PRODUCTION PARAMETER ESTIMATES FOR THE PHILIPPINE NONAGRICULTURAL SECTORS

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Production Parameter Estimates for the Philippine Nonagricultural Sectors*

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The objective of this subcomponent of the APEX project is to make an econometric estimation of the production parameters for the manufacturing and services sectors of the Philippines. The main data base used is the Annual Survey of Establishments (ASE), 1978-1987, obtained from the National Statistical Office (NSO). Constant elasticity of substitution (CES) production functions, translog variable cost functions, and normalized quadratic profit functions are estimated.

More precisely, value added functions are estimated. We assume that value added and intermediate inputs combine in fixed proportions to yield the sector's output. This Leontief structure implies that the primary factors and intermediate inputs are not substitutable. This assumption also implies the separability of value added and intermediate inputs; that is, the demand for intermediate inputs is not affected by changes in output and primary factor prices, except indirectly through changes in the scale of production. With the development of more sophisticated dual approaches to econometric estimation of production technologies, this assumption may seem restrictive. Due to the difficulties in constructing price indices for intermediate inputs for the various sectors which cannot be obtained from the ASE data, the separability assumption has been retained.

Constant returns to scale is imposed on each sectoral technology. The sector specification for the APEX model is given in Table 1. The original 42-sector specification was later disaggregated into 50 sectors. Problems in obtaining data from the NSO at a lower level of disaggregation forced the researchers to work at the 42-sector level of disaggregation. Due to data problems, estimation results are presented for only 23 of the 29 manufacturing and services

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sectors.[1] The ASE uses the Philippine Standard Industrial Classification (PSIC). The categorization of the PSIC sectors in the official 127-sector input-output classification into the APEX nonagricultural sectors is given in Appendix A. A detailed description of the construction of price and quantity data for the goods used in the estimation can be found in Appendix B.

The goods are specified as follows:

"output" good : value added (V);
labor inputs : skilled labor (S),
unskilled labor (U);
capital inputs: land (Z);
buildings, other construction
and land improvements (B);
machinery and equipment (M).

We denote the quantity of good i as q_i and, when convenient and unambiguous, simply by its symbol. For example, in some instances, Z is used to denote the quantity of land. The price of good i is denoted by p_i.

I. CES PRODUCTION FUNCTION ESTIMATION

A CES value added function is estimated using two factors: aggregate labor (L) and aggregate capital (K). The functional form used for the value added production funtion, say f(K,L), is

$$V = \gamma[(1-\delta)]K^{\rho} + \delta L^{\rho}]^{\frac{1}{\rho}} \equiv f(K,L) \tag{1}$$

where V,K and L are the quantities of value added, capital and labor, respectively and $\gamma > 0$, $0 < \delta < 1$ and $\rho \leq 1$ are parameters describing the production technology. The parameter γ is the scale factor; δ is the cost share of labor; and the elasticity of substitution, say σ, is defined as

$$\sigma \equiv \frac{1}{1 - \rho} \tag{2}$$

If $\sigma = 1$, then the CES production function describes a Cobb-Douglas technology. If there are more than two factors, the CES production function allows the CES between pairs of factors to differ from unity, but forces the elasticities between each pair of factors to be identical.

The different methods used to estimate (1) require data on the prices and quantities of aggregate labor and aggregate capital. Using the data on hand, the following steps are taken:

a) to construct the labor data:

Let $i \equiv$ S,U; then

$v_i \equiv$ cost of the ith labor input

$= p_i q_i,$

$v \equiv$ total labor cost

$= v_s + v_u$

$s_i \equiv$ labor cost share of ith labor input

$$= \frac{vi}{v}$$

$w \equiv$ price index for aggregate labor

$= s_s p_s + s_u p_u,$

$L \equiv$ quantity index for aggregate labor

$$= \frac{v}{w}$$

b) to construct the capital data:

Let $i =$ Z,B,M; then

$v_i \equiv$ cost of the ith capital input

$= p_i q_i,$

$v \equiv$ total capital cost

$= \sum_i p_i q_i,$

$s_i \equiv$ capital cost share of ith capital input

$$= \frac{v_i}{v},$$

$r \equiv$ (rental) price index for aggregate capital

$= \sum_i s_i p_i ,$

$K \equiv$ quantity index for aggregate capital

$$= \frac{v}{r}$$

For ease of notation, let us denote by V the quantity of value added and by p the price of value added.

Since the data spans a period of ten years, technical change should be considered in the estimation of the production technologies. A quadratic spline technical change subfunction with two break points was appended to the CES estimating equations. Define a time index t, 2,..., T corresponding to the years 1978, 1979,..., 1987. Specify break points t_1 and t_2. T the technical change subfunction d(t) can be expressed as

$$d(t) \equiv \begin{cases} b_1 t + \frac{1}{2} b_2 t^2 & \text{for } t \leq t_1, \\ b_1 t + \frac{1}{2} b_2 t_1^2 + b_2 (t - t_1) t_1 + \frac{1}{2} b_3 (t - t_1)^2 & \text{for } t_1 \leq t \leq t_2, \\ b_1 t + \frac{1}{2} b_2 t_1^2 + b_2 (t_2 - t_1) t_1 + \frac{1}{2} b_3 (t_2 - t_1)^2 + b_2 (t - t_2) t_1 + b_3 (t - t_2)(t_2 - t_1) + \frac{1}{2} b_4 (t - t_2)^2 & \text{for } t_2 \leq t \leq T. \end{cases} \quad (3)$$

The technical change parameters are the scalars b_1, b_2, b_3, and b_4. A one-break point subfunction can be obtained by setting $t_2 = T$ and the simple quadratic subfunction by setting $t_1 = T$.

The constant GDP for 1978-1987 was plotted to determine the breakpoints. It was increasing prior to and peaked at 1983, then declined till 1985 and increased thereafter. For the two-break point models, the break points are set at $t_1 = 1983$ (or $t_1 = 6$) and $t_2 = 1985$ (or $t_2 = 8$).[2]

Three alternative methods for estimating the CES production function are performed, they are:

Model I : one marginal productivity condition

$$\ln\left(\frac{V}{L}\right) = constant + \sigma \ln\left(\frac{w}{p}\right) + d(t) \quad (4)$$

Estimation is done by ordinary least squares (OLS).

Model II : two marginal productivity conditions

$$\ln\left(\frac{V}{L}\right) = constant + \sigma \ln\left(\frac{w}{p}\right) + d^1(t)$$

$$\ln\left(\frac{V}{K}\right) = constant + \sigma \ln\left(\frac{r}{p}\right) + d^2(t) \quad (5)$$

The technical change subfunction $d^1(t)$ and $d^2(t)$ have the same functional form as d(t) in equation (3) but the technical change parameters are allowed to differ across the equations (5). Estimation is by seemingly unrelated regression (SUR) technique.

Model III: Taylor series approximation

$$\ln\left(\frac{V}{L}\right) = \beta_1 + \beta_2 \ln\left(\frac{K}{L}\right) + \beta_3 \left[\ln\left(\frac{K}{L}\right)\right]^2 + d(t) \qquad (6)$$

The parameter ρ in equation (1) is calculated as

$$\rho = \frac{2\beta_3}{\beta_2(1-\beta_2)} < 1 ,$$

and the elasticity of substitution σ as

$$\sigma \equiv \frac{1}{1-\rho} .$$

Estimation is by OLS.

For each sector, the three models are also estimated without the technical change subfunction. The estimates of the CES elasticities of substitution σ, their standard errors, t-ratios for the null hypothesis Ho: $\sigma=1$, and the adjusted R^2's are given in Table 2.

Model I seems to yield the best results. When only one marginal productivity condition is estimated (Model I), the omitted input, in our case, capital, is assumed to be a fixed input and absorbs the residual profits. The system estimation of the marginal productivity conditions (Model II) is flawed because of measurement errors; the capital rental prices used do not ensure the zero profit (a constant returns to scale) condition. The Taylor series approximation (Model III) uses only quantity data and the right-hand variables are more likely to be correlated with the econometric error term. If prices are competitive and, hence, exogenous to the firms, then the right-hand variables in Model I are more likely to be independent of the error term. This weakness of Model III illustrates a problem in the direct estimation of production functions using only quantity data.

For all models, the adjusted R^2 generally increased with the addition of the technical change subfunction. This result suggests the appropriateness of taking technical change into account in the estimation. In terms of adjusted R^2's, Model III performed slightly better than Model I. The sensitivity of estimated elasticities to the model used is disturbing. Model III also yields negative elasticities of substitution for the machinery and metal products sector (32) and the motor and motor vehicles sector (33). In a two factor model, economic theory says that the factors have to be substitutes which implies that the elasticity of substitution σ defined in equation (2) has to be positive. For those who would like to make further use of the elasticity estimates, we leave the choice between Model I and Model III to the user; extraneous information about the sector under study may help.

The results of Model I with technical change are discussed next. Negative estimates of the elasticity of substitution, implying complementarity of labor and capital, are obtained for the mining and quarrying (15) and the fertilizer (27) sectors. However, the elasticity σ is not significantly different from zero at the 5% level of significance ($df=\infty$, $t_{.025,\infty} = 1.96$). Hence, there might be Leontief technologies in these two sectors.

The hypothesis of a Cobb-Douglas technology, Ho: $\sigma=1$, is rejected in 9 sectors:
(26) wood and wood products,
(28) rubber and chemical products,
(32) machinery and metal products,
(33) motor and motor vehicles,
(34) furniture and other manufacturing,
(35) construction,
(37) transportation and communication services,
(38) trade, and
(42) other services.

The resource-based sectors, food manufacturing sectors and "light" industries (such as textiles and garments) tend to have Cobb-Douglas technologies. With a Cobb-Douglas technology, the factor income shares of capital and labor are constant. Since the inputs are aggregated into two goods, the elasticity from a two-input model is expected to be smaller in magnitude compared to those from a model with more disaggregated inputs.

Impossibility theorems have been derived by Uzawa (1962) and McFadden (1963) which show that if there are more than two factors, it is not possible to obtain a functional form for a production function which has an arbitrary set of constant elasticities of substitution. Duality theory provides us with profit and cost functions which are econometrically useful in estimating the parameters of the underlying technology. The latter approach yields elasticities of substitution at a given set of inputs and input prices and hence, are not necessarily constant. Note that the elasticity of substitution obtained using the CES production function is identical across factor prices of capital and labor. Hence, when the number of inputs is greater than two and we wish to allow for an arbitrary set of elasticities of substitution, then flexible functional forms developed using duality theory can be used. A flexible functional form for a profit (or restricted profit) function provides a second order differential approximation to an arbitrary twice continuously differentiable profit (or restricted profit) function that satisfies the linear homogeneity in prices property at any point in an admissible domain.

II. TRANSLOG VARIABLE COST FUNCTION ESTIMATION

The short-run cost minimization problem for the industry, assumed to be an aggregate of firms having constant returns to scale technologies, can be formulated as

$$\min_x \{ p^T x : T(y,x,z) = 0 \} \equiv C_v(y,p,z) \qquad (7)$$

where $y>0$ is the output quantity, $z>0$ is the quantity of the quasi-fixed input, $p \equiv (p_1, p_2,\ldots, p_N)^T >> 0_N$ is the price vector for the industry's N variable inputs, and $x \equiv (x_1, x_2, \ldots, x_N)^T \geq 0_N$ is the quantity vector for the variable inputs. The function T is a transformation function characterizing a constant returns to scale technology. At the cost minimizing choice of the variable inputs, say x^*, given the output level y, fixed input level z and prices p, the variable cost is given by $C_v(y,p,z) = \Sigma p^T x^*$. The econometric estimation assumes optimizing behavior on the part of the producers; this implies that observed input choices are optimal for the variable cost minimizing problem.

In the estimation, the output quantity y is defined as the value added quantity and the quantity of the quasi-fixed input z is taken as the quantity of land. Two capital goods and two labor categories (N=4) comprise the set of variable inputs and are denoted as follows:

B ≡ buildings, other construction and land improvements;
M ≡ machinery and equipment;
S ≡ skilled labor; and
U ≡ unskilled labor.

The translog functional form with an appended technical change subfunction is used to model the variable cost function defined in (7). The translog variable cost subfunction takes the form

$$\ln\left(\frac{C_V}{y}\right) = \alpha_0 + \alpha_z \ln z + \sum_{i=1}^{N} \alpha_i \ln p_i + \frac{1}{2}\alpha_{zz} (\ln z)^2 + \frac{1}{2}\sum_{i=1}^{N} \sum_{j=1}^{N} \alpha_{ij} \ln p_i \ln p_j + \sum_{i=1}^{N} \alpha_{iz} \ln p_i \ln z. \qquad (8)$$

In the above functional form, linear homogeneity in output or "short-run" constant returns to scale has been imposed. The cost share equation for variable input i, defined as

$$s_i \equiv \frac{p_i x_i}{C_V}, \quad i = 1, 2, \ldots, N \qquad (9)$$

and using Shephard's lemma, takes the following form for the translog variable cost function (8):

$$s_i = \alpha_i + \sum_{j=1}^{N} \alpha_{ij} \ln p_j + \alpha_{iz} \ln z \,, \quad i = 1, 2, \ldots, N \,; \qquad (10)$$

In the estimation of the variable cost function and the calculation of the elasticities of factor substitution and price elasticities of demand, the additional restrictions on symmetry and linear homogeneity in input prices are imposed:

$$\text{symmetry:} \quad \alpha_{ij} = \alpha_{ji} \,, \quad i,j = 1, 2, \ldots, N \,; \qquad (11)$$

linear homogeneity in input prices :

$$\sum_{i=1}^{N} \alpha_i = 1 \; ; \tag{12}$$

$$\sum_{i=1}^{N} \alpha_{ij} = 0 \; , \quad j = 1, 2, \ldots, N \; ; \quad and \tag{13}$$

$$\sum_{i=1}^{N} \alpha_{iz} = 0 \tag{14}$$

With the symmetry restrictions, one of the constraints in (13) is redundant. If $\alpha_{ij} = 0$ for all i,j , then the substitution possibilities among the variable inputs are those of a Cobb-Douglas technology. If $\alpha_{ij} = \alpha_{ik}$ for all $i \neq j$ and $i \neq k$, then the substitution possibilities among the variable inputs are those of a CES technology.

Two alternative specifications of the technical change subfunctions, namely $d^1(p,t,z)$ and $d^2(p,t)$ are used. Consistent with the dual approach used in flexible functional form estimation, the technical change subfunctions are allowed to depend on variable input prices p as well as a proxy variable--the time index t. The time index t is as defined previously in the CES production function estimation; let t = 1, 2, ..., T corresponding to the years 1978, 1979, ..., 1987. The alternative specifications are

A.

$$d^1(p,t,z) \equiv \alpha_t t + \sum_{i=1}^{N} \alpha_{it}(\ln p_i)t + \alpha_{zt}(\ln z)t + \frac{1}{2}\alpha_{tt}t^2 \tag{15}$$

$$\frac{\partial\, d^1(p,t)}{\partial \ln p_i} = \alpha_{it}t \tag{16}$$

B.

$$d^2(p,t) \equiv \begin{cases} p^T b^1 t + \frac{1}{2} p^T b^2 t^2 & \text{for } t \leq t_1 \, , \\ p^T b^1 t + \frac{1}{2} p^T b^2 t_1^2 + p^T b^2 (t-t_1) t_1 + \frac{1}{2} p^T b^3 (t-t_1)^2 & \text{for } t_1 \leq t \leq t_2 \, , \quad (17) \\ p^T b^1 t + \frac{1}{2} p^T b^2 t_1^2 + p^T b^2 (t_2-t_1) t_1 + \frac{1}{2} p^T b^3 (t_2-t_1)^2 + p^T b^2 (t-t_2) t_1 \\ \quad + p^T b^3 (t-t_2)(t_2-t_1) + \frac{1}{2} p^T b^4 (t-t_2)^2 & \text{for } t_2 \leq t \leq T \end{cases}$$

where b^1, b^2, b^3, and b^4, are N-dimensional vectors and t_1 and t_2 are exogenously specified time break points.

$$\frac{\partial d^2(p,t)}{\partial p_i} \equiv \begin{cases} b_i^1 t + b_i^2\left(\frac{1}{2}t^2\right) & \text{for } t \le t_1 , \\ b_i^1 t + b_i^2\left[\frac{1}{2}t_1^2 + (t-t_1)t_1\right] + b_i^3\left[\frac{1}{2}(t-t_1)^2\right] & \text{for } t_1 \le t \le t_2 , \\ b_i^1 t + b_i^2\left[\frac{1}{2}t_1^2 + (t_2-t_1)t_1 + (t-t_2)t_1\right] + b_i^3\left[\frac{1}{2}(t_2-t_1)^2 + (t-t_2)(t_2-t_1)\right] + b_i^4(t-t_2)^2 & \text{for } t_2 \le t \le T . \end{cases} \qquad (18)$$

The subfunction $d^1(p,t,z)$ is quadratic in the time variable t. The subfunction $d^2(p,t)$ is a quadratic spline model with two break points for technical progress, proposed by Diewert and Wales (1989), and has been shown to be technical progress-flexible.[3] The break points have been set at $t_1 = 6$ (for 1983) and $t_2 = 8$ (for 1985) as in the CES estimation. The linear homogeneity in input prices p of the variable cost function implies

$$\sum_{i=1}^{N} \alpha_{it} = 0 \qquad (19)$$

in the subfunction $d^1(p,t,z)$ in equation (15) and

$$\sum_{i=1}^{N} b_i^1 = 0 \; ; \quad \sum_{i=1}^{N} b_i^2 = 0 \; ; \quad \sum_{i=1}^{N} b_i^3 = 0 \; ; \quad \text{and} \quad \sum_{i=1}^{N} b_i^4 = 0 \qquad (20)$$

in the subfunction $d^2(p,t)$ in equation (17).

Three estimation models are used:

Model I : system of N equations--the variable cost function (8) and (N-1) share equations (10) estimated with technical change subfunction A.

Model II : system of (N-1) share equations (10) with technical change subfunction B.

Model III: system of (N-1) share equations (10) with technical change subfunction A.

Since the subsystem of N share equations is singular due to the adding-up constraint, one of the share equations is dropped in the estimation. In Model I, the technical change subfunction $d^1(p,t,z)$ is appended to the translog variable cost subfunction (8); the resulting variable cost function is jointly estimated with (N-1) share equations of the form

$$s_i = \alpha_i + \sum_{j=1}^{N} \alpha_{ij} \ln p_j + \alpha_{iz} \ln z + \frac{\partial d^1(p,t)}{\partial \ln p_i} , \quad i = 1, 2, \ldots, N-1 \tag{21}$$

where the last term is defined in equation (16). In model II, the share equations are specified as

$$s_i = \alpha_i + \sum_{j=1}^{N} \alpha_{ij} \ln p_j + \alpha_{iz} \ln z + \frac{\partial d^2(p,t)}{\partial p_i} , \quad i = 1, 2, \ldots, N-1 . \tag{22}$$

The systems of equations are estimated using Zellner's iterative procedure for seemingly unrelated regressions.

Model I has the most number of parameters to estimate. It has been reported that estimation of the full dual system yields estimates that are more precise and more likely to be consistent with concavity conditions. Hence, Model I is estimated only for those sectors with more than 40 observations.[4] Model III is Model I without the variable cost function; hence, Model III involves a fewer number of parameters and is the least informationally demanding among the three estimation models. Model III was estimated for 22 out of the 29 nonagricultural sectors in the earlier 42-sector APEX model.[5] Model II is Model III with a more complex technical change subfunction and is estimated for four sectors with less than 40 observations.[6]

For the translog variable cost function, the Allen-Uzawa elasticity of substitution between inputs i and j, denoted by σ_{ij} is defined as

$$\sigma_{ij} \equiv \frac{C_V(p,y,z) \dfrac{\partial^2 C_V(p,y,z)}{\partial p_i \partial p_j}}{\dfrac{\partial C_V(p,y,z)}{\partial p_i} \dfrac{\partial C_V(p,y,z)}{\partial p_j}} ; \tag{23}$$

$$= \begin{cases} \dfrac{\alpha_{ij} + s_i s_j}{s_i s_j} & \text{for } i \neq j , \\[2ex] \dfrac{\alpha_{ii} + s_i (s_i - 1)}{s_i^2} & \text{for } i = j . \end{cases} \tag{24}$$

The Allen-Uzawa elasticities of substitution are symmetric, that is $\sigma_{ij} = \sigma_{ji}$. Concavity of the variable cost function in the prices of the variable inputs, which is not imposed in the estimation, implies that $\sigma_{ii} < 0$ for all i, i = 1, 2,...,N. If $\sigma_{ij} > 0$ for $i \neq j$, then inputs i and j are substitutes; if $\sigma_{ij} < 0$ for $i \neq j$, then inputs i and j are complements.

The own and cross-partial price elasticities of conditional demand for input i with respect to the price of input j, denoted by ϵ_{ij}, is defined as

$$\epsilon_{ij} = \sigma_{ij} s_j \quad . \tag{25}$$

The signs of σ_{ij} and ϵ_{ij} are identical but ϵ_{ij} is no longer symmetric, that is, $\epsilon_{ij} \neq \epsilon_{ji}$ for a given pair of inputs i and j. Also, linear homogeneity of the cost function in input prices implies the equality

$$\sum_{j=1}^{N} \epsilon_{ij} = 0 \tag{26}$$

In this study, the elasticities are calculated at the mean values of the variables p, y, z and t.

For each model, estimation is done with and without data transformation prior to the estimation. The models are initially estimated with transformed data: each variable (y, z, p and x) except for the time index (t) was divided by its mean before taking logarithms. If we take the mean values of the variables (before transformation) as the point of approximation, then the calculation of predicted cost shares and the elasticity formulas simplify.[7] Table 3 reports the elasticities of substitution and factor price elasticities for each of the 22 sectors using the transformed data in the translog cost estimation. Table 4 reports the elasticities obtained using the untransformed data.

To facilitate comparison of the results, Tables 5 and 6 list the predicted shares and calculated elasticities in a more compact form using transformed and untransformed data, respectively. A visual inspection indicates that the magnitudes of the factor price elasticities can be sensitive to the data transformation but generally, the signs which are indicators of the substitutability or complementarity of the inputs are preserved. The relative degrees of substitutability are also generally preserved as indicated by the relative magnitudes of the factor price elasticities. It can then be inferred that for sectors where the above are obtained, the factor price elasticities obtained using the translog variable cost function have some degree of "robustness."

Economic theory dictates that own-price elasticities be negative; that is, as the price of an input goes up, the conditional demand[8] for that input goes down. In duality theory, this is implied by the concavity of the cost function in input prices. This theoretical restriction is not imposed on the estimation since the procedure used to impose the curvature condition destroys the flexibility of the translog functional form (Diewert and Wales 1985).

The models estimated using the transformed data performed better than those using the untransformed data with respect to satisfying the concavity condition. The lists of sectors that violate the concavity conditions are given in Tables 7 and 8 for both groups of estimates. Using the transformed data, the translog cost function estimation yielded at least one model that satisfies the concavity condition for each sector except for the following seven of the 22 sectors:

(19) oils and fats,
(21) flour and feed milling,
(25) garments, footwear, and leather,
(27) fertilizer,
(29) coal and petroleum,
(38) trade, storage and warehousing, and
(42) private services.

The concavity condition is still violated by these seven sectors even when the untransformed data is used. Using the untransformed data did not yield any model estimates satisfying the concavity condition in 12 of the 22 sectors-- over one-half of the sectors for which estimation was attempted. A cursory inspection of the results indicates that the concavity condition seems to be grossly violated by the fertilizer (27) and coal and petroleum (29) sectors.

The factor price elasticity estimates are less sensitive to the choice of estimation model (models I, II, III) than to whether the data was transformed prior to estimation. An inventory of elasticity estimates for the different nonagricultural sectors specified in the 42-sector APEX model is given in Table 9. The models that yielded concavity violations are excluded.

The own- and cross-price elasticities of conditional input demands are generally less than one in absolute value. This implies that the conditional input demands are inelastic with respect to the factor prices. Factor price elasticities greater than one in absolute value are obtained in only three sectors: rice and corn milling (16), textiles (24), and cement and basic metal (30); these elasticities are own-price elasticities for either buildings and structures (B) or machinery and equipment (M). In general, the responsiveness of conditional demands for the capital goods (B and M) with respect to their own prices is greater than that of the conditional demands for labor, both skilled and unskilled. An exemption is the semiconductor industry (31) where the demand for unskilled labor is relatively own-price elastic compared to other variable inputs; however, the cost share of unskilled labor in this sector is small with the bulk of the variable cost spent on machinery and skilled labor. The low factor price elasticities and the greater responsiveness of input demands for capital relative to labor with respect to their own prices may be partially due to the high level of protection and regulation accorded some sectors, especially some manufacturing and service sectors, which have led to a highly distorted economy biased towards capital use. With the implementation of structural reforms, such as trade liberalization, tariff reform, and financial deregulation in the late 1980's and the 1990's, greater price responsiveness of input demands and higher degrees of substitutability between inputs may be observed.[9]

Tables 10 and 11 summarize the substitutability and complementarity relationships among the variable inputs as indicated by the estimation results. For sectors where the concavity of the cost function condition is violated, the results must be taken with caution since the wrong sign in the own price elasticity will affect the signs of the other elasticities.[10] Substitutability between inputs dominate except for the pair of labor inputs. Skilled and unskilled labor turn out complementary inputs in all sectors except in mining and quarrying (15) and semiconductor (31) industries.[11]

Some researchers have strong priors that for the Philippines skilled and unskilled labor are complementary factors. To satisfy probable users of the elasticities generated in this study with such priors, two additional estimation procedures are performed. First, a CES labor aggregator function is estimated for each of the sectors to yield an elasticity of substitution between skilled and unskilled labor. The estimation procedure and results are described in Appendix C. Second, a normalized quadratic or a symmetric generalized McFadden (value added) profit function using aggregate labor is estimated for each sector. The curvature condition, convexity in prices in the case of a profit function, can be imposed without destroying the flexibility of the functional form. This procedure may address the problem of getting production estimates for the seven sectors for which the translog functional form did not yield any set of elasticity estimates consistent with the concavity of the cost function. The profit function estimation is described in the next section.

III. NORMALIZED QUADRATIC (SYMMETRIC GENERALIZED McFADDEN) PROFIT FUNCTION ESTIMATION

A unit scale profit function is used to describe the industry's technology assumed to be subject to constant returns to scale. Suppose there are N+1 goods produced or used as inputs in the industry. Let the (N+1)th good be the normalizing good or the good chosen to be the scale variable.[12] Denote the quantity of this good by z_{N+1}. For the quantity variables, let output be indexed positively and inputs be indexed negatively. Denote the price vector of the first N goods at period t as $p^t \equiv (p_1^t, p_2^t, \ldots, p_N^t)^T >> 0_N$ and the quantity vector at period t as $z^t \equiv (z_1^t, z_2^t, \ldots, z_N^t)^T$. The period t unit scale production possibilities set containing the feasible z vectors when $|z_{N+1}| = 1$ can be represented by a set S^t, a nonempty, closed subset of N-dimensional space.[13]

The period t unit scale profit function $\pi(p,t)$ which is dual to the unit scale production possibilities set S^t is defined as

$$\pi(p,t) \equiv \max_z \{p^T z;\ z \in S^t\} \quad (27)$$

Under the assumption of constant returns to scale and finite production plans, the optimal profit defined over the whole set of N+1 goods is zero. Hence, if an input is chosen as the scale variable, then the unit scale profit function defined by equation (27) gives the per unit return to the normalizing or scaling input.

For econometric estimation, a functional form is posited for the unit scale profit function. The symmetric generalized McFadden (SGM) flexible functional form with a quadratic spline model for technical progress, proposed by Diewert and Wales (1989), is used.[14] This model for the unit scale profit function is TP (technical progress) flexible. In measuring elasticities of substitution and factor price elasticities, it is imperative that the estimates reflect the effects of relative price changes on the substitution of goods, net of the technical change effects.

The unit scale profit function used in this study takes the following form:

$$\pi(p,t) \equiv h(p) + d(p,t) \quad (28)$$

where the symmetric generalized McFadden (normalized quadratic) subfunction h(p) is defined as

$$h(p) \equiv p^T b^1 + \frac{1}{2}\left(\frac{p^T B p}{\alpha^T p}\right) , \tag{29}$$

and the quadratic spline technical change subfunction d(p,t) is defined as

$$d(p,t) \equiv \begin{cases} p^T b^2 t + \frac{1}{2} p^T b^3 t^2 & \text{for } t \le t_1 ; \\ p^T b^2 t + \frac{1}{2} p^T b^3 t_1^2 + p^T b^3 (t-t_1) t_1 & \\ \quad + \frac{1}{2} p^T b^4 (t-t_1)^2 & \text{for } t_1 \le t \le t_2 ; \\ p^T b^2 t + \frac{1}{2} p^T b^3 t_1^2 + p^T b^3 (t_2-t_1) t_1 & \\ \quad + \frac{1}{2} p^T b^4 (t_2-t_1)^2 + p^T b^3 (t-t_2) t_1 & \\ \quad + p^T b^4 (t-t_2)(t_2-t_1) + \frac{1}{2} p^T b^5 (t-t_2)^2 & \text{for } t_2 \le t \le T , \end{cases} \tag{30}$$

where T is the maximum value of the time index. The exogenous parameters of the model are $\alpha \equiv (\alpha_1, \alpha_2, \ldots, \alpha_N)^T \geq 0_N$ in (29) and the break points in the quadratic spline model - t_1 and t_2 in (30). The parameters to be estimated are the N-dimensional vectors b^1, b^2, b^3, b^4 and b^5 and the NxN matrix B. The profit function defined by (28), (29) and (30) is linearly homogeneous in prices. Convexity of the profit function in prices is imposed by restricting the B matrix in (29) to satisfy the restrictions: $B = B^T$ and B is positive semidefinite. For identification, a reference vector p^* is chosen such that $Bp^* = 0_N$.

The Diewert-Wales (1989) method of specifying the α vector is followed in the estimation. The exogenous parameters α_n, n = 1, 2,..., N are calculated as follows:

1. Let j^* be the observation index of the reference price vector p^* chosen to satisfy the restriction $Bp^* = 0_N$. Then, define transformed price and quantity variables

$$\bar{p}_n^j \equiv \frac{p_n^j}{p_n^{j^*}} \quad \text{and} \tag{31}$$

$$\bar{z}_n^j \equiv z_n^j (p_n^{j^*}) \tag{32}$$

for all goods n, n = 1, 2,..., N and observation j, j = 1, 2,..., J.

2. For each good n, n = 1, 2,...,N, define the mean value of the quantity variables in (32) over the J observations as

$$\overline{z}_n \equiv \frac{\sum_{j=1}^{J} \tilde{z}_n^j}{J} \quad . \tag{33}$$

3. For each good n, n = 1, 2,..., N set α_n as

$$\alpha_n \equiv \frac{|\, \overline{z}_n \,|}{\sum_{k=1}^{N} |\, \overline{z}_k \,|} = \frac{|\, p_n^{j^*} \hat{z}_n \,|}{\sum_{k=1}^{N} |\, p_k^{j^*} \hat{z}_k \,|} \tag{34}$$

where $\hat{z}_k$ is the mean of the unadjusted quantity variable k.

Hence, α_n is a relative measure of the value share of good n in production when evaluated at j^* prices. If the relative value share of good n is small, its corresponding α_n will also be small. Note too that $\alpha^T p^* = 1$ when p^* is set at its transformed values defined by (31).

For each sector, a system of N unit scale output supply and factor demand equations can be obtained using Hotelling's lemma. The system of equations is given by

$$\frac{\tilde{z}^j}{|\, \tilde{z}_{N+1}^j \,|} = \nabla_p \pi(\tilde{p}^j, t^j) \quad . \tag{35}$$

The functional form assumed for the unit scale profit function π is defined by equations (28)-(30); the components of the N-dimensional vectors $\tilde{z}^j$ and $\tilde{p}^j$ are defined by equations (32) and (31), respectively; and the scalar $\tilde{z}_{N+1}^j$ is defined as

$$\tilde{z}_{N+1}^j = \frac{z_{N+1}^j}{z_{N+1}^{j^*}} \tag{36}$$

for j = 1, 2,..., J.[15] Theoretically, the unit scale profit function is convex in prices; this condition is imposed on the estimation procedure by restricting the B matrix in (29) to be positive semidefinite, that is, by setting

$$B = AA^T \tag{37}$$

where $A \doteq [a_{ij}]$ is a lower triangular matrix. When this restriction is imposed, the system of equations given in (35) becomes nonlinear in parameters. For identification, the restriction $Bp^* = 0_N$ is imposed which implies that $A^T p^* = 0_N$.

The actual estimation model used in this study takes the form

$$\frac{\tilde{z}^j}{|\tilde{z}^j_{N+1}|} = \nabla_p \pi(\tilde{p}^j, t^j) + e^j \quad , \quad j = 1, \ldots, J. \tag{38}$$

where e^j denotes a vector of stochastic disturbance terms for observation j.[16] We assume that the N-vector e^j is an identically and independently distributed vector random variable with zero mean and positive definite variance-covariance matrix Σ. Estimation was performed using the MODEL procedure of the ETS/SAS computer package; the ITSUR (iterative seemingly unrelated regression) estimation method, which minimizes a generalized mean of squared residuals, was used.[17] This method yields consistent estimates of the parameters of the profit function. Along the line of the semiflexible estimation technique where the rank of the matrix B in (29) is restricted to less than N-1, some of the parameters in the matrix A defined in equation (37) have been set to zero to aid convergence of the nonlinear optimization routines. With semiflexible estimation, fewer parameters need to be estimated but second-order derivatives of the profit function can still attain arbitrary values.

The price elasticities ϵ_{ij}, i,j = 1, 2,..., N, are defined as

$$\epsilon_{ij} \equiv \frac{\partial z_i}{\partial p_j}\frac{p_j}{z_i} = \frac{\partial^2 \pi(p,t)}{\partial p_i \partial p_j}\frac{p_j}{z_i} = \frac{\partial^2 h(p)}{\partial p_i \partial p_j}\frac{p_j}{z_i} \tag{39}$$

where h(p) is given in equation (29): By the homogeneity in prices property of the profit function, $[\nabla_{pp}^2 \pi]p = 0_N$; therefore, the equality

$$\sum_j \epsilon_{ij} = 0 \tag{40}$$

is obtained. Since convexity of the profit function is imposed, then $\epsilon_{ii} > 0$ if good i is an output good and $\epsilon_{ii} < 0$ if good i is an input good. For the cross-price elasticity ϵ_{ij}, $i \neq j$, we have the following interpretations of the sign of the elasticity with respect to the substitutability or complementarity of goods i and j:

i) If goods i and j are input goods, then
$\epsilon_{ij} > 0$ implies goods i and j are substitutes and $\epsilon_{ji} > 0$;
$\epsilon_{ij} < 0$ implies goods i and j are complements and $\epsilon_{ji} < 0$.

ii) If good i is an output good and good j is an input good, then
$\epsilon_{ij} < 0$ implies goods i and j are substitutes and $\epsilon_{ji} > 0$;
$\epsilon_{ij} > 0$ implies goods i and j are complements and $\epsilon_{ji} < 0$.

In this study, for each sector an output good and four input goods are specified: value added (V) as the output good and buildings, other construction and land improvements (B), machinery and equipment (M), labor (L)[18] and land (Z) as the input goods. Land is chosen as the scale variable.

In the estimation, the reference price vector p is chosen to be the vector of ones. The first observation that appears in the data set is chosen to be the data point in which all prices are set to unity; this is done using the data transformations described by equations (31) and (32). The values of the exogenous parameters α, calculated using equations (33) and (34) are listed in Table 12.[19] The two break points of the quadratic spline technical change subfunction are exogenously set at default values $t_1 = 6$ (1983) and $t_2 = 8$ (1985). For the rubber and chemicals sector (28), the break points are set at $t_1 = 5$ (1982) and $t_2 = 8$ (1985). A one-break technical change subfunction is used by setting $t_1 = 8$ (1985) and $t_2 = 10$ (1987 or T) for the rice and corn milling (16), garments, footwear and leather (25) and trade, storage and warehousing (38) sectors. A no-break or unsplined linear technical change subfunction is used for the private services sector (42) by setting $t_1 = 10$ (1987 or T) and $b^3 = 0_4$.

Estimates of the price elasticities from the symmetric generalized McFadden profit function model for the different sectors are listed in Table 13. Table 14 gives the same elasticity estimates in a more compact form. A summary of the signs of the elasticities, indicators of the substitutability or complementarity of goods, is given in Table 15. Theoretically, we expect $\epsilon_{VV} > 0$, ϵ_{BB}, ϵ_{MM}, $\epsilon_{LL} < 0$; the signs of the elasticity estimates ϵ_{ij} and ϵ_{ji} to be identical if goods i and j are both input goods; and the signs of ϵ_{ij} and ϵ_{ji} to reverse if one good is an input and the other is an output good. The violations occur in the following sectors:

(15) mining and quarrying,
(27) fertilizer,
(29) coal and petroleum, and
(30) cement and basic metals.

Hence, for these sectors the elasticity estimates are dubious and are disregarded in the succeeding discussion of the elasticities.[20] The above problems occur because the predicted values of the unit scale output supply and input demands in equation (38) are of the wrong sign.[21]

Let us consider first the cross-price elasticities between value added and the inputs. These elasticities are given by the first column and first row of the sector's matrix of price elasticities in Table 13. The results indicate that substitutability between the value added good and the inputs dominates complementarity; that is, most of the elasticities ϵ_{Vj}, where good j is an input good, are negative.[22]

The factor price elasticities, reported as a 3 x 3 submatrix in the lower right hand side of the sector's matrix of elasticities in Table 13, are not directly comparable with those obtained using the translog variable cost function. The estimated factor price elasticities obtained using a profit function reflect output adjustments in response to input price changes. Also, the specification of the labor input differs in the estimation of the cost and profit functions.

As Table 15 shows, there are more instances, slightly over half, where inputs behave as complements than substitutes. This result contrasts with the one obtained using the translog variable cost function. In this other result, substitutability among inputs is dominant, except for the pair of skilled and unskilled labor. The tendency of the input goods to complement when the profit function is used can be attributed to two factors: the elasticities reflect output adjustments and since value added has to be substitutable with at least one input (see Footnote 22), there can be a decreased tendency for inputs to be substitutes; and, skilled and unskilled labor which turn out complements in most of the translog cost function estimates are now aggregated into a composite labor input.

The sensitivity of the factor price elasticity estimates to the use of either cost or profit function is more apparent in the results for five sectors where the inputs are all complements. These sectors are:

(17) sugar milling and refining,
(19) oils and fats,
(25) garments, footwear and leather,
(31) semiconductor devices, and
(33) motor vehicles.

In these sectors, value added is substitutable with each of the inputs. The results indicate that increases in input prices have relatively strong negative effects on output supply.

IV. CONCLUSION

In this study, production parameters for the Philippine manufacturing and services sectors are econometrically estimated. Of the 29 nonagricultural sectors in the 42-sector APEX model specification, six sectors have severe data problems which precluded econometric estimation. These sectors are listed at the bottom of Table 1. Elasticities of substitution between capital and labor are estimated using a CES production function for the remaining sectors. These elasticities of substitution are reported in Table 2.

The value added functions are then estimated using translog variable cost functions and normalized quadratic (symmetric generalized McFadden) profit functions. For the cost function estimation, the variable inputs are specified as buildings, other construction, and land improvements; machinery and equipment; skilled labor; and unskilled labor, with land as a quasi-fixed input. An inventory of translog models which yield reasonable elasticity estimates for 15 of the 22 sectors for which estimation is done is presented in Table 9; the factor price elasticities are reported in Tables 3 and 4. For the profit function estimation, skilled and unskilled labor are aggregated into one labor input. Land is chosen as the scale variable. Reasonable price elasticities, given in Table 13, are obtained for 18 of the 22 sectors for which estimation is done.

Econometric estimation failed to yield reasonable elasticity estimates for the fertilizer (27) and coal and petroleum (29) sectors due most likely to the unreliability of data.

Table 1

Sector Specification for the Apex Model
(Nonagricultural, Manufacturing and Services Sectors)

Sector Code	42-Sector Model	Sector Code	50-Sector Model
14	Forestry and Logging	16	Forestry and Logging
15	Mining and Quarrying	17	Crude Oil, Coal and Natural Gas
		18	Other Mining
16	Rice and Corn Milling	19	Rice and Corn Milling
17	Sugar Milling and Refining	20	Sugar Milling and Refining
18	Milk and Other Dairy	21	Milk and Other Dairy
19	Oils and Fats	22	Oils and Fats
20	Meat and Meat Products	23	Meat and Meat Products
21	Flour and Feed Milling	24	Flour Milling
		25	Animal Feeds
22	Other Food Manufactures	26	Other Food Manufactures
23	Beverage and Tobacco	27	Beverage and Tobacco
24	Textiles	28	Textiles and Knitting Mills
		29	Other Made Up Textile Goods
25	Garments, Footwear and Leather	30	Garments, Footwear and Leather

Table 1 (continued):

26	Wood and Paper Products	31	Wood Products
		32	Paper Products
27	Fertilizer	33	Fertilizer
28	Rubber and Other Chemicals	34	Rubber and Other Chemicals
29	Coal and Petroleum Products	35	Coal and Petroleum Products
30	Cement and Basic Metal	36	Nonferrous Basic Metal
		37	Cement, Basic Metals, and Nonmetallic Mineral Products
31	Semiconductors	38	Semiconductors
32	Machinery and Metals	39	Metal Products and Non-electrical Machinery
		40	Electrical Machinery, Equipment and Parts
33	Motor Vehicles	41	Motor Vehicles
34	Furniture and Other Manufactures	42	Miscellaneous and Other Manufactures
35	Construction	43	Construction
36	Electricity, Gas and Water	44	Electricity, Gas and Water
37	Transport and Communication	45	Transport and Communication
38	Trade, Storage and Warehousing	46	Trade, Storage and Warehousing
39	Financial Services	47	Banks and Nonbanks
		48	Life and Nonlife Insurance and Real Estate
40	Ownership of Dwelling		
41	Government Services	49	Government Services
42	Other Services	50	Other Services
Total	29 Sectors		35 Sectors

Notes about the data for the 42-sector model:

1. No production data is available for the "ownership of dwelling" sector (40).

2. Data problems exist for the following sectors and hence, estimation results for these sectors are not reported:
   - (14) forestry and logging,
   - (18) milk and dairy,
   - (22) other food manufactures,
   - (37) transport and communication services,
   - (39) financial services.

3. Henceforth, estimation results are given for only 23 sectors

4. Estimation results indicate probable data problems with the government services sector (41)

Table 2

CES Elasticities of Substitution Estimates

Note: 1. Models are:

1 one marginal productivity condition (OLS)
2 two marginal productivity conditions (SUR)
3 Taylor series approximation (OLS)

2. Each table entry refers to:

σ elasticity of substitution estimate
(standard error)
(t-ratio for Ho: σ = 1)
adjusted R^2

Sector Code	Sectors	Without Technological Change 1	Without Technological Change 2	Without Technological Change 3	With Technological Change 1	With Technological Change 2	With Technological Change 3
15	mining and quarrying	-0.8026	0.9419	1.3800	-0.7690	0.9094	1.3003
		(0.6706)	(0.1811)		(0.6991)	(0.1940)	
		(-2.6878)	(-0.3208)		(-2.5305)	(-0.4671)	
		0.0060	0.2666	0.1341	-0.0382	0.35570	0.1457
16	rice and corn milling	0.9872	0.6182	0.9098	0.9721	1.0173	0.9124
		(0.2354)	(0.1738)		(0.2232)	(0.1920)	
		(-0.5456)	(-2.1958)		(-0.1248)	(0.0901)	
		0.2739	0.2000	0.3365	0.3582	0.4934	0.3809
17	sugar milling	0.9541	0.6912	-0.3279	1.1874	0.8262	58.5710
		(0.5566)	(0.2567)		(0.6379)	(0.3164)	
		(-0.0824)	(-1.2030)		(0.2939)	(-0.5493)	
		0.0323	0.1076	0.0867	0.0044	0.2068	0.0797
18	milk and dairy	4.7712	0.7546	1.0980	4.0124	0.7338	1.0962
		(1.9685)	(0.4399)		(2.2472)	(0.9672)	
		(1.9158)	(-0.5577)		(1.3405)	(-0.2753)	
		0.3071	0.2064	0.7911	0.2439	0.3877	0.7839

Table 2. (continued)

Sector Code	Sectors	Without Technological Change 1	2	3	With Technological Change 1	2	3
19	oils and	1.2707	0.5742	0.9705	1.4440	0.4943	1.1156
	fats	(0.3555)	(0.1797)		(0.3641)	(0.1887)	
		(0.7612)	(-2.3698)		(1.2197)	(-2.6809)	
		0.1216	0.1074	0.0325	0.1530	0.2211	0.0334
20	meat and	1.3869	1.3182	0.4551	0.0823	1.1832	1.0304
	meat products	(1.0549)	(0.3520)		(1.0614)	(0.4122)	
		(0.3668)	(0.9040)		(-0.8646)	(0.4443)	
		0.0237	0.3168	0.4441	0.3398	0.6766	0.5492
21	flour and	0.9262	0.7492	-0.2376	1.1317	0.6975	0.5507
	flour milling	(0.4442)	(0.2629)		(0.4412)	(0.3029)	
		(-0.1661)	(-0.9541)		(0.2985)	(-0.9989)	
		0.0584	0.1285	0.1969	0.1436	0.3300	0.2519
23	beverages	1.9220	0.7677	0.9486	1.7076	1.0981	1.8490
	and tobacco	(0.3573)	(0.1518)		(0.4483)	(0.1937)	
		(2.5806)	(-1.5304)		(1.5785)	(0.5065)	
		0.2167	0.2093	0.2053	0.3259	0.4507	0.4035
24	textiles	1.5576	0.8040	0.5761	0.8650	0.8434	0.6234
		(0.4895)	(0.2751)		(0.3977)	(0.2672)	
		(1.1391)	(-0.7127)		(-0.3396)	(-0.5859)	
		0.1979	0.1865	0.1255	0.5324	0.6436	0.4867
25	garments,	0.8960	0.6602	0.6399	2.2852	0.4114	0.6297
	footwear	(0.5672)	(0.2249)		(0.6996)	(0.2947)	
	and	(-0.1834)	(-1.5111)		(1.8270)	(-1.9970)	
	leather	0.0222	0.1161	0.2026	0.1458	0.2966	0.1617
26	wood and wood	2.4034	0.9270	0.6554	2.6908	0.9159	0.5925
	products	(0.3917)	(0.1603)		(0.4157)	(0.1914)	
		(3.5834)	(-0.4552)		(4.0671)	(-0.4396)	
		0.2386	0.2319	0.1626	0.2850	0.3079	0.2843
27	fertilizer	-1.1440	-0.5497	1.1212	-2.9552	-0.9256	1.0425
		(1.3167)	(0.4682)		(2.5847)	(0.5045)	
		(-1.6280)	(-3.3095)		(-1.5302)	(-3.8165)	
		-0.0209	0.0955	-0.1691	-0.0540	0.5086	-0.3236
28	rubber and	1.9142	1.1346	0.4920	1.9186	1.5637	0.3499
	chemical	(0.4002)	(0.2345)		(0.4138)	(0.2689)	
	products	(2.2841)	(0.5742)		(2.2200)	(2.0966)	
		0.2577	0.2784	0.3168	0.2436	0.4605	0.4057

29	coal and	0.4603	1.0301	0.9367	0.0518	-0.1355	0.7094
	petroleum	(1.2173)	(0.4865)		(1.0644)	(0.3580)	
		(-0.4434)	(0.6185)		(-0.9482)	(-3.1717)	
		-0.0531	0.1984	0.1874	0.3963	0.9249	0.6735
30	cement and	1.8720	1.1298	1.0906	1.5098	0.9491	1.0166
	basic metals	(0.2888)	(0.1715)		(0.2959)	(0.2007)	
		(3.0198)	(0.7573)		(1.7230)	(-0.2538)	
		0.3536	0.3863	0.6734	0.4244	0.5695	0.7987
31	semi-	0.6613	0.2448	1.0666	1.3704	0.6340	1.1158
	conductors	(0.7193)	(0.4518)		(1.3128)	(0.6776)	
		(-0.4709)	(-1.6714)		(0.2822)	(-0.5401)	
		-0.0143	0.0201	0.0795	0.1251	0.5926	-0.1115
32	machinery	3.4214	1.0774	0.7626	3.5496	0.8093	-2.8268
	and metal	(0.2588)	(0.1708)		(0.2654)	(0.1959)	
	products	(9.3549)	(0.4534)		(9.6054)	(-0.9737)	
		0.6017	0.2127	0.4844	0.6172	0.3007	0.5589
33	motor and	1.6725	0.9052	-4.8757	1.7842	1.0796	-0.3860
	motor vehicles	(0.2813)	(0.1663)		(0.3147)	(0.1992)	
		(2.3909)	(-0.5701)		(2.4915)	(0.3995)	
		0.3458	0.3078	0.3919	0.3229	0.4237	0.4091
34	furniture and	1.5633	1.1185	1.1164	2.1313	1.0970	0.8885
	other manufac-	(0.3489)	(0.1739)		(0.4475)	(0.1966)	
	tures	(1.6146)	(0.6526)		(2.5278)	(0.4935)	
		0.2242	0.4116	-0.0020	0.2573	0.4873	0.0242
35	construction	1.6696	0.7499	1.2860	2.7763	0.8819	1.4327
		(0.5562)	(0.1200)		(0.5432)	(0.1379)	
		(1.2038)	(-2.0831)		(3.2703)	(-0.8559)	
		0.0679	0.2464	0.5280	0.4481	0.5743	0.5707
36	electricity,	0.4828	0.4555	-3.8256	1.2511	0.7059	0.0667
	gas and	(0.4243)	(0.1305)		(0.4571)	(0.1626)	
	water	(-1.2188)	(-4.1710)		(0.5494)	(-1.8092)	
		0.0027	0.1012	0.6703	0.1272	0.2721	0.6632
37	transportation	4.0948	0.9419	1.3800	4.4025	0.9094	1.3003
	and	(0.4327)	(0.1811)		(0.5735)	(0.1940)	
	communication	(7.0780)	(-0.3208)		(5.9334)	(-0.4671)	
	services	0.5533	0.2666	0.1341	0.5956	0.3557	0.1457
38	trade	1.7396	0.3488	0.9881	2.2893	1.8636	0.9865
		(0.4914)	(0.1109)		(0.5534)	(0.3298)	
		(1.5051)	(-5.8673)		(2.3290)	(2.6182)	
		0.1970	0.1732	0.3496	0.4238	0.5799	0.4980
41	government	0.3372	1.0979	0.6680			
	services	(2.0745)	(0.3023)				
		(-0.3195)	(0.3237)				
		0.0012	0.3492	-0.0939			
42	other	0.9092	0.0482	0.3469	2.0152	1.1909	0.5171
	services	(0.2567)	(0.1178)		(0.3889)	(0.3076)	
		(-0.0908)	(-8.0789)		(2.6106)	(0.6204)	
		0.2378	0.0038	0.3144	0.4336	0.2904	0.3205

Tables 3. Elasticities of Substitution and Factor Price Elasticities (Translog Variable Cost Function Estimation Results Using Transformed Data)

Code: B ≡ buildings and structures
M ≡ machinery and equipment
S ≡ skilled labor
U ≡ unskilled labor

Note: The factor price elasticity is the elasticity of the conditional demand for the input indicated on the leftmost column with respect to the price of the input indicated at the top row heading.

The estimation model used is indicated below the table.

Table 3.1a Mining and Quarrying (15)

Elasticities of Substitution

		B	M	S	U
B	:	−0.72127	0.68728	0.06907	−0.03583
M	:		−1.62083	0.28744	0.60628
S	:			−0.80580	0.46262
U	:				−1.00752

Factor Price Elasticities

		B	M	S	U
B	:	−0.17658	0.16813	0.01761	−0.00916
M	:	0.16826	−0.39650	0.07329	0.15495
S	:	0.01691	0.07032	−0.20546	0.11823
U	:	−0.00877	0.14832	0.11796	-0.25750

*Model III

Table 3.1b Mining and Quarrying (15)

Elasticities of Substitution

		B	M	S	U
B	:	−0.77768	0.63418	0.06789	0.06279
M	:		−1.52170	0.30698	0.54171
S	:			−0.78094	0.42321
U	:				−0.99583

Factor Price Elasticities

		B	M	S	U
B	:	−0.18843	0.15488	0.01741	0.01614
M	:	0.15366	−0.37163	0.07871	0.13927
S	:	0.01645	0.07497	−0.20023	0.10880
U	:	0.01521	0.13230	0.10851	−0.25602

*Model I

Table 3.2a Rice and Corn Milling (16)

Elasticities of Substitution

	B	M	S	U
B :	−5.95909	1.87421	1.41853	1.26810
M :		−5.47271	1.57546	1.23959
S :			−1.31813	−0.83472
U :				−0.96693

Factor Price Elasticities

	B	M	S	U
B :	−1.19098	0.40900	0.41544	0.36655
M :	0.37458	−1.19428	0.46140	0.35830
S :	0.28351	0.34380	−0.38603	−0.24128
U :	0.25344	0.27051	−0.24446	−0.27949

*Model III

Table 3.3a Sugar Milling and Refining (17)

Elasticities of Substitution

		B	M	S	U
B	:	−1.26071	−0.28788	0.75676	0.66365
M	:		−0.90421	0.61088	0.56636
S	:			−0.58305	−0.71407
U	:				−0.45670

Factor Price Elasticities

		B	M	S	U
B	:	−0.28818	−0.07486	0.19241	0.17063
M	:	−0.06581	−0.23513	0.15532	0.14562
S	:	0.17298	0.15886	−0.14825	−0.18359
U	:	0.15170	0.14728	−0.18156	−0.11742

*Model III

Table 3.3b Sugar Milling and Refining (17)

Elasticities of Substitution

		B	M	S	U
B	:	−1.28155	−0.02771	0.63855	0.54738
M	:		−1.58962	0.84405	0.77878
S	:			−0.64089	−0.78333
U	:				−0.49527

Factor Price Elasticities

		B	M	S	U
B	:	−0.29619	−0.00713	0.16250	0.14082
M	:	−0.00641	−0.40874	0.21480	0.20034
S	:	0.14758	0.21704	−0.16310	−0.20152
U	:	0.12651	0.20025	−0.19935	−0.12741

*Model I

Table 3.4a Oils and Fats (19)

Elasticities of Substitution

	B	M	S	U
B :	−2.79146	2.11167	0.28390	0.38394
M :		−2.41590	0.27368	0.00595
S :			−0.00577	−0.53844
U :				0.17048

Factor Price Elasticities

	B	M	S	U
B :	−0.68673	0.51704	0.07317	0.09653
M :	0.51950	−0.59153	0.07054	0.00150
S :	0.06984	0.06701	−0.00149	−0.13537
U :	0.09446	0.00146	−0.13877	0.04286

*Model III

Table 3.4b Oils and Fats (19)

Elasticities of Substitution

	B	M	S	U
B :	−2.67304	2.11010	0.24419	0.31723
M :		−2.44158	0.27250	0.02914
S :			0.00869	−0.51429
U :				0.18713

Factor Price Elasticities

	B	M	S	U
B :	−0.65918	0.51665	0.06285	0.07968
M :	0.52036	−0.59781	0.07013	0.00732
S :	0.06022	0.06672	0.00224	−0.12918
U :	0.07823	0.00713	−0.13237	0.04700

*Model I

Table 3.5a Meat and Meat Products (20)

Elasticities of Substitution

	B	M	S	U
B :	−4.28557	−0.34589	1.04864	1.33056
M :		−3.38589	1.14105	0.85546
S :			−0.22211	−0.90775
U :				−0.25183

Factor Price Elasticities

	B	M	S	U
B :	−0.72233	−0.06068	0.33433	0.44867
M :	−0.05830	−0.59396	0.36379	0.28847
S :	0.17675	0.20017	−0.07081	−0.30610
U :	0.22426	0.15007	−0.28941	−0.08492

*Model III

Table 3.5b Meat and Meat Products (20)

Elasticities of Substitution

	B	M	S	U
B :	−3.21183	0.17804	1.13132	1.27737
M :		−2.46864	0.94443	0.61384
S :			−0.63886	−0.89551
U :				−0.54025

Factor Price Elasticities

	B	M	S	U
B :	−0.72930	0.03512	0.31885	0.37533
M :	0.04043	−0.48697	0.26618	0.18036
S :	0.25688	0.18630	−0.18006	−0.26313
U :	0.29005	0.12109	−0.25239	−0.15874

*Model II

Table 3.6a Flour and Feed Milling (21)

Elasticities of Substitution

	B	M	S	U
B :	-3.71841	3.79488	0.09599	0.20805
M :		-5.40431	0.66412	0.36768
S :			0.03592	-0.72573
U :				0.21497

Factor Price Elasticities

	B	M	S	U
B :	-0.94279	0.86443	0.02531	0.05306
M :	0.96218	-1.23103	0.17508	0.09377
S :	0.02434	0.15128	0.00947	-0.18508
U :	0.05275	0.08375	-0.19133	0.05482

*Model III

Table 3.6b Flour and Feed Milling (21)

Elasticities of Substitution

	B	M	S	U
B :	-4.20059	4.13249	0.08797	0.34593
M :		-5.47394	0.61868	0.20616
S :			0.08511	-0.73476
U :				0.22762

Factor Price Elasticities

	B	M	S	U
B :	-1.06226	0.95114	0.02309	0.08803
M :	1.04504	-1.25989	0.16239	0.05246
S :	0.02225	0.14240	0.02234	-0.18698
U :	0.08748	0.04745	-0.19285	0.05792

*Model I

Table 3.7a Beverages and Tobacco (23)

Elasticities of Substitution

		B	M	S	U
B	:	−2.18648	0.66400	0.44597	0.49076
M	:		−2.00271	0.68335	0.61294
S	:			−0.50899	−0.40012
U	:				−0.47951

Factor Price Elasticities

		B	M	S	U
B	:	−0.42526	0.16316	0.12563	0.13648
M	:	0.12915	−0.49210	0.19250	0.17045
S	:	0.08674	0.16791	−0.14338	−0.11127
U	:	0.09545	0.15061	−0.11271	−0.13335

*Model III

Table 3.7b Beverages and Tobacco (23)

Elasticities of Substitution

		B	M	S	U
B	:	−2.48641	0.73108	0.51497	0.56083
M	:		−1.99250	0.66047	0.58665
S	:			−0.50578	−0.43077
U	:				−0.47327

Factor Price Elasticities

		B	M	S	U
B	:	−0.48129	0.18011	0.14512	0.15606
M	:	0.14151	−0.49088	0.18613	0.16324
S	:	0.09968	0.16272	−0.14253	−0.11987
U	:	0.10856	0.14453	−0.12139	−0.13169

*Model I

Table 3.8a Textiles (24)

Elasticities of Substitution

		B	M	S	U
B	:	−5.19110	1.74028	1.18220	0.97033
M	:		−6.18463	0.97874	1.04721
S	:			−0.12423	−1.04196
U	:				−0.03217

Factor Price Elasticities

		B	M	S	U
B	:	−0.97942	0.27809	0.38570	0.31562
M	:	0.32834	−0.98829	0.31932	0.34063
S	:	0.22305	0.15640	−0.04053	−0.33892
U	:	0.18307	0.16734	−0.33995	−0.01047

*Model III

Table 3.8b Textiles (24)

Elasticities of Substitution

		B	M	S	U
B	:	−3.47346	2.33100	1.07886	0.60187
M	:		−3.88501	0.68936	0.83730
S	:			−0.52437	−1.63181
U	:				−0.06132

Factor Price Elasticities

		B	M	S	U
B	:	−0.99015	0.60667	0.24841	0.13508
M	:	0.66448	−1.01112	0.15873	0.18791
S	:	0.30754	0.17941	−0.12074	−0.36622
U	:	0.17157	0.21792	−0.37573	−0.01376

*Model II

Table 3.9a Garments, Footwear and Leather (25)

Elasticities of Substitution

		B	M	S	U
B	:	0.15382	0.48276	−0.27256	−0.33053
M	:		0.07375	−0.29309	−0.21526
S	:			0.61292	−0.08813
U	:				0.59822

Factor Price Elasticities

		B	M	S	U
B	:	0.03609	0.11980	−0.07086	−0.08502
M	:	0.11327	0.01830	−0.07620	−0.05537
S	:	−0.06395	−0.07273	0.15935	−0.02267
U	:	−0.07755	−0.05342	−0.02291	0.15388

*Model III

Table 3.9b Garments, Footwear and Leather (25)

Elasticities of Substitution

		B	M	S	U
B	:	0.74645	0.07149	−0.35384	−0.39586
M	:		0.44724	−0.28082	−0.21336
S	:			0.63422	−0.04559
U	:				0.61507

Factor Price Elasticities

		B	M	S	U
B	:	0.17584	0.01772	−0.09188	−0.10168
M	:	0.01684	0.11088	−0.07292	−0.05480
S	:	−0.08335	−0.06962	0.16468	−0.01171
U	:	−0.09325	−0.05289	−0.01184	0.15799

*Model I

Table 3.10a Wood and Paper Products (26)

Elasticities of Substitution

		B	M	S	U
B	:	−1.57603	0.75831	0.40098	0.43173
M	:		−1.58295	0.34933	0.42320
S	:			−0.23073	−0.50381
U	:				−0.33158

Factor Price Elasticities

		B	M	S	U
B	:	−0.39521	0.18466	0.10157	0.10898
M	:	0.19015	−0.38547	0.08849	0.10683
S	:	0.10055	0.08507	−0.05845	−0.12717
U	:	0.10826	0.10306	−0.12762	−0.08370

*Model III

Table 3.10b Wood and Paper Products (26)

Elasticities of Substitution

		B	M	S	U
B	:	−1.59758	0.81558	0.38555	0.41493
M	:		−1.56496	0.31523	0.38328
S	:			−0.19159	−0.49563
U	:				−0.28547

Factor Price Elasticities

		B	M	S	U
B	:	−0.40095	0.19866	0.09761	0.10468
M	:	0.20469	−0.38119	0.07980	0.09670
S	:	0.09676	0.07678	−0.04850	−0.12504
U	:	0.10413	0.09336	−0.12547	−0.07202

*Model I

Table 3.11a Fertilizer (27)

Elasticities of Substitution

	B	M	S	U
B :	0.38228	−1.61773	0.72006	0.67589
M :		5.59177	−2.19832	−2.31188
S :			1.19610	0.46955
U :				1.40656

Factor Price Elasticities

	B	M	S	U
B :	0.09846	−0.43095	0.17506	0.15744
M :	−0.41666	1.48962	−0.53444	−0.53852
S :	0.18546	−0.58562	0.29079	0.10937
U :	0.17408	−0.61587	0.11415	0.32764

*Model III

Table 3.12a Rubber and Other Chemicals (28)

Elasticities of Substitution

	B	M	S	U
B :	−1.37940	1.36175	0.03661	−0.03468
M :		−3.50570	1.09973	1.09605
S :			−0.36099	−0.78486
U :				−0.30354

Factor Price Elasticities

	B	M	S	U
B :	−0.34437	0.34424	0.00893	−0.00880
M :	0.33996	−0.88621	0.26820	0.27804
S :	0.00914	0.27800	−0.08804	−0.19910
U :	−0.00866	0.27707	−0.19141	−0.07700

*Model III

Table 3.12b Rubber and Other Chemicals (28)

Elasticities of Substitution

	B	M	S	U
B :	−1.46011	1.33312	0.07777	0.02176
M :		−3.58387	1.10731	1.16283
S :			−0.48433	−0.69221
U :				−0.49322

Factor Price Elasticities

	B	M	S	U
B :	−0.35926	0.33451	0.01916	0.00559
M :	0.32801	−0.89927	0.27283	0.29843
S :	0.01914	0.27785	−0.11933	−0.17765
U :	0.00536	0.29178	−0.17055	−0.12658

*Model I

Table 3.13a Coal and Petroleum Products (29)

Elasticities of Substitution

	B	M	S	U
B :	−0.88082	0.82838	0.25393	−0.17579
M :		−1.34605	0.09138	0.41227
S :			1.09183	−1.40973
U :				1.13445

Factor Price Elasticiti s

	B	M	S	U
B :	−0.22530	0.20763	0.06171	−0.04404
M :	0.21189	−0.33739	0.02221	0.10329
S :	0.06495	0.02290	0.26534	−0.35319
U :	−0.04497	0.10334	−0.34260	0.28423

*Model III

Table 3.13b Coal and Petroleum Products (29)

Elasticities of Substitution

	B	M	S	U
B :	−0.57772	0.65743	0.09768	−0.24228
M :		0.20309	−0.39220	−0.46189
S :			1.45250	−1.12637
U :				1.85493

Factor Price Elasticities

	B	M	S	U
B :	−0.13849	0.17431	0.02417	−0.06000
M :	0.15760	0.05385	−0.09707	−0.11438
S :	0.02342	−0.10399	0.35950	−0.27892
U :	−0.05808	−0.12247	−0.27878	0.45933

*Model II

Table 3.14a Cement and Basic Metal (30)

Elasticities of Substitution

		B	M	S	U
B	:	−7.71901	2.51096	1.68365	1.37103
M	:		−3.15635	0.90127	0.77603
S	:			−0.99792	−1.32883
U	:				−0.60248

Factor Price Elasticities

		B	M	S	U
B	:	−1.51577	0.73375	0.43550	0.34652
M	:	0.49307	−0.92234	0.23313	0.19614
S	:	0.33062	0.26337	−0.25813	−0.33586
U	:	0.26923	0.22677	−0.34372	−0.15227

*Model III

Table 3.14b Cement and Basic Metal (30)

Elasticities of Substitution

		B	M	S	U
B	:	−8.05559	2.58540	1.74614	1.41231
M	:		−3.34084	0.95628	0.84758
S	:			−1.04336	−1.34891
U	:				−0.65849

Factor Price Elasticities

		B	M	S	U
B	:	−1.56495	0.74909	0.45567	0.36019
M	:	0.50226	−0.96797	0.24955	0.21616
S	:	0.33922	0.27707	−0.27227	−0.34402
U	:	0.27437	0.24558	−0.35201	−0.16794

*Model I

Table 3.15a Semiconductor Devices (31)

Elasticities of Substitution

		B	M	S	U
B	:	1.32378	−0.88222	0.19204	−0.54537
M	:		1.37445	−0.81430	0.32475
S	:			−0.51630	1.23792
U	:				−1.21409

Factor Price Elasticities

		B	M	S	U
B	:	0.30283	−0.22213	0.05276	−0.13346
M	:	−0.20182	0.34606	−0.22372	0.07947
S	:	0.04393	−0.20503	−0.14185	0.30294
U	:	−0.12476	0.08177	0.34010	−0.29711

*Model III

Table 3.15b Semiconductor Devices (31)

Elasticities of Substitution

		B	M	S	U
B	:	−0.73450	0.17239	1.59108	−1.60979
M	:		−0.47558	−1.13413	1.93393
S	:			−1.16648	1.56059
U	:				−3.11130

Factor Price Elasticities

		B	M	S	U
B	:	−0.14751	0.05055	0.45302	−0.35607
M	:	0.03462	−0.13947	−0.32292	0.42776
S	:	0.31953	−0.33259	−0.33213	0.34518
U	:	−0.32329	0.56713	0.44434	−0.68819

*Model II

Table 3.16a Machinery and Metal Products (32)

Elasticities of Substitution

	B	M	S	U
B :	−0.49079	−0.95689	0.53421	0.49634
M :		−0.80088	0.51631	0.75319
S :			−0.46288	−0.29571
U :				−0.59569

Factor Price Elasticities

	B	M	S	U
B :	−0.10673	−0.19267	0.15425	0.14515
M :	−0.20809	−0.16126	0.14908	0.22027
S :	0.11617	0.10396	−0.13365	−0.08648
U :	0.10794	0.15165	−0.08538	−0.17421

*Model III

Table 3.16b Machinery and Metal Products (32)

Elasticities of Substitution

	B	M	S	U
B :	−0.80369	−0.39294	0.48325	0.41366
M :		−0.45926	0.17890	0.45269
S :			−0.42112	−0.07763
U :				−0.56413

Factor Price Elasticities

	B	M	S	U
B :	−0.17519	−0.08193	0.13805	0.11907
M :	−0.08565	−0.09576	0.05111	0.13031
S :	0.10534	0.03730	−0.12030	−0.02235
U :	0.09017	0.09439	−0.02218	−0.16238

*Model I

Table 3.17a Motor Vehicles (33)

Elasticities of Substitution

		B	M	S	U
B	:	−2.28595	0.94889	0.65547	0.63298
M	:		−2.04292	0.31123	0.34651
S	:			−0.40566	−0.38525
U	:				−0.41253

Factor Price Elasticities

		B	M	S	U
B	:	−0.55057	0.19125	0.18578	0.17354
M	:	0.22854	−0.41176	0.08821	0.09500
S	:	0.15787	0.06273	−0.11498	−0.10562
U	:	0.15245	0.06984	−0.10920	−0.11310

*Model III

Table 3.17b Motor Vehicles (33)

Elasticities of Substitution

		B	M	S	U
B	:	−2.30062	1.07780	0.65015	0.57484
M	:		−2.15707	0.25771	0.37870
S	:			−0.41199	−0.34479
U	:				−0.43734

Factor Price Elasticities

		B	M	S	U
B	:	−0.55853	0.21860	0.18337	0.15657
M	:	0.26166	−0.43749	0.07269	0.10314
S	:	0.15784	0.05227	−0.11620	−0.09391
U	:	0.13956	0.07681	−0.09725	−0.11912

*Model I

Table 3.18a Furniture and Other Manufactures (34)

Elasticities of Substitution

		B	M	S	U
B	:	-2.57147	1.28539	0.50686	0.78947
M	:		-5.73445	1.23189	0.69082
S	:			-0.45356	-0.55211
U	:				-0.39356

Factor Price Elasticities

		B	M	S	U
B	:	-0.59635	0.19904	0.15572	0.24160
M	:	0.29810	-0.88796	0.37846	0.21141
S	:	0.11755	0.19076	-0.13934	-0.16896
U	:	0.18309	0.10697	-0.16962	-0.12044

*Model III

Table 3.18b Furniture and Other Manufactures (34)

Elasticities of Substitution

		B	M	S	U
B	:	-2.39102	1.38789	0.43331	0.69888
M	:		-5.76695	1.20863	0.65361
S	:			-0.38022	-0.56694
U	:				-0.30142

Factor Price Elasticities

		B	M	S	U
B	:	-0.56063	0.21519	0.13251	0.21292
M	:	0.32542	-0.89417	0.36962	0.19913
S	:	0.10160	0.18740	-0.11628	-0.17272
U	:	0.16387	0.10134	-0.17338	-0.09183

*Model I

Table 3.19a Construction (35)

Elasticities of Substitution

	B	M	S	U
B :	−2.18911	1.27028	0.40475	0.41881
M :		−4.00209	0.91394	0.90798
S :			−0.59978	−0.35866
U :				−0.61278

Factor Price Elasticities

	B	M	S	U
B :	−0.49241	0.25644	0.11744	0.11853
M :	0.28573	−0.80791	0.26519	0.25698
S :	0.09104	0.18450	−0.17403	−0.10151
U :	0.09421	0.18330	−0.10407	−0.17343

*Model III

Table 3.19b Construction (35)

Elasticities of Substitution

	B	M	S	U
B :	−2.33922	1.40731	0.41135	0.42432
M :		−4.07010	0.89032	0.88032
S :			−0.58181	−0.36492
U :				−0.59029

Factor Price Elasticities

	B	M	S	U
B :	−0.52428	0.28466	0.11942	0.12021
M :	0.31541	−0.82327	0.25846	0.24939
S :	0.09219	0.18009	−0.16890	−0.10338
U :	0.09510	0.17806	−0.10594	−0.16723

*Model I

Table 3.20a Electricity, Gas and Water (36)

Elasticities of Substitution

	B	M	S	U
B :	−2.26314	1.81491	0.23620	0.03555
M :		−2.62349	0.37238	0.28931
S :			−0.10235	−0.35097
U :				0.10925

Factor Price Elasticities

	B	M	S	U
B :	−0.47174	0.39336	0.06822	0.01017
M :	0.37831	−0.56860	0.10754	0.08275
S :	0.04924	0.08071	−0.02956	−0.10038
U :	0.00741	0.06270	−0.10136	0.03125

*Model III

Table 3.20b Electricity, Gas and Water (36)

Elasticities of Substitution

	B	M	S	U
B :	−3.13714	1.65696	0.53239	0.36177
M :		−2.81388	0.49163	0.42016
S :			−0.27898	−0.42538
U :				−0.11319

Factor Price Elasticities

	B	M	S	U
B :	−0.61547	0.35047	0.15826	0.10674
M :	0.32507	−0.59518	0.14614	0.12397
S :	0.10445	0.10399	−0.08293	−0.12551
U :	0.07097	0.08887	−0.12645	−0.03340

*Model I

Table 3.21a Trade, Storage and Warehousing (38)

Elasticities of Substitution

	B	M	S	U
B :	−5.08867	3.58222	0.61386	−0.02173
M :		−2.21592	−0.49143	−0.24240
S :			−0.03908	0.02855
U :				0.24169

Factor Price Elasticities

	B	M	S	U
B :	−1.10702	0.95209	0.16048	−0.00555
M :	0.77930	−0.58896	−0.12847	−0.06187
S :	0.13354	−0.13061	−0.01022	0.00729
U :	−0.00473	−0.06443	0.00746	0.06169

*Model III

Table 3.22a Private Services (42)

Elasticities of Substitution

	B	M	S	U
B :	−1.75557	1.90083	0.17460	−0.12271
M :		−3.72703	0.36549	0.56438
S :			0.41285	−0.72896
U :				0.46140

Factor Price Elasticities

	B	M	S	U
B :	−0.35905	0.34437	0.05289	−0.03821
M :	0.38875	−0.67521	0.11072	0.17574
S :	0.03571	0.06621	0.12506	−0.22699
U :	−0.02510	0.10225	−0.22082	0.14367

*Model III

Tables 4. Elasticities of Substitution and Factor Price Elasticities (Translog Variable Cost Function Estimation Results Using Untransformed Data)

Code: B ≡ buildings and structures
M ≡ machinery and equipment
S ≡ skilled labor
U ≡ unskilled labor

Note: The factor price elasticity is the elasticity of the conditional demand for the input indicated on the leftmost column with respect to the price of the input indicated at the top row heading.

The estimation model used is indicated below the table.

Table 4.1a Mining and Quarrying (15)

Elasticities of Substitution

	B	M	S	U
B :	-0.34202	0.06852	0.04514	0.05047
M :		-0.39846	0.74409	0.81271
S :			-1.61231	-1.22547
U :				-2.93032

Factor Price Elasticities

	B	M	S	U
B :	-0.05190	0.03877	0.00954	0.00359
M :	0.01040	-0.22545	0.15720	0.05785
S :	0.00685	0.42101	-0.34063	-0.08723
U :	0.00766	0.45984	-0.25890	-0.20859

*Model III

Table 4.1b Mining and Quarrying (15)

Elasticities of Substitution

	B	M	S	U
B :	-0.33052	-0.02511	0.22875	0.20840
M :		-0.47263	0.91576	1.00342
S :			-2.06642	-1.45499
U :				-3.90670

Factor Price Elasticities

	B	M	S	U
B :	-0.05008	-0.01410	0.04910	0.01508
M :	-0.00380	-0.26536	0.19657	0.07260
S :	0.03466	0.51417	-0.44357	-0.10527
U :	0.03158	0.56339	-0.31232	-0.28265

*Model I

Note: No price and quantity transformations

Table 4.2a Rice and Corn Milling (16)

Elasticities of Substitution

	B	M	S	U
B :	−6.94906	1.52903	1.17528	0.95317
M :		−2.15615	1.23107	1.01984
S :			−1.45107	−1.06367
U :				−1.29178

Factor Price Elasticities

	B	M	S	U
B :	−1.09580	0.56614	0.42182	0.10784
M :	0.24111	−0.79834	0.44185	0.11538
S :	0.18533	0.45582	−0.52081	−0.12034
U :	0.15030	0.37761	−0.38176	−0.14615

*Model III

Note: No price and quantity transformations

Table 4.3a Sugar Milling and Refining (17)

Elasticities of Substitution

	B	M	S	U
B :	−1.18506	−0.36815	0.78103	0.46852
M :		−0.55701	0.69459	0.72462
S :			−0.95652	−0.97970
U :				−0.62098

Factor Price Elasticities

	B	M	S	U
B :	−0.13710	−0.16889	0.26643	0.03955
M :	−0.04259	−0.25553	0.23695	0.06117
S :	0.09036	0.31865	−0.32630	−0.08271
U :	0.05420	0.33243	−0.33421	−0.05242

*Model III

Table 4.3b Sugar Milling and Refining (17)

Elasticities of Substitution

	B	M	S	U
B :	−1.01119	−0.18981	0.54448	0.22724
M :		−0.80537	0.90518	0.93016
S :			−1.10974	−1.13338
U :				−0.73001

Factor Price Elasticities

	B	M	S	U
B :	−0.11935	−0.08634	0.18643	0.01925
M :	−0.02240	−0.36633	0.30994	0.07880
S :	0.06426	0.41173	−0.37998	−0.09601
U :	0.02682	0.42309	−0.38807	−0.06184

*Model I

Note: No price and quantity transformations

Table 4.4a Oils and Fats (19)

Elasticities of Substitution

		B	M	S	U
B	:	−6.10260	1.72610	−0.32412	0.23859
M	:		−0.43577	−0.01231	−0.32729
S	:			1.23286	−2.02562
U	:				7.52267

Factor Price Elasticities

		B	M	S	U
B	:	−1.02734	1.06213	−0.04977	0.01498
M	:	0.29058	−0.26814	−0.00189	−0.02055
S	:	−0.05456	−0.00757	0.18930	−0.12716
U	:	0.04017	−0.20139	−0.31102	0.47225

*Model III

Table 4.4b Oils and Fats (19)

Elasticities of Substitution

		B	M	S	U
B	:	−6.35371	1.78391	−0.26809	0.28404
M	:		−0.43720	−0.05701	−0.38538
S	:			1.36158	−2.04145
U	:				8.03745

Factor Price Elasticities

		B	M	S	U
B	:	−1.07555	1.09875	−0.04089	0.01769
M	:	0.30198	−0.26928	−0.00870	−0.02400
S	:	−0.04538	−0.03512	0.20766	−0.12716
U	:	0.04808	−0.23737	−0.31134	0.50063

*Model I

Note: No price and quantity transformations

Table 4.5a Meat and Meat Products (20)

Elasticities of Substitution

	B	M	S	U
B :	−2.99352	0.06716	0.86803	1.58306
M :		−1.21075	1.06421	0.77577
S :			−1.16638	−1.51230
U :				0.50234

Factor Price Elasticities

	B	M	S	U
B :	−0.46728	0.02625	0.33518	0.10585
M :	0.01048	−0.47329	0.41093	0.05187
S :	0.13550	0.41600	−0.45038	−0.10112
U :	0.24711	0.30325	−0.58395	0.03359

*Model III

Table 4.5b Meat and Meat Products (20)

Elasticities of Substitution

	B	M	S	U
B :	−3.25236	0.14011	1.02682	1.60019
M :		−1.03941	0.86101	0.56180
S :			−1.06240	−1.37340
U :				0.64661

Factor Price Elasticities

	B	M	S	U
B :	−0.55490	0.05294	0.39510	0.10686
M :	0.02390	−0.39272	0.33130	0.03752
S :	0.17519	0.32531	−0.40879	−0.09171
U :	0.27301	0.21226	−0.52846	0.04318

*Model II

Note: No price and quantity transformations

Table 4.6a Flour and Feed Milling (21)

Elasticities of Substitution

		B	M	S	U
B	:	−3.68618	2.47023	−0.11768	0.08824
M	:		−2.17411	0.64888	0.44292
S	:			−0.17505	−1.39465
U	:				1.08386

Factor Price Elasticities

		B	M	S	U
B	:	−0.93055	0.94717	−0.02786	0.01124
M	:	0.62359	−0.83363	0.15362	0.05642
S	:	−0.02971	0.24880	−0.04144	−0.17765
U	:	0.02228	0.16983	−0.33017	0.13806

*Model III

Table 4.6b Flour and Feed Milling (21)

Elasticities of Substitution

		B	M	S	U
B	:	−4.11944	2.62948	−0.08458	0.36785
M	:		−2.20890	0.62817	0.28924
S	:			−0.15659	−1.42324
U	:				1.04769

Factor Price Elasticities

		B	M	S	U
B	:	−1.03511	1.00802	−0.02006	0.04715
M	:	0.66072	−0.84679	0.14900	0.03707
S	:	−0.02125	0.24081	−0.03714	−0.18242
U	:	0.09243	0.11088	−0.33759	0.13428

*Model I

Note: No price and quantity transformations

Table 4.7a Beverages and Tobacco (23)

Elasticities of Substitution

		B	M	S	U
B	:	−4.17356	0.94251	0.30640	0.42432
M	:		−0.90183	0.65166	0.61773
S	:			−0.85462	−0.60552
U	:				−1.16250

Factor Price Elasticities

		B	M	S	U
B	:	−0.56176	0.41640	0.08935	0.05601
M	:	0.12686	−0.39843	0.19002	0.08154
S	:	0.04124	0.28790	−0.24921	−0.07993
U	:	0.05711	0.27291	−0.17657	−0.15345

*Model III

Table 4.7b Beverages and Tobacco (23)

Elasticities of Substitution

		B	M	S	U
B	:	−4.54218	0.96566	0.39551	0.51778
M	:		−0.90719	0.65129	0.61316
S	:			−0.87329	−0.65174
U	:				−1.13813

Factor Price Elasticities

		B	M	S	U
B	:	−0.61039	0.42661	0.11541	0.06837
M	:	0.12977	−0.40078	0.19004	0.08097
S	:	0.05315	0.28773	−0.25481	−0.08606
U	:	0.06958	0.27088	−0.19017	−0.15029

Note: No pri

*Model I

Note: No price and quantity transformations

Table 4.8a Textiles (24)

Elasticities of Substitution

	B	M	S	U
B :	−1.32238	2.74481	0.50184	0.30097
M :		−10.74945	0.25860	0.53845
S :			−0.35253	−1.04476
U :				1.97247

Factor Price Elasticities

	B	M	S	U
B :	−0.54191	0.32559	0.18585	0.03047
M :	1.12483	−1.27511	0.09577	0.05451
S :	0.20565	0.03068	−0.13055	−0.10577
U :	0.12334	0.06387	−0.38691	0.19970

*Model III

Table 4.8b Textiles (24)

Elasticities of Substitution

	B	M	S	U
B :	−1.33006	2.32960	0.92539	0.50094
M :		−10.31049	0.56447	1.33856
S :			−1.01831	−2.55266
U :				4.21639

Factor Price Elasticities

	B	M	S	U
B :	−0.63719	0.31584	0.27974	0.04161
M :	1.11603	−1.39785	0.17064	0.11118
S :	0.44332	0.07653	−0.30783	−0.21202
U :	0.23998	0.18148	−0.77167	0.35021

*Model II

Note: No price and quantity transformations

Table 4.9a Garments, Footwear and Leather (25)

Elasticities of Substitution

		B	M	S	U
B	:	−2.31298	0.72734	0.12708	0.05764
M	:		−0.23289	−0.04725	0.00078
S	:			0.05279	−0.12225
U	:				0.23202

Factor Price Elasticities

		B	M	S	U
B	:	−0.21786	0.14374	0.06094	0.01318
M	:	0.06851	−0.04602	-0.02266	0.00018
S	:	0.01197	−0.00934	0.02532	−0.02795
U	:	0.00543	0.00015	−0.05862	0.05304

*Model III

Table 4.9b Garments, Footwear and Leather (25)

Elasticities of Substitution

		B	M	S	U
B	:	−1.26316	0.72270	−0.00732	−0.07974
M	:		−0.39372	−0.00412	0.04613
S	:			0.05832	−0.11576
U	:				0.23637

Factor Price Elasticities

		B	M	S	U
B	:	−0.11976	0.14153	−0.00351	−0.01826
M	:	0.06852	−0.07711	−0.00198	0.01057
S	:	−0.00069	−0.00081	0.02801	−0.02651
U	:	−0.00756	0.00904	−0.05561	0.05413

*Model I

Note: No price and quantity transformations

Table 4.10a Wood and Paper Products (26)

Elasticities of Substitution

		B	M	S	U
B	:	−5.14469	0.73429	0.53279	0.52904
M	:		−0.54337	0.40486	0.45841
S	:			−0.42324	−0.85374
U	:				−0.41825

Factor Price Elasticities

		B	M	S	U
B	:	−0.56899	0.34907	0.12633	0.09359
M	:	0.08121	−0.25831	0.09600	0.08109
S	:	0.05893	0.19246	−0.10036	−0.15103
U	:	0.05851	0.21792	−0.20244	−0.07399

*Model III

Table 4.10b Wood and Paper Products (26)

Elasticities of Substitution

		B	M	S	U
B	:	−5.24642	0.77537	0.51434	0.50924
M	:		−0.47617	0.31883	0.37306
S	:			−0.31944	−0.75684
U	:				−0.31394

Factor Price Elasticities

		B	M	S	U
B	:	−0.58091	0.36958	0.12155	0.08978
M	:	0.08585	−0.22697	0.07535	0.06577
S	:	0.05695	0.15197	−0.07549	−0.13343
U	:	0.05639	0.17782	−0.17886	−0.05535

*Model I

Note: No price and quantity transformations

Table 4.11a Fertilizer (27)

Elasticities of Substitution

		B	M	S	U
B	:	1.93474	−1.52107	2.37426	2.17218
M	:		1.80229	−4.00539	−3.98508
S	:			10.89860	7.44284
U	:				34.94409

Factor Price Elasticities

		B	M	S	U
B	:	0.49822	−0.88138	0.34080	0.04236
M	:	−0.39169	1.04434	−0.57493	−0.07771
S	:	0.61140	−2.32091	1.56437	0.14514
U	:	0.55936	−2.30914	1.06833	0.68144

*Model III

Note: No price and quantity transformations

Table 4.12a Rubber and Other Chemicals (28)

Elasticities of Substitution

	B	M	S	U
B :	−4.78990	1.58214	−0.45524	−0.73918
M :		−1.07859	0.82200	0.82078
S :			−0.67747	−1.43896
U :				1.83864

Factor Price Elasticities

	B	M	S	U
B :	−0.54660	0.75640	−0.14693	−0.06287
M :	0.18055	−0.51566	0.26530	0.06981
S :	−0.05195	0.39299	−0.21865	−0.12238
U :	−0.08435	0.39240	−0.46443	0.15637

*Model III

Table 4.12b Rubber and Other Chemicals (28)

Elasticities of Substitution

	B	M	S	U
B :	−4.80263	1.57083	−0.42378	−0.73162
M :		−1.07126	0.79955	0.82945
S :			−0.67028	−1.33673
U :				1.43851

Factor Price Elasticities

	B	M	S	U
B :	−0.54701	0.74725	−0.13767	−0.06257
M :	0.17891	−0.50960	0.25975	0.07094
S :	−0.04827	0.38035	−0.21776	−0.11432
U :	−0.08333	0.39457	−0.43427	0.12303

*Model I

Note: No price and quantity transformations

ıable 4.13a Coal and Petroleum Products (29)

Elasticities of Substitution

		B	M	S	U
B	:	0.03637	0.32642	−0.75917	−1.44760
M	:		−0.07456	−0.23537	−0.12341
S	:			2.82877	−4.53498
U	:				33.65789

Factor Price Elasticities

		B	M	S	U
B	:	0.00943	0.17374	−0.13064	−0.05254
M	:	0.08466	−0.03968	−0.04050	−0.00448
S	:	−0.19691	−0.12528	0.48677	−0.16459
U	:	−0.37547	−0.06569	−0.78037	1.22153

*Model III

Table 4.13b Coal and Petroleum Products (29)

Elasticities of Substitution

		B	M	S	U
B	:	0.18918	0.16434	−0.59798	−1.67549
M	:		0.40756	−1.45139	−1.79104
S	:			7.14855	−4.09929
U	:				71.79835

Factor Price Elasticities

		B	M	S	U
B	:	0.04526	0.09500	−0.09202	−0.04824
M	:	0.03932	0.23560	−0.22335	−0.05156
S	:	−0.14307	−0.83901	1.10009	−0.11802
U	:	−0.40086	−1.03535	−0.63084	2.06705

*Model II

Note: No price and quantity transformations

Table 4.14a Cement and Basic Metal (30)

Elasticities of Substitution

	B	M	S	U
B :	-9.03613	1.92538	2.05367	2.09438
M :		-1.10537	1.00557	0.91589
S :			-3.22863	-3.96905
U :				-1.26718

Factor Price Elasticities

	B	M	S	U
B :	-1.61805	1.06166	0.40932	0.14707
M :	0.34477	-0.60950	0.20042	0.06432
S :	0.36774	0.55447	-0.64350	-0.27872
U :	0.37503	0.50502	-0.79107	-0.08899

*Model III

Table 4.14b Cement and Basic Metal (30)

Elasticities of Substitution

	B	M	S	U
B :	-9.30552	2.04613	1.96688	1.95736
M :		-1.14991	0.98818	0.90392
S :			-3.09181	-3.70792
U :				-1.29641

Factor Price Elasticities

	B	M	S	U
B :	-1.65895	1.12040	0.39842	0.14013
M :	0.36477	-0.62966	0.20017	0.06471
S :	0.35065	0.54110	-0.62630	-0.26545
U :	0.34895	0.49496	-0.75110	-0.09281

*Model I

Note: No price and quantity transformations

Table 4.15a Semiconductor Devices (31)

Elasticities of Substitution

		B	M	S	U
B	:	2.00268	−0.75340	0.07761	−0.83101
M	:		0.78187	−0.57180	0.07605
S	:			0.20926	1.63724
U	:				−4.72847

Factor Price Elasticities

		B	M	S	U
B	:	0.35275	−0.30357	0.02568	−0.07486
M	:	−0.13270	0.31503	−0.18918	0.00685
S	:	0.01367	−0.23039	0.06923	0.14749
U	:	−0.14637	0.03064	0.54169	−0.42596

*Model III

Table 4.15b Semiconductor Devices (31)

Elasticities of Substitution

		B	M	S	U
B	:	−2.83394	0.79211	1.26523	−4.64868
M	:		−0.16234	−0.61597	2.10030
S	:			−0.28854	2.49053
U	:				−14.51936

Factor Price Elasticities

		B	M	S	U
B	:	−0.43171	0.35917	0.40761	−0.33507
M	:	0.12067	−0.07361	−0.19844	0.15139
S	:	0.19274	−0.27930	−0.09296	0.17951
U	:	−0.70815	0.95233	0.80236	−1.04653

*Model II

Note: No price and quantity transformations

Table 4.16a Machinery and Metal Products (32)

Elasticities of Substitution

	B	M	S	U
B :	2.52840	−1.96530	0.72775	0.79152
M :		−0.49015	0.66174	0.79421
S :			−0.66495	−0.39749
U :				−1.15823

Factor Price Elasticities

	B	M	S	U
B :	0.27593	−0.68347	0.25490	0.15264
M :	−0.21448	−0.17046	0.23178	0.15316
S :	0.07942	0.23013	−0.23290	−0.07665
U :	0.08638	0.27620	−0.13922	−0.22336

*Model III

Table 4.16b Machinery and Metal Products (32)

Elasticities of Substitution

	B	M	S	U
B :	1.11117	−1.63962	0.83843	0.86813
M :		−0.36624	0.51871	0.66759
S :			−0.61336	−0.32007
U :				−1.14517

Factor Price Elasticities

	B	M	S	U
B :	0.12104	−0.57817	0.29128	0.16585
M :	−0.17860	−0.12915	0.18020	0.12754
S :	0.09133	0.18291	−0.21309	−0.06115
U :	0.09456	0.23541	−0.11119	−0.21878

*Model I

Note: No price and quantity transformations

Table 4.17a Motor Vehicles (33)

Elasticities of Substitution

	B	M	S	U
B :	−3.01393	0.88702	0.52658	0.57453
M :		−0.64077	0.22651	0.19669
S :			−0.42943	−0.62608
U :				0.08413

Factor Price Elasticities

	B	M	S	U
B :	−0.57580	0.35795	0.16552	0.05233
M :	0.16946	−0.25858	0.07120	0.01792
S :	0.10060	0.09141	−0.13498	−0.05703
U :	0.10976	0.07937	−0.19680	0.00766

*Model III

Table 4.17b Motor Vehicles (33)

Elasticities of Substitution

	B	M	S	U
B :	−2.79840	0.80792	0.52100	0.53699
M :		−0.62388	0.24105	0.23481
S :			−0.45030	−0.62537
U :				−0.02672

Factor Price Elasticities

	B	M	S	U
B :	−0.53819	0.32647	0.16307	0.04866
M :	0.15538	−0.25210	0.07545	0.02128
S :	0.10020	0.09741	−0.14094	−0.05666
U :	0.10327	0.09488	−0.19573	−0.00242

*Model I

Note: No price and quantity transformations

Table 4.18a Furniture and Other Manufactures (34)

Elasticities of Substitution

	B	M	S	U
B :	−6.11234	1.07504	0.43168	0.94074
M :		−4.27216	1.13649	0.70375
S :			−0.31194	−0.40004
U :				−0.25726

Factor Price Elasticities

	B	M	S	U
B :	−0.68307	0.19346	0.14985	0.33976
M :	0.12014	−0.76881	0.39450	0.25417
S :	0.04824	0.20452	−0.10828	−0.14448
U :	0.10513	0.12665	−0.13886	−0.09291

*Model III

Table 4.18b Furniture and Other Manufactures (34)

Elasticities of Substitution

	B	M	S	U
B :	−6.09338	1.29943	0.38067	0.88506
M :		−4.15017	1.07512	0.65135
S :			−0.28926	−0.38273
U :				−0.23713

Factor Price Elasticities

	B	M	S	U
B :	−0.68606	0.23570	0.13171	0.31864
M :	0.14630	−0.75280	0.37199	0.23450
S :	0.04286	0.19502	−0.10008	−0.13779
U :	0.09965	0.11815	−0.13242	−0.08537

*Model I

Note: No price and quantity transformations

Table 4.19a Construction (35)

Elasticities of Substitution

	B	M	S	U
B :	−4.58781	1.16067	−0.25362	−0.21743
M :		−0.59341	0.81443	0.85588
S :			−2.09751	−1.60297
U :				−2.98084

Factor Price Elasticities

	B	M	S	U
B :	−0.65688	0.71505	−0.04077	−0.01739
M :	0.16619	−0.36558	0.13093	0.06846
S :	−0.03631	0.50174	−0.33720	−0.12823
U :	−0.03113	0.52728	−0.25770	−0.23844

*Model III

Table 4.19b Construction (35)

Elasticities of Substitution

	B	M	S	U
B :	−4.76237	1.15409	−0.14818	−0.11597
M :		−0.54890	0.71150	0.75375
S :			−1.90334	−1.41570
U :				−2.78043

Factor Price Elasticities

	B	M	S	U
B :	−0.67938	0.71239	−0.02375	−0.00925
M :	0.16464	−0.33882	0.11406	0.06012
S :	−0.02114	0.43919	−0.30513	−0.11292
U :	−0.01654	0.46527	−0.22696	−0.22177

*Model I

Note: No price and quantity transformations

Table 4.20a Electricity, Gas and Water (36)

Elasticities of Substitution

		B	M	S	U
B	:	−1.35824	0.97533	−0.64772	−0.92893
M	:		−0.72395	0.59584	0.60371
S	:			−0.75482	−1.22550
U	:				3.80737

Factor Price Elasticities

		B	M	S	U
B	:	−0.43229	0.52974	−0.07206	−0.02539
M	:	0.31042	−0.39321	0.06629	0.01650
S	:	−0.20615	0.32362	−0.08397	−0.03350
U	:	−0.29565	0.32790	−0.13633	0.10408

*Model III

Table 4.20b Electricity, Gas and Water (36)

Elasticities of Substitution

		B	M	S	U
B	:	−1.49414	1.03097	−0.57775	−0.82683
M	:		−0.72960	0.49900	0.51787
S	:			−0.56172	−0.89725
U	:				2.90489

Factor Price Elasticities

		B	M	S	U
B	:	−0.47138	0.56000	−0.06549	−0.02313
M	:	0.32525	−0.39631	0.05657	0.01449
S	:	−0.18227	0.27105	−0.06368	−0.02510
U	:	−0.26085	0.28130	−0.10171	0.08127

*Model I

Note: No price and quantity transformations

Table 4.21a Trade, Storage and Warehousing (38)

Elasticities of Substitution

		B	M	S	U
B	:	−1.51576	1.72583	1.84828	1.48976
M	:		−1.78490	−3.21718	−2.94853
S	:			5.86957	2.96870
U	:				14.22194

Factor Price Elasticities

		B	M	S	U
B	:	−0.80746	0.69760	0.08193	0.02793
M	:	0.91937	−0.72148	−0.14260	−0.05528
S	:	0.98460	−1.30043	0.26018	0.05566
U	:	0.79361	−1.19184	0.13159	0.26664

*Model III

Note: No price and quantity transformations

Table 4.22a Private Services (42)

Elasticities or Substitution

	B	M	S	U
B :	−1.40459	1.51662	0.32819	0.16032
M :		−5.25721	0.51439	0.74423
S :			−0.06261	−0.84539
U :				1.30125

Factor Price Elasticities

	B	M	S	U
B :	−0.38162	0.21644	0.13940	0.02579
M :	0.41206	−0.75025	0.21848	0.11971
S :	0.08917	0.07341	−0.02659	−0.13598
U :	0.04356	0.10621	−0.35908	0.20931

*Model III

Note: No price and quantity transformations

Tables 5. Predicted Shares, Elasticities of Substitution and Factor Price Elasticities (Translog Variable Cost Function Estimation Results Using Transformed Data)

Note: Column labels refer to the sector.
Row labels follow the convention:
$SP_i \equiv$ predicted share of input i in variable cost,
$E_{ij} \equiv$ elasticity of substitution between inputs i and j,

$F_{ij} \equiv$ elasticity of conditional demand for input i with respect to the price of input j.

Models are:
Model I (> 40 observations),
Model II (2 breakpoints), and
Model III (no breakpoints).

Predicted Shares, Elasticities of Substitution and Factor Price Elasticities of Sectors Using Translog Variable Cost Function:

Model I (>40 observations)

	MINE	SUGAR	OILS	FLOUR	BEV	
SPB	0.24230	0.23112	0.24660	0.25288	0.19357	SPB
SPM	0.24422	0.25713	0.24485	0.23016	0.24636	SPM
SPS	0.25639	0.25449	0.25738	0.26247	0.28181	SPS
SPU	0.25709	0.25725	0.25117	0.25448	0.27826	SPU
EBB	−0.77768	−1.28155	−2.67304	−4.20059	−2.48641	EBB
EMM	−1.52170	−1.58962	−2.44158	−5.47394	−1.99250	EMM
ESS	−0.78094	−0.64089	0.00869	0.08511	−0.50578	ESS
EUU	−0.99583	−0.49527	0.18713	0.22762	−0.47327	EUU
EBM	0.63418	−0.02771	2.11010	4.13249	0.73108	EBM
EBS	0.06789	0.63855	0.24419	0.08797	0.51497	EBS
EBU	0.06279	0.54738	0.31723	0.34593	0.56083	EBU
EMS	0.30698	0.84405	0.27250	0.61868	0.66047	EMS
EMU	0.54171	0.77878	0.02914	0.20616	0.58665	EMU
ESU	0.42321	−0.78333	−0.51429	−0.73476	−0.43077	ESU
FBB	−0.18843	−0.29619	−0.65918	−1.06226	−0.48129	FBB
FBM	0.15488	−0.00713	0.51665	0.95114	0.18011	FBM
FBS	0.01741	0.16250	0.06285	0.02309	0.14512	FBS
FBU	0.01614	0.14082	0.07968	0.08803	0.15606	FBU
FMB	0.15366	−0.00641	0.52036	1.04504	0.14151	FMB
FMM	−0.37163	−0.40874	−0.59781	−1.25989	−0.49088	FMM
FMS	0.07871	0.21480	0.07013	0.16239	0.18613	FMS
FMU	0.13927	0.20034	0.00732	0.05246	0.16324	FMU
FSB	0.01645	0.14758	0.06022	0.02225	0.09968	FSB
FSM	0.07497	0.21704	0.06672	0.14240	0.16272	FSM
FSS	−0.20023	−0.16310	0.00224	0.02234	−0.14253	FSS
FSU	0.10880	−0.20152	−0.12918	−0.18698	−0.11987	FSU
FUB	0.01521	0.12651	0.07823	0.08748	0.10856	FUB
FUM	0.13230	0.20025	0.00713	0.04745	0.14453	FUM
FUS	0.10851	−0.19935	−0.13237	−0.19285	−0.12139	FUS
FUU	−0.25602	−0.12741	0.04700	0.05792	−0.13169	FUU
	MINE	SUGAR	OILS	FLOUR	BEV	

Model I (>40 observations)

	GAR	WOOD	RUBB	CEMENT	MACHY	
SPB	0.23556	0.25097	0.24605	0.19427	0.21798	SPB
SPM	0.24792	0.24358	0.25092	0.28974	0.20850	SPM
SPS	0.25966	0.25316	0.24639	0.26096	0.28566	SPS
SPU	0.25686	0.25229	0.25664	0.25504	0.28785	SPU
EBB	0.74645	−1.59758	−1.46011	−8.05559	−0.80369	EBB
EMM	0.44724	−1.56496	−3.58387	−3.34084	−0.45926	EMM
ESS	0.63422	−0.19159	−0.48433	−1.04336	−0.42112	ESS
EUU	0.61507	−0.28547	−0.49322	−0.65849	−0.56413	EUU
EBM	0.07149	0.81558	1.33312	2.58540	−0.39294	EBM
EBS	−0.35384	0.38555	0.07777	1.74614	0.48325	EBS
EBU	−0.39586	0.41493	0.02176	1.41231	0.41366	EBU
EMS	−0.28082	0.31523	1.10731	0.95628	0.17890	EMS
EMU	−0.21336	0.38328	1.16283	0.84758	0.45269	EMU
ESU	−0.04559	−0.49563	−0.69221	−1.34891	−0.07763	ESU
FBB	0.17584	−0.40095	−0.35926	−1.56495	−0.17519	FBB
FBM	0.01772	0.19866	0.33451	0.74909	−0.08193	FBM
FBS	−0.09188	0.09761	0.01916	0.45567	0.13805	FBS
FBU	−0.10168	0.10468	0.00559	0.36019	0.11907	FBU
FMB	0.01684	0.20469	0.32801	0.50226	−0.08565	FMB
FMM	0.11088	−0.38119	−0.89927	−0.96797	−0.09576	FMM
FMS	−0.07292	0.07980	0.27283	0.24955	0.05111	FMS
FMU	−0.05480	0.09670	0.29843	0.21616	0.13031	FMU
FSB	−0.08335	0.09676	0.01914	0.33922	0.10534	FSB
FSM	−0.06962	0.07678	0.27785	0.27707	0.03730	FSM
FSS	0.16468	−0.04850	−0.11933	−0.27227	−0.12030	FSS
FSU	−0.01171	−0.12504	−0.17765	−0.34402	−0.02235	FSU
FUB	−0.09325	0.10413	0.00536	0.27437	0.09017	FUB
FUM	−0.05289	0.09336	0.29178	0.24558	0.09439	FUM
FUS	−0.01184	−0.12547	−0.17055	−0.35201	−0.02218	FUS
FUU	0.15799	−0.07202	−0.12658	−0.16794	−0.16238	FUU
	GAR	WOOD	RUBB	CEMENT	MACHY	

Model I (>40 observations)

	MOTOR	FURNIT	CONST	EGW	
SPB	0.24277	0.23447	0.22413	0.19619	SPB
SPM	0.20282	0.15505	0.20227	0.21152	SPM
SPS	0.28204	0.30582	0.29030	0.29726	SPS
SPU	0.27237	0.30466	0.28330	0.29504	SPU
EBB	−2.30062	−2.39102	−2.33922	−3.13714	EBB
EMM	−2.15707	−5.76695	−4.07010	−2.81388	EMM
ESS	−0.41199	−0.38022	−0.58181	−0.27898	ESS
EUU	−0.43734	−0.30142	−0.59029	−0.11319	EUU
EBM	1.07780	1.38789	1.40731	1.65696	EBM
EBS	0.65015	0.43331	0.41135	0.53239	EBS
EBU	0.57484	0.69888	0.42432	0.36177	EBU
EMS	0.25771	1.20863	0.89032	0.49163	EMS
EMU	0.37870	0.65361	0.88032	0.42016	EMU
ESU	−0.34479	−0.56694	−0.36492	−0.42538	ESU
FBB	−0.55853	−0.56063	−0.52428	−0.61547	FBB
FBM	0.21860	0.21519	0.28466	0.35047	FBM
FBS	0.18337	0.13251	0.11942	0.15826	FBS
FBU	0.15657	0.21292	0.12021	0.10674	FBU
FMB	0.26166	0.32542	0.31541	0.32507	FMB
FMM	−0.43749	−0.89417	−0.82327	−0.59518	FMM
FMS	0.07269	0.36962	0.25846	0.14614	FMS
FMU	0.10314	0.19913	0.24939	0.12397	FMU
FSB	0.15784	0.10160	0.09219	0.10445	FSB
FSM	0.05227	0.18740	0.18009	0.10399	FSM
FSS	−0.11620	−0.11628	−0.16890	−0.08293	FSS
FSU	−0.09391	−0.17272	−0.10338	−0.12551	FSU
FUB	0.13956	0.16387	0.09510	0.07097	FUB
FUM	0.07681	0.10134	0.17806	0.08887	FUM
FUS	−0.09725	−0.17338	−0.10594	−0.12645	FUS
FUU	−0.11912	−0.09183	−0.16723	−0.03340	FUU
	MOTOR	FURNIT	CONST	EGW	

Predicted Shares, Elasticities of Substitution and Factor Price Elasticities of Sectors Using Translog Variable Cost Function:

Model II (2 breakpoints)

	TEXTILE	MEAT	PETROL	SEMI	
SPB	0.28506	0.22707	0.23972	0.20083	SPB
SPM	0.26026	0.19726	0.26515	0.29326	SPM
SPS	0.23025	0.28184	0.24750	0.28473	SPS
SPU	0.22442	0.29383	0.24763	0.22119	SPU
EBB	−3.47346	−3.21183	−0.57772	−0.73450	EBB
EMM	−3.88501	−2.46864	0.20309	−0.47558	EMM
ESS	−0.52437	−0.63886	1.45250	−1.16648	ESS
EUU	−0.06132	−0.54025	1.85493	−3.11130	EUU
EBM	2.33100	0.17804	0.65743	0.17239	EBM
EBS	1.07886	1.13132	0.09768	1.59108	EBS
EBU	0.60187	1.27737	−0.24228	−1.60979	EBU
EMS	0.68936	0.94443	−0.39220	−1.13413	EMS
EMU	0.83730	0.61384	−0.46189	1.93393	EMU
ESU	−1.63181	−0.89551	−1.12637	1.56059	ESU
FBB	−0.99015	−0.72930	−0.13849	−0.14751	FBB
FBM	0.60667	0.03512	0.17431	0.05055	FBM
FBS	0.24841	0.31885	0.02417	0.45302	FBS
FBU	0.13508	0.37533	−0.06000	−0.35607	FBU
FMB	0.66448	0.04043	0.15760	0.03462	FMB
FMM	−1.01112	−0.48697	0.05385	−0.13947	FMM
FMS	0.15873	0.26618	−0.09707	−0.32292	FMS
FMU	0.18791	0.18036	−0.11438	0.42776	FMU
FSB	0.30754	0.25688	0.02342	0.31953	FSB
FSM	0.17941	0.18630	−0.10399	−0.33259	FSM
FSS	−0.12074	−0.18006	0.35950	−0.33213	FSS
FSU	−0.36622	−0.26313	−0.27892	0.34518	FSU
FUB	0.17157	0.29005	−0.05808	−0.32329	FUB
FUM	0.21792	0.12109	−0.12247	0.56713	FUM
FUS	−0.37573	−0.25239	−0.27878	0.44434	FUS
FUU	−0.01376	−0.15874	0.45933	−0.68819	FUU
	TEXTILE	MEAT	PETROL	SEMI	

Predicted Shares, Elasticities of Substitution and Factor Price Elasticities of Sectors Using Translog Variable Cost Function:

Model III (no breakpoints)

	MINE	RICE	SUGAR	OILS	FLOUR	BEV	GAR	
SPB	0.24482	0.19986	0.22859	0.24601	0.25355	0.19450	0.23463	SPB
SPM	0.24463	0.21822	0.26004	0.24485	0.22779	0.24572	0.24815	SPM
SPS	0.25497	0.29287	0.25426	0.25773	0.26363	0.28170	0.25999	SPS
SPU	0.25558	0.28905	0.25711	0.25141	0.25503	0.27809	0.25723	SPU
EBB	−0.72127	−5.95909	−1.26071	−2.79146	−3.71841	−2.18648	0.15382	EBB
EMM	−1.62083	−5.47271	−0.90421	−2.41590	−5.40431	−2.00271	0.07375	EMM
ESS	−0.80580	−1.31813	−0.58305	−0.00577	0.03592	−0.50899	0.61292	ESS
EUU	−1.00752	−0.96693	−0.45670	0.17048	0.21497	−0.47951	0.59822	EUU
EBM	0.68728	1.87421	−0.28788	2.11167	3.79488	0.66400	0.48276	EBM
EBS	0.06907	1.41853	0.75676	0.28390	0.09599	0.44597	−0.27256	EBS
EBU	−0.03583	1.26810	0.66365	0.38394	0.20805	0.49076	−0.33053	EBU
EMS	0.28744	1.57546	0.61086	0.27368	0.66412	0.68335	−0.29309	EMS
EMU	0.60628	1.23959	0.56636	0.00595	0.36768	0.61294	−0.21526	EMU
ESU	0.46262	−0.83472	−0.71407	−0.53844	−0.72573	−0.40012	−0.08813	ESU
FBB	−0.17658	−1.19098	−0.28818	−0.68673	−0.94279	−0.42526	0.03609	FBB
FBM	0.16813	0.40900	−0.07486	0.51704	0.86443	0.16316	0.11980	FBM
FBS	0.01761	0.41544	0.19241	0.07317	0.02531	0.12563	−0.07086	FBS
FBU	−0.00916	0.36655	0.17063	0.09653	0.05306	0.13648	−0.08502	FBU
FMB	0.16826	0.37458	−0.06581	0.51950	0.96218	0.12915	0.11327	FMB
FMM	−0.39650	−1.19428	−0.23513	−0.59153	−1.23103	−0.49210	0.01830	FMM
FMS	0.07329	0.46140	0.15532	0.07054	0.17508	0.19250	−0.07620	FMS
FMU	0.15495	0.35830	0.14562	0.00150	0.09377	0.17045	−0.05537	FMU
FSB	0.01691	0.28351	0.17298	0.06984	0.02434	0.08674	−0.06395	FSB
FSM	0.07032	0.34380	0.15886	0.06701	0.15128	0.16791	−0.07273	FSM
FSS	−0.20546	−0.38603	−0.14825	−0.00149	0.00947	−0.14338	0.15935	FSS
FSU	0.11823	−0.24128	−0.18359	−0.13537	−0.18508	−0.11127	−0.02267	FSU
FUB	−0.00877	0.25344	0.15170	0.09446	0.05275	0.09545	−0.07755	FUB
FUM	0.14832	0.27051	0.14728	0.00146	0.08375	0.15061	−0.05342	FUM
FUS	0.11796	−0.24446	−0.18156	−0.13877	−0.19133	−0.11271	−0.02291	FUS
FUU	−0.25750	−0.27949	−0.11742	0.04266	0.05482	−0.13335	0.15388	FUU
	MINE	RICE	SUGAR	OILS	FLOUR	BEV	GAR	

Model III (no breakpoints)

	WOOD	RUBB	CEMENT	MACHY	MOTOR	FURNIT	CONST	
SPB	0.25076	0.24965	0.19637	0.21747	0.24085	0.23191	0.22494	SPB
SPM	0.24351	0.25279	0.29222	0.20135	0.20155	0.15485	0.20187	SPM
SPS	0.25331	0.24388	0.25867	0.28874	0.28344	0.30722	0.29016	SPS
SPU	0.25242	0.25368	0.25275	0.29244	0.27416	0.30602	0.28303	SPU
EBB	−1.57603	−1.37940	−7.71901	−0.49079	−2.28595	−2.57147	−2.18911	EBB
EMM	−1.58295	−3.50570	−3.15635	−0.80088	−2.04292	−5.73445	−4.00209	EMM
ESS	−0.23073	−0.36099	−0.99792	−0.46288	−0.40566	−0.45356	−0.59978	ESS
EUU	−0.33158	−0.30354	−0.60248	−0.59569	−0.41253	−0.39356	−0.61278	EUU
EBM	0.75831	1.36175	2.51096	−0.95689	0.94689	1.28539	1.27028	EBM
EBS	0.40098	0.03661	1.68365	0.53421	0.65547	0.50686	0.40475	EBS
EBU	0.43173	−0.03468	1.37103	0.49634	0.63298	0.78947	0.41861	EBU
EMS	0.34933	1.09973	0.90127	0.51631	0.31123	1.23189	0.91394	EMS
EMU	0.42320	1.09605	0.77603	0.75319	0.34651	0.69082	0.90798	EMU
ESU	−0.50381	−0.78486	−1.32883	−0.29571	−0.38525	−0.55211	−0.35866	ESU
FBB	−0.39521	−0.34437	−1.51577	−0.10673	−0.55057	−0.59635	−0.49241	FBB
FBM	0.18466	0.34424	0.73375	−0.19267	0.19125	0.19904	0.25644	FBM
FBS	0.10157	0.00893	0.43550	0.15425	0.18578	0.15572	0.11744	FBS
FBU	0.10898	−0.00880	0.34652	0.14515	0.17354	0.24160	0.11853	FBU
FMB	0.19015	0.33996	0.49307	−0.20809	0.22854	0.29810	0.28573	FMB
FMM	−0.38547	−0.88621	−0.92234	−0.16126	−0.41176	−0.88796	−0.80791	FMM
FMS	0.08849	0.26820	0.23313	0.14908	0.08821	0.37846	0.26519	FMS
FMU	0.10683	0.27804	0.19614	0.22027	0.09500	0.21141	0.25698	FMU
FSB	0.10055	0.00914	0.33062	0.11617	0.15787	0.11755	0.09104	FSB
FSM	0.08507	0.27800	0.26337	0.10396	0.06273	0.19076	0.18450	FSM
FSS	−0.05845	−0.08804	−0.25813	−0.13365	−0.11498	−0.13934	−0.17403	FSS
FSU	−0.12717	−0.19910	−0.33586	−0.08648	−0.10562	−0.16896	−0.10151	FSU
FUB	0.10826	−0.00866	0.26923	0.10794	0.15245	0.18309	0.09421	FUB
FUM	0.10306	0.27707	0.22677	0.15165	0.06984	0.10697	0.18330	FUM
FUS	−0.12762	−0.19141	−0.34372	−0.08538	−0.10920	−0.16962	−0.10407	FUS
FUU	−0.08370	−0.07700	−0.15227	−0.17421	−0.11310	−0.12044	−0.17343	FUU
	WOOD	RUBB	CEMENT	MACHY	MOTOR	FURNIT	CONST	

Model III (no breakpoints)

	EGW	TRADE	TEXTILE	FERT	SEMI	PETROL	MEAT	PRIVATE	
SPB	0.20844	0.21755	0.18867	0.25756	0.22876	0.25579	0.16855	0.20452	SPB
SPM	0.21674	0.26578	0.15980	0.26639	0.25178	0.25065	0.17542	0.18117	SPM
SPS	0.28880	0.26142	0.32626	0.24311	0.27474	0.24302	0.31882	0.30293	SPS
SPU	0.28602	0.25525	0.32527	0.23293	0.24472	0.25054	0.33721	0.31139	SPU
EBB	−2.26314	−5.08867	−5.19110	0.38228	1.32378	−0.88082	−4.28557	−1.75557	EBB
EMM	−2.62349	−2.21592	−6.18463	5.59177	1.37445	−1.34605	−3.38589	−3.72703	EMM
ESS	−0.10235	−0.03908	−0.12423	1.19610	−0.51630	1.09183	−0.22211	0.41285	ESS
EUU	0.10925	0.24169	−0.03217	1.40656	−1.21409	1.13445	−0.25183	0.46140	EUU
EBM	1.81491	3.58222	1.74028	−1.61773	−0.88222	0.82838	−0.34589	1.90083	EBM
EBS	0.23620	0.61386	1.18220	0.72006	0.19204	0.25393	1.04864	0.17460	EBS
EBU	0.03555	−0.02173	0.97033	0.67589	−0.54537	−0.17579	1.33056	−0.12271	EBU
EMS	0.37238	−0.49143	0.97874	−2.19832	−0.81430	0.09138	1.14105	0.36549	EMS
EMU	0.28931	−0.24240	1.04721	−2.31188	0.32475	0.41227	0.85546	0.56438	EMU
ESU	−0.35097	0.02855	−1.04196	0.46955	1.23792	−1.40973	−0.90775	−0.72896	ESU
FBB	−0.47174	−1.10702	−0.97942	0.09846	0.30283	−0.22530	−0.72233	−0.35905	FBB
FBM	0.39336	0.95209	0.27809	−0.43095	−0.22213	0.20763	−0.06068	0.34437	FBM
FBS	0.06822	0.16048	0.38570	0.17506	0.05276	0.06171	0.33433	0.05289	FBS
FBU	0.01017	−0.00555	0.31562	0.15744	−0.13346	−0.04404	0.44867	−0.03821	FBU
FMB	0.37831	0.77930	0.32834	−0.41666	−0.20182	0.21189	−0.05830	0.38875	FMB
FMM	−0.56860	−0.58896	−0.98829	1.48962	0.34606	−0.33739	−0.59396	−0.67521	FMM
FMS	0.10754	−0.12847	0.31932	−0.53444	−0.22372	0.02221	0.36379	0.11072	FMS
FMU	0.08275	−0.06187	0.34063	−0.53852	0.07947	0.10329	0.28847	0.17574	FMU
FSB	0.04924	0.13354	0.22305	0.18546	0.04393	0.06495	0.17675	0.03571	FSB
FSM	0.08071	−0.13061	0.15640	−0.58562	−0.20503	0.02290	0.20017	0.06621	FSM
FSS	−0.02956	−0.01022	−0.04053	0.29079	−0.14185	0.26534	−0.07081	0.12506	FSS
FSU	−0.10038	0.00729	−0.33892	0.10937	0.30294	−0.35319	−0.30610	−0.22699	FSU
FUB	0.00741	−0.00473	0.18307	0.17408	−0.12476	−0.04497	0.22426	−0.02510	FUB
FUM	0.06270	−0.06443	0.16734	−0.61587	0.08177	0.10334	0.15007	0.10225	FUM
FUS	−0.10136	0.00746	−0.33995	0.11415	0.34010	−0.34260	−0.28941	−0.22082	FUS
FUU	0.03125	0.06169	−0.01047	0.32764	−0.29711	0.28423	−0.08492	0.14367	FUU
	EGW	TRADE	TEXTILE	FERT	SEMI	PETROL	MEAT	PRIVATE	

Table 6. Predicted Shares, Elasticities of Substitution and Factor Price Elasticities (Translog Variable Cost Function Estimation Results Using Untransformed Data)

Note: Column labels refer to the sector.
Row labels follow the convention:
SP_i ≡ predicted share of input i in variable cost,
E_{ij} ≡ elasticity of substitution between inputs i and j,

F_{ij} ≡ elasticity of conditional demand for input i with respect to the price of input j.

Models are:
Model I (> 40 observations),
Model II (2 breakpoints), and
Model III (no breakpoints).

Predicted Shares, Elasticities of Substitution and Factor Price Elasticities of Sectors Using Translog Variable Cost Function:

Model I (>40 observations)

	MINE	SUGAR	OILS	FLOUR	BEV	
SPB	0.15153	0.11802	0.16928	0.25127	0.13438	SPB
SPM	0.56147	0.45486	0.61592	0.38336	0.44178	SPM
SPS	0.21465	0.34240	0.15251	0.23720	0.29179	SPS
SPU	0.07235	0.08471	0.06229	0.12817	0.13205	SPU
EBB	−0.33052	−1.01119	−6.35371	−4.11944	−4.54218	EBB
EMM	−0.47263	−0.80537	−0.43720	−2.20890	−0.90719	EMM
ESS	−2.06642	−1.10974	1.36158	−0.15659	−0.87329	ESS
EUU	−3.90670	−0.73001	8.03745	1.04769	−1.13813	EUU
EBM	−0.02511	−0.18981	1.78391	2.62948	0.96566	EBM
EBS	0.22875	0.54448	−0.26809	−0.08458	0.39551	EBS
EBU	0.20840	0.22724	0.28404	0.36785	0.51778	EBU
EMS	0.91576	0.90518	−0.05701	0.62817	0.65129	EMS
EMU	1.00342	0.93016	−0.38538	0.28924	0.61316	EMU
ESU	−1.45499	−1.13338	−2.04145	−1.42324	−0.65174	ESU
FBB	−0.05008	−0.11935	−1.07555	−1.03511	−0.61039	FBB
FBM	−0.01410	−0.08634	1.09875	1.00802	0.42661	FBM
FBS	0.04910	0.18643	−0.04089	−0.02006	0.11541	FBS
FBU	0.01508	0.01925	0.01769	0.04715	0.06837	FBU
FMB	−0.00380	−0.02240	0.30198	0.66072	0.12977	FMB
FMM	−0.26536	−0.36633	−0.26928	−0.84679	−0.40078	FMM
FMS	0.19657	0.30994	−0.00870	0.14900	0.19004	FMS
FMU	0.07260	0.07880	−0.02400	0.03707	0.08097	FMU
FSB	0.03466	0.06426	−0.04538	−0.02125	0.05315	FSB
FSM	0.51417	0.41173	−0.03512	0.24081	0.28773	FSM
FSS	−0.44357	−0.37998	0.20766	−0.03714	−0.25481	FSS
FSU	−0.10527	−0.09601	−0.12716	−0.18242	−0.08606	FSU
FUB	0.03158	0.02682	0.04808	0.09243	0.06958	FUB
FUM	0.56339	0.42309	−0.23737	0.11088	0.27088	FUM
FUS	−0.31232	−0.38807	−0.31134	−0.33759	−0.19017	FUS
FUU	−0.28265	−0.06184	0.50063	0.13428	−0.15029	FUU
	MINE	SUGAR	OILS	FLOUR	BEV	

Note: No price and quantity transformations

Model I (>40 observations)

	GAR	WOOD	RUBB	CEMENT	MACHY	
SPB	0.09481	0.11072	0.11390	0.17828	0.10893	SPB
SPM	0.19584	0.47665	0.47570	0.54757	0.35262	SPM
SPS	0.48034	0.23632	0.32488	0.20257	0.34741	SPS
SPU	0.22901	0.17630	0.08552	0.07159	0.19104	SPU
EBB	−1.26316	−5.24642	−4.80263	−9.30552	1.11117	EBB
EMM	−0.39372	−0.47617	−1.07126	−1.14991	−0.36624	EMM
ESS	0.05832	−0.31944	−0.67028	−3.09181	−0.61336	ESS
EUU	0.23637	−0.31394	1.43851	−1.29641	−1.14517	EUU
EBM	0.72270	0.77537	1.57083	2.04613	−1.63962	EBM
EBS	−0.00732	0.51434	−0.42378	1.96688	0.83843	EBS
EBU	−0.07974	0.50924	−0.73162	1.95736	0.86813	EBU
EMS	−0.00412	0.31863	0.79955	0.98818	0.51871	EMS
EMU	0.04613	0.37306	0.82945	0.90392	0.66759	EMU
ESU	−0.11576	−0.75684	−1.33673	−3.70792	−0.32007	ESU
FBB	−0.11976	−0.58091	−0.54701	−1.65895	0.12104	FBB
FBM	0.14153	0.36958	0.74725	1.12040	−0.57817	FBM
FBS	−0.00351	0.12155	−0.13767	0.39842	0.29128	FBS
FBU	−0.01826	0.08978	−0.06257	0.14013	0.16585	FBU
FMB	0.06852	0.08585	0.17891	0.36477	−0.17860	FMB
FMM	−0.07711	−0.22697	−0.50960	−0.62966	−0.12915	FMM
FMS	−0.00198	0.07535	0.25975	0.20017	0.18020	FMS
FMU	0.01057	0.06577	0.07094	0.06471	0.12754	FMU
FSB	−0.00069	0.05695	−0.04827	0.35065	0.09133	FSB
FSM	−0.00081	0.15197	0.38035	0.54110	0.18291	FSM
FSS	0.02801	−0.07549	−0.21776	−0.62630	−0.21309	FSS
FSU	−0.02651	−0.13343	−0.11432	−0.26545	−0.06115	FSU
FUB	−0.00756	0.05639	−0.08333	0.34895	0.09456	FUB
FUM	0.00904	0.17782	0.39457	0.49496	0.23541	FUM
FUS	−0.05561	−0.17886	−0.43427	−0.75110	−0.11119	FUS
FUU	0.05413	−0.05535	0.12303	−0.09281	−0.21878	FUU
	GAR	WOOD	RUBB	CEMENT	MACHY	

Note: No price and quantity transformations

Model I (>40 observations)

	MOTOR	FURNIT	CONST	EGW	
SPB	0.19232	0.11259	0.14266	0.31548	SPB
SPM	0.40408	0.18139	0.61727	0.54318	SPM
SPS	0.31299	0.34600	0.16031	0.11336	SPS
SPU	0.09061	0.36002	0.07976	0.02798	SPU
EBB	−2.79840	−6.09338	−4.76237	−1.49414	EBB
EMM	−0.62388	−4.15017	−0.54890	−0.72960	EMM
ESS	−0.45030	−0.28926	−1.90334	−0.56172	ESS
EUU	−0.02672	−0.23713	−2.78043	2.90489	EUU
EBM	0.80792	1.29943	1.15409	1.03097	EBM
EBS	0.52100	0.38067	−0.14818	−0.57775	EBS
EBU	0.53699	0.88506	−0.11597	−0.82683	EBU
EMS	0.24105	1.07512	0.71150	0.49900	EMS
EMU	0.23481	0.65135	0.75375	0.51787	EMU
ESU	−0.62537	−0.38273	−1.41570	−0.89725	ESU
FBB	−0.53819	−0.68606	−0.67938	−0.47138	FBB
FBM	0.32647	0.23570	0.71239	0.56000	FBM
FBS	0.16307	0.13171	−0.02375	−0.06549	FBS
FBU	0.04866	0.31864	−0.00925	−0.02313	FBU
FMB	0.15538	0.14630	0.16464	0.32525	FMB
FMM	−0.25210	−0.75280	−0.33882	−0.39631	FMM
FMS	0.07545	0.37199	0.11406	0.05657	FMS
FMU	0.02128	0.23450	0.06012	0.01449	FMU
FSB	0.10020	0.04286	−0.02114	−0.18227	FSB
FSM	0.09741	0.19502	0.43919	0.27105	FSM
FSS	−0.14094	−0.10008	−0.30513	−0.06368	FSS
FSU	−0.05666	−0.13779	−0.11292	−0.02510	FSU
FUB	0.10327	0.09965	−0.01654	−0.26085	FUB
FUM	0.09488	0.11815	0.46527	0.28130	FUM
FUS	−0.19573	−0.13242	−0.22696	−0.10171	FUS
FUU	−0.00242	−0.08537	−0.22177	0.08127	FUU
	MOTOR	FURNIT	CONST	EGW	

Note: No price and quantity transformations

Predicted Shares, Elasticities of Substitution and Factor Price Elasticities of Sectors Using Translog Variable Cost Function:

Model II (2 breakpoints)

	TEXTILE	MEAT	PETROL	SEMI	
SPB	0.47907	0.17061	0.23925	0.15233	SPB
SPM	0.13558	0.37783	0.57807	0.45343	SPM
SPS	0.30230	0.38478	0.15389	0.32216	SPS
SPU	0.08306	0.06678	0.02879	0.07208	SPU
EBB	−1.33006	−3.25236	0.18918	−2.83394	EBB
EMM	−10.31049	−1.03941	0.40756	−0.16234	EMM
ESS	−1.01831	−1.06240	7.14855	−0.28854	ESS
EUU	4.21639	0.64661	71.79835	−14.51936	EUU
EBM	2.32960	0.14011	0.16434	0,79211	EBM
EBS	0.92539	1.02682	−0.59798	1.26523	EBS
EBU	0.50094	1.60019	−1.67549	−4.64868	EBU
EMS	0.56447	0.86101	−1.45139	−0.61597	EMS
EMU	1.33856	0.56180	−1.79104	2.10030	EMU
ESU	−2.55266	−1.37340	−4.09929	2.49053	ESU
FBB	−0.63719	−0.55490	0.04526	−0.43171	FBB
FBM	0.31584	0.05294	0.09500	0.35917	FBM
FBS	0.27974	0.39510	−0.09202	0.40761	FBS
FBU	0.04161	0.10636	−0.04824	−0.33507	FBU
FMB	1.11603	0.02390	0.03932	0.12067	FMB
FMM	−1.39785	−0.39272	0.23560	−0.07361	FMM
FMS	0.17064	0.33130	−0.22335	−0.19844	FMS
FMU	0.11118	0.03752	−0.05156	0.15139	FMU
FSB	0.44332	0.17519	−0.14307	0.19274	FSB
FSM	0.07653	0.32531	−0.83901	−0.27930	FSM
FSS	−0.30783	−0.40879	1.10009	−0.09296	FSS
FSU	−0.21202	−0.09171	−0.11802	0.17951	FSU
FUB	0.23998	0.27301	−0.40086	−0.70815	FUB
FUM	0.18148	0.21226	−1.03535	0.95233	FUM
FUS	−0.77167	−0.52846	−0.63084	0.80236	FUS
FUU	0.35021	0.04318	2.06705	−1.04653	FUU
	TEXTILE	MEAT	PETROL	SEMI	

Note: No price and quantity transformations

Predicted Shares, Elasticities of Substitution and Factor Price Elasticities of Sectors Using Translog Variable Cost Function

Model III (no breakpoints)

	MINE	RICE	SUGAR	OILS	FLOUR	BEV	GAR	
SPB	0.15174	0.15769	0.11569	0.16834	0.25244	0.13460	0.09419	SPB
SPM	0.56581	0.37026	0.45876	0.61533	0.38343	0.44180	0.19763	SPM
SPS	0.21127	0.35891	0.34113	0.15354	0.23674	0.29160	0.47957	SPS
SPU	0.07118	0.11314	0.08442	0.06278	0.12738	0.13200	0.22862	SPU
EBB	−0.34202	−6.94906	−1.18506	−6.10260	−3.68618	−4.17356	−2.31298	EBB
EMM	−0.39846	−2.15615	−0.55701	−0.43577	−2.17411	−0.90183	−0.23289	EMM
ESS	−1.61231	−1.45107	−0.95652	1.23286	−0.17505	−0.85462	0.05279	ESS
EUU	−2.93032	−1.29178	−0.62098	7.52267	1.08386	−1.16250	0.23202	EUU
EBM	0.06852	1.52903	−0.36815	1.72610	2.47023	0.94251	0.72734	EBM
EBS	0.04514	1.17528	0.78103	−0.32412	−0.11768	0.30640	0.12708	EBS
EBU	0.05047	0.95317	0.46852	0.23859	0.08824	0.42432	0.05764	EBU
EMS	0.74409	1.23107	0.69459	−0.01231	0.64888	0.65166	−0.04725	EMS
EMU	0.81271	1.01984	0.72462	−0.32729	0.44292	0.61773	0.00078	EMU
ESU	−1.22547	−1.06367	−0.97970	−2.02562	−1.39465	−0.60552	−0.12225	ESU
FBB	−0.05190	−1.09580	−0.13710	−1.02734	−0.93055	−0.56176	−0.21786	FBB
FBM	0.03877	0.56614	−0.16889	1.06213	0.94717	0.41640	0.14374	FBM
FBS	0.00954	0.42182	0.26643	−0.04977	−0.02786	0.08935	0.06094	FBS
FBU	0.00359	0.10784	0.03955	0.01498	0.01124	0.05601	0.01318	FBU
FMB	0.01040	0.24111	−0.04259	0.29058	0.62359	0.12686	0.06851	FMB
FMM	−0.22545	−0.79834	−0.25553	−0.26814	−0.83363	−0.39843	−0.04602	FMM
FMS	0.15720	0.44185	0.23695	−0.00189	0.15362	0.19002	−0.02266	FMS
FMU	0.05785	0.11538	0.06117	−0.02055	0.05642	0.08154	0.00018	FMU
FSB	0.00685	0.18533	0.09036	−0.05456	−0.02971	0.04124	0.01197	FSB
FSM	0.42101	0.45582	0.31865	−0.00757	0.24880	0.28790	−0.00934	FSM
FSS	−0.34063	−0.52081	−0.32630	0.18930	−0.04144	−0.24921	0.02532	FSS
FSU	−0.08723	−0.12034	−0.08271	−0.12716	−0.17765	−0.07993	−0.02795	FSU
FUB	0.00766	0.15030	0.05420	0.04017	0.02228	0.05711	0.00543	FUB
FUM	0.45984	0.37761	0.33243	−0.20139	0.16983	0.27291	0.00015	FUM
FUS	−0.25890	−0.38176	−0.33421	−0.31102	−0.33017	−0.17657	−0.05862	FUS
FUU	−0.20859	−0.14615	−0.05242	0.47225	0.13806	−0.15345	0.05304	FUU
	MINE	RICE	SUGAR	OILS	FLOUR	BEV	GAR	

Note: No price and quantity transformations

Model III (no breakpoints)

	WOOD	RUBB	CEMENT	MACHY	MOTOR	FURNIT	CONST	
SPB	0.11060	0.11411	0.17906	0.10913	0.19105	0.11175	0.14318	SPB
SPM	0.47538	0.47808	0.55140	0.34777	0.40354	0.17996	0.61606	SPM
SPS	0.23712	0.32275	0.19931	0.35025	0.31433	0.34712	0.16076	SPS
SPU	0.17691	0.08505	0.07022	0.19285	0.09108	0.36117	0.07999	SPU
EBB	−5.14469	−4.76990	−9.03613	2.52840	−3.01393	−6.11234	−4.58781	EBB
EMM	−0.54337	−1.07859	−1.10537	−0.49015	−0.64077	−4.27216	−0.59341	EMM
ESS	−0.42324	−0.67747	−3.22863	−0.66495	−0.42943	−0.31194	−2.09751	ESS
EUU	−0.41825	1.83864	−1.26718	−1.15823	0.08413	−0.25726	−2.98084	EUU
EBM	0.73429	1.58214	1.92538	−1.96530	0.88702	1.07504	1.16067	EBM
EBS	0.53279	−0.45524	2.05367	0.72775	0.52658	0.43168	−0.25362	EBS
EBU	0.52904	−0.73918	2.09438	0.79152	0.57453	0.94074	−0.21743	EBU
EMS	0.40486	0.82200	1.00557	0.66174	0.22651	1.13649	0.81443	EMS
EMU	0.45841	0.82078	0.91589	0.79421	0.19669	0.70375	0.85588	EMU
ESU	−0.85374	−1.43896	−3.96905	−0.39749	−0.62608	−0.40004	−1.60297	ESU
FBB	−0.56899	−0.54660	−1.61805	0.27593	−0.57580	−0.68307	−0.65688	FBB
FBM	0.34907	0.75640	1.06166	−0.68347	0.35795	0.19346	0.71505	FBM
FBS	0.12633	−0.14693	0.40932	0.25490	0.16552	0.14985	−0.04077	FBS
FBU	0.09359	−0.06287	0.14707	0.15264	0.05233	0.33976	−0.01739	FBU
FMB	0.08121	0.18055	0.34477	−0.21448	0.16946	0.12014	0.16619	FMB
FMM	−0.25831	−0.51566	−0.60950	−0.17046	−0.25858	−0.76881	−0.36558	FMM
FMS	0.09600	0.26530	0.20042	0.23178	0.07120	0.39450	0.13093	FMS
FMU	0.08109	0.06981	0.06432	0.15316	0.01792	0.25417	0.06846	FMU
FSB	0.05893	−0.05195	0.36774	0.07942	0.10060	0.04824	−0.03631	FSB
FSM	0.19246	0.39299	0.55447	0.23013	0.09141	0.20452	0.50174	FSM
FSS	−0.10036	−0.21865	−0.64350	−0.23290	−0.13498	−0.10828	−0.33720	FSS
FSU	−0.15103	−0.12238	−0.27872	−0.07665	−0.05703	−0.14448	−0.12823	FSU
FUB	0.05851	−0.08435	0.37503	0.08638	0.10976	0.10513	−0.03113	FUB
FUM	0.21792	0.39240	0.50502	0.27620	0.07937	0.12665	0.52728	FUM
FUS	−0.20244	−0.46443	−0.79107	−0.13922	−0.19680	−0.13886	−0.25770	FUS
FUU	−0.07399	0.15637	−0.08899	−0.22336	0.00766	−0.09291	−0.23844	FUU
	WOOD	RUBB	CEMENT	MACHY	MOTOR	FURNIT	CONST	

Note: No price and quantity transformations

Model III (no breakpoints)

	EGW	TRADE	TEXTILE	FERT	SEMI	PETROL	MEAT	PRIVATE	
SPB	0.31827	0.53271	0.40980	0.25751	0.17614	0.25937	0.15610	0.27169	SPB
SPM	0.54314	0.40421	0.11862	0.57945	0.40293	0.53226	0.39090	0.14271	SPM
SPS	0.11125	0.04433	0.37033	0.14354	0.33085	0.17208	0.38613	0.42474	SPS
SPU	0.02734	0.01875	0.10124	0.01950	0.09008	0.03629	0.06687	0.16085	SPU
EBB	−1.35824	−1.51576	−1.32238	1.93474	2.00268	0.03637	−2.99352	−1.40459	EBB
EMM	−0.72395	−1.78490	−10.74945	1.80229	0.78187	−0.07456	−1.21075	−5.25721	EMM
ESS	−0.75482	5.86957	−0.35253	10.89860	0.20926	2.82877	−1.16638	−0.06261	ESS
EUU	3.80737	14.22194	1.97247	34.94409	−4.72847	33.65789	0.50234	1.30125	EUU
EBM	0.97533	1.72583	2.74481	−1.52107	−0.75340	0.32642	0.06716	1.51662	EBM
EBS	−0.64772	1.84828	0.50184	2.37426	0.07761	−0.75917	0.86803	0.32819	EBS
EBU	−0.92893	1.48976	0.30097	2.17218	−0.83101	−1.44760	1.58306	0.16032	EBU
EMS	0.59584	−3.21718	0.25860	−4.00539	−0.57180	−0.23537	1.06421	0.51439	EMS
EMU	0.60371	−2.94853	0.53845	−3.98508	0.07605	−0.12341	0.77577	0.74423	EMU
ESU	−1.22550	2.96870	−1.04476	7.44284	1.63724	−4.53498	−1.51230	−0.84539	ESU
FBB	−0.43229	−0.80746	−0.54191	0.49822	0.35275	0.00943	−0.46728	−0.38162	FBB
FBM	0.52974	0.69760	0.32559	−0.88138	−0.30357	0.17374	0.02625	0.21644	FBM
FBS	−0.07206	0.08193	0.18585	0.34080	0.02568	−0.13064	0.33518	0.13940	FBS
FBU	−0.02539	0.02793	0.03047	0.04236	−0.07486	−0.05254	0.10585	0.02579	FBU
FMB	0.31042	0.91937	1.12483	−0.39169	−0.13270	0.08466	0.01048	0.41206	FMB
FMM	−0.39321	−0.72148	−1.27511	1.04434	0.31503	−0.03968	−0.47329	−0.75025	FMM
FMS	0.06629	−0.14260	0.09577	−0.57493	−0.18918	−0.04050	0.41093	0.21848	FMS
FMU	0.01650	−0.05528	0.05451	−0.07771	0.00685	−0.00448	0.05187	0.11971	FMU
FSB	−0.20615	0.98460	0.20565	0.61140	0.01367	−0.19691	0.13550	0.08917	FSB
FSM	0.32362	−1.30043	0.03068	−2.32091	−0.23039	−0.12528	0.41600	0.07341	FSM
FSS	−0.08397	0.26018	−0.13055	1.56437	0.06923	0.48677	−0.45038	−0.02659	FSS
FSU	−0.03350	0.05566	−0.10577	0.14514	0.14749	−0.16459	−0.10112	−0.13598	FSU
FUB	−0.29565	0.79361	0.12334	0.55936	−0.14637	−0.37547	0.24711	0.04356	FUB
FUM	0.32790	−1.19184	0.06387	−2.30914	0.03064	−0.06569	0.30325	0.10621	FUM
FUS	−0.13633	0.13159	−0.38691	1.06833	0.54169	−0.78037	−0.58395	−0.35908	FUS
FUU	0.10408	0.26664	0.19970	0.68144	−0.42596	1.22153	0.03359	0.20931	FUU
	EGW	TRADE	TEXTILE	FERT	SEMI	PETROL	MEAT	PRIVATE	

Note: No price and quantity transformations

Table 7. List of Sectors that Violate the Concavity Conditions (Using Transformed Data)

Sector Code	Sector	Inputs *
For Model III	(out of 22 sectors estimated)	
19	Oils and Fats	U
21	Flour and Feed Milling	S, U
25	Garments, Footwear and Leather	B, M, S, U
27	Fertilizer	B, M, S, U
29	Coal and Petroleum	S, U
31	Semiconductor Devices	B, M
36	Electricity, Gas and Water	U
38	Trade, Storage and Warehousing	U
42	Private Services	S, U
For Model I	(out of 14 sectors estimated)	
19	Oils and Fats	S, U
21	Flour and Feed Milling	S, U
25	Garments, Footwear and Leather	B, M, S, U
For Model II	(out of 4 sectors estimated)	
29	Coal and Petroleum	M, S, U

* Code:
- B = buildings and structures
- M = machinery and equipment
- S = skilled labor
- U = unskilled labor

Table 8. List of Sectors that Violate the Concavity Conditions (Using Untransformed Data)

Sector Code	Sector	Inputs *
For Model III	(out of 22 sectors estimated)	
19	Oils and Fats	S, U
20	Meat and Meat Products	U
21	Flour and Feed Milling	U
24	Textiles	U
25	Garments, Footwear and Leather	S, U
27	Fertilizer	B, M, S, U
28	Rubber and Other Chemicals	U
29	Coal and Petroleum	B, S, U
31	Semiconductor Devices	B, M, S
32	Machinery and Metals	B
33	Motor Vehicles	U
36	Electricity, Gas and Water	U
38	Trade, Storage and Warehousing	S, U
42	Private Services	U
For Model I	(out of 14 sectors estimated)	
19	Oils and Fats	S, U
21	Flour and Feed Milling	U
25	Garments, Footwear and Leather	S, U
28	Rubber and Other Chemicals	U
32	Machineries and Metals	B
36	Electricity, Gas and Water	U
For Model II	(out of 4 sectors estimated)	
20	Meat and Meat Products	U
24	Textiles	U
29	Coal and Petroleum	B, M, S, U

* Code:
B = buildings and structures
M = machinery and equipment
S = skilled labor
U = unskilled labor

Note: No price and quantity transformations

Table 9. Inventory of Estimation Models Used and Elasticities Generated by the Translog Variable Cost Function Estimation

Sector Code	Sector	With Data Transformation, Estimation Model I	II	III	Without Data Transformation, Estimation Model I	II	III	
14	Forestry and Logging							*
15	Mining and Quarrying	X		X	X		X	
16	Rice and Corn Milling			X			X	
17	Sugar Milling and Refining	X		X	X		X	
18	Milk and Dairy							*
19	Oils and Fats							**
20	Meat and Meat products		X	X				
21	Flour and Feed Milling							**
22	Other Foods							*
23	Beverages and Tobacco	X		X	X		X	
24	Textiles		X	X				
25	Garments, Footwear and Leather							**
26	Wood and Wood Products	X		X	X		X	
27	Fertilizer							**
28	Rubber and Other Chemicals	X		X				
29	Coal and Petroleum Products							**
30	Cement and Basic Metal	X		X	X		X	
31	Semi−conductor Devices		X			X		
32	Machinery and Metal Products	X		X				
33	Motor Vehicles	X		X	X			
34	Furniture and Other Manufacture	X		X	X		X	
35	Construction	X		X	X		X	
36	Electricity, Gas and Water	X						
37	Transport and Communication Services							*
38	Trade, Storage and Warehousing							**
39	Financial Services							*
40	Ownership of Dwelling							*
41	Government Services							*
42	Other Services							**

* Either no data is available or data problems exist for this sector.
** Concavity condition is violated by all model estimates obtained.

Table 10. Substitutability and Complementarity of Inputs
(Using Transformed Data)

Sector Code	Sector	BM	BS	BU	MS	MU	SU
For Model III							
15	Mining and Quarrying	+	+	−	+	+	+
16	Rice and Corn Milling	+	+	+	+	+	−
17	Sugar Milling and Refining	−	+	+	+	+	−
19	Oils and Fats	+	+	+	+	+	−
20	Meat and Meat Products	−	+	+	+	+	−
21	Flour and Feed Milling	+	+	+	+	+	−
23	Beverages and Tobacco	+	+	+	+	+	−
24	Textiles	+	+	+	+	+	−
25	Garments, Footwear and Leather	+	−	−	−	−	−
26	Wood and Paper Products	+	+	+	+	+	−
27	Fertilizer	−	+	+			+
28	Rubber and Other Chemicals	+	+	−	+	+	−
29	Coal and Petroleum	+	+	−	+	+	−
30	Cement and Basic Metal	+	+	+	+	+	−
31	Semiconductor Devices	−	+	−		+	+
32	Machinery and Metal Products	−	+	+	+	+	−
33	Motor Vehicles	+	+	+	+	+	−
34	Furniture and Other Manufacturing	+	+	+	+	+	−
35	Construction	+	+	+	+	+	−
36	Electricity, Gas and Water	+	+	+	+	+	−
38	Trade, Storage and Warehousing	+	+	−	−	−	+
42	Private Services	+	+	−	+	+	−
For Model I							
15	Mining and Quarrying	+	+	+	+	+	+
16	Rice and Corn Milling						
17	Sugar Milling and Refining	−	+	+	+	+	−
19	Oils and Fats	+	+	+	+	+	−
20	Meat and Meat Products						
21	Flour and Feed Milling	+	+	+	+	+	−
23	Beverages and Tobacco	+	+	+	+	+	−
24	Textiles						
25	Garments, Footwear and Leather	+	−	−	−	−	−
26	Wood and Paper Products	+	+	+	+	+	−
27	Fertilizer						
28	Rubber and Other Chemicals	+	+	+	+	+	−
29	Coal and Petroleum						
30	Cement and Basic Metal	+	+	+	+	+	−
31	Semiconductor Devices						
32	Machinery and Metal Products	−	+	+	+	+	−
33	Motor Vehicles	+	+	+	+	+	−
34	Furniture and Other Manufacturing	+	+	+	+	+	−
35	Construction	+	+	+	+	+	−
36	Electricity, Gas and Water	+	+	+	+	+	−
38	Trade, Storage and Warehousing						
42	Private Services						

Code : − complements
+ substitutes

B = buildings and structures
M = machinery and equipment
S = skilled labor
U = unskilled labor

Table 10 (continued)

Sector Code	Sector	BM	BS	BU	MS	MU	SU
For Model II							
15	Mining and Quarrying						
16	Rice and Corn Milling						
17	Sugar Milling and Refining						
19	Oils and Fats						
20	Meat and Meat Products	+	+	+	+	+	–
21	Flour and Feed Milling						
23	Beverages and Tobacco						
24	Textiles	+	+	+	+	+	–
25	Garments, Footwear and Leather						
26	Wood and Paper Products						
27	Fertilizer						
28	Rubber and Other Chemicals						
29	Coal and Petroleum	+	+	–	–	–	–
30	Cement and Basic Metal						
31	Semiconductor Devices	+	+	–	–	+	+
32	Machinery and Metal Products						
33	Motor Vehicles						
34	Furniture and Other Manufacturing						
35	Construction						
36	Electricity, Gas and Water						
38	Trade, Storage and Warehousing						
42	Private Services						

Code : – complements
+ substitutes

B = buildings and structures
M = machinery and equipment
S = skilled labor
U = unskilled labor

Note: The results for the sectors:
(27) fertilizer
(29) coal and petroleum
are suspect because the concavity conditions are violated. This may also be true for some other sectors.

Table 11. Substitutability and Complementarity of Inputs (Using Untransformed Data)

Sector Code	Sector	BM	BS	BU	MS	MU	SU
For Model III							
15	Mining and Quarrying	+	+	+	+	+	−
16	Rice and Corn Milling	+	+	+	+	+	−
17	Sugar Milling and Refining	−	+	+	+	+	−
19	Oils and Fats	+	−	+	−	−	−
20	Meat and Meat Products	+	+	+	+	+	−
21	Flour and Feed Milling	+	−	+	+	+	−
23	Beverages and Tobacco	+	+	+	+	+	−
24	Textiles	+	+	+	+	+	−
25	Garments, Footwear and Leather	+	+	+	−	+	−
26	Wood and Paper Products	+	+	+	+	+	−
27	Fertilizer	−	+	+	−	−	+
28	Rubber and Other Chemicals	+	−	−	+	+	−
29	Coal and Petroleum	+	−	−	−	−	−
30	Cement and Basic Metal	+	+	+	+	+	−
31	Semiconductor Devices	−	+	−	−	+	+
32	Machinery and Metal Products	−	+	+	+	+	−
33	Motor Vehicles	+	+	+	+	+	−
34	Furniture and Other Manufacturing	+	+	+	+	+	−
35	Construction	+	−	−	+	+	−
36	Electricity, Gas and Water	+	−	−	+	+	−
38	Trade, Storage and Warehousing	+	+	+	−	−	+
42	Private Services	+	+	+	+	+	−
For Model I							
15	Mining and Quarrying	−	+	+	+	+	−
16	Rice and Corn Milling						
17	Sugar Milling and Refining	−	+	+	+	+	−
19	Oils and Fats	+	−	+	−	−	−
20	Meat and Meat Products						
21	Flour and Feed Milling	+	−	+	+	+	−
23	Beverages and Tobacco	+	+	+	+	+	−
24	Textiles						
25	Garments, Footwear and Leather	+	−	−	−	+	−
26	Wood and Paper Products	+	+	+	+	+	−
27	Fertilizer						
28	Rubber and Other Chemicals	+	−	−	+	+	−
29	Coal and Petroleum						
30	Cement and Basic Metal	+	+	+	+	+	−
31	Semiconductor Devices						
32	Machinery and Metal Products	−	+	+	+	+	−
33	Motor Vehicles	+	+	+	+	+	−
34	Furniture and Other Manufacturing	+	+	+	+	+	−
35	Construction	+	−	−	+	+	−
36	Electricity, Gas and Water	+	−	−	+	+	−
38	Trade, Storage and Warehousing						
42	Private Services						

Code : − complements
+ substitutes

B = buildings and structures
M = machinery and equipment
S = skilled labor
U = unskilled labor

Note: No price and quantity transformations

Table 11 (continued)

Sector Code	Sector	BM	BS	BU	MS	MU	SU
For Model II							
15	Mining and Quarrying						
16	Rice and Corn Milling						
17	Sugar Milling and Refining						
19	Oils and Fats						
20	Meat and Meat Products	+	+	+	+	+	–
21	Flour and Feed Milling						
23	Beverages and Tobacco						
24	Textiles	+	+	+	+	+	–
25	Garments, Footwear and Leather						
26	Wood and Paper Products						
27	Fertilizer						
28	Rubber and Other Chemicals						
29	Coal and Petroleum	+	–	–	–	–	–
30	Cement and Basic Metal						
31	Semiconductor Devices	+	+	–	–	+	+
32	Machinery and Metal Products						
33	Motor Vehicles						
34	Furniture and Other Manufacturing						
35	Construction						
36	Electricity, Gas and Water						
38	Trade, Storage and Warehousing						
42	Private Services						

Code : – complements
+ substitutes

B = buildings and structures
M = machinery and equipment
S = skilled labor
U = unskilled labor

Note: The results for the sectors:
(27) fertilizer
(29) coal and petroleum
are suspect because the concavity conditions are violated. This may also be true for some other sectors.

Table 12. Values of the Exogenous Parameters of the SGM Model, By Sector

Sector Code	Sector	V	B	M	L
15	Mining and Quarrying	0.61513	0.10005	0.19652	0.08830
16	Rice and Corn Milling	0.39150	0.17755	0.27465	0.15629
17	Sugar Milling and Refining	0.52446	0.04498	0.18319	0.24737
19	Oils and Fats	0.80114	0.02440	0.10279	0.07167
20	Meat and Meat Products	0.49548	0.06456	0.26409	0.17587
21	Flour and Feed Milling	0.69079	0.05495	0.12692	0.12734
23	Beverages and Tobacco	0.79949	0.03192	0.07670	0.09189
24	Textiles	0.57166	0.16946	0.04703	0.21184
25	Garments, Footwear and Leather	0.66120	0.02687	0.04203	0.26990
26	Wood and Paper Products	0.63648	0.02733	0.16142	0.17477
27	Fertilizer	0.69488	0.06008	0.17584	0.06920
28	Rubber and Other Chemicals	0.67542	0.01582	0.09696	0.21179
29	Coal and Petroleum	0.63978	0.07450	0.18289	0.10282
30	Cement and Basic Metal	0.63704	0.08439	0.16831	0.11027
31	Semiconductor Devices	0.59973	0.09816	0.22032	0.08178
32	Machinery and Metal Products	0.67730	0.03318	0.11304	0.17648
33	Motor Vehicles	0.59266	0.05390	0.16574	0.18771
34	Furniture and Other Manufacturing	0.59056	0.02903	0.06561	0.31480
35	Construction	0.36353	0.12176	0.38276	0.13195
36	Electricity, Gas and Water	0.23024	0.58284	0.13245	0.05447
38	Trade, Storage and Warehousing	0.06602	0.52187	0.36611	0.04600
41	Public Services	0.45981	0.10182	0.04841	0.38996
42	Private Services	0.30725	0.27875	0.14207	0.27192

Note:
V = value added
B = buildings and structures
M = machinery and equipment
L = labor

Tables 13. Estimated Price Elasticities,
Using the SGM Profit Function Model, By Sector

Note:

1) The ij-th entry is ϵ_{ij}, where i denotes the row and j the column.
2) The goods are denoted as follows:
   - V ≡ value added;
   - B ≡ buildings, other construction and land improvements;
   - M ≡ machinery and equipment; and
   - L ≡ labor.

Table 13.1 Mining and Quarrying (15)

	Price Elasticities			
	V	B	M	L
V :	0.76983	−3.06916	8.10791	−5.80859
B :	−0.19614	0.78198	−2.06578	1.47995
M :	−0.27136	1.08187	−2.85801	2.04751
L :	−0.30406	1.21222	−3.20238	2.29421

Table 13.2 Rice and Corn Milling (16)

	Price Elasticities			
	V	B	M	L
V :	0.01955	−0.01600	−0.07506	0.07151
B :	0.05059	−0.04140	−0.19425	0.18507
M :	0.10896	−0.08918	−0.41840	0.39862
L :	−0.15698	0.12848	0.60279	−0.57429

Table 13.3 Sugar Milling and Refining (17)

	Price Elasticities			
	V	B	M	L
V :	0.92010	−0.12292	−0.32090	−0.47628
B :	0.56937	−0.08574	−0.24848	−0.23515
M :	0.33173	−0.05546	−0.17316	−0.10312
L :	1.71682	−0.18299	−0.35956	−1.17426

Table 13.4 Oils and Fats (19)

	Price Elasticities			
	V	B	M	L
V :	0.46753	−0.23001	−0.06247	−0.17505
B :	3.86609	−1.90199	−0.51655	−1.44755
M :	0.32805	−0.16139	−0.04383	−0.12283
L :	1.60711	−0.79064	−0.21473	−0.60174

Table 13.5 Meat and Meat Products (20)

	Price Elasticities			
	V	B	M	L
V :	0.18390	0.12650	−0.00828	−0.30212
B :	−0.61125	−0.42045	0.02751	1.00419
M :	0.00937	0.00645	−0.00042	−0.01540
L :	0.22978	0.15806	−0.01034	−0.37749

Table 13.6 Flour and Feed Milling (21)

	Price Elasticities			
	V	B	M	L
V :	0.51479	−0.13203	−0.00368	−0.37908
B :	1.23433	−2.19696	1.58971	−0.62708
M :	0.00970	0.44799	−0.77000	0.31231
L :	1.84408	−0.32630	0.57668	−2.09446

Table 13.7 Beverages and Tobacco (23)

	Price Elasticities			
	V	B	M	L
V :	0.69252	−0.07815	−0.12290	−0.49147
B :	3.15418	−1.21246	−0.98640	−0.95532
M :	0.57180	−0.11371	−0.84129	0.38320
L :	1.93734	−0.09331	0.32466	−2.16870

Table 13.8 Textiles (24)

	Price Elasticities			
	V	B	M	L
V :	1.00192	−0.92650	−0.21672	0.14129
B :	3.26107	−3.62167	−0.10088	0.46147
M :	2.04915	−0.27100	−2.06288	0.28472
L :	−0.16488	0.15299	0.03514	−0.02325

Table 13.9 Garments, Footwear and Leather (25)

	Price Elasticities			
	V	B	M	L
V :	1.19606	−0.01659	−0.09294	−1.08653
B :	0.59094	−0.00820	−0.04592	−0.53683
M :	1.00560	−0.01395	−0.07814	−0.91351
L :	1.84282	−0.02556	−0.14320	−1.67406

Table 13.10 Wood and Paper Products (26)

	Price Elasticities V	B	M	L
V :	0.52563	−0.04203	0.06987	−0.55348
B :	0.98462	−0.48552	0.30229	−0.80138
M :	−0.32737	0.06045	−0.05796	0.32488
L :	2.36300	−0.14603	0.29605	−2.51302

Table 13.11 Fertilizer (27)

	Price Elasticities V	B	M	L
V :	−0.67058	−0.13340	0.28891	0.51507
B :	−4.13803	−0.82318	1.78284	3.17838
M :	−1.67917	−0.33404	0.72345	1.28975
L :	7.82603	1.55684	−3.37178	−6.01109

Table 13.12 Rubber and Other Chemicals (28)

	Price Elasticities V	B	M	L
V :	0.94105	−0.01829	−0.39986	−0.52291
B :	0.48231	−0.46355	−0.07766	0.05890
M :	3.07179	−0.02262	−2.09086	−0.95831
L :	2.99121	0.01277	−0.71358	−2.29041

Table 13.13 Coal and Petroleum (29)

	Price Elasticities V	B	M	L
V :	−6.36765	0.19404	3.26621	2.90740
B :	1.64599	−0.05016	−0.84429	−0.75154
M :	137.52270	−4.19064	−70.54064	−62.79140
L :	−8.26828	0.25195	4.24112	3.77521

Table 13.14 Cement and Basic Metal (30)

	Price Elasticities V	B	M	L
V :	−7.05361	−4.20429	9.54624	1.71166
B :	−1.70285	−1.17769	2.79612	0.08441
M :	11.29122	8.16547	−19.61734	0.16064
L :	0.17518	0.02133	0.01390	−0.21041

Table 13.15 Semiconductor Devices (31)

	Price Elasticities V	B	M	L
V :	0.70374	−0.12426	−0.55848	−0.02100
B :	2.71284	−0.47899	−2.15288	−0.08097
M :	10.71323	−1.89157	−8.50192	−0.31974
L :	0.10013	−0.01768	−0.07946	−0.00299

Table 13.16 Machinery and Metal Products (32)

	Price Elasticities			
	V	B	M	L
V :	0.41138	0.02093	0.06006	−0.49237
B :	−0.32938	−0.01676	−0.04808	0.39422
M :	−0.28869	−0.01469	−0.04215	0.34553
L :	1.49621	0.07612	0.21843	−1.79076

Table 13.17 Motor Vehicles (33)

	Price Elasticities			
	V	B	M	L
V :	0.74477	−0.04962	−0.17108	−0.52406
B :	0.62188	−0.04585	−0.09423	−0.48181
M :	1.57859	−0.06938	−0.75722	−0.75199
L :	1.85307	−0.13594	−0.28818	−1.42895

Table 13.18 Furniture and Other Manufacturing (34)

	Price Elasticities			
	V	B	M	L
V :	2.06324	−0.02058	0.10896	−2.15162
B :	0.32605	−0.00325	0.01722	−0.34002
M :	−0.92840	0.00926	−0.04903	0.96817
L :	5.35409	−0.05341	0.28276	−5.58344

Table 13.19 Construction (35)

	Price Elasticities V	B	M	L
V :	0.02997	−0.02577	0.12084	−0.12505
B :	0.22868	−0.43753	0.89687	−0.68802
M :	−0.09417	0.07876	−0.37991	0.39532
L :	0.33374	−0.20692	1.35392	−1.48074

Table 13.20 Electricity,Gas and Water (36)

	Price Elasticities V	B	M	L
V :	1.00217	−0.20988	−0.02612	−0.76618
B :	0.86668	−0.22118	0.00806	−0.65355
M :	0.02725	0.00204	−0.00669	−0.02260
L :	1.18909	−0.24562	−0.03361	−0.90985

Table 13.21 Trade, Storage and Warehousing (38)

	Price Elasticities V	B	M	L
V :	2.47051	−1.61609	−1.08155	0.22712
B :	0.40968	−0.26799	−0.17935	0.03766
M :	0.36375	−0.23795	−0.15924	0.03344
L :	−0.55106	0.36047	0.24124	−0.05066

Table 13.22 Private Services (42)

	Price Elasticities			
	V	B	M	L
V :	1.54250	0.52432	−0.10615	−1.96067
B :	−0.91357	−0.67584	0.48116	1.10826
M :	0.42464	1.10472	−1.12890	−0.40047
L :	2.08242	0.67555	−0.10632	−2.65165

Table 14. Estimated Price Elasticities, Using the SGM Profit Function Model

Note:

1) $E(i,j) \equiv (\partial z_i/\partial p_j) \;/\; (p_j/z_i)$
(appears in tables as EIJ)

2) The goods are denoted as follows:
$V \equiv$ value added;
$B \equiv$ buildings, other construction and land improvements;
$M \equiv$ machinery and equipment; and
$L \equiv$ labor.

Table 14. Estimated Price Elastcities (Using the SGM Profit Function Model)

	Mining and Quarrying (15)	Rice and Corn Milling (16)	Sugar Milling & Refining (17)	Oils & Fats (19)
EVV	0.76983	0.01955	0.92010	0.46753
EVB	−3.06916	−0.01600	−0.12292	−0.23001
EVM	8.10791	−0.07506	−0.32090	−0.06247
EVL	−5.80859	0.07151	−0.47628	−0.17505
EBV	−0.19614	0.05059	0.56937	3.86609
EBB	0.78198	−0.04140	−0.08574	−1.90199
EBM	−2.06578	−0.19425	−0.24848	−0.51655
EBL	1.47995	0.18507	−0.23515	−1.44755
EMV	−0.27136	0.10896	0.33173	0.32805
EMB	1.08187	−0.08918	−0.05546	−0.16139
EMM	−2.85801	−0.41840	−0.17316	−0.04383
EML	2.04751	0.39862	−0.10312	−0.12283
ELV	−0.30406	−0.15698	1.71682	1.60711
ELB	1.21222	0.12848	−0.18299	−0.79064
ELM	−3.20238	0.60279	−0.35956	−0.21473
ELL	2.29421	−0.57429	−1.17426	−0.60174

	Meat and Meat Products (20)	Flour and Feed Milling (21)	Beverage & Tobacco (23)	Textiles (24)
EVV	0.18390	0.51479	0.69252	1.00192
EVB	0.12650	−0.13203	−0.07815	−0.92650
EVM	−0.00828	−0.00368	−0.12290	−0.21672
EVL	−0.30212	−0.37908	−0.49147	0.14129
EBV	−0.61125	1.23433	3.15418	3.26107
EBB	−0.42045	−2.19696	−1.21246	−3.62167
EBM	0.02751	1.58971	−0.98640	−0.10088
EBL	1.00419	−0.62708	−0.95532	0.46147
EMV	0.00937	0.00970	0.57180	2.04915
EMB	0.00645	0.44799	−0.11371	−0.27100
EMM	−0.00042	−0.77000	−0.84129	−2.06288
EML	−0.01540	0.31231	0.38320	0.28472
ELV	0.22978	1.84408	1.93734	−0.16488
ELB	0.15806	−0.32630	−0.09331	0.15299
ELM	−0.01034	0.57668	0.32466	0.03514
ELL	−0.37749	−2.09446	−2.16870	−0.02325

	Garments, Foot-wear & Leather (25)	Wood & Paper Products (26)	Fertilizer (27)	Rubber and Other Chemicals (28)
EVV	1.19606	0.52563	−0.67058	0.94105
EVB	−0.01659	−0.04203	−0.13340	−0.01829
EVM	−0.09294	0.06987	0.28891	−0.39986
EVL	−1.08653	−0.55348	0.51507	−0.52291
EBV	0.59094	0.98462	−4.13803	0.48231
EBB	−0.00820	−0.48552	−0.82318	−0.46355
EBM	−0.04592	0.30229	1.78284	−0.07766
EBL	−0.53683	−0.80138	3.17838	0.05890
EMV	1.00560	−0.32737	−1.67917	3.07179
EMB	−0.01395	0.06045	−0.33404	−0.02262
EMM	−0.07814	−0.05796	0.72345	−2.09086
EML	−0.91351	0.32488	1.28975	−0.95831
ELV	1.84282	2.36300	7.82603	2.99121
ELB	−0.02556	−0.14603	1.55684	0.01277
ELM	−0.14320	0.29605	−3.37178	−0.71358
ELL	−1.67406	−2.51302	−6.01109	−2.29041

	Coal & Petrol-eum Products (29)	Cement and Basic Metal (30)	Semicon-ductors (31)	Machinery & Metals (32)
EVV	−6.36765	−7.05361	0.70374	0.41138
EVB	0.19404	−4.20429	−0.12426	0.02093
EVM	3.26621	9.54624	−0.55848	0.06006
EVL	2.90740	1.71166	−0.02100	−0.49237
EBV	1.64599	−1.70285	2.71284	−0.32938
EBB	−0.05016	−1.17769	−0.47899	−0.01676
EBM	−0.84429	2.79612	−2.15288	−0.04808
EBL	−0.75154	0.08441	−0.08097	0.39422
EMV	137.52270	11.29122	10.71323	−0.28869
EMB	−4.19064	8.16547	−1.89157	−0.01469
EMM	−70.54064	−19.61734	−8.50192	−0.04215
EML	−62.79140	0.16064	−0.31974	0.34553
ELV	−8.26828	0.17518	0.10013	1.49621
ELB	0.25195	0.02133	−0.01768	0.07612
ELM	4.24112	0.01390	−0.07946	0.21843
ELL	3.77521	−0.21041	−0.00299	−1.79076

	Motor Vehicles (33)	Furniture & Other Manufac–tures (34)	Construction (35)	Electricity, Gas & Water (36)
EVV	0.74477	2.06324	0.02997	1.00217
EVB	−0.04962	−0.02058	−0.02577	−0.20988
EVM	−0.17108	0.10896	0.12084	−0.02612
EVL	−0.52406	−2.15162	−0.12505	−0.76618
EBV	0.62188	0.32605	0.22868	0.86668
EBB	−0.04585	−0.00325	−0.43753	−0.22118
EBM	−0.09423	0.01722	0.89687	0.00806
EBL	−0.48181	−0.34002	−0.68802	−0.65355
EMV	1.57859	−0.92840	−0.09417	0.02725
EMB	−0.06938	0.00926	0.07876	0.00204
EMM	−0.75722	−0.04903	−0.37991	−0.00669
EML	−0.75199	0.96817	0.39532	−0.02260
ELV	1.85307	5.35409	0.33374	1.18909
ELB	−0.13594	−0.05341	−0.20692	−0.24562
ELM	−0.28818	0.28276	1.35392	−0.03361
ELL	−1.42895	−5.58344	−1.48074	−0.90985

	Trade, Storage & Warehousing (38)	Private Services (42)
EVV	2.47051	1.54250
EVB	−1.61609	0.52432
EVM	−1.08155	−0.10615
EVL	0.22712	−1.96067
EBV	0.40968	−0.91357
EBB	−0.26799	−0.67584
EBM	−0.17935	0.48116
EBL	0.03766	1.10826
EMV	0.36375	0.42464
EMB	−0.23795	1.10472
EMM	−0.15924	−1.12890
EML	0.03344	−0.40047
ELV	−0.55106	2.08242
ELB	0.36047	0.67555
ELM	0.24124	−0.10632
ELL	−0.05066	−2.65165

Table 15. Substitutability and Complementarity of Goods
(SGM Profit Function Estimates)

Sector Code	Sector	VB	VM	VL	BM	BL	ML
15	Mining and Quarrying	−	+	−	−	+	+
16	Rice and Corn Milling	−	−	+	−	+	+
17	Sugar Milling and Refining	−	−	−	−	−	−
19	Oils and Fats	−	−	−	−	−	−
20	Meat and Meat Products	+	−	−	+	+	−
21	Flour and Feed Milling	−	−	−	+	−	+
23	Beverages and Tobacco	−	−	−	−	−	+
24	Textiles	−	−	+	−	+	+
25	Garments, Footwear and Leather	−	−	−	−	−	−
26	Wood and Paper Products	−	+	−	+	−	+
27	Fertilizer	−	+	+	+	+	+
28	Rubber and Other Chemicals	−	−	−	−	+	−
29	Coal and Petroleum	+	+	+	−	−	−
30	Cement and Basic Metal	−	+	+	+	+	+
31	Semiconductor Devices	−	−	−	−	−	−
32	Machinery and Metal Products	+	+	−	−	+	+
33	Motor Vehicles	−	−	−	−	−	−
34	Furniture and Other Manufacturing	−	+	−	+	−	+
35	Construction	−	+	−	+	−	+
36	Electricity, Gas and Water	−	−	−	+	−	−
38	Trade, Storage and Warehousing	−	−	+	−	+	+
42	Private Services	+	−	−	+	+	−

Note:
V = value added
B = buildings and structures
M = machinery and equipment
L = labor

Footnotes:

1. No production data is available for the "ownership of dwelling" sector (40). This sector appears in the GNP accounts but there is a question of whether it should be considered a production sector. However, this sector is deleted in the 50-sector APEX model.

   Severe data problems exist for the following five sectors:
   (14) forestry and logging,
   (18) milk and dairy,
   (22) other food manufactures,
   (37) transport and communication services, and
   (39) financial services.

   Examples of the data problems are the total cost of labor being greater than value added, reported number of employees for some categories or book values of capital being zero, and value added being negative.

   Hence, estimation results are given for only 23 sectors. Also, estimation results indicate data problems with the government services sector (41). Estimates are obtained only for the CES production function without the technical change subfunction; even this model is poor and the estimate of the elasticity of substitution has a large standard error.

2. For the rubber and chemicals sector (28), the first break point is set at t_1=1982. For the following sectors, the break point t_1 is set at t_1=1987 resulting in a no-break subfunction:
   (16) rice and corn milling;
   (38) trade, and
   (42) private services.

   Observations for these sectors are only for the period 1984-1987. For the government services sector (41), incorporating the subfunction in the estimation yielded a positive definite matrix which made estimation not possible. Observations for this sector are only for the years 1986-1987. Direct estimation of equation (1), with or without the technical change subfunction, is feasible using nonlinear estimation techniques (maximum likelihood or least squares) but is not performed in this study.

3. In hindsight, the technical change subfunction $d^2(p,t)$ should have been modified to have prices p entering in logarithmic form and to include interaction terms between the fixed input z and the time index t. These modifications would have yielded a more consistent specification of the quadratic spline technical change subfunction when appended to a translog cost function.

   However, since the technical change subfunction $d^2(p,t)$ is used only in estimation Model II below which involves only the share equations, whether the prices p enter in logarithmic form or not does not make a difference. If prices enter in logarithmic form, then the technical change term in the share equations (22) will be $\partial d^2(p,t)/\partial \ln p_i$ instead of $\partial d^2(p,t)/\partial p_i$.

4. Model I results are reported for 14 out of the possible 16 sectors. For the rice and corn milling sector (16) and trade, storage and warehousing sector (38), a singular matrix is obtained at some stage in the estimation. This may be indicative of data problems. From Table B.7 in the Appendix, the original data set from the NSO contained the maximum possible number of observations--130--for each of these sectors. In both sectors, the total labor cost was greater than the value added for observations in the period 1979-1983; hence, these observations were dropped. The retained observations cover only the period 1984-1987. Hence, there might not be sufficient information--for example, price variability--in the data to estimate the full dual system. Dropping the variable cost function and estimating only the system of share equations, yielding Model III, solves the estimation problem.

5. Model III is estimated for each of the 23 sectors (see the notes at the bottom of Table 1 for the list of these sectors). Problems arise with the estimation for the government services sector (41). In this study, only the CES production function without technological change estimation results are reported for this sector. Note, too, as seen in Table B.7, that data problems similar to but probably in more severe form than those in the rice and corn milling sector (16) and trade, storage and warehousing sector (38) mentioned in the previous footnote appear in this sector. Translog variable cost function results are reported for only 22 (out of 29) sectors.

6. Estimation of Model II was attempted for the fertilizer sector (27); estimation problems occured probably due to sparseness of observations. The fertilizer data set, which consists of only 13 observations, may have too little informational content to yield estimates of the parameters. The author believes that it is not the number of observations per se that is the problem but the quality or, more precisely, the informational content of the data. In a previous work (Mendoza 1989), the author has estimated a symmetric generalized McFadden profit function with 66 parameters using 20 observations.

7. Compared to those obtained using untransformed data, the calculated predicted cost shares of the inputs in variable cost tend to equalize when the transformed data is used in the estimation.

8. In this case where a variable cost function is used, the price of other variable inputs, the quantity levels of value added and land, and the time index are held constant.

9. Noulas, Ray and Miller (1990), in a study of scale economies and input substitution for large U.S. banks, present evidence suggesting that substitutability among bank inputs may have risen since the deregulation of banks in the early 1980s. Consistent with the Le Chatelier principle in microeconomic theory, the greater the flexibility of a firm in its operations, the higher (in absolute values) would the elasticities of substitution and factor price elasticities tend to be.

10. This relationship among the elasticities is made clear in equation (26).

11. In a study of the U.S. high-tech industry, Diwan and Chakraborty (1990) show, using a translog cost function, that capital and nonproduction worker (which can be interpreted to correspond to skilled labor in this study) are complementary; capital and production worker (which can be interpreted to correspond to unskilled labor in this study), and production and nonproduction workers are substitutes. Our Model II estimates, which are consistent with the concavity condition, yield the following relationships:

substitutes: (B,M), (B,S), (M,U), (S,U);
complements: (B,U), (M,S).

Hence, our results showing that, in the Philippine semiconductor industry, skilled and unskilled labor are substitutes, buildings and structures and unskilled workers are complementary, and buildings and structures and skilled labor are substitutes, may not be surprising. We would expect machinery to require some level of skill to operate and, hence, machinery and skilled labor are expected to be complements. There seems to be a tradeoff between the use of buildings and unskilled labor, on the one hand, and machinery and skilled labor, on the other.

12. In the profit function estimation, the price of the normalizing good is not used.

13. The production possibilities set of an (N+1)-good constant returns to scale technology is a convex cone in (N+1)-dimensional space. Since a convex cone is closed under addition and nonnegative scalar multiplication, then the projection of the production possibilities set in (N+1)-dimensional space into the unit scale production possibilities set in N-dimensional space is harmless.

14. This functional form is also called the normalized quadratic unit profit function with quadratic splines (NQQS) by Diewert and Wales (1989).

15. This transformation sets the quantity of the normalizing good to unity for the j^* observation.

16. Estimation of the system in the form of equation (38) where output supply and input demands are deflated by the quantity of the normalizing good may reduce the likelihood of heteroscedasticity in the econometric disturbance terms. Also, in the actual estimation of equation (38) rescaling of the left hand side by moving the decimal point was done to aid convergence.

17. The usual method used in flexible functional form estimation is maximum likelihood. The maximum likelihood procedure was initially attempted but the 386 computer in which the software that performs this procedure is installed is too slow for such a computationally demanding method. Hence, the author had to find a faster machine. The computer runs for estimating the parameters of the SGM profit function were done using the HP workstation of the PIDS at Philcotton Building; this computer has ETS/SAS which uses a least squares algorithm installed but has no software that performs the maximum likelihood procedure.

18. Construction of the aggregate labor data using information on skilled and unskilled labor is described in Appendix C.

19. We would expect α_v (for value added) to be around 0.5. It is then surprising to get values for α_v much lower than 0.5, particularly for the electricity, gas and water (36), trade, storage and warehousing (38) and private services (42) sectors. These low values can be indicative of data problems in the measurement of value added or in the reference prices in these sectors.

20. "Well-behaved" factor price elasticities are obtained using the translog variable cost function for the mining and quarrying (15) and cement and basic metals (30) sectors. See Table 9.

21. This shift in signs is a perverse result since it is not expected for factor reversal to occur at the mean values of the variables.

22. Two goods are defined to be substitutes if the cross partial derivatives of the profit function with respect to the prices of the two goods is negative. Defining an output and an input as substitutes seems perverse but makes sense when the output is interpreted as a negative input and we consider substitutability and complementarity as descriptions of relationships among inputs.

Intuitively, we expect that as the price of an input goes up, the output supply decreases; that is, "substitutability" between an output and its inputs dominates over complementarity. This expectation is borne out by the results. Technically, the linear homogeneity and convexity of the profit function in prices ensure that the output good is substitutable with at least one input good.

Appendix A

Sector Classification
(PSIC to 50-Sector APEX Classification)

APEX SECTORS	I-O CLASSIFICATION	PSIC CLASSIFICATION
(16) FORESTRY & LOGGING	(21) Logging (22) Other Forestry Activities	(151) Logging (159) Other Forestry
(17) CRUDE OIL, COAL & NATURAL GAS	(27) Other Non-metallic Mining	(221) Coal Mining (222) Exploration & Production of Crude Petroleum & Natural Gas
(18) OTHER MINING	(11) Metallic Mining	(21) Metallic Ore Mining
	(26) Sand, Stone & Clay	(223) Stone Quarrying, including Clay & Sand Pits
	(27) Other Nonmetallic Mining & Quarrying	(229) Other Nonmetallic Mining
(19) RICE & CORN MILLING	(28) Rice & Corn Milling	(3118) Rice & Corn Milling
(20) SUGAR MILLING & REFINING	(29) Sugar Milling & Refining	(3123) Sugar Milling & Refining
(21) MILK & OTHER DAIRY PRODUCTS	(30) Milk Processing	(3112) Mfr. of Processed Milk
	(31) Other Dairy Products	(3113) Mfr. of Dairy Products
(22) OILS & FATS	(32) Crude Coconut, Vegetable & Animal Oils & Fats incl Copra Cake & Meal	(3116) Prod. of Crude Coconut Oil incl Cake & Meal
	(33) Refined Coconut & Vegetable Oil & Margarine	(3117) Mfr. of Vegetable & Animal Oils & Fats
(23) MEAT & MEAT PRODUCTS	(34) Slaughtering & Meat Packing Plants (35) Processed Meat	(3111) Slaughtering, Preparing & Preserving Meat
(24) FLOUR MILLING	(36) Flour & Other Grain Mill Products	(3119) Flour Milling (3121) Mfr. of Other Grain Mill Products

(25) ANIMAL FEEDS	(37) Animal Feeds	(3128) Mfr. of Prepared & Unprepared Animal Feeds
(26) OTHER FOOD MANUFACTURES	(38) Fruit & Vegetable Preserves	(3114) Canning & Preserving of Fruits & Vegetables
	(39) Fish Preparations	(3115) Canning, preserving & Processing of Fish & Other Sea Foods
	(40) Bakery Products & Noodles	(3122) Mfr. of Bakery Products
	(41) Cocoa, Chocolate & Confectionery	(3124) Mfr. of Cocoa, Chocolate & Sugar Confectionery
	(42) Processed Coffee	(3127) Coffee Roasting & Processing
	(43) Dessicated Coconut	(3125) Mfr. of Dessicated Coconut
	(44) Ice, excpt dry ice	(3126) Mfr. of Ice
	(45) Misc. Food Mfr.,nec	(3129) Food Mfr. nec
(27) BEVERAGE & TOBACCO	(22) Beverage Ind.	(313) Beverage Mfr.
	(23) Tobacco Mfr.	(314) Tobacco Mfr.
(28) TEXTILES & KNITTING MILLS	(51) Textile Mills	(3211) Spinning, Weaving Texturizing & Finishing Textiles
	(52) Knitting Mills	(3212) Knitting Mills
(29) OTHER MADE-UP TEXTILE GOODS	(53) Other Made-up Textile Goods	(3213) Mfr. of Made-up Textile Goods except Wearing Apparel
		(3214) Mfr. of Carpets & Rugs
		(3215) Cordage, Rope & Twine Manufacturing
		(3216) Mfr. of Artificial Leather, Oil Cloth & Other Impregnated & Coated Fabrics except Rubberized
		(3217) Mfr. of Fiber Batting, Padding & Upholstery Filling including Coir

(30) GARMENTS, FOOTWEAR & LEATHER	(54) Wearing Apparel	(322) Mfr. of Wearing Apparel
	(55) Footwear, except Rubber, Plastic or Wooden	(324) Mfr. of Footwear except Rubber, Plastic or Wood Footwear
	(62) Leather and Leather Products	(323) Mfr. of Leather & Leather Products
(31) WOOD PRODUCTS	(56) Rough & Worked Lumber	(3311) Sawmills & Planing Mills
	(57) Veneer & Plywood	(3312) Mfr. of Veneer & Plywood
	(58) Other Wood, Cork & Cane Products	(3316) Mfr. of Wooden & Cane Containers & Small Cane Wares
		(3317) Mfr. of Wood Carvings
		(3319) Mfr. of Wood, Cork & Cane Products, nec
		(3314) Wood Drying & Preserving Plants
		(3315) Millwork Plants
	(92) Furniture & Fixtures Primarily of Wood	(332) Mfr. & Repair of Furnitures & Fixtures except Primarily of Metal
(32) PAPER PRODUCTS	(59-60) Paper and Paper Products	(341) Mfr. of Pulp & Paper Products
	(61) Publishing & Printing	(342) Printing, Publishing & Allied Industries
(33) FERTILIZER	(69) Fertilizer	(3512) Mfr. of Fertilizers
(34) RUBBER & CHEMICAL PRODUCTS	(63-65) Rubber & Plastic Products	(355) Mfr. of Rubber Products
	(66) Fabricated Plastic Products	(356) Mfr. of Plastic Products
	(67) Drugs & Medicine	(3522) Mfr. of Drugs & Medicine
	(68) Basic Industrial Chemicals	(3511) Mfr. of Basic Industrial Chem. except Fertilizers

	(70) Plastic Materials	(3513) Mfr. of Synthetic Resins, Plastic Materials & Man-made Fibers
	(71) Pesticides, Insecticides, etc.	(3514) Mfr. of Pesticides, Insecticides, Fungicides & Herbicides
	(72) Paints, Varnish & Related Products	(3521) Mfr. of Paints, Varnishes & Lacquers
	(73) Soap & Synthetic Detergents	(3523) Mfr. of Soap & Cleaning Preparation, Perfumes, Cosmetics
	(75) Other Chemicals & Chemical Products	(3529) Mfr. of Chem Products, nec
(35) PRODUCTS OF PETROLEUM & COAL	(76) Products of Petroleum & Coal	(354) Mfr. of Misc Products of Petroleum & Coal
(36) NONFERROUS BASIC METAL PRODUCTS	(81) Nonferrous Basic Metal Products	(372) Nonferrous Basic Metal Industries
(37) CEMENT, BASIC METALS & NON-METALLIC MINERAL PRODUCTS	(77) Cement	(363) Mfr. of Cement
	(78) Glass & Glass Products	(362) Mfr. of Glass
	(79) Other Non-Metallic Products	(361) Mfr. of Pottery, China & Earthenwares
		(369) Mfr. of Other Nonmetallic Products
	(80) Primary Iron & Steel Products	(371) Iron & Steel Basic Industries
(38) SEMICONDUCTOR DEVICES	(88) Semiconductors	(38325) Semiconductors
(39) METAL PRODUCTS & NONELECTRICAL MACHINERY	(82) Fabricated Metal Products	(381) Mfr. of Fabricated Metal Products except Machinery & Equipment & Furniture &

		Fixtures Primarily of Metal
	(83) Machinery except Electrical	(382) Mfr. of Machinery except Electrical
(40) ELECTRICAL MACHINERY EQUIPMENT & PARTS	(84-87,89) Electrical Machinery	(383) Mfr. of Electrical Machinery Apparatus, Appliances, Supplies (except 38325)
(41) MOTOR VEHICLES	(90-91) Transport Equipment	(384) Mfr. of Transport Equipment
(42) MISCELLANEOUS MANUFACTURING	(94) Musical Instruments	(3902) Mfr. of Musical Instruments
	(95) Artists & Office Supplies	(3907) Mfr. of Stationery, Office Supplies
	(96) Miscellaneous Manufactures, nec	(3909) Mfr. Industries, nec
(43) CONSTRUCTION	(97) Construction	(501) General Building Construction
		(502) General Engineering Construction
		(503) Special Trade Construction
(44) ELECTRICITY, GAS & WATER	(98) Electricity	(41) Electricity
	(99) Gas	(42) Gas Mfr.
	(100) Waterworks	(43) Waterworks
(45) TRANSPORTATION & COMMUNICATION	(101) Busline operation	(7121) Busline Operation
	(102) P.U. Cars and Taxi	(7122) PU Cars & Taxi
	(103) Jeepneys, Autocalesa, Tricycle	(7123) Jeepneys, Autocalesa,
	(104) Railway & Other Road Passenger Transport	(7124) Other Road (7110) Railway
	(105) Road Freight Transport	(7125) Road Freight Transport
	(106) Water Transport	(713) Water Transport

	(108) Air Transport	(714) Air Transport
	(109) Services Incidental to Transport	(719) Services Incidental to Transport
	(110) Communication Services	(73) Communication Services
(46) TRADE, STORAGE & WAREHOUSING	(111) Storage & Warehousing	(72) Storage & Warehousing
	(112) Wholesale Trade	(61) Wholesale Trade
	(113) Retail Trade	(62) Retail Trade
(47) BANKS & NONBANKS	(114) Banks & Nonbanks	(81) Banking Institutions (82) Financial Intermediaries
(48) LIFE & NONLIFE INSURANCE & REAL ESTATE	(115) Life & Nonlife Insurance	(83) Insurance
	(116) RealEstate	(84) Real Estate
(49) GOVERNMENT SERVICES	(118) Government Services	(931) Public Educational Services (941) Public Medical, Dental & Other Services
(50) OTHER SERVICES	(119) Private Education Services	(932) Private Education Services
	(120) Private Health Services	(942) Private Health Services
	(121-122) Hotels & Restaurants	(98) Hotels & Restaurants
	(123) Business Services	(85) Business Services (92) Sanitary & Similar Services
	(126) Other Social & Related Community Services	(95) Other Social & Community Related Services
	(124) Recreational & Cultural Services	(96) Recreation & Cultural Services
	(125) Personal & Household Services	(97) Personal & Household Services

Appendix B

The Data Construction

The main data set used is the Annual Survey of Establishments (ASE) obtained from the National Statistical Office. The data set covers the 13 regions of the Philippines for the period 1978-1987. A sector can have at most 130 observations, with each observation corresponding to a sample of firms in a given region at a given year. For each sector, there are 21 data items:

a. number of establishments
b. number of persons working in categories:
   - b.1 managers and supervisors
   - b.2 production workers
   - b.3 nonproduction workers
   - b.4 working proprietors and unpaid family workers

c. salaries and wages + other benefits + employer's contribution to SSS/GSIS for
   - c.1 managers and supervisors
   - c.2 production workers
   - c.3 nonproduction workers

d. revenue
   - d.1 value of output
   - d.2 value of nonindustrial services done for others

e. cost of intermediate inputs
   - e.1 cost of materials consumed and industrial services
   - e.2 cost of nonindustrial services done by others
   - e.3 cost of merchandize for resale
   - e.4 indirect taxes

f. book value and depreciation costs*
   - f.1 land
   - f.2 buildings, other construction and land improvements
   - f.3 machinery and other equipment
   - f.4 transport equipment

   *(Land has no depreciation costs.)

Each observation is identified by year and region. Except for the number of establishments and number of persons working, all variables are given in units of thousands of pesos with values in current prices. In this study, we abstracted from regional variation in prices whenever variables in value terms needed to be decomposed into price and quantity components. The ASE covers only large firms defined as establishments with 10 or more workers.

1. Value Added

Total revenue, total intermediate cost, and value added are defined as follows:

total revenue ≡ value of output + value of nonindustrial services done for others

total intermediate cost ≡ cost of materials consumed and industrial services + cost of nonindustrial services done by others + cost of merchandize for resale + indirect taxes

value added ≡ total revenue - total intermediate cost

To decompose value added into price and quantity components, we used the implicit price indices for gross value added in manufacturing and services by industry group published from the national income accounts of the Philippines (Philippine Statistical Yearbook). Hence, if we let

$VA \equiv$ value added (a price x quantity variable), and
$P_v \equiv$ implicit price index for value added,

then

$$V \equiv \text{quantity of value added}$$
$$\equiv \frac{VA}{P_v} .$$

For a sector in a given year, the price index is assumed identical across regions.

The weighted averages of the ratios of value added to total revenue for the different sectors are given in Table B.1. The figures give us an idea of the proportion of the firm's revenue that goes as payment to the labor and capital inputs.

2. Labor

a) Treatment of working proprietors and unpaid family members

In the ASE data set, labor is classified into four categories: managers and supervisors, production workers, nonproduction workers, and working proprietors and unpaid family workers. Salary and wage data are given only for the first three categories. Working proprietors and unpaid family workers were then distributed among these three categories such that the relative proportions of these workers are preserved. The corresponding wage bill data for the three categories were adjusted by imputing wages for the unpaid workers. Note that to reflect the actual cost to the firm, the salary and wage data were corrected to include other benefits and employer's contribution to SSS/GSIS (social security payments) paid by the firm.

b) Reclassification of labor into skilled and unskilled workers

Since the APEX model's labor classification is skilled and unskilled, supplementary information is needed to reclassify the data. An unskilled worker is arbitrarily defined as one who did not complete high school; a skilled worker as one who finished high school or at least have some college education. To obtain the proportions of skilled and unskilled workers in each sector, the 1980 industry by occupation survey results and the annual survey results on number of employed persons by occupation and highest grade completed, which are published in the Philippine Statistical Yearbook, are used. Table B.2 gives the proportion of unskilled workers in the different sectors for the various years. Note that the financial and government services sectors (39, 41) have the lowest proportions of unskilled workers.

The weighted averages of shares of labor cost in value added for the different sectors are presented in Table B.1. The figures indicate that government and private services (41,42) are the most labor-intensive with most of the value added being paid to labor. Over half of value added is paid for labor services in the sugar milling (17), garments (25), transport and communication services (37), and trade (38) sectors. At the other end of the spectrum, the milk and dairy (18), oils and fats (19), and fertilizer (27) sectors are relatively capital-intensive.

Managers and supervisors are all considered skilled workers. Their salaries and wages are much higher than those of production and nonproduction workers, whose wages are more comparable. It was then assumed that the proportions of skilled workers are identical for the latter categories. Hence, to break down the number of production and nonproduction workers into skilled and unskilled labor, the proportions of skilled/unskilled labor in Table B.2 were adjusted using the formula

$$\tilde{\theta}_s = \left[\frac{\theta_s - A}{1 - A} \right]$$

where $\tilde{\theta}_s$ ≡ proportion of skilled labor in the two categories: production workers and nonproduction workers,

θ_s ≡ proportion of skilled labor for all three categories (table B.2), and

A ≡ proportion of managers and supervisors in total number of workers.

A more difficult data exercise is the estimation of the wages for skilled and unskilled labor in the production and nonproduction categories. Real wage indices for skilled and unskilled labor compiled by the Central Bank are used (see Table B.4). Together with the consumer price index (CPI), they give us an indication of the behavior of nominal wages. Over the period 1978-1986, wages of unskilled labor have increased relative to those of skilled labor while, as Tables B.2 and B.3 show, their proportion in labor employment has dropped. To obtain the wages for skilled and unskilled labor, we need information on the wage differential.

The following discussion illustrates the problem and the procedure used to solve it. Note that the methodology is applied only to production and nonproduction workers. Let

$\tilde{L}$ ≡ total number of production and nonproduction workers,

$\bar{w}$ ≡ average wage of production and nonproduction workers,

$\tilde{\theta}_s$ ≡ proportion of skilled labor among production and nonproduction workers,

q_s ≡ quantity of skilled labor among production and nonproduction workers,

$= \tilde{\theta}_s \tilde{L}$,

q_u ≡ quantity of unskilled labor among production and nonproduction workers,

$= (1 - \tilde{\theta}_s)\ \tilde{L}$,

w_s ≡ wage of skilled labor in 1978,

w_u ≡ wage of unskilled labor in 1978,

p_s ≡ nominal wage index for skilled labor (p_s = 1.0 for 1978),

p_u ≡ nominal wage index for unskilled labor (p_u = 1.0 for 1978),

W_s ≡ wage of skilled labor among production and nonproduction workers,

$= w_s p_s$,

W_u ≡ wage of unskilled labor among production and nonproduction workers,

$= w_u p_u$,

All the variables above are known except w_s, w_u, W_s, W_u.

The wage bill can be expressed as

$$\bar{\tilde{w}} L = q_s w_s + q_u w_u$$

which is an equation with two unknowns: the wages w_s and w_u. The equation can be rewritten as

$$\bar{w}\tilde{L} = (\tilde{\theta_s} \tilde{L})(w_s p_s) + [(1 - \tilde{\theta_s})L]^{\sim} (w_u p_u)$$

which reduces the problem to finding the wages for 1978. It is reasonable to assume that the skilled wage was higher than the unskilled wage, that is, for some r>1, we have

$$w_s = r w_u$$

where r, the wage differential (ratio), can be sector-specific. The wage bill can be further rewritten as

$$\bar{w}\tilde{L} = (\tilde{\theta_s} \tilde{L})(r\ w_u p_s) + [(1 - \tilde{\theta_s})L]^{\sim} (w_u p_u)$$

which is an equation with two unknowns: r, the wage differential ratio that existed in 1978, and w_u, the wage for unskilled labor in 1978. Hence the problem reduces to getting more information for only a particular year.

We let the 1978 unskilled wage to be

$$w_u = \begin{cases} 3.8 & \text{for all sectors except the garments sector (25),} \\ 1.9 & \text{for the garments sector.} \end{cases}$$

To arrive at $w_u = 3.8$ (which is ₱3800 annual wage in 1978), we looked at the minimum wage data in the PHilippine Statistical Yearbook and came out with a minimum daily unskilled wage at ₱14.50. To get the annual wage, we used

$$\frac{₱14.50}{\text{day}} \times \frac{261 \text{ days}}{\text{year}} \approx \frac{₱3800}{\text{year}} \equiv w_u$$

For the garments sector, unskilled wages were turning out higher than skilled wages when w_u is set equal to 3.8. Hence, a lower value for w_u was set for this sector.

Even with the 1978 unskilled wage being identical for all sectors but one, the wage differentials as captured by r need not necessarily be identical across sectors. Per observation and given w_u, an r was calculated and the weighted average of the r's (the weighing factor takes into account the number of firms surveyed for the observation) was used to construct the skilled and unskilled wage variables:

$$w_s = r\ w_u p_s,$$
$$w_u = \quad w_u p_u\ .$$

The procedure has some disadvantages. We have taken away some variability in the wage variables to be used in the regression analysis. For a given sector and year and across regions, wages will be identical. The original wage bills for production and nonproduction workers are not preserved.

The final data for skilled labor displays variability in wages across regions in the same year because the final skilled labor data also covers managers and supervisors. If we let

$$w_m \equiv \text{average wage of managers,}$$
$$q_m \equiv \text{quantity of managers,}$$

then $S \equiv$ total quantity of skilled labor,

$$= q_s + q_m ;$$

and $P_s \equiv$ wage of skilled labor,

$$= \frac{w_s q_s + w_m q_m}{S} .$$

3. Capital

Earlier works on the two-factor capital-labor production function estimation have often defined the capital input as the book value of capital stock, and the capital rental price as the surplus value (value added minus labor cost) divided by the book value of capital stock. The problems with basing the measure of capital input on reported book values of fixed assets for the Philippines are discussed by Hooley (1985). An examination of the rates of return based on the surplus value for the ASE data (see Table B.1, last column) indicates possible undervaluation or underreporting of capital stock. Ideally, estimates of capital stock should be constructed, but project resource constraints precluded this estimation. Jorgenson, Gollop, and Fraumeni (1987) describe in detail their procedure for constructing these estimates for various asset classes for the U.S. The perpetual inventory method was used for depreciable assets--equipment and structures; for land and inventories, estimates were based on balance sheet data.

Since capital is a durable input, the relevant price for production estimation is the capital rental price or the user cost of the flow of capital services used in the production process. The earlier definition of the capital rental price, based on the surplus value, is a measure of the rate of return on capital. The capital rental price should consider the interest rate, which reflects the opportunity cost of capital and which in practice is proxied by either an internal rate of return or an exogenous bond rate, depreciation, capital gains, and the tax structure.

The ASE data set gives the book value of four kinds of capital goods. The book value of fixed assets refers to their value net of accumulated depreciation. The weighted averages of reported total book values for the different sectors (see Table B.1) indicate that the capital requirements are highest in the milk and dairy (18), fertilizer (27) and electricity, gas and water (36) sectors. Capital requirements seem to be smallest in the garments (25) and furniture and other manufacturing (34) sectors.

Let us denote the four capital assets as:

l ≡ land;
b ≡ buildings, other construction and land improvements;
m ≡ machinery and other equipment; and
t ≡ transport equipment.

The weighted average share of each of the capital goods in total book value is listed in Table B.5. There seems to be serious underreporting of land values in some sectors. Particularly glaring is the very low share of land in the mining and quarrying sector (15), where there seems to be a problem in accounting for the value of a nonreproducible resource. In the trade sector (38), the share of land is quite small relative to the share of buildings.

Depreciation costs are given for all the capital goods except for land. In the absence of information on firm or establishment-specific property and corporate income taxes, and assuming static expectations of future asset prices, we can express the rental price for capital good i, say p_i, as

$$p_i \equiv (r^* + \delta_i)\ a_i$$

where

$r^* \equiv$ discount rate,
$\delta_i \equiv$ depreciation rate for capital good i, and
$a_i \equiv$ asset price for capital good i.

For the discount rate, an average of Treasury bill interest rates (49, 63, 91,..., 364 day T-bills) is used (Table B.8). The depreciation rate is set as the ratio of depreciation cost to book value of the asset (see Table B.6). Land is assumed to have zero depreciation rate. For land and buildings, the implicit price index for gross capital formation for construction is used as the asset price. For machinery and transport equipment, the implicit price index for gross capital formation for durable equipment is used. These price indices are published in the Philippine Statistical Yearbook.

Note that the use of price indices in constructing the capital rental prices above has reduced the variability of the rental prices which will be used in the regressions. Asset prices are assumed to be identical across firms at a given year. The resulting capital rental prices may vary across firms only if the depreciation rates vary; however, in the data set, the depreciation rates are also quite stable across firms.

To get a measure of the quantity of capital input, the book value of the capital good is divided by its asset price. In other words, the book value is taken as a measure of the current value of the capital stock. After deflating by the asset price index, the "constant value" of the capital stock is taken as a measure of the quantity of capital input. Also, since the book values are unadjusted for relative efficiency, we implicitly assume that capital service flows are proportional to capital stocks, that is, the rate of capital utilization is constant over time and across firms.

To summarize, we have constructed capital rental prices, say p_i, and quantities, say q_i, for each capital good i, i = l, b, m, t. For subsequent use, transport equipment and machinery and other equipment are aggregated; the rental price and quantity of the aggregate machinery and equipment input are constructed as follows. Let M denote the aggregate machinery and equipment input. Then, for i = m, t,

$v_i \equiv$ cost of input i
$= p_i q_i$,

$v \equiv$ cost of aggregate machinery and quipment
$= v_m + v_t$,

$s_i \equiv$ share of input i in aggregate cost v
$= \dfrac{v_i}{v}$,
(note: $\Sigma s_i = 1$)

$p_M \equiv$ rental price of aggregate machinery and equipment
$= s_m p_m + s_t p_t$,

$q_M \equiv$ quantity of aggregate machinery and equipment
$= \dfrac{v}{p_M}$.

Hence, the rental price p_M is a cost share-weighted average of the component rental prices. The quantity q_M is constructed such that capital expenditure v is preserved.

Table B.6 presents other descriptive statistics using weighted averages with respect to the capital data for the different sectors. The ratio of total revenue to book value indicates how much income is generated per ₱1 unit of capital. The cost of capital services as a proportion of value added is also given. The ratio of the residual-- which is defined as the surplus value after intermediate input, labor and capital costs--to value added is also presented. These ratios may be helpful in evaluating the goodness and reliability of the data. The ratio of the residual to value added suggests that we might have some unaccounted input; possibly, the capital book values are understated or the residual can be attributed as entrepreneurial income.

The variables that will be retained for the estimation are the capital rental prices and quantities for the three capital inputs which will be denoted by

Z for land ;
B for buildings, other construction and land improvements; and
M for (aggregate) machinery and equipment.

Their rental prices will be denoted by p_Z, p_B and p_M, respectively. Alternatively, the quantities will be denoted by Z, B, and M, respectively.

List of Variables Retained for the Estimation

For ease of notation, we define the goods and their quantities in the following manner:

"output" good:
V ≡ quantity of value added;

labor inputs:
S ≡ quantity of skilled labor,
U ≡ quantity of unskilled labor;

capital inputs:
Z ≡ quantity of land,
B ≡ quantity of buildings, other construction and land improvements,
M ≡ quantity of machinery and equipment.

When convenient, we may also denote the quantity of good i as q_i. Their relevant prices will be denoted by p_i.

Table B.7 lists the number of observations used in the regressions and the years where observations exist for each of the sectors. As a caution to the reader, it must be noted that some have questioned the reliability of the ASE data set--from the quality of answers given by the respondents to the compilation of the data. In the course of this research, many data inconsisitencies have been uncovered that forced us to throw away some observations. Indeed a lot can be done to upgrade the quality of the ASE not only in gathering the data but also in making it more accessible to the user. Since undertaking surveys of firms in the different sectors ourselves is outside the scope of the project, we have no alternative but to make the most of the existing data.

Table B.1

Descriptive Statistics, Labor and Capital

Sector Code	Sector	Original Obs.*	Obs.	Number of Firms	Weighted Averages: Value Added / Total Revenue	Labor Cost / Value Added	Book Value of Capital Stocks	Value Added – Labor Cost / Book Value of Capital Stocks
15	Mining and Quarrying	130	87	3958	0.4975618	0.2670236	26716.600	0.5129984
16	Rice and Corn Milling	130	48	821	0.1875002	0.3948491	3196.973	0.3418240
17	Sugar Milling	118	61	1272	0.2228094	0.5278005	34716.670	0.2558032
18	Milk and Dairy	59	13	69	0.4011064	0.2342517	204819.400	0.5333758
19	Oils and Fats	99	88	1050	0.2564353	0.2121736	11267.940	1.0144780
20	Meat and Meat products	51	31	478	0.2616024	0.4339522	15822.600	0.3780570
21	Flour and Feed Milling	71	55	1365	0.1266274	0.2773760	4805.337	0.6608185
23	Beverages and Tobacco	118	109	4848	0.2811440	0.2797924	7308.230	1.2903230
24	Textiles	77	41	3042	0.3521561	0.4552629	19071.890	0.6201745
25	Garments, Footwear and Leather	99	67	86247	0.3752907	0.5197859	94.373	0.8546455
26	Wood and Wood Products	129	118	19331	0.2735854	0.3790006	1955.136	0.5520312
27	Fertilizer	27	14	40	0.4145958	0.1178300	242231.900	1.1694550
28	Rubber and Chemicals	75	64	4534	0.2643422	0.3270174	5726.473	0.9750863
29	Coal and Petroleum	33	21	60	0.2315456	0.2970416	12483.860	0.4107545
30	Cement and Basic Metal	99	92	4914	0.2030521	0.3647671	18463.710	0.4734872
31	Semiconductors	29	12	147	0.3243297	0.4036905	12321.040	0.3840234
32	Machinery and Metal Products	130	116	28780	0.3456078	0.4079750	1163.658	0.9396600
33	Motor Vehicles	112	67	3701	0.3053117	0.3732557	7906.956	0.3517446
34	Furniture and Other Manufacturing	128	98	18445	0.3523316	0.4883133	294.645	0.8116130
35	Construction	130	111	9773	0.4060150	0.4570354	20155.950	0.1370958
36	Electricity, Gas and Water	130	110	3424	0.3687000	0.3220749	111610.900	0.1829309
37	Transport and Communication Services	130	71	9933	0.3924626	0.5790649	22999.160	0.1286328
38	Trade	130	48	16336	0.0837806	0.5490560	44554.590	0.0174909
41	Government Services	130	24	1472	0.6763279	0.8759559	8475.449	0.1090608
42	Other Services	130	38	12254	0.5154910	0.8405710	5065.917	0.0799848

NOTE: Weights used in getting averages take into account the number of firms per reported observation.

* Observations

The original number of observations is the number of observations for the sector appearing in the unedited ASE data from the NSO.

The next colomn gives the number of observations after deletion of questionable entries. Hence, the statistics in the succeeding columns are based on the edited data.

Table B.2

Proportion of Unskilled Workers

Sector Code	INDUSTRY	78	79	80	81	82	83	84	85	86	87
14	Forestry and Logging	0.8161	0.8131	0.8102	0.8125	0.7963	0.7970	0.7874	0.7752	0.7689	0.7599
15	Mining and Quarrying	0.6050	0.6010	0.5970	0.5941	0.5699	0.5889	0.5654	0.5567	0.5531	0.5391
16	Rice and Corn Milling	0.5993	0.5946	0.5900	0.5865	0.5638	0.5808	0.5592	0.5491	0.5454	0.5319
17	Sugar Milling	0.5993	0.5946	0.5900	0.5865	0.5638	0.5808	0.5592	0.5491	0.5454	0.5319
18	Milk and Dairy	0.5993	0.5946	0.5900	0.5865	0.5638	0.5808	0.5592	0.5491	0.5454	0.5319
19	Oils and Fats	0.5993	0.5946	0.5900	0.5865	0.5638	0.5808	0.5592	0.5491	0.5454	0.5319
20	Meat and Meat products	0.5993	0.5946	0.5900	0.5865	0.5638	0.5808	0.5592	0.5491	0.5454	0.5319
21	Flour and Feed Milling	0.5993	0.5946	0.5900	0.5865	0.5638	0.5808	0.5592	0.5491	0.5454	0.5319
22	Other Foods	0.5993	0.5946	0.5900	0.5865	0.5638	0.5808	0.5592	0.5491	0.5454	0.5319
23	Beverages and Tobacco	0.5993	0.5946	0.5900	0.5865	0.5638	0.5808	0.5592	0.5491	0.5454	0.5319
24	Textiles ..	0.6565	0.6522	0.6480	0.6467	0.6188	0.6423	0.6134	0.6057	0.6015	0.5851
25	Garments, Footwear and Leathe ..	0.6565	0.6522	0.6480	0.6467	0.6188	0.6423	0.6134	0.6057	0.6015	0.5851
26	Wood and Wood Products	0.6199	0.6154	0.6108	0.6085	0.5831	0.6039	0.5787	0.5695	0.5656	0.5516
27	Fertilizer	0.5115	0.5059	0.5004	0.4953	0.4782	0.4889	0.4744	0.4642	0.4603	0.4502
28	Rubber and Chemicals	0.5115	0.5059	0.5004	0.4953	0.4782	0.4889	0.4744	0.4642	0.4603	0.4502
29	Coal and Petroleum	0.5115	0.5059	0.5004	0.4953	0.4782	0.4889	0.4744	0.4642	0.4603	0.4502
30	Cement and Basic Metal	0.6029	0.5984	0.5939	0.5911	0.5668	0.5863	0.5626	0.5533	0.5496	0.5361
31	Semiconductors	0.5574	0.5526	0.5478	0.5441	0.5225	0.5390	0.5189	0.5094	0.5056	0.4946
32	Machinery and Metal Products	0.5574	0.5526	0.5478	0.5441	0.5225	0.5390	0.5189	0.5094	0.5056	0.4946
33	Motor Vehicles	0.5574	0.5526	0.5478	0.5441	0.5225	0.5390	0.5189	0.5094	0.5056	0.4946
34	Furniture and Other Manufacturing	0.6375	0.6329	0.6284	0.6265	0.6002	0.6220	0.5954	0.5866	0.5826	0.5672
35	Construction	0.6428	0.6387	0.6347	0.6333	0.6059	0.6290	0.6005	0.5935	0.5895	0.5733
36	Electricity, Gas and Water	0.5004	0.4963	0.4923	0.4870	0.4685	0.4806	0.4659	0.4558	0.4527	0.4463
37	Transport and Communication Services	0.5736	0.5698	0.5660	0.5623	0.5386	0.5568	0.5354	0.5253	0.5219	0.5128
38	Trade	0.6562	0.6437	0.6314	0.6284	0.6231	0.6095	0.5961	0.5998	0.5886	0.5508
39	Financial Services	0.2272	0.2230	0.2188	0.2050	0.2028	0.1945	0.2065	0.1875	0.1863	0.2015
41	Government Services	0.2058	0.2034	0.2009	0.1866	0.1881	0.1767	0.1902	0.1776	0.1778	0.1804
42	Other Services	0.4407	0.4394	0.4380	0.4202	0.4240	0.4051	0.4212	0.3976	0.4012	0.3797

Table B.3

Change in Proportion of Unskilled Workers 1978–1987, By Sector

Sector Code	INDUSTRY	Change 1978–87	% Change 1978–87
14	Forestry and Logging	−0.0562	−0.0688
15	Mining and Quarrying	−0.0659	−0.1089
16	Rice and Corn Milling	−0.0674	−0.1125
17	Sugar Milling	−0.0674	−0.1125
18	Milk and Dairy	−0.0674	−0.1125
19	Oils and Fats	−0.0674	−0.1125
20	Meat and Meat products	−0.0674	−0.1125
21	Flour and Feed Milling	−0.0674	−0.1125
22	Other Foods	−0.0674	−0.1125
23	Beverages and Tobacco	−0.0674	−0.1125
24	Textiles	−0.0715	−0.1088
25	Garments, Footwear and Leather ..	−0.0715	−0.1088
26	Wood and Wood Products	−0.0684	−0.1103
27	Fertilizer	−0.0613	−0.1198
28	Rubber and Chemicals	−0.0613	−0.1198
29	Coal and Petroleum	−0.0613	−0.1198
30	Cement and Basic Metal	−0.0669	−0.1109
31	Semiconductors	−0.0628	−0.1127
32	Machinery and Metal Products	−0.0628	−0.1127
33	Motor Vehicles	−0.0628	−0.1127
34	Furniture and Other Manufacturing	−0.0702	−0.1101
35	Construction	−0.0695	−0.1081
36	Electricity, Gas and Water	−0.0540	−0.1080
37	Transport and Communication Services	−0.0608	−0.1061
38	Trade	−0.1054	−0.1606
39	Financial Services	−0.0257	−0.1132
41	Government Services	−0.0254	−0.1234
42	Other Services	−0.0611	−0.1385

Table B.4

WAGE INDICES
(1978 = 1.0)

Year	Skilled IS	Unskilled IU	CPI	IS * CPI (1)*(3)	IU * CPI (2)*(3)	Rate of Growth of (4) and (5)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1978	1.0000	1.0000	100.0000	100.0000	100.0000		
1979	0.9351	0.8860	117.5000	109.8743	104.1050	0.0987	0.0411
1980	0.8369	0.8874	138.9000	116.2454	123.2599	0.0580	0.1840
1981	0.8988	0.9561	157.1000	141.2015	150.2033	0.2147	0.2186
1982	1.0091	1.0424	173.2000	174.7761	180.5437	0.2378	0.2020
1983	1.1450	1.0614	190.5000	218.1225	202.1967	0.2480	0.1199
1984	0.9139	1.0980	286.4000	261.7410	314.4672	0.2000	0.5553
1985	0.8761	0.9810	352.6000	308.9129	345.9006	0.1802	0.1000
1986	0.7931	0.9825	355.3000	281.7884	349.0823	−0.0878	0.0092

Source: World Bank, The Philippines: The Challenges of Poverty (Report #7144−PH), 1988.

Philippine Statistical Yearbook, 1985−1989.

Table B.5

Descriptive Statistics, Capital Book Values

Sector Code	Sector	Weighted Averages: Share of Land	Share of Buildings	Share of Machinery	Share of Transport
15	Mining and Quarrying	0.03883	0.19667	0.75686	0.00765
16	Rice and Corn Milling	0.11263	0.29706	0.53128	0.05903
17	Sugar Milling and Refining	0.05742	0.18247	0.72252	0.03801
18	Milk and Other Dairy	0.04987	0.26749	0.47222	0.20449
19	Oils and Fats	0.10423	0.17930	0.60247	0.11401
20	Meat and Meat Products	0.06579	0.32397	0.51871	0.09154
21	Flour and Feed	0.17277	0.39008	0.37833	0.05882
23	Beverage and Tobacco	0.11304	0.24966	0.50485	0.13246
24	Textiles	0.01928	0.72137	0.18037	0.07899
25	Garments,Footwear,Leather	0.14619	0.33935	0.46718	0.04728
26	Wood and Paper	0.08763	0.23530	0.62885	0.04822
27	Fertilizer	0.15765	0.29732	0.50491	0.03793
28	Rubber and Other Chemicals	0.08459	0.18801	0.68380	0.04360
29	Coal and Petroleum	0.15000	0.27314	0.55955	0.01731
30	Cement and Basic Metal	0.09639	0.28237	0.59406	0.02717
31	Semiconductors	0.19330	0.29188	0.50967	0.00515
32	Machinery and Metals	0.13470	0.25055	0.56238	0.05237
33	Motor Vehicles	0.09350	0.26490	0.51328	0.12832
34	Furniture and Other Mfr.	0.23102	0.32504	0.30441	0.13953
35	Construction	0.03022	0.17792	0.62557	0.16629
36	Electricity, Gas & Water	0.05418	0.34313	0.43989	0.16270
37	Transport & Communication	0.10418	0.28339	0.34297	0.26947
38	Trade	0.00493	0.63248	0.25382	0.10878
41	Government Services	0.08589	0.67718	0.22034	0.01658
42	Other Services	0.13345	0.62504	0.23001	0.01150

Table B.6

Descriptive Statistics, Depreciation Rates

Sector Code	Sector	Total Revenue / Book Value	Depreciation Rates (Weighted Averages): Buildings	Machinery*	Transport*	Cost of Capital** / Value Added	Residual*** / Value Added
15	Mining and Quarrying	0.10050	0.09499	0.11226	0.11226	0.02187	0.71111
16	Rice and Corn Milling	3.46222	0.08610	0.08960	0.08960	0.05009	0.55506
17	Sugar Milling and Refining	2.05515	0.08999	0.07499	0.07501	0.05333	0.41887
18	Milk and Other Dairy	1.61583	0.04120	0.05147	0.05128	0.11897	0.64678
19	Oils and Fats	5.92087	0.08606	0.09769	0.18503	0.50431	0.33565
20	Meat and Meat Products	1.97471	0.04608	0.07113	0.07113	0.03993	0.52612
21	Flour and Feed	7.10696	0.07791	0.10211	0.18928	0.46720	0.25543
23	Beverage and Tobacco	5.68559	0.09939	0.13569	0.22441	0.28512	0.43509
24	Textiles	2.55780	0.08477	0.08477	0.02666	0.00793	0.53681
25	Garments,Footwear,Leather	4.64449	0.08295	0.13188	0.17315	0.21407	0.26615
26	Wood and Paper	2.73305	0.07895	0.11644	0.19817	0.50553	0.11547
27	Fertilizer	5.13029	0.05722	0.07779	0.07796	0.11768	0.76449
28	Rubber and Other Chemicals	4.48477	0.07811	0.11525	0.24025	0.48223	0.19075
29	Coal and Petroleum	2.33549	0.07050	0.09069	0.09069	0.46810	0.23486
30	Cement and Basic Metal	3.13365	0.07311	0.13256	0.21533	0.62987	0.05049
31	Semiconductors	2.09475	0.04580	0.08588	0.08588	0.04914	0.54717
32	Machinery and Metals	4.53461	0.09852	0.15602	0.24059	0.35193	0.24009
33	Motor Vehicles	1.77128	0.04458	0.07492	0.07492	0.00863	0.61811
34	Furniture and Other Mfr.	3.93331	0.10625	0.14859	0.17142	0.28522	0.22646
35	Construction	0.59819	0.14177	0.16835	0.16835	0.02370	0.51927
36	Electricity, Gas & Water	0.79088	0.08212	0.09032	0.09032	0.04660	0.63133
37	Transport & Communication	0.78402	0.07295	0.09622	0.09622	0.00720	0.41374
38	Trade	0.43347	0.04413	0.08227	0.08227	0.02534	0.42560
41	Government Services	1.04506	0.06495	0.12674	0.12674	0.00538	0.11867
42	Other Services	0.84287	0.06132	0.12787	0.13359	0.00192	0.15750

Notes:

* The depreciation rates for machinery and equipment and transport equipment are identical in 14 of the 25 sectors. This is likely to be a data error. Since the resulting rental prices are identical for these two capital goods, they are aggregated into one composite input.

** The cost of capital is evaluated at the imputed rental prices.

*** The residual is value added minus the sum of labor cost and capital cost.

Table B.7

Descriptive Statistics, Years of Observation Used in Regressions

Sector Code	Sector	Number of Orig. Obs.	Number of Obs. Used	Years with Observations									
15	Mining and Quarrying	130	73		79	80	81	82	83	84	85	86	87
16	Rice and Corn Milling	130	45							84	85	86	87
17	Sugar Milling	118	59	78	79	80	81	82	83	84	85	86	87
18	Milk and Dairy	59	12							84	85	86	87
19	Oils and Fats	99	86	78	79	80	81	82	83	84	85	86	87
20	Meat and Meat products	51	31	78	79	80	81	82	83	84	85	86	87
21	Flour and Feed Milling	71	55		79	80	81	82	83	84	85	86	87
23	Beverages and Tobacco	118	102	78	79	80	81	82	83	84	85	86	87
24	Textiles	77	38	78	79	80	81	82	83	84	85	86	87
25	Garments, Footwear and Leather	99	67	78	79	80	81	82	83		85	86	87
26	Wood and Wood Products	129	118	78	79	80	81	82	83	84	85	86	87
27	Fertilizer	27	13		79		81	82	83	84	85	86	87
28	Rubber and Chemicals	75	64	78	79	80		82		84	85	86	87
29	Coal and Petroleum	33	18		79	80	81	82	83	84	85	86	87
30	Cement and Basic Metal	99	76	78	79	80	81	82	83	84	85	86	87
31	Semiconductors	29	12		79	80	81	82	83	84	85	86	87
32	Machinery and Metal Product	130	116	78	79	80	81	82	83	84	85	86	87
33	Motor Vehicles	112	66	78	79	80	81	82	83	84	85	86	87
34	Furniture and Other Manufacturing	128	67	78	79	80	81	82	83	84	85	86	87
35	Construction	130	111		79	80	81	82	83	84	85	86	87
36	Electricity, Gas and Water	130	109		79	80	81	82	83	84	85	86	87
37	Transport and Communication Services	130	71	78	79				83	84	85	86	87
38	Trade	130	48							84	85	86	87
41	Government Services	130	24									86	87
42	Other Services	130	38							84		86	87

Table B.8a

Weighted Average Interest Rates of Treasury Bills * (percent)

YEAR	WEIGHTED AVERAGE**			M		O		N		T		H	
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1978	10.77781	10.536	10.708	11.608	10.768	11.821	9.025	9.857	12.282	13.211	10.615	9.930	10.796
1979	11.87339	12.247	11.678	11.352	11.637	11.510	11.889	12.190	12.264	12.513	11.930	11.791	10.995
1980	12.86161	14.096	12.000	15.196	14.800	14.757	12.395	12.614	10.758	12.120	12.370	12.490	13.609
1981	12.38406	12.751	12.421	9.000	9.000	13.500	–	–	–	13.052	13.517	10.380	17.575
1982	13.52605	13.500	13.890	14.762	14.801	14.954	11.499	10.876	15.586	14.361	12.866	14.203	14.210
1983	10.51379	14.260	14.106	13.921	13.732	13.731	14.002	9.000	9.000	10.641	9.000	9.000	–
1984	33.73672	13.257	10.802	9.720	8.890	22.316	28.289	29.615	31.650	34.543	39.783	39.730	38.358
1985	26.40216	33.555	27.651	30.644	31.924	32.030	30.739	24.875	19.389	16.991	15.526	15.465	14.939
1986	13.74174	14.810	20.998	21.155	18.009	14.481	12.661	11.910	10.815	10.932	11.152	10.333	8.653
1987	10.30795	8.653	8.211	7.882	9.756	10.177	10.334	10.711	10.837	10.930	11.378	11.556	12.396

* average of 49, 63, 91, 147, 182, 273, and 364 day T–bills
** volume of t–bill transactions are used as weights

Source: Table 9d, 4th Quarter (1978–87)
Philippine Financial Statistics
Department of Economic Research
Central Bank

Table B.8b

Volume of Transactions of Treasury Bills (million pesos)

YEAR			M		O		N		T		H	
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1978	18.9	20.2	27.1	30.7	121.4	161.1	174.1	109.9	81.6	26.6	29.5	20.1
1979	39.6	39.8	19.3	38.6	46.3	26.6	21.8	9.2	29.7	13.8	13.1	0.7
1980	1.0	–	–	14.8	14.4	5.3	9.0	19.8	15.3	18.2	24.7	24.9
1981	7.5	9.6	7.4	7.5	0.2	–	–	–	2.7	7.2	11.0	11.4
1982	0.2	45.1	48.7	70.6	25.7	149.3	98.8	34.1	28.6	185.0	335.6	236.8
1983	178.1	147.6	77.9	175.7	510.6	897.2	748.5	514.5	332.3	400.6	589.8	326.4
1984	352.4	322.2	316.8	321.6	790.5	1087.9	2163.2	3008.9	2830.6	4301.4	2522.4	3667.4
1985	3292.0	2746.0	4785.0	5091.0	5076.0	3168.0	3243.0	2498.0	1703.0	2169.0	2713.0	2262.0
1986	3614.0	5526.0	4889.0	4317.0	3761.0	3756.0	4251.0	1560.0	3857.0	6325.0	7480.0	6343.0
1987	8617.0	5181.0	7364.0	8209.0	5809.0	9754.0	11240.0	8509.0	8964.0	7259.0	8380.0	7276.0

Source: Table 9c, 4th Quarter (various years)
Philippine Financial Statistics
Department of Economic Research
Central Bank

Appendix C

Estimation of the Labor Aggregator Function

The data used to estimate the labor aggregator function are:

S ≡ quantity of skilled labor,
P_s ≡ price of skilled labor,
U ≡ quantity of unskilled labor, and
P_u ≡ price of unskilled labor.

The construction of the above variables are described in appendix B.

The price and quantity of aggregate labor are defined as

P_L ≡ price of aggregate labor,

$$= \left(\frac{P_S S}{V_L}\right) P_S + \left(\frac{P_U U}{V_L}\right) P_U \quad , \quad \text{and}$$

L ≡ quantity of aggregate labor,

$$= \frac{V_L}{P_L} \quad ,$$

respectively, where V_L ≡ total wage bill = $P_S S + P_U U$. The price of labor P_L is a weighted average of skilled and unskilled wages with the weights being the share of the sublabor group in the sector's total wage bill. The quantity of labor is determined residually such that the total wage bill for the sector is preserved.

The CES labor aggregator function is defined as

$$L = \gamma [\, \delta S^{\rho} + (1-\delta) U^{\rho}]^{\frac{1}{\rho}}$$

where γ, δ, ρ are parameters of the aggregator function. The elasticity of substitution between skilled and unskilled labor is defined as

$$\sigma \equiv \frac{1}{1-\rho}$$

With two subfactors, the elasticity of substitution is expected to be positive, that is, skilled and unskilled labor are substitutes.

The estimation model used is a variant of the marginal productivity condition, which is probably the simplest method of estimating CES functions. It takes the form

$$\ln\left(\frac{L}{U}\right) = constant + \sigma \ln\left(\frac{P_U}{P_L}\right)$$

which can be estimated using ordinary least squares (OLS). For the private services sector (42), a negative elasticity of substitution is obtained using OLS. An alternative estimate is obtained using nonlinear regression by reexpressing the elasticity of substitution as $\sigma \equiv a^2$, where a is a scalar, thus restricting σ to be nonnegative. The restricted estimate for the elasticity of substitution in the private services sector is near zero, implying that aggregate labor is a Leontief composite of skilled and unskilled labor.

The estimates for the elasticity of substitution between skilled and unskilled labor for the different sectors are given in Table C.

Table C. CES Labor Aggregator Function Elasticity of Substitution Estimates*

Sector Code	Sector	CONSTANT Estimate	CONSTANT T-ratio	ELAST. OF SUBST. Estimate	ELAST. OF SUBST. T-ratio
15	Mining and Quarrying	0.64638	22.808	0.37141	16.152
16	Rice and Corn Milling	0.61777	40.185	0.28889	21.308
17	Sugar Milling and Refining	0.85909	14.998	0.48720	13.091
19	Oils and Fats	0.64293	34.702	0.37274	18.727
20	Meat and Meat Products	0.91120	7.962	0.45841	7.762
21	Flour and Feed Milling	0.61515	41.680	0.32830	15.641
23	Beverages and Tobacco	0.64007	20.052	0.37372	10.180
24	Textiles	0.65219	9.403	0.43757	10.455
25	Garments, Footwear and Leather	0.68308	10.439	0.54639	8.676
26	Wood and Paper Products	0.61815	39.427	0.45010	13.398
27	Fertilizer	1.06310	8.307	0.41125	5.911
28	Rubber and Other Chemicals	0.79867	21.890	0.28655	8.880
29	Coal and Petroleum	0.92940	14.761	0.37877	8.336
30	Cement and Basic Metal	0.49533	21.746	0.22724	10.945
31	Semiconductor Devices	0.63806	8.767	0.25928	3.936
32	Machinery and Metal Products	0.69456	51.582	0.33359	14.063
33	Motor Vehicles	0.73619	24.712	0.35126	14.509
34	Furniture and Other Mfg	0.54689	40.220	0.40154	7.509
35	Construction	0.76289	29.660	0.60850	22.159
36	Electricity, Gas and Water	0.84240	34.778	0.30776	14.611
38	Trade, Storage and Warehousing	0.43960	6.501	0.20063	2.923
41	Public Services	1.85400	441.360	0.24830	44.962
42	Private Services**	0.71479	21.104	−0.30874	−4.106
		(0.85232)	(139.710)	(0.00000)	

* using one marginal productivity condition
equation: ln(QL/QUL)=CONSTANT+SIGMA*ln(PUL/PL)
where: QL=quantity of labor aggregate
PL=wage rate of labor aggregate
QUL=quantity of unskilled labor
PUL=wage rate of unskilled labor
SIGMA=elasticity of substitution between skilled and unskilled labor

** numbers in parenthesis are restricted estimates for Private Services

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