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PRODUCTION FUNCTIONS FOR INDUSTRIAL ESTABLISHMENTS OF DIFFERENT SIZES: THE CHILEAN CASE*

BY PATRICIO MELLER

Using single equation models (CES and Cobb–Douglas), production functions were estimated for Chilean industrial establishments; these establishments were classified according to their sizes. The purpose of the paper is to examine if all establishments of the same industry have the same or different production functions; Chow tests and the translog production function were used to test this hypothesis. Moreover, the trend with establishment size of the technological parameters is examined.

1. INTRODUCTION

The main purpose of this paper is to study the technological characteristics of industrial establishments of different sizes. For each one of 21 Chilean industries the study analyzes the relationship between the size of establishments and the technology they utilize.

The main result can be summarized as follows: the empirical evidence obtained supports the assumption of the existence of structural heterogeneity within the industrial sector—i.e., technology varies at the industry level as the size of establishment increases. In other words, the industry is not a collection of "representative firms," and the size of establishment seems to be an important element in determining the technological characteristics of an industrial establishment.

The relation between establishment size and type of technology is examined through the econometric estimation of production functions. The establishments within each industry are first classified by size, and then production functions are estimated for each size grouping of establishment. The breakdown of establishments by size groupings permits an examination of variations in technological parameters (product-productive factor elasticities, scale economies, elasticity of substitution between factors) as establishment size varies. Such an examination can assist in answering several questions which have important economic policy implications. How does the product-capital elasticity vary as the size of establishment increases? To what extent do economies of scale exist? What happens to the elasticity of substitution between factors as the size of establishment increases (e.g., do isoquants become right angles or straight lines as we move farther away from the origin)?

The validity of the methodology used, i.e., estimating production functions for establishments of different sizes within an industry, is verified by the Chow method and the translogarithmic production function method.

* This paper is a revised version of Chapter III of the author's unpublished Ph.D. Thesis: "Production Functions and Efficiency Frontiers for Industrial Establishments of Different Sizes: The Chilean Case, Year 1967," University of California, Berkeley, Jan. 1975.

The following paragraphs discuss the implicit theoretical framework employed to determine the technological characteristics of different firms within an industry.

Numerous economists have pointed out that a frequent phenomenon in under-developed economies is the prolonged existence in a given economic sector of firms employing substantially diverse production techniques. This phenomenon is commonly called economic dualism.[1] Spaventa and others (see footnote 1) have explained dualism in the following way. Some economies have had a non-homogeneous growth process in which an important segment of the system has stagnated while the remainder has undergone sustained development. The consequence is the coexistence of two groups of firms with sharply different dynamic characteristics which, in turn, have important implications for income distribution and labor absorption.[2] The existence of different growth rates for different segments of an economy is, in itself, not a particularly striking fact. What is striking is the prolonged existence of dualism in underdeveloped countries.[3] A wide range of hypotheses have been formulated to explain the causes, consequences, and prolonged survival of dualism.[4] This study examines in some detail the phenomenon called intra-dualism, i.e., dualism within a given industrial sector as opposed to dualism among different branches of industry or among different economic sectors (e.g., agriculture versus industry).

The literature on economic dualism generally assumes an equivalence among size, modern technology, and efficiency. The prevalent premise is that larger establishments use more modern techniques and are more efficient than smaller firms, but the equivalence among those three concepts is still an empirically open question.

A. Pinto has generalized dualism by examining the feasibility and the consequences of more than two types of firms existing within an industry—a situation known as structural heterogeneity. Both Pinto and di Fillipo suggest that the coexistence of different types of firms within a given industry results from the utilization of different technologies (where 18th and 19th century technologies coexist with those of the 20th century). The technological differences among firms becomes a fundamental factor in explaining the labor productivity differentials among industrial establishments and the low rate of labor absorption by

[1] V. C. Lutz, "The Growth Process in a Dual Economic System" (*Quarterly Review*, Sept. 1958); L. Spaventa, "Dualism in Economic Growth" (*Quarterly Review*, Dec. 1959); S. H. Wellisz, "The Coexistence of Large and Small Firms: A Study of the Italian Mechanical Industries" (*Quarterly Journal of Econ.*, Feb. 1957); T. Watanabe, "Economic Aspects of Dualism in the Industrial Development of Japan" (*Econ. Dev. and Cult. Ch.*, April 1965); A. Pinto, "Naturaleza e Implicaciones de la 'heterogeneidad estructural' de la America Latina" (*Trimestre Econ.*, No. 145, Enero 1970); R. R. Nelson, T. P. Schultz, and R. L. Slighton, *Structural Change in a Developing Economy* (Princeton Univ. Press, 1971).

[2] D. Turnham and I. Jaeger, *The Employment Problem in Less Developed Countries* (OECD, Paris 1971); C.I.E.S., "El Empleo y el Crecimiento en la Estrategia del Desarrollo de America Latina: Implicaciones para la Decada de los Setenta" (VII Reunion Anual del C.I.E.S., Sept. 1971).

[3] W. Leibenstein, "Technical Progress, the Production Function and Dualism" (*Quarterly Review*, Dec. 1960); T. Watanabe, *op. cit.*

[4] In addition to the bibliography of footnote 1, additional bibliography with a survey on the subject is found in H. Ellis, "Las Economias Duales y el Progreso" (*Revista de Economia Latinoamericana No. 3*, 1961).

the industrial sector.[5] Structural heterogeneity as described by A. Pinto corresponds to R. Nelson's arguments that the use of a single production function to characterizerize an entire industry in an underdeveloped country conceals more than it reveals, and that labor productivity differentials among industrial establishments cannot be simply explained by varying capital-labor ratios.[6]

In operationalizing the structural heterogeneity hypothesis, the size of establishment has been used as the fundamental variable in determining the type of technology used by a firm. Furthermore, as previously mentioned, establishments of each industry are classified by size variable, and production functions are estimated separately for each size grouping of establishment.

The study, finally, calls into question the utility of production functions as a microeconomic tool. The economic literature contains many articles concerning the variety of results obtained from econometric estimations of production functions. The sizable variations obtained in the values of the different technological elasticities (product-productive factors, economies of scale, factor substitution), should lead one to question their economic meaning. Why do the estimated parameters have such great instability? Are there any economic hypotheses which are not fulfilled? If so, which are they?

The econometric estimation of production functions in this study permits closer examination of the validity of economic policies based on the results of production function analyses, particularly results concerning economies of scale and elasticity of substitution.

Given the data available (i.e., cross-section series), only a static analysis is possible. Then when variations of different technological and economic variables in the size groupings of establishment are examined, the consequences of the dualistic phenomenon at a given moment of time will be determined.

The data used in this study come from the Chilean Industrial Manufacturing Census of 1967 disaggregated at the establishment level (11,468 establishments employing 5 or more persons). For the purposes of this study, 21 industries will be selected at ISIC (International Standard Industrial Classification), four digit classification level, and a separate analysis will be made for each of the 21 industries.

2. Methodology

Different productive techniques are used by a set of firms of the same industry at a given point in time. The implicit assumption that firms in the same industry use the same production function does not help to explain what happens in reality; on the contrary, it probably obscures a lot. Once the assumption is made that all firms in the same industry use the same production function, the productive techniques selected are a function of relative prices of the productive

[5] A. Pinto y A. di Fillipo, "Notas sobre la Estrategia de la Distribucion y la Redistribucion del Ingreso en America Latina" (Semin. Internac. de Distr. del Ingreso, Ceplan, mimeo, Chile, Marzo 1973).

[6] R. R. Nelson *et al., op. cit.*

factors, and the combination of these productive factors explains the differences in the productivity of labor.[7]

The working hypothesis utilized here is that the production function varies for establishments of different size.

The existence of different production functions within the same industry will allow us to examine more closely some of the so-called "dual" characteristics observed in the industrial sector of an underdeveloped country. The term dualism is used here in the sense of intra-industrial, that is, to refer to the coexistence of firms using modern and old techniques in the same industry. The usual assumption is that the largest firms are the most modern while the smallest are the most backward.[8] With the existence of different production functions it is possible to examine the empirical validity of the dualistic concept.

The production function will be used as a tool to permit us to present in a compact form the most important technological characteristics of an industry. We will also try to identify the degree and types of variations of those technological characteristics for different size establishments within the same industry.

The method of estimating production functions used will be similar to that used by Griliches and Ringstad,[9] with some small variations. Each of the 21 industries will be divided into 5 categories of different size-establishments: 5 to 9 persons employed, 10 to 19, 20 to 49, 50 to 99, and 100 or more people employed.[10] Then we will proceed to estimate production functions (Cobb–Douglas and CES) in each four-digit industry for each individual establishment grouping and for the industry as a whole.

The criterion followed to estimate the different production function elasticities has been to employ a model which allows estimating each elasticity as a first order parameter. Even though every estimation model is different, all models used are very similar and it is assumed they are close approximations of the true model. Using that functional form which has a comparative advantage in the estimation of each elasticity is, in our judgment, the approach that will minimize the unstable fluctuations of the estimators.

The Cobb–Douglas function was used to obtain estimates of the product-capital and product-labor elasticities. Kmenta's linearization of the CES was

[7] R. R. Nelson *et al.*, *op. cit.*, pp. 91–92; B. S. Minhas, *An International Comparison of Factor Costs and Factor Use* (North-Holland, 1963), pp. 30–31.

[8] Traditionally, the relationship between modern firm and large size and backward firm and small size is based on the following. New production techniques require a large volume of production in order to take advantage of economies of scale; they are very capital-intensive, which means a large investment, and are developed in the more industrialized countries in order to operate in larger markets, etc. Small firms use production techniques that are more labor-intensive, which is the factor modern technology tries to save, given the factor endowment prevalent in industrialized countries which are the ones in the vanguard of technological progress. J. Governeur, *Productivity and Factor Proportions in Less Developed Countries* (Clarendon Press, 1971); B. Singh, *The Economies of Small-Scale Industries* (Asia Publishing House, 1961); M. C. Shetty, *Small-Scale and Household Industries in a Developing Economy* (Asia Publishing House, 1963).

[9] Z. Griliches and V. Ringstad, *Economics of Scale and the Form of the Production Function* (North-Holland, 1971).

[10] See P. Meller, Ph.D. Thesis, *op. cit.*, a discussion of different variables that could be used for classificatory establishment size purposes. The main empirical conclusion is that "when an establishment is large, it is generally large in all its dimensions"—i.e., size groupings will not change very much by the use of different size variables.

used for the economies of scale estimator. The traditional CES of Arrow *et al.*,[11] was used to obtain an estimator of the elasticity of substitution.[12]

It is interesting to note that if either of the two traditional production functions is used, i.e., CES and/or Cobb–Douglas, the hypothesis that different-size firms possess different production functions is compatible with the usual assumption in economic theory of the existence of a U-shaped average cost curve. The returns to scale revealed by production functions of different-size establishment will be a test of the validity of the existence of a U-shaped average cost curve for an industry.[13]

The ordinary least-squares single-equation method is used to estimate the parameters of the production function.[14,15]

The industrial establishments have been subjected to a rigorous selection process. (See Appendix.) The criterion of selection has been the quality rather than the quantity of observations. The use of this criterion results in the exclusion of establishments in which some of the variables that are used in the econometric estimates are doubtful or whose data should be omitted.

In relation to the problem of measurement of variables after a series of experiments with alternative measurements, we have adopted a procedure similar to the one used by Griliches and Ringstad.[16] Labor requirements were measured by the number of "equivalent" man-days employed by the establishment, and capital requirements were measured by a flow of capital services obtained by using book values (see footnote 16).

[11] K. J. Arrow *et al.*, "Capital–Labor Substitution and Economic Efficiency" (*Rev. of Econ. and Stat.*, August 1961).

[12] Several other functional forms were estimated: Generalized CES form (J. Katz, *Production Functions, Foreign Investment and Growth*, North-Holland, 1969); Hildebrand-Liu and Nerlove (M. Nerlove, "Recent Empirical Studies of the CES and Related Production Functions," ed. M. Brown, *The Theory and Empir. Anal. of Prod.*, N.B.E.R., 1967); V. Mukerji ("A Generalized SMAC Function with Constant Ratios of Elasticities of Substitution," *Rev. of Ec. Stud.*, 1963).

[13] A. Walters, *An Introduction to Econometrics* (Macmillan, 1968), p. 290.

[14] The estimators obtained by least-squares single-equation have many advantages: simplicity of computation, small standard errors of the coefficients, and a high level of efficiency for prediction. But they also have many disadvantages, and the main one is that if the true model corresponds to a simultaneous equation model, then the least-squares single-equation estimators will be both biased and not consistent. See A. A. Walters, "Production and Cost Functions: An Econometric Survey" (*Econometrica*, Jan. 1963), pp. 18–22.

[15] See P. Meller, "Efficiency Frontiers for Industrial Establishments of Different Sizes" (*Explorations in Economic Research*, forthcoming), for an extensive discussion of the possibility of estimating production functions from cross-section data; i.e., the factors explaining the existence of different productive techniques in a particular industry are discussed.

[16] Z. Griliches and V. Ringstad, *op. cit.*, pp. 22–29. The variables are measured in the following way:

Y: value added measured in E°–1967 (escudos of year 1967).

L: labor factor measured in number of equivalent man-days, where the number of equivalent workers is: $L_1 = m_1 + (w_2/w_1)m_2 + (2w_2/w_1)m_3$; m_1, m_2 and m_3 are the number of blue collar, white collar workers, and entrepreneurs, and w_1 and w_2 are the average wages received by blue and white collar workers.

K: capital factor measured in E°–1967, computed as a flow according to the following expression: $K = 0.10K_M + 0.03K_B + 0.20K_V + 0.10(K_M + K_B + K_V + K_I)$, where K_M, K_B, K_V and K_I are the book values of machinery, buildings, vehicles and inventory goods. Linear depreciation rates of 0.10, 0.03 and 0.20 have been used for machinery, buildings and vehicles, and a 10 percent real interest rate is used as an alternative cost for immobilized capital.

The labor factor could have been measured through the number of man-days (designated by N_1) without using that transformation to equivalent worker which would consider the factor of differences in quality of labor. The simple correlation coefficients between L and N_1 for the establishments within the 21 industries have values close to 1.0 (see Table 1). This indicates it does not make any difference whether the labor variable is measured by the number of man-days or by the number of equivalent worker-days.

TABLE 1

SIMPLE CORRELATION COEFFICIENTS BETWEEN THE CHOSEN MEASUREMENTS AND ALTERNATIVE MEASUREMENTS OF THE LABOR AND CAPITAL FACTORS SEPARATED BY INDUSTRY

Type of Industry ISIC Code	$L; N_1$	$K; K_M$	$K; K_{KW}$	$K; K_{HP}$	$K; K_S$
3111	0.969	0.959	0.806	0.597	0.996
3112	0.992	0.983	0.892	0.874	0.999
3116	0.981	0.972	0.622	0.680	0.997
3117	0.984	0.970	0.866	0.837	0.996
3121	0.982	0.949	0.560	0.806	0.997
3131	0.960	0.824	0.152	0.488	0.999
3211	0.996	0.996	0.925	0.865	0.998
3213	0.992	0.994	0.839	0.888	0.995
3220	0.984	0.971	0.864	0.326	0.997
3231	0.981	0.961	0.904	0.887	0.997
3240	0.989	0.985	0.575	0.641	0.992
3311	0.988	0.913	0.675	0.707	0.995
3320	0.985	0.942	0.875	0.875	0.999
3420	0.884	0.992	0.949	0.672	0.999
3560	0.990	0.994	0.927	0.880	0.994
3693	0.984	0.936	0.558	0.926	0.994
3710	0.989	0.989	0.697	0.840	0.998
3813	0.989	0.986	0.887	0.536	0.998
3819	0.983	0.989	0.810	0.867	0.999
3829	0.976	0.992	0.728	0.790	0.999
3843	0.973	0.832	0.864	0.389	0.995

Note: L: number of equivalent man-days; N_1: number of man-days; K: flow of capital services (see footnote 16); K_M: book value of machinery; K_{KW}: number of KWh; K_{HP}: number of installed HP; K_S: sum of the book values of machinery, buildings, vehicles and inventory goods.

Different alternative measurements (proxy variables) could be used for the capital variable. Among these are two flow variables: the previously defined capital services, called K, and the number of KWh of consumed electricity, K_{KW}; also, the following stock variables could be used: the number of HP installed corresponding to the machinery related to the production process, K_{HP}, the total book value of the fixed assets plus the stocks of goods and inputs, measured in E° 1967, K_S, and lastly, K_M, the book value of the machinery, measured in E° estimated to be the most reliable book value provided by the establishments. Above we present a table of simple correlation coefficients between K and the different measurements of the capital factor for each one of the 21 industries

(Table 1). Most of the correlation coefficients are significant at the 1 percent level (see appendix for number of observations per industry).

Another variable needed for econometric estimation is w, average wages. In this case, w includes average wages received by blue and white collar workers working in a given establishment, plus social legislation payments (employer's contributions, bonuses, and child allowances); i.e., w represents the establishment's cost of labor.

3. Estimation of the Value Added-Productive Factors Elasticities

To obtain estimators of elasticities of value added-productive factors only the Cobb–Douglas function was used because certain of its properties seem more suitable in this case. Specifically, this means: i. Product-productive factor elasticities can be obtained directly as parameters of the first order; ii. Those elasticities are constant for any production level (not the case for the CES) and iii. It is not necessary to make assumptions regarding the type of market structure nor about the firms decision-making policy.

We use the following notation for the Cobb–Douglas function:

$$Y = AL^{\alpha}K^{\beta} \tag{1}$$

where A, α, and β are parameters of the functions and Y, L, and K correspond to aggregate value, labor, and capital respectively. Dividing this expression by L and denoting the parameter of economies of scale $h = \alpha + \beta - 1$, we arrive at the form traditionally used by Griliches:[17]

$$\log \frac{Y}{L} = \log A + b \log \frac{K}{L} + h \log L. \tag{2}$$

The advantage of this form is that, in addition to obtaining the product-capital elasticity[18] directly, we also obtain directly the parameter h, i.e., the economies of scale. It is possible to verify directly whether the function has or does not have constant returns by testing the null hypothesis: $H_0: h = 0$.

The labor-capital elasticity, α, is found using the estimators of β and h, and the equation of definition, $h = \alpha + \beta - 1$. The estimator α found by this indirect method is not biased if $\hat{h}$ and $\hat{\beta}$ are unbiased estimators.[19]

The division of establishments into different size groupings was done to determine whether variations occurred in different parameters of the production function across different-size establishments. Let us see how $\hat{\beta}$ varies as the size of the establishment is increased.

[17] Z. Griliches, "Production Functions in Manufacturing: Some Preliminary Results," *The Theory and Empirical Analysis of Production, op. cit.*, pp. 275–340; Griliches and Ringstad, *op. cit.*, p. 63.

[18] If $Y = AL^{\alpha}K^{\beta}$, $\partial Y/\partial K = A\beta L^{\alpha}K^{\beta-1}$

$$\xi_{YK} = (K/Y)(\partial Y/\partial K) = A\beta L^{\alpha}K^{\beta}/Y = \beta$$

[19] Let $\hat{\beta}$ and $\hat{h}$ be the estimators for β and h, which are found by using the method of least squares. Then, if $\hat{\alpha} = 1 + \hat{h} - \hat{\beta}$

$$E\hat{\alpha} = E(1 + \hat{h} - \hat{\beta}) = 1 + E\hat{h} - E\hat{\beta}$$

$$E\hat{\alpha} = 1 + h - \beta = \alpha$$

The following table contains estimators for $\hat{\beta}$ calculated as a simple arithmetic average[20] of the individual values of each of the 21 industries, for each size group of establishments.

TABLE 2

AVERAGE VALUES FOR THE AGGREGATE VALUE-CAPITAL ELASTICITY BY SIZE OF ESTABLISHMENT

	5 to 9 people	10 to 19 people	20 to 49 people	50 to 99 people	100 or more people
Average values of $\hat{\beta}$	0.401	0.341	0.408	0.515	0.571

As can be seen, the two largest size groupings of establishments have average values far greater than the smaller groups. This suggests that if the marginal productivity of capital were the same across firms, the smaller establishments possess a larger average Y/K (value added per unit of capital) than would the larger establishments.[21]

It is difficult to find a definite trend of stable behavior for the large majority of industries. However, in 16 of the 21 industries, the largest values for $\hat{\beta}$ lie in the two classes containing the largest establishments, while in 15 of the 21 industries, the lowest values for $\hat{\beta}$ lie in the two classes with the smallest establishments. In the majority of the industries the largest establishments have larger value added-capital elasticity than the smallest establishments; however, there are cases where the situation is reversed. Even within the same industry the coefficient varies considerably (see Table A-4); this behavior seems to suggest that the use of the same Cobb–Douglas function for a set of establishments within the same industry is not valid.

Frequently, relative participation of the productive factors in the aggregate value, S_K and S_L are employed as estimators of the respective elasticities of output with respect to factor inputs, i.e. ξ_{YK} and ξ_{YL}. This procedure is theoretically justified assuming a firm has a Cobb–Douglas production function, enjoys constant returns, faces competitive markets in goods as well as factors, and uses the criterion of profit maximization. In this case:

$$\xi_{YK} = S_K = \beta \quad \text{and} \quad \xi_{YL} = S_L = \alpha.$$

I will try different types of tests to check the hypothesis that the $\hat{\beta}$ estimator is equal to the share of capital S_K. Even though the different tests give contradictory results, my own conclusion is that there is no relationship between $\hat{\beta}$ and S_K.

[20] I have calculated the elasticities for each size grouping of establishments by using a simple arithmetic average of the values obtained separately for each size group in each industry. Alternate methods for obtaining this value would be (1) to find an estimator by using a regression for the set of establishments of a determined size group; (2) to calculate a weighted average of the values obtained for each industry separately. Either of these two alternative methods implies a different weight given to different industries. In this study I try to examine the characteristics of establishments of different sizes in general and wish to avoid the influence of what might happen in one particular industry on the general conclusions. Thus, I gave the same weight to each industry, no matter what size it has.

Negative values of $\hat{\beta}$ were excluded, but their inclusion would not have changed the ranking of $\hat{\beta}$.

[21] This would imply that if capital is the only scarce resource, small firms should be preferred because they maximize the output by unit of capital.

Table A-4 of the Appendix denotes values furnished by S_K and $\hat{\beta}$. A second table where α is obtained indirectly was omitted because its values were very unstable, even occasionally negative, while other values were much greater than 1.0. Both of these situations are difficult to accept from an economic point of view.[22]

In Table A-4 the values for S_K and $\hat{\beta}$ are separated by industry for each one of the five establishment size groupings and for the whole industry. It is difficult to determine any stable relation between values S_K and $\hat{\beta}$. In the following two Tables, 3 and 4, we calculated the coefficients of correlation between S_K and $\hat{\beta}$, separated by industry and by establishment size.

TABLE 3

SIMPLE CORRELATION COEFFICIENTS BETWEEN $\hat{\beta}$ AND S_K SEPARATED BY INDUSTRY

Type of Industry	Correlation Coefficients
3111	0.600*
3112	−0.790
3116	0.328*
3117	0.704*
3121	0.353*
3132	0.351*
3211	0.291*
3213	0.463*
3220	−0.071*
3231	−0.163*
3240	0.184*
3311	0.007*
3320	−0.340*
3420	−0.684*
3560	0.475*
3693	0.041*
3710	0.118*
3813	0.677*
3819	−0.008*
3829	0.091*
3843	0.415*

* Correlation coefficient values not significant at 5 percent.

Finally, the correlation coefficient between $\hat{\beta}$ and S_K taken at the industry level for the set of 21 industries was 0.278.

From Tables 3 and 4 and the previously given correlation coefficient, it is indicated that there is no linear association between $\hat{\beta}$ and S_K. In other words, it appears that $\hat{\beta}$ and S_K measure different things, a result also encountered by Griliches and Ringstad.[23] However, in order to render a conclusive judgment, I would test the null hypothesis: $H_0: \beta = S_K$ for each one of the cases analyzed,

[22] A negative value added-productive factor elasticity would stem from the fact that the marginal productivity of that factor is negative, i.e., a greater use of that factor implies a decrease in the value added and would result in an irrational employment of that factor.

[23] Griliches and Ringstad, *op. cit.*, pp. 73–75. Griliches and Ringstad arrive at this conclusion using rank correlation coefficients between α and S_L.

TABLE 4

SIMPLE CORRELATION COEFFICIENTS BETWEEN β AND S_K SEPARATED BY ESTABLISHMENT SIZE

Size of Establishment	Correlation Coefficients
5 to 9 persons	−0.055*
10 to 19 persons	−0.052*
20 to 49 persons	0.299*
50 to 99 persons	−0.121*
100 or more persons	0.295*

* Correlation coefficient values not significant at 5 percent.

TABLE 5

NUMBER OF TIMES THAT THE NULL HYPOTHESIS H_0: $\beta = S_K$ IS ACCEPTED OR REJECTED AT A LEVEL OF SIGNIFICANCE OF 5 PERCENT

Size of Establishment	H_0 Rejected	Impossible to Reject H_0
5 to 9	8	13
10 to 19	9	12
20 to 49	6	15
50 to 99	4	14
100 and more	4	14
Whole Industry	13	8
TOTAL	44	76

using the t values given in Table A-4.[24] The results of this test are given in Table 5.

This table suggests that it is not possible to reject the null hypothesis. The relative share of the capital factor, S_K, is a good estimator of capital-aggregate value elasticity, at least for 63.3 percent of the cases. However, this hypothesis was rejected in those industries or size groupings containing the largest number of observations. Therefore, an increase in the number of observations in each case could make possible the rejection of the null hypothesis $H_0: \beta = S_K$ in a great number of cases. From an empirical standpoint, the estimator of product-capital elasticity S_K is inadequate for the industry as a whole, due to the rejection of this hypothesis in 12 of 21 cases examined and at a significance level of 5 percent. S_K is greater than estimator $\hat{\beta}$ in 74 percent of the cases. Then, when S_K is used as an estimator of product-capital elasticity, this elasticity is overestimated in 74 percent of the cases and underestimated in the remaining 26 percent of the cases. The magnitude of overestimation (and/or underestimation) fluctuates considerably and no regular pattern of behavior emerged.

But, even when the hypothesis $H_0: \beta = S_K$ is rejected for a large number of cases, it does not imply the rejection of the basic assumptions, such as perfect competition, constant returns, and profit maximization. S_K is empirically biased

[24] This t test faces a serious objection due to the fact that S_K is also a random variable; therefore, the t values obtained will be over-estimated, making it easier to reject null hypothesis.

upward because profits earned by the industry are included when determining the relative shares of the capital factor in the aggregate value. This is a partial explanation of why S_K is greater than $\hat{\beta}$ in the majority of cases observed. However, imperfections in the commodities and factors market also contribute a priori to make S_K greater than $\hat{\beta}$ (in a short run model).[25]

4. Estimation of the Economies of Scale

The parameter for the economies of scale was estimated using two different methods: the Cobb–Douglas function and the linearization of Kmenta of the generalized CES function.[26]

The notation for the generalized CES function is as follows:

(3) $$Y = \gamma[(1 - \delta)L^{-\rho} + \delta K^{-\rho}]^{(-\mu/\rho)}$$

where $\gamma, \delta, \rho, \mu$ are the CES function traditional parameters.[27]

Using the linearization of Kmenta (expansion of (3) by a Taylor series around the value of $\rho = 0$), the regression equation becomes:

(4) $$\log Y/L = \log \gamma + \mu\delta \log K/L + h \log L + a_0[\log K/L]^2$$

in which $h = \mu - 1$, being the scale elasticity. The expression (4) is equivalent to (2) plus the term $a_0[\log K/L]^2$. Thus by testing the null hypothesis $H_0: a_0 = 0$, we can determine whether the Cobb–Douglas function is or is not acceptable as an estimation model.

The economies of scale parameters estimated by the Cobb–Douglas and Kmenta functions are presented in Table A-5. In most cases the values obtained with the two indicators are highly similar. For this reason I need only examine the type of variation evidenced by only one of them. I chose the Kmenta approximation because according to Monte Carlo's studies, the biases found in the estimator of the parameter for economies of scale are insignificant when this specification is used.[28]

[25] A model with imperfect competition in the market of goods and profit maximization by the firm gives: $\alpha/S_L = \eta/1 = -\eta$ where η is the price elasticity of the products demand. As α and S_L are positive, for η to be negative it is necessary $\alpha > S$. We reach the same condition through a model of imperfect competition in the labor market available to the firm. If we start from the returns to scale h and α and we calculated β (in this study the estimated elasticity), we would obtain $\hat{\beta} < S_K$. This explanation is not at all satisfactory from an empirical point of view, because 45.8 percent of the η elasticities would be "positive." (α has been indirectly obtained in this study.)

[26] The economies of scale parameter is obtained as a first order parameter. This parameter is constant throughout the whole estimation range and it is not necessary to make any type of assumptions about the market structure and/or the firm's behavior.

[27] γ is the efficiency parameter, δ is the distribution parameter, ρ is the substitution parameter, and μ is the economies of scale parameter.

[28] G. S. Maddala and J. B. Kadana, "Estimation of Returns to Scale and the Elasticity of Substitution" (*Econometrica*, July 1967), pp. 421–422.

Excluding those values for economies of scale where $|\hat{h}| > 1.0$, the figures in Table A-5 reveal the following information:

TABLE 6
NUMBER OF ESTIMATORS WHICH INDICATE ECONOMIES OR DISECONOMIES OF SCALE BY SIZE OF ESTABLISHMENT FOR THE SET OF 21 INDUSTRIES

	Size of Establishment					Industry Total
	5–9	10–19	20–49	50–99	100 or more	
Number of estimators which indicate economies of scale	2	3	5	8	9	20
Number of estimators which indicate diseconomies of scale	16	15	15	9	8	1

If we had estimated production functions for the industrial sector as a whole and for each industry separately, the conclusion inferred from the empirical results would be that nearly all Chilean industries are found to have economies of scale. In some cases, these economies of scale reach 80 percent and their average (simple arithmetic mean) is 26.4 percent. These results might suggest that governmental policy should favor the appearance and survival of the largest establishments within the industrial sector in order to take advantage of these economies of scale. However, this type of result is highly questionable, and below we will provide some reasons to support our doubts. If we examine each industry separately, divided into different size groupings, and observe the $\hat{h}$ estimators obtained for each one of those classes, the results are, in general, quite strange:

(i) First, it is surprising to observe that even in the establishments of smallest size, 16 $\hat{h}$ estimators out of a total of 18 indicate the presence of diseconomies of scale. A similar result was obtained in the two next larger classes; as a result, for the three smallest size establishments (5 to 49 persons), a 10 percent increase in the productive factors L and K, increases the aggregate value by less than 10 percent (for 15 of the 21 industries).

(ii) In a large number of industries each one of the size groupings evidences a negative $\hat{h}$ estimator, although positive economies of scale are obtained for the industry as a whole. One possible explanation for this phenomenon could be the one pictured in Figure 1, where we observe increasing average cost curves for each size group of establishments and a decreasing average cost curve (economies of scale) for the whole industry.

(iii) In various industries the $\hat{h}$ estimator increases with the size of establishment, but goes from negative values to positive values. This could be an excellent test for proving that the average cost curve in various industries "takes the form of an *inverted* U."

An easy way out of all these strange results is to verify the null hypothesis: As shown in Table A-5, the null hypothesis $H_0: h = 0$ is accepted in 77.8 percent of the cases considering only $\hat{h}$ estimators obtained by the approximation of

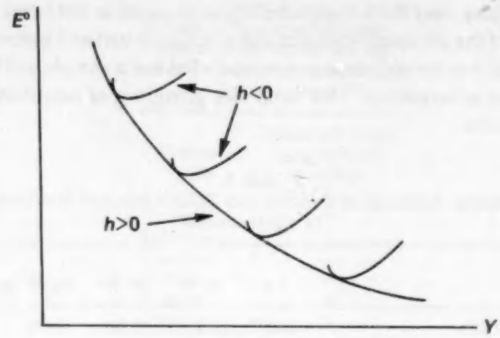

Figure 1

Kmenta for different size groups. This suggests that the hypothesis of constant returns to scale for each size class of establishments is rejected in only 22.2 percent of the cases (with a significance level of 5 percent). Meanwhile, at the level of the whole industry, the hypothesis of constant returns to scale is rejected in 14 of 21 industries, with a significance level at 5 percent. Finally, as can be observed in Table A-5, in each size grouping almost 70 percent of the estimators indicate the presence of diseconomies of scale. Diseconomies of scale prevail in Chilean industry at the level of each size grouping of establishments.

In summary, not much confidence should be given to the results obtained for the economies of scale parameter.

5. Estimation of the Elasticity of Substitution

The traditional Arrow *et al.* method (ACMS)[29] was used to estimate the elasticity of substitution σ.[30]

The estimation model is:

$$\log \frac{Y}{L} = a + \sigma \log w. \tag{5}$$

The implicit economic assumptions in this model are that the establishment operates in a competitive market (goods and factors), maximizes profits, and that there exist constant returns to scale.

Values of σ will be provided at the total industry level and at the establishment-size level. At the end of this section, the trend that σ has across an industry is discussed.

(i) *Values of σ at total industry level.* For 14 of 21 industries values of elasticity of substitution σ fluctuate between 0.8 and 1.2. Except for 2 cases, the total of in-

[29] Arrow *et al.*, *op. cit.*

[30] Two other methods were used to obtain estimators for σ, as pointed out previously: the Katz and Nerlove methods (see footnote 12), but they were rejected because of their theoretical limitations and empirical inconsistencies. See P. Meller's Ph.D. Thesis, *op. cit.*, for a full discussion of these issues.

dustries has σ values over 0.65. Only one negative value is obtained at the industry level and only 2 of the 20 positive values are not significant at 5 percent. (Table A-6.)

(ii) *Values of σ at establishment-size level.* Taking a simple arithmetic average of the elasticity of substitution[31] for each size grouping of establishment, I obtain the following results:

TABLE 7
ARITHMETIC AVERAGES OF SUBSTITUTION ELASTICITIES FOR SIZE GROUPINGS OF ESTABLISHMENT

	5–9	10–19	20–49	50–99	100 and more
Values of σ	0.857	0.839	0.764	0.670	1.266

There is a clearly decreasing tendency in the σ values in establishments of 5 to 99 persons (momentarily excluding the largest ones). Considering these five size groupings, we can think of a U-shape relation between the σ values and the size groupings of establishments. This coincides with the results obtained by Abe in the study of Japanese firms.[32] Establishments of 50 to 99 persons probably have a more inflexible technology, while larger establishments probably use more flexible techniques.

This empirical result also supports Leibenstein's thesis[33] that for any given type of technology, the instrument of relative prices will be more likely to affect the choice of techniques in larger establishments than in smaller ones, because small variations in the relative prices of productive factors will produce a relatively greater impact in those establishments using more elastic techniques from the substitution point of view.

This conclusion requires the following qualification: the first four size groupings of establishments from 5 to 99 persons could be thought of as corresponding to size groupings of establishments approximately comparable to each other in terms of range of technology. Meanwhile, the firms employing 100 or more persons are an open grouping of fairly extensive range, clearly different from the range covered by the other four. Therefore, it was possible to predict a priori high values obtained for this large grouping.

(iii) *Values of σ in each industry.* It is interesting to know the tendency the elasticity of substitution has in each particular industry. Six possible tendencies of σ related to the increase of establishment size groupings were chosen: increasing, decreasing, constant, (all values no different *in more than* 0.2), ∩-form, U-form and indefinite. Those industries with less than 4 values of σ were excluded (they either had negative values or had a small number of observations).

[31] Negative values of σ have been excluded, but if they were considered, the ranking of σ values would not change.

[32] M. A. Abe, "The Growth Path of Firms and the Development Process of the Economy: The Case of Japan" (*The Developing Economies*, June 1972), p. 201.

[33] H. Leibenstein, "Technical Progress, the Production Function and Dualism" (*Banca Nazionale del Lavoro Quarterly Review*, March 1960), pp. 348–351.

TABLE 8
NUMBER OF INDUSTRIES HAVING A DETERMINED TENDENCY BETWEEN σ AND SIZE GROUPINGS OF ESTABLISHMENT.

Tendencies of σ	Excluding large establishment groupings
Increasing	—
Decreasing	1
Constant	—
∩-form	3
U-form	4
Indefinite	6

There is no definite tendency for σ to vary uniformly across the different size groupings. Furthermore, the elasticity of substitution does not remain constant as the size of establishment varies, suggesting that the isoquant map is not homothetic.

Considering the magnitudes taken by the elasticity of substitution, Table 9 provides the number of σ values obtained by size groupings and range of values.

TABLE 9
NUMBER OF ELASTICITY OF SUBSTITUTION VALUES BY SIZE GROUPINGS OF ESTABLISHMENTS AND RANGE OF VALUES

Size groupings	Range of Values			
	0.00–0.50	0.51–0.80	0.81–1.20	1.21 and more
5–9	3	5	8	3
10–13	2	8	5	3
20–49	6	7	4	·3
50–99	8	2	5	1
100 and more	1	1	6	6

The values in this table agree with the condensed and analyzed data of Table 7.

(iv) *Tests of σ for values* 0 *and* 1. The traditional tests made with the elasticity of substitution correspond to the hypothesis $\sigma = 0$ (fixed proportions function) and $\sigma = 1$ (Cobb–Douglas function). In the case $H_0 : \sigma = 0$, Table A-6 shows that this hypothesis is rejected in 83 of 120 cases (69.2 percent) at a significance level of 5 percent. These results indicate that Chilean industry, at a level of different establishment size, does not present a rigid technological structure of fixed proportions. I could also calculate the value of the statistics t in Table A-6 for the null hypothesis $H_0 : \sigma = 1$. However, taking advantage of the Kmenta approximation, it is simpler to use a direct test where the quadratic term parameter permits immediate verification of the null hypothesis by showing whether or not the production function is Cobb–Douglas. This test for the different size groupings of establishments shows that the null hypothesis (the production function is not Cobb–Douglas) is rejected in 7 out of 120 cases (5·8) percent) at a significance level of 5 percent. As a result, I do not have to discard the conclusions and magnitudes previously obtained for the product-capital elasticity and the economies of scale, which critically depend on the condition that the Cobb–Douglas function be consistent with the data.

6. Homotheticity Tests of the Production Function

The central point to be examined in this section will be to find out whether there is a structural change in the technological parameters of the production function when I go from one size grouping of establishments to the next.

In the previous sections, where I examined the estimated values for the product-capital, economies of scale, and substitution elasticities, I affirmed these parameters were subject to change for different size groupings. This already suggests that a production function with constant elasticity is not an adequate tool for synthesizing the technological characteristics of the establishments of differing sizes in the same industry.

The traditional econometric procedure for examining the hypothesis of structural change in the parameters is the Chow test. An alternative way to examine the null hypothesis as to whether the production function is homothetic is using a heterothetic function, the trans-logarithm production function.[34] In this study I will use these two procedures to verify the homothetiticity of the production function.

(a) *Chow Test*

To examine the hypothesis of a structural change in the parameters, a general Chow Test will be used. This test attempts to verify whether the breakdown of the establishments into 5 size groupings is significant or not—i.e., the null hypothesis showing no difference between the five size groupings. If I assume that vector β_i represents the vector of technological characteristics of size grouping i, the H_0 could be written: $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$.

The alternative hypothesis is that the five size groupings are different from each other. This implies that for each size grouping of establishments there prevails a different production function, or that the production function for the industry does not possess constant elasticities (product-inputs, economies of scale, and substitution).

Let K be the number of explanatory variables for the regression and N the number of observations. Q_i will be the sum of the squared residuals of the regression for size grouping i, and Q_T the sum of the squared residuals for the whole industry (the five size groupings simultaneously).

The Chow Test for testing the hypothesis H_0 takes the following expression for the case of five subsamples:[35]

$$F_G = \frac{Q_T - \sum_{i=1}^{5} Q_i}{\sum_{i=1}^{5} Q_i} \cdot \frac{N - 5(K+1)}{4(K+1)} \tag{6}$$

[34] L. R. Christensen, D. W. Jorgenson, and L. J. Liu, "Transcendental Logarithmic Production Functions" (*Rev. of Econ. and Stat.*, Feb. 1973).

[35] D. S. Huang, *Regression and Econometric Methods* (Wiley and Sons, 1970).

where F_G has a distribution F with $4(K + 1)$ and $N - 5(K + 1)$ degrees of freedom. Table 10 provides the F_G values for the three different functional forms used in this study.

TABLE 10

F STATISTICS OF CHOW TEST FOR EACH INDUSTRY AND FOR THREE DIFFERENT FUNCTIONAL FORMS

Type of Industry	ACMS Function	Cobb–Douglas Function	Kmenta's Linearization
3111	1.668*	5.403	3.982
3112	0.795*	3.743	2.754
3116	3.158	2.032	1.907*
3117	7.775	10.100	14.570
3121	3.612	2.890*	3.782
3132	14.375	13.240	10.363
3211	1.527*	4.057	3.582
3213	4.467	2.833	2.150
3220	5.657	2.519	2.609
3231	0.484*	1.952*	1.441*
3240	2.522	5.469	4.085
3311	6.164	3.747	3.502
3320	1.833*	1.167*	0.820*
3420	2.981	2.232	1.676*
3560	1.118*	2.837	2.201
3693	4.870	3.243	2.458
3710	1.958*	1.995*	1.771*
3813	4.559	1.175*	1.396*
3819	3.769	1.985	1.476*
3829	3.818	1.830*	1.572*
3843	1.236*	1.987	1.723

* Values of F not significant at 5 percent.

Table 10 indicates that the null hypothesis according to which no differences exist between technological parameters of establishments of different sizes is rejected in over 60 percent of the industries considered.

(b) *The Trans-logarithmic Production Function*

The trans-logarithmic production function is obtained by expanding the quadratic term of the linear approximation of Kmenta:

$$\log\frac{Y}{L} = a_0 + a_i \log\frac{K}{K} + a_2 \log L + a_3(\log K - \log L)^2$$

$$\log\frac{Y}{L} = a_0 + a_1 \log\frac{K}{L} + a_2 \log L + a_{31}(\log K)^2 + a_{32}(\log L)^2$$

$$-2a_{33}(\log K)(\log L) \tag{7}$$

The trans-logarithmic function is heterothetic, while the Kmenta approximation is homothetic. To verify the homothetic hypothesis for the production function, Griliches and Ringstad suggested three alternative forms,[36] one of

[36] Griliches and Ringstad, *op. cit.*, pp. 10 and 88.

which, the simpler one, will be used here. This method used the Kmenta function as the null hypothesis and the trans-logarithmic function as the alternative hypothesis. We have:

H_0: Kmenta function is the adequate model

H_1: Trans-logarithmic function is the adequate model

Let Q_K be the sum of the squared residuals of the regression for the Kmenta function, Q_j the sum of the squared residuals for the regression in the trans-logarithmic function. The statistics for examining the null hypothesis is:

$$F = \frac{(Q_K - Q_j)/2}{Q_j/[N - (K + 1)]} \tag{8}$$

which has an F distribution with 2 and $N - (K + 1)$ degrees of freedom. The degrees of freedom in the numerator correspond to the difference in the number of independent variables found between the Kmenta function and the trans-logarithmic function. The degrees of freedom in the denominator correspond to the trans-logarithmic function.

An increase in the statistic F in expression (8) indicates a considerable increase in the sum of the squared residuals when the heterothetic function becomes the homothetic function. In other words, there is a resulting unexplained increase in the variation of the observations when the homothetic function is used. When the statistic F in expression (8) has a significantly small value, it indicates that there is no visible change in the explanation given for the behavior of establishments in one industry when a heterothetic function replaces a homothetic function. The statistic F in expression (8) has been calculated for each industry; the values appear in Table 11. Negative F values were obtained for five industries; this indicates the homothetic function produces better fits than those of the heterothetic function, once the respective coefficients R^2 have been adjusted by the corresponding degrees of freedom. I believe the basic reason for the number of industries rejecting the homothetic function not being larger is that the trans-logarithmic function does not have a good fit for the majority of the industries, as can be seen in Table 11.

Table 11 shows the homothetic test at the industry level rejected for half of the industries with a significant level at 5 percent.[37]

The above results (Chow test and trans-logarithmic production function test) suggest that for a majority of Chilean industries, there is no one single production function with constant elasticities which reflects the technological characteristics of the firms in that industry. In other words, to determine the magnitudes of the technological elasticities in industrial establishments, each size grouping must be studied separately (or, a production function with variable elasticities should be used).

7. Some Reflections on the Methodology of Production Functions Econometric Estimation

This research was started in the belief that the available disaggregated data on industrial establishments would permit the estimation of production functions

[37] It is important to denote that in Griliches' and Ringstad's study there is only one industry for which the homothetic hypothesis is rejected. In this paper, the number of industries for which the alternative hypothesis is accepted is considerable.

TABLE 11
HOMOTHETIC TEST FOR THE PRODUCTION FUNCTION USING THE TRANS-LOGARITHMIC FUNCTION

Type of Industry	Values for F (see expression 8)	Degrees of Freedom for F	R^2 (Trans-logarithmic function)
3111	7.495	2–169	0.397
3112	6.492	2– 39	0.681
3116	3.693	2–125	0.352
3117	12.770	2–623	0.197
3121	2.333*	2– 41	0.411
3132	15.846	2–548	0.199
3211	−0.789[a]	2–220	0.320
3213	7.810	2–138	0.488
3220	−3.346[a]	2–187	0.172
3231	1.046*	2– 55	0.359
3240	1.641*	2–136	0.493
3311	−13.358[a]	2–414	0.158
3320	−12.352[a]	2–174	0.194
3420	7.914	2–144	0.585
3560	3.424	2– 45	0.402
3693	−0.315[a]	2– 58	0.188
3710	0.050*	2– 42	0.574
3813	12.857	2– 80	0.564
3819	−1.446[a]	2–115	0.433
3829	0.528*	2– 91	0.471
3843	3.877	2– 76	0.548

* Values of F not significant at 5 percent.

[a] Negative values for F which imply that the Kmenta function has a better fit than the trans-logarithmic function.

and give "excellent" results. By "excellent" results it was understood that the estimators of different elasticities would have the signs suggested by economic theory and magnitudes corresponding to those obtained in other empirical studies; that the values of the estimators would be quite stable for the different functions that were to be estimated; that the statistics t and F would be high enough to reject any null hypothesis which might contradict economic theory; and that the values obtained for R^2 would be close to 1.0.

The first econometric estimations contradicted these expectations. When I examined the literature on the econometric estimations of production functions, the results obtained generally agreed with the ideal conditions described above and drew my attention to the excellent fits shown by the R^2 coefficients (better than 0.90, generally). The findings of Griliches and Ringstad are one of the few exceptions to that rule. This study, just like that of Griliches and Ringstad, uses primary data, i.e., at the establishment level. Why is it then that studies using an ideal source of information (from the production function point of view) furnish results worse than those studies which have no possibility of selecting and refining the data? The values of R^2 obtained in this study are provided in the following table:

TABLE 12
NUMBER OF VALUES FOR R^2 FOR EACH FORMULATION AND BY RANGE OF VALUES

Functional models	Range of Values of R^2			
	0.00–0.24	0.25–0.49	0.50–0.74	0.75–1.00
ACMS	66	38	13	3
Cobb–Douglas	43	44	26	7
Kmenta	50	42	21	7

Disaggregated data at the establishment level allow the elimination of those observations which provide unreliable information. In this study, where the given data were supposed to contain a sufficient number of observations at the 4-digits industry level, the establishments were subjected to a rigid selection process (see appendix) in which the quality of observations was emphasized over their quantity.

After this selection process, I proceeded to examine the effects of measuring the labor and capital variables by different alternatives. The alternative measurements for the different variables showed no significant variation among themselves. This had already been predicted by the high correlation coefficients found for alternative forms of measurement for different proxy variables employed. This result indicates that biases introduced by the type of measurement used do not alter significantly the results already obtained. Therefore, I felt that it was irrelevant to calculate the magnitudes of those biases.

Finally, I have estimated and tested several different functions (others are not discussed explicitly in this study) and all had equally low fits, some with odd signs for some of the parameters.

In short, the basic information used is taken at the establishment level; only establishments with reliable data are selected; the economic variables are measured in several different ways; a variety of functions are estimated; the number of observations is sufficiently large; and the number and type of industries examined is large and varied. In spite of all these "precautions," the degree of variance in the behavior of establishments is considerably greater than that which economic theory can explain.

In light of the results obtained, re-examining the economic assumptions involved in some of the functions (perfect competition and maximization of profits) shows that the norm of bad results is also indifferent to the economic assumptions made. It is necessary to take a closer look at the production function concept. The series of bad results would indicate that the concept of the production function is not useful for studying the behavior of the firm; but, if the production function concept is irrelevant at the microeconomic level, having already been criticized at the macroeconomic level, what is its use?

Re-examining the notion of the production function, I see that the essential condition of the concept is including only productively efficient techniques. Thus, a process of selection is assumed to have taken place eliminating the inefficient techniques and leading to a uni-valued function. This basic premise of the production function concept was not applied in the selection of observations included to estimate the production functions in each industry.

There are two alternatives to the traditional method of production functions' econometric estimation for obtaining the production function that would only include the efficient techniques:[38] (1) The engineering approach, where inefficient techniques are eliminated by monetary cost considerations, and (2) the linear (or quadratic) programming method where the function is fitted to the data by minimizing the sum of deviations on one side of the curve or on it. A simpler variation of this second approach is Farrell's method, which provides the efficiency frontier for all observations.[39]

8. Conclusions

1. *Different production functions exist for an industry's establishments*

Through the application of the general Chow test I concluded that for different functional specifications it is possible to *reject* in at least 16 of 21 industries the hypothesis of *no* technological differences existing among the different size groupings of establishments. There is an increase in the number of industries for which it is not possible to employ only one homothetic production function, since the fit of the different functional specifications improves.

The use of the trans-logarithmic production function does not give a conclusive result. The hypothesis that the production function is homothetic can be rejected in only 10 of 21 industries.

Finally, the technological parameter elasticities (product-capital, economies of scale, and factor substitution) obtained for each size grouping are usually different at each industry level. Therefore, the need to discriminate between the different size groupings of industrial establishments is clearly suggested from a practical point of view.

These results could be used as empirical evidence to support the assumption of structural heterogeneity within the industrial sector, i.e., technology varies at the industry level as the size of establishment increases.

The former discussion suggests that caution must be exercised when using industry level data. The industry is not a collection of "representative firms," and the degree of heterogeneity is fairly high. The size of establishment seems to be an important element in determining the economic and technological characteristics of an industrial establishment.

2. *Principal results of production functions estimation*

(a) Value added-capital elasticity

(i) There is no (simple) correlation between the value added-capital elasticity, β, and the relative share of capital in value added, S_K. In other words, if S_K is used as a value added-capital elasticity estimator, the elasticity would be overestimated in 75 percent of the cases. The magnitude of such overestimation fluctuates considerably.

[38] L. Johansen, *Production Functions* (North-Holland, 1972), Chapter 8.

[39] M. J. Farrell, "The Measurement of Productive Efficiency" (*Journal of the Royal Stat. Soc.*, Series A, Vol. 120, Part 3, 1957) pp. 253–281. This is done in P. Meller's Ph.D. Thesis, *op. cit.*

(ii) In the majority of industries, 16 of 21, the largest establishments have a greater value added-capital elasticity than the smallest ones.

(iii) Size groupings 5–9, 10–19, and 20–49 persons have β elasticities of approximately 0.40; size grouping 50–99 persons has elasticity higher than 0.50; and establishments of 100 or more persons have β values close to 0.60.

(b) Economies of scale

(i) Economies of scale can be observed in 20 of 21 industries, at the industry level. These economies of scale fluctuate between 10 and 35 percent in 14 industries; 26.4 percent (simple arithmetic mean) of economies of scale is observed for the 21 industries.

(ii) The results obtained for economies of scale are highly questionable, given the odd results obtained at the size of establishment level. In the latter case, there are diseconomies of scale for all size groupings of establishment, even for the smallest ones employing 5–9 and 10–19 persons. Moreover, when different size groupings reveal the variation pattern of scale economies across size classes, some industries present an average cost curve with an inverted U form.

(iii) The test for constant returns to scale is accepted for almost 80 percent of the size groupings when estimated separately. But this test is rejected at the industry level in 14 of 21 industries.

(c) Elasticity of substitution

(i) The ACMS method (Arrow *et al.*) produces adequate values for the elasticity of substitution σ. These values are consistent with the expectations provided by economic theory. Furthermore, these values fluctuate only within small ranges of magnitude.

(ii) The elasticity of substitution varies among industries and also among the different size groupings in an industry. At the industry level, σ oscillates between 0.8 and 1.2 in 14 of 21 industries, and save two exceptions, the industries as a whole have σ values above 0.65. No regular pattern of behavior is observed in the variation pattern of σ in the size groupings of an industry. Considering the five size groupings, σ would show a U shaped pattern as the establishment size increases. The fourth group (50–99 persons) has the lowest value of σ, and the largest group (100 and more persons) has the highest σ value. However, the largest group cannot really be compared to the rest because of its much greater size range. As the latter is an open group it is not strange to find there the highest estimated values of σ.

(iii) The traditional tests of values that σ may take are related to values of 0 (fixed proportions function) and 1 (Cobb–Douglas function). The hypothesis $\sigma = 0$ is rejected in almost 70 percent of the cases. The Chilean industrial structure, in general, does not show technological inflexibility. The hypothesis $\sigma = 1$ is only rejected in about 6 percent of the cases.

3. *Fits of different functional specifications, measured by R^2 values, are generally poor for all functional forms*

The traditional ACMS specification produces the worst fits, with 87 percent of the cases having an R^2 below 0.50. The Cobb–Douglas and Kmenta functions have 75 percent of the cases with R^2 below 0.50.

These poor fits, the odd results obtained for the economies of scale, and the great instability and fluctuation of different estimated parameters introduce doubts regarding the utility of the production function concept at the micro-economic level. However, to defend this concept at micro level and to explain the problems mentioned in the previous paragraph, we would have to indicate that in the econometric estimation there is one requirement which has not been considered, namely the technical efficiency condition that must fulfill the different productive techniques.

The fundamental question to be asked is: How reliable are the results and what is their use? These results are merely of a descriptive nature and, given their high variability, are not appropriate for suggesting any kind of economic policy measure. The purpose of the estimators obtained is to show average values indicating an existing empirical situation which in some cases is very different from the one predicted by the theoretical model.

Appendix

Data used in this study correspond to a four-digit disaggregation industry level, ISIC classification. Basic data consists of primary information at industry level for the Chilean Industrial Sector Manufacturing Census of 1967.

The 21 industries shown in Table A-1 were selected according to a flexible application of the following criteria: (1) Each chosen industry should count with a "sufficient" number of observations to enable a meaningful econometric estimation in the different size groupings of establishments; (2) industries chosen

TABLE A-1
ISIC Code and Name of the 21 Industries Selected

ISIC Code	Name of Industry
3111	Cattle slaughtering, preparation and storing of meat
3112	Manufacturing of dairy products
3116	Mill products
3117	Manufacturing of bakery products
3121	Processing of various food products
3132	Wine industries
3211	Spinning, weaving, and textile finishing
3213	Knitting factories
3220	Clothing factories, except shoes
3231	Tannery and finishing workshops
3240	Shoe factory, except plastic or rubber
3311	Sawmills, barracks, and wood workshops
3320	Furniture and accessory factories
3420	Printing presses and publishing companies
3560	Plastic products factories
3693	Cement products factories
3710	Iron and steel basic industries
3813	Structural metal products factories
3819	Nonspecific metal products factories
3829	Machinery and equipment manufacturing
3843	Spare parts and accessories for motorized vehicles

TABLE A-2

NUMBER OF ESTABLISHMENTS ELIMINATED ACCORDING TO DIFFERENT SELECTION CRITERIA

Type of Industry	No. of People Employed less than five	No. of Days Worked less than one	No. of Workers and Employees equal to zero	Buildings Book Value equal to zero	Value added less or equal to zero	Payments to Capital Factor less or equal to zero	Machinery Book Value equal to zero	Total Number of Eliminated Establishments
3111	3	0	1	323	0	2	16	324
3112	1	0	1	41	0	0	0	41
3116	3	0	1	27	0	0	1	29
3117	10	0	2	534	0	2	3	536
3121	1	0	0	24	0	0	0	25
3132	43	0	13	342	0	1	0	380
3211	0	0	0	125	0	0	1	125
3213	3	0	0	199	0	0	0	200
3220	5	0	0	483	0	0	0	485
3231	0	0	0	31	0	0	1	31
3240	1	0	1	200	0	2	0	200
3311	244	0	220	960	1	2	1	975
3320	5	0	1	287	0	1	3	288
3420	2	0	1	233	0	1	1	233
3560	1	1	1	66	1	0	0	66
3693	2	0	0	62	0	0	0	63
3710	0	0	0	12	0	0	0	12
3813	1	0	0	111	0	0	0	112
3819	3	0	2	117	0	0	1	117
3829	0	0	0	66	0	0	0	66
3843	0	0	0	63	0	0	0	63
TOTAL	328	1	244	4306	2	11	28	4371

Note: The figures do not add across to the totals shown in the last column because some establishments are included under more than one heading.

TABLE A-3
NUMBER OF OBSERVATIONS USED FOR PRODUCTION FUNCTIONS ESTIMATION

Type of Industry	Establishment Size Class 5–9 persons	10–19 persons	20–49 persons	50–99 persons	100 and more persons	Total Industry
3111	78	36	39	16	6	175
3112	11	11	12	8	11	53
3116	29	30	50	20	2	131
3117	210	249	143	15	12	629
3121	9	16	12	4	6	47
3132	357	131	56	6	4	554
3211	22	37	73	36	58	226
3213	36	29	44	20	16	145
3220	60	41	43	20	29	193
3231	9	13	20	11	8	61
3240	30	37	31	20	24	142
3311	124	129	97	33	37	420
3320	79	47	37	10	7	180
3420	48	25	39	14	19	145
3560	6	9	19	7	10	51
3693	21	20	17	5	1	64
3710	7	8	17	4	12	48
3813	19	27	20	8	12	86
3819	45	30	32	8	6	121
3829	22	14	27	21	13	97
3843	15	21	19	12	15	82
TOTAL	1.237	960	847	298	308	3.650

should produce more or less homogeneous products; and (3) there should be at least one industry for each two-digit ISIC classification.

These 21 industries have 8021 establishments. These establishments were submitted to the following selection criteria:

1. Number of persons employed per establishment is less than 5.[1]
2. Number of days worked per establishment is equal to 0.
3. Total number of workers and employees is equal to 0.
4. Book value of machinery is equal to 0.
5. Book value of buildings is equal to 0.
6. Added value is less than or equal to 0.
7. Payment to capital factor, obtained as the difference between value added and total labor cost, is less than or equal to 0.

In most cases 0 does not literally mean zero but reflects the omission of information.

The establishments that did not meet any one of the previous criteria were excluded from the sample. The number of establishments was drastically reduced from 8021 to 3650 (see Table A-2).

It should be pointed out that over 80 percent of the eliminated establishments belong to the two smallest size groupings (5–9 and 10–19 people employed).

[1] In spite of the fact that the Industrial Census should include establishments employing at least five persons, there are 328 establishments violating this rule.

TABLE A-4
Capital's Share and Product-Capital Elasticity by Establishment Size and Industry

S_K: Capital Share = $\dfrac{\text{Value Added} - \text{Payments to Labor Factor}}{\text{Value Added}}$

$\hat{\beta}$: Regressor Coefficient of Equation: $\log Y/L = \log A + \beta \log K/L + h \log L$ (See Table A-7)

t: Statistic for null hypothesis $H_0: \beta = S_{\hat{t}}$

Type of Industry CIIU Code	Establishment Size Class								
	5–9 persons			10–19 persons			20–49 persons		
	S_K	$\hat{\beta}$	t	S_K	$\hat{\beta}$	t	S_K	$\hat{\beta}$	t
3111	0.351	0.269	−0.630	0.581	0.585	0.020*	0.661	0.436	−1.301*
3112	0.484	1.547	8.244	0.711	0.118	−1.719*	0.656	1.411	2.188*
3116	0.685	0.437	−1.288*	0.716	0.497	−0.948*	0.714	0.372	−3.455
3117	0.512	0.227	−6.196	0.468	0.226	−6.050	0.453	0.101	−7.184
3121	0.392	0.340	−0.175*	0.628	−0.069	−3.707	0.698	0.679	−0.089*
3132	−0.611	0.172	−9.977	0.741	0.135	−8.684	0.792	0.367	−3.455
3211	0.575	0.915	2.651	0.689	0.335	−3.222	0.596	0.513	−1.123*
3213	0.675	0.559	−0.992*	0.680	0.193	−4.149	0.684	0.388	−2.696
3220	0.387	0.339	−0.374*	0.626	0.029	−4.755	0.618	0.160	−2.802
3231	0.721	0.264	−5.135	0.733	0.202	−2.313	0.625	0.459	−0.927*
3240	0.530	0.481	−0.818*	0.488	0.236	−2.066	0.511	0.363	−1.244*
3311	0.529	0.403	−1.820*	0.588	0.353	−3.351	0.378	0.368	−1.015*
3320	0.388	0.352	−0.358*	0.413	0.420	0.594*	0.545	0.468	−0.849*
3420	0.515	0.384	−1.310*	0.443	0.432	−0.666*	0.483	0.451	−0.217*
3560	0.528	0.259	−0.839*	0.756	0.755	−0.005*	0.627	0.433	−1.576*
3693	0.529	0.169	−3.719	0.555	0.408	−0.477*	0.227	0.146	−0.500*
3710	0.414	0.511	0.558*	0.540	0.333	−0.908*	0.608	0.346	−1.664*
3813	0.361	0.083	−2.248	0.503	0.366	−1.358*	0.481	0.163	−1.600*
3819	0.531	0.223	−2.885	0.572	0.442	−1.284*	0.606	0.399	−1.980*
3829	0.318	0.420	0.495*	0.359	0.265	−0.739*	0.277	0.417	1.102*
3843	0.603	0.600	−0.017*	0.645	0.394	−1.702*	0.635	0.124	−3.498

TABLE A-4—*(cont.)*

Type of Industry CIIU Code	Establishment Size Class								
	50–99 persons			100 and more persons			Total Industry		
	S_K	$\hat{\beta}$	t	S_K	β	t	S_K	β	t
3111	0.680	0.690	−0.053*	0.666	0.598	−0.289*	0.508	0.692	2.326
3112	0.774	0.369	−0.707*	0.670	0.548	−0.667*	0.652	1.019	2.566
3116	0.704	−0.302	−5.427	0.354	(a)	(a)	0.701	0.465	−2.987
3117	0.461	0.616	0.861*	0.595	0.853	2.660	0.482	0.299	−7.038
3121	0.783	(a)	(a)	0.708	1.903	1.306*	0.624	0.280	−2.890
3132	0.817	0.580	−1.658*	0.675	(a)	(a)	0.663	0.363	−8.333
3211	0.563	0.337	1.694*	0.545	0.351	−3.995	0.591	0.495	−2.065
3213	0.577	0.664	0.475*	0.630	0.274	−2.701	0.660	0.509	−2.437
3220	0.615	0.172	−2.150	0.582	1.321	1.977*	0.362	0.406	0.593*
3231	0.531	0.507	−0.047*	0.494	(a)	(a)	0.628	0.441	−2.340
3240	0.481	0.350	−0.830*	0.480	0.478	−0.174*	0.500	0.521	0.356*
3311	0.463	0.018	−3.656	0.350	0.386	0.274*	0.491	0.409	−2.222
3320	0.360	0.939	3.218	0.482	0.572	0.236*	0.429	0.445	0.278*
3420	0.400	0.649	1.618*	0.438	0.601	1.242*	0.473	0.625	3.118
3560	0.634	0.994	1.239*	0.634	0.084	−2.170*	0.651	0.487	−1.689*
3693	0.553	(a)	(a)	0.469	(a)	(a)	0.458	0.313	−1.918*
3710	0.641	(a)	(a)	0.513	0.366	−0.793*	0.317	0.547	0.000*
3813	0.529	0.566	0.145*	0.340	0.253	−0.409*	0.447	0.338	−1.697*
3819	0.559	0.248	−1.275*	0.509	0.504	−0.042*	0.562	0.411	−2.642
3829	0.496	0.394	−0.390*	0.419	0.553	1.139*	0.365	0.559	2.702
3843	0.556	0.564	0.053*	0 711	1.019	2.217	0.634	0.506	−1.803*

* t values non-significant at 5 percent.
(a) Values not computed because number of observations was equal or less than five.

TABLE A-5

ECONOMIES OF SCALE ACCORDING TO COBB–DOUGLAS AND KMENTA PRODUCTION FUNCTIONS BY ESTABLISHMENT SIZE AND INDUSTRY

H_{C-D}: Cobb–Douglas economies of scale. (Table A-7)
h_K: Kmenta economies of scale. (Table A-8)

Type of Industry CIIU Code	Establishment Size Class: 5–9 persons		10–19 persons		20–49 persons		50–99 persons		100 and more persons		Total Industry	
	h_{C-D}	h_K	h_{C-D}	h_K	h_{C-D}	h_K	h_{C-D}	h_K	h_{C-D}	h_K	h_{C-D}	h_K
3111	−0.656	−0.660	−1.350	−1.354	−0.174*	−0.181*	−0.153*	−0.247*	0.748*	0.363*	−0.119	−0.146
3112	0.148*	0.040*	0.390*	0.469*	0.488*	0.194*	−0.992*	−0.699*	−0.471*	0.049*	0.294	0.308
3116	−0.293*	−0.345	0.125	0.177*	−0.495*	0.530	1.062	1.058	(a)	(a)	0.263	0.260
3117	−0.707	−0.713	−0.857	−0.821	−0.140*	−0.380*	0.236*	0.324	0.243*	0.241*	0.080	0.800
3121	0.787*	1.003*	−0.191*	−0.190*	0.218	0.473*	(a)	(a)	1.228*	1.141*	0.454	0.461
3132	−0.400	−0.396	−0.374	−0.374	0.177*	0.294*	0.152*	0.139*	(a)	(a)	0.062	0.065
3211	−0.613*	−0.597*	−0.267*	−0.395*	−0.575	−0.566	−0.142*	−0.145*	−0.023*	−0.022*	0.070*	0.007*
3213	−0.249*	−0.104*	−0.747*	−0.147*	−0.353*	−0.350*	−0.668*	−0.636*	−0.007*	−0.006*	0.216	0.217
3220	−0.277*	−0.331*	−0.738	−0.779	−0.404*	−0.286*	−0.354*	0.235*	0.061*	−0.125*	0.255	0.238
3231	0.233	0.289*	1.087	−1.044	−0.120	−0.155*	−0.404*	−0.499*	(a)	(a)	0.128	0.138
3240	−1.403	−1.365	−1.180*	−0.184*	−0.513	−0.550	−0.289	−0.451	0.265	0.257	0.291	0.291
3311	−0.015*	−0.023*	−0.158*	−0.017	−0.124*	−0.119*	0.082*	0.017*	0.184*	0.181*	0.060	0.550
3320	−0.52*	−0.084*	−0.279*	−0.303*	−0.363*	−0.298*	0.000*	−0.016*	0.585*	0.261	0.299	0.310
3420	−0.791	−0.793	−0.680*	−0.662*	−0.311*	−0.318*	−0.967	0.027*	0.264*	−0.266*	0.021*	0.021*
3560	−0.972*	−0.980*	0.322*	−0.281*	−0.434*	−0.440*	−0.436*	−0.866*	0.453*	0.457*	0.088*	0.095*
3693	−0.532*	−0.551*	0.864*	−0.855*	−0.871	−1.217	(a)	(a)	(a)	(a)	0.157*	0.162*
3710	−0.103*	−3.621*	−0.325*	−0.880*	−0.455*	−0.533*	(a)	(a)	−1.050*	−0.185*	0.118*	0.115*
3813	−0.421*	−0.199*	−0.249*	−0.425*	−0.261*	−0.257	0.224*	0.183*	0.204*	−0.009*	0.343	0.334
3819	−0.556*	−0.580*	−0.301*	−0.193*	−0.126*	−0.196*	−0.129*	−0.293*	0.161*	−0.047*	0.318	0.326
3829	−0.495*	−0.470*	−0.868*	−1.383	0.311*	0.312*	−0.183*	0.076*	0.417	0.457	0.230	0.224
3843	−0.152*	−0.281*	0.623	−0.461*	0.522*	−0.549*	−0.493*	−0.580*	0.035*	0.071*	0.353	0.353

* *h* values whose *t* statistics in non-significant at 5 per cent. See Tables A-7 and A-8.
(a) Values not computed because number of observations was equal or less than five.

TABLE A-6

ACMS Production Function Econometric Results by Establishment Size and Industry

Production Function: $Y = \gamma[\delta K^{-\rho} + (1 - \delta)L^{-\rho}]^{-1/\rho}$
Regression Equation: $\log Y/L = a + \sigma \log w$

Type of Industry CIIU Code	Establishment Size Class: 5–9 persons a	σ	R^2	10–19 persons a	σ	R^2	20–49 persons a	σ	R^2
3111	−5.791 (−11.259)	1.945 (5.162)	0.250	−5.740 (−9.454)	1.598 (4.308)	0.334	−3.710 (−8.168)	0.601 (2.454)	0.117
3112	−5.855 (−9.369)	1.599 (2.471)	0.338	−5.178 (−6.740)	1.205 (2.508)	0.346	−6.577 (−7.086)	1.943 (4.176)	0.599
3116	−6.044 (−10.168)	1.728 (4.247)	0.378	−3.795 (−7.493)	0.590 (2.001)	0.094	−3.439 (−7.772)	0.467 (2.201)	0.073
3117	−5.424 (−35.740)	0.736 (6.940)	0.184	−5.327 (−37.587)	0.729 (8.020)	0.203	−4.896 (−27.537)	0.608 (4.680)	0.128
3121	−5.221 (−8.339)	0.819 (2.242)	0.335	−3.906 (−8.640)	0.468 (1.747)	0.120	−5.199 (−6.661)	1.168 (3.184)	0.454
3132	−3.529 (−85.782)	−0.284 (−6.982)	0.118	−3.034 (−44.366)	−0.270 (−3.963)	0.102	−2.893 (−17.547)	0.161 (1.356)	0.015
3211	−5.328 (−7.884)	1.182 (2.767)	0.241	−4.263 (−11.758)	0.766 (3.577)	0.247	−4.443 (−13.007)	0.777 (4.397)	0.214
3213	−5.134 (−13.461)	0.891 (2.751)	0.158	−4.565 (−12.770)	0.711 (2.476)	0.155	−3.776 (−10.501)	0.433 (1.816)	0.051
3220	−4.854 (−15.080)	0.591 (2.357)	0.072	−4.241 (−10.484)	0.431 (1.429)	0.025	−4.778 (−15.756)	0.911 (4.541)	0.318
3231	−4.322 (−13.070)	0.634 (3.063)	0.512	−4.322 (−5.543)	0.659 (1.327)	0.060	−4.346 (−5.993)	0.748 (1.915)	0.123
3240	−4.958 (−8.753)	0.522 (1.108)	0.008	−5.066 (−14.458)	0.907 (3.200)	0.204	−5.365 (−11.032)	1.206 (3.769)	0.306
3311	−4.110 (−42.523)	−0.034 (−0.382)	−0.007	−3.564 (−39.028)	−0.153 (−2.090)	0.026	−4.071 (−23.299)	0.286 (2.230)	0.040
3320	−5.504 (−22.500)	1.019 (5.212)	0.251	−5.231 (−12.713)	0.873 (3.052)	0.153	−4.299 (−14.308)	0.452 (2.246)	0.101

TABLE A-6—(*cont.*)

3420	−5.704 (−16.614)	1.056 (5.646)	0.397	−6.452 (−9.194)	1.521 (4.491)	0.444	−4.495 (−9.411)	0.699 (3.267)	0.203
3560	−4.512 (−4.594)	0.404 (0.603)	−0.146	−4.146 (−6.106)	0.765 (1.760)	0.208	−4.059 (−6.050)	0.584 (1.533)	0.070
3693	−4.641 (−13.506)	0.308 (1.254)	0.028	−4.973 (−17.667)	0.854 (4.526)	0.506	−3.456 (−4.915)	−0.156 (−0.375)	−0.057
3710	−5.101 (−3.938)	0.668 (0.697)	−0.094	−5.037 (−11.400)	0.883 (2.906)	0.515	−4.801 (−7.436)	0.956 (2.967)	0.328
3813	−5.189 (−15.469)	0.462 (1.974)	0.139	−5.049 (−10.995)	0.830 (2.767)	0.204	−5.662 (−13.101)	1.334 (5.255)	0.584
3819	−5.199 (−18.374)	0.832 (3.886)	0.243	−4.551 (−13.046)	0.547 (2.234)	0.121	−4.055 (−10.937)	0.485 (2.246)	0.115
3829	−5.833 (−10.470)	0.885 (2.651)	0.223	−3.383 (−4.579)	−0.097 (−0.260)	−0.077	−5.207 (−8.823)	0.946 (3.388)	0.287
3843	−4.866 (−10.329)	0.855 (2.525)	0.278	−4.272 (−7.604)	0.696 (2.070)	0.141	−3.793 (−6.531)	0.509 (1.614)	0.082

Type of Industry CIIU Code	Establishment Size Class: 50–99 persons			Establishment Size Class: 100 and more persons			Total Industry		
	a	*σ*	R^2	*a*	*σ*	R^2	*a*	*σ*	R^2
3111	−4.556 (−3.723)	1.019 (1.788)	0.128	−2.675 (−1.935)	−0.011 (0.017)	−0.250	−4.987 (−18.469)	1.258 (7.696)	0.251
3112	−3.355 (−2.023)	0.483 (0.676)	−0.084	−2.364 (−1.117)	−0.051 (−0.060)	−0.111	−5.599 (18.836)	1.380 (8.958)	0.604
3116	−3.640 (−7.121)	0.599 (2.762)	0.259	(a)	(a)	(a)	−4.519 (−19.029)	0.935 (7.624)	0.305
3117	−5.253 (−8.642)	0.922 (2.042)	0.184	−6.120 (16.300)	1.595 (8.188)	0.857	−5.335 (−59.893)	0.800 (12.827)	0.207
3121	(a)	(a)	(a)	−9.324 (−4.796)	3.185 (3.777)	0.762	−5.080 (−14.124)	1.110 (5.991)	0.431
3132	−2.554 (−9.269)	0.060 (−0.374)	−0.208	(a)	(a)	(a)	−3.319 (−90.107)	−0.105 (−3.085)	0.015

3211	−3.301 (−5.660)	0.257 (0.868)	−0.007	−4.677 (−14.554)	0.880 (5.574)	0.345	−4.476 (−25.297)	0.820 (8.607)	0.245
3213	−3.182 (−4.776)	−0.003 (−0.008)	−0.056	−2.464 (−3.488)	−0.107 (−0.329)	−0.063	−4.798 (−27.526)	0.936 (8.071)	0.308
3220	−3.288 (−5.959)	0.124 (0.381)	−0.047	−7.587 (−17.330)	2.403 (10.733)	0.803	−5.137 (−28.554)	1.070 (8.972)	0.293
3231	−3.452 (−3.136)	0.392 (0.776)	−0.042	(a)	(a)	(a)	−4.356 (16.614)	0.743 (5.555)	0.332
3240	−4.128 (−9.260)	0.595 (2.512)	0.218	−4.589 (−9.480)	0.879 (3.647)	0.348	−5.422 (−30.045)	1.206 (10.328)	0.428
3311	−4.156 (−16.866)	0.360 (2.393)	0.129	−5.324 (−19.232)	1.040 (6.313)	0.519	−3.894 (−64.460)	0.078 (1.696)	0.005
3320	−3.580 (−1.680)	0.060 (0.052)	−0.125	−7.185 (−5.513)	2.203 (3.091)	0.588	−5.353 (−31.471)	1.001 (8.330)	0.276
3420	−8.051 (−8.042)	2.079 (5.227)	0.669	−3.200 (−3.439)	0.169 (0.466)	−0.046	−5.611 (−24.621)	1.109 (10.512)	0.432
3560	−3.497 (−2.275)	0.391 (0.492)	−0.145	−5.058 (−11.799)	1.081 (5.280)	0.749	−4.364 (−12.614)	0.750 (3.883)	0.220
3693	(a)	(a)	(a)	(a)	(a)	(a)	−4.825 (−22.701)	0.658 (4.807)	0.260
3710	(a)	(a)	(a)	−4.815 (−7.882)	0.900 (3.535)	0.511	−5.413 (−18.122)	1.196 (8.000)	0.573
3813	−5.145 (−5.480)	1.063 (2.168)	0.346	−4.050 (−6.498)	0.506 (1.821)	0.174	−5.511 (−24.860)	1.102 (8.475)	0.455
3819	−4.931 (−3.634)	0.929 (1.353)	0.106	−5.875 (−6.542)	1.355 (3.439)	0.684	−5.145 (−28.601)	0.953 (8.328)	0.363
3829	−5.488 (−4.278)	1.230 (2.183)	0.159	−4.995 (−5.373)	0.856 (2.139)	0.230	−5.686 (−17.190)	1.130 (7.077)	0.338
3843	−4.490 (−5.469)	0.818 (2.144)	0.246	−5.753 (−5.181)	1.544 (3.451)	0.438	−4.817 (−17.789)	1.042 (8.184)	0.449

Values in parentheses are t statistics for null hypothesis that those parameters have a zero value.

(a) Values not computed because number of observations was five or less.

TABLE A-7

Cobb–Douglas Production Function Econometric Results by Establishment Size and Industry

Production Function: $Y = AL^{\alpha}K^{\beta}$

Regression Equation: $\ln Y/L = \ln \underset{A_0}{A} + (\alpha + \underset{h}{\beta} - 1) \ln L + \beta \ln K/L$

Type of Industry CIIU Code	Establishment Size Class								
	5–9 persons			10–19 persons			20–49 persons		
	h	β	R^2	h	β	R^2	h	β	R^2
			(a)			(a)			(a)
3111	−0.656 (−5.374)	0.269 (2.087)	0.525	−1.350 (−4.940)	0.585 (2.944)	0.506	−0.174 (−0.739)*	0.436 (2.524)	0.215
3112	0.148 (0.298)*	1.547 (11.461)	0.936	0.390 (0.771)*	0.118 (0.347)*	−0.162	0.488 (0.766)*	1.441 (4.902)	0.688
3116	−0.293 (−0.423)*	(0.437) (2.162)	0.131	0.125 (2.190)	0.497 (2.151)	0.850	−0.495 (−1.887)*	0.372 (3.759)	0.272
3117	−0.707 (−5.072)	0.227 (4.933)	0.254	−0.857 (−6.707)	0.226 (5.596)	0.280	−0.140 (−1.014)*	0.101 (2.054)	−0.046
3121	0.787 (1.313)*	0.340 (1.164)*	−0.033	0.191 (0.557)*	−0.069 (−0.369)*	−0.114	0.218 (0.462)*	0.679 (2.868)	0.362
3132	−0.400 (−7.596)	0.172 (3.922)	0.284	−0.374 (−4.184)	0.135 (1.935)*	0.249	0.177 (0.854)*	0.367 (2.977)	0.110
3211	−0.613 (−1.575)*	−0.915 (7.136)	0.774	−0.267 (−0.768)	0.335 (3.046)	0.277	−0.575 (−3.078)	0.513 (6.951)	0.490
3213	−0.249 (−0.508)*	0.559 (3.360)	0.291	−0.747 (−0.239)*	0.193 (1.652)*	0.032	−0.353 (−1.912)*	0.388 (3.550)	0.300
3220	−0.277 (−0.687)*	0.339 (2.647)	0.177	−0.738 (−2.546)	0.029 (0.229)*	0.120	−0.404 (−1.135)*	0.160 (0.978)*	0.052
3231	0.233 (0.607)*	0.264 (2.956)	0.486	1.087 (−3.455)	0.202 (0.880)	0.621	−0.120 (−0.292)*	0.459 (2.561)	0.278
3240	−1.408 (−3.589)	0.431 (3.562)	0.537	−0.180 (−0.481)*	0.236 (1.934)*	0.075	−0.513 (−2.371)	0.363 (3.034)	0.498
3311	−0.015 (−0.175)*	0.403 (5.797)	0.297	−0.158 (−2.222)	0.353 (5.076)	0.350	−0.524 (−0.405)*	0.368 (3.725)	0.135

3320	−0.052 (−0.153)*	0.352 (3.438)	0.140	−0.279 (−0.719)*	0.420 (3.546)	0.276	−0.363 (−1.844)*	0.468 (5.143)	0.410
342[illegible]	−0.791 (−2.262)	0.384 (3.816)	0.381	−0.680 (−2.123)	0.432 (2.509)	0.641	−0.311 (−1.199)*	0.451 (3.062)	0.396
3560	−0.972 (−1.954)*	0.259 (0.806)*	0.267	0.322 (0.817)*	0.755 (3.240)	0.516	−0.434 (−1.795)*	0.433 (4.059)	0.511
3693	−0.532 (−1.499)*	0.169 (1.744)*	0.144	0.864 (1.172)*	0.498 (4.135)	0.453	−0.871 (−2.2321)	0.146 (0.900)*	0.230
3710	−0.103 (−0.33)*	0.511 (2.933)	0.612	−0.325 (−1.723)*	0.333 (1.455)*	0.270	−0.455 (−1.119)*	0.346 (2.202)	0.238
3813	−0.421 (−0.713)*	0.083 (0.667)*	−0.058	−0.249 (−0.749)*	0.366 (3.613)	0.346	−0.261 (−0.488)*	0.163 (0.818)*	−0.038
3819	−0.556 (−1.683)*	0.223 (2.072)	0.147	−0.301 (−1.019)	0.442 (4.375)	0.377	−0.126 (−0.432)*	0.399 (3.822)	0.364
3829	−0.495 (−0.960)*	0.429 (1.904)*	0.297	−0.868 (−2.144)*	0.265 (2.028)*	0.581	0.311 (0.814)*	0.417 (3.286)	0.254
3843	−0.152 (−0.184)*	0.600 (3.489)	0.461	0.623 (3.980)	0.394 (5.633)	0.209	−0.522 (−1.275)*	0.124 (0.736)*	0.582

(continued on next page)

TABLE A-7—(*cont.*)

Type of Industry CIUU Code	Establishment Size Class						Total Industry			
	50–99 persons			100 and more persons						
	h	β	R^2	h	β	R^2	A_0	h	β	R^2
3111	−0.153 (−0.424)*	0.690 (3.690)	0.469	0.748 (2.623)*	0.598 (2.539)*	(a) 0.660	1.481 (2.697)	−0.119 (−2.119)	0.692 (8.747)	(a) 0.343
3112	−0.996 (−0.892)*	0.369 (0.645)*	−0.043	−0.471 (−1.301)*	0.548 (2.996)	0.457	−1.277 (−0.975)*	0.294 (3.033)	1.019 (7.120)	0.614
3116	1.062 (2.180)	−0.302 (−1.632)*	0.140	(a)	(a)	(a)	−2.985 (−2.911)	0.263 (2.834)	0.465 (5.891)	0.314
3117	0.238 (0.381)*	0.616 (3.420)	0.361	0.243 (1.124)*	0.823 (8.453)	0.885	−3.704 (−8.362)	0.080 (2.198)	0.299 (11.512)	0.179
3121	(a)	(a)	(a)	1.228 (2.190)*	1.903 (2.081)*	0.763	−5.841 (−5.588)	0.454 (4.819)	0.280 (2.503)	0.387
3132	0.152 (1.086)*	0.560 (3.604)	0.685	(a)	(a)	(a)	−2.298 (−10.013)	0.062 (1.967)	0.636 (9.932)	0.152
3211	−0.142 (−0.505)*	−0.337 (2.509)	0.126	−0.023 (−0.266)*	0.351 (3.149)	0.122	−0.632 (−1.553)*	0.070 (0.207)*	0.495 (10.637)	0.335
3213	−0.668 (−1.750)*	0.664 (2.783)	0.457	−0.007 (−0.063)*	0.274 (2.076)*	0.139	−2.829 (−4.766)	0.216 (4.674)	0.509 (8.196)	0.443
3220	−0.354 (−1.000)*	0.172 (0.835)*	0.024	0.061 (0.15)*	1.321 (3.533)	0.274	−3.644 (4.875)	0.255 (4.106)	0.406 (5.412)	0.210
3231	−0.404 (−0.841)*	0.507 (0.986)*	0.057	(a)	(a)	(a)	−1.977 (−2.122)	0.128 (1.552)*	0.441 (5.518)	0.372
3240	−0.289 (−1.284)*	0.350 (2.222)	0.334	0.265 (2.296)	0.478 (4.600)	0.528	−3.221 (−5.283)	0.291 (6.028)	0.521 (8.816)	0.488
3311	0.082 (0.301)*	0.018 (0.145)*	−0.088	0.184 (1.023)*	0.386 (2.928)	0.160	−2.131 (−8.324)	0.060 (2.256)	0.409 (11.072)	0.229
3320	0.002 (0.008)*	0.939 (5.209)	0.759	0.585 (1.426)*	0.572 (1.445)*	0.378	−3.879 (−6.003)	0.299 (4.724)	0.455 (7.715)	0.305

3420	−0.967 (−2.270)	0.649 (4.211)	0.744	−0.264 (−1.887)*	0.601 (4.570)	0.535	−0.145 (0.265)*	0.021 (0.467)*	0.625 (12.761)	0.548
3560	−0.436 (−0.953)*	0.994 (3.411)	0.696	0.453 (1.151)*	0.084 (0.328)*	−0.070	−1.417 (−1.517)*	0.088 (1.151)*	0.487 (5.012)	0.343
3693	(a)	(a)	(a)	(a)	(a)	(a)	−3.440 (−2.831)	0.157 (1.286)*	0.313 (4.120)	0.228
3710	(a)	(a)	(a)	−1.050 (−0.510)*	0.366 (1.965)*	0.174	−1.553 (−1.553)*	0.118 (1.405)*	0.547 (2.178)	0.593
3813	0.224 (0.310)*	0.566 (2.219)*	0.296	0.204 (0.855)*	0.253 (1.184)*	−0.042	−4.955 (−5.952)	0.343 (4.749)	0.338 (5.225)	0.436
3819	−0.129 (−0.178)*	0.248 (1.011)*	−0.149	0.161 (−0.582)*	0.504 (0.532)*	0.769	−4.116 (−5.632)	0.318 (4.872)	0.411 (7.184)	0.443
3829	−0.183 (−0.281)*	0.394 (1.503)*	0.058	0.417 (3.116)	0.553 (4.692)	0.674	−2.567 (−3.356)	0.230 (3.690)	0.559 (7.809)	0.475
3843	−0.493 (−0.986)	0.564 (4.082)	0.571	0.035 (0.160)*	1.019 (7.339)	0.783	−2.154 (−3.006)	0.353 (5.378)	0.506 (7.116)	0.521

* t values non-significant at 5 per cent.
(a) Values not computed because number of observations was five or less.

TABLE A-8

Kmenta Production Function Econometric Results by Establishment Size and Industry

Production Function: $Y = \gamma[(1-\delta)L^{-\rho} + \delta K^{-\rho}]^{-\mu/\rho}$
Regression Equation: $\log Y/L = \log B + (\mu - 1)\log L + \mu\delta \log K/L + a_0 (\log K/L)^2$
Values in parentheses are t statistics for null hypothesis that those parameters have a zero value.

Type of Industry CIIU Code	Establishment Size Class: 5–9 persons				10–19 persons				20–49 persons			
	h	b	a_0	R^2	h	b	a_0	R^2	h	b	a_0	R^2
3111	−0.660 (−5.359)	0.025 (0.041)*	−0.024 (−0.412)*	0.519	−1.354 (−4.914)	−0.760 (−0.364)*	−0.135 (−0.147)*	0.500	−0.181 (−0.791)*	−1.024 (−1.165)*	−0.162 (−1.695)*	0.253
3112	0.040 (0.083)*	3.638 (2.722)	0.212 (1.572)*	0.942	0.469 (0.879)*	2.270 (0.757)*	0.209 (0.723)*	−0.242	0.194 (0.248)*	−1.235 (−0.319)*	−0.312 (−0.694)*	0.667
3116	−0.345 (−4.050)	0.337 (0.167)*	−0.009 (−0.050)*	0.095	0.177 (0.305)*	−1.087 (−0.505)*	−0.164 (−0.739)*	0.070	−0.530 (−2.030)	−0.978 (−1.019)*	−0.149 (−1.413)*	0.285
3117	−0.713 (−5.358)	0.112 (0.296)*	−0.009 (−0.306)*	0.334	−0.821 (−6.423)	0.906 (2.764)	0.052 (2.086)	0.394	−0.390 (−1.029)*	0.627 (2.042)	0.042 (1.735)*	−0.005
3121	1.003 (1.269)*	1.895 (0.573)*	0.153 (0.472)*	−0.194	0.190 (0.530)*	0.563 (0.262)*	0.062 (0.296)*	−0.216	0.473 (0.948)*	4.322 (1.500)*	0.352 (1.268)*	0.423
3132	−0.396 (−7.587)	−0.117 (−0.510)*	−0.035 (−1.315)*	0.296	−0.374 (−4.174)	−0.068 (−0.187)*	−0.023 (−0.556)*	0.245	0.294 (1.315)*	−0.161 (−0.391)*	−0.080 (−1.342)*	0.120
3211	−0.597 (−1.669)*	2.879 (3.157)	0.196 (2.171)	0.809	−0.395 (−1.609)*	0.675 (1.931)*	0.046 (1.024)*	0.278	−0.566 (−3.043)	1.675 (2.401)	0.114 (1.675)*	0.496
3213	−0.104 (−0.198)*	1.630 (1.189)*	0.089 (0.787)*	0.278	−0.147 (−0.418)*	−1.557 (−1.482)*	−0.152 (−1.656)*	0.092	−0.350 (−1.875)*	0.809 (0.831)*	0.045 (0.436)*	0.286
3220	−0.321 (−0.753)*	−0.035 (−0.032)*	−0.030 (−0.349)*	0.100	−0.779 (−2.567)	−0.456 (−0.482)*	−0.045 (0.597)*	0.091	−0.286 (−0.782)*	3.205 (1.679)*	0.272 (1.602)*	0.042
3231	0.289 (0.633)*	0.441 (0.755)*	0.016 (0.307)*	0.389	−1.044 (−3.052)	1.808 (0.625)*	0.149 (0.577)*	0.577	−0.155 (−0.361)*	0.577 (−0.265)*	−0.100 (−0.477)*	0.233
3240	−1.365 (−3.372)	1.343 (1.019)*	0.068 (0.695)*	0.519	−0.184 (−0.483)*	−0.369 (−0.297)*	−0.053 (−0.406)*	0.046	−0.550 (−2.398)	0.919 (0.914)*	0.045 (0.577)*	0.483

3311	−0.023 (−0.282)*	0.292 (0.836)*	−0.010 (−0.323)*	0.287	−0.170 (−2.359)	−0.042 (−0.099)*	−0.037 (−0.945)*	0.351	−0.119 (−0.876)*	0.565 (0.796)*	0.018 (0.280)*	0.165
3320	−0.084 (−0.248)*	1.354 (2.614)*	0.081 (1.204)*	0.146	−0.303 (−0.768)*	−0.097 (−0.101)*	−0.041 (−0.543)*	0.201	−0.298 (−1.525)*	1.656 (2.402)	0.098 (1.473)*	0.451
3420	−0.793 (−2.235)	0.216 (0.272)*	−0.014 (−0.214)*	0.364	−0.662 (−2.021)*	0.043 (0.052)*	−0.035 (−0.482)*	0.627	−0.318 (−1.210)*	−0.120 (−0.096)*	−0.055 (−0.495)*	0.384
3560	−0.980 (−1.622)*	−2.385 (−0.371)*	−0.229 (−0.412)*	−0.081	−0.281 (−0.535)*	10.368 (1.854)*	0.970 (1.720)*	0.629	−0.440 (−3.763)*	0.821 (0.729)*	0.036 (0.347)*	0.481
3693	−0.551 (1.499)*	0.340 (0.686)*	0.014 (0.352)*	0.102	0.855 (1.122)*	0.669 (0.561)*	0.015 (0.144)*	0.420	−1.217 (−3.371)	3.482 (2.407)	0.290 (2.318)	0.409
3710	−3.621 (−0.994)	5.739 (1.112)*	0.413 (1.013)*	0.658	−0.880 (−1.440)*	−0.597 (−0.121)*	−0.083 (−0.189)*	0.085	−0.533 (−1.256)*	−0.771 (0.536)*	−0.127 (−0.781)*	0.215
3813	−0.199 (0.317)*	−1.417 (−3.969)*	−0.118 (−1.030)*	−0.050	−0.425 (−1.132)*	1.218 (1.522)*	0.082 (1.074)*	0.346	−0.257 (5.165)	−2.710 (1.085)*	−0.289 (0.354)*	0.128
3819	−0.580 (−1.703)*	−0.154 (−0.143)*	−0.031 (−0.352)*	0.130	−0.193 (−0.659)*	2.536 (1.924)*	0.169 (1.593)*	0.423	−0.196 (−0.684)*	2.319 (2.174)	0.182 (1.807)*	0.402
3829	−0.470 (−0.825)*	0.257 (0.170)*	−0.016 (−0.114)*	0.257	−1.383 (−3.724)	2.158 (3.100)	0.167 (2.710)	0.737	0.312 (0.803)*	0.762 (0.894)*	0.035 (0.410)*	0.225
3843	−0.281 (0.822)*	1.700 (0.939)*	0.097 (0.081)*	0.591	0.461 (0.937)*	−0.534 (−0.647)*	−0.084 (−1.143)*	0.220	−0.549 (−1.073)*	0.352 (0.146)*	0.023 (0.095)*	−0.039

(continued on next page)

TABLE A-8—(*cont.*)

Type of Industry CIIU Code	Establishment Size Class: 50–99 persons				100 and more persons				Total Industry				
	h	b	a_0	R^2	h	b	a_0	R^2	b_0	h	b	a_0	R^2
3111	−0.247 (−0.721)*	−3.523 (−1.414)*	−0.443 (−1.645)*	0.331	0.363 (1.430)*	−9.326 (−2.073)*	−0.104 (−2.208)*	0.589	−0.453 (−0.380)*	−0.146 (−2.533)	−0.214 (−0.425)	−0.091 (−1.822)*	0.351
3112	−0.699 (−0.491)*	−10.605 (−0.486)*	−1.304 (−0.504)*	−0.418	0.049 (0.136)*	5.430 (2.656)	0.571 (2.395)	0.649	0.438 (0.158)*	0.308 (3.097)	1.834 (1.565)*	0.087 (0.701)*	0.610
3116	1.058 (2.106)	0.006 (0.003)*	0.037 (0.169)*	0.089	(a)	(a)	(a)	(a)	−5.449 (−3.230)	0.260 (92.823)	−0.596 (−1.019)*	−0.109 (−1.851)*	0.325
3117	0.324 (0.789)*	3.888 (2.911)	0.257 (2.456)	0.722	0.241 (1.200)*	1.383 (1.300)*	0.053 (0.528)*	0.901	−1.095 (−1.530)*	0.080 (2.198)*	0.931 (4.714)	0.049 (3.233)	0.166
3121	(a)	(a)	(a)	(a)	1.141 (3.196)*	48.050 (1.639)	5.305 (1.574)*	0.906	−4.952 (−1.848)*	0.461 (4.751)	0.685 (0.608)*	0.041 (0.361)*	0.375
3132	0.139 (1.401)*	1.064 (0.684)*	0.060 (0.327)*	0.864	(a)	(a)	(a)	(a)	−3.091 (−7.088)	0.065 (2.047)	−0.032 (−0.108)*	−0.047 (−2.137)	0.155
3211	−0.145 (−0.518)*	1.840 (1.308)*	0.158 (1.073)*	0.140	−0.022 (−0.255)*	0.151 (0.142)*	−0.022 (−0.189)*	0.109	−0.612 (−0.949)*	0.007 (0.211)*	0.503 (2.025)	0.001 (0.041)*	0.331
3213	−0.636 (−1.359)*	−1.530 (−0.264)*	−0.230 (−0.378)*	0.211	−0.006 (−0.063)*	−0.111 (−0.053)*	−0.040 (−0.183)	0.420	−2.555 (−1.917)*	0.217 (4.665)	0.615 (1.322)*	0.010 (0.230)*	0.439
3220	0.235 (0.461)*	−8.981 (−1.635)*	−0.865 (−1.680)*	−0.490	−0.125 (−0.340)*	−10.138 (−2.469)	−0.984 (−2.800)	0.423	−5.227 (−3.121)	0.238 (3.712)	−0.144 (−0.339)*	−0.050 (−1.056)*	0.210
3231	−0.499 (−1.093)*	−11.439 (−1.162)*	−1.369 (−1.215)*	0.173	(a)	(a)	(a)	(a)	−1.446 (−0.905)*	0.138 (1.590)*	0.685 (1.144)*	0.023 (0.412)*	0.358
3240	−0.451 (−2.093)	4.464 (2.342)	0.369 (2.164)	0.462	0.257 (2.207)	−0.456 (−0.391)*	−0.086 (−0.804)*	0.526	−4.607 (−2.799)*	0.291 (6.038)	0.062 (0.121)*	0.037 (−0.906)*	0.488
3311	0.117 (0.411)*	−0.405 (−0.418)*	−0.041 (0.441)*	−0.085	0.181 (0.999)*	1.081 (1.001)*	0.064 (0.648)*	0.141	−2.970 (−4.157)	0.055 (1.974)	0.225 (0.941)*	−0.017 (−0.781)*	0.216
3320	−0.015 (0.046)*	2.170 (0.497)*	2.106 (0.283)	0.563	0.261 (0.504)*	10.060 ([illegible]84)*	0.794 (1.023)*	0.386	−2.162 (−1.339)*	0.310 (4.878)	1.041 (2.013)	0.048 (1.159)*	0.815
3420	0.027 (0.049)*	0.610 (0.381)*	0.003 (0.033)*	0.526	−0.266 (0.147)*	0.190 (1.779)*	0.044 (0.189)*	0.491	−0.050 (1.097)*	0.021 (0.046)*	0.660 (0.355)*	0.003 (0.031)*	0.544

3560	−0.866 (−1.355)*	7.299 (1.081)*	0.637 (0.934)*	0.715	0.457 (1.105)*	1.907 (0.559)*	0.187 (0.536)*	−0.182	1.123 (0.412)*	0.095 (1.227)*	1.498 (1.461)*	0.096 (0.991)*	0.341
3693	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	−2.838 (−1.677)*	0.162 (1.312)*	0.538 (1.209)*	0.019 (0.514)*	0.219
3710	(a)	(a)	(a)	(a)	−0.185 (−0.878)*	−2.002 (−1.020)*	−0.270 (−1.216)*	0.216	−1.750 (−1.378)*	0.115 (1.353)*	0.461 (1.279)*	−0.008 (−0.246)*	0.584
3813	0.183 (0.217)*	1.080 (0.330)*	0.095 (0.158)*	0.120	−0.009 (−0.028)*	−3.825 (−0.918)*	−0.428 (−0.980)*	−0.076	−6.069 (−4.331)	0.334 (4.600)	−0.111 (−0.243)*	−0.041 (−0.988)*	0.458
3819	−0.293 (−0.351)*	2.365 (0.566)*	0.191 (0.508)*	−0.293	−0.047 (−0.044)*	1.830 (0.291)*	0.121 (0.211)*	0.500	−2.196 (−1.318)*	0.326 (5.027)	1.111 (2.019)	0.060 (1.279)*	0.456
3829	0.076 (0.114)*	−2.702 (−1.167)*	−0.329 (−1.345)*	0.093	0.457 (2.329)	1.143 (0.559)	0.054 (0.290)*	0.656	−3.949 (−2.689)	0.224 (3.585)	0.007 (0.013)*	−0.051 (−1.101)*	0.485
3843	−0.580 (−1.130)*	−0.907 (−0.574)*	−0.139 (−0.936)*	0.564	0.071 (0.301)*	1.875 (1.203)*	0.097 (0.552)*	0.773	−3.698 (−2.942)	0.353 (5.322)	0.513 (1.184)*	0.007 (0.018)*	0.514

* *t* values non-significant at 5 percent.
(a) Values not computed because number of observations was five or less.

The distribution of the sample by establishment size groupings is shown in Table A-3. Nevertheless, in spite of the large number of eliminated observations, the sample comprises over 30 percent of the total number of establishments for the two smallest size groupings and over 70 percent of the total number of establishments for the two largest size groupings (50–99 and 100 and more people employed).

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