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TECHNOLOGY CHOICE IN THE MEN'S LEATHER SHOE AND COTTON SPINNING INDUSTRIES IN BRAZIL: THE RELATION BETWEEN SIZE, EFFICIENCY AND PROFITABILITY

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Table of Contents

	Page
List of Tables	iii.
List of Figures	v.
Chapter One: Introduction.....	1.
Chapter Two: Mean Differences Across Size Groups of Firms.....	18.
Chapter Three: A Neo-Classical Model of Size Differences Among Firms.	47.
Chapter Four: Other Production Functions: Cobb-Douglas and CES Production Function Estimates of Scale Elasticity.....	71.
Chapter Five: The Determination and Characterization of Efficient Firms	81.
Chapter Six: Characterization of Firms in Different Size, Efficiency and Profitability Groups: Multiple Discriminant Analysis	102.
Chapter Seven: Conclusions	159.
Appendix A: Survey Implementation and Questionnaires	167.
Appendix B: The Brazilian Shoe Industry	202.
References:	238.

Tables

Chapter One

1. Employment per Unit Output, by Industrial Sector Groups, Brazil
2. Employment Generated by the Secondary Sectors
3. Breakdown in Employment Growth
4. Breakdown in Employment Growth, by Region: Sectoral Productivity Growth
5. Breakdown in Employment Growth, by Region: Sectoral Product Mix
6. Breakdown in Employment Growth, by Region: Scale Productivity Growth
7. Breakdown in Employment Growth, by Region: Scale Product Mix
8. Rank Correlations Between Scale of Production and Labor Productivity

Chapter Two

1. Number of Times Firm Ranked in Given Interval: Shoes
2. Number of Times Firm Ranked in Given Interval: Cotton Spinning
3. Mean Differences by Size Groups: Shoes
4. Wage Differentials in the Shoe Industry
5. Mean Differences by Size Groups: Cotton Spinning
6. Wage Differentials in the Cotton Spinning Industry

Chapter Three

1. Definitions of Production Relations
2. Production Elasticities
3. Isoelasticity Function

4a. Estimates of ϕ_L, ϕ_K, $\frac{\epsilon_{LK}}{\epsilon_{LL}}$: Shoes

4b. Estimates of ϕ_L, ϕ_K, $\frac{\epsilon_{LK}}{\epsilon_{LL}}$: Cotton Spinning

Chapter Four

1. Estimates of Cobb-Douglas Production Functions: Shoes and Cotton Spinning

2a. Estimates of CES and Non-Homothetic Production Functions: Shoes

2b. Estimates of CES and Non-Homothetic Production Functions: Cotton Spinning

Chapter Five

1. Farrell Efficiency Experiments: Variables Used
2. Farrell Efficiency Experiments: Rank Order Correlations Between Efficiency Indexes

3. Farrell Efficiency Experiments: Potential Increase in Output
4. Characteristics of Efficient Firms
5. Characteristics of Profitable Firms

Chapter Six

1. Variables Used in Discriminant Analysis: Shoes
2. Variables Used in Discriminant Analysis: Textiles
3. Shoes: Efficiency Ranks from Farrell Experiments and A Priori Classification
4. Textiles: Efficiency Ranks from Farrell Experiments and A Priori Classification
5. A Priori Profitability Classification: Shoes and Textiles
6. Shoes: Rank Order of Means of Discriminating Variables
7. Shoes: Mean Values of Firm Characteristics by Size, Efficiency and Profitability Group
8. Shoes: Discriminant Functions
9. Shoes: Classification of Firms into Groups
10. Textiles: Rank Order of Means of Discriminating Variables
11. Textiles: Mean Values of Firm Characteristics by Size, Efficiency, and Profitability Groups
12. Textiles: Discriminant Functions
13. Textiles: Classification of Firms into Groups

Figures

Chapter Three

1. Profit Maximization for Fixed Real Wage
2. Isoelasticities
3. Isoelasticities

Chapter Five

1. Efficient/Inefficient Firms
2. Definition of Inefficiency
3. The Relation Between Efficiency and Profitability

Chapter Six

1. Plot of the Discriminant Scores
2. Strength of the Discriminating Variable
3. Shoe Centroids: Discriminant Analysis by Size Groups
4. Shoe Centroids: Discriminant Analysis by Efficiency Groups
5. Shoe Centroids: Discriminant Analysis by Profitability Groups
6. Textile Centroids: Discriminant Analysis by Size Groups
7. Textile Centroids: Discriminant Analysis by Efficiency Groups
8. Textile Centroids: Discriminant Analysis by Profitability Groups

Introduction

The early emphasis of many discussions by development economists centered around problems of growth, of the generation of savings, and of real capital investment. By the 1960's, however, it had become obvious that even among those countries which had experienced growth, many were still faced with high levels of unemployment and underemployment. Frequently the growth process had been accompanied by capital deepening rather than employment generation, and by a worsening distribution of income. Articles, such as the one by W. Baer and M. Hervé pointed to the discrepancy between the rate of growth of manufacturing production and the absorption of labor. There have been many explanations of this phenomenon. The two fundamental explanations might be classified: 1. technological limitations, 2. distortions in relative prices. Most other explanations of the long-run existence of unemployment and the low rate of labor absorption (including that of scale economies. the composition of output, tastes and the distribution of income) ultimately rest upon one or the other of these two. There is by now a large literature--both theoretical and empirical--on the causes of unemployment, which has been surveyed by F. Stewart, D. Morawetz, and S. Acharya. I will not try to repeat their surveys or even their arguments here, but only give a very brief discussion of each of the two categories.

The first explanation is epitomized by R. Eckaus' article "The Factor Proportions Problem in Underdeveloped Areas" and much of the literature on dependency, which assume rigid factor proportions in the production of any commodity. By assumption, increasing the use of a factor in the production process of a particular commodity beyond the requirements given by the fixed proportions, will have no effect on output. If the factors of production are not used in technologically fixed proportions then at least one

factor will exhibit zero marginal productivity. Baer and Hervé's article is essentially an elaboration of this hypothesis. They show that the existence of several factors--including skilled labor, for instance, as well as capital and unskilled labor--might well lead a rational employer to use a relatively capital intensive process, conserving on the use of unskilled as well as of skilled labor.

There has been a good deal of effort put into verifying this basically simple, technological hypothesis. The efforts have ranged from measuring the marginal productivity of labor in agriculture or the service sectors, to measurements of capital-labor substitutability in macro or sectoral production functions, and to more general discussions of the sources of technological development. On this last point, to the extent that most machinery is produced and most R and D is conducted in developed countries, and to the extent that there is little ex post substitutability between capital and labor, there might be a bias in the available machinery. The existing production techniques might be more suited to the factor proportions of developed countries than they are to less developed countries.

The second explanation, based upon distorted factor prices, has also received a great deal of attention in the literature. If institutional arrangements or government intervention (or non-profit maximizing behavior of enterprises) result in market factor prices (or the prices considered by entrepreneurs) different from the shadow prices, then unemployment can result. At a market wage above the shadow wage, employers will not find it profitable to hire the available labor force. During the course of economic development, there often appear to have been several stages of economic policy, associated with varying degrees of price distortions. For instance, the "import substi-

tution" process is usually accomplished through differential sectoral protection from imports, differential access to imported materials and differential capital subsidies. The use of labor has frequently been discriminated against. During the "export substitution" phase (in Taiwan and South Korea, at least), many of these distortions are diminished as the country turns more to international markets and produces more according to its comparative advantage. (See Fei and Ranis for a more extensive discussion of the "import substitution" and "export substitution" phases of growth, as well as for the Taiwanese and South Korean examples.) The Latin American model has been less one of "export substitution" than of "export promotion."[1] The same policy instruments that were used for protection from imports have been used for the promotion of exports. It is not clear that price distortions in all sectors have diminished or that the growing importance of exports has been associated with reliance on classic comparative advantage. Therefore, it is not clear that the increasing reliance on exports has encouraged labor absorption. But the problem is still bigger. It is not clear that even a policy of free trade in a land and resource rich Latin American country will improve the distribution of income--if that is the ultimate goal--even though it should expand employment.

A third explanation of unemployment and low rates of labor absorption rests upon the product mix. To the extent that demand patterns, whether they

[1]"Export substitution" is used to describe an opening of the economy to international trade, by diminishing price distortions. During such a period, the importance of international trade in the economy grows and the list of exports also grows, with an increasing role of new products intensive in the country's abundant factors. "Export promotion ", on the other hand, refers to a policy to expand the role of international trade and the list of exported goods, not according to comparative advantage, but still under a regime of price distortions.

come from the domestic or international markets or from public expenditures, are weighted towards commodities that are inherently capital intensive, then an increase in demand will have only a small effect on employment. This product mix argument cannot by itself explain open unemployment, though it can explain a low rate of labor absorption. To explain unemployment itself, the argument must come back to either the first or the second explanation above.

Brazil has often been considered a typical example of a large country following import substitution policies, with the resulting distortions in factor prices, capital intensive industrial production and low rates of labor absorption in spite of rapid growth. The figures in Baer and Hervé or in Bacha support this view through the 1950's. Bacha's figures, reproduced in Table 1, show that industrial output increased more rapidly than industrial employment even through the 1960's, but there was a noticeable fall-off in the gap between output and employment growth rates after the early 1960's. Moreover, the industrial census shows that, after a decline in the 1950's, there was a rise in the 1960's in the share of the labor force employed in industry and in the ratio of national productivity to industrial productivity. These figures are given in Table 2. This apparent improvement in the Brazilian manufacturing employment picture could have several sources: First, the product mix might have shifted in favor of relatively labor using commodities. Second, factor prices and the incentive structure might have changed so that each commodity is produced in a relatively more labor intensive manner. Third, more labor-using technological alternatives might have opened up. And fourth, balanced growth in production could account for the overall growth in employment.

The goal of this introduction is to isolate, without fully explaining, the share of the increased employment which is due to shifts in the structure of production or in the size composition of firms; the share which is due to changes in sectoral or size specific labor productivity; and that due to growth. If changes in the product or scale mix and in the levels of production account for most of the increased employment, then there is not much to attribute, in a historical sense, to changing techniques of production. On the other hand, if differences in labor productivity account for a large part of the total change in employment, then a microeconomic study of the choice of techniques is warrented.

By definition, we have:

(1) $L \equiv \frac{L\,X}{X}$, where L is total manufacturing (or sectoral) employment and X is total manufacturing (or sectoral) output.

Differentiating:

(2) $dL = X\, d(\frac{L}{X}) + \frac{L}{X}\, dX$

(3) $d\,(\frac{L}{X}) = d\left[\sum_i \frac{L_i}{X_i}\frac{X_i}{X}\right] = \sum_i d\,(\frac{L_i}{X_i})\,\frac{X_i}{X} + \sum_i \frac{L_i}{X_i}\; d(\frac{X_i}{X})$, where L_i is employment in sector (or scale) i, and X_i is output in sector (or scale) i.

(4) $L = \sum_i L_i$.

(5) $X = \sum_i X_i$.

Substituting (3) into (2):

(6) $dL = X\left[\sum_i d(\frac{L_i}{X_i})\,\frac{X_i}{X} + \sum_i \frac{L_i}{X_i}\, d(\frac{X_i}{X})\right] + \frac{L}{X}\; dX$.

In the discrete case, (6) can be written as:

$$(7)\quad L^1 - L^o = X^1 \cdot \{\Sigma \frac{X_i^1}{X^1}\left(\frac{L_i^1}{X_i^1} - \frac{L_i^o}{X_i^o}\right) + \Sigma_i \frac{L_i^o}{X^o}\left(\frac{X_i^1}{X^1} - \frac{X_i^o}{X^o}\right)\} + \left(\frac{X^1 - X^o}{X^o}\right) L^o$$

The terms in the brackets {} show how much of the increase in manufacturing employment is due to anoverall change in labor productivity. The first of these terms measures the effect of a change in sectoral or size specific labor productivity. The second of the terms shows the impact on overall labor productivity of a change in scale or product mix. The final term shows the effect of growth on employment, if sectoral (or scale) labor productivity and the product (or scale) mix had remained unchanged.

If changes in production methods--either in reaction to changes in factor prices or in a gradual adjustment to the cost minimizing technique or due to newly available technology--have been important, we would expect the first term in the brackets to be relatively large. The usual caveat, however, applies: The data available are aggregate, and the subsectoral effects are hidden. For example, if textile production has shifted towards capital intensive synthetics and away from cotton textiles, the data presented here will overestimate the effect of <u>within</u> product changes in laborproductivity. Part of the product mix effect is being attributed to changes in sectoral labor productivity. Similarly, if there have been changes in the scale of production, the first term in brackets can be misleading. For instance, if small scale shoe producers are being replaced by more capital intensive, large producers, it will appear as if production techniques are changing, though at any given scale of production there might be no change.

The data used to measure the relative importance of the various effects come from the Brazilian Industrial Censuses for 1949, 1959 and 1970. The first set of calculations considers manufacturing production broken down by sector, for Brazil as a whole, for the state of São Paulo and for the Northeast region. São Paulo and the Northeast were selected because of the very different regional economic conditions and because the firm level survey was carried out in São Paulo. The second set of calculations selects four sectors--non-metallic minerals (which includes bricks), machinery (which includes agricultural and cotton spinning machinery), textiles (which includes cotton spinning) and clothing (which includes men's leather shoes)-- broken down by employment size, for Brazil and the states of São Paulo and Pernambuco. The sectors cover those which were sampled in the firm level studies in Brazil, Colombia and Taiwan.

The most general breakdown in data is given in Table 3, which shows the proportion of the total change in employment over time which can be attributed to balanced output growth, to sectoral and scale output mix changes, or to within sector and scale labor productivity changes. It is obvious here that overall output growth in manufacturing has been responsible for the major share of the growth in manufacturing employment. This is true whether the focus is on total manufacturing employment, broken down by sectors, or by scale. In every case but those of non-metallic minerals and textiles in the state of Pernambuco, the overall growth of output has a larger absolute impact on employment than does either changing productivity within sector and scale or changing sector and scale mix. Moreover, the balanced growth effect is large enough to offset the possible adverse effects on employment of the latter two combined except in the cases of textiles and clothing in

the state of Pernambuco, where total employment declined from 1959 to 1970.

Not only does labor productivity increase overall, as shown in Table 3, but within almost every sector and scale level. Table 4 gives the results by sector and Table 6 by scale. Only in rubber has there been a small decrease in labor productivity for São Paulo and Brazil, from 1959 to 1970. In the Northeast, wood products, paper and rubber all show minor decreases between 1959 and 1970. And only in nine out of seventy-nine cases analyzed did labor productivity by scale decrease.

The growth in overall labor productivity could be due to economies of scale, as total production and firm size have grown.[1] But the figures in Table 6 tend to contradict this hypothesis, as productivity has grown even for the same scale of production. It appears, then, that the 1950's and 1960's have been a period of capital deepening, one of technical change and/or one of significant changes in subsectoral product mix, even at the same scale of production.

The effect of changing sectoral mix on employment is generally small. Changes in the scale of production have sometimes worked to increase and sometimes to decrease employment, though not always in the same direction for any given sector. Except for non-metallic minerals, these effects have also been small, and have always been smaller in absolute value than the productivity effect. (See Table 3).

---

[1]Table 7 shows that most of the scales that have increased their share in total production have fifty or more employees.

Another way of looking at the effect of changes in size composition of firms is to see whether a growth in firm size will change labor absorption. The *a priori* prediction would be that there exists a positive correlation between firm size and capital intensity of production. In fact, as Table 8 shows, the rank correlations between scale of production and labor productivity are about one-half positive and one-half negative.[1] The general trend towards increasing firm size does not necessarily increase labor productivity

In summary, while the effect of overall growth on employment has been striking, its effect has been considerably diminished by increases in labor productivity by sector and by scale. The effect of productivity increases has been substantial enough to justify a micro level analysis of its causes.

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[1]There is a bias, however, in the measure of scale. For lack of an alternative that would be comparable over time, scale here is measured by number of employees rather than by output. The bias, therefore, is towards increased labor utilization with scale.

Outline of the Monograph

This monograph reports on the results of a survey of firms in the men's leather shoe and the cotton spinning industries of the state of São Paulo, Brazil. The survey was implemented in late 1975 and early 1976. The design of the questionnaires and the survey implementation were carried out jointly with economists at the Fundação Instituto de Pesquisas Econômicas, of the University of São Paulo, Brazil. In particular, José Roberto Mendonça de Barros and Hélio Noguera da Cruz were actively involved in the project and have, also written papers based on the survey.

The monograph focuses on questions related to the size, efficiency and profitability differences among firms. It attempts to characterize firms in each of these groups and to explain the interrelations among the groups. It tries, for instance, to determine whether some firms are profitable because they are large and can take advantage of economies of scale, or because they operate within favorable factor markets, or because they use more effective sources of information and have more skilled managers.

Chapter Two serves as an introductory description of the two industries, where firms are classified according to size. Chapters Three and Four present estimates of standard neo-classical production functions, with more than the usual emphasis placed on the technological or marketing origen of scale economies. Chapter Five questions a major hypothesis of the production function estimates: that all firms operate efficiently. It derives measures of firm's efficiency, based upon process data. The sixth chapter, in a sense, returns to the descriptive analysis of the second, though with a multivariate approach. It describes groups of firms and tests hypotheses about these groups, using multivariate discriminant analysis. Appendix A describes the survey methodology and reproduces sample questionnaires. Appendix B gives a brief description of the Brazilian shoe industry.

Table 1

Employment per Unit Output, by Industrial Sector Groups

(1949 = 100)

Sectors	1949	1954	1958	1962	1966	1969
Total	100	95	70	59	54	48
Traditional	100	100	77	65	63	54
Dynamic A[1]	100	84	60	61	49	47
Dynamic B[2]	100	107	69	59	58	53

[1]Includes; non-metallic minerals, metallurgy, paper, rubber and chemicals

[2]Includes; machinery, electric materials, transport materials.

Source: E. Bacha and M. Mata, "Empregos e Salários na Indústria de Transformacão," 49/69, Pesquisa e Planajamento Econômico, June 1973.

Table 2

Employment Generated by the Secondary Sectors
(in Percent)

	1949	1959	1970
a. Industrial employment as % of total[1]	.1371	.1308	.1782
b. Manufacturing employment as % of total	.0747	.0794	.1027
c. Industrial income as % of total	.2622	.3006	.3273
d. a/c or industrial labor absorption relative to total $(\frac{L_i}{X_i} / \frac{L}{X})$	.523	.435	.544

[1]Includes: manufacturing, mineral extraction, civil construction, and public utilities.

Sources: FIBGE and FGV.

Table 3

Breakdown in Employment Growth[1]

$$\frac{L^1 - L^0}{L^0} = \frac{X^1}{L^0} \Sigma \frac{X_i^1}{X^1} \left(\frac{L_i^1}{X_i^1} - \frac{L_i^0}{X_i^0}\right) + \frac{X^1}{L^0} \Sigma \frac{L_i^0}{X_i^0} \left(\frac{X_i^1}{X^1} - \frac{X_i^0}{X^0}\right) + \left(\frac{X^1 - X^0}{X^0}\right) = A_1 + A_2 + A_3$$

Coverage	1949-1959 $A_1 + A_2 + A_3$	A_1	A_2	A_3	1959-1970 $A_1 + A_2 + A_3$	A_1	A_2	A_3
Sectoral Breakdown								
Brazil	.34	-.69	-.15	1.1722	.50	-.63	-.07	1.1982
São Paulo	.56	-.68	-.22	1.4675	.52	-.71	.01	1.2254
Northeast	-.08	-.56	.02	.4523	.31	-.53	.01	.8172
Scale Breakdown								
São Paulo								
Non-met. min.					.36	-.43	-.11	.9032
Machinery					1.57	-1.39	.08	2.8683
Textiles					.11	-.75	.01	.8442
Clothing					.82	-.40	.11	1.1046
Pernambuco								
Non-met. min.					.50	-1.52	.63	1.3787
Machinery					5.37	-5.65	.08	10.9352
Textiles					-.34	-.49	.02	.134
Clothing					-.05	-.23	-.15	.3232
Brazil[2]								
Total	.31	-.85	.07	1.09	.31	-.56	-.02	.89
Non-met. min.					.19	-.45	-.24	.88
Machinery					1.80	-1.49	.04	3.29
Textiles					.02	-.53	-.02	.57
Clothing					.52	-.43	.02	.92

[1]In this table and Tables 4 and 5, the Northeast excludes the states of Sergipe and Bahia.

Output is defined as value added. Employment in Tables 3-5 includes all occupied personnel. In Tables 5-7, employment includes only production workers.

[2]The size breakdown for Brazil uses the value of production as the measure of output

Source: Censo Industrial, FIBGE, Brazil.

Table 4

Breakdcwn in Employment Growth, by Region: Sectoral Productivity Growth, A_{1i}

$$\frac{L^1 - L^0}{L^0} - \frac{X^1 - X^0}{X^0} = \frac{X^1}{L^0} \Sigma \frac{X_i^1}{X^1} \left(\frac{L_i^1}{X_i^1} - \frac{L_i^0}{X_i^0}\right) + \frac{X^1}{L^0} \Sigma \frac{L_i^0}{X_i^0} \left(\frac{X_i^1}{X^1} - \frac{X_i^0}{X^0}\right) = \frac{X^1}{L^0} \Sigma A_{1i} + \frac{X^1}{L^0} \Sigma A$$

Sector	Brazil 1949-1959	Brazil 1959-1970	São Paulo 1949-1959	São Paulo 1959-1970	Northeast 1949-1959	Northeast 1959-1970
Non-metallic minerals	-.0038	-.0016	-.0026	-.0012	-.0120	-.0060
Metallurgy	-.0044	-.0021	-.0027	-.0026	-.0015	-.0012
Machinery	-.0013	-.0019	-.0015	-.0023	-.0001	-.0011
Electrical and communications equipment	-.0011	-.0011	-.0015	-.0016	-.0006	-.0022
Transportation equipment	-.0028	-.0006	-.0020	-.0004	-.0000	-.0011
Wood products	-.0011	-.0003	-.0003	-.0002	-.0009	.0003
Furniture	-.0009	-.0005	-.0010	-.0005	-.0013	-.0008
Paper	-.0013	-.0002	-.0014	-.0002	-.0021	.0005
Rubber	-.0007	.00005	-.0008	.0005	-.0005	.0001
Leather and skins	-.0005	-.0001	-.0012	-.0000	-.0009	-.0001
Chemicals and cosmetics	-.0040	-.0020	-.0036	-.0025	-.0097	-.0021
Pharmaceuticals	-.0003	-.0009				
Plastics	-.0002	-.0001				
Textiles	-.0049	-.0041	-.0036	-.0039	-.0209	-.0064
Clothing and shoes	-.0016	-.0007	-.0010	-.0006	-.0044	-.0044
Food products	-.0058	-.0020	-.0029	-.0015	-.0167	-.0078
Beverages	-.0005	-.0004	-.0002	-.0002	-.0026	-.0022
Tobacco	-.0005	-.0003	-.0002	-.0001	-.0014	-.0006
Printing	-.0008	-.0012	-.0008	-.0010	-.0011	-.0014
Other	-.0007	-.0007	-.0008	-.0006	-.0003	-.0002
Total						

Source: Censo Industrial, FIBGE, Brazil.

Table 5

Breakdown in Employment Growth, by Region: Sectoral Product Mix, A_{2i}

$$\frac{L^1 - L^0}{L^0} - \frac{X^1 - X^0}{X^0} = \frac{X^1}{L^0} \Sigma \frac{X_i^1}{X^1} \left(\frac{L_i^1}{X_i^1} - \frac{L_i^0}{X_i^0}\right) + \frac{X^1}{L^0} \Sigma \frac{L_i^0}{X_i^0} \left(\frac{X_i^1}{X^1} - \frac{X_i^0}{X^0}\right) = \frac{X^1}{L^0} \Sigma A_{1i} + \frac{X^1}{L^0} \Sigma A_{2i}$$

Sector	Brazil		São Paulo		Northeast	
	1949-1959	1959-1970	1949-1959	1959-1970	1949-1959	1959-1970
Non-metallic minerals	-.0010	-.0007	-.0019	-.0006	.0095	.0042
Metallurgy	.0023	-.0001	-.0003	.0012	.0008	.0032
Machinery	.0015	.0027	.0018	.0026	.0001	.0021
Elec. and com. equip.	.0021	.0008	.0027	.0011	.0008	.0036
Transportation equip.	.0043	.0002	.0047	-.0001	.0004	.0012
Wood products	-.0014	-.0008	-.0013	-.0003	.0006	-.0003
Furniture	.0000	-.0001	.0002	-.0003	.0030	.0008
Paper	.0007	-.0002	.0006	-.0001	.0025	-.0005
Rubber	.0005	-.0003	.0006	-.0004	.0007	.0000
Leather and skins	-.0003	-.0004	-.0003	-.0002	-.0003	-.0012
Chemicals and cosmetics	.0036	.0006	.0021	.0001	.0076	.0000
Pharmaceuticals	-.0002	.0004				
Plastics	-.0003	.0005				
Textiles	-.0119	-.0030	-.0127	-.0020	-.0189	-.0198
Clothing and shoes	-.0012	-.0002	-.0009	-.0001	.0030	.0046
Food products	-.0042	-.0020	-.0021	-.0008	-.0073	-.0021
Beverages	-.0012	-.0004	-.0008	-.0003	-.0002	.0027
Tobacco	-.0001	.0000	-.0001	-.0000	.0006	.0012
Printing	-.0011	.0006	-.0007	.0005	.0000	.0013
Other	-.0002	.0003	-.0001	.0002	.0001	.0001

Source: Censo Industrial, FIBGE, Brazil.

Table 6

Breakdown in Employment Growth, by Region: Scale Productivity Growth, A_{1i}

$$\frac{L^1 - L^0}{L^0} - \frac{X^1 - X^0}{X^0} = \frac{X^1}{L^0} \Sigma \frac{X_i^1}{X^1} \left(\frac{L_i^1}{X_i^1} - \frac{L_i^0}{X_i^0}\right) + \frac{X^1}{L^0} \Sigma \frac{L_i^0}{X_i^0} \left(\frac{X_i^1}{X^1} - \frac{X_i^0}{X^0}\right) = \frac{X^1}{L^0} \Sigma A_{1i} + \frac{X^1}{L^0} \Sigma A_{2i}$$

Scale: Number of Employees	Brazil 1959-1970	Sao Paulo 1959-1970	Pernambuco 1959-1970
Non-Metallic Minerals			
1- 4		-.0001	
5- 9	.0000	.0006	
10- 19	-.0009	.0002	-.0022
20- 49	-.0022	-.0012	-.0006
50- 99	-.0022	-.0017	-.0006
100-249	-.0038	-.0055	.0035
250-499	-.0043	-.0049	-.0467
500 and above	-.0029	-.0026	
Total			
Machinery			
1- 4	-.0002	-	
5- 9	-.0002	.0009	
10- 19	-.0002	-.0005	-.0100
20- 49	-.0012	-.0016	-.0256
50- 99	-.0017	-.0036	
100-249	-.0051	-.0042	
250-499	-.0004	-.0020	
500 and abo	-.0052	-.0080	
Textiles			
1- 4	-.0000	-.0002	
5- 9		-.0000	
10- 19	-.0002	-.0028	-.0002
20- 49	-.0008	-.0013	-.0019
50- 99	-.0012	-.0032	.0003
100-249	-.0021	-.0054	-.0010
250-499	-.0031	-.0068	-.0158
500 and above	-.0090	-.0173	-.9479
Clothing and Shoes			
1- 4	-.0011	-.0012	-.0048
5- 9		-.0006	-.0021
10- 19	-.0003	.0004	-.0037
20- 49	-.0019	.0000	-.0048
50- 99	-.0029	-.0031	.0007
100-249	-.0031	-.0073	-.0116
250-499	-.0015	-.0007	
500 and above	-.0012		

Source: Censo Industrial, FIBGE, Brazil.

Table 7

Breakdown in Employment Growth, by Region: Scale Product Mix, A_{2i}

$$\frac{L^1 - L^0}{L^0} - \frac{X^1 - X^0}{X^0} = \frac{X^1}{L^0} \Sigma \frac{X_i^1}{X^1} \left(\frac{L_i^1}{X_i^0} - \frac{L_i^0}{X_i^0}\right) + \frac{X^1}{L^0} \Sigma \frac{L_i^0}{X_i^0} \left(\frac{X_i^1}{X^1} - \frac{X_i^0}{X^0}\right) =$$

$$= \frac{X^1}{L^0} \Sigma A_{1i} + \frac{X^1}{L^0} \Sigma A_{2i}$$

Scale: Number of Employees	Brazil 1959-1970	São Paulo 1959-1970	Pernambuco 1959-1970
Non-Metallic Minerals			
1- 4		-.0080	
5- 9	-.0146	-.0029	
10- 19	-.0008	-.0014	-.0014
20- 49	.0015	.0004	-.0018
50- 99	.0018	.0013	.0031
100-249	.0016	.0027	-.0126
250-499	.0039	.0028	.0520
500 and above	-.0022	.0011	
Machinery			
1- 4	-.0006	-	
5- 9	-.0001	-.0020	
10- 19	-.0009	-.0015	..0082
20- 49	-.0013	-.0016	-.0097
50- 99	.0002	.0012	
100-249	.0030	.0018	
250-499	-.0004	-.0005	
500 and above	.0004	.0034	
Textiles			
1- 4	-.0005	-.0004	
5- 9		-.0005	
10- 19	0	-.0008	-.0001
20- 49	.0004	-.0006	-.0010
50- 99	.0009	.0018	-.0003
100-249	.0014	.0034	.0056
250-499	-.0012	-.0015	.0023
500 and above	-.0026	-.0007	-.0059
Clothing and Shoes			
1- 4	-.0070	-.0046	-.0287
5- 9		-.0020	-.0141
10- 19	-.0013	-.0023	.0049
20- 49	-.0006	-.0005	-.0131
50- 99	.0019	.0019	.0016
100-249	.0036	.0093	.0325
250-499	.0020	.0008	
500 and above	.0020	.0015	

Source: Censo Industrial, IIBGE, Brazil.

Table 8

Rank Correlations Between Scale of Production and Labor Productivity

Sector	Brazil		São Paulo		Pernambuco	
	1959	1970	1959	1970	1959	1970
Total	.9	.9				
Non-metallic minerals	.95	.93	.95	.32	.80	.30
Machinery	.23	.38	-.11	.89	-1	-1
Textiles	-.95	-.88	-.69	-.71	-.26	-.09
Clothing and Shoes	.19	-.20	-.29	.11	.94	.09

Source: Censo Industrial, FIBGE, Brazil

Mean Differences Across Size Groups of Firms

The main hypotheses of this study relate to the size of the firm: whether large firms exhibit economies of scale, are more efficient and more profitable than small firms; whether large firms have greater advantages over small firms in the internal production process of the firm or in access to credit, in marketing, in information and contacts. To answer these questions with complete confidence would require very detailed technological data (both actual and best-practice) as well as marketing and financial data. In addition to careful comparisons of production efficiency and profitability, statistical methods would have to be devised to isolate the marketing and financial aspects of firm behavior from the purely technological aspects. All of this becomes quite complicated, requires the use of some questionable data and a priori specifications of the model's structure. As a first step, therefore, it should be useful to obtain a general picture of the firms in the two industries, classified by size. Simple tests of means on selected technological, marketing and financial variables will be discussed before entering into more complicated tests involving greater a priori assumptions.

The first task is to classify firms into size classes. Since there are relatively few firms (only 34 in the case of cotton spinning and 50 in the case of shoes) and also since there is no reason to expect more than three distinct size groups, I have classified firms as small, medium or large. Several criteria could be used as measures of size: the value or volume of output, the number of employees or production employees, the real or book value of the capital stock etc. The ranking of firms by the size of each of these variables is not identical. Nor would one expect it to be in every case. For instance, some large firms might use very capital-intensive processes and, therefore, employ fewer workers than a labor intensive medium sized firm. And some firms might produce high quality output or exercise

significant monopoly power, such that the value of production is large relative to the physical output. If there are homogeneous products, no market distortions, and no regressive factors of production, however, the use of each factor should increase with the scale of production.

One could argue that the theoretically most useful measure would be the physical quantity of output, for each different product quality and for the same degree of vertical integration, or perhaps the value added if product quality is not disaggregated and if vertical integration can vary. If production functions are not homothetic, then the capital-labor ratio or degree of mechanization will depend on the scale of production. The appropriate measure of size, then, would be a measure of output.

Steindl, in "Small and Big Business" argues that firms with greater capital stock command a competitive advantage over smaller firms, such as through specialization of machinery when there are large production runs or economizing on inventories and financial needs. In this case, capital would be the appropriate measure of size.

In spite of these theoretical arguments, the most common measure used by investigators is the number of employees. Even though there might be differences in skill and experience, the number of workers can be physically compared across industries and international boundaries and, therefore, has obvious advantages.

Unfortunately, the data quality is not always good. Especially for integrated firms and firms producing several products, the value of output recorded in the questionnaire might not have been produced with the inputs listed. The number of people employed, which is the most common measure of size used by other investigators, does not always correspond to the measured output. In addition, some firms are missing data on one variable but not others. It would

be good to utilize as much of the information as possible and, therefore, to classify each firm into a size group, even when some information is missing.

The procedure used here, then, does not classify firms into a size class on the basis of any single variable. For both the cotton spinning and men's leather shoe industries, I selected ten variables--value of output of cotton spinning (men's leather shoes), value of sales of cotton spinning (men's leather shoes), value of sales of all products, physical quantity of output, the number of people employed in production, equity capital, kilo watt hours of electricity consumed, the number of spindles (in cotton spinning), the estimated real value and book value of the machinery (in shoes), the value of raw cotton (leather) used, the physical quantity of raw cotton used (in cotton spinning). Each firm was ranked for each of these variables. When a firm was generally ranked in the lowest three deciles, it was identified as small; in the middle four deciles, as medium; and in the highest three deciles, as large. The rankings of shoe firms were not always consistent, but still tended to cluster into one of the three groupings. Only two firms were difficult to classify. Eight of the cotton spinning firms had no immediately obvious classification. Tables 1 and 2 show the number of variable observations in each decile for each firm; and the group designated for that firm.

Several variables fairly consistently belong to the cluster that classified the firms into one group rather than another. In the case of shoes, the most reliable indicators of size turned out to be the value of total sales, followed by kilo watt hours of electricity consumed and the number of production employees. Perhaps because of the difficulty of estimating the value of very heterogeneous second hand equipment, the three measures of capital stock were not so successful. The case of textiles is quite different. The number of spindles in the spinning mill is an unambiguous number. Of all the size

variables considered, it is the most consistent. In every case where the assignment of a size category to a firm was obvious, the number of spindles in the factory fell within the appropriate range. Only in the cases of ambiguous classification did it sometimes fall outside the decile range. The quantity of raw cotton used and the kilos of yarn production--both measures free from valuation problems, but incorporating quality differentials --were also reliable. The value of total sales of all products performed fairly well. Consumption of electricity and the number of production employees did not perform well, perhaps because of the measurement problem in integrated plants.

In the final selection, the small firms included those with fewer than 43 production employees in the shoe industry and 110 in cotton spinning. The large firms employed more than 130 or more than 350 in shoes and cotton spinning respectively. The small spinning firms have fewer than 8820 spindles; the large have more than 25,000. There are altogether 15 small, 30 medium and 15 large shoe firms; 11 small, 13 medium, and 10 large textile firms. It is clear that "small," "medium," or "large" is meant in a relative sense only. "Small," as used here, should not be confused with other usage of small scale industry, especially in the case of cotton spinning.

After classifying firms into size groups, the mean values of selected technological, marketing and financial variables were estimated. The mean values along with significance levels are given in Table 3. As is to be expected because of the way the size categories were created, the means of the ten size variables increase with size, for both shoes and cotton spinning. The differences in means for the shoe industry are, in every case, significant at the 5% level of confidence. Average value added and profits, which were not used to determine the size groupings because they are derived variables and therefore of questionable accuracy, also increase with size. Again the differences in mean for value added are always

significant, though not always for profits. In the textile industry, the means for the size variables also increase with size, though the value of raw material consumption is not significantly different between the small and the medium firms. Value added and profits increase significantly with size.

There is no reason to expect the technological possibilities nor the market and policy environments to be the same in different industries. As a result, it is more useful to discuss the two industries separately. I will start with a discussion of the shoe industry and the various hypotheses related to its technological, marketing and financial conditions. Then I will discuss the cotton spinning industry.

The first major area of interest being investigated concerns the technological differences among firms. We can look at several summary measures of technological differences among firms, such as capital-labor ratios, capital-output ratios, the ratio of administrative employees to production employees, the length of production run, the level of technological efficiency, as well as the previous size variables. Our null hypothesis is that the mean values of these variables are equal across size class. Since we expect in the shoe industry that technological differences are important between small and medium firms but that the differences between medium and large firms have little to do with production processes, we hope to reject the hypothesis of equality in the first comparison but not in the second.

There are several possible measures of aggregate capital, output or of employment. Kilo watt hours consumed gives an estimate of machinery use, assuming that large machines are not more efficient in their use of energy than small ones. The other measures - the estimated book value of the machinery and the estimated real value of the machinery in place - both

represent the capital stock used in production. Finally, capital social mais reservas or the book value of capital plus reserves of the firm is an inflation and tax biased estimate of the stock of all capital. Of these measures, kilo watt hours, followed by the book value of machinery, and the estimated real value of the machinery in place best corresponds to the three size groups. Capital social mais reservas was omitted due to its accounting biases.

Since some firms have a diversified product line, including women's shoes or purses, and there is considerable quality variation, total sales seems a better measure of output than physical number of pairs or even the value of men's leather shoe output. It is also true that the value of total sales is the most consistent predictor of a firm's size group.

Employment could include only those involved in production, or also those people in administration and office work. While the occupational categories might be clear-cut for large firms, they are not for small, which have less division of labor. In this case, then, total employment probably creates fewer biases across scale than the number of production employees.

The data do, in general, support our expectations of technological differences across scale. The capital-labor ratio in small firms--whether measured by the ratio of kilo watt hours, book value or estimated real value of machinery relative to the number of all or only production employees--is higher than that of the medium sized firms. The differences are significant half the time. Using the same measures, the capital-labor ratio of large firms is sometimes greater and sometimes less than that of medium firms, and the differences are significant only once.

Predictably, small firms employ significantly more administrative and office personnel relative to production employees.

Small firms also use significantly more capital per sales--in terms of the consumption of electricity and the book or estimated real value of the stock of machines--than do medium firms. Again, there is no difference between the medium and large firms. Apparently, the small firms are relatively inefficient in their use of capital, suggesting that they are too small to take advantage of scale economies.

One reason for this apparent inefficiency of small firms could be their varied product line and relatively short production runs. The average number of different shoe models produced in the survey week is not significantly less for small than larger firms. As a result, the length of the production run (the average number of pairs per model design) is less (at the 10% level of significance) for small than for medium and for medium than for large firms (insignificantly so). When questioned about this, the production managers claimed they could not keep their customers without a varied product line. Apparently it is difficult or impossible for small firms to coordinate, either directly or through the traveling salesmen, in their sales efforts. Whatever the reason, one result of the limited production runs is to inefficiently utilize capital.

If small firms cannot take advantage of scale economies, we would expect them to be technologically relatively inefficient. According to a measure of technological efficiency derived from Farrell's algorithm (See Chapter 5), however, there is no significant difference among the three groups of firms.[1] But, as I explain below, this efficiency index, measuring

[1]The maximum efficiency value is 1.0; the minimum is 0.0.

the distance of a firm's input vector from the efficient isoquant input vector, varies somewhat with the choice of factors. The index is discussed in more detail in Chapter 5.

According to the evidence presented above, the technological process used by large firms does not differ significantly from that used by medium firms. The major technological differences set the small firms off from the remainder. What, if anything, distinguishes the large and medium firms? Are these firms alike in most respects except for size?

Steindl has argued that the advantages of being large are not purely technological but also financial and commercial. There might be large fixed costs in marketing, especially for an export market. And because of the possibilities for lowering risk within a large, diversified organization, these firms might have greater access to credit and at lower cost. If search costs also have a fixed component, large firms might be able to maintain a staff to search out and more quickly adopt innovations. They might be able to employ relatively trained managers, not because the production process--which is essentially the same as that employed by medium size firms--requires it, but to search out new markets and get better access to government officials.

While each of these factors could result in continuous advantages as firms become larger, my hypothesis is that there are no significant differences between medium and small scale firms in the areas of credit, marketing and information flow. I hope to reject this null hypothesis in a comparison between medium and large firms.

A few variables do not fall clearly into the category of technological or financial concepts: In this category, I include the age of the plant, the year in which a major innovation (an automatic conveyor belt) was introduced, and the average salary paid.

Larger firms tend to introduce automatic conveyor belts later than small firms. But the differences are not significant.

The survey evidence indicates that large firms are significantly older than others. This finding is consistent with the view that firms grow gradually from re-invested profits and that there is a progression from small to large over time. Equally consistent, however, would be an interpretation that if a firm can somehow get to be large, it will survive. A large firm is relatively efficient but also does not operate in the same competitive environment as smaller firms. Smaller firms could have a higher turnover, both because they are technologically relatively inefficient and because they operate within a competitive market where many entrepreneurs have access to the limited amount of capital.

In the first interpretation, the age of the firm is primarily explained as a capital market phenomenon: with little access to borrowed funds, firms must grow from internal sources. This theory does not explain, however, why firms should want to grow nor why the larger firms, if there are indeed scale advantages, do not limit the growth of the smaller firms. The second interpretation combines capital market and technological phenomena to explain the relation between size and age. It argues that markets are quite segregated, with no natural tendency for small firms to grow large over time. A firm, once large, has a permanent advantage. Greater institutional background information would be needed to understand how some firms

get to be large. Under this interpretation, however, the chances of a small firm growing large are quite small.

If the evidence showed that large firms were younger, alternative theories could, of course, be spun: Technological advance has increased the optimal size plant, but does not immediately render economically obsolete the older, smaller plants. Any firm starting up a new plant, with access to capital, will build the larger, efficient plant.

In the sample of shoe firms, large firms are significantly older than the medium sized firms, but the latter are not significantly older than the small. This finding is not quite consistent with earlier evidence which separates the small firms from the medium and large firms in their technological operation. Perhaps the age distribution, therefore, is fundamentally tied up with the financial environment, where the distinct group of firms might not be the small ones, but the large.

The average monthly salary plus fringe benefits paid to production employees increases with scale, though not significantly so. Many writers have argued that large firms pay higher wages than small firms, because they are more likely to be covered by social security and minimum wage legislation and, in some countries, unionized. One could argue, however, that differences in the division of labor and the occupational composition within the firm account for most of the apparent wage differentials. That is, if large firms tend to hire more skilled and educated workers, workers higher up the occupational hierarchy, they might pay higher average wages without paying higher wages for any particular job.

To test this alternative hypothesis, I have broken down the average wage differential paid by large and small firms into two components: one component depends on the wage differential for any single occupation; the other depends on differences between firms in the occupational composition. By definition, the average wage (plus fringe benefits) paid by a firm equals the sum of the wages paid to each class of workers divided by the total numbe of workers, as in

$$(1) \quad \bar{w} = \Sigma \frac{w_i L_i}{L}, \text{ where}$$

$\bar{w}$ is the average wage plus fringe benefit rate paid by a particular firm;

w_i is the average wage plus fringe benefit rate paid by that firm for occupation i;

L_i is the number of workers employed in occupation i in a particular firm;

$L = \sum_i L_i$

Differentiating (1) to determine the sources of wage differentials between firms:

$$(2) \quad d\bar{w} = \sum_i w_i \, d\left(\frac{L_i}{L}\right) + \sum_i \left(\frac{L_i}{L}\right) dw_i$$

For discrete wage differentials, such as between large and small firms, (2) can be modified to:

$$(2a) \quad \Delta\bar{w} = \sum_i (w_i)_S \left[\left(\frac{L_i}{L}\right)_L - \left(\frac{L_i}{L}\right)_S\right] + \sum_i \left[(w_i)_L - (w_i)_S\right] \left(\frac{L_i}{L}\right)_L,$$

where the subscripts L and S refer to large and small firms. For every matched pair of a large and small firm, one can calculate such a wage differential. For each pair, the first term on the right hand side of (2a)

represents that part of the wage differential attributable to the different occupational composition within the firms. The second term measures the importance of any wage gap for given occupations.

If the first hypothesis mentioned above--that large firms pay higher wages than small firms because they operate in different labor markets--is correct, the second term, averaged over all matched pairs of firms, should be significantly positive. If the, second hypothesis--that large firms employ relatively more skilled, high-wage labor--is correct, the first term, averaged over all matched pairs, should be significantly positive.

These two hypotheses have been tested by ranking all firms according to the number of pairs produced. On the basis of this ranking, firms were divided into a group of large and a group of small firms. The smallest of each group formed a matched pair, and so forth. Table 4 presents the wage differential and the occupational differential terms of (2a) for each pair, and their averages. The results presented here, though for two rather than three size groupings, are consistent with the mean wages presented in Table 3. The average values of both the wage differential and the occupational differential terms are positive. Neither average is significantly different from zero, a result which is also consistent with the lack of a significant difference in mean wages in Table 3. Looking a little more closely at the individual paired values for the wage and the occupational differential terms, it is clear that the matched pairs 22 and 24 are out of line with the other pairs. These two pairs are largely responsible for the positive value given to the occupational differential average and the small positive value of the average wage differential term. Eliminating these two pairs of observations changes the average value of the occupational differential term from positive to significantly negative, such

that large firms appear to hire relatively fewer skilled workers. The wage differential term becomes significantly positive, indicating that large firms pay higher wages for the same class of work.

While some care was taken to identify workers by their appropriate occupational category, the interviewers were not always successful. For instance, in some cases no breakdown was made. In the two pairs of firms 22 and 24, the larger firms listed the great majority of their employees as "other" rather than machine operators. All other firms, perhaps offer minor "cleaning of the data" had the majority of workers listed as machine operators. It seems reasonable, therefore, to eliminate these two pairs.

In conclusion, large firms appear to use less rather than more skilled labor and to pay higher wages for the same occupational category. The first of these results is not so surprising if one thinks of the greater division of labor that is possible in large firms with separate administrative divisions. I find the second result somewhat more surprising, in spite of its common acceptance in the literature, in view of the fact that all the firms interviewed are located in the same city of Franca. The small businessmen of Franca, however, complain about training workers who then go to work for the big companies. It is possible, therefore, that the small firms might be hiring less skilled labor and paying proportionately less, even though the job title is the same. The conclusion of unequal pay for equal work, therefore, must be taken cautiously.

There are two variables that focus on the firm's output markets. The first one, exports as a percent of sales, is significantly greater for large than for either medium or small firms. Large firms export over two months worth of their sales, on average. This is one more bit of

evidence to support the well known view that the major industrial exporters in Brazil are among the largest firms. More than that, a bigger share of the large firms' sales go to exports.

The marketing network of large and small firms differs substantially. Large firms often have at least one large customer in their export buyer. Medium and small firms typically have their own or use independent traveling salesmen that peddle shoe models for small lot orders. They do not have access to the large purchasers. While their marketing costs are quite high under this system, they also have protection against monopolized purchasers.

Large and small firms appear not to operate in the same credit markets. While large firms are likely to have access to regular bank credit or credit from government loan agencies, much of the small firms' credit comes from their suppliers. Debt, both short and long term, increases significantly as a percentage of the value of machinery across each scale category. Small firms, however, make a (significantly) larger percentage of cash sales and a smaller percentage of cash purchases than do large firms. Consistent with this view that small firms are more limited in the sources of credit than the larger firms is the implicit interest rate that the firms quote. When asked what discount the firm would give to a purchaser who paid cash rather than buying on 60 day credit, the small firms responded they would give a larger discount. The equivalent annual interest rate (in a country with approximately 50% inflation at the time) was 85%, 72% and 68% for small, medium and large firms, respectively. The differences were not significant. Even though not significant, they suggest that small firms might bear greater finance costs than large firms, when they are able to borrow at all.

By buying in bulk, large firms might be able to reduce the unit value of raw materials costs. Moreover, they might be able to manage with smaller inventories in relation to production. The first point is supported by the finding that the cost of leather purchases as a percent of sales is significantly higher for small firms.

Piecing together the bits of information suggesting that small firms are technologically distinct from the other groups and relatively inefficient in their use of capital, with the bits about credit and marketing advantages of the largest firms, leads me to ask which firms make the higher profits. One would not expect the smallest firms to be profitable. While the middle firms appear to be technologically efficient, they do not benefit from the marketing and financial advantages of being large. On the other hand, they appear to pay lower wages than the largest firms. Therefore, I have no clear prediction on the relative magnitude of profit rates between large and middle size firms.

The data on profit rates are not likely to be very reliable, both because of the sensitive nature of any question that allows an investigator to learn about the net financial position of a firm and because of the data on capital stock. Absolute profit levels increase with size, significantly so between the small and medium firms, giving an indicator of minimal reliability. As I discussed before, information on the book value of capital is notoriously unreliable, especially in a rapidly inflating country like Brazil. The estimated value of the machinery in place, whether book or real value, as a measure of the capital stock, or of kilo watt hours, as a measure of capital usage, are probably more reliable. Profit rates based on each of

these measures of capital show that small firms earn significantly lower profit rates. Medium firms earn the highest average profit rates in each case. Only in the case of profits as a percent of electricity consumption is the difference between medium and large firms significant. Perhaps the higher wages paid by large firms mitigate against other cost advantages of the large firms.

This description of the shoe industry allows one to tentatively conclude that small firms are technologically inefficient. While medium firms have the productive capacity and length of production run to overcome the technological disadvantages of being small, they still do not have all the financial and marketing advantages of the large firms.

The textile sample of firms can be described in a way similar to that used for the shoe firms though there is no reason to expect the conclusions to be the same. I will first compare summary measures of the technological processes across the size groupings, and then look at variables more related to financial, marketing and informational characteristics. The variable means are presented in Table 5.

Of the original size variables that were used to create the three groups, the most consistent indicator was the number of spindles in the factory. The number of spindles appears, therefore, to be a good measure of scale and probably, of the plant's physical machinery. It does not, however, take into account the vintage, the spindles' rpm, the number of shifts operating, or the capital stock used in other sections of the plant. The kilo watt hours consumption of electricity can be a proxy for the total

use of machinery, both in all sections of the plant and in all shifts. Finally, the book value of capital, if it were not so distorted with tax and inflationary effects, could be used as a measure of the stock of plant plus equipment.

As an overall summary of the plant's technological process, it is appropriate to include administrative personnel in total employment, since the division of labor is not identical across size categories. The ratio of "non-production" to "production" employees is considerably, but not significantly higher for the smallest sized firms.

Using any one of the three measures of capital stock or use, the capital-labor ratio is lowest for the small firms. The difference between medium and small firms is significant at the 10 percent level only in the case of KWH/employee. The ranking of medium and large firms by their capital intensity is not consistent and never significant. The differences in capital-labor ratios might be partly due to non-homothetic production technology, partly to efficiency in the use of factors and partly to differences in factor costs.

As a related issue, the capital-output ratio (and, therefore, perhaps the capital-labor ratio) might vary with size if there are scale economies or diseconomies. To the extent possible, I will try to identify the causes of different aggregate capital-labor ratios and to determine whether there is any evidence, at this macro level, of scale economies and of a non-homothetic production function.

Since firms clearly have different ratios of administrative to total personnel, production techniques are not duplicated on larger scales. Large firms appear to be able to save on certain kinds of sales and administrative

employees relative to the small firms. In small firms production supervisors tend also to be administrators and appear on the books as administrative employees. These differences in the ratio of non-production to production employees, therefore, are consistent with a non-homothetic production function. Technological differences, however, do not show up in the simple ratio of cotton consumption to kilos of yarn production. That ratio is almost constant. Any estimate of non-homotheticity must either depend on quality differences in raw material and output, or occur in the production of value added.

If small firms are more efficient in their use of capital than are large firms, they would exhibit low capital-output ratios as well as capital-labor ratios. In fact, the reverse is generally the case. Small firms tend to have high capital-sales ratios, measured either as a capital stock or capital use. Therefore, the small firms' low capital-labor ratios might occur in spite of an inefficient use of capital rather than because of economies. Medium firms consistently have the lowest capital-sales ratios. Moreover, the average hourly output, in kilos, per carding machine is another indication of the capital efficiency of that section of the plant. The productivity of the carding machines is significantly higher for medium firms than for either large or small. This productivity variable is not a total factor productivity, and therefore could be due to more machine operators and supervisors, preventing breakdowns and delays. A more comprehensive measure of productivity is the Farrell index, based upon the use of raw materials, labor and capital, disaggregated by plant section.

The Farrell measure suggests that efficiency increases with scale, though the differences are significant at the 10% level only between the small and medium firms. If the Farrell index is reliable, the medium firms' efficient use of capital must be offset by their relatively inefficient use of other factors, such as labor, resulting in their greater capital-labor ratio. While the efficiency estimates are ambiguous for medium and large firms, small firms appear inefficient on all criteria.

But there is another explanation for the differences in capital-labor ratios. The higher capital-labor ratios might be due to firms operating in different factor markets rather than non-homotheticity. Contrary to expectation, the average wage plus fringe benefit rate of medium firms is higher than that of either large or especially small firms. As discussed before, however, this average depends both on the occupational mix within the firm and the wages paid for any occupation. Ordering firms according to the number of spindles and forming pairs--one large and one small firm-- of increasing size, it appears that, overall, small firms pay higher average wages than large firms. This finding is not inconsistent with the comparison of means across the three size groups, since the firms paying high average wages within the middle group might fall predominantly into the smaller half of firms. The average wage paid by small firms is larger, however, because of their occupational structure, and in spite of paying lower wages for the same occupation. The differences are significant, and not too surprising, given the textile industry's geographic dispersion. Table 6 gives the breakdown of the wage differential for each matched pair. The overall conclusions are generally supported at the level of matched pairs, and not by a few outliers.

Similarly, there is some evidence that large and small firms operate in different capital markets. Large firms would offer significantly lower discounts if paid in cash than would small firms. The implicit interest rate is about 29% for large firms, 32% for medium, and 45% for small firms. (Note that all the spinning firms have a substantially lower cost of capital than the shoe firms.) Again the difference is not surprising if small firms have little access to borrowed funds, as suggested by the additional finding of lower debt-equity ratios, the smaller the firm.

Both the lower cost of capital and the higher wage rates should, of course, induce medium and large firms to search out labor saving techniques of production. Since large firms tend to be older than the smaller firms, they must have, through new investments, replaced the older, more labor intensive processes with more capital intensive ones.

Not only are the factor markets in which firms operate different; small firms export a significantly smaller percentage of their total sales than do medium or large firms, and are, therefore, ineligible for certain export drawbacks and tax credits.

The production managers responsible for investment decisions in the large firms tend to be both younger and with less experience in the industry. They are slightly more educated, though the differences are not significant and hardly great enough to warrant any conclusions about greater specialization or training leading to more technically sophisticated machinery, etc. The introduction of sophisticated quality control equipment does, however, seem to come sooner in the larger firms.

The general picture that emerges from this summary data is one of the large firms being older, with access to cheaper capital but paying higher wages. It is not clear whether large or medium firms use more capital-intensive processes and are technologically more efficient. All the evidence points towards small firms being inefficient, without access to cheap credit and ineligible for certain tax credits.

Technical efficiency is not, of course, equivalent to high profits. But, in this case, large firms also appear to earn higher profit rates than medium or small firms, either in terms of the stock of spindles or the consumption of electricity.

Whereas small shoe firms seem to form a group technologically distinct from the larger firms, there is no such clear technological break in the spinning industry. Sometimes the technological differences between small and medium or medium and large firms are significant, but generally not. In addition, the financial advantages that separate large firms from the medium and small appear to be fairly continuous. The gradual differences in technology and financial markets, however, add up to somewhat greater, though not significantly so, profit rates for the large spinning firms.

A description of the characteristic mean differences across firms, such as carried out here, cannot very usefully be used to test hypotheses. It is most appropriate as an introductory survey of the sample firms. The following chapters of this monograph will simultaneously control for firm characteristics, by various methodologies: simple production function estimations, production efficiency estimates, and multiple discriminant analysis.

Table 1

Number of Times Firm Ranked in Given Interval: Shoes

	Large			Medium				Small				
Percentile	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	Missing	Size*
Absolute Rank	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50		Group
Firm No.												
201						5	5					M
202				2			7	1				M
203				1	3	3	2			1		M
204									3	7		S
205								1	7	2		S
206		3	4	2	1							L
207								1	6	3		S
208									3	7		S
209				1		4	5					M
210					1	6	3					M
211								5	3	1		S
212	1		2	4	1	1	1					M
213				3	3	2	2					M
214			4	2	4							M
215	4	5	1									L
216		1	4	2		2	1					M
217						2	4	4				M
218				4	2	4						M
219					1		2	7				S
220			2	5	3							M
221		2	3	1	2	1		1				L
222								2	7	1		S
223							2	8				S
224		2	1	1	2	1	2	1				M
225			3	2	4	1						M
226							1	1	2	6		S
227					3	4	2	1				M
228			1	1		6	2					M
229				1			2	5		2		S
230					1	1		5	2	1		S
231								1	4	5		S
232								1	5	4		S
233				2	3	1	3			1		M
234						2		4	3	1		S
235									5	5		S
101			2		6	1	1					M
102	9	1										L
103		5	5									L
104		3	5	1	1							L
105		4	4	1			1					L
106	1	7		1		1						L
107			2	6	2							M
108		1	1	5	2						1	M
109	10											L
110	2	3	4		1							L
111	8	1	1									L
112			1	4	2	1	1	1				M
113	9										1	L
114	3	6									1	L
115	4	5				1						L

*L = Large; M = Medium; S = Small

Table 2

Number of Times Firm Ranked in Given Interval: Cotton Spinning

	Large			Medium				Small				
Firm No.	0-10%	10-20%	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	Missing	Size Group
1	1	2	1	2	1	2					1	L
2		1	1		1	3	1	3				M
3	3	3	2								2	L
4		1	1	3	1		3			1		M
5			1	3	3		2				1	M
6							1	1		3	5	S
7						2	4	1	2		1	M
8	2	5	1	2								L
9			1		1	1				1	6	M
10						1					9	M
11					1			3	3	2	1	S
12			1				1		1	7		S
13								2	1	5	2	S
14					2	3	1	2	1	1		M
15		1	1	4	1		2			1		M
16						1		1	2	2	4	S
17								1	7	1	1	S
18				1	2	2	4				1	M
19			1	1	1	1	1				5	M
20		1	3	3	2					1		L
21					2	3		3	1		1	M
22			1	2	1	2	2	1			1	M
23								2	4	2	2	S
24		6	4									L
25					1	4	2	2			1	M
26				3	1		1				5	M
27				1		1	1	2	2	2	1	S
28					1	1		3	3	2		S
29	1	1	3		1	1	1	1			1	L
30			1	3	6							M
31	1	4	3	1		1						L
32	7	3										L
33	9	1										L
34	2		3		1		1	2	1			L

*L = Large; M = Medium; S = Small

Table 3

Mean Difference by Size Groups: Shoes[1]

Variable	Large Firms	No. of observations	Medium Firms	No. of observations	Small Firms	No. of observatio
No. pairs produced	21766**	14	7991	21	2384**	15
	(15975)		(3218)		(2342)	
Value of pairs produced	2041**	14	600	21	103**	15
	(1337)		(228)		(85)	
Total value sales (1)	2392**	14	564	21	79**	15
	(1872)		(219)		(49)	
Total value sales (2)	2635**	14	670	21	121**	15
	(1776)		(237)		(77)	
No. prod. employees	344**	14	93	21	17**	15
	(195)		(27)		(12)	
Total employment	377**	14	100	21	19**	15
	(218)		(29)		(13)	
Kilo-watt hours consumed	237,729**	14	49012	20	11432**	15
	(219.742)		(17875)		(8684)	
Book value machines	12822**	14	3588	21	854**	15
	(9926)		(1175)		(625)	
Real value machines	17797**	12	5205	21	1060**	15
	(18070)		(5442)		(739)	
Equity capital & reserve	7686	14	752	21	106**	15
	(9448)		(553)		(84)	
Value raw material purchases	871**	14	193	21	61**	15
	(707)		(75)		(56)	
Value added	1753**	14	474	4	59**	15
	(474)		(213)		(59)	
Profit	1019	14	374	21	42**	15
	(1491)		(198)		(59)	
Profit/book value machinery	.070	14	.116	21	.062**	15
	(.184)		(.086)		(.069)	
Profit/real value machines	.041	12	.121	21	.050**	15
	(.185)		(.133)		(.056)	
Profit/KWH	.004*	14	.008	20	.004**	15
	(.009)		(.004)		(.007)	
KWH/all employees	596	14	503	20	677**	15
	(257)		(126)		(391)	
KWH/production employees	650**	14	509	21	775**	15
	(284)		(185)		(442)	
Book value machines/ all emp.	32	14	39	21	50	15
	(8)		(19)		(26)	
Book value machines/ prod. emp.	35	14	42	21	58**	15
	(9)		(21)		(29)	
Real value machines/ all-emp.	42	12	54	21	63	15
	(14)		(48)		(31)	
Real value machines/ prod. emp.	46	12	58	21	72	15
	(16)		(53)		(58)	

[1]Standard deviations are given in parentheses.
*Significantly different from the mean for medium firms at the 10% level.
**Significantly different from the mean for medium firms at the 5% level.

Table 3: (continued)

Variable	Large Firms	No. of observations	Medium Firms	No. of observations	Small Firms	No. of observations
KWH/total sales (1)	107 (58)	14	98 (47)	20	153** (80)	15
Book value machines/ total sales (1)	5.9 (2.5)	14	7.0 (2.6)	21	12.9** (9.2)	15
Real value machines/ total sales (1)	7.3 (2.4)	12	9.0 (5.7)	21	15.9** (10.9)	15
Administrative & sales emp./prod. emp.	.09 (.04)	14	.08 (.04)	21	.15** (.13)	15
Models/week	31.6 (20.5)	14	28.0 (17.4)	21	20.7 (16.6)	15
Length of prod. run	1359 (2338)	14	476 (466)	21	218** (399)	15
Efficiency	.563 (.183)	14	.548 (.167)	20	.558 (.207)	15
Yr. of conveyor belt	71.3 (3.)	12	71.9 (2.4)	18	69.5 (5.0)	15
Age	18.6** (15.2)	14	9.4 (4.2)	21	7.8 (4.8)	15
Wage & fringe benefit rate	2.9 (6.1)	14	1.1 (.2)	21	1.0 (.4)	15
Exports/total sales (1)	2.2** (2.3)	14	.3 (.7)	21	.7 (2.6)	15
Debt/value of machinery	.986* (.474)	14	.683 (.426)	21	.354** (.178)	14
% sales for cash	17.1 (21.6)	14	18.8 (18.8)	21	60.2** (35.8)	5
% purchases for cash	16.7 (32.5)	14	5.8 (9.2)	21	6.7 (10.5)	15
Discount for cash sales	9.0 (3.7)	14	9.4 (2.5)	21	10.8 (2.6)	15
Raw material purchases/ total sales (2)	.349 (.163)	14	.302 (.089)	21	.489** (.268)	15
Education of prod. manager	3.8 (1.3)	12	3.5 (1.2)	15	2.5** (.55)	6
Age of prod. manager	35.0 (5.4)	13	34.8 (8.7)	15	38.2 (3.4)	6
Experience of director	15.0 (8.8)	14	15.4 (8.6)	21	14.6 (8.4)	15
Personal info. sources/ sales (2)	.0003* (.0000)	14	.0009 (.001)	21	.0069** (.008)	15
Other info. sources. sales (2)	.0007* (.001)	14	.0015 (.001)	21	.0072** (.008)	15
No. fairs/sales (2)	.0020 (.001)	14	.0028 (.002)	20	.0119** (.000)	15
Use of foreign machinery 1 = yes	.50 (.52)	14	.29 (.46)	21	0.0** (0.0)	15

Table 4

Wage Differentials in the Shoe Industry

Matched pair of firms	$(w_i)_S[(\frac{L_i}{L})_L - (\frac{L_i}{L})_S]$	$[(w_i)_L - (w_i)_s](\frac{L_i}{L})_L$
1	-.154	-.096
2	-.105	.070
3	-.012	.510
4	-.152	.250
5	-.040	-.240
6	-.042	-.017
7	-.335	.285
8	-.071	.408
9	-.131	-.648
10	-.053	.010
11	-.056	.247
12	.035	.246
13	-.120	.267
14	-.081	-.235
15	-.084	.268
16	-.061	.098
17	.038	.578
18	-.011	.428
19	-.074	.158
20	-.050	..248
21	-.059	.279
22	2.084	-1.942
23	-.009	.368
24	.915	-.427
25	-.004	-.117
Average(standard deviation)	.055 (.472)	.040 (.506)
Average, excluding #22,24(standard Deviation)	-.064** (.084)	.256** (.181)

**Significantly different from zero at the 5% level.

Table 5

Mean Differences by Size Groups: Cotton Spinning[1]

Variable	Large Firms	No. of observations	Medium Firms	No. of observations	Small Firms	No. of observations
Kilo of yarn produced	496,164** (338,706)	10	124,278 (51,066)	12	36,148** (12,719)	8
Value of cotton yarn (1)	7,216** (6,534)	10	2,179 (1,157)	11	349** (140)	4
Value of cotton yarn (2)	7,679** (4,813)	10	2,452 (1,597)	12	631** (420)	8
Value of all sales	11,128** (6,066)	10	4,365 (2,462)	12	1,246** (1,443)	7
No. prod. employees	580** (319)	9	239 (148)	13	94** (53)	8
Total employment	646** (300)	9	261 (157)	13	115** (53)	8
Kilo-watt hours consumed	10,384** (6,818)	9	2,048 (2,591)	13	383** (276)	7
No. spindles	46,594** (23,557)	10	16,032 (6,634)	15	3,917** (2,214)	9
Book value capital & reserves	75,545** (25,152)	10	26,248 (16,614)	13	11,971* (15,149)	8
Kilos of cotton consumed	430** (327)	10	129 (33)	11	36** (14)	9
Value raw materials	7,622* (8,187)	8	1,340 (706)	8	928 (1,346)	6
Value added	4,724 (3,494)	9	1,449 (1,441)	12	183** (74)	7
Profits	3,642** (2,978)	9	859 (1,348)	12	29** (116)	7
Profit/spindle	.071 (.056)	9	.054 (.072)	12	.022 (.036)	7
Profits/KWH	45.4 (125.5)	8	31.7 (100.5)	11	.151 (.272)	5
Profits/book value capital	.018 (.048)	7	.064 (.082)	10	.028 (.048)	6
Spindles/all employees	86.7 (37.7)	9	161.9 (362.4)	13	34.1 (10.1)	8
KWH/all employees	17.0 (15.3)	8	8.7 (8.1)	12	4.2* (2.7)	6
Book value capital/ all emp.	138.1 (50.7)	9	238.1 (490.5)	12	109.6 (88.2)	7
Spindles/sales	4.681 (1.936)	10	3.926 (2.051)	12	5.818 (5.412)	7
Equity capital/sales	7.591 (2.652)	10	6.125 (3.691)	12	13.888** (10.506)	7
KWH/sales	1.009 (.911)	9	.597 (.957)	12	.889 (.798)	5

*Significantly different from the mean for medium firms at the 10% level.
**Significantly different from the mean for medium firms at the 5% level.

[1]Standard deviations are in parentheses.

Table 5: (continued)

Variable	Large Firms	No. of observations	Medium Firms	No. of observations	Small Firms	No. of observati
Administrative emp./ prod. emp.	.159 (.162)	9	.121 (.106)	13	.335 (.527)	8
Kilos output/carding machine	11.9** (4.202)	10	18.4 (6.31)	14	12.143** (8.552)	7
Efficiency	.771 (.219)	9	.731 (.291)	9	.446* (.338)	7
Age	37.1 (18.3)	10	33.2 (8.1)	13	25.5** (24.6)	8
Years of Ulster installation	9.9 (7.7)	10	5.6 (6.3)	15	.9** (2.7)	9
Wage & fringe benefit rate	.1.81 (.46)	9	2.78 (2.34)	13	1.67 (.64)	8
Exports/total sales	1.165 (1.328)	10	1.415 (2.102)	12	.040** (.107)	7
Debt/spindles	2.242 (2.031)	8	1.593 (1.194)	10	1.472 (1.109)	6
Debt/KWH	838.9 (2327.1)	8	356.8 (1025.4)	10	8.272 (1.765)	4
Debt/book value capital	1.142 (.627)	10	1.017 (.640)	15	.947 (.675)	9
Discount for cash sales	4.286 (.777)	10	4.769 (1.422)	15	6.333** (2.327)	9
Raw material purchases/ total sales	.803 (1.051)	8	.417 (.287)	8	.879 (.955)	5
Cotton use/kilos output	.001 (.000)	10	.001 (.000)	11	.001 (.000)	8
Education of prod. manager	4.40 (.84)	10	4.45 (.69)	15	4.14 (1.36)	9
Experience in industry of prod. manager	13.7 (10.4)	10	17.1 (11.4)	15	22.6 (16.8)	9
Age of manager	41.5 (13.0)	10	44.2 (8.7)	13	43.1 (19.0)	8
Personal info. sources/ sales	.0000 (.000)	10	.0001 (.000)	12	.0008* (.001)	7
Other info. sources/ sales	.0001** (.000)	10	.0000 (.001)	12	.0018 (.002)	7

Table 6

Wage Differentials in the Cotton Spinning Industry

Matched pair of firms	$(w_i)_S[(\frac{L_i}{L})_L - (\frac{L_i}{L})_S]$	$[(w_i)_L - (w_i)_S](\frac{L_i}{L})_L$
1	-.880	.877
2	-.259	1.080
3	-.095	.856
4	.043	.766
5	.220	1.150
6	-.012	.588
7	-.210	.158
8	.237	.218
9	-1.613	.783
10	-.363	-.459
11	-1.847	.787
12	.220	-.330
13	-1.298	-.083
14	-.523	-1.400
Average	-.456**	.357*
(Standard deviation)	(.693)	(.720)

*Significantly different from zero at the 10% level.

**Significantly different from zero at the 5% level.

A Neo-Classical Model of Size Differences Among Firms[1]

In a simple model of a competitive economy, all firms producing the same commodity should look alike. Specifically, when firms are under competitive pressure, they will not only produce with the least costly methods, but will choose that level of production which will maximize profits. In addition, if all firms face the same factor and product prices, they will select identical production methods and scales of production. The only exception would occur in a case of constant returns to scale. If there are neither scale advantages nor disadvantages, a firm's choice of production level is indeterminate but also irrelevant. The only differences observed among firms would, in that case, be one of scale. Techniques of production, profit rates and everything else would remain the same.

The real world appears very different. Even firms in the same industrial sector do not look at all alike. Some are large; some are small. Some are capital intensive; some are labor intensive. Some appear modern and efficient; some appear traditional and inefficient. Some have access to capital; some do not. Perhaps some pay relatively high wages; others pay relatively low wages. The list could grow longer. Many people have noted these differences, emphasizing one or another of the phenomena.

We could respond to this wealth of empirical information by trying to characterize types of firms, shying away from a theoretical discussion of firm behavior. That is, we could describe the techniques used by large

[1]The first part of this chapter is based on work with John Fei.

and small firms, their access to banks and government financing, their sources of information and contacts, their market positions, etc. In this vein, we could even go so far as to argue that the observed differences among firms are not explainable by the usual economists' methods, that there are "economic men" and "engineering men", "profit maximizers" and "satisficers", "efficient" and "inefficient" managers.

Instead, we have constructed a model based on fairly standard assumptions about firm behavior. Our procedure is to construct an optimizing model incorporating several stylized facts. In a separate section to this chapter, Cardwell has tried to test the implications of the model with firm survey data. If the empirical tests are unable to reject the null hypotheses derived from the model, then perhaps fairly standard assumptions about economic rationality adequately describe the interfirm differences we observe. Perhaps we do not need to enter into "non-traditionally" economic explanations about managerial behavior to explain the intrasectoral disparities. Alternatively, if we are able to reject the null hypotheses derived from the model, some more complicated model must be substituted. The revised model might recognize production inefficiencies and non-optimizing behavior among firms.

The Stylized Facts

Underlying our whole discussion is the notion of a describable set of technological alternatives. We assume that there exists some best way,

given the state of scientific and engineering knowledge, to transform factors of production into output. In addition, we assume that these production techniques are known to all potential producers. For simplicity, we assume only two homogeneous factors, capital K and labor L, producing a homogeneous output Q: $Q = f(K, L)$. We will work with a production function that is continuous and differentiable. The first and second derivatives are listed in Table 1. Finally, we assume that the product price is fixed relative to other product prices. The real wage, therefore, can be denominated in physical terms. We can ignore any impact that sectoral output expansion might have on the product price.

Two of the stylized facts we have isolated and are incorporating as parameters to be estimated in the model refer to characteristics of this production function. Two refer to market phenomenon. These latter two, we incorporate explicitely as assumptions of the model.

Large firms appear to use different techniques of production from those used by small firms. We will characterize these purely technological differences in two ways. First, the greater the scale of production--measured either in terms of output, capital stock or labor employed--the greater the capital intensity of production. This phenomenon is suggested by numerous engineering studies and can be summarized in the following way: Specialization is impossible at low levels of production. A human being using

simple tools and equipment is more adaptable than a machine and can perform the required diverse operations. For a large enough production run, however, specialized machines can be built to substitute for the laborer embodying many skills. It is worth emphasizing that these scale related differences in capital intensity exist for any given relative factor prices faced by the firm. Even when paying the same wages and interest charges, a large firm will produce with a more mechanized technique than will a small firm.

The second technological characteristic refers to scale economies. There is a long tradition of writers including Adam Smith and Karl Marx, which has hypothesized the existence of scale economies. More recently, engineering data suggest that large firms are able to operate with lower unit costs of production, or higher output per unit of factor services. Some of these economies might be machine related: For example, specialized equipment associated with a large output run is inherently more productive than general purpose machines operating a batch process; as volume increases, surface area and costs increase less than proportionately. Other economies might be related to stocks: Inventories and cash reserves need not increase proportionately with production and transactions. Some economies allow large firms to increase capacity ulilization when plant and equipment have different minimum scales. Some scale advantages, such as those related to commercialization, risk, contacts and information, operate at the firm rather than the plant level, and are beyond the scope of a simple characterization of the technological production function.

To the extent that scale economies are significant, it might appear as if large firms are more efficient than small firms. Total factor productivity will be higher. Note that efficiency here is entirely due to scale advantages and not to managerial or workers' organization and capabilities, except in so far as managerial capability is related to the scale of production. Small firms combine the resources at hand in such a way as to maximize output. They simply have fewer resources. One consequence of the stylized fact of scale economies, therefore, could be the appearance of inefficient firms, without any misallocation of resources at the firm level.

The two remaining stylized facts relate to factor markets and the firm's behavior in these markets. Unlike many writers, we do not assume that large firms pay higher wages than small firms, especially since the smallest firms in our samples have a minimum of ten employees. What is often taken to be a higher wage scale is perhaps simply a higher average wage due to a different skill mix.[2] Moreover, we assume that employers can freely hire and fire workers, so that each worker earns its marginal product.[3] This behavioral assumption is extremely important in allowing us to derive testable and refutable hypotheses.

The final stylized fact that we emphasize has several possible interpretations. In one form or another, this stylized fact will be used to explain the coexistence of large and small firms over a long period of time.

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[2]There is some evidence that this assumption is not warranted. In the sample of Brazilian textile firms, the higher average skill level in small firms more than offsets the lower wage in each occupational class, resulting in a higher average wage overall. In the shoe industry, the small firms' higher skill level partially offsets their lower average wage in each occupational class. See above, Chapter 2.

[3]This assumption might be more applicable in countries like Brazil and Taiwan than in countries with stronger labor unions.

Firms use different amounts of capital. On one interpretation, the differences are due to imperfect capital markets. Some firms have access to credit; others invest out of their own, limited savings. An alternative explanation for the differences in capital stock could be through machine durability and technological change. Over time, the most profitable volume of capital has risen. Perhaps the real wage has not risen significantly, so that the older firms, given their smaller capital stocks, are still maximizing short-run profits with the marginal product of labor equal to the real wage. Or perhaps, firms are able to optimally adjust employment as wages have changed over time. Capital becomes partly "clay" once it is in place, preventing the older firms from installing the more profitable, more expensive equipment; but firms are still able to adjust employment such that labor's marginal product always equals the real wage. With durability and a situation where the older vintages still cover their variable costs, different vintages will coexist.

We will represent these capital market imperfections by fixing, *ex ante*, the stock of capital that each firm has at its disposal, rather than its interest cost.

The Model

The industry operates with full knowledge of a production function given in (1), where output Q is homogeneous and

(1) $Q = f(K,L)$.

is produced by homogeneous capital K and labor L. The first and second derivatives, obeying the usual signs, are written in Table 1. Each firm has at its disposal a fixed amount of capital, given by (2).

(2) $K_\ell = \bar{K}_\ell$,

Firms maximize profits by hiring labor up to the point where labor's marginal product equals the real wage, as in (3).

(3) $f_L = \bar{w}$.

Equations (2) and (3) embody the two market related stylized facts. The two technological stylized facts will be incorporated as parameters to be estimated, and are defined in (4) and (5), where (4) expresses the property of

(4) $$\frac{d(K/L)}{dK} \frac{K}{K/L} = \frac{dk}{dK} \frac{K}{k} = \eta_{kK}.$$

(5) $$\frac{f_L L + f_K K}{Q} = s$$

capital intensity and (5) that of scale economies.

Graphically the model can be presented in Figure 1. The upper part of the figure incorporates the technological hypothesis of increasing capital intensity with increasing size of the capital stock. The lower half shows short-run profit maximization: For any volume of capital, the firm employs labor up the point where labor's marginal product equals the fixed real wage.

We want to characterize the behavior of a firm operating with these technological and market constraints and, in particular, to characterize the effect of changing scale. For instance, when will we observe capital intensity to rise with scale, holding the real wage constant and equal to labor's marginal product? And under what conditions will labor and capital productivity increase with scale? If both labor and capital productivity can rise, then large firms might appear more efficient than small firms, even when each firm is internally efficient. We can also ask what happens, as the capital stock increases, to income distribution, measured by labor's share ϕ_L and the internal rate of return to capital.

Table 2 summarizes a number of the elasticities between capital and other variables, assuming that the real wage is always equal to the marginal product of labor, and taking the capital stock as exogenous. Clearly, the output and employment elasticities are positive in the normal case where labor and capital are complements in production ($f_{LK} > 0$) and where there is diminishing marginal product of labor ($f_{LL} < 0$).

The impact on capital intensity k of an increase in the capital stock depends on the strength of capital-labor complementarity. We can say that the technology exhibits relatively weak complementarity (RWC) if the elasticity defined in (4) is positive, such that capital intensity rises with scale, or $\frac{\varepsilon_{LK}}{\varepsilon_{LL}} < 1$. This relationship can be explained as follows: As scale increases through an increase in the available capital stock, labor's marginal product rises due to factor complementarity. Since the real wage is fixed, however, employers hire more labor. If there is RWC, the percentage increase in employment, which is required to bring labor's marginal product back into line with its real wage, is less than the percentage increase in capital. Therefore, capital intensity rises with the scale.

The principle observable phenomena associated with scale economies are capital and labor productivities and the internal rate of return. For the first two, one would expect factor productivities to increase when there are scale economies, or when the output elasticities sum to more than one--unless offset by diminishing returns to a single factor. Equations 2.4 and 2.5 in Table 2 show the relations between scale, diminishing marginal productivity, and factor complementarity.

Clearly, the greater the scale economies, the more likely both labor and capital productivity are to increase with scale. RWC, such that there is capital deepening, tends to increase labor productivity but decrease that of capital.

The effect of scale on the three income distribution variables--labor's share, the internal rate of return, and capital's share--is given in equations 2.6, 2.7 and 2.8. The first variable, the elasticity of output with respect to labor, is proportional to the inverse of labor's average productivity, since its marginal product is fixed. Therefore, $\eta_{\phi_L K} = - \eta_{(Q/L)K}$. As for the second, the internal rate of return to capital clearly rises with scale when there are scale economies. Equivalently, as long as the marginal product of capital exceeds the internal rate of return, the latter will increase with scale. As a result, capital's share $\frac{rK}{Q}$ will also increase with scale, unless the complementarity between capital and labor is sufficiently strong to result in a large increase in the labor-capital ratio.

Using the assumptions of short-run profit maximization and integrated labor markets across firms of different sizes, it has been possible to limit the technological information which is needed to trace the behavior of several important variables. The equations listed in Table 2 can be slightly recast into a form where the elasticities are functions of only three technological parameters $\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$, ϕ_L and ϕ_K. Of particular interest are the elasticities relating to factor productivity and factor returns.

We can solve for the various combinations of ϕ_L, ϕ_K and $\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$ which result in a given value of the elasticities for labor and capital

productivity, the internal rate of return and capital's share. That is, for each of the equations 2.4, 2.5, 2.7 and 2.8 we can derive isoelasticity frontiers as functions of the three technological parameters. This is done in Table 3 and Figures 2 and 3, where we illustrate the isoelasticity frontier as functions of ϕ_L and ϕ_K, for given values of $\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$.

In (ϕ_L, ϕ_K) space, a set of parallel straight lines with slope of -1 gives the combination of output elasticities ϕ_L and ϕ_K associated with a specific scale coefficient s. In particular, the line representing the case of no scale economies or diseconomies is indicated, passing through the points (0,1) and (1,0).

The zero isoelasticity lines for each variable are also drawn in Figure 2. When there are neither scale economies nor diseconomies, there is no tendency for the internal rate of return to vary with the firm's capital stock. The zero isoelasticity line $\eta_{r,K}$, therefore, coincides with the line for no scale economies. The set of isoelasticity lines for $\eta_{r,K}$ is that set of lines rotating through the point (1,0), with positive elasticities associated with the more negatively sloped lines.

Whether labor productivity increases with the capital stock faster than capital productivity depends on relative factor complementarity. If there is relatively weak complementarity, such that capital intensity rises with scale and $\frac{\varepsilon_{LK}}{\varepsilon_{LL}} < 1$, labor productivity will increase faster than that of capital for any combination of (ϕ_L, ϕ_K). The reverse is true if there is relatively strong complementarity and a tendency for labor intensity to increase. In (ϕ_L, ϕ_K) space, the isoelasticity frontiers for labor and capital productivity are parallel and separated by an absolute distance of $\left|1 - \frac{\varepsilon_{LK}}{\varepsilon_{LL}}\right|$ along the ϕ_K axis. To the Northeast of the zero isoelasticity line, productivity increases. To the Southwest, productivity decreases.

Figure 2 shows isoelasticity lines for positive and negative elasticity values.

The isoelasticity lines for capital's share of output are also indicated in Figure 2. For a constant share $\frac{rK}{Q}$, the isoelasticity line coincides (except for a segment along the vertical axis) with the zero $\eta_{p,K}$ line. This result is obvious, since a constant labor productivity implies a constant labor share when there is a fixed real wage, and therefore, a constant share for capital. Representative positive and negative isoelasticity lines are drawn in Figure 2. Wherever $\eta_{p,K}$ is positive and therefore $\eta_{\phi_L,K}$ negative, $\eta_{\pi,K}$ will also be positive.

Figure 3 combines the zero isoelasticity lines for three cases of $\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$ --where there is relatively strong and relatively weak complementarity, and where there is no tendency for the capital-labor ratio to change. If the production function were homogeneous, the three cases would correspond to increasing returns, decreasing returns and constant returns to scale. The figure shows those ranges in values for the technological parameters ϕ_L, ϕ_K and $\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$ which are consistent with increasing or decreasing factor productivities and return to capital.

Equations 2.4 - 2.8 can be estimated, to determine the implicit technological coefficients, assuming ϕ_L, ϕ_K and $\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$ are fixed for all values of the capital stock. Statistical tests can then be applied to these estimates. The statistical tests will allow us to reject or not reject the model developed here as a characterization of firm behavior.

Testing for Scale Economies in Two Industrial Sectors of Brazil

The purpose of the second half of this chapter is to test the model presented above. The model assumes that there exists a well known set of technological alternatives open to firms operating in a particular sector. This set can be represented by a production function. Firms maximize profits in the short-run, employing workers up to the point where their marginal product equals the real wage. There are institutional constraints, however,--either due to credit rationing or long-lived equipment--which result in size differences, and therefore technological differences, among firms.

The first half of this chapter derived several estimable relations between factor productivities, the internal rate of return and the firm's capital stock. From the relationships between these potentially observable variables, we can derive technological parameters representing scale economies and relative factor complementarity.

The following section briefly describes the data source used to estimate the technological parameters and states some general hypotheses about differences expected across industries and countries. Then, technological parameters measuring scale economies and factor complementarity are derived from relationships predicted by the model. The conclusion remarks on the usefulness of the model in explaining firm behavior and the technological differences observed. In particular, the differences in efficiency and factor productivity are not accounted for by the technological parameters estimated. The statistical estimates of firm behavior predicted by the model are not significant. Apparently, short-run profit maximization in an integrated labor market but imperfect capital market is not a satisfactory representation of the behavior of firms.

The Data

The model as it has been formulated requires data at the firm level on the technological processes in use and on the factor returns. It would be useful to have data for several industries with different technological and market characteristics. For instance , the implications of the model could be tested both for an industry that, based on secondary sources has technological scale economies and one that does not. In addition the model could be tested for an industry that operates in an apparently competitive environment as well as in a more protected, monopolistic setting.

The assumptions can also be investigated independently of the logical implications of the model. That is, we can ask whether firms of different sizes do, in fact, pay the same wage rate for equivalent skills. Even if firms do not hire workers up to the point where laber's marginal product equals the real wage, equal wage rates suggest mobility and a competitive labor market on the supply side. Institutional constraints such as unions and labor legislation could be explicitly investigated. Effective constraints, however, should show up in wage differentials for similar occupational skill categories. Wage patterns are investigated in an earlier chapter.

Credit rationing can also be investigated directly, though no direct evidence on capital market imperfections will be given here. Interest rate differentials and debt-equity ratios across size classes of firms have been presented.

The data used for testing this model come from the survey of firms carried out in Brazil for the shoe and cotton spinning industries. Additional tests will be carried out at a later date using data from the shoe industry in Colombia and the brick industry in Colombia and Taiwan.

This choice of industries and countries allows a more interesting test of the model than would be possible with aggregate data or with data from only one industry in one country. Generalizations about technology are suspect when based upon estimates of aggregate production functions. The particular nature and combinations of processes and subprocesses within a single industry cannot easily be compared with those of another industry. While some concepts, such as scale economies and mechanization, are generalizable, the particular form and source of scale economies and/or mechanization has many industry-specific characteristics. Machining or assembly operations might be similar from industry to industry, but there are still many non-transferable operations. Thus, it is useful to test the model with data from several industries.

Of the industries that we have selected, we expect some to exhibit more scale economies than others: perhaps shoes, less than cotton spinning (above a minimum scale), less than bricks. We also expect differences in the non-homotheticity of the production function, and in the strength of factor complementarity. Here, casual observation suggests that shoes and bricks might exhibit relatively weak complementarity compared with cotton spinning.

The availability of data in several countries is useful to highlight the role of different market conditions. While Brazil might have a more competitive labor market than Colombia--and therefore, be closer to the assumptions of the model--it might have less competition in product and capital markets. In addition, Brazil's recent encouragement of exports is quite different from Taiwan's policy of export substitution. In Brazil, export promotion has been carried out with the same policy tools and with a similar impact on market protection as its earlier import substitution.

Taiwan's export substitution, on the other hand, has incorporated a tendency towards more competition in all markets and prices nearer their economic shadow values.

In a comparison of Brazil and Colombia, therefore, we might expect the model's labor market assumptions to be more nearly approximated in Brazil. Both Brazil and Taiwan might satisfy the competitive labor market hypothesis. The coexistence in Taiwan of large and small firms, earning different profits, cannot be explained by capital market imperfections, as it can in Brazil. Perhaps only in industries with long-lived machines or rapid technological progress will there be significant size dispersion in Taiwan.

What is important is not only our particular a priori expectations country by country and industry by industry, but whether statistically significant estimates of the technological parameters can be obtained. If not, then the assumptions of the model must be rejected. Either the assumption of a known production function with technological parameters the same for all size classes of firms, or the assumption of short-run profit maximization in a competitive labor market must be rejected.

Estimating Scale Economies and Factor Complementarity

Equations 2.4, 2.5 and 2.7 can be used to estimate the technological parameters ϕ_L, ϕ_K and $\frac{c_{LK}}{c_{LL}}$ as functions of the observable elasticities $\eta_{p,K}$, $\eta_{d,K}$ and $\eta_{r,K}$. The transformed equations that were actually estimated and the parameter estimates associated with each are given in Tables 4a and 4b.

The parameters derived from ordinary least squares estimates are quite unstable, from equation to equation, and far from the hypothetical values, even significantly of the wrong sign.

This approach, based upon a neo-classical production function with profit maximization in a perfect labor market appears to be totally unsuccessful. The difficulties could lie, in part, in the quality of the data. But other simpler tests presented below do seem to make some economic sense. Therefore, the senseless results obtained here cannot be entirely accounted for by data quality. Other explanations, more fundamental to the model, must be important: The production function parameters, ϕ_L, ϕ_K and $\varepsilon_{LK}/\varepsilon_{LL}$ are not constant across scales; firms do not all operate with the same technological choices; firms are not technologically efficient; firms do not all maximize profits etc. Before confronting these problems directly, it might be useful to test some standard forms of production functions, which still make many of the assumptions of this neo-classical model.

Table 1

Definitions of Production Relations

Q: Output

K: Capital input

L: Labor input

$Q = f(K,L)$

$r = \frac{Q - wL}{K}$ = internal rate of return

<u>Derivatives</u>

First order: $\frac{\partial Q}{\partial K} = f_K(K,L)$, $\frac{\partial Q}{\partial L} = f_L(K,L)$

Second order: $\frac{\partial f_K}{\partial K} = f_{KK}(K,L)$, $\frac{\partial f_K}{\partial L} = f_{KL}(K,L)$

$\frac{\partial f_L}{\partial K} = f_{LK}(K,L)$, $\frac{\partial f_L}{\partial L} = f_{LL}(K,L)$

<u>Output elasticities</u>

$$\phi_K = \frac{f_K K}{Q} \qquad \phi_L = \frac{f_L L}{Q}$$

$$s = \phi_L + \phi_K$$

<u>Productivity elasticities</u>

$$\epsilon_{KK} = -\frac{f_{KK} K}{f_K} > 0 \qquad \epsilon_{KL} = \frac{f_{KL} L}{f_K} > 0$$

$$\epsilon_{LK} = \frac{f_{LK} K}{f_L} > 0 \qquad \epsilon_{LL} = -\frac{f_{LL} L}{f_L} > 0$$

Table 2

Production Elasticities, using (3), a given real wage

2.1 $\eta_{Q,K} = \frac{dQ}{dK}\frac{K}{Q} = \phi_K + \phi_L \frac{c_{LK}}{c_{LL}} > 0$

2.2 $\eta_{L,K} = \frac{dL}{dK}\frac{K}{L} = \frac{c_{LK}}{c_{LL}} > 0$

2.3 $\eta_{K/L,\ K} = \eta_{k,K} = \frac{d(K/L)}{dK}\ \frac{K}{(K/L)} = 1 - \frac{c_{LK}}{c_{LL}}$

2.4 $\eta_{Q/L,K} = \eta_{p,K} = \frac{d(Q/L)}{dK}\ \frac{K}{(Q/L)} = \phi_K\ (1 - \frac{c_{LK}}{c_{LL}}) + (s-1)\ \frac{c_{LK}}{c_{LL}}$

2.5 $\eta_{Q/K,K} = \eta_{d,K} = \frac{d(Q/K)}{dK}\ \frac{K}{Q/K} = -\ \phi_L\ (1 - \frac{c_{LK}}{c_{LL}}) + (s - 1)$

2.6 $\eta_{\phi_L,K} = -\ \eta_{p,K}$

2.7 $\eta_{r,K} = \frac{s-1}{1-\phi_L} = \frac{f_K - r}{r}$

2.8 $\eta_{\frac{rK}{Q},K} = \eta_{w,K} = (s-1)\ \frac{\phi_L}{1-\phi_L} + (1 - \frac{c_{LK}}{c_{LL}})\ \phi_L$

Table 3

Isoelasticity Functions

3.1 $\phi_K = \eta_{p,K} + \frac{c_{LK}}{c_{LL}} - \frac{c_{LK}}{c_{LL}} \phi_L$

3.2 $\phi_K = \eta_{d,K} + 1 - \frac{c_{LK}}{c_{LL}} \phi_L$

3.3 $\phi_K = \eta_{r,K} + 1 - (1 + \eta_{r,K}) \phi_L$

3.4 $\phi_K = - \eta_{\pi,K} + \frac{c_{LK}}{c_{LL}} + \frac{\eta_{\pi,K}}{\phi_L} - \frac{c_{LK}}{c_{LL}} \phi_L$

Table 4a

Estimates of ϕ_L, ϕ_K and $\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$* : Shoes

Equations Estimated	R^2	Parameter Values ϕ_L	ϕ_K	$\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$
1. $\eta_{d,K} - \eta_{p,K} = \frac{\varepsilon_{LK}}{\varepsilon_{LL}} - 1$:		-	-	.40
2. $\eta_{r,K} = \frac{\phi_L + \phi_K - 1}{1 - \phi_L}$:		if .20	-5.7	
3. $\eta_{p,K} = \phi_K - \frac{\varepsilon_{LK}}{\varepsilon_{LL}} \frac{(\phi_L + \phi_K - 1)}{\eta_{r,K}}$:	.002		-10.7	
4. $\eta_{r,K} = \frac{-\phi_L (\varepsilon_{LK}/\varepsilon_{LL} - 1)}{1 - \phi_L} + \frac{\eta_{d,K}}{1 - \phi_L}$:	.94	.20	-	-1.35

Table 4b

Estimates of ϕ_L, ϕ_k and $\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$: Cotton Spinning

Equations Estimated	R^2	ϕ_L	ϕ_K	$\frac{\varepsilon_{LK}}{\varepsilon_{LL}}$
1. $\eta_{d,k} - \eta_{p,K} = \frac{\varepsilon_{LK}}{\varepsilon_{LL}} - 1$:				-1.59
2. $\eta_{r,K} = \frac{\phi_L + \phi_K - 1}{1 - \phi_L}$		if .60	-19.5	
3. $\eta_{p,K} = \phi_k - \frac{\varepsilon_{LK}}{\varepsilon_{LL}} \frac{(\phi_L + \phi_K - 1)}{\eta_{r,K}}$	.01		-25.8	
4. $\eta_{r,K} = \frac{-\phi_L (\varepsilon_{LK}/\varepsilon_{LL} - 1)}{1 - \phi_L}$				
$+ \frac{\eta_{d,K}}{1 - \phi_L}$	.87	.60		-5.93

Figure 1

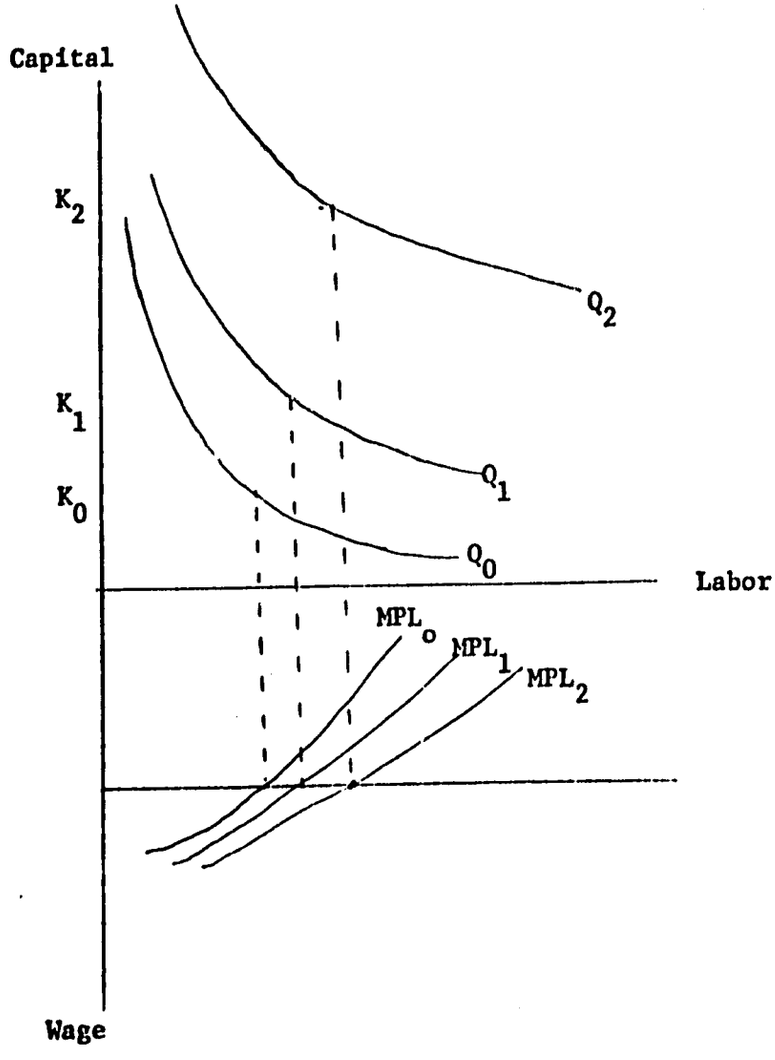


Figure 2

Isoelasticities

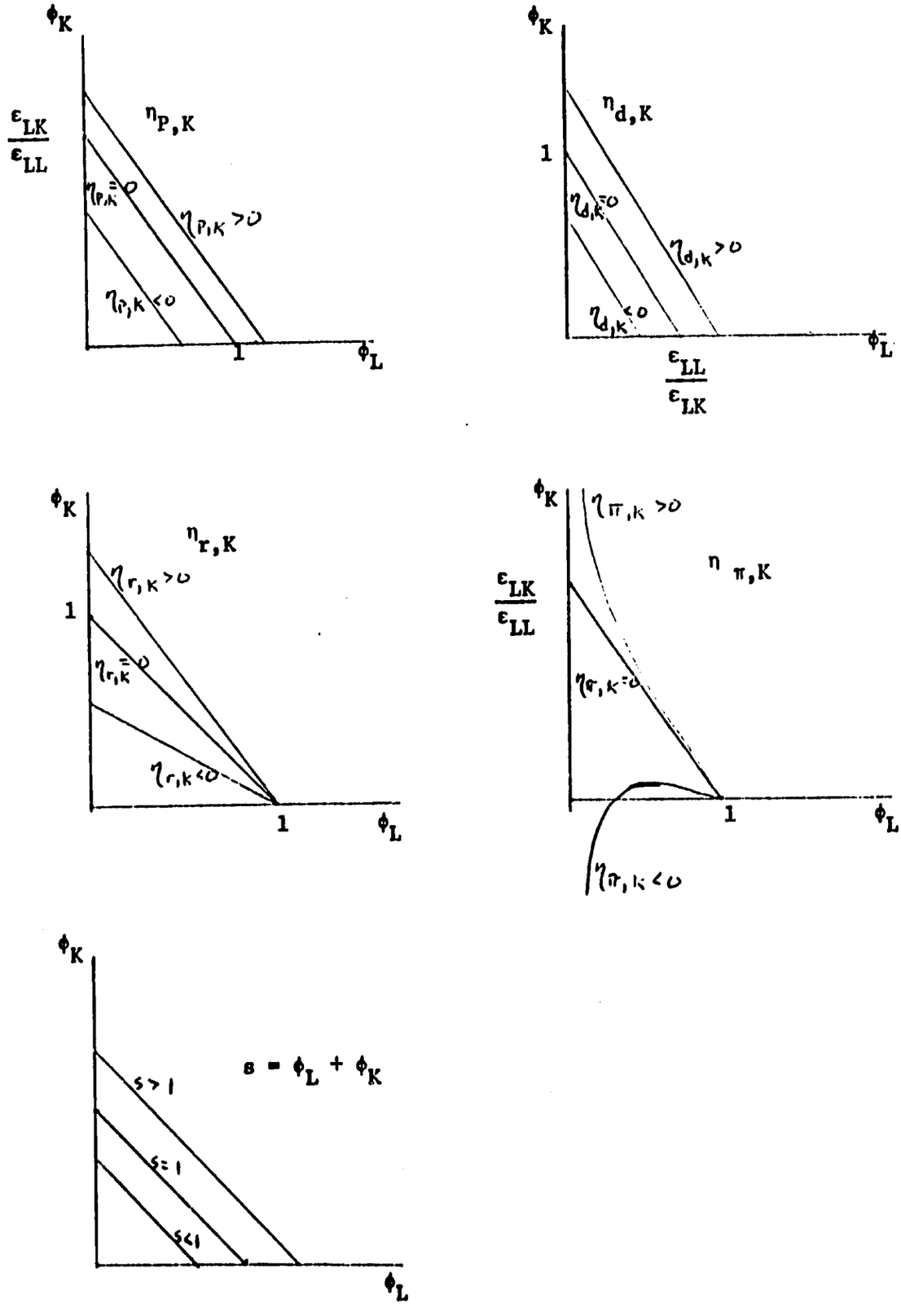
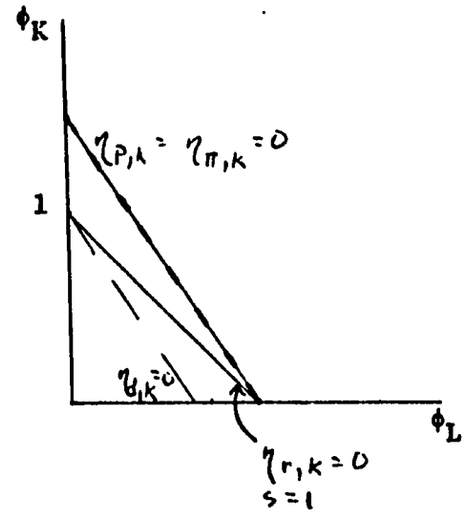
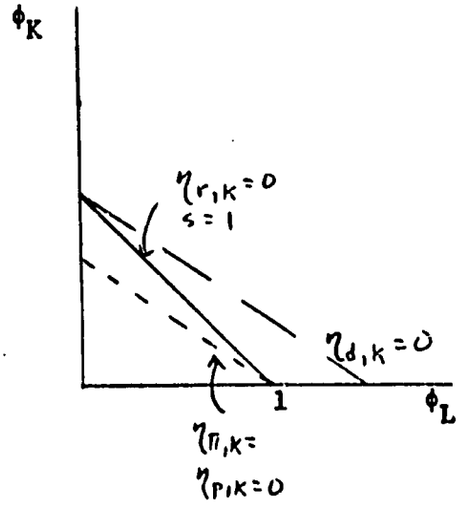


Figure 3

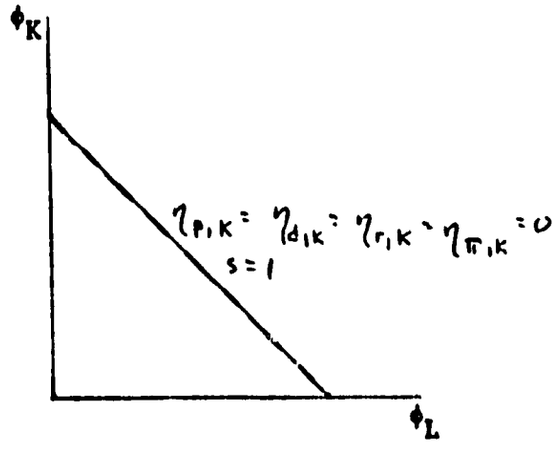
Isoelasticities



(a) $v = \dfrac{\varepsilon_{LK}}{\varepsilon_{LL}} > 1$



(b) $v = \dfrac{\varepsilon_{LK}}{\varepsilon_{LL}} < 1$



(c) $v = \dfrac{\varepsilon_{LK}}{\varepsilon_{LL}} = 1$

Other Production Functions:

Cobb-Douglas and CES Production Function Estimates of Scale Elasticity

I have estimated Cobb-Douglas and CES production functions to see whether estimates of standard neoclassical production functions will be more successful than our earlier model which imposed constraints related to the financial and labor markets. As in the model outlined earlier, the estimates of the Cobb-Douglass (CD) and CES functions assume that each firm is operated efficiently. Any such estimation assumes that all firms operate with the same production function. Even when firms operate in different markets and, therefore, choose different scales and techniques, the underlying technological relations are the same. The survey used to test the various specifications does not have enough observations to subdivide the data by size class, directly testing for differences in production functions.

While the technological specifications are more explicit in this section, there are fewer assumptions about the nature of the factor markets. One form of the CES estimation does, however, assume competitive markets and profit maximization. The goal of this chapter is not only to estimate the industrial production functions and to compare one specification with another, but to study the nature of scale economies. Several forms of both the CD and the CES functions have been estimated in order to understand the sources of scale economies or diseconomies. I have tried to distinguish economies based upon production advantages from those based upon product or input marketing advantages.

Several forms of functions were estimated, using different definitions of output and of capital. The results were systematically "better" using electricity consumption rather than a measure of the capital stock in the case of shoes, and the number of spindles installed rather than the book value of capital, in the case of spinning. In each case, that is, a physical input--whether a flow or a stock--appeared to have fewer measurement errors and to perform clearly better. Only the results based upon KWH's of electricity consumption or spindles are presented in Tables 1 and 2. It is possible--and this should be borne in mind in interpreting the results below--that there are economies of scale in the use of machinery, but not in the consumption of electricity. The choice of electricity consumption as the capital proxy in the shoe industry, therefore, might be biased against any finding of scale economies.

Output was measured as value added, as gross sales, and as a physical quantity. In the case of shoes, physical quantity equals the number of pairs produced and in the case of cotton spinning, kilos of yarn.

Starting with the CD, I will briefly discuss the functions estimated. The CD specifications are given in (1a) and (1b).

(1a) $\ln X_o/L = \ln A + a \ln L + b \ln K/L + c \ln RM/L + u$

(1b) $\ln X_1/L = \ln A + a \ln L + b \ln K/L + u$

where, Xo is a measure of either physical output or sales,

X_1 is a measure of physical output, sales or value added,

L is the number of people employed,

K is a measure of capital (kilo-watt hours of electricity consumed in the case of shoes or spindles in spinning),

RM is the physical consumption of cotton in the case of spinning and the value of raw materials used in the case of shoes,

u is an error term.

The coefficients "b" and "c" are respectively the output elasticities with respect to capital and raw materials; "a" is the estimated difference between the sum of the output elasticities and one, or the degree of homogeneity minus one:

$$b = \partial X_i / \partial K \, (K/X_i)$$

$$c = \partial X_i / \partial RM \, (RM/X_i)$$

If raw material use is proportional to output, then value added and final output can both be represented by a CD production function (or a CES function). If this assumption were valid, in both a physical and a value sense, then the variable coefficients in (1b) would be identical for all three measures of output. Alternatively, the assumption can be checked by comparing the results of (1a) with those of (1b). The two specifications have incompatible representations of raw material usage. If raw material use is a constant proportion of output, the output elasticity "c" should approximate one.

For each equation (1a) and (1b), several forms have been estimated. Both the value of output and physical output are used as dependent variables in (1a). In addition, value added is a dependent variable in (1b). A comparison of the results obtained from the value and quantity of output equations should indicate whether there are scale economies in product marketing. The value measure of output allows for, but does not distinguish, scale economies or diseconomies in product marketing as well in the physical

production process. A comparison of the value added and the value of output equations can show whether there are gains due to cheap sources of raw materials. This last equation confounds scale economies in production, in marketing and in the factor market.

Table 1 gives the CD estimates for both industries. Several conclusions can be drawn from these results. First, the assumption that cotton consumption is a fixed percentage of output is better than the alternative specification of CD. When raw materials are entered in CD form, the output elasticity is approximately one and the estimate of capital share becomes unstable, insignificant and unreasonable. Obviously, there is great multicollinearity between the kilos of cotton input and kilos of yarn output. The choice between a fixed coefficient and CD specification for raw materials, in the case of shoes, is not so clear cut. Since raw materials are included as a value, the physical relation between input and output is not so clear. The capital shares are quite stable and statistically significant. Similarly, the scale elasticities are unaffected by the choice of specification (1a) or (1b).

The main interest here is to estimate the value and sources of scale economies. In both industries, the physical output equations show substantial diseconomies of scale, more so for shoes than for textiles. The estimated difference between industries could be due, in part, to the choice of capital proxy: Large firms might have some advantage through the use of large scale capital equipment, but no savings in energy use relative to smaller firms--and even a substitution of electricity for other sources of energy. The choice of kilo watt hours of electricity consumed must result in an underestimation of physical scale economies in the shoe industry.

If value of output is used as the dependent variable, the estimate of scale economies increases to nearly unity in the case of shoes and over .90 in textiles. Apparently, sales increase faster than physical output and than factor use. Even if large firms produce a higher quality product, they do this without proportionate increases in factor use.

Finally, the value added equations show still greater scale elasticities, this time greater than one for both industries, but not significantly so. If the results are reliable, large firms must have some advantages in the purchase of raw materials.

In addition to the scale elasticity, the CES functions estimated can be used to study the elasticity of substitution between capital and labor. Variants can be used to test for non-homotheticity of the function. The CES and related functions estimated are presented in Tables 2a and 2b.

First, to dispose of the elasticity of substitution. Whether the Kmenta expansion or the form based upon competitive market profit maximization is used, the elasticity is highly unstable, going from negative values, to values less than unity, to values greater than unity. It is not surprising that the estimates should be so poor, since σ is a second order estimate in the Kmenta specification and based upon competitive market behavior in the other case.

The scale elasticities follow a pattern and even absolute magnitudes very similar to the CD equations. That discussion need not be repeated.

Variants on Kmenta's expansion of the CES function or on the competitive profit maximization form can be used to test for non-homotheticity. The latter gives very poor results and is not reproduced here. Its results

would be consistent with numerous interpretations, such as non-profit maximization, unitary/non-unitary scale elasticity, or homothetic/non-homothetic production function. The results of the former are presented in Tables 2a and 2b. If production did in fact take place according to a homothetic CES function, then the coefficients of the variables $(\ln K)^2$, $(\ln L)^2$ and $(-1/2 \ln K \ln L)$ would all equal the coefficient of $(\ln K/L)^2$ in the basic CES form. In three out of nine tests only, were the coefficients of the non-homothetic equations in the shoe industry significantly different from those of the homothetic form. Five out of nine of the coefficients in textiles were significantly different. While the evidence is mixed, it could be a mistake to assume a homothetic production technology.

The results from the production function estimations are intended to be suggestive and to raise certain questions. The first conclusion that appears to be quite general concerns scale economies. Scale economies have traditionally been discussed in the context of physical production capabilities. The evidence presented here, however, suggests that market [illegible] both factor and product market--advantages might be more important in the shoe and cotton spinning industries. The second tentative conclusion concerns the coexistence of firms in spite of the presence of scale economies and the mixed results on homotheticity. Firms cannot all operate in the same markets, since we observe disparities among them. The disparities might include differential knowledge of production techniques, different underlying production functions, and more damaging still, different incen[illegible] to produce efficiently. Any one of these possibilities would invalidate production function estimation in the traditional sense. The estimates obt[illegible]

might summarize an empirical relation between output and input in the sectors observed, without implying any underlying technological relations.

Table 1

Estimates of Cobb-Douglas Production Functions: Shoes and Cotton Spinning*

Independent Variables	Shoes			Dependent Variables		Cotton Spinning				
	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$	$\ln \frac{VA}{L}$	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$	$\ln \frac{VA}{L}$	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$
$\ln \frac{K}{L}$	.36 (2.66)	.31 (3.71)	.79 (5.19)	.36 (2.63)	.32 (3.82)	.93 (3.22)	.90 (3.63)	.80 (1.95)	.04 (.22)	.57 (1.92)
$\ln L$	-.30 (5.51)	-.02 (.71)	.08 (1.28)	-.30 (5.21)	-.005 (.14)	-.20 (1.15)	-.09 (.57)	.15 (.60)	-.004 (.04)	-.02 (.1)
$\ln \frac{RM}{L}$				-.017 (.12)	.15 (1.75)				1.11 (9.22)	.72 (1.85)
Constant	3.46	.06	-3.89	3.48	-.15	3.48	-.51	-2.80	6.82	.72
R^2	.47	.25	.40	.47	.30	.33	.38	.20	.87	.47
No. of observations	46	46	46	46	46	25	25	25	25	25
Scale elasticity	.70	.98	1.08	.70	1.00	.80	.91	1.15	1.00	.98

* t - statistics in parentheses

Table 2a

Estimates of CES and Non-Homothetic Production Functions: Shoes*

Independent Variables	Dependent Variables								
	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$	$\ln \frac{VA}{L}$	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$	$\ln \frac{VA}{L}$	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$	$\ln \frac{V}{I}$
$\ln \frac{K}{L}$	-1.10 (.71)	.02 (.03)	7.27 (5.03)	-1.42 (.88)	-.07 (.07)	7.07 (4.67)			
$\ln L$	-2.8 (5.05)	-.02 (.60)	.014 (.27)	.17 (.22)	-.04 (.08)	.039 (.05)			
$(\ln \frac{K}{L})^2$	.12 (.95)	.02 (.30)	-.54 (4.50)						
$(\ln K)^2$				.16 (1.14)	.03 (.31)	-.53 (4.06)			
$\ln K \ln L$				-.34 (1.04)	-.04 (.17)	1.09 (3.58)			
$(\ln L)^2$				.15 (.74)	-.003 (.03)	-.58 (3.17)			
$\ln w$							-.27 (1.67)	.005 (.05)	.13 (.70
constant	7.73	.91	-22.83	7.71	1.21	-22.34	4.42	1.92	1.38
R^2	.48	.25	.59	.49	.26	.60	.06	0	.01
No. of observations	46	46	46	46	46	46	46	46	46
Scale elasticity	.72	.98	1.01				1	1	1
σ	-2.83	1.25	.19				-.27	.005	.13

* t - statistics in parentheses

Table 2b

Estimates of CES and Non-Homothetic Production Functions: Cotton Spinning*

Independent Variables	Dependent Variables								
	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$	$\ln \frac{VA}{L}$	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$	$\ln \frac{VA}{L}$	$\ln \frac{Q}{L}$	$\ln \frac{PQ}{L}$	$\ln \frac{VA}{L}$
$\ln \frac{K}{L}$	-1.32	3.87	-2.60	-2.76	3.56	-2.78			
	(.33)	(1.10)	(.44)	(.73)	(.95)	(.45)			
ln L	-.18	-.12	.19	-2.47	-1.04	-2.61			
	(.98)	(.75)	(.71)	(1.09)	(.47)	(.71)			
$(\ln \frac{K}{L})^2$	.28	-.36	.42						
	(.56)	(.85)	(.57)						
$(\ln K)^2$				-.20	-.43	.56			
				(.40)	(.89)	(.69)			
ln K ln L				1.35	1.03	-1.29			
				(1.10)	(.85)	(.65)			
$(\ln L)^2$				-1.28	-.57	1.04			
				(1.53)	(.69)	(.76)			
ln w							.24	-.01	1.19
							(.52)	(.03)	(2.04)
constant	7.87	-6.33	3.84	16.88	-3.22	11.69	5.92	2.54	.62
R^2	.34	.40	.21	.49	.41	.25	.01	0	.15
No. of observations	25	25	25	25	25	25	25	25	25
Scale elasticity	.82	.88	1.19				1	1	1
σ	.14	-.27	-.50				.24	-.01	1.19

* t - statistics in parentheses

The Determination and Characterization of Efficient Firms[1]

Much attention in the literature of economic development has gone to the problem of the misallocation of resources and its effect both on labor absorption/unemployment and on aggregate production. Writers in this area have noted that in developing countries, firms of very different sizes and techniques coexist. Some firms are large, others small; some are modern and capital intensive, others more traditional and labor intensive. That is, some appear to use "appropriate" technology while others do not. From these observations, many conclude that the market distortions needed to account for this coexistence should be reduced. Factor and product prices reflecting the economic scarcity would result in a more "appropriate" choice of product and process, and therefore diminish unemployment and increase output.

This discussion of interfirm differences and misallocation of resources could take place within a standard neoclassical framework. Each firm might operate with technical efficiency, minimizing costs given the prevailing factor prices,and even maximize profits in choosing the scale of output, given relative prices and credit restrictions. The explanation for the observed differences would include the firm's operating in separate product or factor markets; durability of equipment, and lagged adjustment to changing market conditions; durability of equipment and technical change among equipment suppliers.

It is likely, however, that the standard neoclassical explanations--even the more complicated ones involving the time structure of the capital

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[1] I want to thank James N. Boles for making available his computer algorithm used in this chapter.

stock--do not tell the whole story. An attempt to test a particular neo-classical model of short-run profit maximizing firms with exogenous capital stock was not very successful.[1] The theoretical implications of the model were not borne out by survey data on Brazilian shoe and cotton spinning firms. The primary effect of reducing distortions and increasing competition might not be to shift from one technically efficient production point to another more socially desirable one. And the increase in the value of output might be significantly larger than is generally attributed to a reallocation of resources used technically efficiently in a micro sense.

Market distortions are frequently devices for market protection. Segmented product and factor markets protect firms operating in one market from those operating in another: Large firms are separated and protected from small; exporters from non-exporters; high quality product from mass market producers; one region from another etc. Protection diminishes the number of competitors and allows firms to produce inefficiently, even in the micro sense.

The increase in output due to more efficient production might be substantially larger than that due to resource reallocation. That is, X-inefficiency, might be empirically much more important than allocative inefficiency in its effect on productivity.

The impact on labor absorption is less clear. Much of the standard neoclassical literature assumes that there exist efficient labor-intensive production techniques. In that case, factor prices more closely approximating shadow prices should decrease unemployment in a long run equilibrium. But,

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*See Chapter 3 of this monograph, "Testing for Scale Economies in Two Industrial Sectors of Brazil."

there are two complications. First, there might not exist efficient labor-intensive techniques. Those labor-intensive techniques actually observed might survive only in a protected market. Second, there might be an intertemporal problem of evaluating employment generation in the present versus unemployment in the future, or vice versa. It could be that the forced increase in competition (when protection is eliminated) will lead to an increase in output among the relatively more efficient firms and a decrease among the less efficient. There might be no change in production techniques for any given firm in the short run. In the long run, with machinery depreciation and new investment, processes might change. Even if the most profitable enterprises in the long run should employ labor-intensive methods of production, the most efficient firms in the short run could be relatively mechanized. Or the reverse could be the case.

A complete answer to any empirical question about the long-run efficient and profitable choice of technique would involve information on blue prints and engineering know-how. The greater the variety of production methods observed, however, the more likely the set of observed techniques is to include those which are technologically efficient.

The short-run effect of eliminating distortions and protection might be predicted from survey data. Detailed information on individual firms can be used to measure relative efficiency. A measure of the degree of efficiency can then be related to a firm's scale, capital intensity, innovativeness, entrepreneurial skills and background etc. The goal of this chapter is to first measure, at the firm level, the technical efficiency of a sample of Brazilian shoe and cotton spinning firms. Then, an attempt

is made to characterize the relative efficiency of these firms. An estimate of the increase in output that could be obtained from the existing factors of production is included.

A Measure of Efficiency

The sense in which a firm's "efficiency" level will be used here is purely technological. The firm's production process is efficient if there is no way in which it could (1) increase its output with its existing factors of production and (2) increase its output per unit of factor consumed by changing its scale of production, maintaining factor proportions constant. Efficient firms are equivalent to those operating along a unit isoquant frontier. Considering only the first point (1) made above, both large and small firms might be efficient: Neither group is able to increase output with its existing factors of production. The entrepreneur--managers and workers are each doing the best possible job in the given plant. But in another sense, including the second point (2), the large firms might be more efficient. If there are increasing returns to scale, larger firms can take advantage of the returns to scale and should make up the observed unit-output efficiency envelope. In this case, the managers have chosen a size of plant which might allow them to reap scale economies. The empirical measure used here includes both aspects of efficiency.

The two-factor case is illustrated in Figure 1, which shows inefficient firms using more of one or both factors to produce output level Q than do the efficient firms, or a linear combination of the efficient firms.

M. J. Farrell (1957, 1952) developed the theory and an algorithm for measuring productive efficiency. Boles (1971) extended the empirical methodology. The basic version of the algorithm determines those firms which are on the unit-isoquant envelope, standardizing output and factor use as if there were constant returns to scale. The algorithm calculates for each firm the factor $(1 + \theta)$ by which output could be expanded if factors were used efficiently, but in the given proportions. The measure is actually presented the inverse of this factor: $E_t = \frac{1}{1+\theta_t}$, for the tth firm. E_t lies between zero and one, with efficient firms in the sample having a value of one.

There are three implicit assumptions in this measure of efficiency that are worth discussing here. First, the measure is based upon a sample of existing firms and not an idealized set. The actual sample might not include any firms that are technologically efficient. The measure calculated, therefore, is one of relative efficiency among existing firms. Second, while the basic version of the algorithm does not allow for scale economies, to the extent that there are scale economies or diseconomics, the large or the small firms will lie on the frontier. There is another version of the algorithm that directly takes into account the degree of scale economies or diseconomies. Third, the measure assumes that all factors of production are used with the same degree of efficiency. The farther a unit production point is from the frontier along a ray through the origen, the lower the measure E. Figure 2 illustrates a case where this proportionality assumption might be false. For example, if workers are always employed up to the point where their marginal productivity equals their wage--they are

hired and fired as desired--but capital might be used at less than full capacity, then the measure of efficiency should look at capital use rather than both capital and labor. The degree of efficiency could be defined as the inverse of the distance along the capital usage axis to the isoquant frontiers. Figure 2 shows a case where two firms have identical degrees of efficiency according to the Farrell measure, but firm (1) is relatively inefficient compared with firm (2) if the only underemployed resource is capital.

In addition to these problems of interpretation, there are several difficulties in implementing the algorithm. While the program can handle up to 39 factors of production, the actual number in a particular production process might be much larger. Alternatively, the larger the number of factors specified, the greater the number of firms that appear efficient since all substitutability among factors is precluded. Errors in data, whether simple mistakes or unidentified variations in quality, can significantly affect the solution. Simple mistakes in accounting are magnified when factors are specified in detail, allowing fewer possibilities for compensating errors. But aggregating factors of production without allowing for real quality variation or when there is less than perfect substitutability can also create biases.

Two simple checks can be made in implementing the Farrell efficiency program in order to limit the data errors. First, the program can be run a second time, eliminating the firms that appeared to be efficient on the original run. (Patricio Meller followed this procedure.) The effect here

is to eliminate outliers, even when real, in order to see if the remaining firms keep their efficiency ranking and a similarly shaped isoquant. Second, various input measures can be used, with their respective efficiency measures and rankings compared.

Firm Profitability

Relatively efficient firms might not be relatively profitable, or vice versa. Whereas the notion of efficiency used above was purely technological and depended only on factor inputs and the scale of production, profitability depends both on product and factor prices. A neo-classical profit maximizing firm, whether or not it is operating in a perfectly competitive market, will minimize costs for any given output choice. If there is some market protection, however, a firm might not be forced to maximize profits or to operate on the isoquant efficiency frontier.

There might not be, then, any relation between relative profitability and efficiency. Figure 3a shows two firms producing the same level of output at points P_1 and P_2. They are equally profitable, since they are operating in the same product and factor markets, and pay the same factor costs. Firm (1), however, is more efficient according to the Farrell measure than firm (2). A slightly different situation is illustrated in Figure 3b. Again the firms operate in the same product and factor markets, and produce the same level of output. But here, their efficiency levels, as defined by their feasible output expansion with fixed factors are identical while firm (1) pays lower factor costs and is more profitable than firm (2). A third kind of situation is possible. If markets are segmented, two firms operating efficiently or even maximizing profits in their separate markets

might earn different profits. It would be only by chance that two firms operating in separate factor markets would make the same profits, as illustrated for firms (1) and (2) in Figure 3c, but not for firm (3).

In each of the three illustrated cases, there is no relation between efficiency and profitability. The lack of correspondence is due to protection, lack of competition and segmented markets.

Estimating Firm Efficiency

The Farrell algorithm has been run on the survey data from both the shoe and the cotton spinning industries. In each industry, the algorithm was run for at least three different choices of factors of production and, in some cases, after eliminating the firms that appeared to be efficient in the first test.

Output, in both industries, was measured by the value of total sales. The factors of production included the value of raw material purchases in the case of shoes and the quantity of cotton consumed in the case of cotton spinning. Capital was measured variously as electricity consumption, or the book value of machinery in the shoe industry, and electricity or the number of machines (or spindles) by several plant divisions in the spinning industry. Labor was sometimes the aggregate number of production workers and sometimes partly disaggregated by plant division or by manual/machine operators. The precise specifications are given in Table 1, the Spearman rank correlations between the efficiency measures in Table 2 and the potential percentage increase in sales for the relevant sample of firms in Table 3.

The correlation coefficients are in all but one case significant at the 10% level. Even with substantial changes in the specification of the

factors of production or after eliminating the firms on the efficiency frontier, the rank orderings stay fairly constant.

The percentage increase in output that would be possible if factors were used efficiently is an even stronger test of the consistency of the index. The output potential takes into account the level of the index rather than the rank. The absolute measure of inefficiency suggests that the shoe industry is less efficient than the cotton spinning industry. This conclusion might be surprising if shoes are thought of as an important manufacturing export and if the ECLA criticisms of Brazil's textile industry are recalled. The shoe industry, however, has been growing rapidly with, until recently, a growing demand for its output such that even inefficient firms can survive. Moreover, only a small percentage of the shoe firms export. The others produce for a quite segmented domestic market.

This conclusion might be questioned. It is possible that the estimate of potential increase in output in the shoe industry is an overestimate. The degree of factor disaggregation might bias the results. For example, textile experiments one and two, which are based upon quite disaggregated capital and, in the latter, disaggregated labor data, indicate firms to be relatively efficient. When, however, a more aggregate measure of capital--electricity consumption--is substituted for the number of machines in each division, as in experiment three, the estimated potential increase in output is substantially larger. Perhaps, then, the estimated potential increase in output is large in the shoe industry because of the use of aggregated factors of production. For instance, the only difference between shoe

experiments one and two lies in a slight diaggregation of the labor force. The experiment with a greater labor force breakdown shows firms to be more efficient. But experiment three, on the other hand, has even more detailed labor categories and reverts to the conclusion of greater inefficiency. There is not a simple one-to-one correspondence between degree of disaggregation and estimate of inefficiency. Moreover, it is inappropriate to disaggregate factors which are close [illegible]. Therefore, it is not obvious that the disaggregated factor specifications are always preferable.

The conclusion that the shoe industry is relatively [illegible] and could attain a substantially larger increase in output than the textile industry is probably warranted. How large an increase is [illegible] for either industry. Whether the potential increase is 35% or [illegible], it appears that firms in both shoes and spinning operate substantially below their maximum efficiency. The lack of competition that permits [illegible] firms to survive might well result in greater social [illegible] through better utilization of resources at the firm level than through [illegible] of resources at a macro level.

Characterizing Firm Efficiency and Profitability

Firms of differing efficiency levels can be characterized by the [illegible] their Farrell indices on firm variables, such as [illegible]. Table 4 presents the results of such regressions for both the shoe and the cotton spinning industries. The results are not very [illegible], especially in the case of shoes. None of its regression coefficients are significantly different from zero at the five percent level. In the textile industry

however, both the level of sales and the productivity of the carding machines are significant. Large firms appear to be technologically more efficient than small firms, as do firms that achieve a high hourly productivity of the cards. The high productivity could be the result of a relatively intense use of labor. The capital-labor measure used--spindles per total number of employees--, however, is insignificant but of the expected sign, perhaps because of multicollinearity.

While none of the coefficients in the shoe regression are significant, the industry shows some tendencies similar to those in spinning: large, relatively labor intensive firms producing in large production runs (less down time on machines) tend to be more efficient.

Do the differences in efficiency level correspond to profitability differences? A second set of regressions in Table 5 shows the relation between the rate of profit as a dependent variable and selected technological, informational and market characteristics of firms as independent variables. Again, the results are not very strong, this time especially in the case of the textile industry. In no case is there a significant, positive association between efficiency and profitability. In fact, the ceteris paribus association is generally negative, but insignificant. The only significant variable is exports as a percent of sales for the shoe industry. Surprisingly, the larger exporters tend to be less profitable. Perhaps the rapid growth in the industry, especially in the export market, has allowed inefficient firms to survive and even to grow. Alternatively, there might be problems with interpreting cross-section data. The exporters might not appear to be very profitable in the short run, either because they are expanding into

new markets or because they have not yet had time to adjust to a downswing in United States shoe imports.

No other variable coefficient is significantly different from zero at the five percent level, but their signs are worth noting. In both industries, large firms with high machinery productivity or long production run tend to be profitable. The more profitable shoe firms, ceteris paribus, are labor intensive and young while they are capital intensive and old in textiles. If only variables having to do with sources of information or managerial background are included in addition to the efficiency index, the quality of the equations is even poorer.

The equations as specified do not very successfully "explain" either efficiency or profitability, in spite of a few suggestive findings that large and perhaps labor intensive firms might be more efficient and that exporters are not necessarily more profitable. There could be several reasons for the weakness of these equations: the quality of the data, a misspecification of the form of the equation, a misspecification of the variables in the equation, or a basic lack of association between efficiency/profitability and the technological-financial-informational variables considered. Rather than try to separate out each of these explanations and, if necessary, reformulate the regression model, I have chosen to study efficiency or profitability differences among firms using another method. In a later chapter, I apply multivariate discriminant analysis to firms grouped according to their size, efficiency or profitability in an attempt to characterize the separate groups.

To conclude, regression analysis has not proved to be very useful in characterizing the significant differences among firms with respect to efficiency or profitability. This negative result should not, however, overshadow the apparent importance of the efficiency differences. X-inefficiency appears to be considerably larger than most traditional estimates of inefficiency due to misallocation of resources at a macro-economic level. Output in the shoe and cotton spinning industries could be increased by up to 85% if resources--most likely capital-- were fully utilized at the firm level.

Table 1

Farrell Efficiency Experiments: Variables Used

Textiles

Experiment 1: Value of sales on kilos of cotton consumed, number of openers and scutchers, number of carding machines, number of draw frames, number of roving machines, number of spindles, number of production workers.

Experiment 2: Value of sales on kilos of cotton consumed, number of openers and scutchers, number workers in opening room, number of carding machines, number of card operators, number of draw frames, number of draw frame operators, number of roving machines, number of roving machine operators, number of spindles, number of spinning frame operators.

Experiment 3: Value of sales on kilos of cotton consumed, kilo watt hours of electricity, number of production workers.

Shoes

Experiment 1: Value of sales on raw material purchases, kilo watt hours of electricity, number of production workers.

Experiment 2: Value of sales on raw material purchases, kilo watt hours of electricity, number of workers in lasting, number of other production workers.

Experiment 3: Value of sales on raw material purchases, kilowatt hours of electricity, number of workers in manual lasting, number of workers in mechanical lasting, number of other production workers.

Experiment 4: Value of sales on raw material purchases, book value of machinery, number of production workers.

Table 2

Farrell Efficiency Experiments: Rank Order Correlations Between Efficiency Indexes[1]

Experiment	Textiles				Shoes						
Textiles	1	1'	2	3	1	1'	2	2'	3	4	4'
1	1	.90**	.98**	.43*							
1'	.90**	1									
2	.98**		1	.38							
3	.43*		.38	1							
Shoes											
1					1	.95**	.90**		.31	.70**	
1'					.95**	1					
2					.90**		1	.76**	.35*	.71**	
2'							.76**	1			
3					.31	.35*			1	.29	
4					.70**	.71**			.29	1	.95**
4'										.95**	1

[1]The primed (') experiments are identical to the unprimed experiments except that those firms which were efficient in the unprimed experiments were omitted. Not all possible primed experiments were run because of the small number of observations.

**Significantly different from zero at the 1% level.

*Significantly different from zero at the 5% level.

Table 3

Farrell Efficiency Experiments: Potential Increase in Output (%)

Textiles	
Experiment 1	37%
Experiment 2	36%
Experiment 3	89%
Shoes	
Experiment 1	88%
Experiment 2	46%
Experiment 3	84%
Experiment 4	86%

Table 4
Characteristics of Efficient Firms[1]
(Efficiency index of first experiments as dependent variable)

Independent Variables	Shoes	Cotton Spinning
Sales	$.220 \times 10^{-4}$ (.750)	$.324 \times 10^{-4}$ (3.264)
Capital/Labor	$-.901 \times 10^{-4}$ (.569)	$-.251 \times 10^{-2}$ (1.54)
Age	$-.110 \times 10^{-2}$ (.322)	$.161 \times 10^{-2}$ (.533)
Administrative emp./Labor	-.122 (.339)	.145 (.315)
Exports/sales	$-.117 \times 10^{-1}$ (.768)	$.190 \times 10^{-2}$ (.032)
Production run	$.243 \times 10^{-4}$ (1.118)	
Productivity of cards		$.193 \times 10^{-2}$ (2.349)
Constant	.580	.285
R^2	.11	.60
No. of observations	32	22

1 t - statistics in parentheses.
Variables defined below.

Table 5

Characteristics of Profitable Firms[1]

Independent Variable	Shoes			Cotton Spinning		
Sales	$.100 \times 10^{-5}$ (1.04)	$.113 \times 10^{-5}$ (1.15)		$.192 \times 10^{-5}$ (.83)	$.344 \times 10^{-6}$ (.11)	
Capital/ Labor	$-.519 \times 10^{-6}$ (.10)	$-.103 \times 10^{-5}$ (.20)		$.114 \times 10^{-3}$ (.30)	$.236 \times 10^{-3}$ (.57)	
Age	$-.127 \times 10^{-3}$ (1.34)	$-.133 \times 10^{-3}$ (1.18)		$.645 \times 10^{-3}$ (.92)	$.567 \times 10^{-3}$ (.79)	
Admin. L/ Labor	$-.722 \times 10^{-3}$ (.06)	$-.141 \times 10^{-2}$ (.128)		-.152 (1.42)	-.159 (1.46)	
Exports/ sales	$-.150 \times 10^{-2}$ (3.00)	$-.157 \times 10^{-2}$ (3.08)		$-.489 \times 10^{-2}$ (.33)	$-.498 \times 10^{-2}$ (.34)	
Prod. run	$.738 \times 10^{-6}$ (1.03)	$.875 \times 10^{-6}$ (1.19)				
Productivity of cards				$.156 \times 10^{-2}$ (.82)	$.625 \times 10^{-3}$ (.28)	
Efficiency		$.564 \times 10^{-2}$ (.85)	$-.834 \times 10^{-3}$ (.11)		$.487 \times 10^{-1}$ (.80)	$-.547 \times 10^{-2}$ (.11)
Personal info./ sales			$.139 \times 10^{-1}$ (.04)			-24.117 (1.18)
Other info./ sales			-.303 (1.000)			-7.641 (.77)
Age of manager			$.556 \times 10^{-4}$ (.27)			$.109 \times 10^{-3}$ (.11)
Education of manager			$.104 \times 10^{-2}$ (.87)			$-.114 \times 10^{-1}$ (.86)
Constant	$.645 \times 10^{-2}$	$.972 \times 10^{-2}$	$.925 \times 10^{-4}$	$.150 \times 10^{-1}$	$.111 \times 10^{-2}$	.109
R^2	.36	.38	.09	.19	.22	.18
No. of observations	32	32	32	22	22	22

[1] t - statistics in parentheses

Definition of Variables for Tables 4 and 5

Variable	Definition
Sales	Value of all sales in Cr $1000, both industries;
Capital/Labor	KWH electricity consumer/total employment, in shoes; No. of spindles installed/total employment, in spinning;
Age	No. of years since plant installation, both industries;
Administrative emp/ Labor	Administrative personnel/production personnel, in shoes; Administrative personnel/total employment, in spinning;
Exports/sales	Value of exports/sales, both industries;
Production run	No. of pairs of shoes produced/model, in shoes;
Productivity of cards	No. kilos produced per hour, per carding machine, in spinning;
Profit rate	Profits/KWH electricity consumed, in shoes; Profits/spindles installed, in spinning;
Efficiency	Efficiency index from first Farrell experiment, both industries;
Personal info./ sales	Experience of other firms very important as a source of information for new machinery purchases/sales, both industries;
Other info/sales	More formal sources of information, such as journals and suppliers' representatives and fairs, very important for new machinery purchases/ sales, both industries;
Age of manager	Age of production manager, both industries;
Education of manager	Education of production manager, both industries;

Figure 1
Efficient/Inefficient Firms

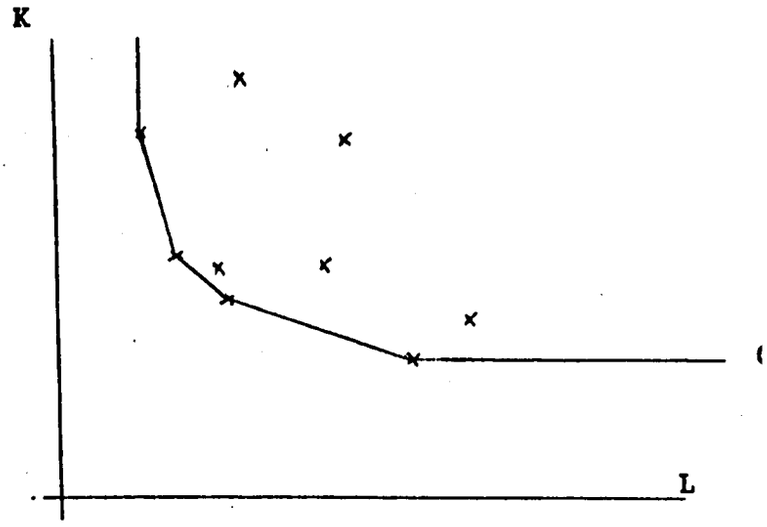


Figure 2
Definition of Inefficiency

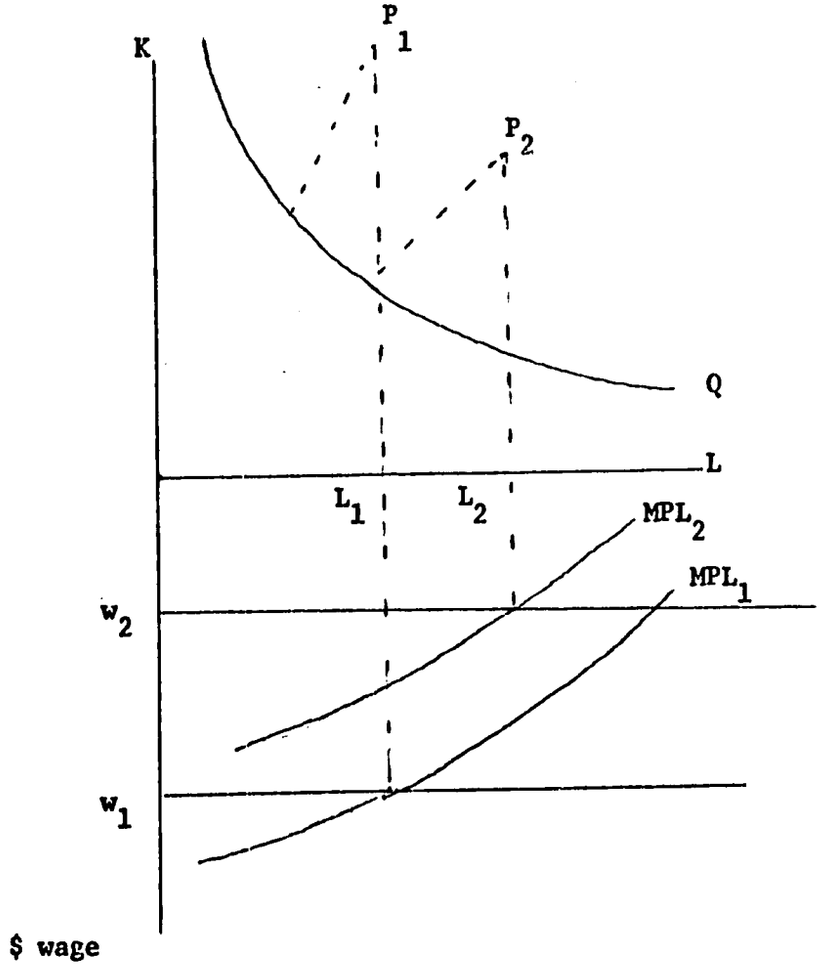


Figure 3
The Relation Between Efficiency and Profitability

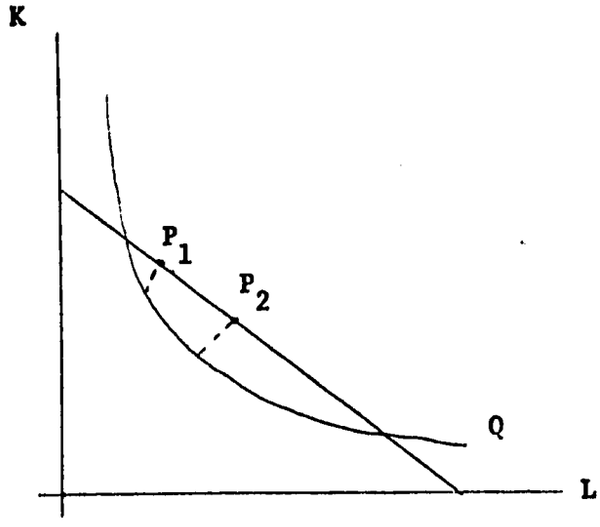


Figure 3a
Same Profitability; Different Efficiency

Figure 3b
Same Efficiency; Different Profitability

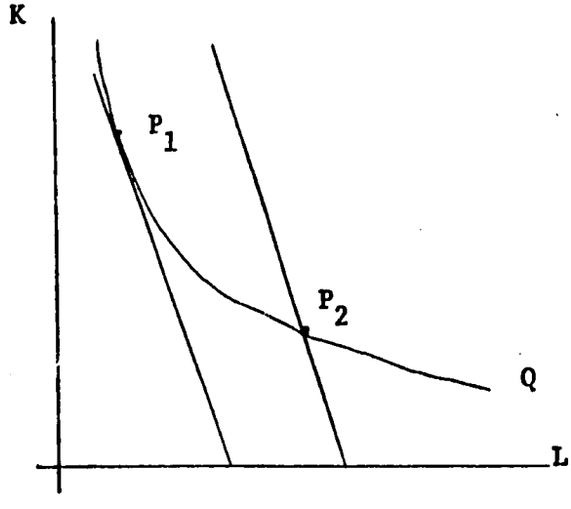
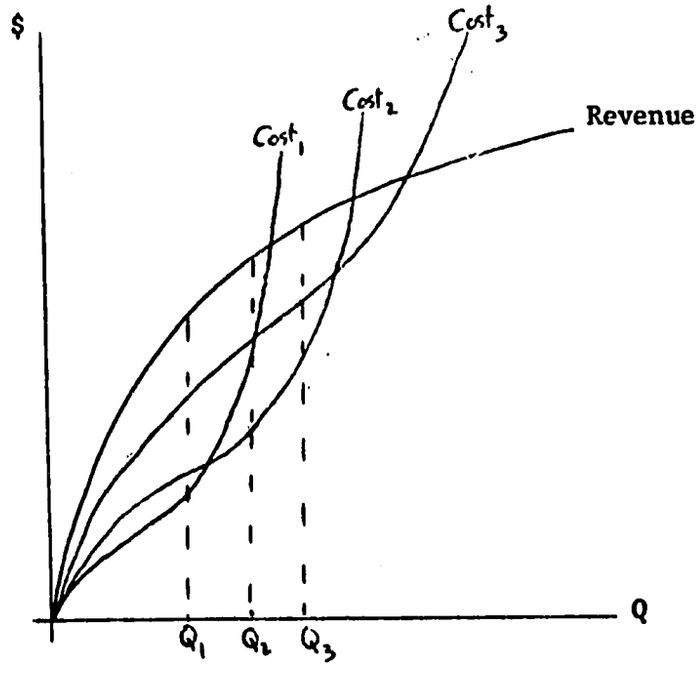


Figure 3c
Same Efficiency; Same or Differe
Profitability



Characterization of Firms in Different Size, Efficiency and Profitability Groups: Multiple Discriminant Analysis

Introductory Discussion

An earlier chapter in this monograph suggested that scale economies might not be purely technological but instead might also include advantages based on the marketing and financial operations of the firm. Simple estimates of two factor Cobb-Douglas production functions indicate greater scale elasticities when the dependent variable is the value of output or value added than when it is a physical quantity. In the case of the function estimated in value terms, scale economies could be derived from oligopolistic marketing advantages which increase the value of output. Similarly, cheap capital could decrease production costs below a competitive borrower's. When the production function is estimated with value added, firms having access to cheaper sources of materials produce greater value added from the same physical primary inputs. So long as product market oligopoly or factor market price advantages increase with scale of production, the industry will exhibit financial and market-based scale economies.

The goal of this chapter is to characterize in more detail firms in different size, efficiency or profitability groups, with special emphasis on distinguishing technological from financial aspects. The earlier analysis based on production functions required fairly rigid assumptions. Production function estimates typically assume continuous changes among firms as a function of scale. Whether the function is estimated in physical or value terms, there is supposedly a continuum of firms, some larger than others and some more capital-intensive. All firms are assumed to be technologically efficient. If this is so, a production function may capture the essential differences.

Perhaps, however, technological differences are significant in distinguishing the small from the medium and large firms, but not in distinguishing the large from the medium firms. Within the shoe industry, for instance, the minimum efficient scale of production might be reached by the medium size plant.

The differences between the large and medium-small firms, moreover, might best be characterized by marketing and financial market positions. The large firms (as distinguished from large plant) might have non-technological advantages: They have access to public and commercial bank credit; they can buy in large quantities at lower average prices; they can afford specialists in international marketing and maintain contacts in government offices; they can send representatives to national and international trade fairs etc. What distinguishes the large firms from the others might have little to do with the efficient running of their plants, but a great deal to do with their sources of information, contacts, credit and market facilities.

These scale advantages of large firms are partly due to the nature of being large. Large firms can spread risk, can afford specialists, can channel information from one branch to another. But partly, these advantages are man-made. Greater access to subsidized credit can only partly be attributed to lower risks and greater collateral. Government contacts are based on social patterns as well as non-discriminatory availability of public services. To the extent that marketing and financial characteristics are important in distinguishing large from medium firms, changes in government policy might limit these differences.

If technological differences separate the small firms from the others, and financial and marketing differences separate the large

firms, it would be a mistake to assume that all firms operate with the same technological information and a misspecification to force all firms onto the same continuous production function.

The approach taken in this chapter is to characterize groups of firms defined by their size, efficiency or profitability. In particular, I will test the following hypotheses: The first hypothesis is that firms can be clustered, and that the differences within the group are less significant than the differences among the groups. I will define three "representative" types of firms, whether measured by size, efficiency or profitability; I will then test whether these types are statistically distinguishable. If all firms operated in the same competitive markets with constant returns to scale technology, the hypothesis of these clusters would be rejected. Similarly, it would be rejected if the differences among firms were continuous, such that any choice of clusters would be arbitrary.

The second hypothesis is that the multidimensional differences among firms can, to a large extent, be summarized in two dimensions. Third, the two dimensional representation of differences among firms can be characterized as technological and marketing/financial differences. Perhaps the smallest and the least profitable firms differ from the larger and more profitable ones along the technological dimension. Perhaps the largest and the most profitable firms can be distinguished from the smaller and less profitable ones along the marketing/financial dimensions. Finally, these two dimensions can be related to the larger number of variables describing individual firm behavior. Of the original variables characterizing firms, those such as efficiency, capital intensity and share of non-production

labor etc. are important in defining the technological dimension. The debt-equity ratio, share of exports in total sales, access to foreign contacts etc. define the financial/marketing dimension.

The statistical tool used in this part of the monograph is multiple discriminant analysis. Each firm can be represented by a vector of characteristics, including technological, financial, marketing and informational variables. The question here is whether it is possible to reduce the multidimensional representation of firms into a two-dimensional representation, based upon linear combinations of the many firm characteristics. If the hypotheses presented here are upheld, one of the dimensions could be interpreted as technological. The other dimension would represent the financial, marketing and informational differences among firms.

Figure 1 illustrates the kind of representation that might come out of a multiple discriminant analysis.

First of all, the sample of firms is divided into three groups: small, medium and large firms. Second, each of these firms can be described precisely by a large vector of variables but might be characterized quite well by two linear discriminant functions of these variables. The first function might be primarily a linear combination of the technological variables and the second, a linear combination of marketing and financial variables. Figure 1 has on its axes the value of these two linear functions. Third, the small firms might be more like each other in terms of the discriminant function values than they are like either the medium or large firms. Similar statements can be made for medium and large firms. Fourth, in the case illustrated here, small firms are significantly different from medium and large firms in terms of the discriminant function which is being interpreted as a technological function. They are also significantly different from large firms in

terms of the function interpreted as representing the financial and marketing position of the firms, but not different from medium firms along this axis. Large firms differ significantly from medium firms only along the financial and marketing axis. The representative firm in each group, having average characteristic values, is illustrated with a circle.

The role of the original firm characteristics can be studied by writing out the linear discriminant functions, with the largest coefficients indicating the relative importance of the standardized variables. Alternatively, we could superimpose onto Figure 1 a vector for each characteristic, pointing toward that cluster of firms with a relatively large and significant average value associated with that particular characteristic.[1] These vectors would indicate, for instance, which group of firms is relatively capital intensive when the difference in intensity is significant. Such a procedure is illustrated in Figure 2, but will not be developed below, because of the small number of groups being studied.

A technical discussion of multiple discriminant analysis (MDA) can be found in C. R. Rao's Advanced Statistical Methods in Biometric Research, or W. W. Cooley and P. R. Lohnes', Multivariate Data Analysis, and will not be repeated here.

MDA is well suited for the problem discussed here. It provides tests of significance for the *a priori* placement of firms with multiple characteristics into several groups and derives the reduced number of orthogonal dimensions along which these groups differ significantly. It determines those characteristics of firms which enter (perhaps significantly) into

[1](See D.C.O. Alves, unpublished Ph.D. thesis, Yale University, 1976.)

the discriminant functions and which describe a large part of the difference in average characteristics across the groups of firms.

For the analysis to be valid and to obtain discriminant functions which are linear combinations of the discriminating variables, it is necessary to assume that these variables have a multivariate normal distribution with equal variance-covariance matrices in every group. The results, however, appear to be fairly robust and not very sensitive to these assumptions.

Formulating the Discriminant Analysis Tests

Discriminant analyses were run for two Brazilian industries separately, to test whether firms with many characteristics can be sensibly grouped into several size, efficiency or profitability categories. For each criterion, the firms were divided into three groups. We can then ask whether the groups differ along one or two dimensions, and try to characterize these dimensions according to the significance and relative importance of the discriminating variables entering into the functions. Finally, the discriminant functions can be used to classify all firms, whether previously classified or unclassified, into that group which it is most similar to. The percentage of firms correctly classified is a final check on the reliability of the whole procedure.

In addition to the Brazilian shoe and cotton spinning industries, I have looked at the Colombian shoe industry. Two sets of tests using the Colombian data -- one categorizing firms by size and the other by technology types -- will not be discussed here. The results will be available in a separate paper.

The Brazilian firms in each industry were classified into three size groups, using the same classification scheme as described earlier, in Chapter Two.

In the case of the efficiency criterion, an index was created, similar to that created for the size of firm. Firms were ranked according to the efficiency levels derived from several Farrell experiments. Firms that ranked consistently in all experiments among the lowest 33% were classified as least efficient. Those ranked consistently among the middle 33% were classified as medium efficient, etc. Where the rankings were not consistent from one experiment to another, the firms was classified according to my best judgement. The rankings for the individual experiments and the group classification are given in Tables 3 and 4.

Firms were also classified into high, middle and low profitability groups according to the level of profits as a percentage of kilowatt hours of electricity consumed in the case of the shoe industry, and the number of spindles installed for textiles. The a priori classification is given in Table 5.

The analysis was based on a set of n firm characteristics. In the first stage, this set was limited to technological variables. In the second stage, only informational-financial-commercial variables were used as discriminators. In the third, the technological variables as well as the additional informational-financial-commercial variables were included. Tables 1 and 2 give the complete list of variables used. The technological variables selected for the shoe industry are: capital/output, capital/total employment, non-production employment/production employment, age of the plant, average length of production run, a dummy variable for the use of foreign machinery, and the year in which the firm installed an automatic conveyor belt. Sometimes the firm's efficiency level and volume of sales were also included. The marketing-financial variables are: the number of years of

experience the production manager has had in the industry, the production manager's level of education, the percentage of sales for cash, the percentage of purchases for cash, the percentage discount that would be given if the sales were paid in cash rather than on sixty days credit, the number of types of personal sources of information that has been very important for the purchase of machinery relative to total sales, the number of formal sources of information that has been very important for the purchase of machinery relative to total sales, the number of fairs visited relative to total sales, debt/equity, and exports/total sales. The variables selected for the textile industry are similar, except that the average productivity of a carding machine replaces the length of production run, the number of spindles replaces the sales volume, and there are no variables for the use of foreign machinery or the percentages of sales and purchases for cash. Instead, the physical cotton use and the value of cotton use as a percent of output or sales are included.

The division between technological and financial-commercial variables is somewhat arbitrary. Clearly, the technological choices a firm makes will depend on the firm's financial standing and market opportunities. If, however, there is limited factor substitutability, or limited efficient processes, firms will differ more with respect to the financial, marketing and informational variables than they will with respect to pure technological process variables. In particular, the technological variables might be important in distinguishing small from medium and large firms, if the small firms have not reached the minimum efficient scale of production, but be relatively unimportant in distinguishing the large firms from the medium, which might use quite similar processes. If differences in factor prices and

access to financing, however, are the causes of technological differences observed, the correlation of the discriminating variables might result in only a few or none of the variables entering the discriminant function significantly.

Aside from the theoretical interconnections between technological and financial variables, there are sometimes simple definitional ambiguities.

An example of a variable whose classification is ambiguous is the age of the firm. Age could represent the machinery vintage, the firm's experience and some notion of learning by doing, or the extent of a firm's contacts, etc. Even if it turns out, therefore, that the age of the firm is a variable that discriminates well among the groups, the interpretation is not absolutely clear. I have tentatively called "age" a technological variable.

A second example of an ambiguous variable is the year of installation of a new process. Surely the production process or system of control changes, and therefore the year of installation could be called a technological variable. But, the process of diffusion requires information. This ambiguity becomes moot if the minimum firm scale associated with information networks is the same as that associated with the technological requirements of the new process. Again, I have tentatively classified the year of installation as a technological variable.

There are five general aspects of the discriminant analysis results that I will discuss, starting with the shoe industry. The first section presents the variables used in the discriminant analysis and covers the mean differences across size, efficiency or profitability groups of firm characteristics. The second discusses the significance of the discriminant functions

based upon technological variables, informational and market variables or both. The third graphs the centroids of each function. The fourth considers the variables entering the discriminant functions and attempts to characterize those functions. The final section gives the classification results, indicating how well the functions are able to predict the a priori classifications.

A. The Shoe Industry

1. Characteristic Mean Differences

For each defining criterion of the groups -- whether size, efficiency or profitability - three discriminant analysis experiments were made. The first analysis used only the technological variables as discriminators, the second used only informational-marketing variables, and the third used all the variables.

For each analysis, the mean values by groups of the discriminating variables were calculated for the sample of firms used in the analysis. The sample differed from analysis to analysis, since the number of firms without missing observations for the discriminating variables differed. Expecially where the sample was small, the mean values were sometimes unstable. In this case, the rank ordering of means was not always invariant for different sets of discriminating variables. Only the rank ordering and value of means for the largest available sample size is given in the accompanying Tables 6 and 7. In addition to the rank ordering of the characteristic means, those where the F ratio for the one-way analysis of variance is greater than 3.5 are indicated. The mean values are especially suspect for technological variables among small shoe firms. There are only two observations. The mean values given in Chapter Two are more reliable.

Several general comments can be made about the rank ordering of means. Changes in sample size result in fewer reversals of ordering for the technological than for the financial variables. In a one-way analysis of variance

test, the technological and financial variables have an equal number of mean differences with F ratios greater than or equal to 3.5 for both the efficiency and profitability classification. Even though there are more ambiguous classifications among the financial variables in the case of the size grouping, the financial mean differences are more likely to be significant than the technological mean differences. In a simple one-way analysis of variance test, therefore, technological variables appear to have a slight edge over the financial variables in discriminating among firms of different efficiency or profitability. The reverse is the case for firms of different sizes.

Before entering into a discussion of the discriminant analysis itself, it is worth describing the characteristic differences among firms, noting especially how the mean values and rank ordering for firm size relate to that for efficiency and profitability.

Of the technological variables, the most conventional are the capital-output and capital-labor ratios. Related to the capital-labor ratio are the administrative share of total personnel (a measure of the human capital intensity of production or of organizational hierarchy) and the use of foreign machinery. Related to the capital-output ratio are the indexes of efficiency and the length of production run, assuming a long production run allows a firm to use its capital stock more efficiently.

As in many other empirical studies, the data show the larger shoe firms are more capital intensive (higher capital-labor ratio).[1] They do not, however, appear to use a relatively higher proportion of human capital. The small firms have the highest share of administrative personnel. Consistant with

[1]Given the extremely small sample size of the small firms, only the comparison between medium and large firms is at all meaningful.

the large firms' capital intensity is their relatively great reliance on foreign machinery.

These empirical findings say nothing about the economic efficiency of large relative to small firms. The technically most efficient firms, however, do appear both to be more capital intensive and to rely on foreign machinery though by a smaller differential than with the size groupings. Now, however, the least efficient firms have the smallest share of administrative personnel.

The association of capital intensive and modern firms with efficiency is one that has often been noted by engineers but disputed by economists. The dispute could lie in the concepts considered rather than the facts. It is quite possible for the technically efficient firms to be relatively capital intensive but the most profitable firms, in a labor abundant economy, to be relatively labor intensive. This is, indeed, the case here. The most profitable shoe firms tend to be least capital intensive and use relatively less foreign machinery, though they employ a somewhat higher percentage of administrative personnel. There is not necessarily a correspondence between efficiency in production and profitability (or social efficiency to the extent that factor and product prices reflect shadow prices).

Production efficiency can be measured directly, as with the Farrell index, or indirectly. The indirect estimates used here are the capital use-output ratio and the length of production run. A low capital-output ratio can be taken as a sign of efficient production, though it might, of course, simply reflect a labor-intensive process. A firm with large average production runs can avoid down-time on machines, lowering the ratio of fixed capital

relative to output, though not necessarily the ratio of capital usage (kwh) to output.

As expected and frequently observed by others, large firms have a relatively high capital use-output ratio, associated with their high capital-labor ratio. But, they are apparently rather efficient, both in terms of the direct Farrell index and large production runs. If firms are ranked in terms of efficiency rather than size, however, the most efficient firms tend to be of middle size, with the largest average production run and the lowest capital use-output ratio.

If competitive conditions allow inefficient firms to survive, it is quite possible that the most profitable will not be the most efficient firms. It is reassuring to note, at least in the shoe industry, that the most profitable firms also have a significantly higher average efficiency index than either the medium or low profitability groups. They also tend to operate with long production runs and low electricity consumption relative to output. Their mean value of sales is in the middle range, though not very different from the larger firms of medium profitability. The least profitable firms tend to be small in terms of sales.

Summarizing the discussion of technological variables, the most efficient <u>and</u> the most profitable firms tend to be of middle size. The least efficient and least profitable tend to be small. One way to run either an efficient or a profitable firm might be to operate with long production runs and relatively little energy per unit output. It is also true that the more efficient and profitable firms tend to be young, while the largest firms tend to be old. While these similarities between efficient and profitable firms exist, there are important differences that might help explain the disagreements between economists and engineers. Efficient firms tend to be

capital intensive and greater users of foreign equipment. Profitable firms are relatively labor intensive and use relatively little foreign machinery.

It is also possible to compare firms' financial characteristics and sources of information across size, efficiency and profitability groups. While a comparison of the means of these variables is more confusing, still certain patterns are clear. The variables used can be classified under four headings: sources of information, capital markets, product markets, and managerial training.

Under the first heading, three general channels suggested in the literature have been included: personal contacts with other business managers; more formal channels such as trade magazines, catalogues and suppliers' representatives; trade fairs - all taken relative to the volume of sales. It turns out that neither the large, the efficient nor the profitable firms rely on either personal contacts or on fairs; even the use of the more formal channels is quite low in all three groups. One explanation could be that there are scale economies in the use of these informational channels.

Alternatively, the large, efficient and profitable firms might obtain information on technological processes by other means, such as through educated production managers, consultants and foreign travel.

The evidence on managerial training is mixed. The largest and most profitable firms employ experienced production managers. In the most efficient firms, however, the level of experience is the lowest. I also find that the largest and most profitable firms have managers with the most education. This is not true of the most efficient firms. Since the rankings are not monotonic and the mean differences are small, a simple interpretation is impossible. It

appears, however, as if large and profitable shoe firms employ experienced and relatively educated managers. Efficient firms do not. On the basis of a simple comparison of means, little importance should be given to the production manager's background. As in all this description based upon simple associations, no controls are imposed such as for firm size, making the evaluation difficult.

Several items are related to the firm's position in the capital market. The debt-equity ratio indicates the volume of credit and the discount rate offered buyers, along with the percentage of cash purchases and sales indicate the cost of credit. As expected, large firms have the highest debt-equity ratio, as do the most efficient firms. The ranking of the debt-equity ratio for the profitability groups coincides with their size ranking. From the available data it is impossible to determine whether the differences in debt-equity ratios observed are due to differential availability of credit or differential demand.

If capital markets were perfect and riskless, interest rates would not differ across groups. That is not the case here. The largest, most efficient and most profitable firms offer their customers the lowest average discount, reflecting their own low opportunity cost of money. The percentages of their purchases or sales in cash is difficult to explain, since they depend on the firm's own interest rate relative to the purchasers' or suppliers'. Large and efficient firms pay cash for a relatively large share of their purchases, presumably reflecting an interest rate lower than their suppliers'. The smallest, least efficient and least profitable firms, on the other hand, make the largest cash sales, as a reflection perhaps of their somewhat higher

rates relative to their customers'. What appears to be a surprise is the finding that the more profitable firms both buy and sell on credit. Possibly they operate on opposite ends of two quite separate markets: they extend credit to their customers who have a higher opportunity cost of money, and receive credit from their suppliers, who might be larger tanners with lower rates. This result is not altogether surprising if one thinks of the profitable firms as medium sized, and notes that they are not exporters. They are relatively young firms, producing for the domestic market, and do not yet have long lines of credit.

It has been repeatedly observed that large firms control most of the exports. It is not true, however, that the most efficient or profitable firms are exporters. The reverse is the case.

While many of the tendencies observed in this description of firms make sense, there has been no attempt to ask whether the groups are significantly different one from another, or to characterize the important differences. The remainder of the discussion of the shoe industry will focuss on the discriminant analysis (D.A.) results. I will use the D.A. to investigate these other areas.

Significance of the Discriminant Analysis

Discriminant analyses were run for firms classified according to size, efficiency and profitability. In each case, the analysis was done for three sets of discriminating variables: those with technological properties, financial and informational properties and both. Since firms were divided into three groups, two discriminant functions (D.F.) can theoretically be derived. Table 8 gives the significant discriminant functions derived for the shoe industry. Both functions discriminate significantly among the three

groups when all the variables are included. In five out of six of the other cases, only the first function is significant at the five percent level. It can, therefore, be concluded that the differences between the groups, whether classified according to size, efficiency or profitability, are greater than the differences within the groups. These differences can generally be summarized in one dimension.

Graphs of Group Centroids

Figures 3, 4, and 5 plot the D.F. centroids for each of the three classifications. The discussion of the centroid positions will focus on the significant discriminant functions. Even when the D.F. is significant and the differences between groups are greater than the differences within groups, the centroids might be lined up along a continuum. I will focus on those centroids where the isolation from the others is both statistically significant and large numerically.

When firms are grouped according to size, large firms are separated from the medium and small firms, using technological discriminators. Small firms are isolated when financial-informational variables are included. None of the efficiency groups are separated by a large absolute distance along the main axis, which is nonetheless significant. The spread is fairly continuous. The centroids of the profitability groups follow a pattern similar to the size classification case. High profit firms are separated from the others when the discriminating variables are technological. Low profit firms, on the other hand, are isolated when the financial-informational variables are used to discriminate.

Apparently, the technological cutoff when firms are classified by size or profitability occurs between the large (high) and medium groups. The cutoff

line for financial and informational characteristics separates the small (low) group from the others. While I cannot claim causality, the largest as well as the most profitable firms are isolated from the others by the technological discriminators. It is at the other end of the spectrum - the small and least profitable firms - where the financial and informational characteristics discriminate most. These findings go contrary to the hypotheses outlined at the beginning of the chapter, suggesting the technological differences might be greater between small and unprofitable firms and the others, while financial differences might distinguish the large.

Variables in the Discriminant Function

The financial-informational variables discriminate among the size groups more significantly than do the technological variables, whether the criterion for significant discrimination is the significance of the D.F.; the number of discriminating variables entering significantly; or the rank ordering of the discriminating variables in terms of their relative weights in the D.F. Specifically the D.F. using only financial-informational variables has a higher level of significance than does the function based on technological variables, though the probability of either function being obtained from a population which is not clustered into groups is very small. Also, in the function which includes all the variables, four of the financial-informational variables have "F to enter" values greater than 3.5, whereas none of the technological variables do. Similarly, the variables with the largest absolute except in the D.F. are financial and informational. In sum, while firms can be clustered according to their size on the basis of their technological characteristics, a clustering based on their financial and informational characteristics is more useful.

One can look only at the variables that enter the D.F. significantly. It appears that the relative unimportance of trade journals etc. as a source of information for large firms, combined with their low credit costs and large export shares are important in characterizing the differences between large, medium and small firms. Small firms are distinguished from medium/large firms (as seen on the graph of centroids) more by their market relations and by their sources of information and contacts, than by their technological processes.

The interpretation of the analysis based upon efficiency groupings is somewhat different. In this case, technological factors are better discriminators than the financial-informational, on all three criteria. When all the variables are included as discriminators, those with the largest, significant weights in the D.F.'s are the capital-output ratio, the capital-labor ratio and the use of foreign machinery. The most efficient firms, which the centroids graph shows are isolated along the second discriminant axis, are characterized by low capital/output, relatively high capital intensity and use of foreign equipment. That is, efficient firms appear to be modern.

The final analysis discriminates among firms according to their profitability. Both technological and financial-informational variables are important in distinguishing among the groups. If only technological variables are included, the most profitable group is isolated from the others along the first discriminant axis. That group's relatively high efficiency index and low capital-sales ratio distinguish it from the others. When only the financial variables are entered, and the least profitable group is segregated, that group's relatively great use of the formal information channels and large

share of sales for cash are important. When all the variables are entered, the technological discriminators are again most important in terms of their absolute effect in the D.F. The firm's credit market position, as measured by its interest rate, percent of purchases for cash and debt-equity ratio, also enters significantly, though of lesser magnitude. Like the case with only the financial characteristics entered, however, the least profitable group is isolated from the others.

In a standard theory of the firm, profit maximization requires technological efficiency, cost minimization and the appropriate choice of output levels. When firms do not all operate efficiently or in the same factor and product markets, there need be no systematic relation between profitability, efficiency and prices. It turns out, in the shoe industry, however, that the most profitable group of firms tends to operate efficiently and to charge lower interest rates when selling on credit. The least profitable group -- which is the group most different from the others -- is relatively inefficient technologically, has a low debt-equity ratio and a moderate interest charge. Not only does the least profitable group have the lowest average efficiency, but it is the smallest (though not significantly so). Recall that the financial and informational variables best discriminate among size groups and, in particular, isolate the smallest size from the remainder. It appears that financial characteristics might be even more important in discriminating among profitability groups if there were no multicollinearity.

One can note that it is the small and the least profitable but the most efficient groups of firms that have the greatest isolation of their centroids from the remaining groups. It is as if there is a qualitative difference in

efficiency between the most efficient, capital-intensive firms using foreign machinery, and the others. But efficiency alone does not imply profitability. The mere fact that the selected variables discriminate significantly among size groups suggests that firms operate in different markets and use different information networks. Profitability (or lack thereof) requires both efficiency, favorable markets and adaptation to markets. That small firms are most different from the others and probably operate in the least favorable markets is reflected in the least profitable group (of small firms) also being substantially different. The most efficient firms are of medium size; and the medium size firms have less access to credit and a higher opportunity cost of capital than the largest. Profits are determined by both efficiency and by access to credit.

Classification of Firms

The D.F.'s can be used to classify firms *ex post* into the size, efficiency or profitability groups. The percentage of firms classified "correctly", that is, in the same group as *ex ante*, is a measure of the procedure's reliability. Table 9 presents the classification tables for each of the three groups. Between 70 and 76% of the firms were correctly classified.

B. The Cotton Spinning Industry

The methods used to study the cotton spinning industry are the same as those used for the shoe industry. The organization of the following discussion will also be the same.

1. Characteristic Mean Differences

As a first attempt to understand the differences that exist among the groups, I will describe the mean differences of firm characteristics. Then I will discuss the ability and manner in which these characteristics statistically discriminate among the groups. Tables 10 and 11 present the values and rank order of the means of the discriminating variables.

Starting with groups selected according to size, it appears that the small firms (with one exception only) have either the highest or the lowest mean value of the various characteristics. That is, the small firms tend to be outliers. The medium and large firms alternate in being the opposing outlier. Among the firms classified according to efficiency, the least efficient again are the outliers. The most profitable, on the contrary, tend to have either high or low mean characteristic values.

The smallest firms tend to be relatively inefficient, in terms of the Farrell efficiency index, capital stock or capital use relative to output, and the productivity of the carding machines. They do, however, exhibit a slightly lower cotton-output ratio. They are relatively labor intensive and have a relatively high share of their labor force in non-production jobs. They tend to be young, and slow to introduce quality control devices such as the Ulster. Their production managers have both less experience and less education than average. And while they depend more on personal sources of information, they use the more formal channels, such as trade journals and machinery representatives, less. They export less than the other groups, and have the highest opportunity cost of money. Their expenditures on raw materials relative to sales are the highest among the three size groups, indicating either that they use relatively high quality cotton, or that they are unable to buy at a discount.

The least efficient firms, when firms are ordered according to the results of several Farrell experiments, have much in common with the smallest. This statement is perhaps not surprising, since the smallest turn out to have the lowest efficiency rating. The main differences are in the labor

force structure, the background of the production manager, and the debt-equity ratio. Unlike the smallest firms, which had the largest share of administrative employees, the least efficient have the smallest. Perhaps the high value for small firms is partly an artifact of data: the division of labor is less in small firms. The low value for technically inefficient firms could be more substantive, indicating a lack of control and organization. The production manager's experience and education both, are in the middle range, though the differences in education are too small to be of any importance. Finally, the low debt-equity ratio combined with the high discount rate offered to customers paying cash, suggests that the inefficient firms do not have access to capital for modernization, improvements or entrance into riskier markets.

To a large extent, the most profitable firms are a mirror image of the least efficient and small firms. There are, however, important differences. First, the ways in which the mirror image is reflected. The most profitable firms tend to be efficient by all criteria: the Farrell index; capital stock and capital use relative to sales (the latter is in the middle range); cotton usage relative to output; and output of the carding machines. They are, also, the largest in terms of the number of spindles installed explaining their relative capital intensity. They export relatively a lot and have cheap and abundant sources of debt relative to equity. But contrary to expectations, the mirror image is not always reflected. Like the inefficient firms, the most profitable are relatively young, as well as slow to introduce modern quality control equipment. Organizationally, they are not top-heavy with administrators. Whereas the physical use of cotton per unit output is low, the value of raw materials to sales is high, indicating perhaps a high quality cotton.

In summary, there is considerable similarity between the small and inefficient firms which themselves tend to be mirror images of the most profitable. Whereas the former tend to be labor intensive, the latter are capital intensive. Where the former have little access to capital and high opportunity cost of money, the latter have high debt-equity ratios and offer low discount rates. The former are more oriented towards the domestic market and the latter more towards exports. The former are influenced by personal contacts in their technology decisions and the latter are not.

There are characteristics that do not follow this pattern, however, and that are revealing. Neither the most profitable nor the least efficient firms put many employees into straight administrative positions. Neither employs highly experienced managers. Both tend to be young and to introduce quality control slowly, perhaps because they use higher quality cotton.

From the evidence presented here, there does not appear to be a conflict between size, efficiency and profitability. Since the correspondences are not exact, one should not assume that all small firms are inefficient and unprofitable or that all profitable firms are large and relatively efficient. More to the point, one cannot assume that all large firms are efficient and profitable, or that in order to be profitable, a firm must be large. To be profitable, a firm not only needs a certain level of technical efficiency, but also access to capital at low interest rates and the opportunity to sell in export markets. While these latter criteria might be functionally dependent on technical efficiency and size, they can be influenced by government policy. For instance, the technically most efficient firms are neither the largest nor the most capital intensive. Still, the most profitable firms are. It

could be that some firms' access to cheap capital allows them to grow and to be capital intensive. While size is associated with efficiency, and efficiency is associated with profitability, neither size nor efficiency guarantees profitability. The most profitable firms are not identical with the most efficient nor the largest. Perhaps, access to cheap capital and subsidies associated with exports guarantees their profitability.

Significance of the Discriminant Analysis

As is the case of the shoe industry, discriminant analyses were done for all the group classifications - size, efficiency and profitability. In each case, the discriminating variables were technological alone, financial-informational alone, or all combined. The significant D.F.'s are presented in Table 12. At least one out of the two possible discriminant functions derived using technological variables or all the variables together was always significant. Only one out of six functions based on the financial-informational variables was significant at the 5% level. The significant function occurred for a classification of firms by their efficiency levels.

One can conclude that the differences in mean characteristics between the groups are greater than the differences among firms within each group. In the terms of the significance of the discriminant function, the technological variables describe the size and profitability clusters better than do the financial-informational variables. The reverse is the case for the efficiency clusters.

Graphs of Group Centroids

Figures 6, 7, and 8 graph the centroids of the two discriminant functions in each of the three classifications. The discussion will focus on the statistically significant functions.

The graph of the centroids by size class is not very revealing. Along the dimensions of the significant function, the medium size firms are isolated from the others in two cases and the smallest are isolated in one case, along the secondary axis. There was no a priori reason to expect the medium firms to differ from the others. The separation of the smallest firms is consistent both with my hypotheses and with the characteristic mean differences described above.

When the firms are classified according to efficiency indexes, the least efficient firms are isolated from the others along the principle axis, just as they were in the study of characteristic means. This finding is true whether technological or financial-informational variables are the discriminators. When all the variables are included, the most efficient group is slightly set apart.

The centroid of the least profitable group of firms is isolated in the dimension of the second discriminant function, when technological variables only are discriminators. When all variables are included in the analysis, however, the most profitable group is separated. The discriminant function sometimes separates the least profitable group centroid and sometimes the most. The analysis of individual characteristic means separated the most profitable group. There is not necessarily a contradiction here, since the D.F. is that linear combination of firm characteristics that maximizes the differences between groups relative to the differences within groups.

The graphs of group centroids based on technological discriminators alone, indicate that the least efficient and the least profitable groups are separated from the others. In the only case, moreover, where a financial-informational D.F. is statistically significant, the conclusion still holds.

Only when all variables are included in the analysis do the most efficient and most profitable firms stand out. It is as if the technological or the financial-informational variables separately discriminate the least efficient and least profitable firms from the others. The combined effect, however, is to create a gap between the most efficient, the most profitable and the remainder.

Variables in the Discriminant Functions

A strength of multivariate discriminant analysis is that it collapses a many-dimensional characterization into one or a few dimensions which will best distinguish among observations from different groups. But this strength is also a weakness. The many characteristics of each observation are observable, even when their interpretation is open to question. A linear combination of these characteristics, however, is not observable. A discriminant function is just such a linear combination, a weighted sum of perhaps disparate characteristics. As a result, the function might be even more difficult to decipher than the original characteristics. Alternatively, the variables which are statistically significant and with large weights might follow some obvious pattern, allowing a simple description of the groups in terms of one or a few interpretable dimensions.

In the case of the cotton spinning industry, there is no obvious interpretation of most of the discriminant functions. In order to get a better handle on the problem, I have focussed on these variables which have a significant F-to-enter, which have relatively large weights in the D.F. and whose weights also work in the direction actually observed for the group centroid. For instance, I have focussed on those variables with average group values below the overall sample average, significant and large negative

discriminant function coefficients, and positive group centroids for the associated D.F.

The first general comment that can be made about the variables entering the discriminant functions has already been made: In the cases of size and profitability classification of firms, the financial-informational variables alone do not discriminate significantly among the groups. Only for a classification based on efficiency do these variables discriminate significantly at the 5% level and at least as well as the technological variables.

The hope is to go beyond these general statements and to describe size, efficiency or profitability differences among firms with reference to the discriminating variables. The description would be most illuminating if the D.F.'s with all variables entered into the analysis could be interpreted as representing either capital intensity, scale effects, information channels or access to capital markets, etc. That is, ideally the important variables in any single D.F. could be classed under one rubric. When there are two significant functions discriminating among the groups, one function might summarize the important technological differences and the other might summarize the financial differences.

The efficiency classification is the only grouping where financial variables appear to be important, looking at the significance of the D.F.'s. A close analysis, however, does not bear out this suggestion. Of the variables with large and significant weights in the comprehensive D.F. for the efficiency test, only kilowatt hours of electricity consumed relative to sales operates in the direction predicted by the centroid values. The

significant informational variables do not have the predicted sign. Even the function with only financial-informational variables included does not give strong support to the importance of these variables in distinguishing among efficiency groups. For the least efficient firms, however, it appears that their relatively high opportunity cost of credit and high cost of raw materials relative to sales contribute to their inefficiency. Once technological variables are included in the analysis, however, these marketing variables disappear and are replaced by a scale proxy. The technological capabilities of firms, of course, are not independent of their market choices and access to credit.

Predictably, the size differences among firms cannot so easily be described by technological variables, or financial variables mediated through technology. An explanation revolving around the firm's market or informational environment is needed to explain why firms are of different sizes, using different techniques. The results of the discriminant analysis are less easily summarized. Both of the comprehensive D.F.'s include scale effects (spindles or sales). In the principle D.F., large firms appear to be characterized by their capital intensity and high debt-equity ratio. Small firms are characterized by their youth. In the secondary function, the production manager's education is important in addition to scale. When only technological variables are included in the analysis, productivity and capital intensity are important discriminators. Apparently, access to capital (a high debt-equity ratio) allows firms to grow, to become capital intensive and relatively efficient. Since the small firms are significantly characterized by their youth, their lack of access to capital could be the result of inexperience.

This view is hard to support, however, since the average age of the small firm is over nineteen years (compared with thirty-two for the large firms).

Even though the picture is somewhat blurrier than for the efficiency breakdown, technological differences are important in characterizing size groups. Unequal access to capital, however, might be an important determinant of the technique chosen.

One would expect profitable firms to exhibit many of the characteristics of efficient firms, in addition to favorable factor or product market positions. To some extent, the evidence bears out this expectation. When only technological variables are in the analysis, efficiency measures - either the Farrell index or the consumption of electricity per sales - are significant discriminators. Both of these variables disappear, however, and are replaced by the opportunity cost of capital and exports when the non-technological variables are included. Once again, the cost of credit to a firm appears to substitute for the pure efficiency criteria.

Another significant variable with a large impact on the direction of the D.F. centroid is a diffusion variable. The year a firm introduces the Ulster quality control device can have several interpretations. On the one hand, it indicates a difference in technique among firms. Firms using high quality raw material may do without the quality control equipment. Others produce for a mass market without high quality control standards. But on the other hand, the introduction of the Ulster could reflect different managerial attitudes and different financial considerations. Firms slow to introduce the Ulster, such as the most profitable firms, could adopt a wait-and-see attitude and correctly resist premature modernization.

The most profitable group of firms is large, efficient, and relatively capital-intensive. While each of these characteristics significantly discriminates among the profitability classes of firms, it would be a mistake to conclude that all large firms, or all efficient firms or all capital-intensive firms will also be profitable. In addition to technological efficiency, a firm must operate in a favorable environment if it is going to make profits. In the case of the textile industry, for instance, the most efficient firms are not very capital-intensive. Something important is happening which results in the most efficient firms being moderately labor-intensive, and the most profitable being capital-intensive. Whereas the cost of capital does not even appear as a discriminator in the comprehensive D.F. for the efficiency grouping, it is the most important discriminator for the profitability analysis. It takes more than efficiency to be profitable.

Classification of Firms

As seen in Table 13, the D.F.'s correctly classify firms between 65 and 93% of the time.

Comparison of the Two Industries

The D.F. does not unambiguously determine the causes of a firm's profitability. It does, however, allow a characterization of firms by those variables that significantly discriminate among different profitability groups. It supports the view that firms do not all operate in the same perfect markets, with the same efficiency or techniques of production, or with the same responsiveness to new methods. The simplest of traditional models would predict identical firms, or firms which are identical in all important respects. A somewhat more complicated, but still standard, model

would have competitive firms operating in segmented markets with different factor costs and different market outlets. But even in this more complicated model, there is no a priori prediction of which kinds of firms will be most profitable. For instance, higher labor costs in one market could offset the lower cost of capital and the subsidies available to exporters. But this study does not show a random pattern among either the shoe or the textile firms. In both industries, firms can be classified according to whether they have high, medium or low profit rates. Classified in this way, the differences among firms within each group are significantly less than the differences among the groups. The linear function of firm characteristics that maximizes the differences among groups relative to the differences within groups includes both technological and financial variables. The form of the function and the relative importance of the discriminators is, of course, different from one industry to another. There is no reason to expect the same variables to appear for industries with different technological problems, different historical experience and different market structure. What is important to note, however, is the existence of segmented markets and the lack of competitive behavior within the submarkets. In each industry, financial and marketing variables discriminate significantly among the groups. The firms do not all have the same access to capital, at the same cost, or export to the same degree. And in each case, efficiency levels discriminate. That is, even within the segmented markets, competition does not necessarily force firms to operate efficiently.

Perhaps the most general and most important conclusion that one can draw from the study is the necessity of industrial studies. Each sector has

its own historical background and technological problems. More specifically, it appears that lack of competition within and between markets allows firms of different efficiency levels and profitability to survive.

The characterization of the efficient and profitable firms across industries, however, might not be identical. In both the shoe and the cotton spinning industries, the more profitable firms are also more efficient. These firms tend to be large and capital-intensive in the textile industry, but medium to large sized and labor-intensive in the shoe industry. The former have access to credit at low interest rates and export their products; the latter also have a low cost of capital though they do not export.

The profits discussed here are private profits, based on the firms' stated factor costs and product prices, rather than social profitability derived from shadow prices. I have not attempted any estimates of social profitability, which would require very detailed measures of physical machinery and labor skills. Instead, I have a comparison of firms with varying levels of technological efficiency. One cannot argue that the technologically more efficient firms are also socially more efficient. Technological efficiency, however, is a necessary though not sufficient condition for social efficiency. Moreover, in a world of imperfect competition, those firms which are using a socially appropriate technique of production might not be forced to operate efficiently. Similarly, the sample firms which appear to be relatively efficient might not be those using the most appropriate techniques. Still, it is possible that the firms which appear to be inefficient in the sample are using outmoded techniques and could never operate efficiently. This latter interpretation gives a prime motive for characterizing firms by their current

efficiency levels. Even if it should turn out that the most efficient firms in the sample are not using socially efficient techniques of production, in the short run these same firms could be producing at lower social cost than the others.

The most efficient textile firms tend to be in the middle rank for size, capital intensity, age, speed of diffusion, opportunity cost of capital, and cost of raw materials relative to sales. The efficient shoe firms are somewhat different. They are also medium size, and speed of diffusion, but tend to be young, capital intensive, users of foreign machinery, with a high debt-equity ratio and a low cost of capital. While the shoe industry might support an engineer's love of the modern, the older textile industry does not. But even this picture of the modern, efficient shoe firm is not altogether what one would expect. The most efficient shoe firms, like the most profitable, tend not to export. They do not rely on educated and experienced production managers or quickly introduce conveyor belts.

The differences between the efficient and the profitable firms is interesting and not altogether predictable. For the shoe industry, the most surprising finding is the relative capital-intensity and reliance on foreign machinery of the efficient firms but the labor-intensity and relative absence of foreign machinery among the most profitable. At least in this sample of firms, the more capital-intensive efficient firms do not use experienced managers while the labor-intensive profitable firms do. The changes are not so dramatic for the textile industry, though they work in the opposite direction. The more profitable firms are the <u>most</u> capital-intensive group, with a low share of administrative personnel. The

efficient firms seem to be both less capital-intensive and to rely on a relatively larger share of administrative personnel.

Conclusion

From all this discussion one conclusion is clear. It is not possible to generalize from one industry to another. But I will make a few summary and often agnostic comments. Large firms are not always efficient and profitable, nor are small firms. Firms using capital intensive production methods are sometimes efficient, sometimes not. Exporters are not always forced to be competitive, especially in an industry experiencing active export promotion policies. Managerial background-experience, education and sources of information - can be used to characterize efficiency or profitability differences among firms, but appear to be less important than either technological processes or access to capital.

One should be warned against assuming that "small and labor-intensive is beautiful." Sometimes labor-intensive firms in the samples are profitable, but never do they appear to be efficient. And never do the smallest firms appear to be either efficient or profitable. The contemporary hope that encouragement of small, labor-intensive firms will simultaneously improve social efficiency, employment and the distribution of income cannot be supported on the basis of this evidence. This is not to say that the hope is wrong. It does, however, require a closer look at the institutional surroundings. The access to capital at relatively low cost clearly increases the observed profitability, no matter what the technological efficiency of a firm. Government policies, and the historical pattern of growth might not have encouraged the development of new, small-scale techniques, or favored the introduction of the available ones. All one can say with any certainty is that the existing small firms do not appear to compete effectively with the larger firms.

Capital markets should be integrated to allow firms of different sizes access at the same rates. Such a reform might require cooperative pooling of risks by the smaller firms. But even integrated capital markets will not help the smaller firms if they are in fact less efficient. Since this seems to be the case, the smaller firms will have to not only pool their financial resources but their physical capital to take advantage of scale economics.

Table 1

Variables Used in Discriminant Analysis: Shoes

Variable Name	Description
KWH/sales	Kilo watt hours of electricity consumption per Cr $ sales
KWH/L	Kilo watt hours of electricity consumption per employee
A/L	Administrative employees/production employees
Age	Years since installation of plant
Production run	Pairs of shoes produced/model
Foreign machinery	1 if the firm uses foreign machinery; 0 otherwise
Year of belt	Year in which firm introduced mechanical conveyor belt
Efficiency	Farrell efficiency index (value = 1 if efficient, 0 if no output)
Sales	Total sales Cr $
Experience	Years of experience in industry of production manager
Education	Education of production manager: 1 if illiterate; 2 if primary school; 3 if junior high school; 4 if high school; 5 if university; 6 if graduate work
Cash sales	Percent of sales for cash
Cash purchases %	Percent of purchases for cash
Discount	Discount given if cash sale, %
Personal info./sales	1 if experience of other businessmen is very important in selection of equipment; 0 otherwise (per Cr $ sales)
Info./sales	ΣD_i/sales where $D_i = 1$ if suppliers' catalogues, suppliers' representatives, national fairs, international fairs, or technical journals is very important in selection of equipment
Debt/equity	Short term plus long term debt/equity capital of firm
Exports/sales	Value of exports/sales
Fairs/sales	No. of fairs visited in 1976/sales Cr $

Table 2

Variables Used in Discriminant Analysis: Textiles

Variable Name	Description
Spindles/sales	Number of spindles installed/sales Cr $
Spindles/L	Number of spindles/total employees
A/L	Administrative employees/total employees
Age	Years since installation of plant
Prod. of card	Average production in kg. per hour of carding machine
Years of Ulster	Years since installation of Ulster quality control device
KWH/sales	Kilo watt hours of electricity consumed/sales Cr $
Cotton/output	Kg. consumption of cotton/kg. yarn output
Spindles	Number of spindles installed
Efficiency	Farrell efficiency index (value = 1 if efficient, 0 if no output)
Experience	Years of experience in industry of production manager
Education	Education of production manager (see Table 1 for values)
Discount	Discount given if cash sale, %
Personal info./ sales	1 if experience of other businessmen is very important in selection of equipment; 0 otherwise (per Cr $ sales)
Info./sales	Number of formal information channels that are very important in selection of equipment/Cr $ sales (see Table 1 for types)
Export/sales	Value of exports/sales
Value of raw materials/ sales	Value of raw material purchases /sales
Debt/equity	Short term plus long term debt/equity capital of firm

Table 3

Shoes: Efficiency Ranks from Farrell Experiments and A Priori Classification*

Firm	A Priori Efficiency Group	Farrell Experiment 1	2	3	4
1	Low	5	5	5	3
2	Medium	3	4		
3	L	5	5	5	2
4	M	4	3	3	2/1
5	L	3	5	4	4
6	L	5	4	4	2/1
7	M	4	3	3	2/1
8	L	4	4		
9	L	5	4	5	5
10	M	3	2		
11	H	1	1		
12	H	2	2	2	3/1
13	M	4	3	4	2
14	H	2	2	2	3
15	H	1	1		
16	H	1	3	1	2/1
17	M	2	3		
18	M	3	2	2	5
19	H	2	2	1	2/1
20	M	3	4	4	4
21	H	2	1		
22	H	1	1		
23	M	3	3		
24	H	1	1	1	2/1
25	H	2	1	1	5
26	L	5	5		
27	L	4	4	2	4
28	H	1	3		
29	L	5	5		
30	M	5	2	3	2/1
31	M	2	5		
32	H	2	2		
33	M	4	3	4	2
34	L	1	5		
35	L	5	5	5	3
36	M	3	4		
37	L	3	4	3	4
38	L	5	5	5	5
39	H	2	1	1	2/1
40	H	1	4	1	2/1
41	M	4	3	3	4
42	M	4	3	4	2/1
43	L		4		
44	M	3	2	2	5
45	H	2	1	2	3
46	M	3	2	3	2/1
47	L	5	1	5	4
48	M	4	2	3	2
49	L	4	5	5	5
50	H	1	1	1	2/1

*The variables entering the Farrell experiments are given in the chapter "The Determination and Characterization of Efficient Firms." Rank = 1 if the efficiency index was among the top 20%, 2 if among the next 20%, etc.

Table 4

Textiles: Efficiency Ranks From Farrell Experiments and A Priori Classification*

Firm	A Priori Efficiency Group	Farrell Experiment 1	2	3
1				
2	Low	4		5
3	Medium	3	3	
4	High	1/2	1/2	1
5	M	1/2		3
6				
7	M	4	5	1
8	L	4	4	4
9				
10				
11	L	4		5
12	H	2	2	1
13	L	5	5	4
14	L	5		3
15	H	1/2	1/2	5
16				
17	L	4		3
18	M	3	4	1
19				
20	M	4	4	1
21	M	3	3	2
22				
23	L	4		
24	M	3	3	4
25	H	1/2	1/2	1
26				
27	H	1/2	1/2	
28	L	5	5	5
29	H	2		1
30	H			2
31	M	3	4	2
32	M	1/2		4
33	H	1/2	1/2	3
34	H	1/2	1/2	1

*The variables entering the Farrell experiemnts are given in an earlier chapter. Rank = 1 if the efficiency index was among the top 20%, 2 if among the next 20% etc.

Table 5

A Priori Profitability Classification: Shoes and Textiles

Firm	Shoes	Textiles
1	Low	
2	High	L
3	L	H
4	Medium	M
5	L	M
6	L	
7	L	H
8	L	H
9	M	
10	H	
11	H	M
12	M	H
13	M	M
14	H	M
15	H	H
16	H	
17	H	L
18	M	L
19	L	
20	M	M
21	M	H
22	H	M
23	H	M
24	H	M
25	H	L
26	L	L
27	M	L
28	H	L
29	L	H
30	L	M
31	M	L
32	L	H
33	M	H
34	L	L
35	L	
36	M	
37	M	
38	L	
39	L	
40	H	
41	M	
42	M	
43		
44	L	
45	H	
46	H	
47	M	
48	M	
49	L	
50	M	

Table 6

Shoes: Rank Order of Means of Discriminating Variables[1]

Group Criterion \ Variable	Sample Size Tech.	Sample Size: All	Sample Size: Financial	KWH/Sales	KWH/L	A/L	Age	Prod. runs	Foreign Mach.	Yr. of belt	Eff.	Sales	Exp.	Ed.	Cash/Sales	Cash purch	Dis-count	Pers. Info./Sales	Info/Sales	Debt/Equity	Exp./Sales	Fairs/Sales
Size																						
Large	12	11	12	1	1	2*	1*	1	1	2	1		1	1	2*	1	3	3*	3*	1*	1	3*
Medium	17	12	15	2	2	3*	3*	2	2	1	2		2	2	3*	2	2	2*	2*	2*	3*	2*
Small	2	1	6	3	3	1*	2*	3	3	3	3		3	3	1*	3	1	1*	1*	3*	2	1*
Efficiency																						
High	9	8	10	3	1	2*	3	1	1	2		2	3	2	3	1	3	3	2*	1	3	3
Medium	11	8	11	2	2	1*	2	2	2.5	3		1	2	3	2	3	1	2	3*	2	2	2
Low	11	8	12	1	3	3*	1	3	2.5	1		3	1	1	1	2	2	1	1*	3	1	1
Profitability																						
High	9	8	12	3*	3	1	3	1	2	2	1*	2	1	1	3	3	3	3	2*	2	3*	3
Medium	13	9	12	1*	1	2	2	3	3	1	2*	1	3	2	2	2	1	2	3*	1	2*	2
Low	9	7	8	2*	2	3	1	2	1	3	3*	3	2	3	1	1	2	1	1*	3	1*	1

1 = highest value of mean; 2 = middle value; 3 = lowest value

The mean is always given for the largest sample available in each group.

*$F \geq 3.5$

Table 7

Shoes: Mean Values of Firm Characteristics, by Size, Efficiency and Profitability Groups

Variable / Group Criterion	Size			Efficiency			Profitability		
	Large	Medium	Small	High	Medium	Low	High	Medium	Low
KWH/sales	91.3	77.4	73.8	69.6	85.4	90.3	58.4	92.6	92.2
KWH/L	601.1	512.8	278.5	590.5	575.6	440.2	462.2	596.9	507.6
A/L	.09	.08	.12	.09	.10	.08	.10	.09	.08
Age	20.8	10.3	16.5	13.4	14.5	16.2	11.7	13.4	20.0
Prod. run	1543	360	60	1688	436	433	1478	514	530
Foreign mach.	.50	.29	.0	.56	.27	.27	.33	.31	.44
Year of belt	71	72	69	72	71	72	72	72	71
Efficiency	.55	.54	.44				.66	.52	.43
Sales				1316	1891	571	1117	1185	892
Experience	15	14	10	12	13	16	17	10	14
Education	3.8	3.6	2.5	3.5	3.3	3.7	3.5	3.5	3.3
Cash sales %	20	18	56	18	24	34	17	24	35
Cash purchases %	20	7	5	16	5	12	6	13	15
Discount	9.0	10.1	11.8	9.6	10.2	10.2	9.7	10.5	9.9
Personal info/sales	.0003	.0007	.0085	.0006	.0018	.0033	.0006	.0020	.0031
Info/sales	.0007	.0015	.0102	.0007	.0006	.0065	.0012	.0004	.0061
Debt/equity	.909	.798	.333	.958	.698	.634	.733	.881	.651
Exports/sales	.19	.04	.14	.08	.09	.15	.03	.07	.20
Fairs/sales	.0021	.0028	.0146	.0023	.0051	.0063	.0027	.0039	.0071
no. of observations	12	15	6	10	11	12	12	12	8

Table 8

Shoes: Discriminant Functions[1]

Discriminating Variables	Discriminating Groups: Size					Efficiency				Profitability			
	1	2	2'	3	3'	1	2	3	3'	1	2	3	3'
KWH/sales						1.08		-.00	1.27	-.53*		1.20*	-1.02
KWH/L	-.28					-1.12*		.64*	-1.19*			-.62	-.07
A/L	-.25					-.22		-.73*	.12*				
Age	-.75*			.14	-.39					-.28			
Prod. run	-.44			-.02	-.37	-.22		-.45	-.40				
Foreign mach.						-.25		-.66*	-.53*	-.13			
Yr. belt				.18	-.09			-.17	-.26				
Efficiency										-.64*		-1.20*	.38*
Sales						.29	-.56	-.21	.37				
Experience				.18*	.13*						.19		
Education							.38					-.31	.14
Cash sales %							.61				-.80	-.49	.38
Cash purchases %							.20	-.24	.09		-.32	-.88*	.13*
Discount for cash				-.34*	.04*		-.31				.43	.49*	-.77*
Personal info./sales				.09	.40			-.36	-.18		.51		
Info./sales				-1.10*	.35*		1.07*	-.99	-.36		-.84*		
Debt/equity				-.01	.38		.18	-.57	-.22			-.56*	-.17*
Exports/sales		.26*	.98*	.22*	-.79*			.44	-.04		-.44	-.72	.31
Fairs/sales		1.01*	-.09*				-.78					-.25	-.25
p	.03	.00	.05	.00	.01	.00	.01	.00	.01	.00	.04	.00	.01

* F-to-enter ≥ 3.5

[1]The significant D.F.'s are recorded, for $p \leq .05$

Table 9

Shoes: Classification of Firms into Groups (%)

Actual/Predicted	Size Large	Size Medium	Size Small	No. of cases
Large	78.6	21.4	0.0	14
Medium	9.5	90.5	0.0	23
Small	6.7	60.0	33.3	15

Percent of "grouped" cases correctly classified: 70%

	Efficiency High	Efficiency Medium	Efficiency Low	
High	87.5	0.0	12.5	16
Medium	16.7	72.2	11.1	18
Low	25.0	6.3	68.8	16

Percent of "grouped" cases correctly classified: 76%

	Profitability High	Profitability Medium	Profitability Low	
High	93.3	0.0	6.7	15
Medium	17.6	58.8	23.5	17
Low	5.9	23.5	70.6	17

Percent of "grouped" cases correctly classified73.5%

Table 10

Textiles: Rank Order of Means of Discriminating Variables[1]

Group Criterion \ Variable	Sample size: tech.	Sample size: all	Sample size: financial	SPN/Sales	SPN/L	A/L	Age	Prod. Cards	Yrs. of Ulster	KWH/Sales	Cotton Output	SPN	Eff.	Exp.	Ed.	Dis-count	Pers. info./sales	Info./Sales	Export/Sales	Value raw mats./sales	Debt/equity
Size																					
Large	8	6	7	2	1*	2	1	2	1	2	1.5		1	2	1*	3	2	2.5	1	2	1
Medium	8	3	5	3	2*	3	2	1	2	3	1.5		2	1	2*	2	3	1	2	3	3
Small	5	2	3	1	3*	1	3	3	3	1	3		3	3	3*	1	1	2.5	3	1	2
Efficiency																					
High	8	6	7	3*	2	1	2	2	2*	3*	1	2		1	3	2*	2.5	2.5	1	2	1
Medium	7	3	4	2*	1	2	1	1	1*	2*	2	1		3	1	3*	2.5	1	2	3	2
Low	7	3	3	1*	3	3	3	3	3*	1*	3	3		2	2	1*	1	2.5	3	1	3
Profitability																					
High	8	5	6	3	1	3	3*	1	3*	2	3	1	1	2	3	3	2.5	2	1	1	1
Medium	7	2	3	2	3	2	2	2	1*	3	1	3	2	1	1	2	2.5	3	3	2	3
Low	6	4	5	1	2	1	1	3	2*	1	2	2	3	3	2	1*	1	1	2	3	2

[1] 1 = highest value of the mean; 2 = middle value; 3 = lowest value.
The mean is always given for the largest available sample in each group.

* $F \geq 3.5$

Table 11

Textiles: Mean Values of Firm Characteristics, by Size, Efficiency and Profitability Groups

Variable \ Group Criterion	Size			Efficiency			Profitability		
	Large	Medium	Small	High	Medium	Low	High	Medium	Low
Spindles/sales	5.0	4.4	6.8	3.6	4.6	7.2	4.3	5.0	6.5
Spindles/L	86.9	53.3	35.3	57.4	85.3	45.0	65.6	55.1	64.6
A/L	.14	.12	.15	.17	.12	.11	.07	.14	.22
Age	32	31	19	28	32	25	24	30	32
Prod. of cards	11.8	17.8	9.0	15.3	16.4	8.7	14.4	13.4	12.0
Years 6f Ulster	10.0	6.1	0	5.6	11.1	1.3	3	11	4
KWH/sales	.79	.79	.89	.48	.59	1.39	.74	.52	1.26
Cotton/output	.0011	.0011	.0010	.0012	.0011	.0010	.0010	.0012	.0011
Spindles				29536	33659	11799	33536	19866	21127
Efficiency	.77	.74	.39				.81	.60	.57
Experience	11.3	15.7	10.9	15.0	8.5	13.3	13.7	18.3	9.3
Education	4.7	4.7	3.7	4.3	4.8	4.5	4.3	4.8	4.4
Discount	4.5	4.8	6.7	4.8	4.0	7.3	4.3	4.3	6.2
Personal info./ sales	.0001	0.0	.0008	0.0	0.0	.0009	0.0	0.0	.0004
Info./sales	.0002	.0004	.0002	.0002	.0003	.0002	.0002	.0001	.0003
Exports/sales	.25	.17	.16	.23	.15	.12	.23	.14	.14
Value raw materials/sales	.78	.25	1.06	.52	.43	1.38	1.37	.30	.29
Debt/equity	2.46	.98	1.39	2.23	1.51	1.17	2.17	.80	1.98
No. of observations	8	8	5	8	7	7	8	7	6

Table 12

Textiles: Discriminant Functions[1]

Discriminating Variables	Size				Efficiency			Profitability		
	1	1'	3	3'	1	2	3	1	1'	3
Spindles/sales	.216	.471	.654*	-.617*				.246	-.492	.650*
Spindles/L	.728*	.377*	1.180*	.173*				.526*	-.476*	
A/L	-.049	.585						-.169*	-.776*	.112
Age	.203	-.583	-.701*	.260*			-.544			-.363*
Prod. of cards	-.379*	-.868*			.441					
Years of Ulster					.283*		1.104	-.914	.575	-.776*
KWH/sales					-.500		1.762*	-.008*	-.570*	
Cotton/output								-.396*	-.434*	
Spindles					.414		-.329			-.123*
Efficiency	.853*	.202*						.898	-.158	
Experience			.142*	-.258*		.304*	-.523			
Education			-.393*	.814*		.354*	.497			
Discount for cash						1.232*				-1.242*
Personal info./ sales						-.226	-.293*			-.146
Info./sales			.066	-.130		.216	-1.088*			
Exports/sales			-.385*	-.012*						.317*
Value raw mat./ sales						.709*				
Debt/equity			.678*	.038*			.015*			
P	.006	.036	.000	.000	.037	.003	.000	.000	.012	.000

* F to enter $\geq$ 3.5

[1] The significant D.F.'s are recorded, where P $\leq$ .05

Table 13

Textiles: Classifications of Firms into Groups (%)

Actual/Predicted	Size: Large	Medium	Small	No. of cases
Large	80.0	20.0	0.0	10
Medium	13.3	80.0	6.7	15
Small	11.1	33.3	55.6	9

Percent of "grouped" cases correctly classified: 73.5%

	Efficiency: High	Medium	Low	
High	55.6	33.3	11.1	9
Medium	44.4	55.6	0.0	9
Low	12.5	0.0	87.5	8

Percent of "grouped" cases correctly classified: 65.4%

	Profitability: High	Medium	Low	
High	100.0	0.0	0.0	9
Medium	0.0	100.0	0.0	10
Low	11.1	11.1	77.8	9

Percent of "grouped" cases correctly classified: 92.9%

Figure 1

Plot of the Discriminant Scores

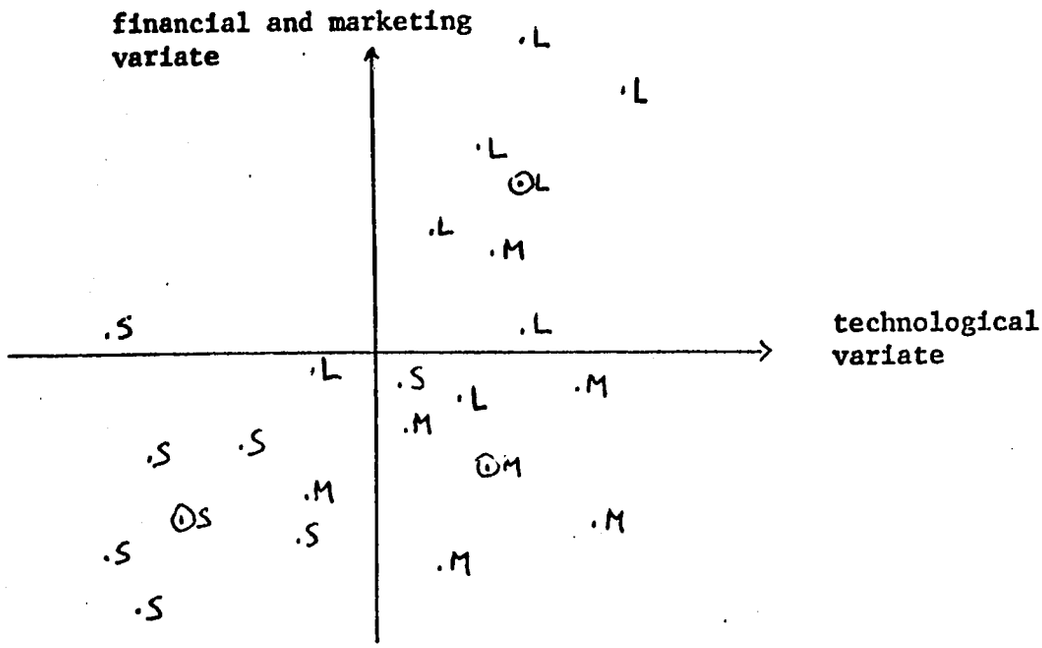
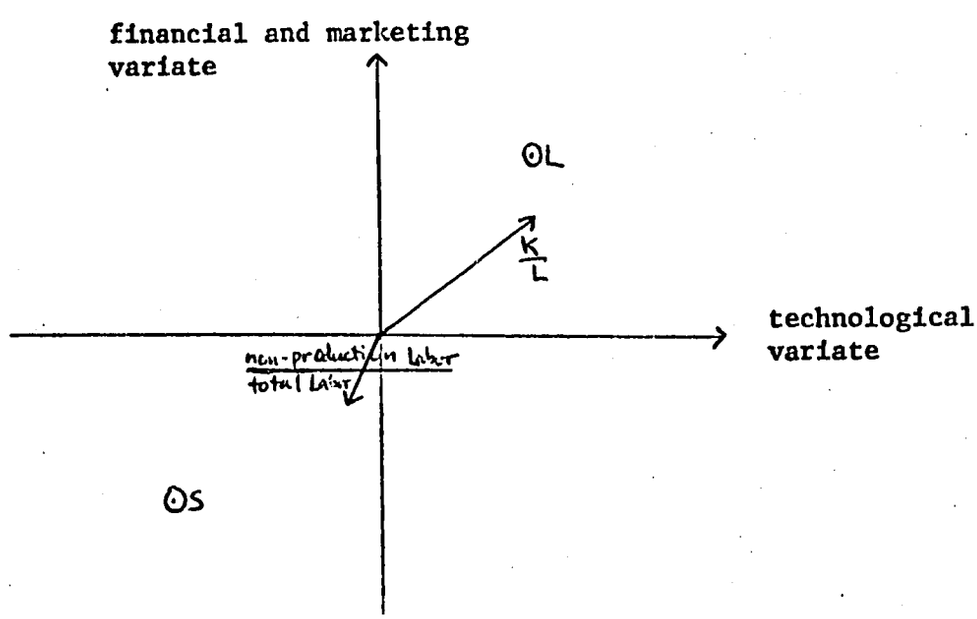


Figure 2

Strength of the Discriminating Variable



Code for Figures 3-8

1	:	largest, most efficient or most profitable
2	:	medium size, efficiency or profitability
3	:	smallest, least efficient or least profitable
	:	technological discriminators
x	:	financial-informational discriminators
⊖	:	technological plus financial-informational discriminators
DF1	:	primary discriminant function value
DF2	:	secondary discriminant function value

Figure 3

Shoe Centroids: Discriminant Analysis by Size Groups*

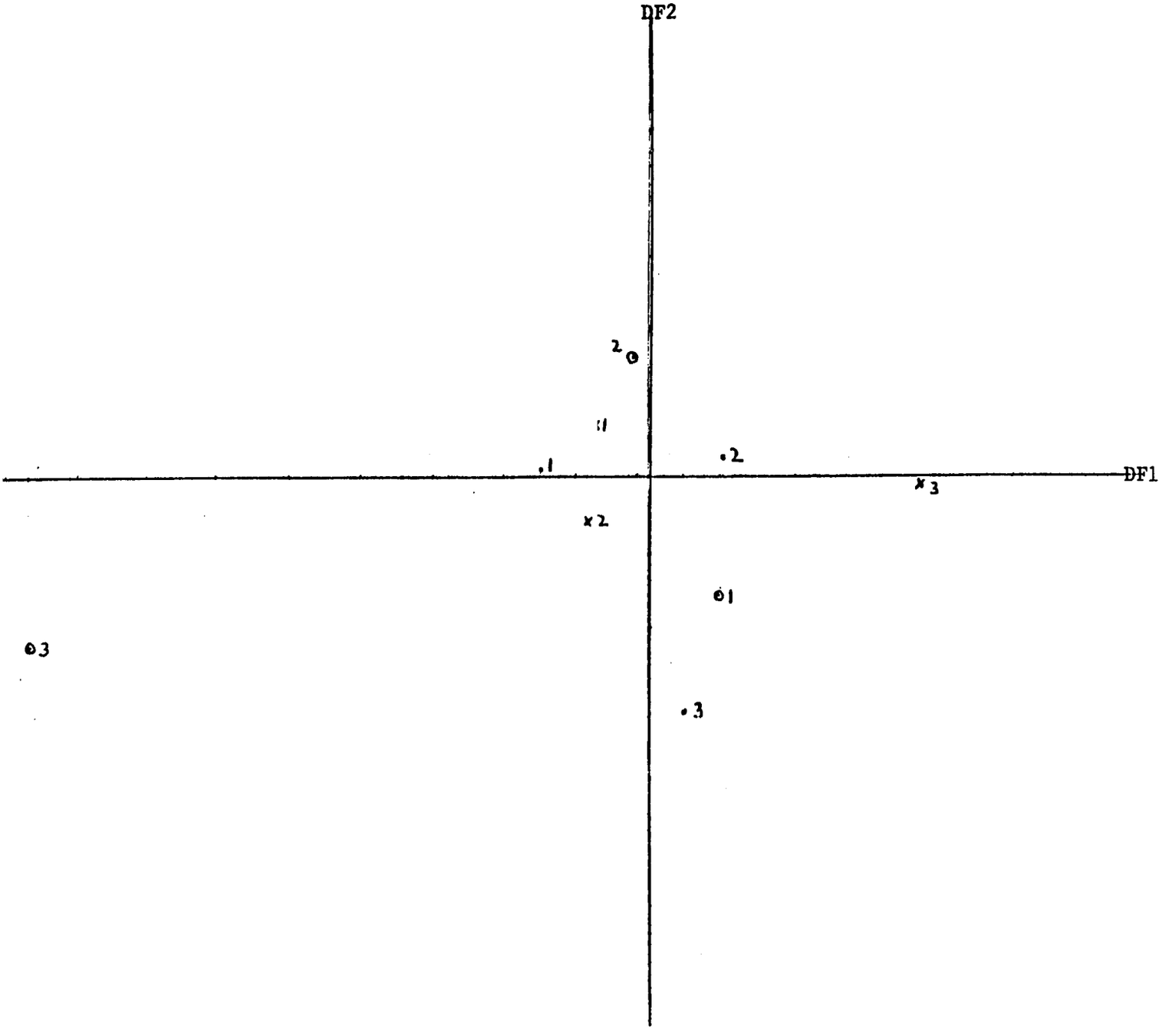


Figure 4

Shoe Centroids: Discriminant Analysis by Efficiency Groups*

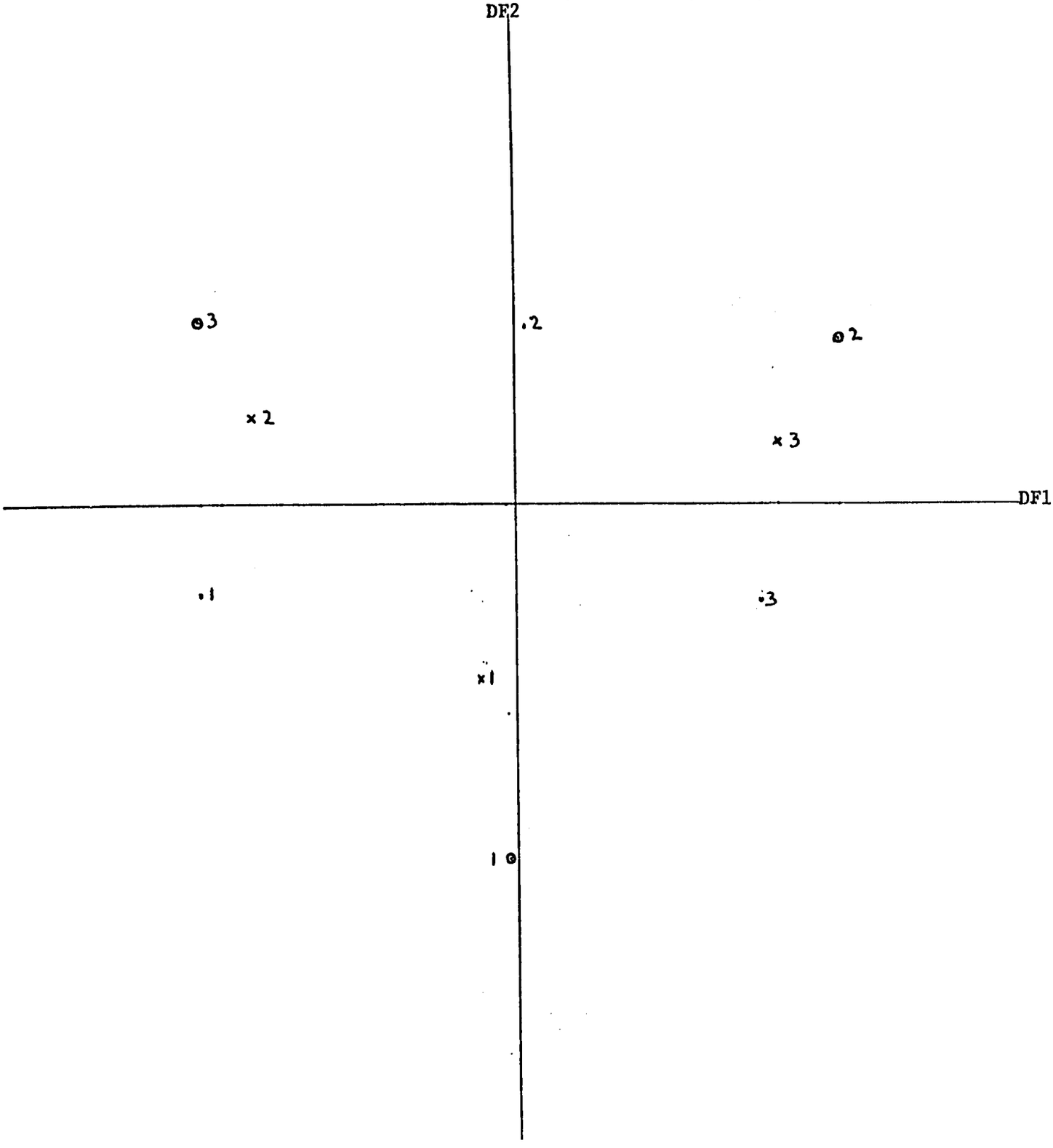


Figure 5

Shoe Centroids: Discriminant Analysis by Profitability Groups*

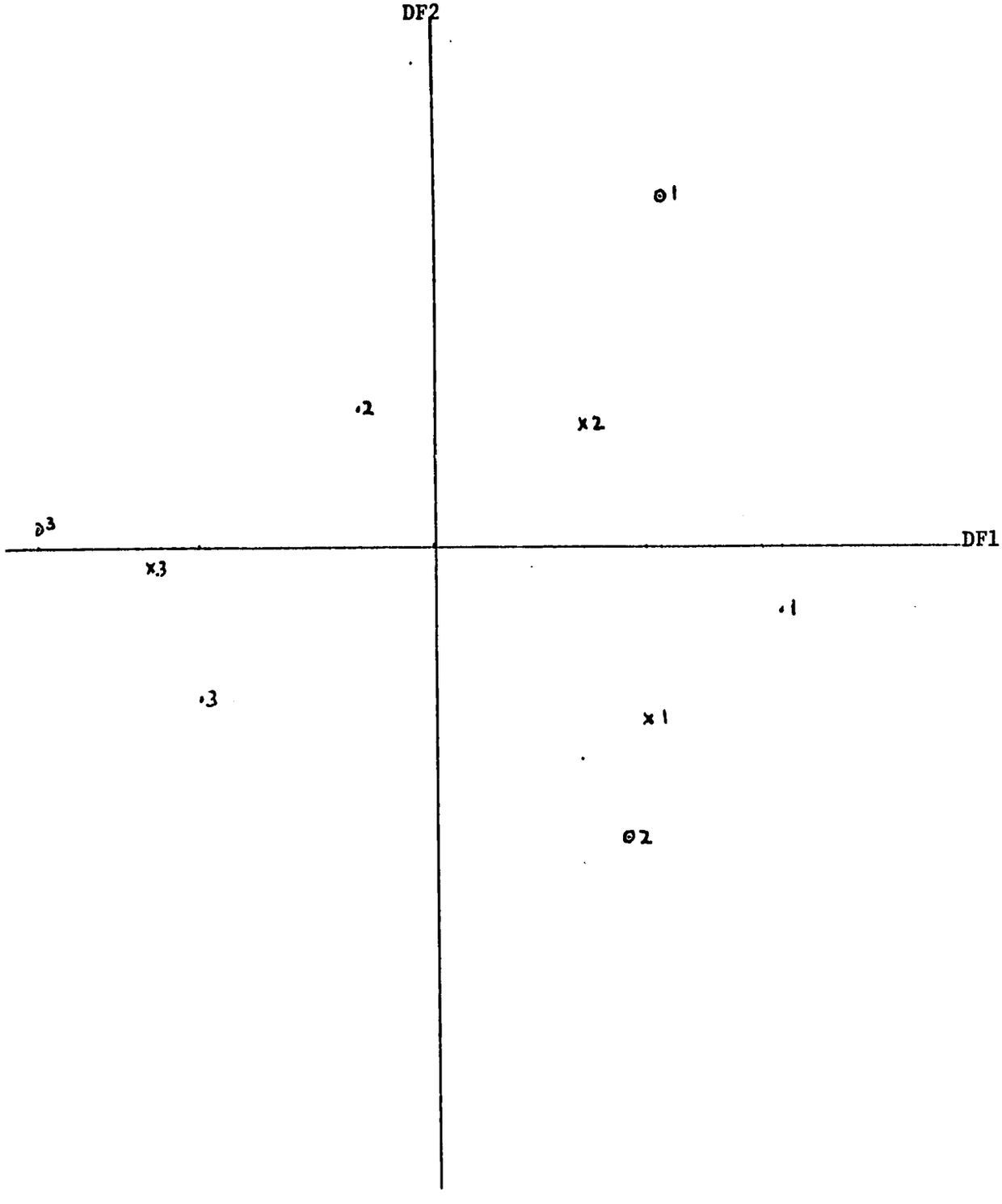


Figure 6

Textile Centroids: Discriminant Analysis by Size Groups*

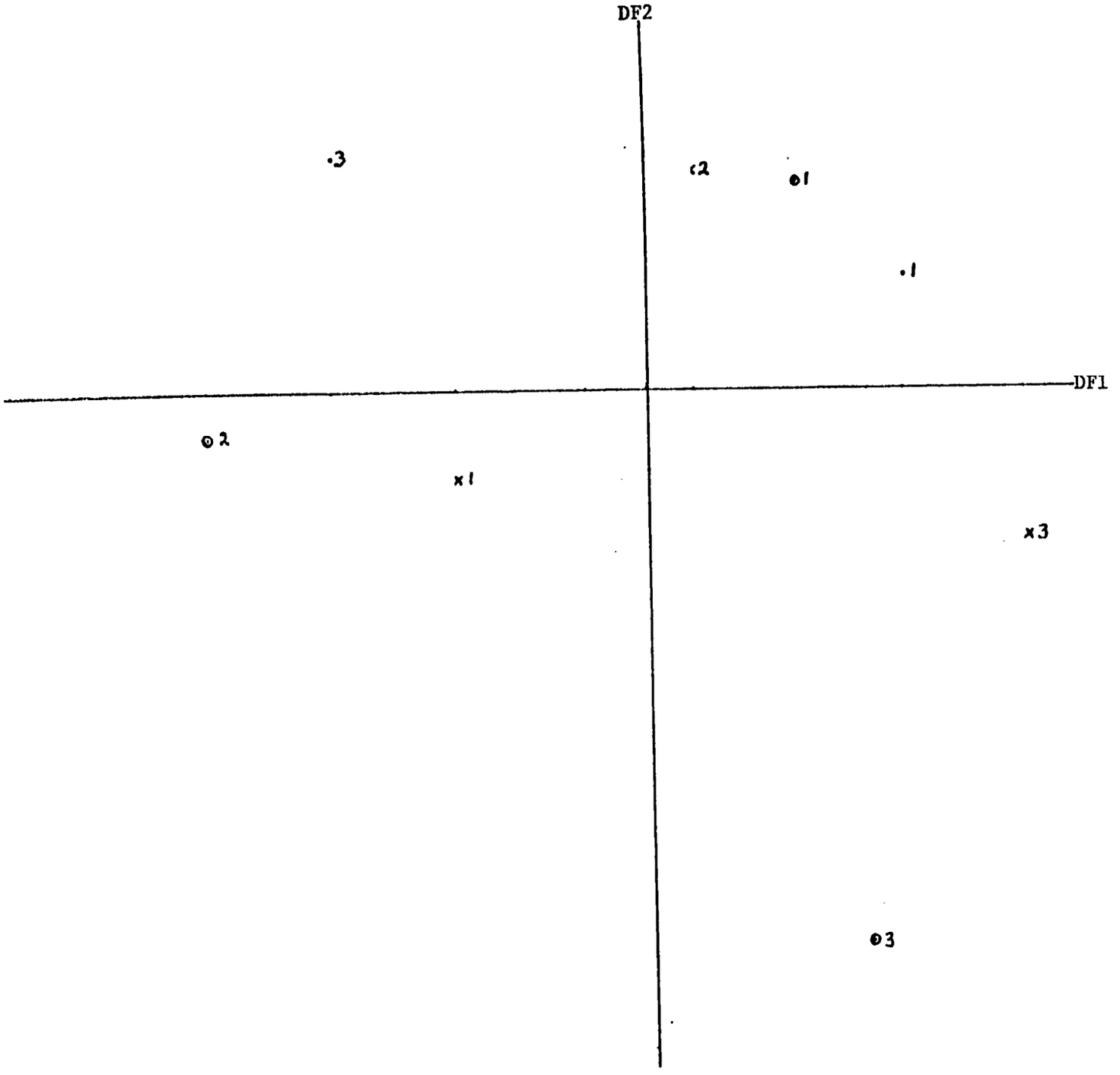


Figure 7

Textile Centroids: Discriminant Analysis by Efficiency Groups

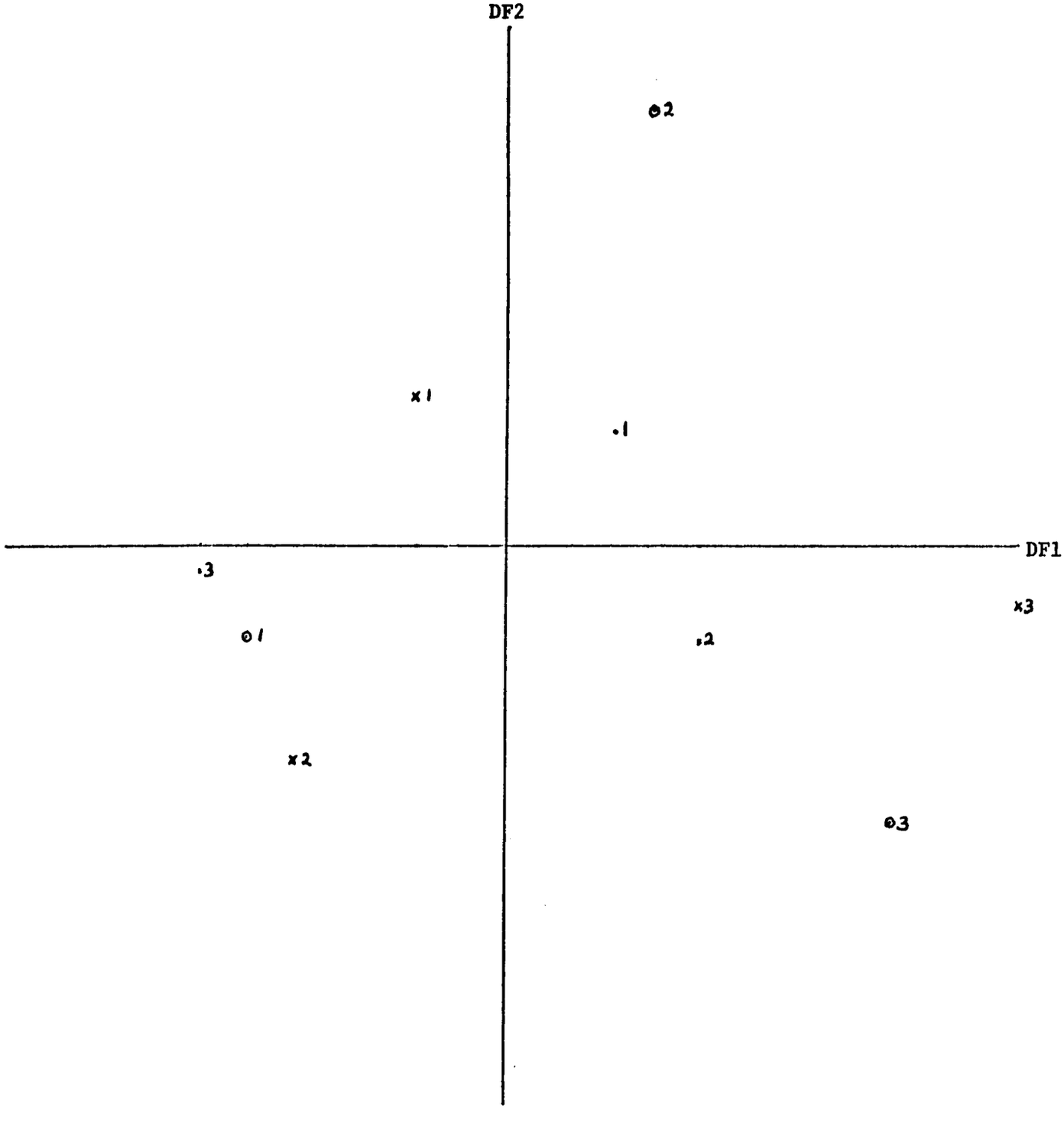
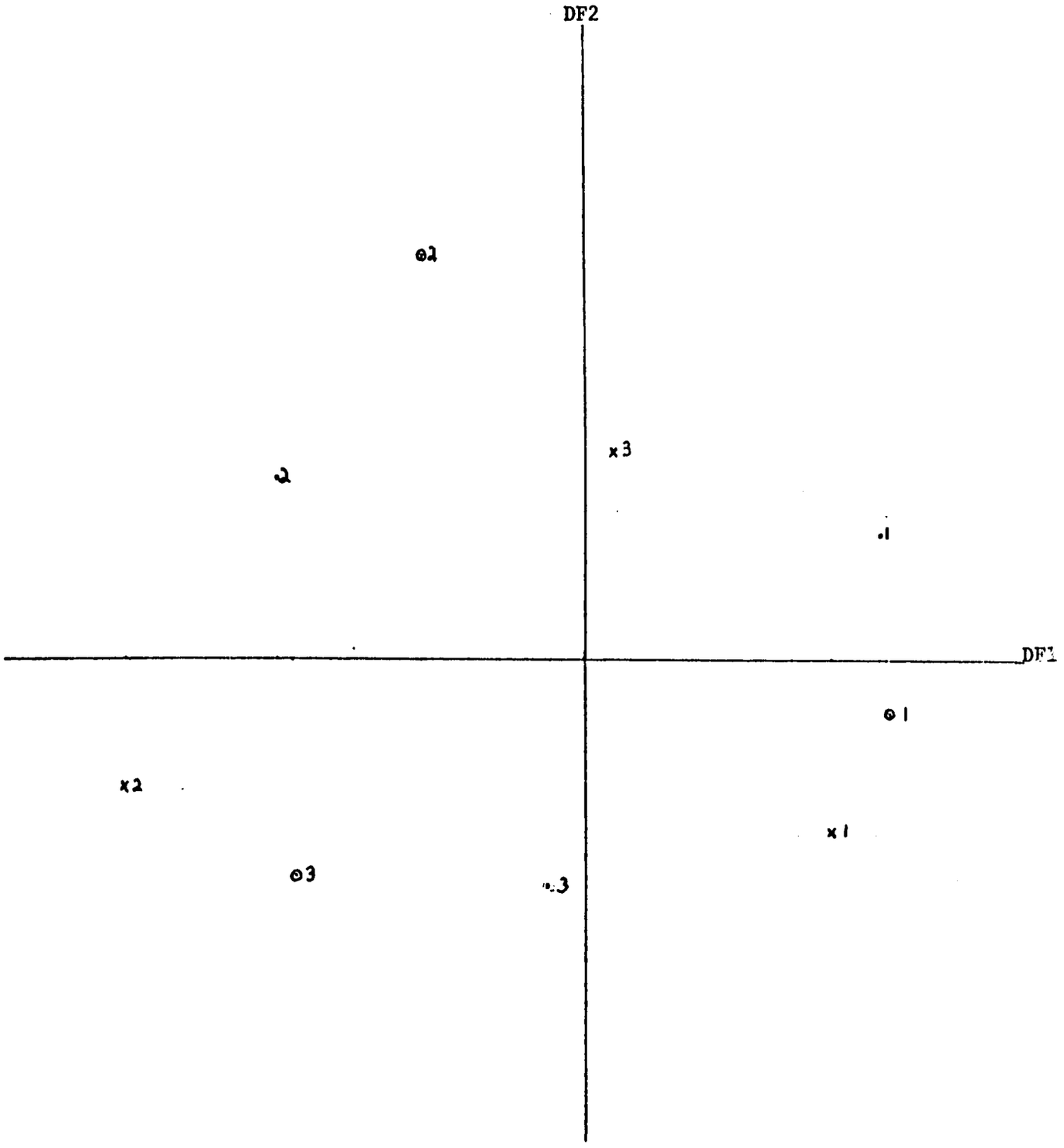


Figure 8

Textile Centroids: Discriminant Analysis by Profitability Groups



CHAPTER SEVEN

Conclusions

That firms produce relatively homogeneous products, such as men's leather shoes and cotton yarn, in different ways is no longer questioned. If nothing else, a few factory visits should convince one that techniques can be different in more ways than scale alone. The observation should be straightforward for the shoe industry, with its many operations. Side by side in Franca are workshops of ten people, using largely manual techniques, and factories of 500 to 900, using automatic machines along assembly lines. The scale, the mechanization, the organization, the degree of specialization are totally different, even when the shoe styles are similar. Cotton yarn factories are less visibly different. Nonetheless, a few well-selected visits would show manual or automatic transport systems, 1900 or 1977 vintage machinery, carding machines and spinning frames which have been modernized or not, variable spindle rpm. Again, there are differences in capital intensity, skill intensity, quality of raw material, as well as the obvious difference in scale.

The main focus of this monograph has been to characterize the size, efficiency and profitability differences across firms. From this characterization, then, one can draw tentative conclusions about the viability of various policies to encourage small scale and labor intensive firms.

The major conclusions are of several types. The first relates to economies of scale; the second to the degree of inefficiency among existing firms; the third to the relation between size, efficiency and profitability among shoe firms; the fourth to the relation between size, efficiency and profitability among textile firms.

1. Standard production function estimation indicates that sample firms in the two industries do not exhibit economies of scale when output is measured in physical terms. There do appear to be, however, smaller diseconomies in the production of sales and actual economies in the production of value added. These findings have been interpreted as evidence of marketing advantages held by large firms. Larger firms can buy in bulk, hold proportionately smaller inventories, undertake the risk of entering into more profitable but less certain markets, obtain cheaper credit and be eligible for export subsidies etc. Some of these advantages are simply due to the nature of being large, rather than to market distortions or government policy. Nonetheless, new institutions and new market organizations could be created to help smaller firms obtain the benefits of scale. Other advantages might be the direct result of policy such as the export promotion policy and the allocation of government credits. Government policy could, also, be redesigned. More will be said on the policy alternatives below.

2. Estimates of technological inefficiency, based upon process level data, are extremely high. Estimates suggest that output in each of the industries could be increased by 35 to as much as 85 percent if factors were employed as efficiently as in the most efficient firms of the sample. While the absolute magnitude may not be plausible, the order of magnitude is so high as to warrent further study.

An attempt to characterize the efficiency level of firms was not statistically very successful. There is, however, a positive association in each industry between degree of efficiency on the one hand and sales, hourly output of the carding machines or length of production run on the other hand. Both of the latter variables measure kinds of machinery productivity. One hypothesis, which has not been directly tested but was confirmed in interviews, is

that firms in the relatively unregulated Brazilian labor market hire and fire labor quite freely. Most firms do not hoard underutilized labor in the off-season. Still, they might have excess capacity and simply not try to cost minimize in the relatively protected, non-competitive industrial environment. If firms were forced to operate efficiently, the underutilized capital stock could service a great expansion in employment.

3. The conclusions on the cross classification of shoe firms by size, efficiency and profitability, come from the characteristic mean differences presented in Chapter Two, the regressions relating efficiency or profitability to firm characteristics in Chapter Five, and the discriminant analysis of Chapter Six.

The overall picture is one of small firms being relatively capital intensive, inefficient and unprofitable. They tend to be capital intensive, in part, because of the great variety of shoe models they produce; the resulting underutilization of capital equipment; their relative youth, inexperience and poor organization; and possibly the technological diseconomies in production: the smallest group of firms simply has not reached even the minimum scale of production.

While small firms appear to be both capital intensive and inefficient, it would not be correct to conclude that efficient firms are labor intensive, though they do tend to be fairly large. In fact, it appears as if the most [illegible] shoe firms in the sample are relatively capital intensive, suggesting that there are two types of capital intensive firms: those that underutilize capital (small firms), and those that use relatively modern equipment (efficient firms). The most efficient group, like the large firms, has a relatively large share of imported machinery.

The most profitable firms are of medium size, efficient, but fairly labor intensive. Those medium firms' relative labor intensity is consistent with the finding that they pay lower wages than large firms but have higher interest charges.

The data is drawn from an industry which is growing rapidly, surely out of equilibrium, and in an environment full of uncertainty and distortions. There are obvious data problems, at the level of getting consistent and reliable survey responses. But there are other problems associated with the growth and institutional instability. The firms that appear to be profitable in the sample might not be the most profitable in the long run. For these reasons, any conclusions must be made cautiously.

Tentatively, then, it would be a mistake to encourage the establishment of small firms without substantially changing their environment. They are inefficient users of capital. Medium size firms are diverse enough to include both the relatively capital intensive, efficient firms and the relatively labor intensive, profitable firms. It is possible that a more competitive environment could stimulate the relatively labor intensive, but profitable firms.

The product and factor markets are not integrated. Neither the most efficient nor the most profitable firms are exporters, though large firms are. On the factor market side, the largest, the most efficient and the most profitable firms have a relatively low opportunity cost of money and extend credit to their customers. Large firms, also, pay higher wages for the same occupations. While some of the wage differentials might reflect unmeasured skill differences, and the lower interest rates might reflect lower risk, there are probably real factor price distortions.

4. The textile industry bears both similarities and dissimilarities to the shoe industry. Here, the small firms appear to be relatively labor intensive, but again disappoint hopes for efficiency. In spite of their labor intensity, they exhibit the highest capital-output ratios, lowest hourly output of the carding machines, and lowest efficiency index.

By contrast, the most efficient firms are fairly large and of moderate capital intensity. The most profitable are large, capital intensive and efficient, by the criteria of the Farrell index, carding productivity and the number of spindles relative to output.

Both the most efficient and the most profitable firms have a relatively low opportunity cost of money. To the extent that they are large, however, they pay higher labor costs. They, also, export, benefitting from the export incentives. Their higher labor and lower capital costs could explain their capital intensity.

Whereas the most efficient and profitable shoe firms tend to be of medium size, the textile firms tend to be large. The most profitable group of textile firms is more capital intensive than the efficient group, while the picture is reversed for shoes. In both industries, profitable firms are relatively efficient; small firms are neither efficient not profitable. There is apparently no contradiction, even in a world of many distortions and X-efficiency, between efficiency and profitability. There are, however, potential contradictions between labor intensive or small firms, on the one hand, and efficiency/profitability on the other.

The conflicts observed in the case of Brazilian shoe and spinning firms might be resolved in a different economic and institutional setting. Changes in government policy could be aimed towards encouraging small labor intensive, yet efficient firms. The environment today does not foster these goals.

Several policy changes and programs could be considered further:

a. A standard recommendation, and one supported by the evidence presented above, concerns capital markets. Segmented capital markets, which allow firms of different sizes, efficiency and profitability to coexist, appear to be of substantial importance. In both industries, variables related to capital markets--such as the opportunity cost of credit, the importance of purchases or sales for credit, the debt-equity ratio--are some of the most important and significant discriminators among groups. They are the most important in discriminating among profitability groups, and are second to sources of information in discriminating among efficiency groups.

To the extent that real risks account for part of the interest rate differential observed, smaller firms will continue to pay higher rates unless cooperatives and mutual insurance groups can be organized to spread the risk.

b. Scale economies associated with the larger firms appear to be, at least partly, due to marketing rather than purely technological advantages. If smaller firms could organize to buy in bulk, to market jointly, to provide updated information on both markets and techniques, they could overcome some of the disadvantages of being smaller. The industrial associations are dominated by the larger firms and, to the extent that they have any useful function, predominantly serve the larger firms. The smaller firms could be helped by organizing trading companies, both to buy and to sell. In the shoe industry, for example, small firms participated in a large export contract with the Soviet Union arranged through Petrobras, but otherwise have a difficult time breaking into the export market. Coordinating sales among the smaller firms

would allow them to limit their model offerings, increase their production runs, simplify internal organization and make better use of their machinery.

c. Some of the disadvantages of being small appear to be related to physical production inefficiencies. In both industries, the least efficient group of firms has the smallest average size.

Technological choices have not been developed in an historical vacuum. Many of the available techniques of production have been developed by large firms in capital-rich, capitalist countries. These firms have an incentive to search for new techniques which will lower their costs as much as possible and perhaps, therefore, to search for relatively labor-saving methods of production. Moreover, they operate in a market environment where they must recoup their research and investment costs if they are to be profitable and survive. For these reasons, they are likely to search for new methods which will not be easily replicated and which have a minimum scale of production sufficient to forestall competitors. If the market environment were altered to be more favorable to small firms and to eliminate capital subsidies to larger firms, there might be more incentive to develop labor-using techniques, for smaller scale production.

Some of the survey questions were designed to investigate the sources and the nature of innovations made within the plant. The goal was, for example, to understand whether small firms are likely to make capital-saving adaptations such as organizational changes, while large firms make few shop floor adaptations. Based upon the questionnaire responses, I reinterviewed a number of shoe firms, in order to elaborate on the responses and associate concrete situations with the categorical questionnaire. Unfortunately, the

reinterviews showed that the original questions were not very useful. Further, detailed plant-level work needs to be done in this area. Systematic questionnaires are not likely to be successful.

The current recession in Brazil is especially hurting the medium and small firms. In the shoe industry, the small firms seem to be going out of business. Even if they are relatively capital intensive, their total investment is quite small, and so they have little financial capital to lose. The medium firms, however, are more capitalized and have more to lose. If the United States market is cut off, the large exporters will turn toward the domestic Brazilian market, competing in markets where the medium firms now dominate. Without credit to tide them over, the medium firms might be severely hurt. The whole structure of the industry might be transformed in favor of large scale firms, which are neither the most efficient nor the most labor-intensive.

Appendix A

SURVEY IMPLEMENTATION AND QUESTIONNAIRES

An obvious difficulty in any survey work is the availability of reliable information about the population. As a result, the sources are not always the same for every sector being studied, and the variables used to stratify the population are not always identical. Theoretical considerations would suggest that some measure of output would be the best variable for stratification if a major concern is the relation between scale and factor utilization. Much easier to obtain and more reliable, however, is ex ante information on employees. The shoe sample in Brazil was selected from population data stratified according to the number of employees. The cotton spinning sample was selected according to the number of spindles.

A second difficulty related to our estimates of the population concerns the potential underestimate of small firms. This is a particularly important problem in the shoe industry and is compounded by the high rate of turnover of the small firms. The Brazilians decided to eliminate all shoe firms with five or fewer employees, essentially avoiding the problem. In both the shoe and the cotton spinning sectors, they included the largest firms.

Given the total number of firms to be interviewed, that sample number must be distributed within the industry population. The Brazilians cooperating in the project used Neyman's solution to the optimal allocation problem, assuming that the sample cost is the same for every stratum. They first distributed the total sample size among the sectors being studied and then within the sectors according to the size strata. Altogether fifty shoe firms and thirty-four spinning firms responded to questionnaires.

The geographic coverage of the sample has been handled in different ways. Cotton spinning firms were sampled from the state of São Paulo. Shoe firms were sampled only in the City of Franca, the major producing area of men's leather shoes in the state of São Paulo.

After the first set of questionnaires was completed and partially analyzed, a selected group of shoe firms was revisited. The purpose of the second interview was to ask open-ended questions about innovations. Therefore, the firms were selected, non-r and only, to include firms which had indicated some concern about innovations and which appeared to be relatively efficient. The reinterviews were particularly useful in understanding the relations between model changes, the length of production run and the efficiency of factor use. They were less useful is associating particular innovations with answers given to questions of the formal questionnaire.

Questionnaire for Plant Level Study
Men's Leather Shoes
Large firms

Part 1. To be answered by the Financial Director or the Financial Division

Person interviewed _____

Position in firm _____

Date of interview _____

1. Name of company _____

2. Name of factory visited _____

3. Address of factory

   Street _____ Zip _____

   City _____ Telephone _____

4. Number of factories in company _____

5. Current legal organization of company

   S.A. aberta _____

   S.A. fechada _____

   Sociedade por cotas de responsabilidade limitada _____

   Firma individual _____

   Other _____

6. Year in which company began operations _____

7. Year in which factory began operations _____

8. Year of acquisition of the factory if different from first year of operations

   _____

9. Equity capital, December 31, 1975 ("Capital social mais reservas e fundos, não exigivel") _____

10. Short term debt, December 31, 1975 _____

    Long term debt, December 31, 1975 _____

11. Structure of capital, in percentage terms

	National		Foreign		Total
	Private	Official	Private	Official	
Equity capital					100%
Debt					100%

12. What are the outstanding debts of the factory (including the names of the machinery suppliers which sell on credit).

Source	Value	Interest Rate	Collateral as a percentage of value

13. Value of sales of all products of the factory in 1975 (FOB factory value)

_____

14. Value of sales of all products of the factory in November 1975 (FOB factory value) _____

15. Percentage of sales in 1975:

a. for cash

b. with credit up to 60 days

c. with credit more than 60 days

16. What price discount would you give a sale with 60 day credit if this sale were paid for in cash _____

17. Percentage of sales of men's leather shoes in 1975

a. through the company's chain of stores _____

b. through the company's own sales representatives _____

c. through independent salesmen _____

d. for export _____

e. to other shoe factories _____

18. What was the percentage of men's leather shoes sold to the largest purchaser in 1975 _____

19. What was the cruzeiro value of leather shoes exported in

1969 _____

1972 _____

1975 _____

20. Production of men's leather shoes and boots

Product	Number of pairs March 1975	Number of pairs October 1975	Value of production in October 1975 in Cr $1000
1. Cemented sole, with FOB factory value ≤ cr $70.00 > cr $70.00			
2. Sewn sole with FOB factory value ≤ cr $70.00 > cr $70.00			
3. Injected sole with FOB factory value ≤ cr $70.00 > cr $70.00			

21. Number of different models produced this week (as different models include any variant in color, finishing, sole) _____

22. Subcontracting

	yes	No	Type	Value, Oct.1975
a. Contract services from third parties (e.g., model design, sewing uppers, sewing soles)				
b. Contract services from other factories of the company				
c. Provide services to third parties				

23. Value of production of products produced by the factory other than men's leather shoes, October 1975:

a. other types of shoes _____

b. Purses _____

c. Other _____

24. Area, in square meters

a. constructed area _____

b. unconstructed area _____

25. What percent of the purchases of leather for uppers were from the largest supplier, 1975 _____

26. Purchases of inputs, 1975

	Value, in cr$1000 March	October
Leather for uppers		
Soles and heels		
other		

27. Purchases of leather for uppers in October 1975, in square meters

_____

28. Average stock of leather for uppers in square meters, or in value, 1975:

Cr $ _____

m^2 _____

29. Percentage of purchases of leather for uppers in 1975 for cash _____

on credit up to 60 days _____

on credit more than 60 days _____

30. Electricity consumption in October 1975

Cr $ _____

or
KWH _____

[illegible] e answered by the Administrative Director or the Administrative [illegible]ion

1. [illegible] viewed _____

2. [illegible] directors, October 1975:

   [illegible] _____

   [illegible] economic background _____

   [illegible] _____

3. [illegible] personnel (excluding the directors and factory personnel), [illegible]:

   [illegible] _____

   [illegible] economic background a_____

   [illegible] higher education _____

   [illegible] higher education _____

4. [illegible] rnover rate of production workers, 1975 _____

5. [illegible] visors ("mestres and contra-mestres") received their basic training in

   [illegible] _____

   [illegible] _____

   [illegible] _____

Part III. To be answered by the Director of Production of the factory

1. Name _____

2. Year of birth _____

3. Most advanced education

   Level _____

   Specialization _____

4. Specify the foreign languages which you read _____

5. Years of experience

   in the sector _____

   in the company _____

6. Position in last employment _____

7. The company receives [check (✓) if yes]

   a. Catalogues of machinery suppliers _____

   b. Trade journals

      i. O Atualizado _____

      ii. Exclusivo _____

      iii. As Sutoris _____

      iv. Moda en Pele _____

      v. Schuh Technik _____

      vi. Footwear News _____

      vii. Leather and Shoes _____

8. How many people from the company visit trade fairs of shoe machinery each year

   a. national fairs _____

   b. foreign fairs _____

9. Have you had a contract for technical assistance?

	yes	no
national	___	___
foreign	___	___

Have you had a contract for maintenance?

	yes	no
national	___	___
foreign	___	___

10. In your last purchase of equipment, what were the sources of information that you used:

	much	little	not at all
a. Suppliers' catalogues			
b. Machinery suppliers' representative			
c. National fairs			
d. International fairs			
e. Experience of other businessmen in the sector who have the equipment			
f. Technical journals			
b. Others, specify			

11. In your last purchase of machinery, what were the essential characteristics of this equipment:

	Very important	Somewhat important	Not important
a. Availability of technical assistance and maintenance			
b. Flexibility of the equipment to handle various operations			
c. Actual price of the machine in relation to the future expected price			
d. Reduction of labor costs			
e. Durability of the machine			
f. Quality of the product produced			
g. Others, specify			

12. Number of pairs per hour produced in October 1975 by a worker doing heel lasting _____

13. Maximum number of pairs per hour that could be produced by a worker doing heel lasting, with the existing equipment _____

14. Does the factory use conveyor racks in the section of sewing? yes _____ no _____. If yes, when was the conveyor rack introduced? _____. Does the factory use conveyor racks in the sections of lasting and sole attachment (montagem and acabamento)? yes _____ no _____. If yes, when was the conveyor rack introduced? _____

15. Value of in-house production of cement, soles, heels and other components in October 1975 _____

16. What were the company's preoccupations during recent years in the production division?

	Very important	Somewhat important	not important
a. Lower cost of unskilled labor			
b. Lower cost of skilled labor			
c. Increase capital productivity			
d. Better balancing of the equipment to diminish excess capacity of machinery already in the factory			
e. Better use of raw materials			
f. Increase production of cemented shoes			
g. Increase production of sewn shoes			
h. Increase production, with a concomitant decrease in the quality of the product sold in internal markets			
i. Improve the quality of the products sold in internal markets			
j. Improve the quality of the products sold in foreign markets			
k. Others, specify: i ii iii			

17. To reach these objectives, you might have adopted several measures. In the table below, relate the measures adopted to the objectives that were designated "very important."

I "Very important" objectives	II Measures adopted													III Measures adopted
	a	b	c	d	e	f	g	h	i	j	k	l	m	
														a. Adjust machine velocity b. Mechanical adaptation to machine c. New transport methods in factory d. More vigorous quality control e. Less vigorous quality control f. New packaging systems g. Different type of raw material h. Change skill of labor i. Change lay-out j. Maintenance k. Buy machines l. Change shoe design m. _____

18. Did you buy new machines in the last 8 years for the sole purpose of export? yes _____ no _____. What was the value of the investment for this purpose? Cr$ _____. Year _____.

19. Note the technical problems you have encountered in producing for export.
a. Problems already solved:

b. Problems to be solved in the near future:

c. Problems which should be solved but cannot be in the near future:

See questionnaire for small firms, for tables on labor costs and machinery.

Questionnaire for Plant Level Study
Men's Leather Shoes
Small Firms

Part I. To be answered by the administration.

Person interviewed _____

Position in firm _____

Date of interview _____

1. Name of company _____

2. Name of factory visited _____

3. Address of factory

   Street _____ Zip _____

   City _____ Telephone _____

4. Current legal organization of company _____

   _____

   _____

   _____

   _____

   _____

5. Year in which company began operations _____

6. Year in which factory began operations _____

7. Year of acquisition of the factory if different from first year of operations _____

8. Equity capital, December 31, 1975 ("capital social mais reservas e fundos, nao exigivel") _____

9. Short term debt, December 31, 1975 _____

   Long term debt, December 31, 1975 _____

10. Structure of capital, in percentage terms

Own capital _____

Debt _____

100%

11. What are the outstanding debts of the factory (including the names of the machinery suppliers which sell on credit):

Source	Value	Interest rate	Collateral as a % of Value

12. Value of sales of all products of the factory in 1975 (at factory prices)

_____

13. Value of sales of all products of the factory in November 1975 (at factory prices) _____

14. Percentage of sales in 1975:

a. for cash _____

b. with credit up to 60 days _____

c. with credit more than 60 days _____

15. What price discount would you give a sale with 60 day credit if this sale were paid for in cash _____

16. Percentage of sales of men's leather shoes in 1975

a. Through independent sales men _____

b. Through the company's own sales representatives _____

c. To other shoe factories _____

d. Other _____

17. What was the percentage of men's leather shoes sold to the largest purchaser in 1975 _____

18. Value of exports, 1975 _____

19. Production of men's leather shoes and boots

Product	Number of Pairs March 1975	Number of Pairs October 1975	Value of Production in October 1975 in Cr. $1000
1. Cemented sole with factory value <Cr $70.00 >Cr $70.00			
2. Sewn sole with factory value <Cr $70.00 >Cr $70.00			

20. Number of different models produced this week (as different models include any variant in color, finishing, sole) _____

21. Subcontracting

	Type	Value, October 1975
a. Contract services from third parties (e.g., model design, sewing uppers, sewing soles)		
b. Provide services to third parties		

22. Value of production of products produced by the company other than men's leather shoes, October 1975:
   a. Other types of shoes _____
   b. Purses _____
   c. Other _____

23. Area, in square meters.

a. Constructed area _____

b. Unconstructed area _____

24. What percent of the purchases of leather for uppers were from the largest supplier., 1975 _____

25. Purchases of inputs , 1975

Type	Value, in Cr $1000 March	October
Leather for uppers		
Soles and heals		
Other		

26. Purchases of leather for uppers in October 1975, in square meters

_____

27. Average stock of leather for uppers in square meters, or in value, 1975:

cr $ _____

m^2 _____

28. Percentage of purchases of leather for uppers in 1975

For cash _____

On credit up to 60 days _____

On credit more than 60 days _____

29. Electricity consumption in October 1975

Cr $ _____

KWH _____

Labor

30. Partners and owners, October 31, 1975

Position in the company	Age	Most advanced education	No. of years. in shoe sector	No. yrs. in company	Position in last employment
Director of administration					
Director of production					
Others (Specify)					

31. Administrative personnel. Number on October 31, 1975 (excluding partners and owners) _____

32. Percentage of company personnel that are family members of the partners and owners _____

33. What was the turnover of production workers in 1975 _____

34. Most frequent destination, in percentage terms of workers who leave the company:

Larger shoe factories _____

Smaller shoe factories _____

Shoe factories that they themselves set up _____

Other _____

35. Does the company hire workers without previous experience in shoe production?

Yes _____ No _____

36. The company receives [check (✓) if yes]

a. Catalogues of machinery suppliers _____

b. o atualizado _____

c. Exclusivo _____

d. Others, specify _____

Cost of Labor in the Factory

Function, by Principal activity in the Production of Shoes	Number 31/10/75	Number of hours Worked per employee, on average, per day October 1975	Number of Workers paid by piece rate 31/10/75	Value of Total salaries, October 1975 in cr $1000	Fringe benefits, October 1975 in cr $1000[1]	Night shift rate	Overtime rate
Engineers							
Supervisors							
Machinists and production line workers							
Workers whose principal activity is transport							
Maintenance personnel							
Warehouse and storage personnel							
Others in the factory							

[1]Include not only the monthly benefits, but the Christmas 1/13, holidays etc, that can be allocated to October.

37. How many times did someone from the company visit trade fairs in 1975

_____

38. Does the company have an outside maintenance contract?

Yes _____ No _____

39. In your last purchase of equipment, what were the sources of information that you used:

	Much	Little	Not at all
a. Suppliers' catalogues			
b. Machinery suppliers' representatives			
c. Trade fairs			
d. Experience of other businessmen in the sector who have the equipment			
e. Journals			
f. Others, specify			

40. In your last purchase of machinery, what were the essential characteristics of this equipment:

	Very Important	Somewhat Important	Not Important
a. Availability of technical assistance and maintenance			
b. Flexibility of the equipment to handle various operations			
c. Actual price of the machine in relation to the future expected price			
d. Reduction of labor costs			
e. Durability of the machine			
f. Quality of the product produced			
g. Others, specify			

41. Number of pairs per hour produced in October 1975 by a worker doing heel lasting? _____

42. Maximum number of pairs per hour that could be produced by a worker doing heel lasting, with the existing equipment? _____

43. Does the factory use any conveyor racks? Yes _____ No _____.

If yes, in what part of the factory? _____

When was the conveyor rack introduced? _____

44. What were the company's preoccupations during recent years in the production division?

	Very Important	Somewhat Important	Not Important
a. Lower cost of unskilled labor			
b. Lower cost of skilled labor			
c. Increase capital productivity			
d. Better balancing of the equipment to diminish excess capacity of machinery already in the factory			
e. Better use of raw materials			
f. Increase production of cemented shoes			
g. Increase production of sewn shoes			
h. Increase production, with a concomitant decrease in the quality of the product sold in internal markets			
i. Improve the quality of the products sold in internal markets			
j. Improve the quality of the products sold in foreign markets			
k. Others, specify i ii iii			

45. To reach these objectives, you might have adopted several measures. In the table below, relate the measures adopted to the objectives that were designated "very important."

I "Very Important" Objectives	II Measures Adopted													III Measures Adopted
	a	b	c	d	e	f	g	h	i	j	k	l	m	
														a. Adjust machine velocity
														b. Mechanical adaptation to machine
														c. New transport methods in factory
														d. More vigorous quality control
														e. Less vigorous quality control
														f. New packaging systems
														g. Different type of raw material
														h. Change skill of labor
														i. Change lay-out
														j. Maintenance
														k. Buy machines
														l. Change shoe design
														m. _____

189.

	Cutting				Preparation	Sewing	Lasting		Soling			Finishing and Packaging
	Uppers		Bottoms									
	Manual	Mechanical	Manual	Mechanical			Manual	Mechanical	Cemented	Sewn	Injected	
1. Number of machines												
2. Number of machines of origen:												
a. Brazil												
b. Czechoslovakia												
c. England												
d. Germany												
e. Italy												
f. U.S.A.												
g. Others												
3. Number of machines produced												
a. before 1960												
b. 1960-1968												
c. 1969-1975												
4. Estimate the average number of years you will use themachines produced												
a. before 1960												
b. 1960-1968												
c. 1969-1975												
5. Number of machines bought second hand												
6. What is the balance sheet value of the machines (in Cr$1000)												
7. What is the real value of the machines, such as they are (in Cr$1000)												
8. Average number of operators in March 1975												
a. first shift												
b. second shift												
9. Average number of operators in October 1975												
a. first shift												
b. second shift												
10. Average number of supervisors in October 1975												
11. Average number of hours per week that the section operated, 1975												
a. in March												
b. in October												
12. Average number of hours per week that the machines did not operate due to, for example, storages for materials feeding, maintenance or adjustments; effects on productivity of the machines; model changes.												

Questionnaire for Plant Level Study

Cotton Spinning

Part I. To be answered by the Financial Director or the Financial Division

Person interviewed _____

Position in firm _____

Date of interview _____

1. Name of company _____

2. Specify the industrial group, if any, that the company belongs to

_____

3. Name of factory visited _____

4. Address of factory

Street _____ Zip _____

City _____ Telephone _____

5. Number of factories in company _____

6. Current legal organization of the company

S.A. aberta _____

S.A. fechada _____

Sociedade por cotas de responsabilidade limitada _____

Firma individual _____

Other _____

7. Year in which company began operations _____

8. Year in which factory began operations _____

9. Year of acquisition of the factory if different from first year of operations

_____

10. Equity capital, December 31, 1975 ("capital social mais reservas e fundos, não exigivel") _____

11. Short term debt, December 31, 1975 _____

Long term debt, December 31, 1975 _____

12. Structure of capital, in percentage terms

	National		Foreign		Total
	Private	Official	Private	Official	
Equity Capital					100%
Debt					100%

13. What are the outstanding debts of the factory (including the names of the machinery suppliers which sell on credit):

Source	Value	Interest Rate	Collateral as a % of value

14. Value of sales of all products of the factory in 1975 (FOB factory value)

_____

15. Value of sales of all products of the factory in September 1975 (FOB factory value) _____

16. Percentage of sales in 1975:

a. for cash _____

b. on credit up to 60 days _____

c. on credit more than 60 days _____

17. What price discount would you give a sale with 60 day credit if this sale were paid for in cash _____

18. Percentage of sales of cotton yarn in 1975 to third parties _____

to other factories of the same industrial group _____

19. What was the percentage of cotton yarn sold to the largest purchaser in

1975 _____

20. Value of exports of cotton yarn in

1962 _____

1966 _____

1969 _____

1972 _____

1975 _____

21. Production of cotton yarn

Product	Kilos produced March 1975	Kilos produced September 1975	Value of Production September 1975
Carded yarn with count >10			
10 to 20			
21 to 30			
31 to 40			
above 40			
Combed yarn			

22. Value of production of products produced by the factory other than cotton yarn, September 1975:

a. Other yarn _____

b. Weaving _____

c. Other _____

23. Area, in square meters

a. Constructed area _____

b. Unconstructed area _____

24. What percent of the purchases of cotton were from the largest supplier

1975 _____

25. Cotton consumption in the factory, 1975

Point grade	Kilos	
	March	September
Less than 3		
4-6		
More than 7		

26. Value of cotton purchases in September, 1975 _____

27. Average stock of cotton, in kilos or in value, 1975:

Cr $ _____

kg _____

28. Percentage of cotton purchase in 1975

for cash _____

on credit up to 60 days _____

on credit more than 60 days _____

29. Electricity consumption in September 1975

Cr $ _____

KWH _____

Part II To be answered by the Administrative Director or the Administrative Division

1. Person interviewed _____

2. Number of directors, September 1975:

   Engineers _____

   Business or economic background _____

   Other _____

3. Administrative personnel (excluding the directors and factory personnel), September 1975:

   Engineers _____

   Business and economic background _____

   Others with higher education _____

   Others without higher education _____

4. What was the turnover rate of production workers in 1975 _____

5. How many supervisors ("mestres and contra-mestres") received their basic training in

   SENAI _____

   Another factory _____

   This factory _____

   Other training institutions _____

Cost of Labor in the Factory

Function by principal activity in the production of yarn	Number 30/09/75	Number of hours worked per employee, on average, per day in Sept. 1975	Value of total Salaries, 9/75, in cr $1000	Fringe benefits 9/75, in cr $1000[1]	Night shift rate	Overtime rate
Engineers						
Supervisors						
Machinists in the production line						
Workers whose principal activity is transport						
Maintenance personnel						
Warehouse and storage personnel						
Other in spinning						

[1] Include not only the monthly benefits, but the Christmas 1/13, holidays etc., that can be allocated to September.

Part III. To be answered by the Director of Production of the Factory

1. **Name** _____

2. Country of birth _____

3. Year of birth _____

4. Most advanced education

   Level _____

   Specialization _____

5. Specify the foreign languages which you read _____

6. Years of experience

   in the sector _____

   in the company _____

7. The company receives [check (✓) if yes]

   a. Catalogues of machinery suppliers _____

   b. Trade journals

      i. Boletin do Sindicato de Fiação e Tecelagem do Estado de São Paulo ____

      ii. Revista Textil Brasileira _____

      iii. Fios e Costura _____

      iv. Indústria Textil Suíca (I.T.S.) _____

      v. Textiles Pan Americanos _____

      vi. Others, specify _____

8. How many people from the company visit trade fairs of textile machinery each year

   a. national fairs _____

   b. foreign fairs _____

9. Has the company ever registered a patent? yes _____ no _____

   If yes, specify _____ _____

10. Have you had a contract for technical assistance?

	yes	no
national	___	___
foreign	___	___

If yes, in what areas? _____

Have you had a contract for maintenance?

	yes	no
national	___	___
foreign	___	___

11. In your last purchase of equipment, what were the sources of information that you used:

	much	little	not at all
a. suppliers' catalogues			
b. Machinery suppliers' representatives			
c. National fairs			
d. International fairs			
e. Experience of other businessmen in sector who have the equipment			
f. Foreign partner			
g. Technical journals			
h. Technical assistance contracts with nationals			
i. Technical assistance contracts with foreigners			

12. In your last purchase of machinery, what were the essential characteristics of this equipment

	Very Important	Somewhat Important	Not Important
a. Availability of technical assistance and maintenance			
b. Flexibility of the equipment to produce various products			
c. Actual price of the machine in relation to the future expected price			
d. Reduction of labor costs			
e. Durability of the machine			
f. Quality of the product produced			

13. Number of renovated carding machines

before 1967 _____

after 1967 _____

Number of renovated spinning frames _____

14. How many spindles in the factory _____

15. Average hourly production of the carding machines, in September 1975, in kilos _____

16. Average hourly production per spindle of the spinning frames, in September 1975, in kilos, for 30 count yarn _____

17. Kilos in September 1975

of residue _____

of return _____

18. For the counts listed below, when the yarn is to be used for "tramm", what was the spindle rpm used:

Count	rpm
20	
30	
40	
70	

19. How many spinning frames have a travelling cleaning system? _____

When were they installed? _____

20. Does the company have a quality control laboratory?

yes _____ no _____. If yes, what of equipment _____

21. What kind of transport and feeding system does the factory have between the blow room and the carding room?

	yes	no
carts		
pneumatic		
hand carried lats		

22. Describe the system of preventive maintenance, if any _____

_____

23. What were the company's preoccupations during recent years in the production division?

	Very Important	Somewhat Important	Unimportant
a. Lower cost of unskilled labor			
b. Lower cost of skilled labor			
c. Increase capital productivity			
d. Better balancing of the equipment to diminish excess capacity of machinery already in the factory			
e. Better use of raw materials			
f. Increase production of higher count yarn for the domestic market			
g. Increase production of lower count yarn for the domestic market			
h. Increase production of higher count yarn for the export market			
i. Increase production of lower count yarn for the export market			
j. Increase production, with a concomitant decrease in the quality of the product sold in internal markets			
k. Improve the quality of the products sold in internal markets			
l. Improve the quality of the products sold in foreign markets			
m. Others, Specify i. ii. iii.			

24. To reach these objectives, you might have adopted several measures. In the table below, relate the measures adopted to the objectives that were designated "very important."

I "Very important" objectives	a	b	c	d	e	f	g	h	i	j	k	l	m	III Measures Adopted
														a. Adjust machine velocity b. Mechanical adaptation to machine c. New transport methods in factory d. More vigorous quality control e. Less vigorous quality control f. New packaging systems g. Different type of raw material h. Change skill of labor i. Change lay-out j. Maintenance k. buy machines l. Renovate machines

25. Did you buy new machines in the last 8 years for the sole purpose of export
yes _____ no _____

26. Note the technical problems you have encountered in producing for export.

a. Problems already solved:

b. Problems to be solved in the near future.

c. Problems which should be solved but cannot be in the near future?

	Blowing	Carding	Drawing	"Lamine-deira"	Combing	Roving	Spinning	Winding
1. Number of machines								
2. Number of machines of origen								
a. Brazil								
b. Europe								
c. Japan								
d. U.S.A.								
e. Others								
3. Number of machines produced								
a. before 1945								
b. 1945-1960								
c. after 1970								
4. Estimate the average number of years you will use the machines produced								
a. before 1945								
b. 1945-1960								
c. after 1970								
5. Number of machines bought second hand								
6. What is the balance sheet value of the machines (cr $1000)								
7. What is the real value of the machines, such as they are (cr $1000)								
8. Average number of operators in March 1975								
a. first shift								
b. second shift								
c. third shift								
9. Average number of operators in September 1975								
a. first shift								
b. second shift								
c. third shift								
10. Average number of hours per week that the machines operated in 1975								
a. in March								
bb. in September								
11. Average number of hours per week that the machines did not operate due to, for example, stoppages for loading, unloading, breaks, maintenance, adjustments								

Appendix B

THE BRAZILIAN SHOE INDUSTRY

The first part of this survey will summarize information contained in the handful of reports on the Brazilian shoe industry that we have had access to[1] and Brazilian and U.S. government data. The outstanding point in each of these reports is the rapid transformation of the industry from one based on the traditional shoemaker to a major manufacturing exporter. While the character of the industry is changing, there is still a large number of handicraft cobbler-repair shops. And many of the other firms have grown out of small shops. Starting in the 1960's, exports and the volume of production have increased rapidly. It is usually argued that those firms that have increased their foreign sales--a more demanding market in terms of quality control and standardization--have tended to invest, increase production and productivity, and use more modern equipment.

The first part of this industry report will be an overview of the shoe sector, based on the secondary sources. It includes some figures on total production, the breakdown by type of shoe and exports. The section also looks at each of the two major shoe producing areas. The second section summarizes our findings on the Brazilian shoe and shoe machinery industries, based on our open ended interviews. It also suggests some topics for research.

1. The Brazilian shoe sector.

Unfortunately we do not have a long time series of data. From 1968 to 1974, the shoe sector grew rapidly, as can be seen in Table 1. The average annual rate of growth of physical production was 14 % within this period. Evidence is mixed on the relative volume of men's and women's shoe production. IBGE data give a larger value of men's shoe production, and by 1974 even a larger quantity. The regional data, however, do not support this.

The increase in production is commonly attributed to the growth of exports. By 1972, shoes were a major export for Brazil, ranking third on the list of manufactured and semi-manufactured exports. (See Table 2.) Even including agricultural produce, shoes are now about ninth on the list, with 1974 exports of 1000 Cr $814,856. (See Table 3). Within a short space of time, Brazil rose from twentieth to third place among world exporters of shoes. Concomitantly, the share of world trade in shoes accounted for by the first two exporters--Italy and Spain--has slipped. Spain especially has felt the competition for the U.S. market, which is the major foreign buyer for Brazilian shoes (77% in 1974 , as shown in Tables 4 and 5). Between 1969 and 1974, Brazilian exports grew from about 1% to about 9% of U.S. leather shoe imports, both in physical and in value terms. (See Table 6). The major increase, both in terms of pairs sold and in terms of value came from an expansion in the exports of women's shoes, though Brazil rose from fifth to third place in terms of the volume of U.S. imports of men's shoes. The total value of Brazilian shoe exports to the U.S. has grown at a 173 % annual rate between 1969 and 1973. Men's leather shoes, which are predominantly of the cemented variety, have grown at 161% a year between 1969 and 1974. In spite of this rapid growth, Brazil's exports to the U.S. account for only about 1% of U.S. shoe consumption and, therefore, allow for a substantial increase without becoming a major competitor within the U.S. market.

The rapid growth of exports is changing the character of the Brazilian shoe industry, attracting more government attention than formerly. Still, the registered exporters (those that export directly) are a very small part of

the total number of firms. Table 7 lists the exporters from the state of São Paulo (S.P.), clearly showing how concentrated the export market is. In general, however, the shoe sector is described as highly competitive. There are a large number of medium and small firms in each of the major shoe producing areas. In Rio Grande do Sul (RS), there are some 729 firms with annual sales of under Cr$200,000 in 1973. In the state of SP, there were 695. It is among the exporters, generally the large firms producing higher but not the highest quality shoes, that competition is probably oligopolistic. A few of the large firms have their own chain of stores and maintain their own marketing outlets in the U.S. The smaller firms sell to sales representatives of independent retailers, sometimes to the larger firms, and sometimes to U.S. shoe importers. They do not have their own marketing network and appear to operate in a quite competitive market.

2. Regional producing areas.

Brazil's shoe industry is largely concentrated in three areas: the city of São Paulo, which produces a heterogeneous product mix; Franca in the state of São Paulo, which largely specializes in men's leather shoes; and the Vale do Rio dos Sinos (Vale) in the state of Rio Grande do Sul (RS) which specializes in women's leather shoes. Since our study is only of men's leather shoes, we will conduct our survey only in Franca. But this report will include secondary data from the Vale and RS, to compare with the Franca market. RS accounted for about 43% of the physical production in Brazil in 1973 and 40% in 1974. By our estimate, adjusting upwards the production data of 1974 by 15%--the amount that the sample's production fell short of the population's production in Franca in 1972--Franca produced about 7%.

Franca

The city of Franca, in the state of São Paulo (SP), is in the interior of the state in a cattle raising area. The population is about 100,000. According to one estimate, 60% of the city's employment is in the shoe industry. As Table 8 shows, shoe and clothing establishments numerically dominate the industrial sector of Franca, and have been growing more rapidly than any other sector, accounting for 33% of the establishments in 1960 and 73% in 1974.

There appear to exist benefits from regional concentration, both in Franca and in the Vale. In an industry with few technological secrets, the advantages of an experienced labor force and from sharing market information appear to dominate. Several entrepreneurs located in the city of SP complained about the lack of a stable, trained labor force, and gave the availability of trained workers as an explanation for their move to Franca.

Our information on the Franca firms is limited to surveys carried out by the Instituto Econômico de Pesquisas, Estudos e Serviços de Franca. IEPES was supported by the municipal government and coordinated with the RS based organization of Instituto Brasileiro de Couros, Calçados e Afins. It functioned from 1973 to 1975, but has now dissolved. IEPES sampled 100 firms which accounted for 85% of the physical production of shoes in 1972, 85% of the employment, 89% of the sales and 100% of the exports. There was a total of 330 listed firms in 1973. Tables 9 and 10 give the size distribution of firms in the sample, according to physical production and employees. The average number of pairs produced per day per firm during the first half of 1973 was 230.

One observation has repeatedly been made: Production is seasonal. The

first half of the year is a period of low domestic sales, though exports are beginning to even out the cycle for some firms. Arco Flex, for instance, one of the largest producers in Brazil and the fifth largest exporter in SP, (Table 7) claims that it maintains a fairly constant level of production and employment through its export line. Makerli, on the other hand, again one of the largest producers and the second largest exporter in SP, admits to a large turnover annually, much of it not voluntary. A month's "vacation" in January is common, and slack production continues through June. October and November are said to be the months when the industry operates at full capacity.

Unfortunately, extended time series data are unavailable, but Table 1 gives physical production and sales for selected dates. The period is too short to be conclusive, but the table is consistent with an expansion of the sector. According to personal conversations, the major expansion came after 1972. It is clear that men's shoes and boots dominate the Franca industry, with 94% of the sales in 1974. Therefore, in our sample of firms we can randomly select firms from the population without much danger of ending with firms specializing in the production of women's or children's shoes or sandals. It is interesting to note that this product specialization suggests that the benefits from geographical concentration are in part due to marketing, rather than to technological or labor-skill enternalities.

The sample data include factor costs only for labor, and sometimes for electricity. During the first semester of 1973, labor costs (excluding social security payments etc.) varied between 12 and 19% of the total sales. The average kwh consumed per month was 480, or about one twentieth of the

cost of the shoes. Data from the UNIDO Profiles of Manufacturing Establishments show that leather can be from 40% to 67% of total sales, which suggests that attempts to economize on raw materials might be more important than on labor. Our interviews support this hypothesis, in the sense that none of the business men that we have spoken to have complained about the high cost of labor. Rather, they comment on the cost of leather and the shortage of supervisors and trained middle level personnel.

Vale do Rio dos Sinos

The Vale is in a cattle raising area near Porto Alegre in Rio Grande do Sul. In 1971, it had a population of 679,663 or about 10% of the state's. Sixteen of the 24 municipalities are shoe producers, with a total of 455 establishments in 1971, 407 in 1972, 356 in 1973, and 340 in 1974. The 340 Vale firms made up 85% of the 1974 RS shoe establishments. Of these 340, 150 are in Novo Hamburgo. Several organizations have been created to service this regional industrial concentration. Located in the same building of Novo Hamburgo are industrial syndicates of several municipalities and the Associação de Commercio e Industria de Novo Hamburgo (ACI/NH). Starting in 1963, the industry has held fairs, organized by FENAC, biennial until 1969, annual until 1971, semi-annual until 1974 and now three times a year with a special fair for machinery. The fairs have also promoted exports. The 1969 fair attracted only 6 importers, in a year when exports amounted to only US $1.8 million. In 1974, Brazil was exporting US $121 million. The COMEX, a division of FENAC, was created to advise exporters and to coordinate participation in international fairs and missions. FENAC has associated itself with the trading company BRASPETRO, selling about 100,000 pairs through it to the Soviet Union in 1974.

The data bank of the ACI/NH was founded in 1971 to carry out an annual census of the RS shoe industry. The data come from a questionnaire mailed to firms, and is based substantially on information from income tax returns: sales, employment, installed capacity, intermediate inputs, electricity consumption, area occupied and book value of capital.

It appears, then, that the RS industry is well organized and cooperating through various organizations to expand its markets. The new trade fair for machinery, also, indicates the increasing mechanization and the need to spread information at the process level and not only the product and market levels.

The declining number of firms between 1971 and 1974 has been largely among the smaller ones, while total production has increased. The average number of pairs produced per firm per year has risen from 87,568 in 1971 to 151,865 in 1974 (or from 337 per day to 584).

Of the 340 shoe firms in the Vale in 1974, 59% produce only women's shoes, 7% men's, 6% children's, 2% sandals, and 26% a combination of types. Of total shoe production, 63% is of women's shoes, 11% men's, 11% children's and 16% sandals. (See Table 11).

The size distribution of firms, presented in Table 11, allows a comparison over time in the Vale as well as between the Vale and Franca, (given in Tables 9 and 10.). First, while the total number of firms has declined in the Vale, the number of firms with more than 100 employees has risen from 69 to 98, or from 15% to 29% of the firms. The size distribution of firms producing men's shoes is more weighted towards the larger firms in Franca than in the Vale, again with the caveat that the Franca sample

includes all the largest firms but excludes some of the smaller. Wheress 20% of the Vale firms have ten or fewer employees, only 7% of the Franca firms do. And while 43% of the Franca firms have more than 50 employees, only 32% of the Vale firms do.

In certain other respects, the Franca firms appear to be less modern than the RS firms. First, the Vale firms export 38% of their production and the Franca firms (a sample including all exporters) about 27%. Second, labor costs appear to be about the same share of sales (15% in the Vale, including social security costs, and between 12 and 19% in Franca, excluding social security). If anything, labor costs appear to be a smaller share in the Vale, where the average labor costs are higher (Cr $7462 average annual salary in 1974 including social security, compared with Cr$4865 in 1973 in Franca, excluding Social security). These data do not allow a definitive comparison, but if in fact wage costs are higher where the share is smaller, the Vale's production must be more mechanized. Conversations with machinery suppliers support this hypothesis. Third, the output per worker in the Vale is almost double that in Franca: 1585 versus 868 per year in 1973 or 6.2 versus 3.4 per day.

Table 12 provides information on credit, Table 13 data on labor productivity, and Table 14 on other factor utilization.

2. Interviews and other secondary research.

A. Our preliminary interviews have been of several types:

a. Shoe firms in São Paulo, SP and Franca, SP.

We have visited many of the largest firms in the state of SP, several of the "normal" medium and small firms, and a medium one that produces high quality, man-made shoes. All the firms that we have visited produce shoes with leather

uppers, but the soles and method of attachment differ. Most firms cement the sole, but some use McKay stitching as well, and some use injection molded pvc or rubber soles.

b. Schools

SENAI, in SP city: the industry supported center which trains production workers and "mestres." It is relatively new, still lacks students, and has little industry support. It is in the process of moving to Franca.

Faculdade Pestalozzi, Franca: Founded in 1973 to train technicians and administrators. Originally supported by the firm Pestalozzi, it has since been sold and seems to be disintegrating.

SENAI, in Novo Hamburgo.

c. Machinery suppliers

International Shoe Machinery Companhia do Brasil, a subsidiary of the American company. It produces a three machine line of lasting machines for cemented shoes.

Svit: Representatives of the Czech firm, the former Bata.

USMC: Produces shoe inputs, but no machines in Brazil.

Popi, in Franca: Produces a wide variety of machines, including conveyors, presses to cement soles, machines to mount the true mocassin, presses, but not yet lasting machines.

Second hand machinery repair and sales offices in SP, city.

d. Trade fairs

FIMEC: the machinery trade fair in Novo Hamburgo, November 1975, with a large number of machinery exhibitors. There are few producers of lasting machines--Tocchetto--but a sizable number of producers of equipment to cut leather, skive etc. (the preparation for sewing) and to finish the shoe.

e. Syndicates and other associations

Syndicate, SP city: weak, a two person office.

Syndicate and Associação de Commercio e Industria de Franca: somewhat stronger.

Syndicates of the Vale.

IEPES, Franca.

Generally the syndicates and other organizations appear to be lobbying bodies. The state government of RS is reputed to give more support to the RS industry than the Franca industry receives from the SP government. The associations also organize industry fairs for shoes and shoe machinery, arrange trips to international fairs, collect a limited amount of data, and most importantly mediate labor problems. The latter appears to be the main function of the Franca syndicate. IEPES in Franca, which was associated with the RS organization of IBCCA, collected data on production, exports and the labor force from 1973-1975, when it collapsed. About 75 out of about 440 firms in Franca belong to the syndicate, including the largest and medium size firms.

f. Consultant

Zdenck Pracuch, an engineer trained by Bata in Czechoslovakia before the war, formerly director of the Faculdade Pestalozzi in Franca, employed in several of the largest Brazilian firms and now with Makerli. He has spent several hours discussing the industry and its technology with us, and has commented on our questionnaire.

B. Structure of the Industry and the Market.

Table 15 shows the size distribution of firms, by value of sales in 1973, by sector and region, for all the firms in Brazil that filed income

tax returns. Other information on the population of firms comes from the previously cited reports and newspaper stories. Unfortunately, the various sources do not quite coincide. According to the Jornal da Tarde (28/7/75) there are 1298 shoe firms in S.P., compared with Table 15's estimate of 1129, and 3916 in Brazil compared with 2536. Of the S.P. firms, about 450 are in Franca.

The large number of firms, even considering only those specializing in the production of men's leather shoes, probably results in a quite competitive domestic market. The export market, however, is limited to a much smaller group of firms. Out of about 3900 firms in the whole country, only 150 exported in 1974 and of these, 40 accounted for about 83% of the exports. The largest (Arthur Lange, S.A. in RS) accounted for 6%. In S.P., where the exports are predominantly of men's shoes, there were 60 exporters. The entire list of S.P. exporters and figures on concentration is given in Table 7.

About five of the large firms--for instance, Samello--have their own shops, but the great majority produce to order and on credit, using travelling salesmen and independent buyers. Exports are mainly through middlemen importers, who go to the major shoe centers. A few of the large firms make direct contact with foreign shoe sellers at international fairs. A still smaller number maintain offices in the United States.

Terms of credit on sales are generally 30-90 days. It is common also to buy leather, soles, etc. with 30-90 day financing. While the repayment period might be the same, it appears as if the average price of leather is lower for large purchases. Machinery sales, especially for export production,

can be financed through the Banco do Brasil and FINAME. More generally, the machinery producers provide credit. (Svit's financial branch, Investa, gives credit up to 360 days from the date of embarcation. USMC, on the other hand, works through FINAME.) With the recent tightening of import controls, only the exporting firms will probably have access to imported machinery, and that means only the large firms.

The producers in the city of S.P. are frequently of Armenian background. Those in Franca are more likely to be of Italian or Spanish origin. While there are some multinationals-- a division of Bata, producing pvc shoes in Minas Gerais, for instance--the sector is mainly national. The president of the Franca syndicate said all the Franca firms are national.

C. The Product

Most of the firms produce shoes with leather uppers, though a few of the largest make entirely synthetic shoes or shoes with cloth uppers. As far as we know, all the Franca firms produce leather upper shoes. The soles, however, can be of leather, rubber or of pvc. The method of attachment also differs. In most cases, the soles are cemented. Sometimes, the soles are McKay sewn as well. Much rarer are goodyear welt shoes. A few firms, perhaps five in the whole country, vulcanize the soles. A similar number inject the pvc sole directly onto the upper. Most firms, however, using pvc or rubber soles buy the soles.

It is not yet clear to me why Brazil should specialize in the production of cemented shoes. The more sewing involved, as a rule, the more labor intensive is the production process. High quality welted shoes should be the most labor intensive of the shoe varieties. But since goodyear welted

shoes are expensive, they are not frequently consumed in Brazil and therefore, there is no domestic experience to grow from. Moreover, goodyear welt shoes have been declining in US consumption. In 1974, they made up 14% of non-rubber shoe consumption (down from 20% in 1958), whereas cemented shoes made up 55%. (See Table 16).

D. Subcontracting.

The Brazilian adaptations which are labor using appear to come more from an adaptation of the market structure and process than of the product. The product choice--cemented leather shoes--is certainly more labor intensive than injected or vulcanized shoes, but less so than sewn shoes. More important, as far as overall labor absorption in Brazil is concerned, is the existence of subcontracting, to take advantage of home production and to economize on the use of expensive equipment.

Both large and small firms subcontract. The most commonly subcontracted part of the production--used by several of the largest and many of the smallest firms--is the sewing of the uppers. Most factories work one shift, with extra hours during peak seasons. Household workers (women), on the other hand, do not have fixed hours, can combine sewing with other activities, and work longer hours than the regular shift. By paying for the piece, the contracting firms can avoid paying the minimum wage plus benefits. The sewing machines might belong to the household worker, but typically are rented or supplied by the contracting firm.

Other operations can also be subcontracted. The small firms, for instance, might subcontract the making of decorative holes or the holes for laces and McKay stitching of the soles. These are operations where a mechanized process, with a relatively high daily output rate seems to be

more profitable than the manual process at the existing factor prices. The medium and small firms all hire specialized designers to make the models and lasts. Only the largest firms make their own pvc or rubber soles. In at least one case, a large firm even makes its own cement and matal cams for cutting leather.

Subcontracting, then, serves two functions. In the most labor intensive part of the production process, sewing, it uses cheap labor without paying the minimum wage. All sizes (but not all firms) take advantage of this kind of subcontracting. In the more capital intensive operation, such as McKay stitching, perfurating and the production of soles, and in the skill intensive operations such as designing, full capacity utilization of the worker or machine can be maintained by subcontracting. Only the smaller firms use this type of subcontracting.

The larger firms that do not subcontract or claim that they want to eliminate their subcontracting, say that it is difficult to control a diversified product line when production is not centralized.

E. Technology

The second major adaptation to local conditions and to the different situations faced by large and small firms comes in the production technique for particular operations.

The sector uses both national and imported equipment. The national is generally simpler and less mechanised than the imported equipment. The more complex operations such as lasting and sewing have few national suppliers (Tocchetto, International Shoe Machinery, a proposed installation of Popi and maybe a few others for lasting; Pfaff and Singer who assemble in Brazil

for sewing), whereas the competition among national suppliers of finishing machines is stronger. Machinery is also imported from the United States, England and Germany, Italy and Czechoslavakia, in approximate order of cost.

The large firms in Franca are expanding, buying new equipment, keeping some of their older machines, but also selling many. The smaller firms have quite a high rate of turnover and frequently use second hand equipment, one small firm buying from another or from a large firm which is modernizing. Increased production of cheaper, more easily maintained national equipment (simpler machines and easier access to parts) is also encouraging mechanization among some of the smaller firms. There does not appear to be any import of used equipment, since government financing and import credits are not available for used machinery.

As a result of the rapid growth both of shoe and of shoe machinery production, there is a great variety of production methods existing side by side. The lasting operations, which are central to shoe production, run the whole gamut from entirely manual, with tacks; to a mocassin, pull-over lasting with relatively simple equipment and hand sewing; to a two machine, operator controlled, cement lasting process (such as Tocchetto's); to a three machine cement lasting, semi-automatic system (such as International Shoe or Svit); to USMC's most modern equipment including their two machine lasting system. The full capacity, one shift scale of production increases from about 36 pairs a day for two workers in the hand lasting process, to about 300 pairs for Tocchetto, 1500 for Svit and International Shoe, and 2000 for USMC , using three workers each.

While the process used depends to some extent on the scale of production, simple reference to scale or different market conditions does not

seem to explain all the observed differences. In some cases, the owners simply seemed to like the machine (the expensive McKay stitching machine at Fascar's operating three hours a day) or thought that it would help control production and organization (such as the conveyor in Gasparzinho's which required additional equipment operating with excess capacity). In some cases, there is a strong preference for buying locally produced machines, which have better servicing, but others, as Italian-Brazilian firms, might prefer to buy Italian machines, with poor maintenance networks. To understand the extent to which the differences and choice of techniques depends on such "non-economic" factors requires more detailed, firm level information.

F. Innovation

There is no national or state research institute for shoes. For a while, it appeared as if the Faculdade Pestalozzi would train administrators and directors of production, who might be more open to change than the traditional shoe maker, but that no longer is likely. Government export promotion agencies have little contact with the Franca firms and do not seem to handle any technological questions. As the industry is almost entirely national, there is no transfer of information from the MNC headquarters. With the exception of Pracuch, we have heard of no consultants with any technical expertise.

The innovations that do occur come either from the machinery suppliers, embodied in new equipment, or from within the firm itself. Moreover, the innovations are usually not of a patentable variety. The 24 patents registered in the shoe industry from January through October 1975 are predominantly, if not entirely for models. Of these, 15 were taken out by the same firm,

which has English minority ownership and is one of the few to use vulcanizing processes. Several of the other patents also come from the firms that supply rubber soles.

The predominance of patents for models supports what we know about the technical training and literature received by the directors of production. Those firms that make their own model designs subscribe to Italian fashion magazines, but only the biggest subscribe to technical journals. Few firms have trained engineers on their staff, and the mechanics are self-taught.

More important than patents must be the many unregistered adaptations: layout changes to economize on space or transport and to facilitate productivity control; planning systems to save on inventories, shortage of materials, and penalties for late delivery; model changes to save on leather (more pieces to use scraps of leather or imitation mocassin to eliminate the innersole); model changes to save on labor (fewer pieces and less sewing); transport changes (conveyor racks) to control the rhythm of production, etc.

The kinds of innovations might differ according to the size of firm: For example, one larger firm said it selected designs to economize on sewing and labor; smaller firms appear to use more pieces. A medium size firm has just introduced a planning chart, whereas a smaller firm leaves all its buying and selling to another firm (from which it is a spinoff). Those firms which use conveyor racks justify the investment by reference to productivity control and rhythm of production, never to labor costs. Therefore, even though there is a minimum scale of production associated with the conveyor rack, for the same size of firm, some use conveyor systems to control production and others not.

Before drawing any conclusions about innovations, we need a lot more information on the characteristics of the innovations and of the firms making them.

Footnotes

[1] Diagnóstico da Industria de Calçados de Franca e do Estado de São Paulo, BADESPE, 1975.

Contribuição Estatística à Industria de Calçados em Franca, vol. 1, Instituto Econômico de Pesquisas, Estudos e Serviços de Franca, 1978.

Produção de Calçados No Sul, Censo da Industria de Calçados do Vale do Rio dos Sinos, Associação Comercial e Industrial de Novo Hamburgo, 1971.

Table 1

Shoe Production

Year, area	Men's Shoes Pairs (000)	Men's Shoes CR$(000)	Men's Boots Pairs(000)	Men's Boots Cr$(000)	Women's Shoes Pairs(000)	Women's Shoes Cr$(000)	Sandals Pairs(000)	Sandals Cr$(000)	Children's Shoes Pair(000)	Children's Shoes Cr$(000)	Total pairs(000)	Total Cr $(000)
1968 Brazil											61,637	
Vale											24,655	256,178
1969 Brazil											62,721	
Vale											23,835	275,587
1970 Brazil											70,428	
Vale											26,763	341,305
1971 Brazil											88,642	
Vale	5,614	87,593			24,134	451,672	3,718	50,413	4,423	55,416	39,889	645,694
1972 Brazil											92,208	
RS											42,855	882,959
Vale											41,494	847,101
1973 Brazil											125,000	
RS											53,932	1,464,062
Vale											51,853	1,384,940
France	7,328	368,022	146	7,742	34	1,670			303	7,250	7,812	384,684
1974 Brazil											134,425	
RS	5,594	238,689			33,669	1,158,750	8,186	215,604	5,776	148,964	54,376	1,802,170
Vale	4,188	162,320			32,777	1,132,612	8,131	214,635	5,536	140,368	51,634	1,684,459
France	7,112	442,934	275	19,522	56	3,332			137	4,003	7,607	469,791
1975 France*	2,783	197,296	38	3,408	58	4,651	28	1,182	20	603	2,927	207,140

*Jan. - June only.

Sources: IEPES data for France cover a sample of 100 firms.
ACI/NH for RS and Vale, which is a region of RS, and Brazil.

Table 2

Principle Manufactured and Semi-Manufactured Exports, 1972

Principle Products	Value (US$ millions)	%
Pine timber	59.7	10.12
Timber other	12.8	2.17
Cocoa butter	33.1	5.61
Peanut oil, unrefined	27.4	4.64
Mamona oil, unrefined	53.8	9.12
Processed coffee	67.9	11.51
Shoes	54.5	9.24
Processed beef	50.5	8.57
Laminated metal	23.7	4.02
Cotton yarn	22.7	3.85
Laminated wood	24.8	4.20
Office machinery	30.9	5.24
Molasses	13.5	2.29
Menthal	21.7	3.68
Essential oils	12.0	2.03
Fruit juices	43.6	7.39
Cotton cloth	25.8	4.37
Glass	11.5	1.95
Total	589.9	100.00

SOURCE: CACEX

Table 3

Shoe Exports

Year, area	Men's Shoes & Boots Pairs(000)	Men's Shoes & Boots CR$(000)	Women's Shoes Pairs(000)	Women's Shoes CR$(000)	Sandals Pairs(000)	Sandals CR$(000)	Children's Shoes Pairs(000)	Children's Shoes Cr$(000)	Total Pairs(000)	Total Cr$(000)
1968: Brazil									60	
1969: Brazil									1861	
Vale									206	
1970: Brazil									3778	
Vale									2221	21,247
1971: Brazil									10,637	
Vale	168	4380	4103	67751	1839	17140	88	1662	6183	92,729
1972: Brazil									15675	320,824
RS									11,686	246,052
Vale									11,656	245,385
1973: Brazil									21,604	566,477
RS									17,738	427,700
Vale									17,585	419,625
Franca									1,953	100,065
1974: Brazil									27,786	814,856
RS	280	16,708	15,131	417,150	2783	53901	1617	35,751	20,123	533,784
Vale	209	11,362	15,150	396,414	2764	53500	1605	35,092	19,573	518,504
Franca	2044	120,616	10	433			5	160	2034	122,146
1975:										
Franca*	692	45,552	5	233	8	426			702	47,642

*June-July only

SOURCE: IEPES data for Franca, covering all the export firms.
ACI/NH for RS, Vale, Brazil.

Table 3

Principle Markets for Brazilian Shoes, 1972

Markets	Value exported US$ million	Millions of pairs	% of value
U.S.A.	47,4	13,743	87,13
Canada	2,8	741	5,15
U.K.	1,4	358	2,57
Other	2,8	834	5,15
Total	54,4	15,676	100

SOURCE: CACEX

Table 5

U.S. Shoe Imports: Percentage Distribution by Country of Origin and Type of Shoe

	1st semester 1972		1st semester 1973	
Women's Shoes	Pairs	Value	Pairs	Value
Italy	62.3%	61.0	54.1	53.0
Spain	21.9	25.9	18.2	22.7
Brazil	7.0	5.4	15.0	12.7
India	3.3	1.0	2.9	.8
Mexico	.8	.5	1.5	.9
France	.4	1.0	.4	1.0
Others	4.3	5.2	7.9	8.9
Men's Shoes				
Italy	33.4	39.5	30.0	35.0
Spain	27.6	23.2	21.9	20.7
France	5.4	4.9	--	--
Germany	5.3	6.2	3.2	4.2
Brazil	5.0	4.8	9.1	8.7
India	--	--	2.7	.5
Mexico	1.8	2.4	--	--
Others	21.5	19.0	33.1	30.9

SOURCE: CACEX

Table 6

U.S. Imports: Shoes

SITC	DESCRIPTION	$1969	PR 1969	$1970	PR 1970	$1971	PR 1971	$1972	PR1972	$1973	PR1973	$1974	PR1974	Ct.
851.0223	Footwear, leather welt, for work, over $2 per pair	-	-	-	-	2,507	302	20,727	4,608	59,868	11,544	9,091	1,860	B
		-	-	-	-	648	144	19,462	2,880	92,362	18,600	210,448	37,168	C
		3,241,069	738,749	4,565,472	954,181	67,257	16,946	162,145	42,372	636,479	142,044	1,293,527	214,848	T
						5,820,537	1,194,580	8,007,506	1,534,457	14,287,116	2,594,078	15,949,069	2,633,740	TT
851.0229	Footwear, leather, welt, NES, for men over $2 per pair	73,387	7,435	268,466	31,142	665,051	78,809	139,409	54,926	446,619	63,268	427,204	48,692	B
		-		8,009	1,704	41,940	12,108	88,987	18,390	80,279	17,049	18,388	3,000	C
		-	-	34,933	10,124	72,743	17,544	126,590	35,150	499,895	111,156	683,534	122,352	T
		27,221,244	3,737,100	24,508,666	3,194,778	30,920,704	3,979,370	25,861,325	2,899,804	26,937,555	3,061,943	25,901,402	2,693,681	TT
851.0234	Footwear, leather welt, NSPF	12,095	1,764	13,021	2,116	150,795	20,383	62,989	12,366	90,922	8,124	40,092	5,028	B
		-	-	3,666	2,772	-	-	-	-	-	-	2,861	612	C
		-	-	-	-	-	-	27,792	9,465	19,089	5,692	71,199	16,114	T
		1,775,755	188,134	2,755,344	338,677	4,137,645	529,212	3,508,577	416,843	2,918,980	263,918	3,654,038	329,255	TT
851.0237	Footwear, leather McKay-sewed	-	-	1,510	367	24,349	4,784	39,116	5,298	26,374	2,553	-	-	B
		-	-	-	-	-	-	9,579	3,996	-	-	-	-	C
		-	-	-	-	-	-			395	86	-	-	T
		167,420	35,960	191,365	44,602	194,699	27,607	213,448	24,848	248,740	29,631	213,331	32,184	TT
851.0242	Footwear, leather athletic, NSPF, exc. McKay and turn or turned	41,434	4,992	11,019	2,312	28,067	17,010	35,822	18,754	84,359	10,032	438,063	73,946	B
		-	-	-	-	24,233	6,383	57,074	15,488	10,295	4,100	2,488,924	510,533	C
		5,778	1,501	9,905	7,128	101,480	30,241	284,638	90,844	503,998	136,022	1,179,914	255,684	T
		12,259,679	2,022,476	20,591,944	4,073,786	27,586,707	5,179,953	37,109,739	6,020,871	46,926,509	6,104,538	55,430,920	7,265,718	TT
851.0243	Footwear, leather, women, youths and boys, NSPF	988,809	334,448	3,023,216	1,064,809	6,532,751	1,525,407	13,259,188	2,461,219	25,983,800	3,882,695	27,538,827	3,817,633	B
		1,212	200	40,322	12,996	583,089	171,053	1,336,156	364,604	2,159,125	528,313	1,249,184	282,480	C
		83,594	36,944	15,739	10,992	57,360	20,936	648,316	291,472	2,110,777	686,905	1,829,298	472,466	T
		88,827,926	23,331,448	108,688,367	26,849,255	133,387,165	29,241,069	182,922,117	32,558,838	214,585,102	32,609,724	205,586,776	28,332,232	TT
Total of the above		1,115,725	348,639	3,317,232	1,100,746	7,403,520	1,646,695	13,557,251	2,557,171	25,691,942	3,978,216	29,253,208	3,729,111	B
		-	200	51,997	17,472	64,991	189,688	1,511,258	405,358	2,342,061	568,062	3,987,822	825,543	C
		89,372	38,445	60,577	28,244	298,840	85,667	1,249,481	469,303	3,770,633	1,081,905	5,142,596	1,056,648	T
		133,493,093	30,073,867	161,301,158	35,455,279	202,047,457	40,151,800	257,622,712	43,455,661	305,904,002	44,663,832	306,735,536	41,284,810	TT
851.0	Footwear, new exc. orthopedic	1,502,099		6,534,542										
		116,250		247,337						83,267,111				B
		21,827,330		39,973,741						2,918,413				C
		488,172,106		629,401,742						143,498,639				T
										1,079,166,190				TT

Source: U.S. Bureau of the Census: U.S. Imports.

B: Brazil
C: Colombia
T: Taiwan
TT: Total
Ct: Countries

Table 7

Shoes

64.02.01.00. Leather shoes
64.02.03.00. Leather boots
64.02.04.00. Leather sandals and slippers
64.03.00.00. Wood shoes or shoes with wood or cork sole

Company	Exports, state of São Paulo, 1972, ($,FOB)				
	64.02.01.00	64.02.03.00	64.02.04.00	64.03.00.00	TOTAL
1. Aci Com. Internacional	80,764				80,764
2. Acrio Cia Ltda	467,111	147,457		9,000	614,568
3. Alceu Tonnato	31,131		24,442		55,573
4. Danílio Dudus	78,181	17,585			95,766
5. Deeaud Ind. Com.Art.Couro Ltda			810		810
6. Bettarello S.A. Com. Ind. Calçados	161,646	3,680			165,326
7. Calçados Atlântida Ltda	6,020				6,020
8. Calçados Horizonte Ltda	1,600		1,992		3,592
9. Calçados King Day Ltda	10,980	219,433			230,413
10. Calçados Martiniano S.A.	27,216				27,216
11. Calçados Paragon S.A.	88,805	15,808			104,613
12. Calçados Roberto Ltda	28,950				28,950
13. Calçados Samello S.A.	627,354	4,404,058			5,031,412
14. Calçados Sândalo S.A.	215,121				215,121
15. Calçados Terra S.A.	435,283	7,241			442,524
16. Camillo Ferrari S.A. Ind. Com.	135,638	139,604			275,242
17. Castanho Calçados S.A.	477				477
18. Cintra Coelho Ltda Calçados Cincoli	46,740				46,740
19. Classic Ind. Calçados Art. Couro	74				74
20. Cia Bras. Calçados Cobramil	44,452				44,452
21. Cia Calçados Palermo	257,151	9,840	19,385		286,376
22. Cia Calçados Semerdjian	639,458	5,335	308,004	5,400	956,197
23. Cia Ind.Bras.Calçados Vulcan-Vulcabras	497,832	269,511			767,393
24. Cia Ind.Com. Induscal	8,751	71			8,822
25. Cia Prada	132,179	43,041			175,220
26. Com. Imp. Exp. Liege Ltda			600		600
27. Decolores Calçados Ltda	126,598		994		127,592

Table 7 (continued)

Company	Exports, state of São Paulo 1972, ($FOB)				
	64.02.01.00	64.02.03.00	64.02.04.00	64.03.00.00	TOTAL
28. Forte e Filhos Ltda	15,015				15,015
29. Francisco Mucillo e Cia Ltda	2,328				2,328
30. Fund. Educandário Pestalozzi	682,514	1,766			613,590
31. Hercules S.A. Ind. Reunidas	165	20,679	1,037		21,881
32. Ikatrex Imp. Exp. Ltda	950	6,131			7,081
33. Ind. Calçados Arno-Flex S.A.	78,719	450,944	100,257		629,920
34. Ind. Calçados Dacle S.A.	10,768	14,557			25,325
35. Ind. Calçados Elbena S.A.	54,751				54,751
36. Ind. Calçados Formica Ltda	26,448	2,160			28,608
37. Ind. Calçados Kuchkarian S.A.	200	211,008	238		211,446
38. Ind. Calçados Lar Ltda			304		304
39. Ind. Calçados Helnon Palermo S.A.	85,452	4,464			89,916
40. Ind. Calçados Pal-Flex S.A.	15,800				15,800
41. Ind. Calçados Sólido Ltda	14,005				14,005
42. Imp. Exp. Michimen do Brasil Ltda	158				158
43. Jarbas Faracco S.A.	59,312				59,312
44. Kevin Apovian S.A. Ind. Com. Calçados	1,953				1,953
45. Lojas Mazode Ltda	3,280				3,280
46. Luciano S.A. Ind. Com. Calçados	3,186				3,186
47. Makerli S.A. Ind. Com. Calçados	1,437,362	623,244			2,057,606
48. Manuf. Bras. Calçados Ltda	20,273	106			20,379
49. Mifrabras Com. Exp. Minta Franco Bras.					90
50. Organização Social Educacional	23,827	543,053			566,880
51. Pereira Neto Oliveira Cia. Ltda			921		921
52. Popi Ind. Com. Calçados Ltda	281				281
53. Rachel e Assumpção Ltda	94,611		11,244		105,855
54. Rebelle Calçados e Bolsas Ltda	115		146		261
55. Rios e Nunes Ltda	214,188				214,188

Table 7 (continued)

Company	Exports, state of São Paulo 1972, ($FOB)				
	64.02.01.00	64.02.03.00	64.02.04.00	64.02.05.00	TOTAL
56. São Paulo Alpargatas S.A.			33,928	-	33,928
57. Iquald Calçados Ltda	449,031				449,031
58. Tecna Eng. de Manuf. Prod. e Process.Ltda	19,875		44,334	-	64,209
59. Valdir A. Pereira	8,447				8,447
60. Verbania Ind. Calçados Ltda	10,667				10,667
TOTAL	7,480 ,283	7,158,086	548,726	14,400	15,201,495
% of largest firm	19,2	61,5	56,1	62,5	33,0
% share of 3 largest firms	45,2	77,8	82,5	100,0	52,8
% share of 5 largest firms	51,9	87,9	93,1		62,4
% share of São Paulo firms in total exports	23,8	56,1	6,3	6,5	28,1

Table 8

Number of Manufacturing Establishments, by Sector, in Franca

Sector	Number of Establishments 1960	1967	1974	Act. rate of gro
Mineral Products	1	--	--	
Non-metallic minerals	8	4	13	.04
Metallurgy	8	8	20	.07
Machinery	3	6	16	.13
Electrical and Communication equipment	--	--	1	
Transport	6	--	1	-.12
Wood	20	11	13	-.03
Housing	9	15	21	.06
Paper	7	8	6	-.01
Rubber	2	4	6	.08
Leather and Skins	15	17	25	.04
Chemicals	4	4	12	.08
Phamaceuticals	1	--	--	
Cosmetics, soap, candles	1	1	2	.05
Plastics	--	1	3	
Textiles	3	3	5	.04
Clothing and Shoes	73	198	572	.16
Food Products	51	30	26	-.05
Beverages	2	2	5	.07
Tobacco	--	--	--	
Printing	10	12	21	.05
Other	--	--	--	
TOTAL	224	324	780	.09

SOURCE: 1960 Censo Industrial - IBGE, 1967- Registro Industrial- Depto. de Estatistica, 1974- Cadastro Industrial - Secret. da Faz. do Est. SP.

Table 9

Number of Franca Establishments According to Pairs Sold in the (Domestic Market) or in the Foreign Market, June 1973*

Sales in pairs	Women	Men	Children	Boots	TOTAL
0-100		2(1)	(1)	1	3 (2)
101-200					
201-500		1(1)	(2)	(1)	1 (4)
501-1000		(8)	(1)		(9)
1001-2000		3(19)			3 (19)
2001-4000		6(29)	(3)		6 (32)
4001-10,000		6(25)	1(2)	(1)	7 (28)
10,001-30,000		1(13)		1	2 (13)
TOTAL		19(96)	1(9)	2(2)	22 (107)

*Double counting of firms that sell both for exports and domestically
SOURCE: IEPES

Table 10

Number of Franca Establishments According to Number of Employees, March 1973

Number of employees	Number of Establishments				
	Woman's shoes	Men's shoes	Children's shoes	boots	TOTAL
0-10	--	7	2	--	9
11-50	1	48	7	--	56
51-100	--	23	1	--	24
101-200	--	8	--	--	8
201-500	--	9	--	2	11
500-1000	--	2	1	1	4
More than 1000	--	--	--	--	
TOTAL	1	97	11	3	112

SOURCE: IEPES

Table 11

Number of Establishments According to Sales, Vale 1974

Sales (1000 pairs)	Women's shoes	Men's shoes	Children's shoes	Sandals	Other	TOTAL
0 - 10	41	8	1		15	66
11 - 50	70	8	8	--	19	105
51 - 150	45	6	9	1	19	80
151 - 500	31	3	--	5	26	65
501 - 1,500	14	--	--	--	5	19
1501 - 5000	--	--	1	1	3	5
5000 or more	--	--	--	--	--	--
TOTAL	201	25	19	8	87	340
Sales (Cr$ 1000)						
0 - 100	9	4	--	1	8	22
101 - 500	37	1	7	--	15	60
501 - 1,500	33	4	6	1	13	57
1,501 - 5,000	74	11	5	1	23	114
5,001 - 12,000	33	5	1	1	17	57
12,001 to 30,000	13	--	--	3	6	22
30,001 or more	2	--	--	1	5	8
TOTAL	201	25	19	8	87	340

SOURCE: ACI/NH

Number of Establishments According to Number of Employees, Vale

Table 11 (continued)

1974

Employees	Women's Shoes	Men's shoes	Children's shoes	Sandals	Other	TOTAL
0 - 10	41	5	6	1	15	68
11 - 50	61	12	7	--	26	106
51 - 100	41	3	5	2	17	68
101- 200	38	4	1	1	15	59
201 - 500	12	1	--	3	11	27
501 - 1000	6	--	--	--	2	8
1001 - 1500	1	--	--	--	2	3
1501 or more	--	--	--	1	--	1
TOTAL	200	25	19	8	88	340

1971

0 - 10	119	9	7		21	150
11 - 50	96	16	15		27	154
51 - 100	61	5	4	1	11	82
101 - 200	28	2	3		13	46
201 - 500	8	1		1	8	18
501 - 1000	2				2	4
1000 or more				1		1
TOTAL	308	33	29	3	82	455

SOURCE: ACI/NH

Table 12

Sales, According to Terms of Credit, Vale, 1973-74

Type	Cr$ 1973	Cr$ 1974	% 1973	% 1974
Cash	419,571,064	484,265,665	28.7	26.9
30 day financing	152,041,553	206,863,500	10.4	11.5
30-60 day financing	431,080,627	523,611,944	29.4	29.1
60-90 day financing	364,111,884	468,469,400	24.9	25.9
more than 90 day financing	97,257,688	118,954,518	6.6	6.6
TOTAL	1,464,062,816	1,802,170,027	100.0	100.0

SOURCE: ACI/NH

Table 13

Average Productivity (Pairs/Production Employee)

	1971	1972	1973	1974
Pairs/production employee				
Vale	1563	1535	1585	1611
Franca			868	

SOURCE: ACI/NH , IEPES

Table 14

Factor Utilization, 1974/RGS (1971 Vale)

Average area occupied per firm (m^2):	
for production	796
for administration	88
for storage	87
Average installed capacity (HP) per firm:	343
Average electricity consumed (kw) per firm:	
1974 RGS	57,565
1971 Vale	31,510
Average electricity consumed (kw)per shoe	
1974 RGS	.42
1971 Vale	.41

SOURCE: ACI/NH

Table 15

Number of Shoe Firms by Size Classification (Cr$000), 1973[1]

Sales (Cr$000)	São Paulo	South	Northeast	North-Central West
63,791	1			
46,134		1		
10,479			1	
10,000-30,000	9	14	--	
2,000- 10,000	65	113	2	
500-2,000	178	181	14	
200-500	181	168	9	
50-200	352	287	29	
Less than 50	343	442	67	
TOTAL	1129	1206	122	79

[1]"São Paulo" includes all firms filing income tax forms in the state of São Paulo.

"South" includes those in Rio Grande do Sul, Santa Catarina, Paraná, Rio de Janeiro, Espirito Santo and Minas Gerais.

"Northeast" includes the census definition of the Northeast.

"North-Central West" includes all others.

SOURCE: income tax returns.

Table 16

TOTAL DOMESTIC FOOTWEAR CONSUMPTION CALENDAR 1958 - 1971 (pairs)

Calendar Year	DOMESTIC NON-RUBBER FOOTWEAR: Oxfd. & Casual Vulc.	Moccy & Lock-stitch	Stitch-down	Welted Prewelt Turn	Cement	Soft Soles	Inj. Mold. Socary String	Inj. Mold String	Vulcan Direct Socary String	Vulcan Direct String	TOTAL NON-RUBBER	DOMESTIC CANVAS-RUBBER: Inj. Mold String	Vulc. Direct String	Vulcan Auto.	Slush Molded	Inj. Shoe Mold	TOTAL CANVAS RUBBER	TOTAL DOMESTIC PRODUCTION	IMPORTS: Non-Rubber Leather	Non-Rubber Total	Canvas Rubber	TOTAL IMPORTS	TOTAL U. S. CONSUMPTION
1958	113,[illegible]	[illegible]	35,[illegible]	11,515	327,543	26,321	-	-	-	-	577,100	-	9,000	78,000	-	-	87,000	664,100	-	33,490	3,248	36,738	700,838
1959	123,445	[illegible]	40,185	12,348	354,098	32,810	3	-	-	-	637,400	-	28,461	69,000	-	-	97,461	734,861	-	32,177	12,614	34,791	769,652
1960	116,753	44,115	37,030	9,741	348,895	26,331	255	-	-	-	600,900	-	33,460	77,000	-	-	110,460	710,460	-	26,639	30,631	57,070	767,514
1961	109,392	42,047	41,529	9,388	339,519	46,764	2,301	-	2,000	-	591,900	-	40,464	93,000	-	-	133,464	726,364	-	36,704	28,676	65,260	791,624
1962	105,497	44,273	36,036	9,186	337,592	47,010	7,331	-	4,000	-	591,900	-	49,[illegible]	99,000	-	-	133,000	724,900	-	43,018	29,225	72,243	796,[illegible]
1963	93,211	39,259	28,314	7,739	349,116	57,087	18,635	-	5,000	-	604,300	36	59,100	81,000	-	-	140,036	744,336	-	53,279	28,676	81,946	826,282
1964	94,169	37,088	23,323	7,332	344,437	62,[illegible]	12,289	-	7,000	-	630,062	8,000	65,436	94,172	-	-	167,728	797,790	-	75,372	29,263	104,635	902,425
1965	91,635	35,635	19,969	7,313	372,569	62,450	14,591	-	9,082	-	658,157	21,448	58,548	103,122	-	-	183,118	841,275	36,722	87,633	33,363	120,535	919,193
1966	94,[illegible]	31,153	16,354	6,259	334,531	69,739	13,695	-	11,287	-	668,045	38,484	50,342	75,961	-	-	154,787	853,631	46,036	94,135	35,653	131,135	984,824
1967	87,178	31,135	13,463	5,124	355,247	63,119	12,616	1,090	12,201	-	634,235	49,372	42,588	88,640	1,023	-	181,605	816,340	61,567	129,137	44,659	173,734	990,[illegible]
1968	87,316	29,335	11,831	5,295	331,634	55,319	15,571	10,090	13,069	-	659,011	55,640	39,242	94,004	5,680	-	194,695	853,526	86,195	175,291	49,266	224,557	1,078,[illegible]
1969	77,523	30,904	11,631	5,114	342,046	59,455	16,532	20,090	13,110	-	664,089	64,923	26,116	75,327	9,829	-	176,195	782,334	96,851	202,840	44,463	246,563	1,028,897
1970	75,141	44,613	13,722	4,134	323,138	58,382	18,652	30,090	8,839	-	576,879	64,015	17,337	60,531	9,762	552	152,187	729,066	120,051	241,560	49,726	291,285	1,020,351
1971	75,429	34,859	20,133	4,271	359,559	53,630	16,728	35,009	6,612	-	554,377	74,385	16,214	68,166	11,034	389	161,237	715,774	139,183	268,559	63,872	332,441	1,047,215
1972	74,783	24,599	15,255	3,604	321,317	52,633	16,163	40,000	6,573	-	556,738	87,195	16,718	[illegible],348	10,173	374	163,762	720,438	143,658	295,665	58,880	354,525	1,075,123
1973	79,[illegible]	25,156	11,174	2,936	305,134	47,343	14,312	37,335	6,784	2,191	525,560	68,197	14,[illegible]	47,654	8,671	134	159,081	684,361	148,325	315,514	66,250	381,864	1,067,165
1974	67,150	25,488	11,119	3,774	268,645	34,329	13,116	31,301	6,634	1,007	483,111	81,511	12,356	49,822	6,511	171	150,571	633,732	127,030	194,457	67,912	262,379	996,171

NOTE: Domestic Non-Rubber Footwear includes an estimate of Injection Molded - String Lasted Footwear for the years 1967 - 1972 previously reported as Domestic Canvas-Rubber

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