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A CROSS SECTION ESTIMATE OF TRANSLOG PRODUCTION FUNCTION: JORDANIAN MANUFACTURING INDUSTRY.

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ABSTRACT

The objective of this paper is to estimate the Transcendental Logarithmic Production Function of manufacturing industry in Jordanian economy. Manufacturing industry can be considered as the fourth large one in Jordanian economy. In last decade, the growth rate in this sector is the second one after transport and communications. The gross fixed capital formation in manufacturing is the third one. In this paper we need a cross sectional data for cost shares, factor inputs, factor prices, and output. Main source of data for manufacturing industry in Jordan is the Industry Survey - Department Statistics - the Hashemite Kingdom of Jordan. The data for factor inputs and output were transferred to logarithm. A point around which production function should be estimated was chosen. Cost shares of inputs have been calculated by dividing compensations to employees, operating surplus, and value of materials by value manufacturing output. The theoretical framework in this research is the flexible production function. S0, the thee-input transcendental logarithmic (Translog) production function could be used. This function is approximated by second order Taylor series. The log of likelihood ratio test has been used to choose among different hypotheses. The symmetric translog hypothesis has been found as an appropriate one among other hypotheses. It is well behaved, where positivity and concavity of production function have been satisfied. After testing for nested hypotheses, the symmetry restrictions were be imposed. So, restricted and unrestricted functional forms are estimated. However, Iterative Zellner-Efficient Estimate has been used to get estimates equivalent to the maximum likelihood estimates. Allen partial elasticities of substitution, AES, and own and cross price elasticities for factor inputs have been calculated. AES measure the substitutability or complement among factors of production. On the other hand, AES can measure the curvature of isoquant. AES shows that capital-labor, capital–materials, and labor-materials are all substitutive. But, AES for labor-materials is more than a half of that for capital-labor. AES for capital-labor is one and three fourth of that for labor-materials. The Price elasticities of factor inputs show that capital and labor demand are more elastic than demand for materials.

JEL Classification Codes: **D2**
Keywords: Translog Production, Nonhomothetic Translog cost, AES, Factor Price Elasticity

I. INTRODUCTION

Jordanian manufacturing industry can be considered as fourth largest sector in Jordanian economy. In this paper we introduce the results of an attempt to characterize the structure of technology in Jordanian manufacturing in 2002. This paper can be considered as a first attempt to estimate the three-input translog production function for four digits seventy seven Jordanian manufacturing industries in 2002. In addition, we estimate partial elasticity of substitution, and own and cross price elasticities of factor inputs. The homothetic and nonhomothetic cost functions had been estimated. Then, our estimates of partial elasticities of substitution and factor cross price elasticities are based on IZEF estimates of homothetic symmetric translog cost function and the fitted cost shares of factor inputs.

Technology can be represented by a production function, such as Cobb-Douglas and Constant Elasticity of Substitution (CES) place a restriction on elasticity of substitution (Cobb and Douglas 1928), (Arrow, et al. 1961). Alternatively, the generalized Leontief, generalized Cobb-Douglas and Translog function all are sufficiently flexible. The Translog function allows for variability of Allen partial elasticities of substitution and for using any number of inputs (Berndt and Christensen 1973), (Caves and Christensen 1980). Bernd and Wood, in their estimate of homothetic constant returns to scale cost function, show that Allen elasticities of substitution (AES) are stable over time, but they are different from one (Berndt and Wood 1975). Christensen and Greene, estimate a nonhomothetic cost function (Christensen and Greene 1976). Bbani Hani and Shamia, had estimated two-input Cobb-Douglas production function for Jordanian industrial sector 1967-86 the found that production function were decreasing returns to scale over the period of study (Bani Hani and Shammia 1989).

II. PRODUCTION FUNCTION:

The translog function is an attractive flexible function. This function has both linear and quadratic terms with the ability of using more than two factor inputs. This function can be approximated by second order Taylor series (Christensen, et al. 1973). The three-input translog production function can be written in terms of logarithms as follows,

$$
\begin{aligned}
Ln\, Q = \alpha_o &+ B_K\ Ln\, K + B_L\, Ln\, L + B_M\, Ln\, M + \\
&\tfrac{1}{2} B_{KK}\, Ln\, K^2 + B_{KL}\, Ln\, K\, Ln\, L + B_{KM}\, Ln\, K\, Ln\, M \\
&\tfrac{1}{2} B_{LL}\ Ln\, L^2 + B_{LM}\, Ln\, L\, Ln\, M + \tfrac{1}{2} B_{MM}\, Ln\, M^2 \qquad (1)
\end{aligned}
$$

Where Q is the gross manufacturing output, K is real stock of capital input, L is labor input, and M is material input. α_o is the intercept or the constant term. B_K, B_L, and B_M are first derivatives. B_{KK}, $B_{LL,}$ and $B_{M\,M}$ are own second derivatives. B_{KL}, $B_{KM,}$ and B_{LM} are cross second derivatives.

Under perfect competition assumption, output elasticity with respect to input equals to cost share of that input. Thus, we can get a system of equations from differentiating the translog production function with respect to each factor input,

$$\partial\, Ln\, Q / \partial\, Ln\, K = B_K + B_{KK}\, Ln\, K + B_{KL}\, LnL + B_{KM}\, Ln\, M$$

$$\partial\, Ln\, Q / \partial\, Ln\, L = B_L + B_{LK}\, Ln\, K + B_{LL}\, LnL + B_{LM}\, Ln\, M$$

$$\partial\, Ln\, Q / \partial\, Ln\, M = B_M + B_{MK}\, Ln\, K + B_{ML}\, LnL + B_{MM}\, Ln\, M \qquad (2)$$

Where B_K represents the average cost share of capital, B_{KK} , $B_{KL,}$ and B_{KM} represent constant capital share elasticity with respect to capital, capital share elasticity with respect to labor, and capital share elasticity with respect to material input respectively. B_{MK} B_{ML} and B_{MM} are constant material share elasticity with respect to capital, with respect to labor and with respect to materials.

Translog production function can be estimated under different nested hypotheses. So, to choose among nested models, we use log of likelihood ratio that approximated by Chi-square with a degrees of freedom equal to number of parameter restrictions (Norsworthy and Malmquist 1983). The hypotheses to be tested are: $H_0 :$ $P_{1's} = P_{2's}$ and $H_1 : P_{1's} \neq P_{2's}$. Where, H_0 and H_1 represent the null and the alternative hypothesis respectively. $P_{1's}$ and $P_{2's}$ represent parameter estimates from unrestricted and restricted model respectively. The test statistic is based on the likelihood ratio. This ratio is the maximum value of the likelihood function for restricted production function to the maximum value of the likelihood function for the unrestricted one. However, this test statistic is based on minus twice the logarithm of the likelihood ratio, -2Ln (R-U). Where, Ln R and Ln U represent restricted and unrestricted log of likelihood production function respectively. [1] However, under the null hypothesis, this test statistic is distributed asymptotically as Chi-square distribution with degrees of freedom equal the number of restrictions that we are testing. To choose among nested model we calculate Chi-square. Then, if we get a calculated Chi-square less than tabulated one, we accept the null hypothesis and we conclude that restricted model is appropriate to our data. But, if test statistic is greater than critical value of Chi-Square, we reject the null hypothesis and we say that the restricted model is inappropriate to our data.

However, we check for symmetry, constant returns to scale, existence of separability, and even for Cobb-Douglas hypothesis (Berndt and Wood 1975), (Norsworthy and Malmquist 1983).

So we impose symmetry restriction on parameters,

$$B_{KL} = B_{LK},$$

$$B_{KM} = B_{MK}$$

$$B_{ML} = B_{LM}.$$

For constant returns to scale, we impose the following restriction:

$$B_K + B_L + B_M = 1,$$

$$B_{KK} + B_{LK} + B_{MK} = 0,$$

$$B_{KL} + B_{LL} + B_{ML} = 0,$$

$$B_{KM} + B_{LM} + B_{MM} = 0 \,.$$

And for weak separability, we check whether the linear separability restrictions are satisfied with Jordanian manufacturing data. The linear restriction might be:

$$B_{LM} = B_{MK} = 0$$

Finally, we impose restrictions for existence of Cobb-Douglas,

$$B_{KK} = B_{KL} = B_{KM} = B_{LL} = B_{LM} = B_{MM} = 0 \,.$$

However, if log of maximum likelihood ratio is greater than critical value of Chi-square weak separability is rejected, and we conclude that value added specification is inappropriate to our data. After choosing the appropriate model for our data, we check for positivity of the function. Positivity is satisfied when the fitted cost share of capital, of labor and of materials are positive. Then, concavity of the function should be checked. Concavity of the function is satisfied if the Hessian determinant of IZEF parameter estimates is negative semidefinite (Berndt and Wood 1975).

Finally, we can measure the curvature of isoquant by estimating Allen partial elasticities of substitution (AES). However, it is possible to get AES for pair of factor inputs. It will be estimated from translog production function by the formula,

$$\sigma_{ij} = \frac{\Sigma f_i}{x_i} \cdot \frac{x_i}{x_j} \cdot \frac{|Bij|}{|B|},$$

Where i and j represent inputs and they are different, $i \neq j$. f_i, $|B|$ is and $|Bji|$ are the first derivative, the determinant of bordered Hessian of the estimates, and the cofactor of the B_{ji} parameter respectively. By Shephard duality, we can get ASE from estimated parameters of cost function and fitted estimated cost share of inputs as follows,

$$\sigma_{ij} = (\gamma_{ij} + S_i S_j) / (S_i S_j)$$

$$\sigma_{ii} = (\gamma_{ii} + Si^2 - S_i) / (S_i^2) \,. \qquad (3)$$

Where γii represent the estimated second order derivatives on the diagonal of Hessian Matrix. γ_{ij} represent parameter estimated of constant elasticities of cost share with respect to price of factor input service. S_i and S_j represent fitted cost share of inputs (Christensen, et al. 1971), (Diewert 1971), (Uzawa 1962). So, we can recognize the existence of complementary or substitutability among factor inputs of production.

Factor price elasticities are related to AES as we see below:

$$\zeta_{ij} = (\gamma_{ij} + S_i S_j) / S_i$$

$$\zeta_{ii} = (\gamma_{ii} + S_i^{\,2} - S_i) / S_i \quad \text{where } i \text{ and } j \text{ are } K, L, \text{ and } M. \qquad (4)$$

We should remember that, in general, $\zeta_{ij} \neq \zeta_{ji}$. [2]

III. ESIMATION OF PRODUCTION FUNCTION

The main sources of cross section data for Jordanian manufacturing is the Department Of Statistics (DOS), and the Central Bank Of Jordan (CBJ) (Central Bank of Jordan) (Department of Statistics 2002). However, we have got data on gross output, gross value added by economic activity, data on number of workers, capital stock, depreciation of capital, and total fixed capital formation. In addition, we get data on compensation of employees by economic activity, operating surplus and intermediate goods and services that are used in production. Data on price of factors such as price of labor, price of capital and price of material input are obtained from DOS.

To get the values of estimates for three-input manufacturing symmetric translog production, we have to estimate the system of share equations (2). This can be done by OLS, whereas, a greater efficiency might be obtained by using Zellner Efficient (ZEF) estimation. So, we drop one of the three equations and we estimate only two equations. But, the problem with ZEF raise when we arbitrarily drop one of the equation in the system (2), where the estimates may not invariant with respect to the deleted equation. Thus, to avoid this problem we iterate ZEF until the estimates converge to the maximum likelihood ML estimates (Kmenta and Gilbert 1968).

However, we use IZEF to estimate the symmetric translog production function. Then, we check for various hypotheses such as constant returns to scale, weak separability with linear separability restrictions, and Cobb-Douglas hypothesis. We find that log of likelihood ratios are 54.34, 70.70, and 100.14 for constant returns to scale, weak separability, and Cobb-Douglas hypotheses respectively. While, the 0.01 critical values of Chi-square are 13.24, 11.34 and 16.81 for constant returns to scale, weak separability, and Cobb-Douglas hypotheses respectively. Thus, we reject the null hypotheses, and we conclude that constant returns to scale, value added specification, and Cobb-Douglas hypothesis are not satisfied with Jordanian manufacturing data.

Table 1 shows IZEF estimates of three-input Jordanian manufacturing symmetric translog production function. The raw moment R-square for capital and labor cost share are 0.87, and 0.94 respectively. The estimates of translog production and cost functions, under different hypotheses, have been introduced in Table 4 and 5 in the appendix.

Now, let us check for *positivity* and *concavity* of the function. For positivity, we find that fitted cost share of capital, labor and materials are all positive at each data point. Next, we check for concavity of production function, and we find that Hessian matrix, based on IZEF parameter estimates, is negative semidefinite (Berndt and Wood 1975). Thus, we can say that production function is well behaved for manufacturing industrial data of 2002.

In measuring substitutability of factor inputs, we compute AES by using (3). In addition, we calculate factor cross price elasticities by using (4). [3] Where we use fitted cost share of inputs and estimates of symmetric translog cost function in our estimations. However, our estimate of AES and ξ_{ij} and ξ_{ji} are presented in Table 2 and coefficient of variation of 0.139 (Norsworthy and Malmquist 1983). So, σ_{KL} is close

to be constant but it is significantly different from one. This result is similar to that of Berndt-Wood, where the estimated σ_{KL} are rather stable time period of study 1947-71. We also find that factor input cross price elasticities, ζ_{KL} and ζ_{LK}, are about 0.17 and 0.25 respectively.
(iii) Capital and material are slightly substitutive. Where, average σ_{KM} is 0.82 with variance and coefficient of variation equal to 0.001 and 0.035 respectively. Factor input cross price elasticities ζ_{KM} and ζ_{MK} are 0.53 and 0.17 respectively. (iv) The average of σ_{LM} is equal to 0.70 with variance of 0.009 and coefficient of variation equals to 0.139. The factor input price elasticities, ζ_{LM} and ζ_{ML}, are 0.45 and 0.10 respectively. (v) It is clear, that σ_{KM} is less variant than σ_{KL} and σ_{LM}. (vi) σ_{KM} is about two thirds of σ_{KL}. σ_{LM} is about eighty five percent of σ_{KM} and about fifty five percent of σ_{LM}. However, in Table 6, we introduce only thirty estimates of AES out of seventy seven estimates. In Table 7, we also introduce estimated cross price elasticities for selected manufacturing industries.

IV. SUMMARY AND CONCLUSIONS

Our objective has been to estimate a translog production function and show its internal structure for four digits Jordanian manufacturing industries in a point of time. We estimate parameters that represent the average cost share of inputs and the elasticities of cost share of input with respect inputs. In addition, we have checked for positivity, concavity, substitutability and separability of inputs. Our main conclusions are: (a) After testing for different hypotheses we find that three-input symmetric translog production function is an appropriate one for Jordanian manufacturing industry in 2002. (b) The Jordanian translog production function is well-behaved. (c) Capital-labor substitutability is larger than capital-materials and labor-material. (d) Allen partial elasticities of substitution are almost constant, but they are significantly different from one.

APPENDIX

Table 1. IZEF estimates of Jordanian Manufacturing Translog Production Function*

Parameter	Estimates	Parameter	Estimates
B_K	0.1778 (14.498)	B_{KM}	-0.0237
B_L	0.0810 (13.291)	B_{LL}	0.0198 (2.883)
B_M	0.7413	B_{LM}	-0.0253
B_{KK}	0.0181 (2.812)	B_{MM}	0.0490
B_{KL}	0.0056 (1.018)		

(*) asymptotic t-ratio in parentheses

Table 2. IZEF Allen Elasticity of Substitution for Jordanian Manufacturing Industry (*)

Elasticity	Estimate	Elasticity	Estimate
σ_{KK}	-3.62	σ_{KL}	1.25
σ_{LL}	-5.55	σ_{KM}	0.82
σ_{MM}	-0.43	σ_{LM}	0.70

(*) Each estimate represents an arithmetic average of 77 estimates of Elasticity of substitution.

Table 3. IZEF Factor Input Price Elasticity for Jordanian Manufacturing Industry (*)

Elasticity	Estimates	Elasticity	Estimates
ζ_{KK}	-0.70	ζ_{LK}	0.45
ζ_{LL}	-0.70	ζ_{LM}	0.26
ζ_{MM}	-0.27	ζ_{MK}	0.17
ζ_{KL}	0.17	ζ_{ML}	0.10
ζ_{KM}	0.53		

(*) Each estimate represents an arithmetic average of 77 estimates of Factor Price Elasticity.

Table 4. IZEF Translog Production Function Estimates-
Jordanian Manufacturing 2002 (*)

Parameter	Unrestricted	CRS	Weak Separability	Cobb-Douglas
B_K	0.1778	0.026	0.2062	0.20561
	(14.498)	(14.149)	(12.375)	(19.139)
B_L	0.0810	0.1377	0.0966	0.1377
	(13.291)	(14.073)	(10.600)	(17.666)
B_M	0.7413	0.6567	0.6972	0.6567
B_{KK}	0.0182	0.0512	0.01575	
	(2.812)	(3.683)	(2.170)	
B_{KL}	0.0056	0.0112	-0.0319	
	(1.018)	(1.990)	(-6.246)	
B_{KM}	-0.0237	-0.0624		
B_{LL}	0.0198	0.0264	0.0182	
	(2.883)	(5.918)	(2.825)	
B_{LM}	-0.0253	-0.0376		
B_{MM}	0.0490	0.10000		
$R^2_{K.}$	0.8679	0.8640	0.8175	0.8282
$R^2_{L.}$	0.9354	0.8766	0.8784	0.8042
LLF	224.85	197.68	189.50	172.78

(*) asymptotic t-ratio in parentheses

Table 5. IZEF Translog Cost Function Estimates-
Jordanian Manufacturing 2002 (*)

Parameter	Unrestricted	CRS	Weak Separability	Cobb-Douglas
γ_K	0.1383	0.2056	0.1859	0.2056
	(11.079)	(8.957)	(12.532)	(19.139)
γ_L	0.0808	0.1377	0.1022	0.1377
	(8.025)	(11.621)	(10.628)	(17.667)
γ_M	0.7809	0.7413	0.7119	0.6576
γ_{KK}	0.0705	0.0501	0.0072	
	(7.710)	(5.320)	(1.407)	
γ_{KL}	0.0223	0.0037	-0.0072	
	(3.377)	(0.538)	(-1.407)	
γ_{KM}	-0.0929	-0.0537		
	(-8.552)	(-4.303)		
γ_{LL}	0.0170	-0.0033	0.0072	
	(1.439)	(-0.255)	(1.407)	
γ_{LM}	-0.0393	-0.0033		
	(-2.974)	(-0.027)		
γ_{MM}	-0.0971	0.0496		
γ_{YK}	0.0827	0.0602	-0.0090	
	(7.054)	(4.082)	(-1.416)	
γ_{YL}	0.0144	-0.0106	-0.0248	
	(1.120)	(-0.705)	(-6.069)	
γ_{YM}	-0.071	0.0496		
R^2_K	0.9140	0.8755	0.8428	0.8282
R^2_L	0.8776	0.351	0.8623	0.8042
LLF	215.88	192.17	189.159	172.77

(*) asymptotic t-ratio in parentheses

Table 6. IZEF Estimated Elasticities of Substitution Translog Cost Function for Thirty Selected Jordanian Manufacturing 2002

Economic Activity	*ISIC*	σ_{KK}	σ_{LL}	σ_{MM}	σ_{KL}	σ_{KM}	σ_{LM}
Production, Processing, and Preserving of Meat and Meat Product	**1511**	-3.70	-7.51	-0.30		0.83	0.62
Manufacturing of Soft Drink; Production of Mineral Water	**1554**	-2.86	-5.25	-0.48	1.19	0.84	0.70
Preparation and Spinning of Textile Fibber ; Weaving of Textiles	**1711**	-3.59	-6.55	-0.34	1.29	0.82	0.67
Manufacturing of Made-up Textile Articles,	**1721**	-4.40	-3.50	-0.46	1.19	0.77	0.80
Manufacturing of Wearing Apparel, Except Fur Apparel	**1810**	-3.16	-3.51	-0.58	1.14	0.81	0.78
Manufacturing of Luggage, Handbags and the Like, Saddler and Harness	**1912**	-3.26	-2.59	-0.72	1.11	0.79	0.81
Manufacturing of Footwear	**1920**	-2.29	-3.95	-0.57	1.15	0.83	0.76
Sawmilling and Planning of Wood	**2010**	-3.84	-4.63	-0.41	1.22	0.80	0.75
Manufacturing of Wooden Containers	**2023**	-2.86	-3.24	-0.67	1.12	0.82	0.78
Manufacturing of Pulp, Paper and Paperboard	**2101**	-3.62	-6.01	-0.36	1.27	0.82	0.69
Manufacturing of Publishing of Newspapers Journals and Periodicals	**2212**	-3.25	-4.75	-0.46	1.19	0.82	0.74
Manufacturing of Refined Petroleum Product	**2320**	-9.91	-7.76	0.07	2.04	0.65	0.72
Manufacturing of Basic Chemicals, except Fertilizers and Nitrogen Compounds	**2411**	-2.70	-7.54	-0.41	1.27	0.85	0.59
Manufacturing of Fertilizer and Nitrogen Compounds	**2412**	-6.19	-6.55	-0.08	1.49	0.77	0.73
Manufacturing of Plastic in Primary Forms and of Synthetic Rubber	**2413**	-3.02	-5.75	-0.43	1.22	0.84	0.69
Manufacturing of Rubber Tires and Tubes; Retreating and Rebuilding of Rubber Tiers	**2511**	-3.29	-4.94	-0.44	1.20	0.82	0.73
Manufacturing of Plastic Products	**2520**	-3.85	-6.54	-0.32	1.31	0.82	0.67
Manufacturing of Glass and Glass Products	**2610**	-2.91	-4.86	-0.50	1.18	0.83	0.72
Manufacturing of Non-structural and Non- refractory Ceramic Ware	**2691**	-2.76	-4.26	-0.57	1.15	0.83	0.74
Manufacturing of Structural Non-refractory Clay and Ceramic Product	**2693**	-2.88	-4.39	-0.54	1.16	0.83	0.74
Manufacturing of basic iron and steel	**2710**	-4.09	-8.97	-0.25	1.48	0.82	0.55
Manufacturing of Structural Metal Products	**2811**	-3.93	-4.10	-0.44	1.20	0.80	0.77
Treatment and Coating of Metals, General Mechanical Engineering on a Fee or Contract Basis	**2892**	-2.23	-2.91	-0.89	1.09	0.83	0.77
Manufacturing of Agricultural and Forestry Machineries	**2921**	-6.36	-7.90	-0.18	1.63	0.74	0.64
Manufacturing of Domestic Appliances,	**2930**	-3.57	-5.43	-0.39	1.24	0.82	0.72
Manufacturing of Electronic Motors	**3110**	-3.62	-6.36	-0.34	1.28	0.82	0.67
Manufacturing of Medical and Surgical Equipments and Orthopedic Appliances	**3311**	-2.70	-4.08	-0.59	1.14	0.83	0.75
Building and Repairing of Pleasure and Sporting Boats	**3512**	-3.15	-4.01	-0.53	1.16	0.82	0.76
Manufacturing of Furniture	**3610**	-3.53	-3.99	-0.49	1.18	0.81	0.77
Manufacturing of Jewelry and Related Articles	**3691**	-4.48	-4.95	-0.34	1.27	0.79	0.75

Table 7. IZEF Estimated Factor Input Cross Price Elasticities of Demand Translog Cost Function for Thirty Selected Jordanian Manufacturing 2002

Economic Activity	*ISIC*	ζ_{KL}	ζ_{KM}	ζ_{LM}	ζ_{LK}	ζ_{MK}	ζ_{ML}
Production, Processing, and Preserving of Meat and Meat Product	**1511**	0.12	0.59	0.44	0.25	0.16	0.06
Manufacturing of Soft Drink; Production of Mineral Water	**1554**	0.16	0.52	0.44	0.28	0.20	0.10
Preparation and Spinning of Textile Fibber ; Weaving of Textiles	**1711**	0.14	0.57	0.46	0.25	0.16	0.07
Manufacturing of Made-up Textile Articles,	**1721**	0.24	0.49	0.51	0.19	0.13	0.16
Manufacturing of Wearing Apparel, Except Fur Apparel	**1810**	0.23	0.47	0.45	0.25	0.18	0.16
Manufacturing of Luggage, Handbags and the Like, Saddles and Harness	**1912**	0.28	0.42	0.43	0.24	0.17	0.21
Manufacturing of Footwear	**1920**	0.20	0.48	0.44	0.27	0.20	0.14
Sawmilling and Planning of Wood	**2010**	0.19	0.53	0.49	0.22	0.15	0.12
Manufacturing of Wooden Containers	**2023**	0.24	0.45	0.43	0.27	0.20	0.17
Manufacturing of Pulp, Paper and Paperboard	**2101**	0.15	0.56	0.47	0.24	0.16	0.08
Manufacturing of Publishing of Newspapers Journals and Periodicals	**2212**	0.18	0.52	0.47	0.25	0.18	0.11
Manufacturing of Refined Petroleum Product	**2320**	0.17	0.67	0.74	0.13	0.04	0.07
Manufacturing of Basic Chemicals, Except Fertilizers and Nitrogen Compounds	**2411**	0.12	0.56	0.38	0.31	0.21	0.05
Manufacturing of Fertilizer and Nitrogen Compounds	**2412**	0.16	0.67	0.64	0.17	0.09	0.08
Manufacturing of Plastic in Primary Forms and of Synthetic Rubber	**2413**	0.15	0.54	0.44	0.27	0.19	0.09
Manufacturing of Rubber Tires and Tubes; Retreating and Rebuilding of Rubber Tiers	**2511**	0.17	0.53	0.47	0.25	0.18	0.11
Manufacturing of Plastic Products	**2520**	0.14	0.58	0.47	0.24	0.15	0.07
Manufacturing of Glass and Glass Products	**2610**	0.17	0.51	0.44	0.27	0.20	0.11
Manufacturing of Non-structural and Non- refractory Ceramic Ware	**2691**	0.19	0.49	0.43	0.28	0.21	0.13
Manufacturing of Structural Non-refractory Clay and Ceramic Product	**2693**	0.19	0.50	0.44	0.27	0.20	0.12
Manufacturing of Basic Iron and Steel	**2710**	0.11	0.61	0.41	0.25	0.15	0.04
Manufacturing of Structural Metal Products	**2811**	0.21	0.51	0.50	0.21	0.15	0.14
Treatment and Coating of Metals, General Mechanical Engineering on a Fee or Contract Basis	**2892**	0.25	0.39	0.37	0.31	0.24	0.18
Manufacturing of Agricultural and Forestry Machineries	**2921**	0.14	0.59	0.51	0.18	0.09	0.06
Manufacturing of Domestic Appliances,	**2930**	0.16	0.55	0.48	0.24	0.16	0.10
Manufacturing of Electronic Motors	**3110**	0.14	0.57	0.47	0.25	0.16	0.08
Manufacturing of Medical and Surgical Equipments and Orthopedic Appliances	**3311**	0.20	0.48	0.43	0.28	0.21	0.13
Building and Repairing of Pleasure and Sporting Boats	**3512**	0.20	0.49	0.46	0.25	0.18	0.14
Manufacturing of Furniture	**3610**	0.21	0.50	0.48	0.23	0.16	0.14
Manufacturing of Jewelry and Related Articles	**3691**	0.18	0.55	0.52	0.20	0.13	0.11

ENDNOTES

[1] There are two alternative tests that can be used for testing hypotheses, Wald test, and Lagrangian Multiplier test

[2] The translog cost function is:
$Ln\ TC = \alpha o + \alpha Y\ Ln\ Y + 1/2 \gamma YY\ Ln\ Y2 + \Sigma \gamma i\ Ln\ Pi + 1/2 \Sigma\ \Sigma\ \gamma ij\ LnPi\ Ln\ Pj. + \Sigma\ \gamma Yi\ LnY\ Ln\ Pj$
and by differentiating the function we get:
$\partial\ Ln\ TC / \partial\ Ln\ PK = \alpha\ K + \gamma KK\ Ln\ PK + \gamma KL\ Ln\ PL + \gamma KM\ Ln\ PM + \gamma KY\ Ln\ Y$
$\partial\ Ln\ TC / \partial\ Ln\ PL = \alpha\ L + \gamma LK\ Ln\ PK + \gamma\ LL\ LnPL + \gamma\ LM\ Ln\ PM + \gamma LY\ Ln\ Y$
$\partial\ Ln\ TC / \partial\ Ln\ PM = \alpha\ M + \gamma MK\ Ln\ PK + \gamma\ ML\ LnPL + \gamma\ MM\ Ln\ PM + \gamma MY\ Ln\ Y$

[3] Cross price elasticities of factor inputs can, also, be estimated as follows:
$\zeta ij = S_j \sigma ij$

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