A CROSS SECTIONAL MICRO ANALYSIS OF PRODUCTION:
THE CASE OF VENEZUELAN MANUFACTURING

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
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*** ***

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FIELDS OF STUDY

Economic Theory
Economic Development
Econometrics
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CHAPTER I
INTRODUCTION

The central focus of this study is to examine in the context of micro firm-level production functions a variety of hypotheses and issues dealing with the manufacturing sector in less developed countries (LDC's). Such work is of vital interest for two reasons. First, there is a real dearth of empirical studies of the manufacturing sector in LDC's. In spite of the fact that most LDC's depend upon this sector to provide the dynamism to their plans for rapid growth, employment and industrialization, little information on the performance and productive capacity of this sector is available. Second, empirical studies of this sector's performance even in the developed countries have been based on sector or industry level data. The Venezuelan manufacturing sector provides a unique opportunity. It provides much needed information at a level of aggregation that could be most useful to economic planners attempting to allocate scarce resources to this sector.

This study thus has both a methodological and empirical content. The former focuses on the proper specification and estimation of industry production functions using firm-level data hitherto unavailable. The
latter attempts to apply this methodology to firm specific Venezuelan manufacturing census data to examine both the functional and variable specifications. This empirical part attempts to pinpoint factors that significantly affect industrial production to show how they differ by industry and region. The firm level data base in this study permits a more complete breakdown of inputs than has been available in most other empirical studies. This study also hopes to show how data obtained from firm level census surveys may be used to provide information relevant for industrial policy in the LDC's.

The study is limited to the manufacturing sector of one less developed, but rapidly developing, country. The industrial sector is of particular interest to the less developed nations for a number of reasons. The Western European and Japanese experience has shown that economic development is characterized in the earlier stages by a shift in national employment from the agricultural to the industrial sector. This transformation is one of the few broad generalizations regarding economic development that can be validated.

Kuznets has stated that "a country's economic growth may be defined as a long-term rise in capacity to supply increasingly diverse economic goods to its population, this growing capacity based on advancing technology and the institutional and ideological adjustments that it demands."¹ In the development sphere this means initially a transition from agricultural to nonagricultural products and later a

movement from industrial production to the provision of services. Within the industrial sector, this usually involves a relative shift from income inelastic to income elastic industrial products.

Several arguments have been advanced in favor of industrialization. Industrialization provides employment for underemployed and unemployed labor in the agricultural and service sectors. It allows a high rate of investment and thus a high rate of economic growth for the economy. It provides positive externalities in terms of changing the attitudes and skills of the people. Thus, Myrdal claims that "industrial growth is . . . not only important in itself but is a vital catalyst for a larger economic transformation . . . creation of external economies in the widest meaning of the term includes such institutional and attitudinal changes as the development of markets, the rationalization of attitudes, the spread of skills and the spirit of enterprise, and increased mobility."²

In addition, there are political reasons for industrializing in less developed countries. Industrialization policies are often geared to an effort of de-colonization of the economic structure in order to reduce the dependence on the outside world. The force of this argument was amply demonstrated during World War II for Latin American countries. Specialization and dependence on the outside world for supplies of manufactured products led to economic chaos when these products and factories producing them were directed towards the war effort.

The industrialization process has been carried out in the LDC's in ignorance of how the various inputs contribute to industrial output.

One of the reasons for this paucity of knowledge has been that developing countries have invested too little in developing a data base for properly investigating the problem. Kuznets has written that "for the less developed countries . . . the great need is for a wider supply of tested data, which means essentially data that have been scrutinized in the process of use for economic analysis."³ Where data is available, it has not been effectively used to provide economically meaningful information to decision makers.

The existing literature on the estimation of production functions for the manufacturing sector range from the early work by Cobb and Douglas ⁴ to the recent theoretical breakthroughs in the area of variable elasticity of substitution production functions.⁵ The empirical studies of the production functions in the manufacturing sectors have generally been those relating aggregate value added to labor and capital and using time series and/or cross sectional data for individual industries for the same year. Another related category is the estimation of an aggregate production function fitted to data on the manufacturing sector


across regions for the same year. The regional categories have included states within a country or sometimes different countries. 6

This study is motivated by the work of Griliches 7 and others who have estimated industry production functions and have examined the impact of factor quality variables on productivity. A large number of social scientists, including Griliches, 8 have argued that the Cobb-Douglas formulation is an adequate tool for estimating industry production functions. In the spirit of their work, this analysis will rely primarily on the Cobb-Douglas or one of its modified forms. This functional form has the additional advantage of being able to incorporate more than two inputs easily. The detailed nature of the data base available allows the measurement of many traditional inputs in flow terms. This is a great improvement over most empirical studies which have utilized stock terms in their estimation procedures by assuming, usually unrealistically, that flows are proportional to stocks. The actual form of the production function also has implications for such problems as income distribution and price responsiveness in LDC's. For example, low, near zero elasticities of factor substitution have been one widely publicized explanation for the

6 For a description and list of some of these studies, see George H. Hildebrand and Ta-Chung Liu, Manufacturing Production Functions in the United States, 1957 (Geneva, New York: W. F. Humphrey, Inc., 1965).


8 Ibid.
existence of unemployment in LDC's. Further, in the aggregate, it follows that the greater the elasticity of substitution between factors, the greater the rate at which output can grow because the relatively fast growing factors may be substituted more easily for the relatively slow growing factors. An empirical test of this would be most useful.

Venezuela presents a unique case and opportunity for the study of the manufacturing sector in a less developed country. Due to a superior export position as a result of rich oil resources, Venezuela is not hampered, as are many other less developed countries, by a relative shortage of capital and foreign exchange resources. The problem for Venezuela is one of allocating these resources in an economically efficient manner.

The Venezuelan manufacturing census and the corresponding complementary census (1970) contain firm specific data for all the relevant components needed to measure the output, inputs, and efficiency variables used in this study. These data define the scope of the study as well as the number of available observations. However, this is not restrictive, since the set contains information on approximately

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11 Ibid., Planilla Complementaria.
twenty-four hundred firms in all twenty two-digit manufacturing industries.

Unlike many previous studies which include only crude and/or aggregate stock indicators of the basic variables such as capital and labor, the Venezuelan census data allows the measurement of value of output as well as the flow of capital and labor. This is possible because information is available on depreciation, general expenses, working capital, and fixed assets as well as on labor costs, number of employed workers, and number of production man hours. Furthermore, it provides detailed information on intermediate inputs which, though of critical importance, are often excluded, leading to biased estimates of the production function. 12

Firm specific data enables a disaggregation by industries, which are more homogeneous and thus more comparable than data for the manufacturing sector as a whole. Furthermore, micro data with the firm as a unit of observation allows the specification of different technologies among industries. It prevents much of the loss in variation which occurs in studies based on aggregate sector data. Since production decisions are made by firms, it is more meaningful to specify and estimate the production functions using micro firm level data. Edwards and Orcutt have stated that "micro models have an upper hand . . . macro models are not equipped to fight battles when it comes to forecasting

micro behavior. ... We need to exert a bigger effort in collecting and using disaggregate data, particularly if we wish to utilize policy response models.13

Another unique opportunity is presented by the availability of a matching set of complementary manpower data which gives the occupational mix and additional firm characteristics for each sampled firm. Over nine hundred of the Venezuelan manufacturing firms have auxiliary data that can be matched with the corresponding census data. This permits the development of disaggregated measures of labor. This complementary data set for 1970 also contains detailed information for constructing dummies on capital and manpower utilization as well as indicators of whether the firms were in existence in 1965.

There are several ways of analyzing the available data. Firm-level data provides an opportunity for specifying different production functions for each industry. This procedure could prove to be cumbersome because there are twenty two-digit industries. Differences among industries may not have any analytic or policy significance. It is therefore useful to examine the data by categories of industries to test specific hypotheses.

Preliminary work on this data showed a significant positive rank correlation between industries ranked by skill intensity and growth rates.14


14 See Appendix A for a discussion of the test of "no association" between industries ranked by skill intensity and growth rates.
This suggested the possibility that different industries had different production functions. One useful way to examine the data would be to analyze a fast growth versus a slow growth industry. Most of the analyses will be directed towards estimating the production functions of one relatively slow growing industry, food processing, and one relatively fast growing industry, fabricated metals.

In addition to differences between industries, different behavioral characteristics of decision makers suggest another basis for separating the data. Alternate forms of liability and possible biases in capital and labor markets suggest the estimation of separate production functions for both proprietorships and nonproprietorships. Regional differences in social and physical infrastructures which encompasses regional fragmentation suggest that it would be valuable to estimate regional production relations. Because of a large number of sample firms, the food processing industry will be examined to analyze variations in the structural parameters across regions and with different forms of ownership.

The basic objectives of this study can therefore briefly be stated as follows:

1. To specify firm level micro production functions for the industrial sector in less developed countries.

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2. To estimate these for specific industrial categories using firm-level data.

3. To test a variety of hypotheses concerning the manufacturing sector of LDC's, including:
   1) The elasticity of substitution between labor and capital is significantly different from zero (i.e., the fixed coefficient specification); or unity (i.e., the Cobb-Douglas specification).
   2) Human skills have a positive impact on labor productivity in the manufacturing sector.
   3) Managers significantly affect the productivity of other factor inputs; and
   4) a wide variety of other hypotheses.

4. To use the results to arrive at broad conclusions regarding the impact of firm specific inputs on industrial output in order to provide some information for making policy decisions for the Venezuelan industrial sector.

Chapter II describes the major sectors of the Venezuelan economy and the development of the manufacturing sector. It also provides some evidence of decreasing growth rates in the major manufacturing sectors. Chapter III provides the theoretical model of the production function used to analyze firm-level data. The data and the measurement of variables used in the theoretical model are then described in detail in Chapter IV. The empirical results, including the estimated production functions and the tests of some specific hypotheses, are presented and analyzed in Chapters V and VI. The major conclusions and some policy implications are summarized in Chapter VII.
CHAPTER II

VENEZUELAN MANUFACTURING

Rapid economic expansion since the 1940's brought about by the export of petroleum products has transformed Venezuela from a low to an intermediate level of economic development. In the 1950's Venezuela was a classical case of a monoculture or enclave society with a small rich modern subsector based on petroleum, separated from the rest of the national economy. Government policies in the intervening years have led to a much more expanded and diversified economy as of 1970.

Structure of the Venezuelan Economy

By 1970 rapid economic expansion had permitted Venezuela to attain a gross domestic product of 45.8 billion bolivars (4.5 bolivars equaled one U.S. dollar in 1969) and a per capita income of 4,762 bolivars per person.\(^1\) This has been accomplished in spite of one of the highest rates of population growth in the world -- 3.6 percent per annum from 1967 to 1969.\(^2\)


Labor

Approximately three million people, about 30 percent of the total population, made up the labor force in 1970. About 31 percent of the population was in the labor force in 1960, and 34 percent was in the labor force in 1950.\(^3\) The decline was probably due to the very high birth rates coupled with a higher rate of retention in school enrollment in the intervening years. There has also been a change in composition of the labor force. People have moved from the country to the cities. The urban population which accounted for 39.4 percent of the total population in 1941 has steadily increased, so that by 1970, some 75.7 percent of the population is classified as urban\(^4\) (see Table 1).

<table>
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</tr>
<tr>
<td>1941</td>
</tr>
<tr>
<td>Urban</td>
</tr>
<tr>
<td>Rural</td>
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</table>


This transition from a rural to a mainly urbanized economy was accompanied by a rise in secondary sector employment from 16.8 percent in 1950 to 22.8 percent in 1969, and a decline in primary sector employment from


\(^4\) Ibid., p. 63.
44.4 percent in 1950 to 24.0 percent in 1969. Females constituted 20 percent of the labor force in 1970, which was higher than it had been in 1960. The real income of workers is rising, and pay scales are the highest in Latin America.

Price Stability

The economy is relatively free of the inflationary pressures that have plagued most other Latin American countries. The wholesale price index increased by 29 percent between 1958 and 1968. The consumer retail price index increased by an average of only 0.5 percent annually between 1961 and 1968.

Income Distribution

In 1970 the country had over ten million inhabitants and a highly skewed income distribution. This can be seen by examining Gini coefficients of concentration among countries. Venezuela had a Gini coefficient of .483 compared to .346 for the United States and .330 for the United Kingdom. However, it is smaller, and thus income was distributed more equitably than for Brazil (.617), Colombia (.586), and Mexico (.534).

Banco Central de Venezuela prepared a study showing that in the 1960's 44 percent of all families received only 11 percent of the total

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5 Ibid., p. 76.


7 Ibid., p. 427.

income. The same study showed that income was disproportionately distributed between rural and urban families. Only 21 percent of families in larger cities, but as many as 67 percent of rural families earned an income of less than 6,000 bolivars per family per year. These results tend to be confirmed by the Central Office of Coordination and Planning. Efforts to develop demand for industrial products should probably be related to efforts to correct inequities in income distribution in the coming years.

Sectoral Gross Domestic Product and Employment

A breakdown of Venezuelan gross domestic product and employment by major sectors of the economy are presented in Tables 2 and 3. One of the salient features of the structure of the economy is the extremely high productivity, i.e., output per worker, in the petroleum and mining sector, and the relatively low productivity in agriculture. Productivity is approximately four times as great in manufacturing as compared to agriculture. The manufacturing sector, excluding the extracting industries, provided 16.8 percent of the employment and 20.4 percent of the GDP in 1968. Its percentage of the GDP has been increasing in recent years. In 1970 the agricultural sector provided about 7 percent of the gross domestic product, and less than 2 percent of the export earnings.

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11. The results of the complementary questionnaire show that approximately a quarter of the Venezuelan industrial firms have perceived capital underutilization. Lack of demand is the most commonly given reason for underutilization.
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<th>1969</th>
<th>1970</th>
<th>Annual Growth (%)</th>
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<td>Agriculture</td>
<td>3.000</td>
<td>3.235</td>
<td>3.452</td>
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<td>Crude Petroleum and Natural Gas</td>
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<td>7.157</td>
<td>7.395</td>
<td>3.3</td>
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<tr>
<td>Mining</td>
<td>0.423</td>
<td>0.579</td>
<td>0.637</td>
<td>10.0</td>
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<tr>
<td>Industrial Manufacturing</td>
<td>8.410</td>
<td>8.665</td>
<td>9.380</td>
<td>8.3</td>
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<tr>
<td>Electricity and Water</td>
<td>0.701</td>
<td>0.787</td>
<td>0.858</td>
<td>9.0</td>
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<tr>
<td>Construction</td>
<td>2.256</td>
<td>2.218</td>
<td>2.158</td>
<td>-2.7</td>
</tr>
<tr>
<td>Commerce, Restaurants and Hotels</td>
<td>4.842</td>
<td>4.871</td>
<td>5.354</td>
<td>9.9</td>
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<tr>
<td>Transportation, Storage and Communication</td>
<td>2.828</td>
<td>3.172</td>
<td>3.484</td>
<td>9.8</td>
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<tr>
<td>Finance</td>
<td>3.939</td>
<td>4.037</td>
<td>4.285</td>
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<td>1.922</td>
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<td>Non-Profitable Private Service</td>
<td>0.530</td>
<td>0.583</td>
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<td>Import Taxes</td>
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<td>0.531</td>
<td>0.607</td>
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<tr>
<td><strong>Gross Domestic Product</strong></td>
<td><strong>41.265</strong></td>
<td><strong>42.715</strong></td>
<td><strong>45.809</strong></td>
<td><strong>7.2</strong></td>
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### TABLE 3

**VENZUELAN EMPLOYMENT (1968)**

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<thead>
<tr>
<th>Sector</th>
<th>Employment (Thousands)</th>
<th>Percentage Employment</th>
<th>Percentage of GDP</th>
<th>Productivity&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
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<td>7.3</td>
<td>4.342</td>
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<td>Mining and Petroleum</td>
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<td>1.8</td>
<td>18.9</td>
<td>156.160</td>
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<tr>
<td>Manufacturing</td>
<td>473</td>
<td>16.8</td>
<td>20.4</td>
<td>17.780</td>
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<tr>
<td>Construction</td>
<td>174</td>
<td>6.2</td>
<td>5.5</td>
<td>12.966</td>
</tr>
<tr>
<td>Electricity and Gas</td>
<td>37</td>
<td>1.3</td>
<td>1.7</td>
<td>18.946</td>
</tr>
<tr>
<td>Commerce</td>
<td>489</td>
<td>17.5</td>
<td>15.4</td>
<td>12.966</td>
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<tr>
<td>Transport and</td>
<td>158</td>
<td>5.7</td>
<td>6.9</td>
<td>17.899</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td>724</td>
<td>25.9</td>
<td>24.1</td>
<td>13.713</td>
</tr>
<tr>
<td>Unspecified</td>
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<td>..</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2,798</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td><strong>14.750</strong></td>
</tr>
</tbody>
</table>

<sup>a</sup>Productivity in this table is defined as gross domestic product per worker.

However, because of the large number of people employed in agriculture -- approximately 25 percent in 1968 -- its social significance is out of proportion to its economic contribution. Traditional technology and limited availability of financial resources seem to be major constraints to increased agricultural production.\textsuperscript{12}

**Trade**

Tables 4 and 5 present the sectoral distribution of Venezuelan exports and imports from 1966 to 1969. Ninety percent of Venezuela's export earnings in 1970 originated from petroleum, with an additional 5 percent from iron ore. In addition, petroleum was the source of nearly two-thirds of the fiscal revenues and 17 percent of the gross domestic product. There has been an attempt in recent years to increase the share of industrial exports of Venezuelan export earnings.

The principal imports in 1970 were industrial raw materials, machinery, transport equipment, construction materials and food. Trade, both exports and imports, occurred mainly with the United States, Great Britain, Canada, the European Economic Community (EEC) countries and the European Free Trade Association (EFTA). Trade with members of the Latin American Free Trade Association (LAFTA), of which Venezuela is a member, was relatively small as of 1970.

**Industrial Policy in Venezuela**

The basic goal of Venezuelan economic policy over the last several decades has been the diversification of the economy and reduction of its

<table>
<thead>
<tr>
<th></th>
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<tr>
<td>Food</td>
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<td>592.5</td>
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<tr>
<td>Beverages and Tobacco</td>
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<td>58.1</td>
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<td>73.8</td>
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<td>Crude Materials, Inedible, Except Fuels</td>
<td>2</td>
<td>233.6</td>
<td>4.6</td>
<td>240.9</td>
<td>4.3</td>
<td>263.3</td>
<td>4.0</td>
<td>249.9</td>
<td>3.7</td>
</tr>
<tr>
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<td>3</td>
<td>39.7</td>
<td>0.8</td>
<td>36.6</td>
<td>0.6</td>
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<td>41.8</td>
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<tr>
<td>Animal and Vegetable Oils and Fats</td>
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<td>71.3</td>
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<td>71.0</td>
<td>1.1</td>
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<tr>
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<td>505.2</td>
<td>9.9</td>
<td>589.5</td>
<td>10.5</td>
<td>706.6</td>
<td>10.8</td>
<td>710.1</td>
<td>10.5</td>
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<tr>
<td>Manufactured Goods Classified by Material</td>
<td>6</td>
<td>1096.3</td>
<td>21.4</td>
<td>1150.7</td>
<td>20.4</td>
<td>1233.9</td>
<td>18.9</td>
<td>1269.3</td>
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<tr>
<td>Machinery and Transport Equipment</td>
<td>7</td>
<td>2236.8</td>
<td>43.7</td>
<td>2420.9</td>
<td>43.0</td>
<td>2942.0</td>
<td>45.1</td>
<td>3146.5</td>
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<td>546.9</td>
<td>8.4</td>
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<td>7.8</td>
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<tr>
<td>Miscellaneous Transactions and Commodities</td>
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<td>39.0</td>
<td>0.8</td>
<td>39.6</td>
<td>0.7</td>
<td>42.1</td>
<td>0.6</td>
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<td>0.7</td>
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<tr>
<td>TOTAL</td>
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<td></td>
<td>5631.6</td>
<td>100.0</td>
<td>6527.4</td>
<td>100.0</td>
<td>6737.8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<sup>a</sup>This refers to the Standard Industrial Trade Classification.

### TABLE 5

**VENEZUELAN EXPORTS BY COMMODITIES ACCORDING TO THE STANDARD INDUSTRIAL TRADE CLASSIFICATION**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Food</td>
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<td>183.0</td>
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<td>1.2</td>
</tr>
<tr>
<td>Beverages and Tobacco</td>
<td>1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.7</td>
<td>0.0</td>
<td>0.3</td>
<td>0.0</td>
<td>0.9</td>
<td>0.0</td>
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<tr>
<td>Crude Materials, Inedible, Except Fuels</td>
<td>2</td>
<td>640.2</td>
<td>5.4</td>
<td>614.0</td>
<td>4.8</td>
<td>563.4</td>
<td>4.5</td>
<td>685.6</td>
<td>5.4</td>
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<tr>
<td>Mineral Fuels, Lubricants, Related Materials</td>
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<td>11037.5</td>
<td>92.4</td>
<td>11727.3</td>
<td>92.3</td>
<td>11670.7</td>
<td>92.8</td>
<td>11662.1</td>
<td>91.6</td>
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<tr>
<td>Animal and Vegetable Oils and Fats</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Chemicals</td>
<td>5</td>
<td>6.8</td>
<td>0.1</td>
<td>3.8</td>
<td>0.0</td>
<td>3.8</td>
<td>0.0</td>
<td>8.1</td>
<td>0.1</td>
</tr>
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<td>Manufactured Goods Classified by Material</td>
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<td>0.3</td>
<td>29.3</td>
<td>0.2</td>
<td>42.4</td>
<td>0.3</td>
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<tr>
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<td>9.0</td>
<td>0.1</td>
<td>6.3</td>
<td>0.0</td>
<td>6.6</td>
<td>0.0</td>
<td>10.1</td>
<td>0.1</td>
</tr>
<tr>
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<td>0.2</td>
<td>19.2</td>
<td>0.2</td>
<td>19.3</td>
<td>0.2</td>
<td>16.7</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>11941.0</td>
<td>100.0</td>
<td>12699.3</td>
<td>100.0</td>
<td>12576.4</td>
<td>100.0</td>
<td>12732.3</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<sup>a</sup>This refers to the Standard Industrial Trade Classification.

traditional dependence upon petroleum. The export earnings experienced by this sector are for the most part beyond Venezuelan control. The precariousness of such an economic structure built on a single product has been emphasized by Farley:

When oil was discovered early in the nineteenth century, Venezuela became comparatively affluent, but like most Latin American countries, was extraordinarily dependent on this one product. Petroleum exports and petroleum investment gave basic dynamism to the Venezuelan economy, contributing to a rapid expansion of exports and to an estimated annual growth in the gross national product of well over 8 percent a year between 1950-58. On the other hand, extreme dependence on petroleum made the economy immediately vulnerable to any exogenous changes affecting petroleum. In fact, Venezuela's share of world petroleum exports had been consistently declining before 1958. This declining trend continued, and falling prices for petroleum exports immediately after 1958 intensified the crises confronting the new regime. The pattern of dependence was typical. The petroleum industry in 1960 accounted for over 96 percent of the export earnings of Venezuela.

Between 1958-61, however, the terms of trade worsened for Venezuela when realized prices for petroleum fell when the Korean War ended, the Suez Canal reopened, and oil competition from other areas rose. The index of crude petroleum prices fell from 100.0 in 1958 to 91.8 in 1961, and exports expanded too slowly to compensate for this price decline. Venezuela's share of world petroleum exports dropped from 36.0 percent in 1958 to 32.8 percent in 1960 while import prices rose and external purchasing power declined.13

Because of this vulnerable and volatile structure, the government places high priority on the development of the manufacturing sector, and the major objective of this policy has been to diversify the industrial base, create employment, lower imports, and reduce the dependence of the economy upon the petroleum sector. The country's foreign trade policy has been shaped by the goals of

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promoting industrialization through the substitution of imports, encouraging export-oriented industries, and maintaining a balance of payments equilibrium.

Like the policies of most other Latin American countries, Venezuelan industrial policy can be characterized as one fostering industrialization by protective import substitution. Policy tools affecting both the domestic and foreign economic sectors are geared towards meeting these objectives.

Venezuela is a mixed economy and the industrial sector is primarily private. However, in an effort to industrialize, the Venezuelan government has directly and indirectly promoted industrial development. This is described in detail in the Overseas Business Reports:

The Government enjoys an important role in the Venezuelan economy, yet one which leaves much freedom of operation for private investors. A high degree of Government ownership and operation is accepted for public utilities, transportation, and "basic industries" (industries which require large amounts of capital and which exert a strong influence on many other industries by virtue of supplying their raw materials). In addition, Government activity is accepted for other areas when private capital has not been forthcoming. The Government has stated its intention to remove itself from such areas when private capital does become available for them.

Investors are free to establish a business in any industry not reserved to the Government, but usually investors in industrial ventures have found it desirable to obtain official approval from the Division of Projects (Division de Proyectos) of the Ministry of Development (Ministerio de Fomento). This approval provides duty exemption for equipment and raw materials, and is necessary for obtaining protection from competing imports. The approval system furnishes the Government with a device for guiding the development of the economy. Other devices exist in tax incentives, in loans to (or participation in) private firms by autonomous development entities, and in strong discouragement of investment in industries in which investment is believed already to be sufficient to the country's needs.

Government involvement in the conduct of private business is relatively great. The Government uses many regulatory devices
on a continuing basis, such as price controls, review of profits, curbing of competition, intervention in labor-management disputes, and licensing of exports. (The last is rarely applied in a restrictive manner, however.)

The Government recognizes the need for foreign investment in Venezuela and accords generally the same rights, guarantees and obligations as apply to domestic capital. In granting official approval, however, the Government does appear to give preference to those foreign investors who introduce new industries or technological methods, or who provide access to foreign markets. It is also preferred for investors to enter into partnership with local investors and make minimal demands for non-participating local capital.

The Venezuelan Development Corporation (Corporacion Venezolana de Fomento — CVF) is the principal development agency of the Government. It provides financing for development through loans, loan guarantees, bond purchases, direct participation, and establishment of wholly-owned subsidiaries. It also provides technical services to industry and leases fixed equipment and assets to firms on an option-to-buy basis. The Government has established or participated in several other development finance organizations as well.14

The government is thus an active participant in the coordination and development of domestic financial intermediaries that channel savings into investment. The operations of banks and credit institutions are governed by the General Law on Banks and other Credit Institutions and the banking system is supervised by the Office of Superintendent of Banks, an arm of the Ministry of Finance. Government banks are the source of one-third of the total credit in Venezuela, and charge an interest from 1.5 to 5 percent less than commercial banks.

In 1949, the Venezuelan Development Corporation, established regional development banks in the interior where commercial banks refused to operate. By 1970, it held major stocks in four of these

regional banks, while three others have been sold to private interests. The regional banks are an important source for granting initial capital and improvement loans to new and developing industries.

While commercial banks have grown rapidly (i.e., three by the early 1900's, thirteen by 1948, and thirty-one with 450 branches by 1969), well developed banking services are established only in the economically active areas of Venezuela. Insurance companies, investment companies and two stock exchanges (i.e., the Caracas Stock Exchange, founded in 1947, and the Miranda Stock Exchange, founded in 1958 -- both located in Caracas) also exist to mobilize savings. These too are situated in the economically active areas. By 1970, even the insurance companies, of which there were fifty with total assets of Bs1,500,000,000, in response to the growing demand, began making industrial loans.

In 1970, the Venezuelan government was studying the possible creation of a more sophisticated financial market to increase transactions, make stock more attractive, raise capital and stop the flow of capital and investment abroad.

In spite of this considerable expansion of financial intermediation, financial markets are neither fully integrated nor spatially well distributed, leading to a certain amount of market fragmentation.

In 1970, the manufacturing sector was one of the most dynamic sectors of the economy, and this expansion can be attributed to

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the deliberate national policy of encouraging industrial development to reduce the nation's dependence upon petroleum. Domestic policy has stimulated investment in manufacturing, directly through the control and operation of certain key industries and indirectly through favorable tax and corporate structure laws.

In the foreign trade area, the Venezuelan government offers a variety of incentives to encourage industrialization. Included among these are tariffs or other import restrictions for the protection of local industries, provision for the duty-free importation of capital equipment and raw materials, and exemption from some taxes. Oftentimes imports of competing products were restricted, but capital goods or primary materials destined for manufacturing operations are permitted almost unlimited entry, at nominal duties.

Customs duties bring in about 7 percent of the revenue. With few exceptions, duties are based on weight, and not value of goods. The rate schedule ranges from .05 bolivars per kilogram to 50 bolivars per kilogram. The president is given powers to increase or decrease duties by 100 percent, and to grant rebates up to 25 percent. Duties are revised to protect domestic industries.

A potent tool for developing the industrial sector has been the encouragement of foreign investment. The Venezuelan government will generally accord it the same rights and guarantees that it applies to domestic capital. Foreign capital which establishes new industries or technological innovation is considered most
desirable, especially if the investment is made in partnership with local capital. ¹⁶

Moreover, the government has provided some inducements to attract foreign capital. High protective tariffs are provided for new industries. Exemptions from import duties for capital equipment and raw materials are available. There is relatively low industrial taxation.

Organization

The government has assumed primary responsibility for the planning, coordination, and development of the country's industrial sector. In addition, it sets the goals for economic growth and provides the physical and social infrastructure for development. This has included not only capitalization and preparation of technical studies, but also actual operations.

The following three government agencies bear the most responsibility for the planning and carrying out of industrial development programs: ¹⁷ 1) The Ministry of Development has a constitutional responsibility for executing presidential decrees relating to economic growth and the development of a favorable environment for continued development. 2) The Venezuelan Development Corporation is a semiautonomous agency which is engaged in many activities in all


sections of the economy. Among its activities are making feasibility studies for the establishment of new industries, providing technical assistance to established enterprises, and operating several government industrial enterprises through subsidiary corporations. While this agency is administratively largely independent from the Ministry of Development, it is required to report annually to the Minister of Development. 3) The Central Office of Coordination and Planning (Oficina Central de Coordinación y Planificación), is responsible to the president. It is engaged in broad and long-range planning, which includes the formulation of multiyear economic plans within which the industrial sector occupies an important place.

In addition to the above, there is another semiautonomous agency, the Venezuelan Guayana Corporation (Corporación Venezolana de la Guayana), which is in charge of the overall development of the mineral-rich Guiana Highlands. Its activities have ranged from the basic construction of roads, ports, and dams, to the operation of a steel mill. It has also been in charge of the development of Ciudad Guayana, a new industrial city.

The government views its managerial position in the industrial development field as limited to the basic industries providing essential primary inputs that are very important to the economy. As indicated above, the government is prepared to participate in the formation of specific industries required by the public interest.
Impact

The primary result of Venezuelan government intervention during the 1950-70 period has been the rise in the share of manufacturing in GNP from 10 percent in 1950 to approximately 20 percent in 1970.\(^{18}\) With the development of this sector has come increasing urbanization. The primary industrial areas of the country included the Federal District of Caracas and the nearby states of Aragua, Carabobo and Miranda. In 1970 these states accounted for 70 percent of Venezuela's industrial production and 75 percent of the industrial employment. These same states constituted 2-4/10 percent of the land area, and contained one-third of the country's inhabitants.\(^ {19}\)

The industrialization process in Venezuela began late compared with other Latin American countries, and acquired momentum in the fifties when her growth rates were the highest in the region. As a result of the rich petroleum resources and these direct and indirect government policies, Venezuela is rapidly becoming a modern industrialized nation.

The most rapidly growing industrial sector by 1970 was the manufacturing sector which, for the first time in 1967, accounted for a larger proportion of the gross domestic product than petroleum. In 1969, the principal industrial branches generated 44.9 percent of

\(^{18}\) Weil, Handbook for Venezuela, pp. 303-304; different sources yield different estimates of the increase. However, they all agree that the share of manufacturing in the gross domestic product has risen significantly from 1950 to 1970.

\(^{19}\) Ibid., p. 337.
the gross domestic product and employed 24.2 percent of the labor force. The gross domestic product contributions were distributed as follows: manufacturing, 19.5 percent; petroleum, 17.1 percent; construction, 5.8 percent; power production, 1.5 percent; and minerals, 1 percent. Principal manufacturing branches in 1970 included food-stuffs and beverages, chemicals, textiles and clothing, primary metals, and transport equipment.

Because of favorable public sector policies, foreign private capital continued to play a significant role in Venezuelan industrial development. In 1970, 86 percent of foreign investment was in the petroleum industry, about 5 percent was in manufacturing, and about 5 percent was in mining. Seventy-one percent of foreign investment originates from the United States, while 22 percent came from Great Britain. Excluding the extractive industries, foreign capital has played the most important role in the manufacturing industries. Manufacturing is confined to established product lines that were previously imported. The incentives offered by the Venezuelan government have been responsible for inducing United States' industries to establish new firms in Venezuela.

While one of the goals has been the diversification of export products, the structure of Venezuelan trade has not changed much. In the external sector, exports continue to be dominated by petroleum, although iron has managed to account for almost 5 percent of the value of exports — an increase over earlier years. Moreover, there has been some indication that Venezuela is developing potential markets for some of her industrial products.
As a result of import substitution, there has been a shift from consumer goods to intermediate goods and capital goods required for further development.

Because of the foreign trade policy to encourage export-oriented industries, there has recently been some movement toward greater economic integration with other Latin American countries.

**Declining Industrial Growth Rates**

Although industrial growth between 1950 and 1970 was greater than the growth of the gross domestic product, the industrial growth rates have been decelerating. (Appendix B presents output indices of the major two-digit manufacturing industries over a twenty-two year time span from 1948 to 1969. It should be noted that the indices use 1953 values as a base.)

Using the data in Appendix B, the growth rates for the two-digit sectors are calculated separately for 1948-59, for 1959-69, and for 1948-69, using the equation

\[ y = ae^{rt} e^u \]

where \( y \) is the sectoral output, \( r \) is the rate of growth, \( t \) is time, \( e \) is the natural base, \( a \) is the constant, and \( u \) is the random variable possessing the properties needed for ordinary least squares estimation procedures. Taking the natural logarithm of both sides of Equation (2.1) yields the regression equation

\[ \ln y = \ln a + rt + u \]

Table 6 gives the growth rates (\( r \) estimated using (2.2)) by industrial category. The industries are ranked according to the rates
<table>
<thead>
<tr>
<th>Sector</th>
<th>1948-1969 t-ratio below</th>
<th>Rank</th>
<th>1948-1958 t-ratio below</th>
<th>Rank</th>
<th>1959-1969 t-ratio below</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>0.0402 (27.3499)</td>
<td>15</td>
<td>0.0507 (24.03908)</td>
<td>15</td>
<td>0.028004 (11.1266)</td>
<td>12</td>
</tr>
<tr>
<td>Beverages</td>
<td>0.0328 (20.0005)</td>
<td>18</td>
<td>0.0425 (15.9859)</td>
<td>16</td>
<td>0.0171 (10.7019)</td>
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</tr>
<tr>
<td>Tobacco</td>
<td>0.0432 (27.2478)</td>
<td>9</td>
<td>0.0368 (16.4017)</td>
<td>17</td>
<td>0.0343 (-1.2796)</td>
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<tr>
<td>Textiles</td>
<td>0.0501 (23.2750)</td>
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<td>0.0634 (12.4054)</td>
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<td>0.0318 (10.6086)</td>
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<td>0.0404 (6.3277)</td>
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<td>0.1073 (13.6433)</td>
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<td>0.0050 (1.4533)</td>
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<tr>
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<td>0.0462 (11.9067)</td>
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<tr>
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<td>0.0423 (12.0846)</td>
<td>12</td>
<td>0.0755 (15.5045)</td>
<td>8</td>
<td>0.0280 (6.8883)</td>
<td>13</td>
</tr>
<tr>
<td>Leather</td>
<td>0.0342 (9.6546)</td>
<td>16</td>
<td>0.0635 (29.5102)</td>
<td>10</td>
<td>-0.0017 (-0.44747)</td>
<td>19</td>
</tr>
<tr>
<td>Rubber</td>
<td>0.0626 (12.3412)</td>
<td>4</td>
<td>0.1118 (13.3587)</td>
<td>3</td>
<td>0.0308 (14.6483)</td>
<td>10</td>
</tr>
</tbody>
</table>
### Table 6 -- Continued

<table>
<thead>
<tr>
<th>Sector</th>
<th>1948-1969 t-ratio below</th>
<th>Rank</th>
<th>1948-1958 t-ratio below</th>
<th>Rank</th>
<th>1959-1969 t-ratio below</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>.0535 (21.2933)</td>
<td>5</td>
<td>.0766 (15.4625)</td>
<td>7</td>
<td>.0397 (15.5335)</td>
<td>7</td>
</tr>
<tr>
<td>Petroleum</td>
<td>.0428 (9.9044)</td>
<td>10</td>
<td>.0810 (9.4092)</td>
<td>6</td>
<td>.0137 (7.7877)</td>
<td>17</td>
</tr>
<tr>
<td>Stone, Clay, Glass</td>
<td>.0333 (9.5187)</td>
<td>17</td>
<td>.0689 (12.8718)</td>
<td>9</td>
<td>.0208 (4.3981)</td>
<td>14</td>
</tr>
<tr>
<td>Primary Metals c</td>
<td>.1271 (16.1621)</td>
<td>1</td>
<td>.1297 (4.5931)</td>
<td>2</td>
<td>.1250 (6.4977)</td>
<td>1</td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>.0828 (13.2830)</td>
<td>3</td>
<td>.1381 (20.5472)</td>
<td>1</td>
<td>.0305 (12.8608)</td>
<td>11</td>
</tr>
<tr>
<td>Machinery (36-37)</td>
<td>.0520 (17.5434)</td>
<td>6 &amp; 7</td>
<td>.0314 (11.0692)</td>
<td>18 &amp; 19</td>
<td>.0792 (18.2747)</td>
<td>2 &amp; 3</td>
</tr>
<tr>
<td>Transport d</td>
<td>.0423 (13.2830)</td>
<td>11</td>
<td>.0608 (8.5917)</td>
<td>12</td>
<td>.0483 (8.5483)</td>
<td>4</td>
</tr>
</tbody>
</table>

\(^a\) The equation \( y = Ae^{rt} \), \( \ln y = \ln A + rt \) was used to calculate the growth rates.

\(^b\) The t-statistics are given in parentheses.

\(^c\) For Sector 34, data is only available for the years 1952-1969.

\(^d\) For Sector 38, data is only available for the years 1950-1969.

Source: Banco Central de Venezuela, "Indice De Valor Agregado Produccion Macroeconomica," (CORDIPLAN, "Producto Territorial Bruto.")
of growth during the periods 1948-69, 1948-58, and 1959-69. The statistics in Appendix B indicate that durable goods production grew more rapidly than nondurable goods production during the twenty-two year span. Over the entire time span, the more rapidly growing two-digit industries were primary metals, paper, fabricated metals, rubber, chemicals, and machinery. Their growth rates ranged from 5.2 percent to 12.7 percent per annum. The slower growing industries included lumber; beverages; stone, clay and glass; leather; food; and apparel. Their per annum growth rates ranged from 2.6 percent to 4.0 percent.

A decrease in industrial growth would be indicated if the estimated growth rates over the first eleven-year span were greater than those of the second eleven-year span. The results tend to suggest that this indeed has occurred in the Venezuelan manufacturing sector. The growth rates have decreased in all two-digit sectors except the one producing machinery. In this sector the growth rate increased from 3.1 between 1949-59 to 7.9 percent per annum between 1959-69.

There are several possible reasons for declining industrial growth. A strong import substitution policy, failure to export industrial products, and a highly skewed income distribution may be preventing Venezuela from taking advantage of economies of scale, because of a lack of demand.

The decline may have been the result of a decline in the growth of income from the petroleum sector which was used to finance industrial development.
The decrease may be due to a lack of critical supply factors, such as skilled labor, which are needed to produce the goods previously made in the developed nations where human skills and "research and development" are in large supply.

A fourth possible reason for the decline in industrial growth rates may be due to factor market distortions which may exist in Venezuela. For example, if the economy responds to the relative prices of factors, then an artificially low price of capital may lead to a capital intensive structure which hampers the productive use of labor.

The analysis that follows will try to shed light on the validity of some of these possibilities. At this point, it is noted that industrial growth rates are generally declining. This is inconsistent with Venezuela's broad welfare goals. Thus, to gain more insight into the industrial process, the following analysis estimates disaggregate industrial production functions examining not only the productivity of various factors but also such questions as the existence of factor substitution possibilities which have often been considered fixed in the industrial sectors of less developed countries. As will be shown, such knowledge may play an important role in making economic policy decisions.
CHAPTER III

THEORY OF INDUSTRIAL PRODUCTION

There are a great variety of algebraic forms as well as input and output specifications that can be used to characterize industrial production functions. In this chapter an overview of the empirical estimation of industrial production functions is given. Some of the criticisms of these studies are mentioned along with a discussion of how they are handled in relation to this study. The chapter concludes with the specification of the theoretical model that is used in this study.

Review of Literature

Early attempts to understand the production process with the use of precise mathematical forms occurred in the late eighteen hundreds and early nineteen hundreds when Walras, Wicksteed, Wicksell and others developed the explicit theoretical formulation of marginal productivity analysis. A good theoretical summary of the current state of knowledge is given in Ferguson.\(^1\) In the late nineteen twenties Cobb and Douglas began their studies attempting to estimate statistical production functions for various commodities.\(^2\) This led to an interest in inductive studies of production that has continued to the present day. Moreover, the basic methodology developed by Cobb and Douglas has continued to be

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used. The popularity of the Cobb-Douglas form of the production function has continued in spite of the flowering of new mathematical formulations of the production relationship. These include various forms of the Leontief fixed-coefficient production functions, constant elasticity of substitution production functions, and variable elasticity of substitution production functions. The technique and understanding of the statistical formulations, however, have been improved and developed over the years. A relatively comprehensive survey of the literature of production functions in general and manufacturing production functions in particular is provided in

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4 For a variety of studies using the input-output and linear programming techniques for development planning, see H. B. Chenery, Studies in Development Planning, (Cambridge, Massachusetts: Harvard University Press, 1971).


Walters and Hildebrand and Liu.

Before the advent of the constant elasticity of substitution production function, in the now classic article by Arrow, Chenery, Minhas and Solow (ACMS) in 1961, most inductive studies of the industrial sector used the Cobb-Douglas production function. They could be classified into two categories. The first group tended to estimate manufacturing production functions fitted to aggregate time series data on value added, labor and capital, or to aggregate cross-sectional data for individual industries for the same year. The typical study estimated a production function for the United States' manufacturing sector by fitting aggregate figures of value added to stocks of physical capital and labor. A second group tended to estimate manufacturing or aggregate industry production functions for data across


11 An example is P. H. Douglas and G. T. Gunn, "The Production
regions for the same year. The regions represented states within a
country or different countries.

In addition to studies based on aggregate published census data,
there have been some studies based on micro data. An example is an
Eisner study of United States' manufacturing based on individual firm
responses from the McGraw-Hill Capital Expenditure Surveys. While the
data set contains information at the firm level, it suffers from a lack
of complete information. Possibly the greatest source of bias is due to
a lack of information on intermediate inputs. Output which is defined
as sales plus changes in inventories is regressed on labor and capital
stock. Intermediate inputs are not netted out of the output figure.
Capital stock was in most instances measured as "gross fixed assets"
reported by "original cost" accounting. Some attempts were made to
deflate capital stock. Another improvement in the study would have
been to make parameter estimates separately for different industries.

The advent of the ACMS paper, developing the constant elasticity
of substitution production function has led to a recent flourish of

Function for American Manufacturing for 1914," Journal of Political
Economy (August 1942).

12Hildebrand and Liu, Manufacturing Production Functions; and
Arrow, Chenery, Minhas and Solow, "Capital-Labor Substitution."

13R. Eisner, "Capital and Labor in Production: Some Direct
Estimates," in Murray Brown, ed., The Theory and Empirical Analysis of
431-475; another study based on micro data is D. Levhari and E.
Sheshinski, "Experience and Productivity in the Israeli Diamond industry,"

14This might not be that great of a bias, as will be shown later in
Appendix C.

15Arrow, Chenery, Minhas, and Solow, "Capital-Labor Substitution."
theoretical and empirical studies developing the CES and the variable elasticity of substitution production functions.

In addition to these inductive studies of production, there has been another type of production function, the fixed coefficient type functions, which are the basis of the Leontief input-output and linear programming models. These functions, along with the Cobb-Douglas type, have been the most common mathematical models used in development planning. These noninductive models are based on the assumption of a zero elasticity of factor substitution. A simple version of this type of model is the well known Harrod-Domar model. The capital-output ratio based on this Harrod-Domar model has been used by many planners to estimate capital requirements needed to achieve production output goals.

A search of the literature of inductive production functions for the industrial sector for less developed nations provided few examples. They are footnoted in this chapter, or are mentioned in the footnoted articles. The only available inductive study of the Venezuelan industrial sector is the dissertation of Ann Witte. Her study used aggregate regional data and estimated the elasticity of factor substitution for the ACMS constant elasticity of substitution specification. No attempt was made to fit a Cobb-Douglas model.

16Chenery, *Studies in Development Planning*.


A Critique of Inductive Studies

There have been many criticisms of these inductive studies. Some of them will now be articulated along with a discussion of how this study attempts to avoid some of these pitfalls where possible.

1. High correlation between independent variables.
2. Aggregation error.
3. Nonhomogeneous factor inputs.
4. Interdependence.
5. Variable measuring errors.
6. Treatment of intermediate inputs.
7. Ignoring factor underutilization.
8. Variable omission.

First, time series studies use labor and capital figures that tend to have a high degree of correlation. Because the capital and labor aggregates cluster together, there is often insufficient scatter for accurately estimating manufacturing production functions. Cross sectional data does not generally suffer from this problem. This is especially the case when using firm level data based on different sized firms. This study, based on a cross section of Venezuelan manufacturing firm data, hopes to avoid this problem associated with time series estimates of the production parameters.

Secondly, most studies are based on aggregate published census data for output and factor totals. However, the production function is basically a microeconomic concept. It describes the alternative production frontiers available to individual decision units in the allocation of their resources. This in essence involves the
aggregation problem that has long plagued econometric studies. When
census data available only in arithmetic sums and averages are used
to make estimates, the relationship between the aggregate functions
and the underlying micro production functions is not clear. Furthermore,
the meaning of the marginal product estimates derived from such
aggregate estimation procedures is also not clear.

The confidentiality of firm records in the United States has
prevented the estimation of United States' industrial production
functions using firm level data. Hildebrand and Liu, using aggregates
across states to estimate U. S. industrial production functions,
concluded that

estimates of production functions can best be obtained from
data for individual establishments. While the Bureau of the
Census has such tabulations at its disposal, they were
unavailable to us. 19

They attempted to collect sample observations from manufacturing
establishments in New York State, but the response was poor. Through
television conversations they found three main reasons for the poor
response.

First, the required data involved some confidential
information not required in census and other reports to
government. Business firms were generally unwilling or
reluctant to reveal these data to private investigators,
because there is no legal protection against disclosure,
even though they had no question about our good faith
in keeping the information confidential. Second, the
large and growing number of private and public surveys
in which these firms were asked to cooperate have now
become a burden which they are increasingly unwilling
to shoulder. Finally, in spite of the effort we made to
explain the purpose and nature of the study in terms
readily understandable to laymen, the technical nature
of the project was such that many did not really grasp
its meaning and practical usefulness. 20

20 Ibid., p. 203.
This study, by using firm level data, hopes to overcome some of these objections due to using aggregate census averages.

The meaning of production function for the entire manufacturing sector based on aggregate cross-sectional data is obscure. It is common sense to anticipate different sizes of structural parameters between industries. In addition, the neoclassical assumption of homogeneity of factors is more apt to hold within an industry than between industries. This study attempts to estimate individual industry production functions within the manufacturing sector and thus lessens the importance of this criticism. Most empirical studies allow no heterogeneity of labor and capital. Marginal productivity estimates of heterogeneous factors are worthless unless they can be disaggregated into relatively homogeneous factor categories. This study attempts to disaggregate both capital and labor into more homogeneous categories.

A fourth concern has been related to the use of ordinary least squares methods to arrive at parameter estimates. This has to do with the "simultaneous equation bias," and involves the feedback effects of output on inputs. However, it can be argued that ordinary least squares procedures are not necessarily inferior, because the relative sharpness of these procedures more than compensates for their bias.

Since the appropriate flow measures are usually unavailable, empirical studies typically use stock figures for labor and capital. These often assume unrealistically that the flow of labor and capital services are proportional to their stocks. This study attempts to

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use a better measure of capital than the value of the stock of fixed assets. The measures of capital included in this study incorporate not only the depreciation of capital, but also the value of variable capital and the opportunity costs of holding inventory capital into the capital measure. This approximates the flow of capital services more closely.

A sixth criticism leveled against production studies involves the treatment of intermediate inputs. Nobody denies that bread is not made without flour. Intermediate inputs are often subtracted from the value of output to get a value-added concept. Value added is then used as the dependent variable. Kendrick has written that "real net output estimates consistent with national income, rather than value-added, would be preferable. Again, due to lack of data, we have to be satisfied with real value-added estimates as a first approximation to the real net measure." 22 Star claims that the practice of using value added instead of net output "probably is derived in part from the national accounts in which all intermediate goods net out, and in part from the lack of a suitable alternative." 23 The Venezuelan Manufacturing census (1970) has information on intermediate inputs, and thus permits the treatment of intermediate inputs as a separate input, along with capital and labor, contributing to industrial output. Thus the data available for this study allows a departure from the conventional production formulation which treats value added as the independent variable. 24


24A more complete analysis of this problem with respect to Venezuelan manufacturing is given in Appendix C.
A seventh criticism of inductive production studies, especially those based on time series data, involves the use of capital measures that do not account for the underutilization of capital. When underutilization of capital occurs, empirical studies, not taking this factor into account, tend to overemphasize the importance of capital in the production process. Walters states that "an advantage of cross section studies is the fact that variations in the amount of idle capacity are probably less over the cross section than the time series." 25

Moreover, this study attempts to examine to a certain degree whether or not the underutilization of either capital or labor significantly affects Venezuelan industrial productivity.

The eighth argument against many of these studies is that certain productive factors, which have a significant impact on industrial productivity, are often omitted from the model specification. In this study, in addition to disaggregated capital and labor, a number of additional environmental and technical factors are included in the model specification. These variables are often not included in other specifications because of lack of data. Another version of the model also attempts to incorporate regional factors into the functional specification.

The ninth criticism, arguing that the functional specification may be inappropriate, is handled by examining the validity of the assumptions underlying the model. For example, the often questioned validity of a unitary elasticity of substitution between capital and labor is tested before the Cobb-Douglas function is used extensively.

While there are many legitimate criticisms of inductive statistical studies of production, the present study goes far in correcting many of the biases that have been embedded in previous studies.

**A Micro Production Function for Industry**

A production function is a single valued mapping from input space into the maximum output attainable from any specified set of inputs. The function in most general terms may be expressed as

\[(3.1) \quad 0 = F(X_1, X_2, \ldots, X_n)\]

where \(0\) is industrial output; \(X_i\), \(i = 1, 2, \ldots, n\), are the productive inputs; and \(F\) is the mathematical expression which defines how the inputs relate to output.\(^{26}\) Thus the complete specification of the model or function requires both the specification of the output and input space plus the explicit mathematical expression.

The analysis in this dissertation is limited to Venezuelan manufacturing. The specification used for manufacturing is in general different from the specification used for estimating other sectors of the economy, although it may be the same or similar. For instance, an agricultural production function would probably include land as a separate input in the model specification. However, in manufacturing, land is less important, and is included in the capital input variable.

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\(^{26}\) For a fundamental idea of a function, consider the following: "The notion of a function involves three things: (1) a set \(D\), called the domain of the function, (2) a set \(R\), called the range of the function, and (3) a rule that assigns to each element \(x \in D\) an element \(y \in R\). The set of pairs \(\{(x, y) | x \in D, y \text{ the corresponding element of } R\}\) is the function." R. C. Fisher and A. D. Ziebur, *Calculus and Analytic Geometry* (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1965), p. 25. In our model the element \(x\) is the n-tuple of inputs and firm characteristics.
The validity of the mathematical form as well as the inputs which have been specified on an a priori basis as making a contribution to the value of output are matters that are subject to empirical investigation. The validity of which variables to include depends on numerous environmental or technical considerations.

Functional Specification

This study hypothesizes that a Cobb-Douglas production function is the most appropriate functional form for estimating the Venezuelan manufacturing industries. This hypothesis is tested against the more general CES specification which included the Leontief, linear and Cobb-Douglas as special cases. 27 To do this the CES function was fitted to industry data. The results are shown in Appendix D. It was found that the elasticities of substitution are significantly greater than zero for all two-digit industries except primary metals. 28 Only primary metals, paper and nonelectrical machinery have elasticities of substitution different from unity at a 95 percent level of confidence, and that of nonelectrical machinery is not significantly different from unity at a 99 percent level of confidence. This rejected the hypothesis that the production function is of a linear or fixed-coefficient type, but did not reject the hypothesis that the function was of the Cobb-Douglas form. 29

27 For a complete exposition of this concept, see Ferguson, The Neoclassical Theory of Production and Distribution.

28 These results are presented in Appendix D.

Based on the results of the above test, those of other empirical studies of industry production functions\(^3\) and because of its facility for handling more than two inputs, a basic Cobb-Douglas production function is used. The specification of the basic model is

\[
O_i = A \cdot L_{1i}^{a_1} \cdot L_{2i}^{a_2} \cdot L_{3i}^{a_3} \cdot L_{4i}^{a_4} \cdot K_{1i}^{b_1} \cdot K_{2i}^{b_2} \cdot K_{3i}^{b_3} \cdot M_i^{c}.
\]

\[(3.2) \quad \sum_{j=1}^{5} \sum_{i=1}^{n} \sum_{e=1}^{l} d_{ji} f_{li} u_{1i} e \cdot i=1,...,n .
\]

For the \(i^{th}\) firm contained in the 1970 cross sectional census data, these variables are defined as follows:

- \(O_i\) = output during the year 1970
- \(L_{1i}\) = services of managers
- \(L_{2i}\) = services of professional and subprofessionals
- \(L_{3i}\) = services of skilled workers
- \(L_{4i}\) = services of semi- and unskilled workers
- \(K_{1i}\) = services of fixed assets
- \(K_{2i}\) = services of working capital
- \(K_{3i}\) = services of inventory capital
- \(M_i\) = services of intermediate inputs
- \(D_{1i}\) = utilization of capital
- \(D_{2i}\) = utilization of labor
- \(D_{3i}\) = experience
- \(D_{4i}\) = generating own electricity
- \(D_{5i}\) = advertising

\(^3\)Ibid.
\( Y_1 \) = foreign imports as a percentage of intermediate inputs

\( \Lambda \) = a constant

\( a_1 \) = elasticity of output with respect to managers

\( a_2 \) = elasticity of output with respect to professionals and sub-professionals

\( a_3 \) = elasticity of output with respect to skilled workers

\( a_4 \) = elasticity of output with respect to unskilled and semiskilled workers

\( b_1 \) = elasticity of output with respect to fixed assets

\( b_2 \) = elasticity of output with respect to variable capital

\( b_3 \) = elasticity of output with respect to inventory capital

\( c \) = elasticity of output with respect to intermediate inputs

\( d_1 \) = coefficient associated with the utilization of capital

\( d_2 \) = coefficient associated with the utilization of labor

\( d_3 \) = coefficient associated with experience

\( d_4 \) = coefficient associated with generating own electricity

\( d_5 \) = coefficient associated with advertising

\( f_1 \) = coefficient associated with percent of foreign imports used in intermediate inputs

The natural base is e and the random variable u is assumed to have the usual properties associated with ordinary least squares estimation procedures.

Input space is separated into the following two basic categories: primary inputs and efficiency factors. Primary inputs, or factors of production are defined as scarce resources used in the production of goods and services. They generally have a positive impact on industrial production. An exception would occur if increasing supplies
of an already abundant factor lowered the output capability of a firm. The efficiency factors, measured by dummies and shift factors, are environmental or technical factors affecting the way the primary factors combine to form output. They may add or detract from industrial productivity.

The focus of all primary input combinations for a given level of output is an isoquant or an isoproduct line. An illustration for a two factor case is given in Figure 1.

Figure 1: Industrial Isoquant for Primary Factor Inputs

In the two factor case, labor and capital are assumed to be substitutable. The rate of technical substitution between them at any particular input combination is the negative of the slope. In equilibrium, the point of operation occurs where the ratio of factor prices equals the rate of technical substitution.

The exponents of the primary factors—labor, capital and intermediate inputs—represent the elasticities of output with
respect to the corresponding inputs. They measure the percentage change in output with respect to a percentage change in that input. Moreover, the elasticities of output represent the income shares going to these factors in a competitive equilibrium situation with constant returns to scale.

The marginal product of output with respect to say managerial labor is \( \frac{dO}{dL_m} = a_1 \cdot \frac{0}{L_m} \) which may be rearranged as \( \frac{dO}{dL_m} \cdot \frac{L_m}{0} = a_1 \).  

Thus, the marginal product as well as the share of output going to managerial labor is positive if \( a_1 \) is positive (since both 0 and \( L_m \) are positive). Thus testing if \( a_1 \) is positive and significant enables the determination of where managerial inputs significantly add to industrial productivity (i.e., \( \frac{dO}{dL_m} > 0 \)) or where it does not add to industrial productivity (i.e., \( \frac{dO}{dL_m} = 0 \)). For example, managerial labor may not significantly contribute to value of output in one industry, but may be highly significant and positive in another. Knowledge of what and where factors are important has policy implications in terms of industrial promotion programs. These results also have relevance for decisions in the area of education and skill development.

The dummies and shift factors describe environmental, institutional and technical conditions which add to or detract from the quantity of primary inputs required to produce a given level of output. Consider representation given in Figure 2 of isoproduct lines in a simple two factor function.

\[31\] Ferguson, Neoclassical Theory, p.99.
A significant and positive efficiency factor shifts the isoproduct line from 0₁ to 0₂. This means that in the presence of a positive impact of an efficiency factor, the same industrial output is produced with less of at least one of the primary inputs (without increasing the amount of the other input); a negative impact would imply a reverse shift from 0₂ to 0₁.

**Output and Inputs**

Output refers to the value of products produced and services rendered by the firm during a year. Producing output requires scarce resources which are designated as inputs or factors of production. The inputs in the production process are defined as the flow of services of scarce resources that are rendered or are consumed during a production year. Capital, labor and intermediate inputs are the principal inputs that will be examined in this study.
Labor services are disaggregated into four categories in an attempt to measure their separable impact on industrial output. The first category is services rendered by managers which carry out the unique task of coordinating the other inputs. The second is the services rendered by nonmanagerial professional and subprofessionals directly employed by the firm. The third set is services of skilled workers. The fourth set of labor services contributing to the value of output are those services performed by semi- and unskilled, uneducated workers directly employed by the firm.

Capital services are broken down into three categories. The first is the set of services rendered by fixed assets employed in the production process. This set includes the services flowing from machinery, buildings, transport machinery and land. A second set of capital services is variable capital. This factor includes general expenses such as publicity and advertisement. The third set of capital services are output and input inventories which are maintained by the firm to avoid the costs involved in work slowdowns and stoppages that occur due to shortages of inputs needed for production. Output inventories are needed to avoid costs of lost sales due to a consumer's seeking alternate sources of supply because of shortages of firm output at a given period of time.

32 Human capital literature in general argues for the disaggregation of labor into more comparable categories. It is hard to argue that highly trained and educated workers should be included in the same input category as unskilled and uneducated workers.

33 This can be thought as analogous to the surplus of reserves held by banks to avoid the costs and penalties of running out of reserves required for their operations.
A third set of inputs are designated as intermediate inputs. These include the inputs not produced by the firm during the production year, and comprise such items as fuels, packing materials and raw materials.

In addition to the inputs mentioned above, a number of firm characteristics are included in the variable specification of the model. Capital and labor utilization are included to examine if the rate of factor utilization significantly affects industrial output. By categorizing industries, it is hoped to determine where these factors significantly affect industrial production and where they are most inhibiting. Experience is also examined to measure its impact on productivity. If this is a significant causal factor for a particular industry, it has important implications for the type of managers and workers needed to start a new firm. Other factors such as whether or not the firm generates its own electricity and whether or not a firm advertises are also incorporated in the model.

Another factor involves the impact of imported foreign intermediate inputs in contributing to Venezuelan industrial productivity. The significance of this variable has policy implications for both the allocation of foreign inputs among competing firms, and for direction of efforts to determine the feasibility of new areas of domestic import substitution.
CHAPTER IV

DATA

This study utilizes a very unique and detailed data set available for the Venezuelan manufacturing firms during the year 1970\textsuperscript{1}. This chapter describes briefly the data that is available, how it was obtained, and how it will be used to measure the variables for the theoretical model developed in the previous chapter. Some of the limitations of the data with respect to the model are pointed out. This chapter also presents characteristics of those Venezuelan manufacturing firms which are treated in detail in the next two chapters. This facilitates an understanding of much of the analytical analysis that will be presented.

\textbf{General Description}

The data are obtained from questionnaires filled out by Venezuelan manufacturing firms in 1970. The Venezuelan Manufacturing Census (1970) and complementary census of the manufacturing sector were carried out in the same year by the Venezuelan Ministry of Planning (Ministerio de Formento)\textsuperscript{2}. The data are in two parts. The first part contains information from the main census for approximately twenty four hundred manufacturing firms. The second contains data on firms for which information from both the main census and the

\textsuperscript{1}Republica de Venezuela, Ministerio de Fomento, Direccion General de Estadistica y Censo Nacionales, Cuestionario Anual De La Industries Manufacturea Fabril, (Caracas, 1970).

\textsuperscript{2}Ibid.
complementary census can be matched. The second data set includes approximately nine hundred firms.

Briefly, the available firm level data provides information on the number of workers employed by the firms during 1970. These workers are divided into five categories: proprietors, family workers, production workers (obreros), directors, and other employees (empleados). The first two labor categories are considered to be null sets when the firm is incorporated. Also available are the total manhours worked by production workers.

Data also exists on the value of fixed assets owned by the firm. These are divided into four categories consisting of buildings, transport equipment, machinery, and land. The value of depreciation of fixed assets owned by each firm is also given. Unlike most other data sets, information is available on the value of variable capital inputs used by the firm during the year 1970. Included in this category is the amount paid out by firms for rents, insurance expenses, publicity, advertisement, professional services, and other expenses. Data is also available on the value of input and output inventories being held at the beginning (on January 1) of the survey year.

Finally, the main census contains the value of intermediate

\[3\] With respect to the third and fifth labor categories: "The distinction between manual and nonmanual occupations has considerable legal and social significance. The obrero (laborer) is defined under the law as a person engaged in an occupation in which he works for another at a trade or performs a service in which manual or physical efforts predominate. An empleado (employee) is defined as a person who works for another at work where the intellectual effort predominates over the physical. The obrero is paid in daily or weekly wages whereas the empleado receives a salary, usually paid on a monthly basis. The white-collar empleado usually receives considerably more pay than the blue-collar obrero." Thomas E. Weil, et.al., Area Handbook for Venezuela, (Washington: U.S. Government Printing Office, 1971), p.364.
inputs used by the firm during 1970. Included in this category are the value of raw materials, fuels, lubricants and packing. This information is available for foreign and domestically produced intermediate inputs.

The complementary census contains very detailed data on employment by occupation. Included are data on the manager's perceived views of whether or not their firms have underutilized capital and/or labor. 4 If underutilization occurs, the reasons for it are delineated. Finally, the complementary data has information on individual firm growth. The value of fixed assets and sales as well as the number of employees working for the firm in 1965, are available.

**Selection of Firms for the Study**

As in similar survey data, especially surveys conducted in less developed countries, there are some gross inconsistencies. They must be corrected to obtain meaningful data that will not distort the analysis. This data bank is no exception. Thus, it was decided to eliminate many firms for which very crucial information was missing and which could seriously have biased the results. 5 The five criteria used for selecting firms for this study were:

1. Value of products produced must be positive.

2. Number of production workers must be positive.

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4 Note questions III - A.2 and III - B.6: "Are you satisfied with the number of hours that your machine operates?" and "Are the workers who are not currently fully used?" These questions are phrased so that underutilization of say capital could occur even if the first question was answered in the affirmative. They represent the perceived view of the person filling out the questionnaire.

5 A similar procedure was carried out in Eisner's study of
3. Wages of production workers must be positive.
4. Manhours of production workers must be positive.
5. Fixed assets (e.g. the sum of the values of buildings, transport equipment, machinery, and land) must be positive.

Firms not meeting these five obvious criteria were eliminated from the sample. For example, in the food processing industry, twenty three of five hundred and forty seven firms in the main census, and thirteen of two hundred and ninety one firms in the matched census, were eliminated. In the metal fabrication industry, nine of one hundred and ninety five firms in the main, and three of the fifty eight firms in the matched set, were removed. In no industry in either set were more than fifteen percent of the firms deleted from the sample. The distributions of firms kept and removed for each two-digit industry on both sets are presented in Appendix E.

Variable Measures

The problem of measuring output and input components of the model are very important items in the process of developing the theory. If the theoretical components are measured incorrectly, then the structural parameters estimated through the inductive process of regression are probably wrong, and at best misleading. These are worthless when used to say something about their counterparts in the theoretical model. In this section, the important task of defining how the variables

in the theoretical model will be measured within the confines of the Venezuelan manufacturing census data is described.

**Dependent Variable**

Firm output (O) is the sum in bolivars of the value of production during the year 1970, plus the value of auxiliary services performed for others through contracts, commissions, maintenance and construction, plus the sale of unfinished products, that is products sold in the same condition they were bought during the production period, plus the value of electricity sold during the year, plus any other incomes accruing to the firm.

For theoretical reasons discussed earlier, and for empirical reasons elaborated on in detail in Appendix C, the gross value of output and not value added (defined as value of output minus value of intermediate products), is used to measure the output of the firm. This formulation also has more intuitive appeal in the sense that the value of output and not value added is the final result of the production process. "Intermediate inputs" by their very name are inputs, and should be so specified, just as labor and capital are, as contributing to the final value of the product.

**Independent Variables**

The labor input is disaggregated into four categories: 1) managers \( (L_1) \), 2) other professionals and subprofessionals, \( (L_2) \), 3) skilled workers \( (L_3) \), and 4) semiskilled and unskilled workers \( (L_4) \). These categories correspond roughly to the groupings by occupational
classifications used by Kelley, et.al.  with the exception that "managers" are separated out of "professionals and subprofessionals". The groupings represent workers with roughly the same formal educational requirements in terms of years of schooling "normally" required to enter the work force.

Examples of occupations in the professional and subprofessional grouping \((L_2)\) are architects, engineers, chemists, physicists, geologists, economists, statisticians, lawyers, auditors, accountants, draftsmen, subprofessional technicians, and laboratory assistants. Included in the group of skilled workers \((L_3)\) are bookkeepers, cashiers, stenographers, secretaries, office machine operators, industrial mechanics, machine repairmen, precision instrument makers, electricians, and radio technicians.

Labor in each category is measured by applying the percentage distribution of the four categories obtained from the complementary census to the number of workers given in the main census. This was done because the employment data in the questionnaire and complementary census did not always match, and it was assumed that the total

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\(^6\) For a description of how skilled and unskilled workers are separated, see the classifications given in S.C. Kelley, et. al., *Human Resources in Ecuador* (Columbus, Ohio: Center for Human Resource Research, the Ohio State University), pp. 27-28, pp. 265-266. Professional and subprofessional workers are those in groups A and B. Skilled workers are in group C. Semiskilled and unskilled workers are in groups D and E.

\(^7\) For an example of the distribution of years of formal education completed upon entering the work force, see *Ibid*, p. 28.
employment in the main census was a more accurate measure of the number of employees in the firm for the entire year. 8

Ideally, labor should be measured by the total number of manhours worked in each category. This was not possible, because manhour information was only available for production workers. However, initially, labor in each category was assumed to work the same number of hours per year as production workers. In effect, this measure takes into account the possibility of inter-firm differences of manhours per worker per year. There was, however, little variation in the structural parameter estimates when this measure of the flow of labor services was used. Thus, labor is measured in stock terms, but with confidence that the parameter estimates will not be seriously biased.

The capital input as pointed out earlier, is generally measured by the value of the stock of fixed assets. The available data permits the measurement of capital in flow terms. The flow of services from fixed assets is defined as depreciation plus ten percent of all fixed assets, i.e., buildings, transport equipment, machinery and land. Ten percent of all fixed assets represents the opportunity costs of holding capital in the form of fixed assets. 9

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8 The complementary census represents the occupational distribution of workers at one point in time. The main census records the total number of workers that the firm has employed over the year 1970.

Initially, the sensitivity of the parameter estimates to different measures was checked. First, instead of adding the listed depreciation to the opportunity costs of holding fixed assets, depreciation rates were estimated for each of the four fixed asset components. This was done by using the reciprocal of the anticipated average life span of each of the four assets. These four new depreciation components, obtained by multiplying the depreciation rate times the corresponding value of the fixed asset, were added to the opportunity cost of holding the fixed assets. Second, five and fifteen percent, instead of ten percent, were used to calculate the opportunity cost of holding fixed assets. The empirical results indicated that there was little sensitivity in the parameter estimates using these alternative measures of capital. Thus, the value of depreciation, plus ten percent of the value of all fixed assets, was chosen as the measure of service flow from fixed assets.

Variable capital is often ignored or assumed proportional to fixed assets in production studies. As is shown at the end of this chapter, variable capital is a sizable part of the capital component, and is unlikely to be proportional to fixed assets. Initial empirical work indicated that it makes a significant contribution to industrial output, and its omission leads to distortions in the parameter estimates. In this study variable capital (Kᵥ) is measured by taking the sum of rents, insurance expenses, publicity, advertisement expenses, and the payments

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for professional services and other expenses incurred by the firm during the year.

The third capital item which is also generally ignored in production studies -- at least no empirical studies of the manufacturing sector which consider this input are available -- is inventory capital \( (K_3) \). This input represents a capital cost to a firm which is not included in the previous two capital inputs. Inventory capital is expected to be very important in industries requiring large stocks of both input and output inventories at any point in time. These inventories are kept in order to avoid work stoppages due to lack of critical inputs, or sales losses to competitors as a result of the unavailability of output. Kuznets has pointed out that inventories are relatively more important in less developed than more developed nations.\(^{11}\) The significance of this variable may differ from industry to industry, or between regions within an industry, due to differences in the basic production function or differences in the accessibility of firms to scarce and crucial inputs required for production. Inventory capital \( (K_3) \) in this study is measured by taking the value of inventories on hand on January 1. Inventories are defined as the sum of raw materials, fuels, lubricants, packing, and materials that are accountable property assets of the company. Ten percent of the stock of inventories, a measure of the opportunity costs of holding inventories, is used to measure the service flow from inventory capital.

Intermediate inputs (M) are measured by taking the sum of consumed raw materials, packing materials, fuels, lubricants and other operation expenses, such as purchased electricity, auxiliary expenses, and the contracts of industrial services. This measure represents the amount of these products used, but not produced by the firm, between January 1 and December 31 of 1970. These include items produced both domestically and abroad.

To summarize then, the direct input variables — labor, capital, and intermediate inputs — are measured as follows:

- \( L_1 \) is the number of managers.
- \( L_2 \) is the number of professionals and subprofessionals.
- \( L_3 \) is the number of skilled workers.
- \( L_4 \) is the number of semi- and unskilled workers.
- \( K_1 \) is the sum of depreciation plus ten percent of the value of machinery, land, transport machinery, and buildings.
- \( K_2 \) is the sum of the values of rent, insurance, publicity and advertisement, professional services and other expenses.
- \( K_3 \) is ten percent of the sum of the value of raw materials, packing materials, products in progress and finished products.
- \( M \) is the value of foreign and domestically produced raw materials, packing and consumed materials, fuels, lubricants and other operation expenses.

The dummies and efficiency factors discussed in the theoretical model of Chapter III are measured as follows:

- \( D_1 = 1 \) if no "perceived" underutilization of capital occurs; 0 otherwise.
- \( D_2 = 1 \) if no "perceived" underutilization of labor occurs; 0 otherwise.
\[ D_3 = \begin{cases} 1 & \text{if the firm was in existence five years ago;} \\ 0 & \text{otherwise.} \end{cases} \]

\[ D_4 = \begin{cases} 1 & \text{if the firm generates its own electricity;} \\ 0 & \text{otherwise.} \end{cases} \]

\[ D_5 = \begin{cases} 1 & \text{if the firm advertise;} \\ 0 & \text{otherwise.} \end{cases} \]

\[ F_1 = \text{the value of foreign-produced intermediate inputs as a percentage of the value of total intermediate inputs.} \]

The impact of underutilization of capital and labor on industrial output is of interest because it is generally assumed that LDC's lack the entrepreneur skills as well as a social and physical infrastructure needed to fully utilize industrial resources. The dummies \( D_1 \) and \( D_2 \) are adequate measures only if "perceived" underutilization of labor and capital in fact reflect the existence of actual underutilization.

Experience is an efficiency factor of great interest in LDC's because manufacturing techniques, specially in the modern industries, are new and experience is generally lacking. \( D_3 \) is used to measure this factor, on the basis that if a firm has been operating for at least five years its personnel and management have acquired some amount of learning and expertise that a new firm has yet to achieve.

\( D_4 \) is a straightforward measure of whether or not a firm generates its own electricity; and \( D_5 \) is a measure of whether or not a firm advertises.

The importance of foreign imports in intermediate inputs is of relevance in the linkage arguments of Hirschman. The measure \( F_1 \)
reflects the importance of the foreign inputs in the intermediate input mix.

Limitations of Data

The data set is very good in terms of both the large sample size and the detailed information it possesses for each firm, but it does have some limitations. Some have been mentioned before. No information is available on capital vintage, and thus a further refinement in the measurement of capital is not possible. A better measure of labor would be possible if information were available on total manhours worked in each of the specified labor categories. Some inconsistencies in the data might lead to biased parameter estimates. However, the effects of this are anticipated to be minimal due to the small percentage loss of sampled firms.

A potentially more serious problem occurs with the use of the matched data from the complementary census. Lack of information for linking information from the two census questionnaires permitted the inclusion of only a little over nine hundred firms. The randomness of this matching is unknown. In the next chapter, estimates are made using both census sets in order to insure that the results based on the matched set are in reasonable correspondence with those based on the main census. There is no evidence that indicates that the firms in the matched set were not selected randomly from the firms in the main census set. There are a large number of firms for the matched set, and thus consistent parameter estimates are anticipated.

Another limitation of the data stems from a lack of information on what regions in Venezuela the regional codes represent! As a
result, the estimates of the regional functions for the food processing industry are presented without knowing what regions are under consideration!

Other limitations of the data stem from a lack of information that prevents the identification of firm subgroups of interest to both economic theoreticians and practical planners. Two subcategories not distinguished are whether or not the firm is a foreign enterprise, and whether or not the firm is unionized. Basically, these limitations are small compared to the opportunities presented by the data. It is in general excellent data that permits the estimation of industry-level production models which has not before been possible.

Briefly, to summarize, there are two data sets available. The main data set has a larger number of firm observations, but less detailed information. The matched data set has a smaller number of observations, but permits the inclusion of more firm characteristics. It also allows the disaggregation of labor into relatively homogeneous skill categories. The latter set is used to estimate the expanded versions of the production function. The former is used to estimate the less detailed models.

**Industrial Firm Characteristics:**

**Food Processing and Metal Fabrication**

Summary statistics of the industries being examined in this study are discussed briefly in this section. These statistics provide insight into the structure and technology of the industries and facilitate the interpretation of the analysis of industrial production functions presented in the next two chapters.
The means and standard deviations of output, input, and other characteristics of Venezuelan food processing and metal fabricating firms are presented in Appendix F. Some highlights and salient differences between firms in the food processing and metal fabrication industries, and between proprietorships and non-proprietorships in the food processing industry are described below.

The mean value of output for food processing industries is B$6,033,167$ (bolivars)\(^\text{12}\). This is substantially larger than a mean value of output of B$3,644,571$ for the metal fabrication industry. Within food processing the mean value of output is B$688,138$ for proprietorships, which is substantially below that of nonproprietorships with a mean output value of B$8,546,775$. These statistics are consistent with the conventional view of the "small" proprietor and the "gigantic" corporation.

Another salient feature of proprietorships in food processing in contrast with either nonproprietors in food processing or firms in fabricated metals is that professional and subprofessional as well as skilled workers are relatively small components of the labor force when compared to those in the semi- and unskilled worker category. Another distinction of firms in fabricated metals is that skilled workers compared to semi- and unskilled workers are relatively more important than in the food processing industry. This agrees with our earlier finding of a positive rank correlation between industries ranked by skill intensity and growth rates.

Within the capital measures, variable capital compared to fixed

\(^{12}\)4.5 bolivars equals 1 United States dollar in 1969.
assets is of smaller importance in proprietorships. Inventory compared to noninventory capital is more pronounced with fabricated metals than in the food processing industries, as one would expect. The mean share of foreign produced to total intermediate inputs is much larger in metal fabrication (30.8 percent) than in food processing (6.7 percent). Moreover, the proportions within food processing are larger for nonproprietorships (8.1 percent) than proprietorships (3.6 percent). This is consistent with the notion regarding the development of linkages in the older, more mature industries as opposed to the newer dynamic industries. Fabricated metals, as a newer industry, relies on a larger proportion of its intermediate inputs from abroad, because the industries supplying these inputs, are not yet sufficiently developed to meet these input demands, as postulated by Hirschman. 13

There do not appear to be significant variations in the utilization of capital, the utilization of labor, and the experience variables between industries. However, 73 percent of the firms in metal fabrication advertise, as opposed to only 65 percent in food processing. However, upon breaking the latter industry down into two groups, it is noted that over 71 percent of nonproprietorships as opposed to less than 51 percent of proprietorships advertise.

Finally, it appears that the larger nonproprietorships tend more often to generate their own electricity—8 percent—as opposed to 1 percent for proprietorships.

Having described the data, defined the variables to be used and delineated the main characteristics of the two industries under study, we now turn to the empirical estimates of their production functions.
CHAPTER V

EMPIRICAL ANALYSIS

Introduction

This chapter presents the estimates of the production function developed in Chapter III. The function is estimated for the food processing and fabricated metals industries. Several specific hypotheses are postulated and tested using the Venezuelan manufacturing census data for these two industries. Chapter V concludes with an examination of the value of marginal product of disaggregated forms of labor and capital.

An infinite number of classification schemes are available for analyzing the data. Alternate classification schemes depend on the problem being solved. In the context of looking at other problems, this does not present difficulties since the methodology can easily be modified to handle alternate firm groupings, various levels of aggregation and disaggregation of the inputs, as well as different dummies and shift factors which characterize the firm.

The Estimating Equations

Two basic models are estimated using the matched data. The first model restricts the independent variables to the set of primary inputs, while the second includes in addition five dummies and one shift factor. The estimating equations are the doublelog transformation of the
Cobb-Douglas production function. Explicitly these models can be written as follows:

**Model I:**

\[
\ln Q_i = \ln A + a_1 \ln L_{1i} + a_2 \ln L_{2i} + a_3 \ln L_{3i} + a_4 \ln L_{4i} \\
+ b_1 \ln K_{1i} + b_2 \ln K_{2i} + b_3 \ln K_{3i} + c \ln M_{1i} + u_i, \ i=1, \ldots, n
\]

**(5.1)**

**Model II:**

\[
\ln Q_i = \ln A + a_1 \ln L_{1i} + a_2 \ln L_{2i} + a_3 \ln L_{3i} + a_4 \ln L_{4i} \\
+ b_1 \ln K_{1i} + b_2 \ln K_{2i} + b_3 \ln K_{3i} + c \ln M_{1i} + d_1 D_{1i} + d_2 D_{2i} \\
+ d_3 D_{3i} + d_4 D_{4i} + d_5 D_{5i} + f_1 F_{1i} + u_i, \ i=1, \ldots, n
\]

**(5.2)**

where

0 = value of output (in bolivars)

A = a constant

L\textsubscript{1} = number of managers

L\textsubscript{2} = number of professionals and subprofessionals

L\textsubscript{3} = number of skilled workers

L\textsubscript{4} = number of semi- and unskilled workers

K\textsubscript{1} = fixed assets (in bolivars)

K\textsubscript{2} = variable capital (in bolivars)

K\textsubscript{3} = inventory capital (in bolivars)

M = intermediate inputs (in bolivars)

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1 The symbol "\ln" refers to the taking of the logarithm to the base "e".

and

\[ D_1 = \text{capital utilization} \]
\[ D_2 = \text{labor utilization} \]
\[ D_3 = \text{experience} \]
\[ D_4 = \text{electrical generation} \]
\[ D_5 = \text{advertising} \]
\[ F_1 = \text{percent foreign intermediate inputs} \]
\[ n = \text{number of firms}. \]

The way in which these variables are measured was described in Chapter IV.

The models are fitted to data for food processing and metal fabrication in the sample. Ordinary least squares procedures are used to estimate all of the parameters in the equations. A one tailed t-test is used to test the significance of independent variables except those associated with the dummies for electricity and advertising, for which a two tailed t-test is used, since they may affect output either positively or negatively. ³

Advertising may affect output positively if it represents a productive input informing the consumer about the product and this increased information increases consumer demand. It may affect output negatively if it represents a cost to the firm which is incurred in order to maintain the firm's market share, but which in fact has no effect on the firm's output.

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³For a general discussion of these various statistics and how they are used for testing, consult any econometric textbook, for example, Goldberger, *Econometric Theory*, pp. 156-212.
With respect to a firm generating its own electricity, the internal generation of electricity by a plant may not be significant in a relatively developed region with an abundance of inexpensive electric power. But in a relatively backward region where public power facilities do not exist or have not been adequately developed and where outside sources of electricity are expensive, the internal generation of electricity may be a highly significant and critical input.

These factors may vary in importance among firms but would be consistently important in a given institutional or environmental setting. In a planning context it is vital to know under what conditions a scarce factor does or does not significantly affect production output.

Rapid and Slow Growth Industries: Food Processing and Metal Fabrication

An industry classification scheme is an obvious choice for grouping firms. Since products being produced, while still very heterogeneous, are much more homogeneous within an industry grouping than between industry groupings, it is more appropriate to estimate a production function for an industry than a production function for the entire manufacturing sector.

Industrial classifications are also important in a planning context because policy decisions often involve determining what industry or group of industries should be promoted, developed and subsidized. As was pointed out in Chapter II, government banks are a source of one-third of the total credit in Venezuela and play a strong role in coordinating and developing the domestic financial institutions. Thus, knowledge of the industries' productive inputs aids policy makers in making decisions.
about what productive inputs should be developed and possibly subsidized to prevent factor supply constraints from inhibiting production goals.

For example, if certain industries are to be encouraged and their production function involves a high proportion of skilled labor or if imported inputs are a significant productive input, then efforts need to be made to supply these factors in the future either through expanded domestic facilities or through foreign imports.

Because of the difficulty of analyzing all twenty two-digit sectors and the problem of comparing and contrasting them, an attempt has been made to isolate two prototype industries which may be substantially different in terms of the relative importance of their inputs and the factors that influence firm productivity.

In an economy where per capita income is steadily rising, rapid growth industries tend to produce relatively income elastic goods, while slower growing industries tend to produce relatively income inelastic products. Consumer durables tend to be associated with the former set of industries and consumer nondurables tend to be associated with the latter. It is felt that examining the production function in two representative industries in each group will bring out some of these interesting contrasts. Some of these can be stated in the form of a priori hypotheses, but many others will have to await full empirical investigation. For example, it is hypothesized that the high growth industries are more skill-intensive than the slow growth industries. It is also hypothesized that the management input is likely to be more important in dynamic industries than slow growth industries. In a preliminary investigation,
a positive rank correlation between industries ranked by skill intensity and industries ranked by growth rate was evident.\(^4\) The policy implications for increasing supplies of skilled labor are obvious if the economy is to avoid stagnation in these industries. In addition, it is also anticipated that the newer, dynamic industries require more imported intermediate inputs because the backward linkages needed to supply these industries have not yet been fully developed. This has policy implications for determining which industries should be permitted to import as well as examining the imports to check the feasibility of their being produced efficiently in the domestic economy.

For these reasons, one relatively fast growing and one relatively slow growing industry are examined. The food processing industry (hereafter referred to as FP) is chosen as the slow growth industry partly because of its modest growth performance and also because it has the largest sample size of any of the industry groupings. The metal fabrication industry (hereafter referred to as MF) is chosen because it has both a high growth rate and a relatively large number of firms in the sample.

Some Hypotheses

The statistical significance of each variable will be tested to see if and what differences and similarities occur between the two industries. Some \textit{a priori} hypotheses can be stated briefly as follows:

\(H_1:\) The skilled labor input is relatively more important in MF than in FP because specialized skilled workers, including managers, engineers, and technicians, are required to a larger extent for transforming and using modern technology.

\(^4\)See Appendix A and corresponding discussion in Chapter III.
H2: Publicity and advertisement inputs are more important in MF than in FP because the product specifications of the newer industries are less well known by consumers and thus marketing services play a more important productive role.

H3: Imported intermediate inputs are relatively more important in MF than in FP because backward-linkages which produce the inputs required by the new industries in MF have not yet developed sufficiently to enable domestic firms to adequately provide these inputs.

Each of these hypotheses is examined with a t-test. They are confirmed if the corresponding variable in the model is significant and positive for MF but not for FP. If both are significant and positive, the relative size of the elasticities of output for skilled labor compared to the elasticities of output for other factors will be used to infer the relative importance of this factor in the production relationship. That is, the ratio of the estimated coefficients \((\hat{a}_1 \hat{a}_2 \hat{a}_3)/(\hat{a}_1 \hat{a}_2 \hat{a}_3 \hat{a}_4)\) for MF greater than the same ratio for FP would indicate that skilled labor is a relatively more important component of the labor force for MF than for FP. The denominator could also include the parameter estimates of the elasticities of output with respect to capital and intermediate inputs suggesting the importance of skilled labor with respect to all specified primary inputs. The numerator could be reduced to include the elasticity of output of a single primary input.

The relative size of the coefficient of the dummy for publicity, \(d_5\), or the relative size of the coefficient of the shift variable for imported intermediate inputs, \(f_1\), will be used to make a judgment concerning the relative importance of the inputs in each of the two industries. It should be added that the latter procedure just "indicates"
or "reinforces" the hypotheses but does not provide a statistically significant test. In testing the relative importance of the factor, a ratio of the parameter estimates for the factor of interest and the other productive factors would have to be developed. Since all of these estimates are random variables, the distribution of such a ratio is useless since it may not specify levels of significance with any degree of confidence. However, because of the relatively large sample size, the parameter estimates of the model are consistent so there is a relatively large degree of confidence in the parameters approximating the actual parameter values (i.e., there is small sampling error).

Another hypothesis that has important implications for income distribution is one that relates the quality of labor in a firm's work force to the relative income shares of labor and capital.

\[ H_4: \text{Industries where skilled labor is a relatively more important component of the work force are industries where the relative share of income going to labor is greater than that going to capital.} \]

It is hypothesized that skilled labor is relatively more important in MF than in FP (see \( H_1 \) above), that is, \[ \left[ \frac{(a_1+a_2+a_3)/(a_1+a_2+a_3+a_4)}{MF} \right] > \left[ \frac{(a_1+a_2+a_3)/(a_1+a_2+a_3+a_4)}{FP} \right] . \] If both \( H_1 \) and \( H_4 \) are valid, then labor share with respect to capital share would be greater in MF than FP, i.e., \[ \left[ \frac{\Sigma a_1/(\Sigma a_1+\Sigma b_1)}{MF} \right] > \left[ \frac{\Sigma a_1/(\Sigma a_1+\Sigma b_1)}{FP} \right] . \] It should be noted again that this type of analysis is based on the assumption of perfectly competitive factor markets.

It should also be pointed out that this hypothesis would not necessarily be supported if skilled labor and capital are complementary factors in the sense that their elasticity of substitution is zero or near zero.
While it is beyond the scope of this study to investigate this problem, some recent literature has considered this possibility.\(^5\)

Hirsch also found a positive correlation between skill and capital intensity in Israeli manufacturing.\(^6\) Using a similar procedure, and two-digit industries as observations, it was found that a positive correlation between skill and capital intensities exists in Venezuelan manufacturing.\(^7\) The Spearman rank coefficient describing this correlation is .35, which is positive and significant at a ninety percent level of confidence. The distribution by skill and capital intensity of two-digit industries in the Venezuelan manufacturing sector is presented in Appendix G.

Further analysis is carried out using the firms for which complementary census data was not available. Since there are over two and a half times as many firms in the sample without matching complementary data, the next step was to modify the models in Equations (5.1) and (5.2) to examine

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\(^7\)There was an a priori suggestion that this might be the case. "...non-mining industries and some large manufacturing firms are staffed by well-trained personnel. These are, however, for the most part modern capital intensive operations, requiring relatively few hands," T. Weil, et al., Area Handbook for Venezuela, (Washington, D.C.: U.S. Government Printing Office, 1971), p. 368.
those questions which may be answered when the analysis is restricted to information obtained from the main manufacturing census. This provides a feasibility check for using the matched set based on a smaller number of sample firms to examine the Venezuelan industry production functions. One modified form of the model is:

**Model III:**

\[
\ln q_{i1} = \ln A + a_1 \ln L_{11} + a_2 \ln L_{01} + b_1 \ln K_{11} + b_2 \ln K_{21} \\
+ b_3 \ln K_{31} + c \ln M_{i1} + u_i, \; i=1, \ldots, n.
\]  

(5.3)

Its expanded version that includes the dummy variables is:

**Model IV:**

\[
\ln q_{i1} = \ln A + a_1 \ln L_{11} + a_2 \ln L_{01} + b_1 \ln K_{11} + b_2 \ln K_{21} + b_3 \ln K_{31} \\
+ c \ln M_{i1} + d_4 D_{4i} + d_5 D_{5i} + f P_{i1} + u_i, \; i=1, \ldots, n.
\]  

(5.4)

The only difference in the inputs other than the omission of some of the dummies and scale factors is the use of an aggregated labor term, \(L_0\), which was disaggregated earlier into professional and subprofessional, \(L_2\); skilled, \(L_3\); and unskilled, \(L_4\), worker categories. The results for this modified model will be compared and contrasted with the same model using matched census data to test the reliability and consistency of the parameter estimates using the matched census data.

**Results**

Parameter estimates and some corresponding statistics for these models are presented in Tables 7 and 8. Table 7 presents the results based on just the primary inputs, Model I, and the expanded version, Model II. The estimates for Models III and IV based on both the matched and main data sets are given in Table 8.
TABLE 7

REGRESSION COEFFICIENTS AND RELATED STATISTICS FOR THE VENEZUELAN FOOD
PROCESSING AND FABRICATED METALS INDUSTRIES (1970): MODELS I AND II

Model I:  \( y = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + a_4 x_4 + b_1 + b_2 + b_3 + c + d_1 + d_2 + d_3 + d_4 + d_5 + f_1 \)

<table>
<thead>
<tr>
<th>Sector</th>
<th>( a_1 )</th>
<th>( a_2 )</th>
<th>( a_3 )</th>
<th>( a_4 )</th>
<th>( b_1 )</th>
<th>( b_2 )</th>
<th>( b_3 )</th>
<th>( c )</th>
<th>( d_1 )</th>
<th>( d_2 )</th>
<th>( d_3 )</th>
<th>( d_4 )</th>
<th>( d_5 )</th>
<th>( f_1 )</th>
<th>( \text{Constant} )</th>
<th>( # ) of Obs.</th>
<th>( F )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Processing (20)</td>
<td>-.004</td>
<td>.022*</td>
<td>.027*</td>
<td>.146*</td>
<td>.165*</td>
<td>.048*</td>
<td>-.000</td>
<td>.590*</td>
<td>3.681</td>
<td>.992</td>
<td>272</td>
<td>719.943</td>
<td>.956</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal Fabrication (35)</td>
<td>.027***</td>
<td>.012</td>
<td>.023**</td>
<td>.092*</td>
<td>.127**</td>
<td>.170*</td>
<td>.020</td>
<td>.640*</td>
<td>3.909</td>
<td>.953</td>
<td>54</td>
<td>121.243</td>
<td>.956</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Model II:  \( y = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + a_4 x_4 + b_1 + b_2 + b_3 + c + d_1 + d_2 + d_3 + d_4 + d_5 + f_1 \)

<table>
<thead>
<tr>
<th>Sector</th>
<th>( a_1 )</th>
<th>( a_2 )</th>
<th>( a_3 )</th>
<th>( a_4 )</th>
<th>( b_1 )</th>
<th>( b_2 )</th>
<th>( b_3 )</th>
<th>( c )</th>
<th>( d_1 )</th>
<th>( d_2 )</th>
<th>( d_3 )</th>
<th>( d_4 )</th>
<th>( d_5 )</th>
<th>( f_1 )</th>
<th>( \text{Constant} )</th>
<th>( # ) of Obs.</th>
<th>( F )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Processing (20)</td>
<td>-.005</td>
<td>.020*</td>
<td>.027*</td>
<td>.145*</td>
<td>.154*</td>
<td>.052*</td>
<td>.001</td>
<td>.591*</td>
<td>-.011</td>
<td>.055</td>
<td>.195**</td>
<td>-.035</td>
<td>.032</td>
<td>3.408</td>
<td>.989</td>
<td>272</td>
<td>413.200</td>
<td>.957</td>
</tr>
<tr>
<td>Metal Fabrication (35)</td>
<td>.030**</td>
<td>.025**</td>
<td>.015</td>
<td>.100*</td>
<td>.151*</td>
<td>.155*</td>
<td>.013</td>
<td>.458*</td>
<td>.027</td>
<td>.237</td>
<td>.099</td>
<td>--</td>
<td>.079</td>
<td>.312**</td>
<td>3.786</td>
<td>.947</td>
<td>54</td>
<td>71.204</td>
</tr>
</tbody>
</table>

Note: The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (***) at the 10 percent level.
The regression results for food processing and fabricated metals in Model I explain a significant part of the value of firm output. The multiple coefficients of determination are .956 in both industries. The F statistics are 719.9 and 121.2 in food processing and metal fabrication, respectively, and are significant at all conventional statistical levels. The sums of the elasticities of output with respect to the primary inputs are .992 in food processing and .953 in fabricated metals. This indicates that constant returns to scale are probably occurring in both industries, although slightly decreasing returns may be occurring in fabricated metals.

In food processing only managers, \( L_1 \), and inventory capital, \( K_3 \), are not significant with at least a ninety percent level of confidence. The other primary inputs are significant and positive at a ninety-nine percent level of confidence. In fabricated metals, professional and subprofessional workers, \( L_2 \), and inventory capital, \( K_3 \), are the only insignificant inputs. The regression results indicate that two of the three skilled labor categories are significant and positive in each industry.

These results indicate that higher educated workers are significant in both industries. Moreover, both variable capital, \( K_2 \), and fixed assets, \( K_1 \), are significant in the food processing and metal fabrication industries. The hypothesis of a significant positive inventory capital input, implicit in the model specification, is not supported in these two industries.

When introducing dummies as independent variables in the regression, (Table 7), in Model II the regression coefficients attached to the primary
inputs do not change much. When Model II is fitted to the data for metal fabrication, professionals and subprofessionals are significant while skilled labor is not.

In food processing, the only significant dummy is the one indicating if a firm generates its own electricity. It is positive and significant with a ninety-five percent level of confidence. In metal fabrication, only the shift factor representing the proportion of foreign imports to total intermediate inputs is significant and positive.

There is some support for the hypothesis that skilled labor is relatively more important in MF than in FP. This can be seen by taking the share going to skilled labor categories over the share going to labor. In FP, this is \((-0.004 + 0.022 + 0.027)/(-0.004 + 0.022 + 0.027 + 0.144) = 0.238\) and this is lower than the corresponding value in MF, \((0.027 + 0.012 + 0.023)/(0.027 + 0.012 + 0.023 + 0.092) = 0.403\). Thus in terms of the relative shares going to these factors, skilled labor is more important than unskilled labor in MF than in FP, confirming one of our hypotheses.

The second hypothesis relating to the relative impact of advertising in these two industries was not confirmed. The advertising variable was insignificant in both industries. However, advertisement is one component of variable capital and a larger share of total output accrues to variable

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8Alternate indicators give the same result. For example, the ratio of elasticities of skilled workers (that are statistically significant) to semi- and unskilled workers is \(0.340\) (\(= (0.022 + 0.027)/0.144\)) for FP and this is lower than \(0.543\) (\(= (0.027 + 0.023)/0.092\)) for MF.
capital in fabricated metals than in food processing, where their respective elasticities of output are .136 and .048.

Some support was found for the third hypothesis relating to the greater significance (and productivity) of imported intermediate inputs in a dynamic rather than in a slow-growing industry. Since the shift factor was significant and positive in fabricated metals, but not significant in food processing, some credibility could be attached to this hypothesis.

Finally, the fourth hypothesis, which stated that industries where skilled labor is a relatively more important component of the work force are industries where the relative share of income going to labor is greater than that going to capital, was not supported by these results. This might be due to the relative complementarity of skilled labor and capital that occurs in the Venezuelan manufacturing sector, the implications of which were pointed out earlier.

The results of Models III and IV, using the two data sets, are presented in Table 8. The results for primary inputs in the food processing sector are very good. All six of the primary inputs are significant with the exception of inventory capital in Model III. The values of the parameter estimates are generally the same size. The three efficiency factors, however, lead to inconsistent results. The electricity generation variable is significant on the matched data but not in the main data. The foreign intermediate input factor is significant in the main data but not in the matched data.

The results for fabricated metals likewise are reasonably good, with the exception that managerial workers are significant on the main
<table>
<thead>
<tr>
<th>Sector</th>
<th>Model III: $0 = a_1 b_1 + b_2 + c$</th>
<th>Constant</th>
<th>N of Obs.</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food (Matched)</td>
<td>$a_1 = .212^<em>$, $b_2 = .045^</em>$, $c = -.000$</td>
<td>(.005), (.008), (.008)</td>
<td>2.783</td>
<td>.954</td>
</tr>
<tr>
<td>Food (Main)</td>
<td>$a_1 = .187^<em>$, $b_2 = .017^</em>$, $c = .012^*$**</td>
<td>(.026), (.010), (.018)</td>
<td>2.646</td>
<td>.948</td>
</tr>
<tr>
<td>Metal (Matched)</td>
<td>$a_1 = .068^<em>$, $b_2 = .024^</em>$*<strong>, $c = .003$</strong></td>
<td>(.020), (.007), (.015)</td>
<td>4.359</td>
<td>.962</td>
</tr>
<tr>
<td>Metal (Main)</td>
<td>$a_1 = .349^<em>$, $b_2 = .074^</em>$, $c = .003$</td>
<td>(.029), (.049), (.025)</td>
<td>3.453</td>
<td>.960</td>
</tr>
</tbody>
</table>

Notes: *significant at the 0.10 level; **significant at the 0.05 level; ***significant at the 0.01 level.
### Table 8 — Continued

Model IV: \( \hat{y} = a_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + c x_4 + d_4 x_5 + f_1 x_6 \)

<table>
<thead>
<tr>
<th>Sector</th>
<th>( a_1 )</th>
<th>( a_0 )</th>
<th>( b_1 )</th>
<th>( b_2 )</th>
<th>( b_3 )</th>
<th>( c )</th>
<th>( d_4 )</th>
<th>( d_5 )</th>
<th>( f_1 )</th>
<th>Constant</th>
<th># of Obs.</th>
<th>( F )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Processing (20)</td>
<td>-.005</td>
<td>.210*</td>
<td>.176*</td>
<td>.049*</td>
<td>.022*</td>
<td>.599*</td>
<td>.249*</td>
<td>-.018</td>
<td>.061</td>
<td>2.809</td>
<td>272</td>
<td>625.943</td>
<td>.956</td>
</tr>
<tr>
<td>1 (Matched)</td>
<td>(.009)</td>
<td>(.036)</td>
<td>(.027)</td>
<td>(.011)</td>
<td>(.009)</td>
<td>(.022)</td>
<td>(.104)</td>
<td>(.052)</td>
<td>(.141)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Processing (20)</td>
<td>-.000</td>
<td>.162*</td>
<td>.170*</td>
<td>.018**</td>
<td>.010***</td>
<td>.642*</td>
<td>.080</td>
<td>.011</td>
<td>.341*</td>
<td>2.689</td>
<td>524</td>
<td>1057.771</td>
<td>.949</td>
</tr>
<tr>
<td>1 (Main)</td>
<td>(.007)</td>
<td>(.029)</td>
<td>(.020)</td>
<td>(.008)</td>
<td>(.019)</td>
<td>(.018)</td>
<td>(.081)</td>
<td>(.042)</td>
<td>(.108)</td>
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</tr>
<tr>
<td>Metal Fabrication (35)</td>
<td>.015</td>
<td>.325*</td>
<td>.081***</td>
<td>.149*</td>
<td>.020</td>
<td>.446</td>
<td>--</td>
<td>.019</td>
<td>.126</td>
<td>4.242</td>
<td>54</td>
<td>125.663</td>
<td>.963</td>
</tr>
<tr>
<td>1 (Matched)</td>
<td>(.016)</td>
<td>(.083)</td>
<td>(.054)</td>
<td>(.051)</td>
<td>(.016)</td>
<td>(.051)</td>
<td>--</td>
<td>(.085)</td>
<td>(.128)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal Fabrication (35)</td>
<td>.025*</td>
<td>.274*</td>
<td>.066*</td>
<td>.110*</td>
<td>-.001</td>
<td>.530*</td>
<td>.669**</td>
<td>-.046</td>
<td>.146**</td>
<td>3.601</td>
<td>186</td>
<td>496.205</td>
<td>.962</td>
</tr>
<tr>
<td>1 (Main)</td>
<td>(.009)</td>
<td>(.043)</td>
<td>(.024)</td>
<td>(.025)</td>
<td>(.009)</td>
<td>(.029)</td>
<td>(.293)</td>
<td>(.049)</td>
<td>(.073)</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (***) at the 10 percent level.
data and insignificant on the matched data. This result, however, is not that far out of line because the t-statistic is approximately equal to one. Again the size of the elasticities of output are roughly the same size.

There is an inconsistency in the shift parameter. While the dummy for electrical generation is highly significant in the equation using the main census data, it does not enter the model in the matched data because none of the firms generate their own electricity. However, the foreign input factor is significant and positive using the main data but insignificant on the matched data.

These results highlight the need for properly identifying the census firms so that potential biases involving the use of data can be avoided. These results, however, indicate that the parameter estimates are in general agreement for both sets of data.

While inconsistencies do occur on the parameter estimates of the model when fitted to the two sets of data, the examination of the stated hypotheses lead to basically the same results. Since the only skilled labor category is managers and it is significant in both equations, the conclusion of a relatively greater importance of this factor in MF than in FP is indicated.

The dummy for advertising is not significant in either set of data. Foreign inputs in the intermediate capital term is significant for both models on the main data. The fourth hypothesis which was not supported by the use of the matched data is supported by the use of the main data. The share going to labor is greater than the share going to capital in fabricated metals. The reverse results occur in food processing.
Thus, it has been seen that irrespective of the data sets, the main hypotheses are supported. Because the matched data set has more information on various inputs, such as permitting a more disaggregated specification of such inputs as labor, the matched rather than the main data set will be used for the bulk of the remaining analysis.

**Labor and Capital Productivity**

This study argues that labor and capital are nonhomogeneous and should be disaggregated into more homogeneous classifications when entered into the production function. The estimates of elasticities of output of these inputs permit the calculation of estimates of the value of marginal product of these disaggregated capital and labor inputs.

One important reason for obtaining these estimates is to see whether the marginal value products of labor increase as skill or education increases, a hypothesis that human capital theory would suggest. A second, possibly more cogent, reason is to check whether estimated marginal value products are in line with the observed wage rates in this sector.

From Model I, the value of marginal product of labor and capital are

\[
\frac{dO}{dL_i} = a_i \frac{0}{L_i}, \quad i=1,\ldots,4,
\]

\[
\frac{dO}{dK_i} = b_i \frac{0}{K_i}, \quad i=1,2,3.
\]

The estimates of the value of marginal products for the four labor and three capital categories are calculated at their geometric
means for the food processing and fabricated metal industries and are shown in Table 9.

The results of Table 9 strongly support the hypothesis put forward by human capital theory. It suggests that investments in man have a high payoff even in less developed nations. With the exception of managers in the food processing sector, which did not have an estimate of the elasticity of output significantly different from zero, workers in the three skilled labor categories had a much larger value of marginal product than a worker in the semi- and unskilled worker category.

Further, for those labor categories with "significant" regression coefficients, higher skill levels had higher values of marginal product. Note that the first two labor categories are the most skilled, with no differentiation between their relative educational levels. Skilled workers are at the second skill level. Semi- and unskilled workers are at the third skill level.

The results of Table 9 indicate that in each of the two industries, the value of marginal product of a worker drops as the educational level

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9 The geometric mean is used instead of the arithmetic mean, since the regression line passes through the geometric mean but not necessarily the arithmetic mean. See E. O. Heady and J. L. Dillon, Agricultural Production Functions, (Ames, Iowa: Iowa State University Press, 1964), p. 231.

10 This category is an aggregation of "professionals" and "sub-professionals." Managers would be part of the "subprofessional" category with a lower educational level. Thus, a lower value of marginal product for managers might be expected than for "professionals" and "subprofessionals" taken together.
TABLE 9
VALUE OF MARGINAL PRODUCT OF DISAGGREGATED LABOR AND CAPITAL IN THE VENEZUELAN FOOD PROCESSING AND FABRICATED METAL INDUSTRIES (1970)
(Calculated at Geometric Mean Output and Input Values)

<table>
<thead>
<tr>
<th>Factor Inputs</th>
<th>Geometric Input Mean</th>
<th>Regression Coefficient</th>
<th>Estimated Value of Marginal Product</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food Processing (20)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managers</td>
<td>0.536</td>
<td>-0.004</td>
<td>-9,910c</td>
</tr>
<tr>
<td>Professionals and Subprofessionals</td>
<td>0.012</td>
<td>0.022*</td>
<td>2,416,071</td>
</tr>
<tr>
<td>Skilled Workers</td>
<td>0.088</td>
<td>0.027*</td>
<td>406,561</td>
</tr>
<tr>
<td>Semi- and Unskilled Workers</td>
<td>16.302</td>
<td>0.144*</td>
<td>11,734</td>
</tr>
<tr>
<td>Fixed Assets</td>
<td>89.391</td>
<td>0.165*</td>
<td>2,452</td>
</tr>
<tr>
<td>Variable Capital</td>
<td>34.190</td>
<td>0.048*</td>
<td>1.865</td>
</tr>
<tr>
<td>Inventory Capital</td>
<td>3.315</td>
<td>-0.000</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Fabricated Metals (35)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managers</td>
<td>0.597</td>
<td>0.027*</td>
<td>59,939</td>
</tr>
<tr>
<td>Professionals and Subprofessionals</td>
<td>0.031</td>
<td>0.012****</td>
<td>514,974</td>
</tr>
<tr>
<td>Skilled Workers</td>
<td>0.709</td>
<td>0.023**</td>
<td>42,980</td>
</tr>
<tr>
<td>Semi- and Unskilled Workers</td>
<td>15.844</td>
<td>0.092*</td>
<td>7,695</td>
</tr>
<tr>
<td>Fixed Assets</td>
<td>96.552</td>
<td>0.170*</td>
<td>1.743</td>
</tr>
<tr>
<td>Variable Capital</td>
<td>81.034</td>
<td>0.170*</td>
<td>2.780</td>
</tr>
<tr>
<td>Inventory Capital</td>
<td>9.797</td>
<td>0.020****</td>
<td>2.075</td>
</tr>
</tbody>
</table>

a Geometric mean outputs of food processing and fabricated metals are 1,328,400 and 1,325,200 bolivars, respectively.

b The regression coefficients are obtained from Table 7; four asterisks (****) denote that the estimate of the elasticity of output had a t-statistic greater than unity.

The value of marginal productivity for labor represent bolivars of output per man-year; for capital, bolivars of output per bolivar of input. Note that the negative estimate of the value of marginal product for managers in food processing is associated with a small and statistically insignificant coefficient.
of a typical worker in that category drops. These results provide very strong support that the marginal product of skilled workers, professionals and subprofessionals is extremely high in the Venezuelan industrial sector.\footnote{\textit{Some introductory work examining the value of marginal productivity of these labor categories for other two-digit sectors led to similar results.}}

It would also be useful to see if observed wage rates of these labor categories correspond to their estimated marginal value products. This is not possible because of lack of wage information by different skill categories. However, the average yearly wages of all workers and production workers are available. They were B13,952 and B9,129 for food processing and B13,186 and B10,364 for fabricated metal in 1970. Since a large portion of production workers are semi- and unskilled workers, the average wage of production workers and the marginal value product of semi- and unskilled workers should be approximately the same. This is indeed the case as the estimated values of marginal product for semi- and unskilled workers were 11,734 and 7,695 bolivars, respectively, for FP and MF and the observed wages for production workers were 9,129 and 10,364 bolivars in the same year. Thus, the estimated values of marginal product are in line with the observed data on wages.

These results are important because, although the human element in production has been given increasing importance over the last decade and a half, there is still not enough appreciation of the importance of human skills in the development literature and this is in part due to
the dearth of empirical work using data from LDC's. The above results based on firm level Venezuelan manufacturing data are very much in accordance with human capital theory.

Further, the results of Table 9 suggest that capital is also very productive in these two Venezuelan industries. For example, one additional bolivar in service flow of fixed assets yields 2.452 bolivars in value of output in food processing and 1.743 bolivars in fabricated metals.

One interesting result is that while fixed assets and variable capital are productive in both industries, variable capital is more productive in the new industry, metal fabrication, and fixed assets are more productive in the mature industry, food processing. This provides additional support for encouraging development and financial institutions to provide loans for inputs other than buildings, transport, and machinery.
CHAPTER VI

FURTHER ANALYSIS

Introduction

This chapter estimates the production function of the food processing industry under different forms of ownership and for different regions. Within these subcategories several additional hypotheses are postulated and tested using the Venezuelan manufacturing firm data.

A modified version of the Cobb-Douglas specification, which treats the managerial input as an augmenting factor in the production function, is examined next. This treatment differs from the approach which used managers as a direct factor input in that it expands their contribution to production as being indirect through their role in organizing and assembling the other inputs. We are interested in seeing whether this "coordinating role" affects the productivity of other factor inputs or not.

The chapter concludes with the fitting of Models I and II to the Venezuelan manufacturing data for the remaining two-digit industries.

Form of Ownership: The Food Processing Industry

A second classification scheme is based on the form of firm ownership. Since the behavior of a proprietorship (hereafter called P)

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1 Factor augmentation in a modified Cobb-Douglas function is not new. For example, see E. F. Ulleling and E. B. Fletcher, "A Cobb-Douglas Production Function with Variable Returns to Scale", American Journal of Agricultural Economics, (May, 1970), pp. 322-326.
and a nonpropriorship (hereafter called NP) may differ because of noneconomic considerations, differing attitudes toward risk aversion, or different mean sizes of the establishments, it seems fruitful to examine the production function for both classes of firms. Moreover, small scale manufacturing workshops employ a large portion of the urban workforce. As many LDC's are presently plagued by widespread urban unemployment, and examination of this subsector would be most informative.

Further, the "financial deepening" argument in the development literature suggests an additional and possibly the most cogent reason for isolating these two sets of firms. Financial deepening means that financial markets have expanded not only extensively but intensively, reaching down to all stages of the production process. The accumulation of financial assets has been repressed in many "lagging countries" and this resulting shallow finance has restricted the emergence of an effective domestic capital market for efficiently channeling funds from potential savers to potential domestic investors. The main tool for repression has been public policies aimed at keeping the real interest rate artificially low, thus making capital cheap and labor expensive and leading to a capital intensive technology inconsistent with the countries' relative factor proportions.

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2 This classification is based on whether or not the company has limited liability. See Section VIII.1 in the main census.

One consequence of this is that small proprietorships have trouble obtaining loans for capital and operating expenditures. Unless these smaller firms can obtain family loans or cash advances from the larger corporations for which they supply inputs, they must cut back on operations or borrow from private noninstitutional money lenders at an exorbitant interest rate. Thus, due to the lack of financial deepening in LDC's, credit from organized financial institutions, including government development banks, does not reach down to the smaller firms in the manufacturing sector, and production there becomes stagnant.

Moreover, little is known about the growth of new firms, which often begin as small proprietorships. Official statistics usually aggregate all firms in an industry and thus provide little knowledge of their makeup. However, these firms are often assumed to provide important functions for an industrial economy. One study examining the economic significance of small firms in Great Britain considered the prime function of these firms as providing a source for new enterprise and entrepreneurial talent, a source of new life blood and ideas, and

---

4 The concept of "proprietorship" and "smallness" are very closely linked. A small firm is sometimes defined in terms of its ownership. For example, in one study a small firm was associated with "a close association of ownership and management functions, so that concern was primarily with private unquoted companies and unincorporated businesses", D. Waite, "The Economic Significance of Small Firms", The Journal of Industrial Economics, Vol. XXI, April, 1973, No. 2, pp. 154-55.
potential growth to maintain a spirit of competition. The same study also found that in some industries, small firms are important suppliers of components and sub-assemblies to larger manufacturers. Since proprietorships are usually the smaller firms in an industry, knowledge about their production behavior and efficiency of factor use would prove useful.

The same models used for fitting the data on the food processing and fabricated metals industries will be used for proprietorships and nonproprietorships. The estimation will be done using data only from the food processing industry to avoid biases which might be encountered in examining proprietorships and nonproprietorships in all industries.

Some Hypotheses

The hypotheses relating to differences in production behavior between P and NP can be stated as follows:

H₅: Skilled labor is relatively more important in NP than P because skilled labor is attracted toward larger corporations which possibly offer more pecuniary and nonpecuniary incentives. In addition the technologies used in P might not be as sophisticated as in NP and thus would require less skilled labor.⁶

⁵Ibid.

⁶"...Non-mining industries and some large manufacturing firms are staffed by well-trained personnel. These are, however, for the most part modern capital intensive operations, requiring relatively few hands". T. Weil, et al., Area Handbook for Venezuela (Wash., D.C.: U. S. Gov't. Printing Office, 1971) p.368.
H.6: Proprietorships are less capital intensive than nonproprietorships because of the difficult access to the capital market. 7

H.7: The total productivity of proprietorships is less than nonproprietorships because of lack of economies of scale and/or lack of access to capital and labor markets. (This means that the output to input ratio for all inputs together is hypothesized to be smaller for proprietorships than nonproprietorships.)

The tests are the same as those described in the previous chapter. It should be remembered that these hypotheses are only a priori expectations about the relative behaviors which one might expect to see between the two groups. They are refinements of the basic hypotheses testing the statistical significance of the inputs specified in the model. The estimated production functions for Model I and Model II for the food processing industry broken down by P and NP are shown in Table 10.

7There is some a priori notion that corporations have more of an advantage in obtaining capital than small proprietorships. "Most banks request excessive guarantees and collateral because of the borrower and few banks exchange credit information", Neil, Area Handbook, pp. 426-7; since industrialization development efforts often involve lowering the price of capital, large, established low-risk firms get easy access to loans and smaller companies find them hard to obtain.
Results

The fifth hypothesis which states that skilled labor is relatively more important in NP than P was supported by the regression results. As shown in the results for Models I and II, two of the three skilled labor categories specified in the model were significant and positive for nonproprietorships. This compares to only one of the three being significant and positive in proprietorship firms. In terms of the relative shares going to skilled labor, the results again tended to support the hypothesis that skilled labor is more important in nonproprietorships. Including only significant inputs, the ratio of the share going to skilled labor over total labor was \(0.293 = (0.020 + 0.023) / 0.147\) in nonproprietorships as compared to \(0.144 = 0.020 / 0.119\) in proprietorships.

The sixth hypothesis which contends that proprietorships are less capital intensive than nonproprietorships is also given support. While fixed assets and variable capital inputs are significant and positive at a 99 percent degree of confidence for both groups of firms (and inventories are insignificant), their respective elasticities of output are \(0.188\) and \(0.053\) for nonproprietorships and \(0.110\) and \(0.038\) for proprietorships. Further, note that although intermediate inputs are significant and large for both P and NP, the size of the output elasticity of intermediate inputs is appreciably higher in NP than in P. Again, this is consistent with both the factor price flexibility of the industrial sector and the argument suggesting distortions in the financial markets since lack of access to capital markets means a
higher effective price of intermediate inputs to proprietorships. This result further supports the specification of the model using value of output as the dependent variable and intermediate inputs as a factor with a unitary elasticity of substitution with the other factors (see Appendix C).

Introducing the second set of independent variables in Model II does not significantly alter the parameter estimates of the primary inputs. It also does not alter the results of the hypotheses examined above.

Only the dummy for advertising is significant and negative for nonproprietorship firms. This is a curious result as one expects advertising to have a positive impact on output generally.

One economically meaningful reason for this result might be that proprietorships manufacture traditional commodities appealing to low income groups. These commodities using labor intensive technologies lack standardization and quality control. Thus advertising serves the useful function of informing the consumer of these less known products.

To test the seventh hypothesis, which states that total productivity of proprietorships is less than nonproprietorships, Model III was expanded to include a dummy for proprietorships (i.e., \( P_{1i} = 1 \) if \( i \) is a proprietorship, 0 otherwise). This model is explicitly defined as:

(Model V:

\[
\ln o_i = \ln A + a_1 \ln L_{1i} + a_2 \ln L_{0i} + b_1 \ln K_{1i} + b_2 \ln K_{2i} + b_3 \ln K_{3i} + \\
\ln M_i + d_1 D_{1i} + d_2 D_{5i} + f_1 \ln F_{1i} + p_1 P_{1i} + u_i, \quad i = 1, \ldots, n
\]
TABLE 10
REGRESSION COEFFICIENTS AND RELATED STATISTICS FOR PROPRIETORSHIPS AND NON-PROPRIETORSHIPS IN THE VENEZUELAN FOOD PROCESSING INDUSTRY (1970): MODELS I AND II

MODEL I:  \( y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \alpha_5 x_5 + \epsilon \)

<table>
<thead>
<tr>
<th>Sector</th>
<th>( \alpha_1 )</th>
<th>( \alpha_2 )</th>
<th>( \alpha_3 )</th>
<th>( \alpha_4 )</th>
<th>( \alpha_5 )</th>
<th>( \alpha_6 )</th>
<th>Constant</th>
<th># of Obs</th>
<th>( F )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proprietorships</td>
<td>.033</td>
<td>.046</td>
<td>.020**</td>
<td>.119*</td>
<td>.110*</td>
<td>.038*</td>
<td>.009*</td>
<td>.682*</td>
<td>3.011</td>
<td>1.021</td>
</tr>
<tr>
<td></td>
<td>(.014)</td>
<td>(.032)</td>
<td>(.010)</td>
<td>(.045)</td>
<td>(.033)</td>
<td>(.010)</td>
<td>(.011)</td>
<td>(.033)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonproprietorships</td>
<td>-.000</td>
<td>.020**</td>
<td>.013*</td>
<td>.147*</td>
<td>.188*</td>
<td>.053*</td>
<td>-.000</td>
<td>.546*</td>
<td>3.785</td>
<td>.977</td>
</tr>
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<td></td>
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<td>(.025)</td>
<td>(.017)</td>
<td>(.011)</td>
<td>(.013)</td>
<td>(.029)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MODEL II:  \( y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \alpha_5 x_5 + \alpha_6 x_6 + \epsilon \)

<table>
<thead>
<tr>
<th>Sector</th>
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<th>( \alpha_2 )</th>
<th>( \alpha_3 )</th>
<th>( \alpha_4 )</th>
<th>( \alpha_5 )</th>
<th>( \alpha_6 )</th>
<th>( \alpha_7 )</th>
<th>( \alpha_8 )</th>
<th>( \alpha_9 )</th>
<th>( \alpha_{10} )</th>
<th>( \alpha_{11} )</th>
<th>( \alpha_{12} )</th>
<th>( \alpha_{13} )</th>
<th>( \alpha_{14} )</th>
<th>Constant</th>
<th># of Obs</th>
<th>( F )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proprietorships</td>
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<td>.036</td>
<td>.018**</td>
<td>.110*</td>
<td>.105*</td>
<td>.037*</td>
<td>.007</td>
<td>.677*</td>
<td>.009</td>
<td>.050</td>
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<td>.085</td>
<td>.064</td>
<td>3.057</td>
<td>.997</td>
<td>87</td>
<td>102.882</td>
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<td>(.015)</td>
<td>(.034)</td>
<td>(.011)</td>
<td>(.049)</td>
<td>(.034)</td>
<td>(.011)</td>
<td>(.011)</td>
<td>(.035)</td>
<td>(.077)</td>
<td>(.114)</td>
<td>(.075)</td>
<td>(.292)</td>
<td>(.067)</td>
<td>(.028)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonproprietorships</td>
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<td>.019**</td>
<td>.026*</td>
<td>.140*</td>
<td>.179*</td>
<td>.058*</td>
<td>.008*</td>
<td>.547*</td>
<td>.065</td>
<td>.063</td>
<td>.055</td>
<td>.108</td>
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<td>.973</td>
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<td>(.012)</td>
<td>(.009)</td>
<td>(.010)</td>
<td>(.045)</td>
<td>(.039)</td>
<td>(.018)</td>
<td>(.012)</td>
<td>(.029)</td>
<td>(.071)</td>
<td>(.145)</td>
<td>(.082)</td>
<td>(.127)</td>
<td>(.076)</td>
<td>(.165)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (***)) at the 10 percent level.
The results are shown in Table 11.

Based on a one-tail t-test, the coefficient of $P_{11}$ was negative and significantly different from zero at a 99 percent level of confidence. This indicates that generally proprietorships tend to be less productive when productivity is measured in terms of all the inputs jointly. 8

The results of this section do not disconfirm the \textit{a priori} notion that small proprietorships discriminated against in the Venezuelan capital markets, and thus forcing them to use a technology which has a negative impact on their productivity. These results are quite significant when coupled with the flexibility of the Venezuelan manufacturing sector to respond to factor prices as discussed in Appendix D. If small proprietorships are indeed being excluded from the financial capital markets by being charged an excessively high price on credit, then one expects a lower capital intensity in these firms, as was shown.

The confirmation of the hypothesis that proprietorships are less productive than the larger corporations suggests that this restrictive institutional barrier is having a significant and negative impact on the productivity of these smaller firms.

These results suggest that while the financial sector is fairly well developed in Venezuela, when compared to other less developed

\[8\] A frequency distribution of $P$ and $NP$ by size indicated a large overlap and this further strengthens the result of this test.
### Table 11

REGRESSION COEFFICIENTS AND RELATED STATISTICS FOR THE FOOD PROCESSING INDUSTRY: MODEL V

<table>
<thead>
<tr>
<th>Sector</th>
<th>( a_1 )</th>
<th>( a_0 )</th>
<th>( b_1 )</th>
<th>( b_2 )</th>
<th>( b_3 )</th>
<th>( c )</th>
<th>( d_4 )</th>
<th>( d_5 )</th>
<th>( f_1 )</th>
<th>( p_1 )</th>
<th>Con-</th>
<th>Obs.</th>
<th>F</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Processing</td>
<td>.003</td>
<td>.156*</td>
<td>.161*</td>
<td>.015**</td>
<td>.011***</td>
<td>.632*</td>
<td>.061</td>
<td>--</td>
<td>.322*</td>
<td>-.197*</td>
<td>3.042</td>
<td>524</td>
<td>1099.88</td>
<td>.051</td>
</tr>
</tbody>
</table>

\(^a\) F-level insufficient for inclusion.

**Note:** The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (***) at the 10 percent level.
nations it is still inadequate to meet the needs of a rapidly growing economy that requires intensive as well as extensive development of financial intermediation. The government should take an even more active role in developing financial institutions that provide credit at a reasonable rate to firms at all levels of the vertically integrated production process, where smaller firms are further back in the industrial linkages evident in this sector.

Regional Differences: The Food Processing Industry

A third classification scheme which is of particular interest in much of the literature on economic planning is the one which focuses on the regional aspects of industrialization. It is felt that certain factors, such as the utilization of labor or capital, may be significant in affecting productivity in some regions and not in others due to regional differences in social and physical infrastructures (which includes the problem of regional fragmentation of capital and labor markets).

A modification of the basic Model II is used to test the regional impacts on productivity in the food processing sector. The model incorporates five additional regional dummies. Again a t-test is used to test if the regional effects have a statistically significant impact on industrial productivity. The model which incorporates the regional effects is:
Model VI:

\[
\ln y_i = \ln A + a_1 \ln L_{1i} + a_2 \ln L_{2i} + a_3 \ln L_{3i} + a_4 \ln L_{4i} + \\
b_1 \ln K_{1i} + b_2 \ln K_{2i} + b_3 \ln K_{3i} + c \ln M_i + d_1 D_{1i} + d_2 D_{2i} + \\
d_3 D_{3i} + d_4 D_{4i} + d_5 D_{5i} + r_1 R_{1i} + r_2 R_{2i} + r_3 R_{3i} + \\
r_4 R_{4i} + r_5 R_{5i} + u_i, \quad i=1, \ldots, n.
\]

where \( R_{mi}, \ m=1, \ldots, 5 , \) represent the five regional dummies and \( r_{mi}, \ m=1, \ldots, 5 , \) are their corresponding parameter estimates. The other variables are as defined earlier. The parameter estimates of this model for the food processing sector are presented in Table 12.

The inclusion of the regional dummies does not change the significance of the other factors. However, very strong indications of regional differences in industrial productivity were found. In the food processing, dummy coefficients for Regions 1 and 2 are significant and positive at a 99 percent level of confidence and that for Region 4 was significant and positive at a 90 percent level of confidence.

To further test the impact of regional affects, the model was fitted to data from the fabricated metals industry. Again the inclusion of the regional variables did not significantly change the significance of the other inputs. Again it was found that regional differences did matter. The dummy coefficient for Region 1 was significant and positive and that for Region 2 was significant and negative at a 90 percent level of confidence. This suggested that data should not be aggregated across regions and that different production
### TABLE 12

**REGRESSION COEFFICIENTS AND RELATED STATISTICS FOR THE FOOD PROCESSING AND FABRICATED METAL INDUSTRIES:**

**MODEL VI**

<table>
<thead>
<tr>
<th>Sector</th>
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<th>$a_2$</th>
<th>$a_3$</th>
<th>$a_4$</th>
<th>$b_1$</th>
<th>$b_2$</th>
<th>$b_3$</th>
<th>$c$</th>
<th>$d_1$</th>
<th>$d_2$</th>
<th>$d_3$</th>
<th>$d_4$</th>
<th>$d_5$</th>
<th>$f_1$</th>
<th>$r_1$</th>
<th>$r_2$</th>
<th>$r_3$</th>
<th>$r_4$</th>
<th>$r_5$</th>
<th>$F$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Processing</td>
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<td>0.023*</td>
<td>0.028*</td>
<td>0.130*</td>
<td>-0.052*</td>
<td>0.002</td>
<td>0.592*</td>
<td>0.053</td>
<td>-0.031</td>
<td>0.060</td>
<td>0.201**</td>
<td>-0.020</td>
<td>-0.024</td>
<td>0.168*</td>
<td>0.183*</td>
<td>0.004</td>
<td>0.090***</td>
<td>-0.053</td>
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<td>272</td>
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<td></td>
<td>(.009)</td>
<td>(.008)</td>
<td>(.007)</td>
<td>(.033)</td>
<td>(.027)</td>
<td>(.010)</td>
<td>(.009)</td>
<td>(.092)</td>
<td>(.053)</td>
<td>(.060)</td>
<td>(.103)</td>
<td>(.051)</td>
<td>(.140)</td>
<td>(.065)</td>
<td>(.074)</td>
<td>(.078)</td>
<td>(.067)</td>
<td>(.096)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal Fabrication</td>
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<td>.015</td>
<td>.017</td>
<td>.057***</td>
<td>.149***</td>
<td>.146*</td>
<td>.009</td>
<td>.347*</td>
<td>.101</td>
<td>.087</td>
<td>.044</td>
<td>--</td>
<td>.114</td>
<td>.356*</td>
<td>.192***</td>
<td>.009</td>
<td>.029</td>
<td>-.240***</td>
<td>-.287</td>
<td>2.882</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>(.020)</td>
<td>(.015)</td>
<td>(.016)</td>
<td>(.036)</td>
<td>(.065)</td>
<td>(.059)</td>
<td>(.018)</td>
<td>(.068)</td>
<td>(.113)</td>
<td>(.301)</td>
<td>(.113)</td>
<td>--</td>
<td>(.098)</td>
<td>(.148)</td>
<td>(.128)</td>
<td>(.141)</td>
<td>(.186)</td>
<td>(.148)</td>
<td>(.287)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (***) at the 10 percent level.
surfaces existed in different regions.

In order to examine these regional differences more closely, Models I and II were fitted to each of six separate regional data sets. The results indicated that production function of the Venezuelan food processing industry differed significantly across regions. The significance of factors as well as the relative size of their output elasticities varied across regions. These results may be due to fragmentation of capital and labor markets which are creating factor supply shortages in certain Venezuelan regions.

These results give strong support for the further development of regional analysis of the Venezuelan economy. They are also consistent with the notion that capital utilization is a regional problem and suggest that the development of regional capital markets should occur to prevent oversupplies of capital in certain regions.

The implication for policy of the analysis of the regional production functions is limited by ignorance of the identity of the regions. All we know is that these regions are different, but they are not identified. One highly interesting and productive area for future analysis would be to investigate the regional aspects of production. In particular, it would be very interesting to examine the effect of deficient financial deepening on the technology and productivity of manufacturing firms across regions. One could conjecture that there is a strong causal relationship.
Managers as Augmenting Factors

Management and organization have long been considered as special inputs in the production process, because they supposedly combine, coordinate, and organize the other factors in the process of production. The manager serves as the organizer of the firm. He makes both crucial and routine decisions that have an impact on the livelihood of the enterprise. He combines the inputs in appropriate proportions, and in so doing "augments" their productivity.

Because of this unique role of mixing and synchronizing other primary inputs, it is hypothesized that management has an impact on the productivity of other primary inputs. This impact in turn has an allocative effect on the efficient use of other productive factor inputs.

There are many justifications in the literature for singling out managers for special treatment in the production relation. For example, Kindleberger claims that "all other factors tend to be substitutable for one another...but organization is a complement rather than a substitute". 9 Harbison has implied that differences in organization explain differences in labor productivity. 10


In order to investigate the augmenting role of managers and to test the impact of managerial input on the productivity of other primary inputs, a homogeneous modification of the Cobb-Douglas specification was fitted to the main census data. The modified function that treats managers as an augmenting factor is as follows:

**Model VII:**

\[
0 = A L_1 \cdot L_0 \cdot K_1 \cdot K_2 \\
\{a_1\} \{a_2 + m_1 \frac{L_1}{L_0}\} \{b_1 + m_2 \frac{L_1}{K_1}\} \{b_2 + m_3 \frac{L_1}{K_2}\} \\
\{b_3 + m_4 \frac{L_1}{K_3}\} \{c_1 + m_5 \frac{L_1}{M}\} \cdot e^u
\]

(6.3)

where the dependent and independent variables are as defined in Model III (Chapter V).

The regression equation for estimating the structural parameters of Model VII are obtained by taking the natural logarithmic transformation of both sides of Equation (6.3), which yields

\[
\ln y_{1i} = \ln A + a_1 \ln L_{1i} + a_2 \ln L_{0i} + m_1 \frac{L_{1i}}{L_{0i}} \ln L_{0i} + b_1 \ln K_{1i} + \\
+ m_2 \frac{L_{1i}}{K_{1i}} \ln K_{1i} + b_2 \ln K_{2i} + m_3 \frac{L_{1i}}{K_{2i}} \ln K_{2i} + b_3 \ln K_{3i} + \\
+ m_4 \frac{L_{1i}}{K_{3i}} \ln K_{3i} + c_1 \ln M_1 + m_5 \frac{L_{1i}}{M_1} \ln M_1 + u_i, \quad i=1,...,n,
\]

(6.4)

where \(i\) refers to the \(i\)-th firm and \(n\) is the number of observations.

The effect of a nonzero value of one of these coefficients on the marginal productivity of a primary factor, say labor \((L_0)\), can
be seen by calculating the marginal product. Taking the derivative of $\ln o$ in Equation (6.4) with respect to labor, $L_0$, yields

$$\frac{1}{o} \frac{d o}{dL_0} = a_2 \frac{L_0}{L_0} + m_1 \frac{L_1}{L_0} \left(\frac{1}{L_0} - \ln \frac{L_0}{L_0} \right)$$

$$\frac{d o}{dL_0} = a_2 \frac{0}{L_0} + m_1 \frac{0}{L_0} \frac{L_1}{L_0} (1 - \ln L_0).$$

Since the marginal product of labor under a Cobb-Douglas specification is $a_2 0/L_0$, an "$m_1$" significantly different from zero implies that managers have an impact on the productivity of labor.

The null hypothesis that managers have no impact on the productivity of other factors is

$$H_0: m_1 = m_2 = m_3 = m_4 = m_5 = 0.$$  

This null hypothesis is rejected if one or more of the above coefficients is significantly different from zero.  

The results of fitting Model VII to the main census data for the food processing and fabricated metals industries are presented in Table 13.

These results give strong support to the notion that the managerial input has a significant impact on the productivity of labor and

11 Ulveling and Fletcher, "A Cobb-Douglas Production Function."

12 Alternate formulations were also fitted to the data and they also rejected the hypothesis that managers had no impact on the productivity of other factor inputs.
### Table 13

**Regression Coefficients and Related Statistics for the Venezuelan Food Processing and Fabricated Metal Industries (1970), Managers as an Augmenting Factor: Model VII**

<table>
<thead>
<tr>
<th>Sector</th>
<th>$a_1$</th>
<th>$a_2$</th>
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<th>$b_3$</th>
<th>$m_4$</th>
<th>$c_1$</th>
<th>$m_5$</th>
<th>Constant</th>
<th>$#$ of Obs.</th>
<th>$F$</th>
<th>$R^2$</th>
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</thead>
<tbody>
<tr>
<td>Food Processing</td>
<td>-.019*</td>
<td>.204*</td>
<td>.374**</td>
<td>.158*</td>
<td>-27.538</td>
<td>.019**</td>
<td>-.000</td>
<td>.012**</td>
<td>-.024</td>
<td>.653*</td>
<td>195.444**</td>
<td>2.454</td>
<td>524</td>
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<td>.949</td>
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<td>(.010)</td>
<td>(.033)</td>
<td>(.151)</td>
<td>(.024)</td>
<td>(34.147)</td>
<td>(.010)</td>
<td>(.000)</td>
<td>(.007)</td>
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<td>(.019)</td>
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</tr>
<tr>
<td>Metal Fabrication</td>
<td>.032*</td>
<td>.194*</td>
<td>-.398**</td>
<td>.092*</td>
<td>25.312</td>
<td>.153*</td>
<td>33.988</td>
<td>-.004</td>
<td>--</td>
<td>.583*</td>
<td>173.311</td>
<td>2.982</td>
<td>186</td>
<td>432.983</td>
<td>.961</td>
</tr>
<tr>
<td>(35)</td>
<td>(.012)</td>
<td>(.054)</td>
<td>(.206)</td>
<td>(.030)</td>
<td>(22.453)</td>
<td>(.030)</td>
<td>(23.056)</td>
<td>(.009)</td>
<td>--</td>
<td>(.034)</td>
<td>(202.389)</td>
<td></td>
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</tr>
</tbody>
</table>

*F*-level insufficient for inclusion.

Note: A two-tailed t-test is used to test if the coefficients associated with the augmenting factors ($m_1$, $m_2$, $m_3$, $m_4$, and $m_5$) are significantly different from zero. A one-tailed t-test is used to test the other coefficients. The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (***) at the 10 percent level.
intermediate inputs in the food processing industry. Using a two-tailed t-test for examining whether or not the coefficient associated with the augmenting term was equal to zero, it was found that this null hypothesis was rejected with a 95 percent level of confidence for the above two inputs. The results, using Model VII, are less conclusive in the fabricated metals industry. Only the coefficient associated with labor augmentation is significant.

These results provide empirical support to the hypothesis that managers affect the productivity of other primary inputs. The importance of these results lies in the allocation impact of managers on the other factor inputs. Increasing the productivity of a factor, ceteris paribus, leads to its greater use in production. Thus this empirical evidence suggests that managers do combine and coordinate the other factors in the production process. The results of this section are encouraging, and indicate that a more detailed examination of the role of management could be a profitable avenue for further research in production theory.

**Production Function Estimates for All Two-Digit Industries**

The production function for every two-digit Venezuelan manufacturing industry are estimated using Models I and II to see whether the main results obtained from FP and MF can be broadly confirmed. A detailed analysis of all two-digit industries is not within the scope of this study. It is in this light that the results are included and shown in Appendix H.
The petroleum sector has only one firm and thus no estimates are possible. Moreover, tobacco with 14 firms, furniture with 17 firms, printing with 16 firms, and rubber with 14 firms do not provide enough observations to adequately estimate the production function using Model II.

The results for all two-digit industries reveal the need for separate industry estimates for the production function. Both the significance of the variables and the actual sizes of the parameter estimates differ greatly across industries, using the same basic model and data.

The F statistics, in Appendix H, all confirm the "goodness of fit" of the basic models at a 99 percent level of confidence. Only one multiple coefficient of determination is below .90, the beverage industry with a coefficient of .87.

Several broad conclusions follow from these results. First, skilled labor is quite productive in all Venezuelan manufacturing industries. Only in the tobacco, lumber, printing, rubber, stone glass and clay, and primary metals were skilled coefficients not significant and positive. Of these industries, the estimates from tobacco, lumber, printing, and primary metals industries are based on a small number of firms. In fact, of these four suspect industries, only printing shows unskilled and semiskilled workers as a positive and productive input.

Second, a majority of the industries show either fixed assets or variable capital or both as significant productive inputs. Those that show neither as being productive and significant are tobacco,
apparel, leather, primary metals, and nonelectrical machinery. Again, all of these industries have few firms in the sample.

A third major finding in this study is that inventory capital is a significant and productive input in a large number of the two-digit industries. Table 25 in Appendix H shows that inventories are significant and positive in the beverage, apparel, chemical, stone, clay and glass, primary metals, and transport industries.

These broad findings for all two-digit industries further strengthen the findings obtained from the detailed analysis of MF and FP, suggesting that the conclusions obtained in the earlier analysis are likely to be supported in a more detailed analysis of the two-digit industries.
CHAPTER VII
CONCLUSIONS AND IMPLICATIONS

The central problem in this study has been to show how conventional neoclassical economic theory can be used in conjunction with firm level census data to understand the industrial production structure in less developed countries. The methodology has been applied to firm specific Venezuelan manufacturing data to examine both the functional and variable specifications.

Information on the form and structure of the manufacturing sector is of vital importance for economic planners attempting to allocate scarce resources because policy decisions are often central to the development and provision of these physical and human capital resources. Moreover, policy decisions often directly and indirectly influence the relative commodity and factor prices which in turn affect commodity and factor allocation in the manufacturing sector. The likely impact and success of these interventions depend upon the nature of the underlying production process. A good understanding of these processes therefore becomes a critical input in development planning, especially in the LDC's.

The study attempts to make a contribution to economic production theory by examining, in the context of the Venezuelan manufacturing sector, the form for estimating industry production functions and their specification under alternate classification schemes. As indicated, the base used in this study permitted a more complete breakdown of inputs than has been available in most other empirical studies to date.

As a result this study is unique for a number of reasons. The first distinctive feature is that the functional estimates obtained
are based on a large number of individual industrial firms in a rapidly industrializing LDC. The 1970 Venezuelan manufacturing census data permitted a very detailed measure of outputs and factor inputs for each industrial firm. Thus it was possible to break away from the necessity of using aggregate stock variables to estimate production functions as has commonly been done for the United States' manufacturing sector.

Secondly, this study was enhanced by a matching set of complementary manpower data giving the occupational mix for each firm in the sample. Over nine hundred firms had auxiliary data that were matched with their corresponding manufacturing census data to permit the development of measures of disaggregated labor used by the firms. This complementary data set also contained detailed information on many of the efficiency factors. These were matched up by firm to provide additional insights into the production process in the Venezuelan industrial sector.

This chapter summarizes some of the major findings of this study and their implications for economic theory and development policy.

Major Findings

This study employed a variety of Cobb-Douglas models and used ordinary least squares estimation procedures to estimate the structural parameters of the production function. The empirical results indicate that the models fit the data very well. On the basis of these findings broad implications are drawn both with regards to the manufacturing sector in Venezuela as well as with regards to their implications for further empirical work of this nature, specially in LDCs.
The first major finding that emerges from this study is that there is significant factor substitutability in the Venezuelan manufacturing sector. This follows from the extensive testing of the form and specification of the production function in the study. It was shown that the Cobb-Douglas production function is an appropriate functional form. Using the more general constant elasticity of substitution form, the hypothesis that the elasticity of substitution was zero was easily rejected indicating that the fixed coefficient production function of the Harrod-Domar type was inappropriate. On the other hand, the hypothesis that the elasticity of substitution was equal to one was not rejected. This implied that the Cobb-Douglas form with unitary elasticity of factor substitution was a form that was most appropriate for this study, and probably other studies of this kind.

This finding has several implications. To begin with, these results showing a near unitary elasticity of factor substitution in production tend to refute the traditional notion still prevailing in the development literature that less developed countries have narrow substitution possibilities in the manufacturing sector. Much of the literature on technological dualism as a cause for unemployment in LDC's rests on this argument.\(^1\) The study shows that the fixed factor proportion assumptions, associated with models of the Harrod-Domar type, are totally inadequate for a study of production behavior, and their use in development planning is vitiated. The relatively high factor substitution parameters suggest that planning models treating these

as fixed are likely to be most misleading. The planning literature emphasizing the use of fixed factor Harrod-Domar type models has been criticized on a variety of grounds including the observed variability in the factor proportions. This study has confirmed these reservations concerning the narrow substitution possibilities in the industrial sector of LDC's using fundamental empirical techniques.

Further, the implications of this finding for industrial pricing policy are also extensive. In a mixed and developing economy like Venezuela's where fragmented capital and labor markets as well as policy decisions may have distorted relative factor prices (e.g. through excessively cheap credit to certain firms), it should be evident that lowering the price of capital or raising the effective industrial wage rate is likely to have a significant impact on the industrial technology by making it more capital intensive. Firm level data shows that capital stock grew consistently faster than labor stock over the 1965-1970 period. This suggests that factor market distortions have had an impact on the industrial technology of Venezuela.\(^2\) This has implications for a number of Venezuela's stated goals. In particular it has an important effect on the manufacturing sector's role in providing employment. Such employment is likely to be retarded if policy makers distort factor prices that encourage the use of capital since industrialists are likely to substitute labor for it, given the underlying structural parameters exhibited by our results.

More broadly, it suggests that instead of the use of direct

\(^2\) Data for a complete examination of this question was not available. However, there is evidence that Venezuelan financial markets are fragmented. See Chapter II. Moreover, further support that factor price distortions influenced Venezuelan industrial technology are discussed below.
controls over the industrial sector through publicly operated firms, the government has a powerful and discretionary tool available in factor pricing policies which can be used to affect the type of technologies employed by the manufacturing sector without resulting in inefficient public ownership. These indirect controls through factor markets can come to play a dominant role and reduce the need for direct government intervention in the industrial sector substantially. The argument that markets will not respond to changing relative factor prices due to the fixed factor proportions assumed in the industrial sector does not stand up in the light of the empirical evidence advanced here. In view of this price sensitivity the use of factor price distortions as a policy tool cannot be undertaken lightly as these distortions are likely to be extensive in their impact.

Further, a number of interesting and significant findings emerged as a consequence of the disaggregated input specifications used in this study. First, as anticipated, human skills were found to be of prime importance in explaining labor productivity in Venezuelan manufacturing. Educated workers—managers, professionals and sub-professionals, and skilled industrial workers—were all highly significant productive factors in the Venezuelan manufacturing sector. Further the marginal productivities of skilled worker categories were significantly greater than those of the semi- and unskilled worker category. The marginal productivity of labor generally increased with the amount of education embodied in workers of the different labor categories. This suggests that the policy encouraging skilled immigrants (which stopped in 1959 when the government was attempting to halt growing unemployment) and the formal and informal educational system has been providing relevant skills for industry. This is significant in the
context of developing countries because it is often argued that their educational systems do not offer the kind of training needed for productive employment in domestic industries. 3

There also appeared to be a fundamental and positive relationship between industrial skill intensity and industrial growth, indicating that an increase in the quality of the industrial labor force has been associated with Venezuela's industrial growth. A positive and significant Spearman rank correlation between two-digit Venezuelan industries ranked by skill intensity and growth rates provided partial evidence on this as also did the relationship between estimated marginal value products and skills.

The implications for policy are readily evident. Skill development has a high payoff in terms of increased productivity in Venezuelan industry as indicated by the high estimates of the value of marginal product for the skilled labor categories. Loosening immigration restrictions and permitting the inflow of skilled workers will also most probably have a positive impact on productivity and growth in Venezuelan manufacturing. 4

Educational and credit policies should be geared toward supplying more educated workers to the labor force and providing the skills


4 It is noteworthy that industrial growth was significant but lower after 1959 when the change in the immigration policy cut off the inflow of skilled workers.
needed for industry and especially for those new industries that will be producing what was formerly imported from more skill-intensive countries like the United States and Great Britain.

The importance of skilled labor in the industrial production process also has implications for Venezuela's new adventure into regional integration (LAFTA). Venezuela, being the more economically developed of the LAFTA countries and having a relatively large supply of skilled workers, should attempt to export those products with skill-intensive technologies and import those products that require fewer skills assuming the immobility of human capital between LAFTA countries. This will permit an increase in labor productivity, an overall increase in wage income and in a manner consistent with economic efficiency.

These results point out not only the actual but also the potential role of skills in industrial production in Venezuela. Human capital formation is directly related to policy decisions. Thus, this shows another area in which the public sector is important in influencing the productivity and structure of the Venezuelan industrial sector.

Another basic result uncovered by the study is that the managerial input has a significant impact on the productivity of the other inputs in the production relationship. The empirical results suggest that managers contribute to production indirectly by organizing and coordinating the other primary inputs. A more detailed inquiry of the managers role would be a fruitful area for future research in production theory.

Another set of significant findings were due to the disaggregation of the capital input into three components. Fixed capital is an important input, but equally critical are inputs in the form of
intermediate inputs, inventories and variable capital services.

As expected, fixed assets—buildings, transport machinery, land and machinery—were highly significant and positive for almost all industries. However, significant and negative elasticities of output for fixed assets were found in the primary metals and transport industries. This result is probably due to overcapitalization as a result of government policies to develop these two relatively new industries. 5

Furthermore, variable capital services—rent, insurance, professional services, advertising, etc.—were also found to be highly significant. In fact, in a large number of industries the elasticity of output with respect to variable capital was greater than that of fixed assets.

A third type of capital services—inventory capital—was also significant and positive in a sizable portion of Venezuelan industries.

The policy implications associated with the results relating to capital are quite evident. Economic planners need to concern themselves with more than just the fixed asset needs of the industrial sector. Financial institutions and government development agencies must provide the proper environment to permit industrial firms—big and small—to receive financial and technical assistance for obtaining inventories, working capital, and human capital, all of which are very productive factors in Venezuelan industry.

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If new capital available to Venezuela from outside goes into only the formation of buildings and machinery, then the areas of human capital and variable capital, two important productive factors in Venezuelan manufacturing, will be neglected leading to distorted and suboptimal production techniques.

Further the results indicate that capital markets and financial deepening have an important and significant role to play in development. In the development literature a recent line of thinking has emerged, arguing that "financial deepening", the development of a complex of markets for financial assets and services, is essential in the development process and highly complementary to other more widely recognized factors needed for economic growth. According to this line of reasoning, shallow finance due to an undeveloped financial system leads to a discriminatory and inefficient system of credit. This fragmentation of capital markets leads to inefficiently cheap credit for large firms, and exorbitantly expensive or no credit for the smaller proprietorships. Given the flexibility of the Venezuelan manufacturing sector in responding to relative factor prices as shown in this study, this would lead to an expected high capital and skill intensity in the favored large corporations, as was evidenced. If this adversely affects productivity and growth, as is argued by proponents of the financial deepening argument, then one expects a decrease in the efficiency and productivity of the non-favored firms and thus the manufacturing sector overall. This too was shown by the significant and negative coefficient for the proprietorship dummy variable. These results along with available evidence of fragmented markets in Venezuela indicate that discrimination of the small proprietorship was
partly responsible for their inefficiency. Thus, while other factors might also contribute to the inefficiency of proprietorships, our results also suggest the possible acceptance of the financial deepening argument as an explanation.

Some policy implications from these results are evident. Given that proprietorships serve a useful function as a seedbed for entrepreneurs and a supply source for the more productive corporations and given that the alternative of financial failure for proprietorships is unemployment leading possibly to political unrest, it is important that these firms have access to capital and labor markets. Biases in the capital market, through no credit or exorbitant prices on credit, are a probable reason for a non-capital intensive structure and lower total factor productivity for proprietorships. These firms need access to credit for fixed capital expenditures and working capital. More government effort should be directed toward providing credit, services, and information to this subset of industrial firms. This implication is given further support by the fact that a large percentage of Venezuelan industrial firms are proprietorships.

Another probably related set of results are the regional aspects of industrial production. There are probably significant regional disparities in industrial productivity. The first empirically supported test was that industrial productivity, when measured using all productive factors, differed significantly across regions. A second result supported by the study was that different technologies are employed in different regions of Venezuela.

These results imply that regional factors must be taken into account
when examining industrial production. Moreover, this supports the use of decentralized planning. It suggests the need for overcoming regional differences through the expansion of communication, transportation, health, education and government administration services as well as the financial services which were discussed earlier. Such a direction is also consistent with reducing rural to urban migration and regional income disparities which are plaguing the developmental efforts of LDC's.

Several related methodological findings have emerged that have a bearing on studies of this nature. We saw that the Cobb-Douglas specification with value of output as the dependent variable led to a better statistical fit and more consistent estimates than the Cobb-Douglas specification with value added as the dependent variable. The former model, which explicitly treats intermediate inputs as a primary input, did an excellent job estimating Venezuelan manufacturing functions both with and without intermediate inputs included in the set of independent variables. High F statistics and multiple coefficients of determination gave support for the use of the model. Moreover, large numbers of specified inputs were statistically significant, as expected, and had correct signs.

These results indicate the presence of substitution between primary factors and intermediate inputs. Moreover, they suggest that in estimating industrial production functions with a Cobb-Douglas specification more consistent estimates can be obtained from firm level data when intermediate inputs are treated as a factor, like capital and labor, having a unitary elasticity of substitution with other inputs, even when intermediate inputs are proportional to
industrial output. Previous studies that have generally used a
value added specification for the dependent variable in the production
function should be viewed with some reservations. The results of
this study which unlike most studies had very detailed information on
intermediate inputs, indicate that the value added form is inadequate
and inappropriate.

Besides the implications of this result for theoretical models
treating value added and not value of output as the dependent variable,
there are significant implications for development and trade policy
in LDC's. For example, much of the theoretical and empirical liter-
ature using effective rates of protection to examine tariff policies
in LDC's is based on the assumption of no substitution between
primary factors and intermediate inputs. Bela Belassa in a recent and
important study pointed out fundamental problems encountered in
measuring effective rates of protection when such substitutability
exists. He, however, argued that "empirical studies give evidence
of little substitutability between primary factors and material inputs".\footnote{B. Belassa, "Effective Protection in Developing Countries", in J. Bhagwati, R. Jones, R. Mundell and J. Vanek, eds., \textit{Trade Balance of Payments and Growth}, (Amsterdam: North-Holland Publishing Company, 1971), p. 303.} In view of the results of this study, such techniques based upon this
assumption should be seriously reevaluated.

These results concerning the disaggregated specification of
capital and labor inputs in the production function have methodological
implications, as anticipated from studies based primarily on developed
countries. It is very clear that labor in the Venezuelan industrial
sector is not homogeneous. Workers in less developed countries often lack even basic literacy. Therefore, entering labor as a single homogeneous input is an inappropriate input specification. Not disaggregating the labor component of the production function by skill levels will most probably lead to misleading results. Even more importantly, it obscures the importance and thus the need of human capital in industrial production. Thus planning methodologies using a single aggregate labor input without correcting for differences in skill should be viewed with extreme reserve.

With regard to disaggregating capital into three service flow categories, it was apparent that the often used assumption of proportionality of stock of fixed assets to flow of capital services used so often in aggregate production studies was not supported. This was evident for several reasons. One reason was that the significance of each of these three capital inputs differed across industries. Moreover, their elasticities of output varied substantially.

If these microeconomic results apply to the aggregate economic structure, then this commonly used methodological procedure will lead to erroneous and misleading results.

More broadly, these results highlight the need for disaggregating capital services into more homogeneous categories with respect to their impact on industrial output. Both variable capital and inventory capital have been inadequately examined in earlier production studies and should be examined more closely in future studies to avoid biases in the role and importance of capital in production.

The methodological implication of the findings on the form of ownership suggests that if information is wanted on the structure of unincorporated enterprises, these firms should be examined separately.
Aggregate census figures are completely inappropriate for examining these firms which play a very important role in the manufacturing sector of LDC's.

**Areas for Further Inquiry**

Finally, there appear to be a number of areas of further research to pursue. First, alternate more general functional specifications can be fitted to the industry data. One set of functional forms are the variable elasticity of substitution production specifications containing the CES as a special case.

Another obvious avenue would be to disaggregate the study to three-digit industries and carry out a more detailed analysis on other two-digit industries along the same lines as was done with the food processing and fabricated metals industries.

A third potential area of study would be to obtain information on the regional codes and examine the impact of regional financial deepening on the technology and productivity of Venezuelan industries across regions.

A fourth area, as indicated above, would be to examine the role of managers in affecting the allocation of the other conventional inputs.

It is hoped that the methodological framework and empirical results of this study will make a useful contribution to the industrial production literature. By providing some useful information on the industrial production structure in Venezuela and pointing out their implications for economic development policy, it hopes to enrich both the industrial production as well as the development literature. The results of this study suggest that if consistent estimates are required,
greater resources will need to be devoted to collecting good micro-
economic data at the firm level, as the one used here. This calls
for a de-emphasis on macroeconomic aggregates and their overwhelming
and often misleading use in development planning.

As micro data is made available from less developed nations
permitting the estimation of their industrial production functions,
it will be interesting to see how they compare with the results and
conclusions of this study.
APPENDIX A

HUMAN CAPITAL DEVELOPMENT, INDUSTRIAL GROWTH, AND IMPORT SUBSTITUTION STRATEGY IN LESS DEVELOPED NATIONS: THE CASE OF VENEZUELAN MANUFACTURING

Venezuela's industrial sector is growing rapidly, and this growth involves basic structural change. It is hypothesized that the skill intensity of the industrial sector is increasing. There are several basic theoretical reasons for anticipating this.

First, with respect to the theory of the firm, as the country progresses, consumer demand shifts from standardized products, requiring few skills, to differentiated products.¹ Firms producing these "new" products require relatively more skilled workers. This is because production runs are short, specifications are loose, and the production process must frequently be adjusted to handle changes in specification design or methods. This can be compared to existing or "mature" products with a stabilized technology and specification, frozen design, and long production runs.

Moreover, studies have shown that the share of industrial output rises and the growth of industries based on import substitution account

for a greater portion of the total rise in output. This also seems to be the case for Venezuela. Thus, a second set of reasons for expecting an increase in skill intensity derives from (1) the human capital version explaining the Leontief paradox and thus international trade flows and (2) the fact that Venezuela, like most other less developed nations, is adopting an industrial promotion strategy based on import substitution. The human capital explanation of international trade flows in brief is that skill intensity goes a long way in explaining trade flows. A country with a large supply of skilled workers exports skill-intensive products and imports nonskill-intensive products. Venezuela has been importing manufactured goods from the United States and other skill-abundant developed countries. As import substitution has taken place, Venezuela has adopted more skill-intensive technologies, producing goods that were previously imported. Thus, if these theories are valid, one would expect the industrial sector of a rapidly developing country, like Venezuela, to become more skill-intensive over time.

In this context this illustrates the need for disaggregating labor in the production function. This is done by testing the

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3 One study supporting the importance of skilled labor in explaining international trade flows is Donald B. Keesing's "Labor Skills and the Structure of Trade in Manufacturing," in The Open Economy, ed. by Peter B. Kenen and Roger Lawrence, (New York: Columbia University Press, 1968).
importance of skilled labor categories across industry groupings.

The following test was devised to see if, in fact, skilled labor was significantly connected to interindustry growth rates.

In an attempt to understand the relation between labor skills and growth rates among two-digit industries, alternate skill indices were calculated for each two-digit industry.

The skill indices are based on manpower data given in the complementary manpower questionnaire. The occupational categories and corresponding occupational description are as follows:

<table>
<thead>
<tr>
<th>Labor Category</th>
<th>Occupations</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Scientists and Engineers</td>
</tr>
<tr>
<td>II</td>
<td>Technicians and Craftsmen</td>
</tr>
<tr>
<td>III</td>
<td>Other Professionals</td>
</tr>
<tr>
<td>IV</td>
<td>Managers</td>
</tr>
<tr>
<td>V</td>
<td>Machinists, Electricians and Tool and Die Makers</td>
</tr>
<tr>
<td>VI</td>
<td>Other Skilled Manual Workers</td>
</tr>
<tr>
<td>VII</td>
<td>Clerical, Sales and Service Workers</td>
</tr>
<tr>
<td>VIII</td>
<td>Semi-Skilled and UnskilledWorkers</td>
</tr>
</tbody>
</table>

The skill indices were defined as follows. 4

Skill Index I (SI) = \( \frac{2(L_1 + L_2 + L_5)}{\sum_{L=1}^{8} L_1} \)

Skill Index II (SII) = \( \frac{2(L_1 + L_2 + L_3 + L_5)}{L_7 + L_8} \)

Skill Index III (SIII) = \( \frac{2(L_1 + L_2 + L_3) + L_5 + \frac{1}{2} (L_4 + L_6) + \frac{1}{4} (L_7 + L_8)}{\sum_{L=1}^{8} L_1} \).

---

The skill indices give more weight to higher educated and less weight to the lower educated workers and indicate the relative intensities of human capital embodied in a typical worker in a given industry. The calculations are based on the Venezuelan complementary census data, and are presented in Table 14. Also included are the ranks of the two-digit industries. It should be noted that the industry rankings are relatively invariant with respect to each of the three skill indicators.

A Spearman rank test was conducted to test the hypothesis of "no association" between industries ranked by growth rates and skill intensities. A Spearman rank coefficient of .44 was found, and it was significant at a 95 percent level of confidence. Thus, the hypothesis of no association was rejected in favor of a significant and positive association between industries ranked by skill intensity and industries ranked by growth rates. The distribution of two-digit industries by skill indices and growth rates is presented in Table 15. This association is one of the reasons for anticipating different production functions between industries, as well as for using disaggregated labor categories in this specification. In particular, skilled labor is anticipated to be relatively more important in dynamic industries than slow-growing industries.

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5 A description of the Spearman rank coefficient for testing the hypothesis of "no association" is given in William Mendenhall's, *Introduction to Probability and Statistics*, (Belmont, California: Wadsworth Publishing Company, Inc., 1968), pp. 314-317, 362; the ranks of growth rates are based on the twenty-two year time span in Table 6; the ranks of the skill intensities are based on skill index I in Table 14.
<table>
<thead>
<tr>
<th>Industry</th>
<th>Skill Index I&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Rank</th>
<th>Skill Index II&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Rank</th>
<th>Skill Index III&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Rank</th>
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### TABLE 14 -- Continued

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<th>Skill Index II&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Rank</th>
<th>Skill Index III&lt;sup&gt;c&lt;/sup&gt;</th>
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<sup>a</sup>\[ \text{Skill Index I} = \frac{2(L_1 + L_2 + L_3) + L_5}{8 \sum_{i=1}^{8} L_i} \]

<sup>b</sup>\[ \text{Skill Index II} = \frac{2(L_1 + L_2 + L_3) + L_5}{L_7 + L_8} \]

<sup>c</sup>\[ \text{Skill Index III} = \frac{2(L_1 + L_2 + L_3) + L_5 + \frac{1}{2}(L_4 + L_6) + \frac{1}{4}(L_7 + L_8)}{8 \sum_{i=1}^{8} L_i} \]
### TABLE 15

DISTRIBUTION OF TWO-DIGIT MANUFACTURING INDUSTRIES BY GROWTH RATE AND SKILL INTENSITY

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<td>3 (25)</td>
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<td>Medium</td>
<td>(22)</td>
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<td>Total</td>
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\[ \text{Skill intensity index } SI = \frac{2(L_1 + L_2 + L_3) + L_5}{8 \sum L_1} \]

*The correlation is based on the ranks of the two-digit industrial sector.*

*The growth rates are based on the twenty-two year time span.*

*The two-digit industrial classification codes are given in parentheses.*
APPENDIX B

INDICES OF VENEZUELAN INDUSTRIAL OUTPUT
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\[\text{a}\text{The two-digit classification is given in parentheses.}\]

Source: Banco Central de Venezuela.
APPENDIX C

AN ANALYSIS OF THE RELATIONSHIP BETWEEN THE OUTPUT SPECIFICATION AND INTERMEDIATE INPUTS

This appendix and the next focus on the validity of some of the basic assumptions of the model used in this study. They examine the theoretical and empirical foundations of the form of the production function with a view for strengthening the arguments for their use here. This work, however, has relevance in its own right.

In this appendix, the role of intermediate inputs in the Cobb-Douglas production specification is examined. Empirical support is presented for using output, not value-added, as the dependent variable, and treating intermediate inputs as another factor of production, which like capital and labor is implicitly assumed to have a unitary elasticity of substitution with the other primary factors.

Cobb-Douglas Production Functions with Proportionality Between Output and Intermediate Inputs

The treatment of intermediate inputs has been the subject of controversy in production function estimation for a number of years. 1 When information on intermediate inputs is not directly

available, several methods have been used to estimate production functions. The most common method has been to regress value added on labor and capital. Such a procedure assumes away the interrelationship of intermediate inputs with other primary factor inputs. An alternate method is to estimate the structural parameters directly by regressing output or its value on labor and capital. Having explicit information on intermediate inputs in our data allows us to use the value added and the direct method to see their separate implications. We intend to show that the inclusion of intermediate inputs directly, as done in this study, yields more consistent and superior results.

Consider the following two alternate production function specifications (Cases I and II) and their implications. The first case is specified by Equations (1) - (3):

**Case I:**

(1) \[ V = a_1 L_1^a_2 L_2^a_3 L_3^a_4 K_1^b_1 K_2^b_2 K_3^b_3 \]

(2) \[ V = O - M \]

(3) \[ M = \lambda O \]

where \( V \) is value added, \( L_i \) and \( K_i \) are labor and capital inputs, \( M \) is the intermediate input, \( O \) is value of output and \( \lambda \) is a constant factor of proportionality between \( M \) and \( O \). In this case,

---


the production function is specified with value added as the dependent variable; value added is value of output minus value of intermediate inputs by definition, and intermediate inputs are assumed to be proportional to output.

From this specification the following relationships may be derived:

\[(4) \quad 0 - M = a_1 L_1 L_2 L_3 L_4 K_1 K_2 K_3 \]
\[(5) \quad 0 - \lambda Q = a_1 a_2 a_3 a_4 b_1 b_2 b_3 \]
\[(6) \quad (1 - \lambda)Q = a_1 a_2 a_3 a_4 b_1 b_2 b_3 \]
\[(7) \quad 0 = (A/1 - \lambda) \cdot L_1 L_2 L_3 L_4 K_1 K_2 K_3 \]

If Equations (1) - (3) define the correct functional specification, then fitting the double log form of Equations (1) and (7) should yield equally good fits to the data and yield identical parameter estimates for both forms.

Table 17 presents the estimates for both regressions connected with Equations (1) and (7). It can be seen that the two forms do not fit the data equally well. The multiple coefficients of determination for (7) are significantly higher than for (1). These increase from .455 to .839 and .368 to .884 in food processing and metal fabrication, respectively. The corresponding F statistics for the models increase from 37.0 and 3.9 for (1) to 197.1 and 51.4 for (7) in food processing and metal fabrication, respectively. Thus, Equation (7) fits the data far better than (1).
### Table 17

#### Regression Coefficients and Related Statistics for Production Functions for the Venezuelan Food Processing and Fabricated Metal Industries (1970): Case I

**Equation (1):** \( V = a_1 + a_2 L_2 + a_3 L_3 + a_4 L_4 + b_1 K_1 + b_2 K_2 + b_3 K_3 \)

<table>
<thead>
<tr>
<th>Sector</th>
<th>( a_1 )</th>
<th>( a_2 )</th>
<th>( a_3 )</th>
<th>( a_4 )</th>
<th>( b_1 )</th>
<th>( b_2 )</th>
<th>( b_3 )</th>
<th>Constant</th>
<th># of Obs.</th>
<th>F</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Processing</td>
<td>-.034</td>
<td>.056***</td>
<td>.137*</td>
<td>.723*</td>
<td>.124</td>
<td>.159*</td>
<td>-.040</td>
<td></td>
<td>8.387</td>
<td>272</td>
<td>.455</td>
</tr>
<tr>
<td></td>
<td>(20) (.049)</td>
<td>(.040)</td>
<td>(.037)</td>
<td>(.167)</td>
<td>(.139)</td>
<td>(.051)</td>
<td>(.041)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>.030</td>
<td>.083</td>
<td>.201*</td>
<td>.194</td>
<td>.124</td>
<td>.150</td>
<td>-.004</td>
<td></td>
<td>9.894</td>
<td>54</td>
<td>.368</td>
</tr>
<tr>
<td></td>
<td>(35) (.112)</td>
<td>(.081)</td>
<td>(.084)</td>
<td>(.207)</td>
<td>(.315)</td>
<td>(.327)</td>
<td>(.109)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Equation (7):** \( O = (A/1-\lambda) L_1 L_2 L_3 L_4 K_1 K_2 K_3 \)

<table>
<thead>
<tr>
<th>Sector</th>
<th>( a_1 )</th>
<th>( a_2 )</th>
<th>( a_3 )</th>
<th>( a_4 )</th>
<th>( b_1 )</th>
<th>( b_2 )</th>
<th>( b_3 )</th>
<th>Constant</th>
<th># of Obs.</th>
<th>F</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Processing</td>
<td>.006</td>
<td>.074*</td>
<td>.034*</td>
<td>.380*</td>
<td>.276*</td>
<td>.119*</td>
<td>.067*</td>
<td></td>
<td>8.512</td>
<td>272</td>
<td>.839</td>
</tr>
<tr>
<td></td>
<td>(20) (.017)</td>
<td>(.015)</td>
<td>(.013)</td>
<td>(.061)</td>
<td>(.051)</td>
<td>(.014)</td>
<td>(.015)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>.005</td>
<td>-.002</td>
<td>-.018</td>
<td>.157*</td>
<td>.565*</td>
<td>.315*</td>
<td>.063*</td>
<td></td>
<td>4.201</td>
<td>54</td>
<td>.884</td>
</tr>
<tr>
<td></td>
<td>(35) (.028)</td>
<td>(.020)</td>
<td>(.021)</td>
<td>(.051)</td>
<td>(.078)</td>
<td>(.082)</td>
<td>(.027)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (***) at the 10 percent level.
Moreover, the number of inputs entering the production function at a significant and positive level of significance increases when moving from (1) to (7) using the same data for both industries. Thus, the second form in (7) provides a much better overall goodness of fit than the model in (1).

With respect to the parameter estimates, a casual glance at these two sectors shows that the parameter estimates for the two forms are not even remotely similar. To further test this, a Spearman rank correlation coefficient ranking nonintermediate input coefficients, irrespective of significance, for estimates from the two regression equations was estimated at .643 and -.036 for food processing and metal fabrications, respectively. Neither was significant at a 90 percent level of confidence.

These results indicate clearly that the parameter estimates obtained from the two forms are substantially different. These results lead to the strong conclusion that the value added model of (1), so often used, is a poor model for estimating production functions, because it leads to inconsistencies when estimates of its revealed form (7), which uses output as a dependent variable, are obtained.

The effectiveness of these results does depend on the validity of the specification in (3) that specifies a factor of proportionality between output and intermediate inputs. An examination of the data showed that this condition of proportionality was certainly valid in

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these two Venezuelan industries. While not perfect, the correlation between output and intermediate inputs was .982 in food processing and .985 in metal fabrication. This input has a higher correlation with output than any other input. However, other inputs also were highly correlated with output. In food processing, the correlation was .858 for variable capital and .867 for professional and subprofessional labor. In fabricated metals it was .911 for fixed assets, .837 for variable capital, and .780 for semi- and unskilled workers.

In addition, a simple regression of the form

\( y = a + bM + cM^2 \)

was established using ordinary least squares, where \( y \) is output and \( M \) is intermediate inputs. The estimate of \( a \) was insignificant and the estimates of \( b \) and \( c \) were significant and positive. However, the estimate of \( c \) was so small that in essence it was not significantly different from zero. Thus, the assumption of proportionality was confirmed for our data and was not the cause of differences between (1) and (7). Thus, the specification in Equation (1) seems to be in doubt in terms of the evidence presented here, and suggests that the use of the value added method is inappropriate. Its use should be avoided, especially where data for intermediate inputs is available.

Now let us consider a second case as specified by Equations (1') and (2') below:

**Case II:**

\[(1') \quad 0 = a_1 L_1 + a_2 L_2 + a_3 L_3 + a_4 K_1 + b_1 K_2 + b_2 K_3 + c M \]

\[(2') \quad M = \lambda 0\]
where the variables are defined as before. Equation (1') is Model I.

Now substituting (2') into (1') yields

\[(3') \quad 0 = \frac{a_1 a_2 a_3 a_4 b_1 b_2 b_3}{A L_1 L_2 L_3 L_4 K_1 K_2 K_3} (\lambda 0)^c\]

\[(4') \quad 0^{1-c} = \frac{a_1 a_2 a_3 a_4 b_1 b_2 b_3}{A L_1 L_2 L_3 L_4 K_1 K_2 K_3}\]

\[(5') \quad 0 = (A \lambda)^{1-1-c} a_1^{1-1-c} a_2^{1-1-c} a_3^{1-1-c} a_4^{1-1-c} b_1^{1-1-c} b_2^{1-1-c} b_3^{1-1-c} K_1 K_2 K_3\]

Then if (1') is the true relationship and the correct specification of the model and proportionality between output and intermediate inputs exists as assumed in (2'), then the log-linear forms of (1') and (5') should give good fits. While the coefficients would not be equal, they would be proportional to each other by a factor, $1/(1-c)$, assuming constant returns to scale.

The empirical results of these equations are shown in Table 18. Both forms (1') and (5') give good fits. The $F$ statistic is 197.1 and 719.9 in food processing, and 51.4 and 121.2 in fabricated metals, respectively, for the two equations. In addition, both have high multiple coefficients of determination with .839 and .956 in food processing and .884 and .956 in fabricated metals.

Further, the same Spearman rank test was carried out on the regression coefficients of the two models. If proportionality between the parameter estimates holds for the nonintermediate inputs, then the test of nonassociation between the sizes of the regression coefficients should be rejected, as it is. The Spearman rank coefficient for these
TABLE 18
REGRESSION COEFFICIENTS AND RELATED STATISTICS FOR PRODUCTION FUNCTIONS FOR THE VENEZUELAN FOOD PROCESSING AND FABRICATED METAL INDUSTRIES (1970): CASE II

<table>
<thead>
<tr>
<th>Sector</th>
<th>a_1</th>
<th>a_2</th>
<th>a_3</th>
<th>a_4</th>
<th>b_1</th>
<th>b_2</th>
<th>b_3</th>
<th>c</th>
<th>Constant</th>
<th># of Obs.</th>
<th>F</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Processing</td>
<td>-.004</td>
<td>.022*</td>
<td>.027*</td>
<td>.144*</td>
<td>.165*</td>
<td>.048*</td>
<td>-.000</td>
<td>.590*</td>
<td>3.481</td>
<td>272</td>
<td>719.943</td>
<td>.956</td>
</tr>
<tr>
<td></td>
<td>(.009)</td>
<td>(.008)</td>
<td>(.007)</td>
<td>(.033)</td>
<td>(.027)</td>
<td>(.010)</td>
<td>(.008)</td>
<td>(.022)</td>
<td>(       )</td>
<td>(       )</td>
<td>(     )</td>
<td>(.     )</td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>.027*</td>
<td>.012</td>
<td>.023**</td>
<td>.092*</td>
<td>.127**</td>
<td>.170*</td>
<td>.020</td>
<td>.482*</td>
<td>3.909</td>
<td>54</td>
<td>121.243</td>
<td>.956</td>
</tr>
<tr>
<td></td>
<td>(.017)</td>
<td>(.013)</td>
<td>(.014)</td>
<td>(.032)</td>
<td>(.042)</td>
<td>(.054)</td>
<td>(.017)</td>
<td>(.022)</td>
<td>(       )</td>
<td>(       )</td>
<td>(     )</td>
<td>(.     )</td>
</tr>
</tbody>
</table>

Equation (5'): \[ 0 = (A\lambda)^{1-c} L_1^{a_1/1-c} L_2^{a_2/1-c} L_3^{a_3/1-c} L_4^{a_4/1-c} K_1^{b_1/1-c} K_2^{b_2/1-c} K_3^{b_3/1-c} \]

<table>
<thead>
<tr>
<th>Sector</th>
<th>a_1/1-c</th>
<th>a_2/1-c</th>
<th>a_3/1-c</th>
<th>a_4/1-c</th>
<th>b_1/1-c</th>
<th>b_2/1-c</th>
<th>b_3/1-c</th>
<th>Constant</th>
<th># of Obs.</th>
<th>F</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Processing</td>
<td>.006</td>
<td>.074*</td>
<td>.034*</td>
<td>.380*</td>
<td>.276*</td>
<td>.119*</td>
<td>.067*</td>
<td>8.512</td>
<td>272</td>
<td>197.116</td>
<td>.839</td>
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<td></td>
<td>(.017)</td>
<td>(.015)</td>
<td>(.013)</td>
<td>(.061)</td>
<td>(.051)</td>
<td>(.019)</td>
<td>(.015)</td>
<td>(       )</td>
<td>(       )</td>
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<td>Fabricated Metals</td>
<td>.005</td>
<td>-.002</td>
<td>-.018</td>
<td>.157*</td>
<td>.565*</td>
<td>.315*</td>
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<td>(.021)</td>
<td>(.051)</td>
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<td>(.082)</td>
<td>(.027)</td>
<td>(       )</td>
<td>(       )</td>
<td>(     )</td>
<td>(.     )</td>
</tr>
</tbody>
</table>

\(^a\)The estimates for Equation (5') are identical to those of (7).

Note: The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (***) at the 10 percent level.
two rankings was .857 for food processing and .786 for metal fabrication. Both are significant and positive with a 95 percent level of confidence. These results suggest that the parameter estimates obtained from the two specifications (1') and (5') in Case II are not significantly different. From this we can conclude that specification (1') is appropriate, since it produces no inconsistencies in the parameter estimates, and gives better fits for the data. Thus, the production model as specified in Equation (1') for Case II is the more reliable form, compared to (1) for Case I. These results give strong support to the model being used in this study, which treats intermediate inputs as a primary factor with unitary elasticity of substitution with the other primary intermediate inputs.

In contrast, the commonly used value added specification in (1) leads to inconsistencies in the parameter estimates and produces poorer fits to the data. All this evidence suggests that the direct method, using value of output as a dependent variable and including intermediate inputs as independent variables as in (1'), is far more appropriate, because it conforms with theory, gives better results, and produces no inconsistencies in the direct estimates. Thus we were justified in using it in this study.
APPENDIX D

ESTIMATES OF THE SECTORAL ELASTICITIES OF FACTOR SUBSTITUTION

This appendix examines the validity of the implicit Cobb-Douglas assumption of a unitary elasticity of substitution between capital and labor. In the context of this study, these results are intended to test the appropriateness of the Cobb-Douglas specification, with an assumed elasticity of factor substitution ($\sigma$) equal to one against a fixed coefficient, Harrod-Domar, type model with an elasticity of substitution equal to zero and/or a linear model with an elasticity of factor substitution approaching infinity. All three of these functional forms are embedded in the more general constant elasticity of substitution production function specification.¹ This section, in more general terms, may be interpreted as an attempt to estimate sectoral elasticities of substitution under a constant elasticity of substitution production function specification.

Constant Elasticity of Substitution Production Functions

The elasticity of substitution ($\sigma$) has been of particular interest to economists since its introduction to the literature in the pa-

¹For a theoretical explanation of this see C. E. Ferguson, The Neoclassical Theory of Production and Distribution; (Cambridge, England; University Printing House, 1969); pp. 103-107.
per by Arrow, Chenery, Minhas, and Solow (ACMS). The sectoral
elasticities of substitution between capital and labor are of special in-
terest to developing countries as argued by Behrman.

First, the size of such elasticities is an important component of
the degree of static flexibility of the economy in response to
changes such as those which occur in international markets. In
this particular respect, a number of observers have maintained
that the developing economies are relatively inflexible and thus
are not able to exploit well their dynamic comparative advantages.
Second, the possibility that these elasticities are low underlies
one prominent explanation of the reputed existence of large quan-
tities of unemployed and underemployed labor. Third, the same
assumption underlies the use of many linear planning models, the
construction of which has absorbed considerable resources among
development economists. Fourth, under neoclassical assumptions,
changes in relative factor shares between labor and non-labor de-
pend upon the relative growth of the factors and the aggregate
elasticity of substitution between capital and labor. This
aggregate elasticity of substitution between capital and labor in
turn depends upon the sectoral elasticities of substitution be-
tween capital and labor and the relative growth of the various sec-
tors. Fifth, the higher is the aggregate elasticity of substi-
tution between capital and labor, ceteris paribus, the greater is
the possible rate of growth of product, because the relatively fast
growing primary factor can be substituted more easily for the re-
atively slow growing primary factor. Changes in this aggregate
elasticity of substitution between capital and labor, once again,
depends upon the sectoral elasticities of substitution between cap-
ital and labor and the relative growth of the sectors.

Many empirical production studies assume that this elasticity of
substitution is unity (in Cobb-Douglas functions) or zero (in input-
output models). With the ACMS article, it was demonstrated that the

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2K. J. Arrow, H. B. Chenery, B. S. Minhas, and R. M. Solow,
"Capital Labor Substitution and Economic Efficiency", The Review of

3J. R. Behrman, "Sectoral Elasticities of Substitution Between
Capital and Labor in a Developing Economy: Time Series Analysis in the
Case of Postwar Chile", Econometrica, Vol 40, No. 2 (March, 1972),
pp. 311-312.

elasticity of substitution could be tested to examine which of these underlying assumptions, if either, holds. As pointed out earlier, this test is of particular importance in this study, since a Cobb-Douglas function has been used for estimating Venezuelan industrial production functions. We now provide the tests which supported the use of this form.

A large number of theoretical and empirical studies dealing with the elasticity of factor substitution have appeared over the past decade and a half. These studies have tended to use aggregate data to estimate elasticities of factor substitution, mainly in various industries in the U. S. Our estimates based on micro data for a developing country will provide additional information for understanding this facet of production.

The genesis of the ACMS study rested on the empirically observed fact that value added per unit of labor varied with wage rates. The equation for fitting the data to this hypothesis was

\[ \ln \frac{V_i}{L_i} = \ln A + \beta \ln W_i + u_i \]

where

- \( V_i \) = Value added in the i-th firm
- \( L_i \) = Labor in the i-th firm
- \( W_i \) = Money wage rate in the i-th firm
- \( A, \beta \) = parameters
- \( u_i \) = random variable

\(^5\) A number of these were mentioned in Chapter III.
Under the assumptions of a perfect competitive equilibrium in both product and factor markets, constant returns to scale, and with product prices not varying simultaneously with the wage level, Arrow, et al. showed that $\beta$ in the above equation is the elasticity of substitution between labor and capital.\(^6\)

Integrating the above equation yielded the constant elasticity of substitution production function.

\[(6.2) \quad V = \gamma[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{-1/\rho}\]

where

$V = $ Value added

$\gamma = $ Efficiency parameter

$\delta = $ Distribution parameter

$\rho = $ Substitution parameter

$K = $ Capital

$L = $ Labor

Using the ACMS method, one may apply the $t$-test to accept or reject the hypothesis that the elasticity of substitution is either zero or one. This we do for all industries in Venezuela for which we have adequate firm-level data.

Alternate methods for estimating the elasticity of substitution were also developed, but they require information impossible to find. Sometimes it has been estimated by highly suspect residual procedures. Our data does not provide information on the price of capital, and thus

\[^6\text{Arrow, "Capital Labor Substitution," pp. 228-9.}\]
the estimation techniques which use it will not be discussed. The method we adopt to estimate the CES production function has been used cross-sectionally on manufacturing industries in the United States by Minisian, Solow, Ferguson, Liu and Hildebrand, and others.

The Venezuelan manufacturing census permits a very accurate measure of value added, capital services, labor services and wage rates for each firm in the sample. To avoid biases that might occur from

7For a case where this procedure was used to generate values for the price of capital which were then used to estimate a production function:

This system, however, works only if the data on the price of capital variable are available. The lack of these data has of course plagued earlier empirical studies by other authors, and so has it in our case. While other authors have been bold enough to report on their empirical findings in an authentic manner, we have preferred not to do so...This is because all our findings are based on the data on the price of capital variable generated according to \( r = (V-W)/K \), where \( r \) is taken as the price of capital. And it is well known that such a procedure of generating the data on this variable raises too many econometric problems.


different production functions in different industries, the elas-
ticities of substitution are estimated for each two-digit industry on
the Venezuelan industrial sector. The results are presented in Table
19.

The regressions in Table 19 compare very favorably in terms of
goodness of fit with other cross-section studies using this estimation
procedure. The adjusted multiple coefficient of determination for
the primary metals industry is an exception, with $R^2 = .000$. This is
probably due to the fact that two of the eighteen firms contribute
over 95 percent of the total output of the industry, and thus either
the technique is relatively fixed, or the assumptions of the classical
linear model do not hold in this case. Again, with the exception of
primary metals, the estimates of the elasticity of substitution range
from .353 to 1.378, and are significantly different from zero for all
sectors. Furthermore, only paper, primary metals and non-electrical
machinery have elasticities of substitution significantly different
from unity at a 95 percent level of confidence, and that of non-elec-
trical machinery is not significantly different from unity at a 99
percent level of confidence; all others have an elasticity of substi-
tution that is not significantly different from unity at the 95 per-
cent level of significance.

In the context of this study, these results give strong support
for the use of the Cobb-Douglas specification, which is what the CES

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12 For example, Z. Griliches, "Production Functions in Manufac-
turing: Some Preliminary Results", in Murray Brown, ed., The Theory
and Empirical Analysis of Production, (New York: NBER, Columbia Uni-
TABLE 19


\[ \ln V/L = \ln A + \sigma \ln W + u \]

<table>
<thead>
<tr>
<th>Industry</th>
<th>lnA</th>
<th>(\sigma)</th>
<th>(R^2) (adj)</th>
<th>Number of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>2.699</td>
<td>.944* (.073)</td>
<td>.375</td>
<td>277</td>
</tr>
<tr>
<td>Beverages</td>
<td>2.392</td>
<td>.863* (.081)</td>
<td>.596</td>
<td>77</td>
</tr>
<tr>
<td>Tobacco</td>
<td>1.726</td>
<td>1.373* (.414)</td>
<td>.384</td>
<td>17</td>
</tr>
<tr>
<td>Textile</td>
<td>2.470</td>
<td>.740* (.209)</td>
<td>.203</td>
<td>46</td>
</tr>
<tr>
<td>Apparel</td>
<td>2.096</td>
<td>.957* (.138)</td>
<td>.582</td>
<td>35</td>
</tr>
<tr>
<td>Lumber</td>
<td>1.523</td>
<td>1.070* (.227)</td>
<td>.490</td>
<td>23</td>
</tr>
<tr>
<td>Furniture</td>
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<td>.606* (.227)</td>
<td>.264</td>
<td>18</td>
</tr>
<tr>
<td>Paper</td>
<td>3.039</td>
<td>.353* (.133)</td>
<td>.144</td>
<td>37</td>
</tr>
<tr>
<td>Printing</td>
<td>.903</td>
<td>1.168* (.142)</td>
<td>.823</td>
<td>16</td>
</tr>
<tr>
<td>Leather</td>
<td>1.968</td>
<td>1.102* (.071)</td>
<td>.920</td>
<td>22</td>
</tr>
<tr>
<td>Rubber</td>
<td>2.809</td>
<td>.502* (.318)</td>
<td>.103</td>
<td>14</td>
</tr>
<tr>
<td>Chemicals</td>
<td>2.087</td>
<td>1.061* (.172)</td>
<td>.420</td>
<td>52</td>
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<td>Petroleum</td>
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<td></td>
<td></td>
<td>(Insufficient number of firms)</td>
</tr>
<tr>
<td>Stone, Clay, Glass</td>
<td>1.685</td>
<td>.983* (.146)</td>
<td>.452</td>
<td>55</td>
</tr>
<tr>
<td>Primary Metals</td>
<td>3.392</td>
<td>.168 (.170)</td>
<td>.000</td>
<td>18</td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>1.976</td>
<td>.965* (.167)</td>
<td>.375</td>
<td>55</td>
</tr>
</tbody>
</table>
TABLE 19 -- Continued

<table>
<thead>
<tr>
<th>Industry</th>
<th>$\ln \bar{A}$</th>
<th>$\sigma^a$</th>
<th>$R^2$ (adj)</th>
<th>Number of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery, except Electrical</td>
<td>(.36)</td>
<td>.980</td>
<td>1.378* (.147)</td>
<td>.789</td>
</tr>
<tr>
<td>Electrical Machinery</td>
<td>(37)</td>
<td>1.918</td>
<td>1.162* (.177)</td>
<td>.600</td>
</tr>
<tr>
<td>Transport</td>
<td>(38)</td>
<td>1.766</td>
<td>1.151* (.133)</td>
<td>.621</td>
</tr>
<tr>
<td>Other</td>
<td>(39)</td>
<td>1.813</td>
<td>.986* (.196)</td>
<td>.254</td>
</tr>
</tbody>
</table>

* Standard errors are in the parentheses. Those marked with one asterisk (*) are significant at the 1 percent level.

form is reduced to when we assume an elasticity of substitution equal to unity.

In light of earlier reasons for examining sectoral elasticities of substitution, it appears that there is a great deal of flexibility in the Venezuelan economy to respond to factor prices, and this would tend to refute the argument that factor proportions in the manufacturing sector in developing economies are relatively inflexible.

It also tends to refute a low elasticity of substitution as a cause of unemployment in Venezuela. However, unemployment rates in Venezuela are among the lowest in Latin America, and it might be partly due to relatively more flexible prices in Venezuela as compared to other Latin American nations. In addition, the high elasticities of substitution may be a reason why Venezuela's economic growth has been so high over the past several decades.
The purpose of this section was to indicate that the choice of the Cobb-Douglas form to estimate the production function for Venezuelan manufacturing was far from arbitrary. The validity of the functional form allows us to have greater confidence in our results.
APPENDIX E

DISTRIBUTION OF "USABLE" AND "NONUSABLE" FIRMS BY TWO-DIGIT INDUSTRY FOR BOTH THE MAIN CENSUS AND MATCHED CENSUS
### TABLE 20

DISTRIBUTION OF "USABLE" AND "NONUSABLE" FIRMS BY TWO-DIGIT INDUSTRY FOR BOTH THE MAIN CENSUS AND MATCHED CENSUS

<table>
<thead>
<tr>
<th>Industry</th>
<th>Matched Census</th>
<th>Main Census</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Usable Firms</td>
<td>Number of Nonusable Firms</td>
</tr>
<tr>
<td>Food (20)</td>
<td>278</td>
<td>13</td>
</tr>
<tr>
<td>Beverages (21)</td>
<td>78</td>
<td>0</td>
</tr>
<tr>
<td>Tobacco (22)</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>Textile (23)</td>
<td>46</td>
<td>1</td>
</tr>
<tr>
<td>Apparel (24)</td>
<td>34</td>
<td>1</td>
</tr>
<tr>
<td>Lumber (25)</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>Furniture (26)</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Paper (27)</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>Printing (28)</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Leather (29)</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>Rubber (30)</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Chemicals (31)</td>
<td>53</td>
<td>1</td>
</tr>
<tr>
<td>Petroleum (32)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Stone, Clay, Glass (33)</td>
<td>55</td>
<td>3</td>
</tr>
<tr>
<td>Primary Metals (34)</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Fabricated Metals (35)</td>
<td>55</td>
<td>3</td>
</tr>
<tr>
<td>Machinery, except Electrical (36)</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>Electrical Machinery (37)</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>Transport (38)</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>Other (39)</td>
<td>73</td>
<td>5</td>
</tr>
</tbody>
</table>

*a"Usable Firms" are those firms having positive "value of products produced," "number of production workers," "wages of production workers," "manhours of production workers," and "fixed assets."

bThe number in parentheses is the two-digit classification number.
APPENDIX F

MEANS AND STANDARD DEVIATIONS OF THE DEPENDENT AND INDEPENDENT VARIABLES FOR FIRMS IN THE VENEZUELAN FOOD PROCESSING AND FABRICATED METAL INDUSTRIES
<table>
<thead>
<tr>
<th>Sector Description</th>
<th>Variable</th>
<th>Output (Bolivars)</th>
<th>Managers (Total Number)</th>
<th>Professionals and Sub-Professionals (Total Number)</th>
<th>Skilled Workers (Total Number)</th>
<th>Semiskilled and Unskilled Workers (Total Number)</th>
<th>Non-Inventory Capital (Bolivars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD PROCESSING (20) Mean</td>
<td>6033167</td>
<td>1.6141</td>
<td>1.7436</td>
<td>7.0019</td>
<td>38.2777</td>
<td>824154.</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>(15599538.)</td>
<td>(2.0369)</td>
<td>(7.6714)</td>
<td>(7.8858)</td>
<td>(64.5462)</td>
<td>(222561.)</td>
<td></td>
</tr>
<tr>
<td>FOOD PROCESSING (PROPRIETORSHIPS) Mean</td>
<td>688138</td>
<td>1.0691</td>
<td>0.0185</td>
<td>0.7234</td>
<td>10.3518</td>
<td>82645.</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>(1295014.)</td>
<td>(0.5452)</td>
<td>(0.1156)</td>
<td>(1.7870)</td>
<td>(9.3514)</td>
<td>(98385.)</td>
<td></td>
</tr>
<tr>
<td>FOOD PROCESSING (NONPROPRIETORSHIPS) Mean</td>
<td>8546775</td>
<td>1.8704</td>
<td>2.5549</td>
<td>9.9544</td>
<td>51.4105</td>
<td>1172863.</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>(18378275.)</td>
<td>(2.4011)</td>
<td>(9.1979)</td>
<td>(21.0301)</td>
<td>(74.5190)</td>
<td>(2628434.)</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>(6698342.)</td>
<td>(1.1196)</td>
<td>(2.5271)</td>
<td>(27.4053)</td>
<td>(38.7988)</td>
<td>(872809.)</td>
<td></td>
</tr>
<tr>
<td>Sector Description</td>
<td>Variable</td>
<td>Fixed Assets (Bolivars)</td>
<td>Variable Assets (Bolivars)</td>
<td>Inventory Capital (Bolivars)</td>
<td>Intermediate Inputs (Bolivars)</td>
<td>Intermediate Inputs (Foreign) (Bolivars)</td>
<td>Full Perceived Capital Utilization D_1</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------</td>
<td>-------------------------</td>
<td>---------------------------</td>
<td>----------------------------</td>
<td>-------------------------------</td>
<td>------------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td></td>
<td>K_1</td>
<td>K_2</td>
<td>K_3</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOOD PROCESSING (20) Mean</td>
<td>382872.</td>
<td>362680.</td>
<td>77790.</td>
<td>402840.</td>
<td>2969428.</td>
<td>745666.</td>
<td>0.7574</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>(912536.)</td>
<td>(1229582.)</td>
<td>(263863.)</td>
<td>(11391806.)</td>
<td>(6760560.)</td>
<td>(5280492.)</td>
</tr>
<tr>
<td>FOOD PROCESSING (PROPRIETORSHIPS) Mean</td>
<td>48600.</td>
<td>30324.</td>
<td>5283.</td>
<td>441866.</td>
<td>380968.</td>
<td>28012.</td>
<td>0.7471</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>(49972.)</td>
<td>(53468.)</td>
<td>(11976.)</td>
<td>(683083.)</td>
<td>(623526.)</td>
<td>(170449.)</td>
</tr>
<tr>
<td>FOOD PROCESSING (NONPROPRIETORSHIPS) Mean</td>
<td>540069.</td>
<td>518978.</td>
<td>111889.</td>
<td>5715163.</td>
<td>4186703.</td>
<td>1083157.</td>
<td>0.7622</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>(1071266.)</td>
<td>(1465810.)</td>
<td>(314358.)</td>
<td>(13489723.)</td>
<td>(7904192.)</td>
<td>(6379346.)</td>
</tr>
<tr>
<td>FABRICATED METALS (35) Mean</td>
<td>273646.</td>
<td>202442.</td>
<td>77004.</td>
<td>2039382.</td>
<td>965389.</td>
<td>986243.</td>
<td>0.7636</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>(524452.)</td>
<td>(383869.)</td>
<td>(169275.)</td>
<td>(4217295.)</td>
<td>(2057408.)</td>
<td>(2245513.)</td>
</tr>
<tr>
<td>Sector Description</td>
<td>Variable</td>
<td>Full Perceived Labor Utilization</td>
<td>Operated in 1965</td>
<td>Advertises</td>
<td>Generates Own Electricity</td>
<td>Percent of Intermediate Inputs That are Foreign Produced</td>
<td>Number of Observations</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------</td>
<td>---------------------------------</td>
<td>------------------</td>
<td>------------</td>
<td>--------------------------</td>
<td>-------------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(D_2)</td>
<td>(D_3)</td>
<td>(D_4)</td>
<td>(D_5)</td>
<td>(F_1)</td>
<td></td>
</tr>
<tr>
<td>FOOD PROCESSING (20)</td>
<td>Mean</td>
<td>0.9338</td>
<td>0.8051</td>
<td>0.6471</td>
<td>0.0551</td>
<td>0.0668</td>
<td>272</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>(0.2490)</td>
<td>(0.3968)</td>
<td>(0.4788)</td>
<td>(0.2287)</td>
<td>(0.1701)</td>
<td></td>
</tr>
<tr>
<td>FOOD PROCESSING (PROPRIETORSHIPS)</td>
<td>Mean</td>
<td>0.8966</td>
<td>0.7471</td>
<td>0.5057</td>
<td>0.0115</td>
<td>0.0356</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>(0.3063)</td>
<td>(0.4372)</td>
<td>(0.5029)</td>
<td>(0.1072)</td>
<td>(0.1136)</td>
<td></td>
</tr>
<tr>
<td>FOOD PROCESSING (NONPROPRIETORSHIPS)</td>
<td>Mean</td>
<td>0.9514</td>
<td>0.8324</td>
<td>0.7135</td>
<td>0.0757</td>
<td>0.0814</td>
<td>185</td>
</tr>
<tr>
<td></td>
<td>Deviation</td>
<td>(0.2157)</td>
<td>(0.3745)</td>
<td>(0.4533)</td>
<td>(0.2652)</td>
<td>(0.1895)</td>
<td></td>
</tr>
<tr>
<td>FABRICATED METALS (35)</td>
<td>Mean</td>
<td>0.9636</td>
<td>0.7636</td>
<td>0.7273</td>
<td>0.000</td>
<td>0.3078</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>(0.1889)</td>
<td>(0.4288)</td>
<td>(0.4595)</td>
<td>(0.000)</td>
<td>(0.3159)</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX G

COMPLIMENTARITY BETWEEN SKILL INTENSITY
AND CAPITAL INTENSITY

Skill intensities and physical capital intensities are calculated and ranked at the two-digit sectoral level in Tables 22 and 23. The distribution indicates a positive correlation between physical capital intensity and skill intensity supporting the complementarity hypothesis.
<table>
<thead>
<tr>
<th>Industry</th>
<th>Fixed Capital Per Employee (Bolivars)</th>
<th>Rank</th>
<th>Fixed and Working Capital Per Employee (Bolivars)</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>(20) 43,365</td>
<td>7</td>
<td>59,131</td>
<td>9</td>
</tr>
<tr>
<td>Beverages</td>
<td>(21) 63,052</td>
<td>2</td>
<td>82,155</td>
<td>3</td>
</tr>
<tr>
<td>Tobacco</td>
<td>(22) 44,554</td>
<td>6</td>
<td>82,847</td>
<td>2</td>
</tr>
<tr>
<td>Textile</td>
<td>(23) 30,893</td>
<td>11</td>
<td>47,300</td>
<td>13</td>
</tr>
<tr>
<td>Apparel</td>
<td>(24) 7,315</td>
<td>19</td>
<td>15,176</td>
<td>19</td>
</tr>
<tr>
<td>Lumber</td>
<td>(25) 18,271</td>
<td>16</td>
<td>22,885</td>
<td>17</td>
</tr>
<tr>
<td>Furniture</td>
<td>(26) 8,926</td>
<td>18</td>
<td>17,890</td>
<td>18</td>
</tr>
<tr>
<td>Paper</td>
<td>(27) 60,682</td>
<td>3</td>
<td>76,243</td>
<td>5</td>
</tr>
<tr>
<td>Printing</td>
<td>(28) 37,770</td>
<td>8</td>
<td>50,779</td>
<td>12</td>
</tr>
<tr>
<td>Leather</td>
<td>(29) 36,104</td>
<td>9</td>
<td>54,996</td>
<td>10</td>
</tr>
<tr>
<td>Rubber</td>
<td>(30) 59,583</td>
<td>4</td>
<td>77,060</td>
<td>4</td>
</tr>
<tr>
<td>Chemicals</td>
<td>(31) 35,891</td>
<td>10</td>
<td>64,644</td>
<td>6</td>
</tr>
<tr>
<td>Petroleum</td>
<td>(32) 27,635</td>
<td>14</td>
<td>38,723</td>
<td>15</td>
</tr>
<tr>
<td>Stone, Clay, Glass</td>
<td>(33) 49,747</td>
<td>5</td>
<td>62,724</td>
<td>7</td>
</tr>
<tr>
<td>Primary Metals</td>
<td>(34) 213,998</td>
<td>1</td>
<td>241,976</td>
<td>1</td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>(35) 25,787</td>
<td>15</td>
<td>42,400</td>
<td>14</td>
</tr>
<tr>
<td>Machinery, not Electrical</td>
<td>(36) 18,107</td>
<td>17</td>
<td>26,690</td>
<td>16</td>
</tr>
<tr>
<td>Electrical Machinery</td>
<td>(37) 30,839</td>
<td>12</td>
<td>54,984</td>
<td>11</td>
</tr>
<tr>
<td>Transport</td>
<td>(38) 28,863</td>
<td>13</td>
<td>60,508</td>
<td>8</td>
</tr>
</tbody>
</table>
TABLE 23

DISTRIBUTION OF TWO-DIGIT MANUFACTURING INDUSTRIES
BY CAPITAL INTENSITY AND SKILL INTENSITY

<table>
<thead>
<tr>
<th>Skill Intensity</th>
<th>Fixed and Working Capital per Employee</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(24)</td>
<td>(28)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(25)</td>
<td>(29)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(26)</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(32)</td>
<td>(20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(35)</td>
<td>(23)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(30)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(36)</td>
<td>(37)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(38)</td>
<td>(33)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(34)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

aThe correlation is based on the ranks of the two-digit industrial sectors. See Tables 14 and 22 for description of indexes for capital intensity and skill intensity.
APPENDIX H

REGRESSION COEFFICIENTS AND RELATED STATISTICS
FOR ALL TWO-DIGIT VENEZUELAN MANUFACTURING
INDUSTRIES (1970): MODELS I AND II

The results of fitting Models I and II to data for all two-digit
Venezuelan manufacturing industries are given in this appendix. A
description of Models I and II is given in Chapter V. These results
have been included to provide a frame of reference for the detailed
analysis presented in this study for the food processing and fabricated
metals industries.

The F statistics all confirm "goodness of fit" at a 99 percent
level of confidence. The insignificance of large numbers of inputs in
some of the industries is attributable to the small number of sample
firms.
### TABLE 24
REGRESSION COEFFICIENTS AND RELATED STATISTICS FOR ALL TWO-DIGIT VENEZUELAN MANUFACTURING INDUSTRIES (1970): MODEL 1

\[
Y = \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + b_1 + b_2 + b_3 + c
\]

<table>
<thead>
<tr>
<th>Sector (^a)</th>
<th>(a_1)</th>
<th>(a_2)</th>
<th>(a_3)</th>
<th>(a_4)</th>
<th>(b_1)</th>
<th>(b_2)</th>
<th>(b_3)</th>
<th>(c)</th>
<th>Constant</th>
<th># of Observ.</th>
<th>(F)</th>
<th>(R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food (20)</td>
<td>-.004</td>
<td>.022*</td>
<td>.027*</td>
<td>.144*</td>
<td>.165*</td>
<td>.048*</td>
<td>-.000</td>
<td>.590*</td>
<td>3.481</td>
<td>.992</td>
<td>272</td>
<td>719.943</td>
</tr>
<tr>
<td>Beverages (21)</td>
<td>.023</td>
<td>.052**</td>
<td>-.017</td>
<td>.063</td>
<td>.129**</td>
<td>.079*</td>
<td>.099*</td>
<td>.467*</td>
<td>4.870</td>
<td>.920</td>
<td>78</td>
<td>57.582</td>
</tr>
<tr>
<td>Tobacco (22)</td>
<td>.052</td>
<td>.025</td>
<td>.101</td>
<td>.001</td>
<td>.196</td>
<td>.025</td>
<td>-.055</td>
<td>.667*</td>
<td>3.887</td>
<td>1.021</td>
<td>14</td>
<td>96.231</td>
</tr>
<tr>
<td>Textile (23)</td>
<td>.001</td>
<td>.038*</td>
<td>.033**</td>
<td>.166*</td>
<td>.092***</td>
<td>.086**</td>
<td>-.027</td>
<td>.607*</td>
<td>3.782</td>
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^aPetroleum (32) was omitted due to insufficient firms in the sample.

Note: The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (***) at the 10 percent level.
**Table 24**

REGRESSION COEFFICIENTS AND RELATED STATISTICS FOR ALL TWO-DIGIT VENEZUELAN MANUFACTURING INDUSTRIES (1970): MODEL II

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<td>.932</td>
<td>29</td>
<td>14.544</td>
<td>.936</td>
</tr>
<tr>
<td>Transport (38)</td>
<td>.007</td>
<td>.018</td>
<td>.061*</td>
<td>.119***</td>
<td>-.197*</td>
<td>.182*</td>
<td>.071*</td>
<td>.633*</td>
<td>-.019</td>
<td>-.311***</td>
<td>-.217***</td>
<td>--</td>
<td>-.157</td>
<td>.120</td>
<td>5.339</td>
<td>.894</td>
<td>44</td>
<td>79.848</td>
<td>.975</td>
</tr>
<tr>
<td>Other (39)</td>
<td>.046*</td>
<td>.034**</td>
<td>.009</td>
<td>.037***</td>
<td>.114**</td>
<td>.083*</td>
<td>-.011</td>
<td>.601*</td>
<td>.087</td>
<td>-.036</td>
<td>.087</td>
<td>--</td>
<td>.063</td>
<td>.109</td>
<td>3.880</td>
<td>.913</td>
<td>73</td>
<td>49.124</td>
<td>.922</td>
</tr>
</tbody>
</table>

*aTobacco (22), Furniture (26), Printing (28), Rubber (30), and Petroleum (32) were omitted due to insufficient firms in the sample.

Note: The standard errors are given in parentheses below each coefficient; those marked with one asterisk (*) are significant at the 1 percent level, those marked with two asterisks (**) at the 5 percent level, and those marked with three asterisks (****) at the 10 percent level.
APPENDIX I

BIBLIOGRAPHY


Kelley, S. et al., Human Resources in Ecuador, Columbus, Ohio: Center for Human Resource Research: The Ohio State University.


