodman, D. E. and Albuquerque, R. C. de. Incentivos à Industrialisacão e Desenvolvimento do Nordeste: Colecão Relatórios de Pesquisa. Rio de Janeiro; IPEA, 1970, no. 20.

Goodman, D. E., Sena, J. F.; Albuquerque, R. C. de. "Fiscal Incentives for the Industrialization of the Northeast of Brazil and the Choices of Techniques," Brazilian Economic Studies, 1 (1975), pp. 201-226.

Griliches, Zvi. "Production Functions in Manufacturing: Some Preliminary Results," in The Theory and Empirical Analysis of Production, ed. M. Brown, New York: National Bureau of Economic Research, 1967, pp. 275-322.

Griliches, Zvi, and Ringstaad, V. Economies of Scale and the Form of the Production Function, Amsterdam: North Holland Publishing Co., 1971.

Haitovsky, Y. "Unbiased Multiple Coefficients Estimated from one way Classification Tables when the Cross Classifications Are Unknown," Journal of the American Statistical Association, 61 (June 1966), pp. 720-728.

Harbinson, F. W. "Entrepreneurial Organization as a Factor in Economic Development," Quarterly Journal of Economics, 70 (August 1956), pp. 364-379.

Hardin, Einar and Strassman, W. P. "La Productividad Industrial y la Intensidad de Capital de Mexico y los Estados Unidos," El Trimestre Economico, 35 (Jan.-March 1968), pp. 51-62.

Hicks, J. R. "The Measurement of Capital in the Relation to the Measurement of other Economic Aggregates," in Theory of Capital, ed. D. C. Hague. New York: St. Martin's Press, Inc., 1961, pp. 18-31.

Hirschman, A. O. Journeys Toward Progress. New York: The Twentieth Century Fund, 1963.

________. "Industrial Development in the Brazilian Northeast and the Tax Credit Scheme of Articles 34-18," The Journal of Development Studies, 5 (October 1968), pp. 5-28.

________. The Strategy of Economic Development, 4th edition, New York: Yale University Press, 1963.

Ho, Yhi-Min. The Production Structure of the Manufacturing Sector and its Distribution Implication: The Case of Taiwan. Paper no. 78, Program of Development Studies. Houston, TX.: Rice University.

Huddle, D. L. Inflationary Financing, Industrial Expansion and the Gains from Development in Brazil. Paper no. 60, Program of Development Studies. Houston, Tx.: Rice University.

________. "Post-war Brazilian Industrialization: Growth Patterns, Inflation and Sources of Stagnation," in The Shaping of Modern Brazil, ed. Eric N. Blaklanoff. Baton Rouge: Louisiana State University Press, 1969, pp. 86-108.

Jatobá, J. Politica de Precos, Mudanca de Tecnologia e Absorcão de Mão de Obra. Recife: PIMES--Universidade Federal de Pernambuco, 1977.

Johnston, J. Econometric Methods. 2nd edition, New York: McGraw Hill Book, Co. Inc., 1972.

________. Statistical Cost Analysis. New York: McGraw Hill Book Co., Inc., 1960

Jorgenson, D. W. and Griliches, Z. "The Explanation of Productivity Change," Review of Economic Studies, 34 (July 1967), pp. 249-283.

Kendrick, John. "Capital, Labor and Income in Manufacturing: Comment," in The Behavior of Income Shares--Selected Theoretical and Empirical Issues. Princeton: National Bureau of Economic Research, 1964, pp. 140-142.

Kmenta, J. Elements of Econometrics. New York: The MacMillan Company, 1971.

Kravis, I. "Relative Income Shares in Fact and Theory," American Economic Review, 49 (December 1959), pp. 917-949.

Kuznets, S. Postwar Economic Growth--Four Lectures, Cambridge Mass.: Harvard University Press, 1964.

________. Economic Growth and Structure--Selected Essays. New York: W. W. Norton and Company, Inc., 1965.

________. "Quantitative Aspects of the Economic Growth of Nations v. Capital Formation Proportions: International Comparisons for Recent Years," in Economic Development and Cultural Change, 8 (July 1961), pp. 1-124.

Lau, L. J. And Yotopoulos, P. A. "A Test of Relative Efficiency and Application to Indian Agriculture," American Economic Review, 59 (March 1971), pp. 94-108.

Leontief, W. W. "Domestic Production and Foreign Trade: The American Capital Position Re-examined," in International Trade, ed. J. Bhagwati. Harmansdsworth: Penguin Books Ltd., 1972, pp. 93-139.

Lewis, A. W. "Economic Development with Unlimited Supply of Labor," Manchester School of Economics and Social Studies, 22 (May 1954), pp. 139-191.

Liebenstein, H. "Allocative Efficiency vs. X-Efficiency," American Economic Review, 56 (June 1966), pp. 392-415.

Loeb, F. G. "Numero Indices de Desensolvimento Fisico da Producão Industrial, 1939-1949," Revista Brasileira de Economia, year 7 (March 1953), pp. 31-66.

Lovell, C. A. K. "Capacity Utilization and Production Functions in Post-war American Manufacturing," Quarterly Economic Journal 82 (May 1968), pp. 219-239.

Luque, C. A. Elasticidada de Escala e Taxa Efetiva de Incentivos a Exportacão, Master's thesis, Universidade de São Paulo, 1976.

Macedo, R. B. M. Models of the Demand for Labor and the Problem of Labor Absorption in the Brazilian Manufacturing Sector. Ph.D. dissertation, Harvard University, 1974.

Martone, C. "Efeitos Alocativos da Concessão de Incentivos Fiscais," in O Imposto sobre a Renda das Empresas (Série Monográfica), ed. Fernando Resende. Rio de Janeiro: IPEA, 1975, no. 19, pp. 53-94.

Mehta, B. V. "Size and Capital Intensity in India Industry," Bulletin-Oxford University Institute of Economics and Statistics, 31 (August 1969), pp. 189-204.

Meir, Gerald. Leading Issues in Economic Development: Studies in International Poverty. 2nd edition, New York: Oxford University Press, 1970.

Miller, M. H. and Modigliani, F. "Some Estimates of the Cost of Capital to the Electric Utility Industry," American Economic Review, 26 (June 1966), pp. 333-391.

________. "The Cost of Capital, Corporation Finance and the Theory of Investment," American Economic Review, 48 (June 1958), pp. 261-297.

Minhas, B. S. An International Comparison of Factor Costs and Factor Use. Amsterdam: North-Holland Publishing Co., 1963.

Moroney, J. R. The Structure of Production in American Manufacturing. Chapel Hill: The University of North Carolina Press, 1972.

Nadire, I. "Some Approaches to the Theory and Measurement of Total Factor Productivity: A Survey," Journal of Economic Literature, 8 (May 1968), pp. 219-239.

Nelson, R. R. "The C. E. S. Production Function and Economic Growth Projections," Review of Economic and Statistics, 47 (August 1965), pp. 326-329.

________. "Aggregate Production Function and Medium Range Growth Projections," American Economic Review, 54 (September 1964), pp. 575-606.

Nelson, R. R.; Schultz, T. Paul; Slighton, Robert L. Structural Change in a Developing Economy: Colombia's Problems and Prospects. Princeton, N. J.: Princeton University Press, 1971.

Nerlove, M. "Recent Empirical Studies of the C. E. S. and Related Production Functions," in The Theory and Empirical Analysis of Production, ed. M. Brown. New York: National Bureau of Economic Research, 1967, pp. 55-122.

Ness, W. L. "Financial Markets, Innovation as Development Strategy: Initial Results from the Brazilian Experience," Economic Development and Cultural Change, 22 (April 1974), pp. 453-472.

PIMES--Efeitos Espaciais da Politica Nacional de Desenvolvimento Industrial. (Unpublished monograph) Recife: Universidade Federal de Pernambuco, 1978.

Reboucas, O. E. Inter Regional Effects of Economic Policies: Multi-sectoral General Equilibrium Estimates for Brazil, Ph.D. dissertation, Harvard University, 1974.

Robinson, Rommey. "Factor Proportions and Comparative Advantage -- Part I," Quarterly Journal of Economics, 70 (May 1956), pp. 181-197.

Robock, H. Brazil's Development Northeast: A Study of Regional Planning and Foreign Aid. Washington, D. C.: The Brookings Institution, 1963.

Ruggles, R. and R. Nancy. "Concepts of Real Capital Stock and Services," in Output, Input and Productivity Measurement. Princeton: National Bureau of Economic Research, 1961, pp. 387-403.

Sahota, G. S. and Rocca, C. A. Investment of Growth. São Paulo: Fundacão Instituto de Pesquisas Economicas, Universidade de São Paulo, 1976. (Mimeographed.)

Salter, W. E. G. Productivity and Technical Change. Cambridge, Eng.: Cambridge University Press, 1969.

Samuelson, P. A. "The Surrogate Production Function," Review of Economic and Statistics, 29 (June 1962), pp. 193-206.

Sandesara, J. C. "Sale and Technology in India Industry," Bulletin-Oxford University Institute of Economics and Statistics, 28 (August 1966), pp. 181-198.

Shalit, S. S. and Sankar, U. "The Measurement of Firm Size." Review of Economic and Statistics, 59 (August 1977), pp. 290-298.

Smith, D. J.; Boyes, William J.; Peseau, Dennis E. "The Measurement of Firm Size: Theory and Evidence for the United States and United Kingdom." Review of Economic and Statistics, 58 (February 1975), pp. 111-119.

Smith, Vernon L. Investment and Production, Cambridge: Harvard University Press, 1961.

Solow, R. M. "Capital, Labor and Income in Manufacturing," in The Behaviour of Income Shares--Selected Theoretical and Empirical Issues. Princeton: National Bureau of Economic Research, 1964, pp. 101-128.

Strassman, P. W. Technological Change and Economic Development. Ithaca: Cornell University Press, 1968.

Superintendencia do Desenvolvimento do Nordeste (SUDENE). Pesquisa sobre a Industria Textil do Nordeste. Recife: MINTER-SUDENE, 1971.

Superintendencia do Desenvolvimento do Nordeste (SUDENE). Resultados do Programa de Industrializacao até 1968. Recife: MINTER-SUDENE, 1972.

Syvrud, D. E. Foundations of Brazilian Economic Growth. Stanford: Hoover Institution Press, 1974.

________. "Estrutura e Politica de Juros no Brasil." Revista Brasileira de Economia, 26 (Jan./March 1972), pp. 117-139.

Thurow, L. C. "Desiquilibrium and the Marginal Productivity of Capital and Labor," Review of Economics and Statistics, 50 (February 1968), pp. 23-31.

Walmsley, Vernon T. Os Determinantes da Productividade Media do Trabalho, na Industria da Transformacão do Brazil. Master's thesis. Recife: Universidade Federal de Pernambuco, 1975.

White, Lawrence J. "The Evidence on Appropriate Factor Proportions for Manufacturing in Less Developed Countries: A Survey," Economic Development and Cultural Change, 27 (October 1978), pp. 27-60.

Yotopoulos, Pan A. and Nugent, Jeffrey B. Economic of Development--Empirical Investigations. New York: Harper and Row, 1976.

LATIN AMERICAN PERSPECTIVES
A Journal on Capitalism and Socialism

REVIEW PROCESS

All manuscripts will be submitted to the following review process. A coordinating editor will be named in accordance with area of interest and current editorial workload. The coordinator will serve as liaison between the author and the other editorial members in charge of the article. For authors who so wish, and where appropriate, the coordinator will provide editorial assistance. Manuscripts (with author's name and affiliation deleted) will be sent to two Participating Editors, one Latin American and one non-Latin American. Reviewers will make one of three judgements: that the manuscript be published in its present form, rejected or returned to the author for revision. In case of rejection or return for revision, the reviewers' signed comments will be sent to the author. If there is substantial disagreement among there viewers, the decision will be made by the Coordinating Editor. Authors who feel that important political and theoretical view shave been improperly rejected may appeal the decision; this will be reviewed by all Coordinating Editors. This review process is intended to promote constructive dialogue between reviewers and authors. It is hoped that the exchange of well-intended criticism and suggestions will promote collaboration in the review process without undermining standards of rigor or objectivity and that the process will produce the best possible paper for publication. All authors are requested to submit five copies of their manuscript along with two copies of an abstract of 100 words or less.

Articles appearing in **Latin American Perspectives** are abstracted and/or indexed in: ABC POL SCI, Alternative Press Index, Bibliographic Index, Development and Welfare (Delhi), Development Education Exchange (Rome), Documentación Iberoamericana (Madrid), Historical Abstracts, International Political Science Abstracts, and Peace Research Abstracts.

LATIN AMERICAN PERSPECTIVES: Published four times annually, in winter, spring, summer and fall. Third class postage paid at Riverside, California. Subscription price: Individuals, $12. Low Income (Students and Unemployed), $10; Educational Institutions, $20. Private Corporations and Government Agencies, $40. For two years, Individuals, $20; Educational Institutions, $36. Foreign mail: add $2 per year for regular and $10 for air mail. Individual copy, $3.50. Back issues, $5. Bulk orders of 10 or more, 20% discount.

Editorial Address:

The Managing Editor
Latin American Perspectives
P.O. Box 5703
Riverside, California 92651

Subscriptions and Bulk Orders:

Latin American Perspectives
c/o CMS
P.O. Box 792
Riverside, California 92502