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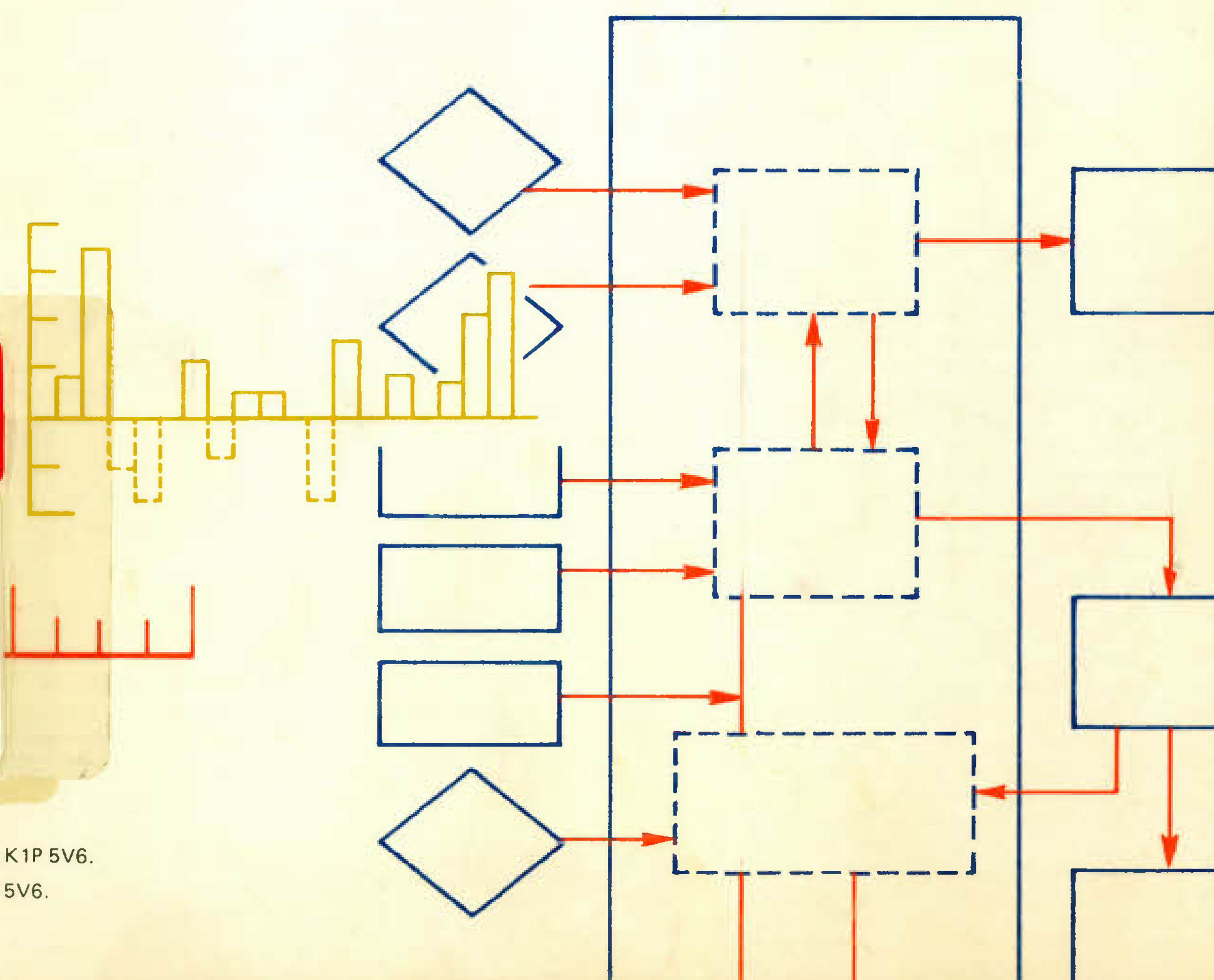

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DISCUSSION PAPER NO. 194

Factor Prices and Labour Productivity

by P. Someshwar Rao

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TABLE OF CONTENTS

Résumé

Le principal objectif de la présente étude consistait à trouver, pour des industries particulières des secteurs manufacturier, minier et des transports, les causes des changements, sur une période de temps donnée, dans les proportions de chaque facteur de production qui y sont utilisés. À cette fin, nous avons estimé quatre équations des parts relatives des facteurs (le capital, le travail, l'énergie et les matières industrielles) selon l'approche de la fonction frontière de prix "translog" introduite par Christensen, Jorgensen et Lau. Pour chaque industrie, nous avons évalué les diverses équations des parts relatives des facteurs en supposant la présence, et l'absence, d'homothétie.

Voici quelques-uns des résultats les plus importants de l'étude :

1. Pour chacune des 36 industries étudiées, la supposition d'homothétie a été rejetée, ce qui donne à penser que les proportions des facteurs sont influencés par le niveau de production, indépendamment des prix.

2. Dans la plupart des industries, une augmentation de la croissance de la production réduit la proportion des facteurs de production primaires (notamment celle du travail) et accroît la proportion de facteurs intermédiaires. Le contraire est vrai lorsque la croissance de la production est au ralenti.

3. Dans la plupart des industries, les élasticités des prix de chaque facteur sont inférieures à l'unité, sauf dans le cas du capital. En outre, les élasticités des prix de l'énergie et des matières industrielles sont assez peu élevées.

4. Pour les cinq industries agrégées (l'ensemble de l'industrie manufacturière, la fabrication de biens durables, le secteur des biens non durables, l'industrie minière et les transports), nos résultats laissent supposer que l'énergie et le capital sont des substituts. Même dans le cas des industries manufacturières à coefficient élevé d'énergie, l'élasticité de substitution entre l'énergie et le capital n'est négative et significative (complémentarité) que dans l'industrie chimique.

5. Pour l'ensemble de l'industrie manufacturière, la croissance de la productivité du travail est tombée de

4 % pour la période de 1967-1973, à 1,35 % pour les années 1974-1976. Selon notre simulation, 60 % de ce fléchissement serait imputable aux changements dans les prix relatifs des facteurs, et 40 % aux modifications dans la croissance de la production.

ABSTRACT

The primary objective of this study is to analyze the causes of variation in factor intensities over time, for individual manufacturing, mining, and transportation industries. For this purpose, we have estimated the four factor share equations (capital, labour, energy, and materials) based on translog price possibility frontier approach introduced by Christensen, Jorgensen, and Lau. For each industry, we have estimated the factor share equations with and without the assumption of homotheticity.

The following are some of the important findings of the present study:

1. For all the 36 industries studied, the assumption of homotheticity is rejected. This implies that factor proportions are affected by output level, independent of factor prices.

2. In most of the industries, an increase in output growth reduces the share of primary inputs (mainly labour) and increases the share of intermediate inputs, and the opposite is true in the case of reduced output growth.

3. In most of the cases, with the exception of capital, all the own-price elasticities are below unity. Moreover, the energy and material price elasticities are quite small.

4. For all the five aggregate industries (total manufacturing, durables and nondurables manufacturing, mining, and transportation industries) our results imply that energy and capital are substitutes. Even in the case of energy intensive manufacturing industries, only for the chemicals and chemical products industry, the substitution elasticity between energy and capital is negative and significant (complementarity).

5. For the total manufacturing industry, labour productivity growth has declined from 4 per cent for 1967-73 to 1.35 per cent for 1974-76. Our simulation results suggest that changes in relative factor prices and output growth account for 60 per cent and 40 per cent of this decline respectively.

Acknowledgements

I are greatly indebted to Dr. R.S. Preston, Director, CANDIDE Project for his guidance and encouragement on this study. I are grateful to Pat Nevin and Shirley Gilby for their excellent assistance with this project. I are also thankful to Haider Saiyed for helping us set up the computer programs and Marg Willis for preparing the graphs. We are extremely thankful to Denyse Desaulniers for patiently typing the whole manuscript and removing some of the inconsistencies from the rough draft.

List of Tables

LIST OF TABLES

LIST OF CHARTS

I Introduction

Productivity performance is perhaps the best single indicator of an economy's vitality. Productivity analysis, through its implications for unit costs, prices, and standard of living, is a potentially rich source of insight into the underlying causes of the economic conditions facing the industrial world today. In the post-1973 period, the productivity growth of all industrial nations has reduced dramatically. This in turn has created a considerable degree of anxiety about the causes of productivity slowdown in the post-1973 period.

In Canada, the aggregate labour productivity growth has declined from an annual rate of 3.10 per cent for the period 1957-73 to a mere 0.40% for the post-oil embargo period 1974-78. In 1979, labour productivity has actually declined by 1% and the prospects of 1980 are even grimmer. This disastrous performance of labour productivity has created an upsurge of interest in the measurement and analysis of labour productivity in the last couple of years.[1]

In Discussion Paper No. 134, Rao (1979) has analysed the sources of labour productivity growth by industrial sector for the subperiods 1957-66,1967-73, and 1974-76. Using gross output data, productivity equations based on KLEM production functions were estimated for 35 industrial sectors (22 manufacturing, 4 mining, and 9 nonmanufacturing industries). Using the parameters of these productivity equations, the causes of post-1973 productivity slowdown in each industrial sector were analysed. The following were some of the important findings of Rao (1979)'s study:

1. In every industry (with the exception of commercial and personal services) the estimate of total factor productivity growth (based on gross output) is smaller than the value added productivity given in Rao (1978) and this bias is serious in industries with large material content.

2. Estimated residuals of productivity equations were fairly random in the 1970's-- in none of the equations was the productivity dummy used. Thus, the results implied no structural break in total factor productivity in the post- 1973 period.

3. In all manufacturing industries (with the exception of nonauto transportation equipment) at least 50% of the labour productivity growth is due to material deepening (growth of material-labour ratio). However, its share varies considerably across industries. Capital-labour

ratio growth has contributed about 10% of the labour productivity growth. About 35% of labour productivity growth for the manufacturing industry as a whole has come from total factor productivity growth.

4. For the subperiod 1974-76, manufacturing industry's labour productivity has declined from 4.0% for 1966-73 to a mere 1.35% for the period 1974-76. Most of this productivity slowdown is explained in terms of lower growth rates of material-labour ratio and lower levels of capacity utilization.

5. With the exception of finance, insurance and real estate, all of the nonmanufacturing industries have experienced considerable productivity slowdown during the post-1973 period. However, for all the industries, the estimated productivity growth pattern is quite similar to the actual productivity growth, implying no productivity break down in the 1970's. Lower rates of accumulation of both capital and material inputs in relation to labour input and lower levels of capacity utilization explain most of the productivity slowdown.

In summary, the results of Discussion Paper No. 134 imply no structural break in total factor productivity (with the exception of cyclical factors), and most of the productivity slowdown is caused by reductions in the rate of growth of materials and capital inputs in relation to labour input and lower levels of capacity utilization. The next interesting question to answer is what are the causes of slowdown in the rate of growth of materials-labour ratio and capital-labour ratio. Alternatively, what are the factors behind the substitution of labour for capital, materials and energy?

The objective of the present paper is to analyse the causes of variations in factor intensities over time for the 22 manufacturing, 4 mining and 5 transportation industries. For this purpose, we estimate the four factor proportions (in current dollars) equations based on the translog price possibility frontier approach of Hudson and Jorgenson (1974), Berndt and Christensen (1973), Morney and Toevs (1977) and others. For each industry, we estimate the factor share equations both with and without the assumption of homothecity. Homothecity ensures that output level per se would not affect the relative shares in the long-run. In contrast, in the nonhomothetic case, the relative shares depend on both factor prices and output. In this instance, pure scale changes would alter relative marginal products and thus affect factor proportions and relative shares independent of factor prices.

This approach would enable us to investigate the role of relative factor prices and output growth in the slowdown of material-labour and capital-labour ratio growth in each industry for the post-1973 period. This would also enable us to investigate the substitutability or complementarity relation among the four factors of production (capital, labour, energy and materials) in each industry. We could test for the significance of substitution and complementarity relations among the factors of production. If there is no substitution between intermediate inputs (materials and energy) and the primary inputs (capital and labour), factor proportions based on gross output cannot be explained by variations in relative prices. This information about the substitution of elasticities between intermediate inputs and the primary inputs would shed light on the appropriate output measure to be used in the productivity analysis in each industry. Finally, the results of this study would enable us to make predictions about the long-run prospects for productivity performance for each industrial sector under alternative assumptions about relative factor prices and output growth.

The plan of the paper is as follows:

Section II gives a nontechnical overview of relative factor prices, output growth and productivity growth in Canada by industry for the subperiod 1957-66, 1967-73 and 1974-76.

In Section III, we will discuss in detail the theoretical basis of the factor share equations based on translog price possibility frontier approach. For each industry, we derive the factor share equations with and without the assumption of homotheticity.

Section IV is devoted to the discussion of empirical results of two models (homotheticity and hetrotheticity) by industry.

In Section V the important findings of the study are summarized. We will also discuss the implications of our results for the labour productivity growth in the 1980's.

II International Comparisons and an Overview of Factor Prices, Output and Labour Productivity Growth and Energy Intensity

In this section we will present an overview of developments in factor prices, output and labour productivity growth over the last two decades for the 22 manufacturing, 4 mining and 5 transportation industries making extensive use of graphical and tabular analysis. We will discuss the energy consumption and energy intensities for these industries. This nontechnical overview will provide insights into the interrelationships between output growth, factor prices and labour productivity growth and offer some nontechnical explanations for the post-1973 productivity slowdown. The information about total energy consumption and energy intensity will give a good idea about the industries which we have to concentrate on in analysing the important energy related questions -- energy conservation and the relations between energy and other inputs in production process.

Manufacturing Industries

Table 1 and Charts 1 to 3 provide the developments in factor prices for the period 1957-76, for manufacturing industries. As seen from Table 1 for both durable and

Table 1

Average Annual Percent Change in Factor Prices - 1957-76

Industry	1957-66				1967-73				1974-76			
	P_L	P_K	P_M^*	P_E^*	P_L	P_K	P_M	P_E	P_L	P_K	P_M	P_E
Manufacturing - Total	3.7	4.7	1.0	-1.7	7.2	5.2	3.5	3.0	14.2	18.4	12.7	23.2
Durables	3.8	4.6	1.2	-1.6	8.0	4.9	3.5	2.6	12.4	19.1	11.0	22.8
Nondurables	4.0	4.7	0.9	-1.9	7.8	5.4	3.6	3.3	14.5	17.8	14.3	23.5
Mining	5.7	3.6	1.6	0.2	11.2	7.0	4.8	5.0	15.6	15.0	30.5	19.5
Transportation	4.8	4.5	1.6	0.2	7.4	7.8	4.3	4.5	16.4	17.3	12.1	31.5

* Price of energy and material inputs for mining and transportation industries is only for the period 1961-66.

CHART 1

% CHANGE IN FACTOR PRICES - TOTAL MANUFACTURING

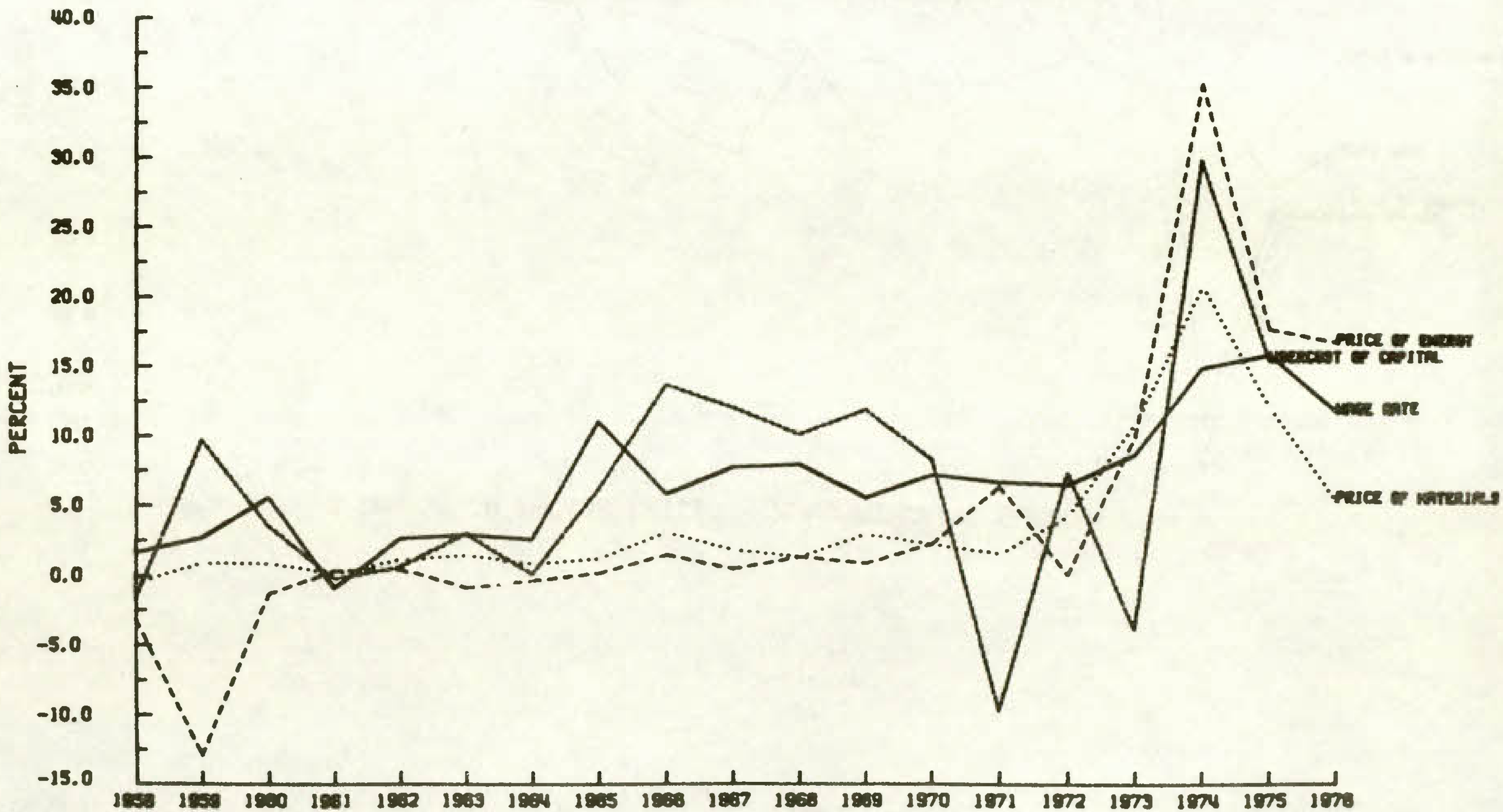


CHART 2

% CHANGE IN FACTOR PRICES - MANUFACTURING DURABLES

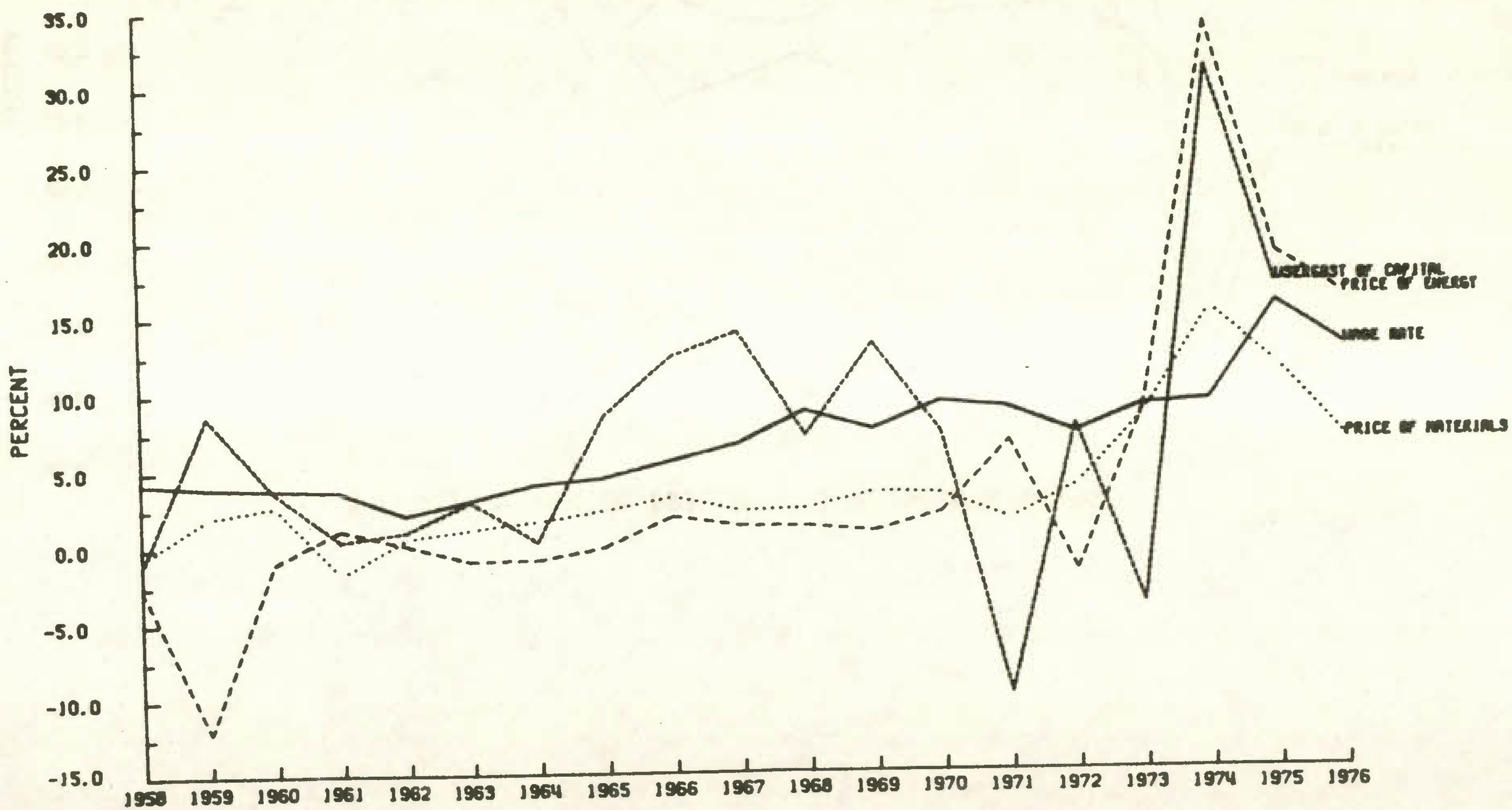
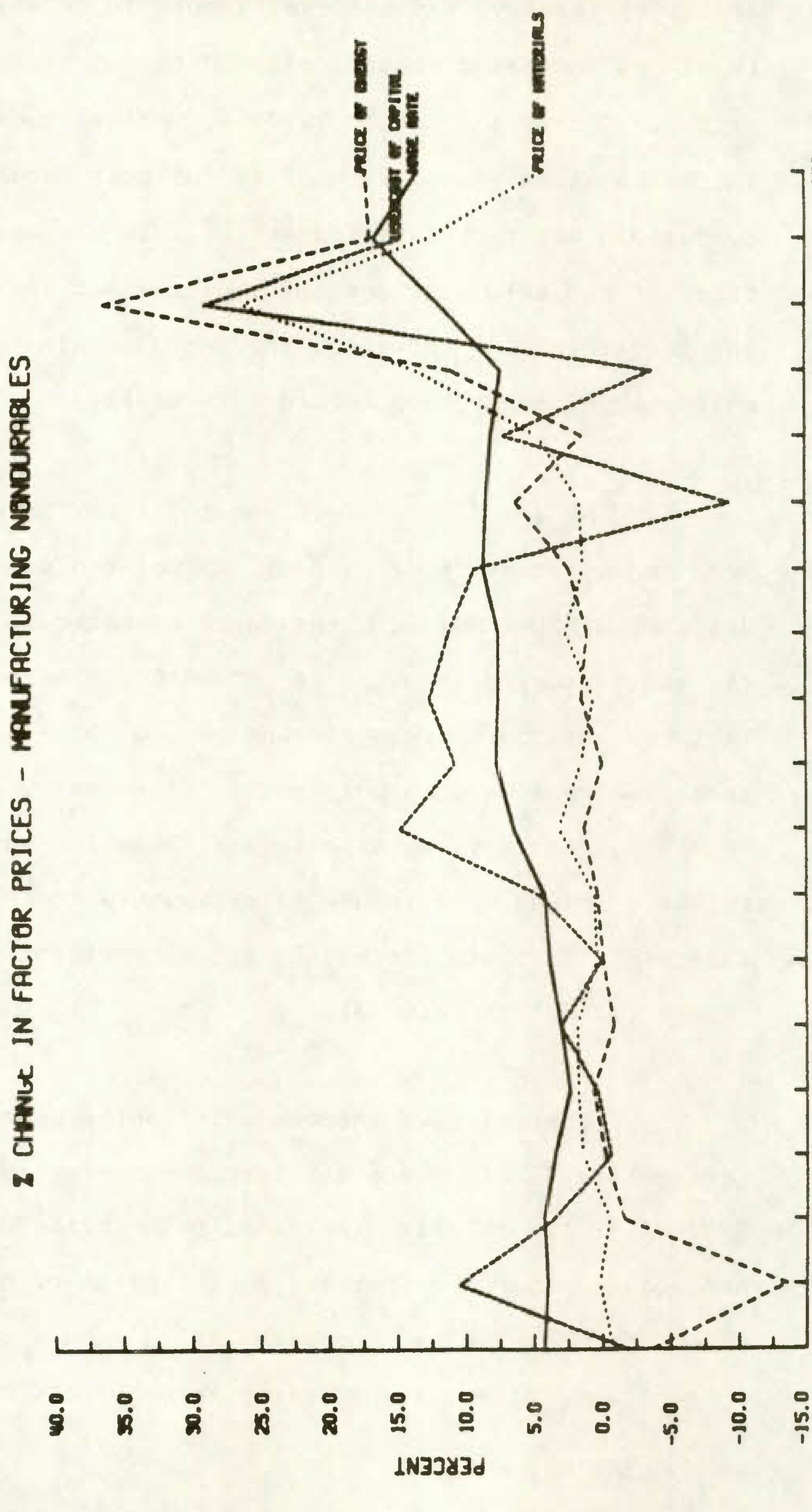


CHART 3


% CHANGE IN FACTOR PRICES - MANUFACTURING NONDURABLES
PERCENT
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
1958
1959
1960
1961
1962
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1968
1969
1970
1971
1972
1973
1974
1975
1976
PRICE OF ENERGY
COST OF CAPITAL
WAGE RATE
PRICE OF MATERIALS

nondurable manufacturing industries the acceleration price of capital energy, and material inputs in relation to labour input has increased dramatically in the post-oil embargo period. During the period 1957-66, nominal wage rate has increased at an annual rate of 4% for both durable and nondurable manufacturing industries. In the same period, price of capital (user cost of capital) has increased at an annual rate of 5%. However, the increases in the price of material and energy inputs are very small.

As a matter of fact, energy input prices have declined by about 2% per annum. As pointed out in Discussion Paper No. 134, the share of material inputs for the manufacturing industry is around 65%. As seen from Table 1, material prices for the period 1957-66 have increased by a mere 1% per annum. In summary, all things remaining constant, we expect that these increases in relative prices will induce enterpreneurs to substitute intermediate inputs (materials and energy) for the primary inputs (labour and capital).

The relative increases in factor prices for the period 1967-73 are quite similar to the experience of 1957-66 -- the relative increase in the price of labour is much bigger than the increase in the price of other inputs. Labour input price has increased at an annual rate of 8%. In contrast, material and energy input prices have increased only by 3% per annum, and the capital price has increased by about 5% per annum. In this period too, there is an incentive for the producers to substitute intermediate inputs (materials and energy) and capital for the labour input.

The experience of 1974-76 is dramatically different from the relative price developments of the earlier periods. In this period, all four input prices have increased considerably, and the increases in price of labour are smaller than the increases in the other input prices. During this period, price of labour has increased at an annual rate of 14%. In the same period the price of capital, materials, and energy inputs have increased by 18%,13% and 23% respectively. Contrary to the experience of earlier periods, in the post-1973 period labour has become a cheap factor of production relative to other inputs. This in turn would induce entrepreneurs to substitute labour for other inputs in production process, resulting in lowered labour productivity growth.

Tables 2 and 3 summarize the developments in output and labour productivity growth for the 22 manufacturing industries over the last two decades. With the exception of a few manufacturing industries, both the output and labour productivity growth rates have declined

Table 2

Average Annual Percent Growth in Gross Output
(Manufacturing Industry)

Industry	1957-66	1967-73	1974-76
Total Mfg	4.82	5.59	1.48
Durables	5.32	6.32	1.51
Wood	3.97	5.17	3.17
Furniture & Fixtures	4.58	5.20	-1.51
Iron & Steel	4.64	4.86	-0.81
Nonferrous Metals	3.17	3.08	-2.48
Metal Fabricating	4.21	3.18	1.47
Machinery (ex elec. mach)	6.80	5.84	4.05
Nonauto Trsp Equip	1.47	1.00	-2.47
Motor Vehicle Ind. (ex. Parts & Acc.)	9.88	14.44	5.46
Motor Vehicle Parts & Acc.	8.45	11.94	-0.15
Electrical Prod.	5.13	5.21	-0.37
Nonmetallic Mineral Prod.	4.02	3.99	0.38
Nondurables	4.40	4.90	1.45
Food & Beverages	3.68	3.32	2.28
Tobacco Products	3.78	2.59	4.69
Rubber & Plastic	8.99	10.40	1.63
Leather	1.55	0.63	2.34
Textiles	6.22	8.96	-1.65
Knitting & Clothing	4.29	5.19	1.42
Paper & Allied Prod.	3.97	4.41	0.68
Printing & Publishing	3.84	4.47	3.22
Petroleum & Coal Prod.	5.00	6.56	0.27
Chemicals & Chem. Prod.	6.04	6.43	1.31
Misc. Mfg.	4.87	5.07	3.22

Source: Based on the data from Statistics Canada (Industry Product Division)

Table 3

Average Annual Percentage Rate of Growth of Labour Productivity - Manufacturing Industries

	1957-66	1967-73	1974-76
Total Manufacturing	2.863	3.996	1.352
Total Durables	3.791	4.221	1.813
Wood	2.406	1.901	3.032
Furniture & Fixtures	2.626	2.847	.422
Iron & Steel	4.224	3.190	-1.623
Nonferrous Metal	4.769	1.524	-.983
Metal Fabricating	2.863	2.366	1.370
Machinery (except electrical machinery)	4.320	3.627	3.698
Nonauto Transportation Equipment	3.425	3.515	.317
Motor Vehicles (except Parts & (Accessories)	3.806	7.666	3.962
Motor Vehicles Parts & Access.	4.284	6.567	-1.430
Electrical Products	5.188	3.850	.176
Nonmetallic Mineral Products	2.142	3.437	.682
Total Nondurables	3.234	3.803	.893
Food & Beverages	2.410	2.722	1.603
Tobacco Products	5.033	4.275	5.202
Rubber & Plastic	7.202	5.688	2.914
Leather	1.697	2.393	4.292
Textiles	5.915	6.567	2.789
Knitting & Clothing	3.016	4.474	2.444
Paper & Allied Industries	3.347	3.474	-2.679
Printing, Publishing	1.588	2.848	1.005
Petroleum & Coal Products	6.132	5.406	-3.111
Chemicals & Chemical Products	5.076	5.649	-1.944
Miscellaneous Manufacturing	.957	2.580	2.570

Source Based on data from Statistics Canada.

considerably in all the manufacturing industries during the post-1973 period. Total output growth of the manufacturing industry has declined from an annual rate of 4% for the 1967-73 period to 1.41% per annum. An industry by industry analysis of output and labour productivity growth for the period 1966-73 and 1974 strongly suggests a positive relationship between output growth and labour productivity growth -- industries that have experienced considerable decline in productivity growth have also experienced dramatic reductions in output growth, i.e., iron and steel, nonferrous metals, electrical products, paper and allied products, petroleum and coal products, et cetera. Similarly, the industries for which the output growth has remained constant or increased did not experience any productivity slowdown, i.e., wood industries, machinery and equipment, tobacco products and leather products.

In summary, the developments in output and labour productivity growth for the last two decades strongly suggest that the lower output growth rates might have been partly responsible for the productivity slowdown in the post-1973 period. The results of Discussion Paper No. 134 did not reject the hypothesis of constant returns to scale for the manufacturing industries. This result in turn suggests that the output growth might affect labour productivity growth by changing the factor proportions. As pointed out earlier, nonhomotheticity will imply that output level per se would change factor proportions independent of factor prices. In Section III, we specify the factor share equations both with and without the assumption of homotheticity. The empirical results presented in Section IV strongly support the hypotheses of nonhomotheticity for all the manufacturing industries.

In Table 4, energy consumption in current dollars and energy intensity are recorded for all the 22 manufacturing industries for the year 1976. As seen from the table, nondurable manufacturing industries account for 60% of the total energy consumption in the manufacturing industry.

Energy intensity[2] varies considerably across the manufacturing industries -- from as low as 0.3% for motor vehicle industries to as high as 6.8% for the non-metallic mineral products. The following six manufacturing industries account for about 75% of total energy consumption of the manufacturing industry -- iron and steel, nonferrous metals, nonmetallic mineral products, food and beverages, paper and allied products and chemical and chemical products. Moreover, paper and allied industries alone account for 25% of manufacturing industries' energy consumption. This uneven distribution of energy consumption

Table 4

Energy Consumption by Two-Digit Manufacturing Industries - 1976

Industry	Total Energy Consumption ($ millions)	Percent of Total	Energy Intensity (per cent)
Total Mfg	2265.6	100.0	2.0
Durables - Total	920.8	40.6	1.7
Wood Industries	105.1	4.6	2.0
Furniture & Fixtures	14.0	0.1	0.9
Iron & Steel	197.4	8.7	4.3
Nonferrous Metal Industries	178.6	7.9	5.3
Metal Fabricating Industries	77.1	3.4	1.0
Machinery (ex.elec mach)	34.6	1.5	0.7
Motor Vehicle Industries (ex. parts & Acc)	35.8	1.6	0.3
Motor Vehicle parts & acc	38.8	1.7	1.2
Nonauto transportation equipment	24.9	1.1	1.1
Electrical Equip. Products	41.5	1.8	0.7
Nonmetallic mineral Products	214.4	9.4	6.8

(cont'd)

Table 4
(cont'd)

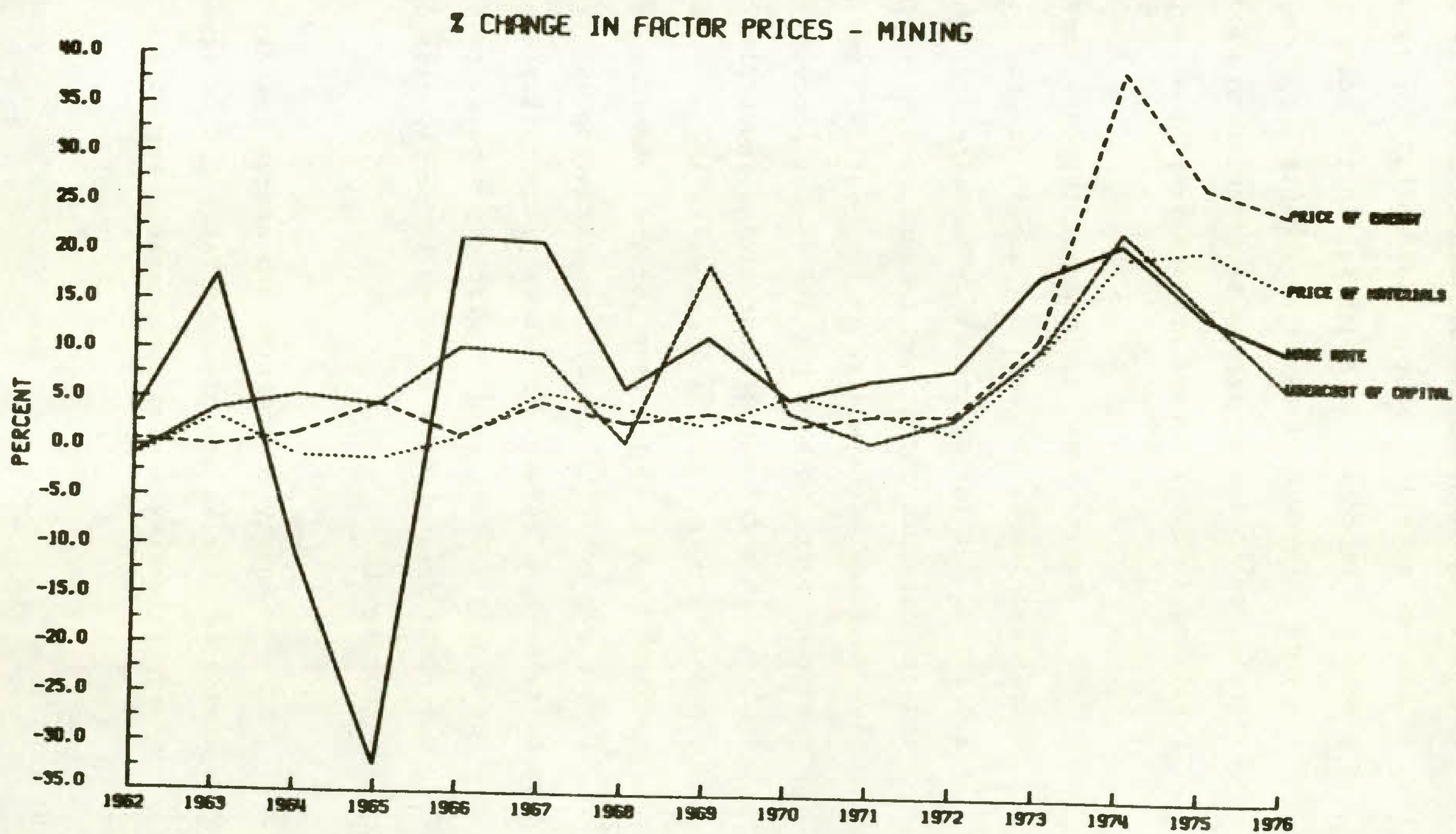
Industry	Total Energy Consumption ($ millions)	Per cent of Total	Energy Intensity (per cent)
Nondurables - total	1344.8	59.4	2.3
Food & Beverage Industries	231.4	10.2	1.2
Tobacco Products	4.2	0.0	0.5
Rubber & Plastic Products	45.0	2.0	1.7
Leather Industries	5.7	0.0	0.7
Textile Industries	57.9	2.6	2.0
Knitting & Clothing	16.4	0.1	0.5
Paper & Allied Products	571.7	25.2	6.4
Printing & Publishing	19.3	0.1	0.6
Petroleum and coal Products	65.5	2.9	1.0
Chemical and Chemical Products	325.5	14.4	4.8
Miscellaneous Mfg Industries	19.1	0.1	0.7

strongly suggests that the substitution or complementarity relationships between energy and other factors of production, found by earlier researchers for the total manufacturing industry, are subject to serious aggregation bias and might lead to misleading conclusions.[3] For example, the question of complementarity between energy and capital inputs should be tested mainly in the above energy intensive industries.

Mining Industries

As seen from Table 1 and Chart 4, the relative changes in factor prices for the mining industries are quite similar to the developments in manufacturing industry-- in the first two subperiods the increases in the price of labour are much bigger than the increases in the other input prices and this pattern is reversed in the post-1973 period. In the period 1967-73, price of labour, capital materials and energy have increased at an annual rate of 11.2%, 7%, 4.8%, and 5% respectively. As in the manufacturing industry all the four factor prices for the mining industry have increased dramatically during the post-1973 period and the increases in the price of labour are lower than the increases in other input prices -- labour, capital, materials and energy input prices have increased at an annual rate of 16%, 15%, 31%, and 20% respectively.

CHART 4


% CHANGE IN FACTOR PRICES - MINING
PERCENT
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
PRICE OF ENERGY
PRICE OF MATERIALS
WAGE RATE
USERCOST OF CAPITAL

In summary, in the first two subperiods, all things being equal, one would expect the entrepreneurs to substitute material, energy and capital for labour in the production process. In contrast, in the post-1973 period, the rate of growth of materials, capital and energy inputs in relation to labour inputs is expected to slowdown resulting in lower labour productivity growth.

Tables 5 and 6 summarise the developments in output and labour productivity growth for the four mining industries for the period 1962-76. Like the manufacturing industries, both output and labour productivity growth rates have declined dramatically in the post-1973 period. As a matter of fact, both output and labour productivity have declined in three out of four mining industries -- mining industry's output has declined at an annual rate of 3.5% compared to a 7.6% increase for the 1966-73. Similarly the labour productivity has declined at an annual rate of 5.6%. In summation, output and labour productivity developments of the mining industries also strongly suggest that the post-1973 productivity slowdown is partly caused by low output growth.

Energy consumption and energy intensities for the mining industries are given in Table 7. As expected the energy intensity varies considerably across the mining

Table 5

Average Annual Percent Growth in Gross Output
(mining industry)

Industry	1962-1966	1967-73	1974-1976
Total Mining Industry	5.32	7.55	-3.41
Coal	7.44	11.78	7.85
Crude petroleum, natural gas & service incidental to mining	7.34	11.62	-6.34
Metal Mining	4.14	5.76	-2.87
Nonmetal Mining	5.64	5.35	0.71

Source: Based on the data from Statistics Canada (Input-Output Division)

Table 6

Average Annual Percentage Rate of Growth of labour Productivity Mining Industries

Industry	1957-66	1967-73	1974-76
Total Mining	7.231	7.041	-5.64
Coal Mining	3.810	17.134	-0.108
Crude Petroleum natural gas & services incidental to mining	8.775	7.493	-8.725
Metal Mining	5.446	6.157	-3.705
Nonmetal mining (except coal)	7.213	5.192	-1.437

Table 7

Energy Consumption for the Mining Industries - 1976

Industry	Energy Consumption ($ millions)	Percent of Total	Energy Intensity (per cent)
Total Mining	440.2	100.0	3.0
Coal Mining	15.5	3.5	2.9
Crude Petroleum, Natural gas & Services incidental to mining	90.5	20.5	1.2
Metal Mining	231.8	52.7	5.6
Nonmetal Mining	102.4	23.3	4.5

industries -- as low as 1.2% for crude petroleum products industries to as high as 5.6% for the metal mining industry. Metal mining industry accounts for about 53% of total energy consumption of the mining industry. However, the energy consumption share is more or less equal to the output share. This, in turn suggests, compared to the manufacturing industry, that the aggregate relationship between energy and other factors of production for the mining industry will not be seriously affected by the aggregation bias.

Transportation Industries

As seen from Table 1 and Chart 5, the relative changes in factor prices for the transportation industry are quite similar to the price developments in manufacturing and mining industries -- in the first two subperiods, the increases in the price of labour are bigger than the increases in other input prices and the reverse is true in the post-1973 period. These results also strongly suggest that the post-1973 productivity slowdown might have been partly caused by changes in relative prices of factor inputs.

The output growth pattern of transportation industries over the last two decades is quite similar to that of mining and manufacturing industries (see Table 8).

chart 5

% CHANGE IN FACTOR PRICES - TRANSPORTATION

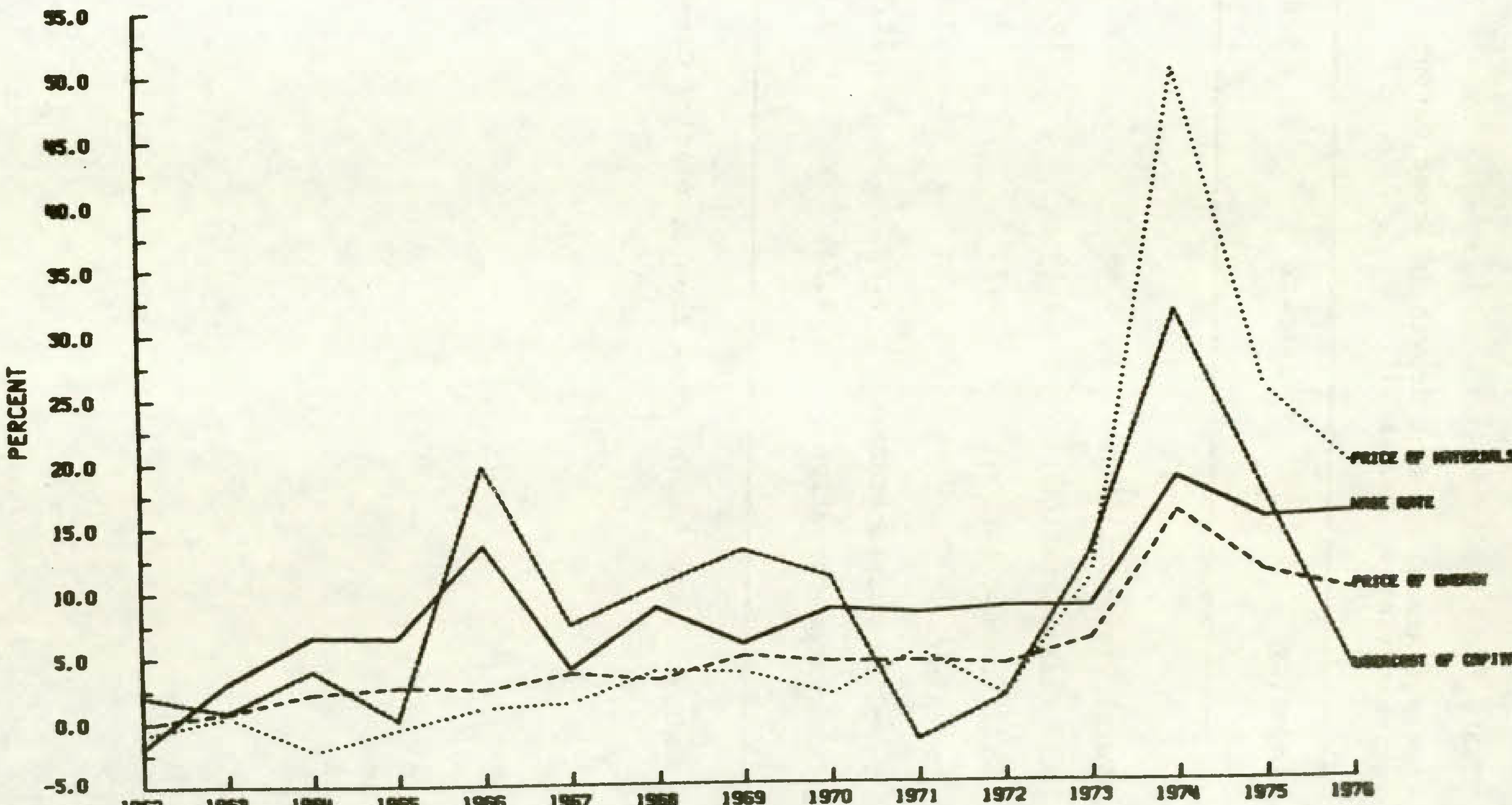


Table 8

Average Annual Percent Growth in Gross Output
(transportation industry)

Industry	1962-66	1967-73	1974-76
Total Transportation	5.69	6.39	0.88
Air Transportation	8.58	10.10	4.29
Rail Transportation	4.56	3.92	1.44
Trucking	6.17	7.83	-1.67
Pipeline Transportation	9.89	15.91	-4.22
Other Transportation	4.54	3.61	3.70

Source: Based on the data from Statistics Canada (Input-Output Division)

Output growth of all the five transportation industries has declined considerably in the post-1973 period, and moreover the output of trucking and pipeline industries has actually declined during this period.

In Table 9 energy consumption and energy intensity data for the transportation industry are recorded. As expected, the energy intensity of transportation industries is bigger than the other two industries -- manufacturing and mining industries. Energy intensity varies from a low of 5.5% for rail transportation to a high of 10.4% for air transportation. This uneven distribution of energy consumption among the transportation industries might result in serious aggregation bias of the aggregate relationships between energy and other factors of production.

In summary, the development in factor prices, output and labour productivity growth for mining, manufacturing and transportation industries clearly suggest that the recent productivity slowdown is mainly caused by relative changes in factor prices and low output growth caused by reductions in the growth rate of aggregate demand. Data on the distribution of energy consumption for these industries imply that the aggregate relationship between energy and other inputs will seriously suffer from aggregation bias.

Table 9

Energy Consumption - Transportation Industries - 1976

Industry	Total Energy Consumption ($Millions)	Percent of Total	Energy Intensity
Air Transportation	226.6	21.9	10.4
Rail Transportation	172.7	16.7	5.5
Trucking	279.5	27.0	7.1
Pipeline	92.0	8.9	8.6
Other Transportation	264.7	25.6	6.6
Total Transportation	1035.4	100.0	7.2

III Theoretical and Empirical Model

In the last section, we have analyzed the developments in factor prices and output and labour productivity growth over the last two decades in the mining, manufacturing and transportation industries. The major qualitative conclusion of our analysis is that the recent developments in relative factor prices and output growth have significantly contributed to the post-1973 labour productivity slowdown by changing factor proportions. In this section, we will present factor share equations, based on the principles of duality developed by Samuelson (1947), Shephard (1953), Uzawa (1962) and Diewert (1971). Our objective is to estimate substitution elasticities among the four factors of production from the cost minimizing factor demand equations.[4] For each industry we estimate factor demand equations with and without the assumption of homotheticity.

We assume that there exists a production function for each industry, summarising the underlying technology.

$$Q_i = F_i(K_i, L_i, E_i, M_i) \tag{1.1}$$

Q_i = gross output of the ith industry

K_i = capital input of the ith industry

L_i = labour input of the ith industry

and

M_i = material input of the ith industry

If factor prices and output levels are exogenously determined the theory of duality between cost and production implies that given cost-minimizing behaviour, the production structure given in (1.1) can be uniquely represented by a cost function of the form

$$C_i = g_i(P_{Ki}, P_{Li}, P_{Ei}, P_{Mi}, Q_i) \tag{1.2}$$

where

C_i = total cost of the ith industry

and P_{Ki} , P_{Li} , P_{Ei} , and P_{Mi} are the prices of capital labour,energy, and material inputs for the ith industry.

In order to estimate the substitution elasticities, we must specify a parametric form of equation (1.2).[11] For this purpose, a transcendental logarithmic (translog) form proposed originally by Christensen, Jorgenson and Lau (1970), seems quite useful for three reasons.[5] First, it may be regarded as a general second-order approximation to any arbitrary cost function. Second, it enables direct estimation of substitution elasticities and own and cross-price elasticities, and permits tests of their statistical significance. Finally, it requires no restrictions either on their values or constancy.

A translog functional form of the equation (1.2) can be written

$$\ln C = \alpha_0 + \alpha_Q \ln Q + 1/2\alpha_{QQ}(\ln Q)^2 + \sum_{i=1}^{4} \alpha_i \ln P_i + \sum_{j=1}^{4} \sum_{j=1}^{4} \gamma_{ij} \ln P_i \ln P_j + \sum_{i=1}^{4} \gamma_{Qi} \ln Q \ln P_i + \lambda t \qquad (1.3)$$

where

$i,j =$ K,L,E,M

The underlying production structure in (1.3) is homothetic and is $\gamma_{Qi} = 0$ for all i.
It is linear homogeneous if $\gamma_{Qi} = \alpha_{QQ} = 0$ and $\alpha_Q = 1$
As pointed out ealier, if the production function is homothetic, factor proportions depend only on the factor-price ratio (the slope of the isocost curve), and in particular factor proportions are independent of the level

of output. In contrast, if the production function is nonhomothetic, pure scale changes would alter relative marginal products and thus affect factor proportions and relative shares independent of factor prices. Therefore, the expansion path will not be a straight line.

Shephard's lemma [(Diewert(1971)] implies $\partial C/\partial P_i = X_i$ the cost-minimizing quantity demanded of the ith input then,

$$\partial \ln C/\partial \ln P_i = P_i X_i / C = S_i^*, \text{ or}$$

$$S_i^* = \alpha_i + \sum_{j=1}^{4} \gamma_{ij} \ln P_j + \gamma_{Qi} \ln Q \qquad (1.4)$$

where

S_i^* is the ith input demand function in terms of cost share.

In order that the system of demand equations in (1.4) satisfy the adding up criterion ($\Sigma S_i = 1$) and the properties of a well-behaved production function the following parameter restrictions are required.[6]

$$\Sigma_i \alpha_i = 1,$$

$$\Sigma_i \gamma_{Ji} = \Sigma_j \gamma_{ij} = 0$$

$$\Sigma_i \gamma_{Qi} = 0, \qquad i,j = K,L,E,M$$

$$\text{and} \quad \gamma_{ij} = \gamma_{ji}, \quad i \neq j \qquad (1.5)$$

Empirical Model

Due to variations in input prices, employment and raw material contracts, capital in place, technical innovation and entrepreneurial inertia, one might expect factor proportions toward optimal combinations given in (1.4). Thus the observed factor shares (S_i) will have a disturbance term.

$$S_i = S_i^{*} + \varepsilon_i \quad \text{and}$$

$$\Sigma_i \varepsilon_i = 0 \tag{1.6}$$

where

ε_i is the disturbance from cost minimization. Substituting equations (1.6) into (1.5), we can write the four stochastic input demand functions as

$$S_k = \alpha_K + \gamma_{KK} \ln P_k + \gamma_{KL} \ln P_l$$

$$+ \gamma_{KE} \ln P_E + \gamma_{KM} \ln P_M$$

$$+ \gamma_{QK} \ln_Q + \varepsilon_K \tag{1.6a}$$

$$S_L = \alpha_L + \gamma_{LK} \ln P_K + \gamma_{LL} \ln P_L$$

$$+ \gamma_{LE} \ln P_E + \gamma_{LM} \ln P_M$$

$$+ \gamma_{QL} \ln Q + \varepsilon_L \qquad (1.6b)$$

$$S_E = \alpha_E + \gamma_{EK} \ln P_K + \gamma_{EL} \ln P_l$$

$$+ \gamma_{EE} \ln P_E + \gamma_{EM} \ln P_M$$

$$+ \gamma_{QE} \ln Q + \varepsilon_E \qquad (1.6c)$$

$$S_M = \alpha_M + \alpha_{MK} \ln P_K + \alpha_{ML} \ln P_L$$

$$+ \alpha_{ME} \ln P_E + \alpha_{MM} \ln P_M$$

$$+ \alpha_{QM} \ln P_M + \varepsilon_M \qquad (1.6d)$$

In equations (1.6a) - (1.6d) relative shares depend on factor prices and output. Changes in factor prices affect relative shares directly, as well as indirectly by inducing shifts in output mix. However, the factor share equations will not be affected by an uniform increase in factor prices (factor demand equations are homogeneous of degree zero in all factor prices). The presence of output level in share equations ensures nonhometheticity, unless $\gamma_{QK} = \gamma_{QL} = \gamma_{QM} = 0$ In the case of nonhometheticity, pure scale change would affect the factor proportions and relative shares independent of factor prices, by altering the relative marginal products. Such changes could be either "factor using or factor saving" of the ith input; hence there are no a priori expectations concerning the signs of γ_{QI}, however, the restriction $\Sigma_i \gamma_{Qi} = 0$ applies.

Linear homogenity in factor prices ($\Sigma\alpha_i = 1$, $\Sigma\alpha_{Qi} = 0$) and the symmetry restrictions $\gamma_{ij} = \gamma_{ji}$ for $i \neq j$, ensures that the parameters of any three equations identify exactly all the parameters of the system (over identification problem). Consequently we have to disregard one of the factor demand equations in estimating the parameters of the system.

Since, the data on capital share is derived residually, we choose to derive the parameters of capital share equation for each industry by making use of the restrictions in (1.5). Using the time-series data on factor prices, gross output in both current and constant dollars, we have estimated the factor share equations for the industries shown in Table 10.[7] For each industry, we have estimated the labour, materials and energy equations subject to the following six restrictions:

$$\alpha_{LE} = \alpha_{EL}$$
$$\alpha_{LM} = \alpha_{ML}$$
$$\alpha_{EM} = \alpha_{ME}$$
$$\alpha_{LL} + \alpha_{LK} + \alpha_{LE} + \alpha_{LM} = 0$$
$$\alpha_{ML} + \alpha_{MK} + \alpha_{ME} + \alpha_{MM} = 0$$
$$\alpha_{EL} + \alpha_{EK} + \alpha_{EE} + \alpha_{EM} = 0 \qquad (1.7)$$

The last three restrictions in (1.7) ensures that the remaining three symmetry conditions ($\alpha_{LK} = \alpha_{KL}$, $\alpha_{MK} = \alpha_{KM}$ and $\alpha_{EK} = \alpha_{KE}$) are satisfied. As mentioned above, the parameters of capital share equations are derived residually using, the restrictions given in (1.5). In summary, for only 18 of the 30 parameters, we can obtain independent estimates.

In estimating the model, we ignore error-term autocorrelation within equations, but account for error

Table 10

Listing of the Industries for Which Translog Functions are Estimated

Number	Description
1	Total Manufacturing
2	Total Durable Manufacturing
3	Wood
4	Furniture & Fixtures
5	Iron and Steel
6	Nonferrous Metals
7	Metal Fabricating
8	Machinery (ex. electrical machinery)
9	Nonauto Transportation Equipment
10	Motor Vehicle (ex parts & accessories)
11	Motor Vehicle Parts & Accessories
12	Electrical Products
13	Nonmetallic Mineral Products
14	Total Nondurable Manufacturing
15	Food Beverage
16	Tobacco Products
17	Rubber and Plastic Products
18	Leather
19	Textiles
20	Knitting & Clothing
21	Paper and Allied
22	Printing and Publishing
23	Petroleum and Coal Products
24	Chemical and Chemical Products
25	Miscellaneous Manufacturing
26	Total Mining
27	Coal Mining
28	Metal Mining
29	Crude Petroleum, Natural Gas and Services Incidental to Mining
30	Nonmetal Mining (except coal)
31	Total Transportation
32	Air Transportation
33	Rail Transportation
34	Trucking
35	Pipeline Transportation
36	Other Transportation

correlation across equations. We use iterative Zellner's estimation procedure, which (under assumptions of no hetroscedensticity and autocorrelation within equations) is equivalent to full information maximum - likelihood estimation.

In an effort to compare and contrast our results on substitution elasticities with the findings of other researchers both in Canada and in other countries, for each industry we have estimated the factor share equations with and without the assumption of homotheticity. This would also provide an estimate of the bias in substitution elasticities, if one arbitrarily imposes the assumption of homotheticity on the production structure.[8]

Two commonly used measures of price responsiveness are the Allen-Uzawa partial elasticities of substitution (σ_{ij}) and the price elasticity of demand (ε_{ij}). It can be shown [Berndt and Wood (1975)] for translog function these measures can be calculated as:

$$\sigma_{ij} = (\alpha_{ij} / S_i S_j) + 1 \qquad (1.8)$$

$$i, j = K,L,E,M; \quad i \neq j$$

$$\sigma_{ij} = (\alpha_{ii} + S_i^2 - S_i) / S_i^2$$

$$i = K, L, E, M \qquad (1.9)$$

$$\varepsilon_{ii} = S_i \quad \sigma_{ii} \tag{1.10}$$

$$\varepsilon_{ij} = S_j \quad \sigma_{ij} \tag{1.11}$$

These elasticities generally vary over time with the values of relative input shares, as shown by equations in (1.8 - 1.11). Hence, the standard errors for their estimates cannot be calculated exactly. However, if one treats the mean values of the relative shares as constants, the asymptotic variance of the estimated substitution and price elasticities can be estimated as

$$\text{asym var}\ (\sigma_{ij}) = (1/\bar{S}_i\bar{S}_J)^2\ \text{asym var}\ (\alpha_{ij}) \quad , \ i,j = K,L,E,M \quad i \neq j \tag{1.12}$$

$$\text{asym var}\ (\sigma_{ij}) = (1/\bar{S}_i)^4\ \text{asym var}\ (\alpha_{ii}) \quad , \ i = K,L,E,M \tag{1.13}$$

$$\text{asym var}\ (\varepsilon_{ij}) = \text{asym var}\ (\alpha_{ij})/\bar{S}_i^2 \tag{1.14}$$

$$\text{asym var}\ (\varepsilon_{ii}) = \text{asym var}\ (\alpha_{ii})/\bar{S}_i^2 \tag{1.15}$$

where $\bar{S}_i$ and $\bar{S}_j$ are simple mean values of input shares.

IV Empirical Results

In this section, we will analyze the empirical results of the model presented in Section III, for each industry are given in Table 10. For each industry, the estimates of translog coefficients substitution elasticities, own and cross-price elasticities, are recorded for both Models I and II.[9] In Model I, the assumption of homotheticity is imposed on the production structure. Consequently, factor proportions are determined solely by factor prices. In contrast, in Model II, factor shares are determined by both factor prices and output level (nonhomotheticity).

The empirical results are interesting for several reasons. First, in all the industries our results reject the assumption of homotheticity decisively. Second, for almost all the industries, own price elasticities of the four factors of production are negative and statistically significant. Third, as expected, with the exception of capital, own-price elasticities in most of the industries are below unity, and moreover the energy and material elasticities are quite small. Finally, our results show significant substitution among all the four factors of production. This in turn suggests that the productivity analysis should be carried out in terms of gross output at the industry level and the use of net output will result in biased estimates of total factor productivity.

Manufacturing Industries

First, we will discuss the empirical results of total manufacturing industry. Here, we will compare and contrast our estimates of substitution and price elasticities with the findings of other researchers for Canada and other industrial economies. Next, we will discuss the empirical results for all the 22 manufacturing industries, with a special emphasis on the energy intensive industries.

The empirical results for the total manufacturing industries are recorded in Table 11. As seen from the estimates of translog coefficients of Model I and II, our results strongly support the hypothesis of non-homotheticity -- the coefficients of output variables in factor share equations are highly significant. Our results strongly suggest that in period of strong output growth, entrepreneurs of the manufacturing industry substitute materials and energy for the primary input and vice versa, independent of factor prices.[10]

Table 11

Estimates of Translog coefficients, elasticity of substitution and own and cross-price elasticities (1975 values) - Total Manufacturing

Variable	α_{iJ} Model I	α_{iJ} Model II	σ_{iJ} Model I	σ_{iJ} Model II	ε_{iJ} Model I	ε_{iJ} Model II
KK	-0.0431	-0.0391	-15.140	-15.238	-1.378	-1.386
KL	0.0474	0.0348	3.463	2.809	0.737	0.593
	(2.68)	(4.60)	(3.76)	(7.13)	(8.73)	(16.57)
KE	0.0004	0.0038	1.246	3.416	0.021	0.0589
	(0.21)	(3.31)	(1.06)	(4.68)	(0.20)	(0.89)
KM	-0.0051	0.0049	0.918	1.079	0.625	0.734
	(1.04)	(1.00)	(11.62)	(15.60)	(86.92)	(101.69)
LL	-0.1083	0.0221	-6.161	-3.240	-1.302	-0.684
	(5.86)	(2.53)	(14.88)	(16.60)	(14.88)	(16.60)
LE	-0.0056	-0.0131	-0.542	-2.609	-0.0093	-0.045
	(2.89)	(6.86)	(1.01)	(4.96)	(0.08)	(0.40)
LM	0.0666	-0.0437	1.463	0.696	0.996	0.474
	(12.36)	(7.12)	(39.04)	(16.31)	(125.74)	(52.55)
EE	0.0119	0.0099	-16.848	-23.661	-0.290	-0.408
	(11.14)	(9.51)	(4.67)	(6.75)	(4.68)	(6.75)
EM	-0.0067	-0.0006	0.428	0.952	0.292	0.648
	(4.45)	(0.29)	(3.34)	(5.92)	(131.78)	(233.76)
MM	-0.0548	0.0394	-0.588	-0.384	-0.400	-0.262
	(17.15)	(6.69)	(85.15)	(30.28)	(85.15)	(30.29)
KQ	-	-0.0063				
LQ	-	-0.0551				
		(16.10)				
MQ	-	0.0582				
		(20.89)				
EQ	-	0.0032				
		(4.03)				

Moreover the sum of the coefficients of output variable in labour and material shares equations is almost equal to zero. This in turn implies that part of the post-1973 slowdown in material-labour ratio reported in Discussion Paper 134 is caused by reductions in output growth, caused by slowdown in aggregate demand in most of the industrial countries.

As seen from Table 11, factor shares are significantly influenced by variations in relative factor prices, and the signs and significance of substitution and price elasticities are fairly roboust for both the models. However, our results show that the assumption of homotheticity will result in an upward bias of these price elasticities: own price elasticity of labour and materials and the cross-price elasticity between materials and labour. As expected, all the own price elasticities are negative and statistically significant. However, with the exception of capital elasticity, all the elasticities are below unity and moreover the energy and material elasticities are quite small. Our results show that there is a significant substitution between capital and the other three inputs (labour, energy, and materials), in response to changes in relative prices. Similarly, labour and energy inputs are good substitutes for materials. Our results suggest that labour and energy are complimentary in the production process of manufacturing industry.

In summary, our empirical results suggest that in the manufacturing industry, factor proportions are significantly influenced by variations in both relative prices and output growth. Using the estimated parameters of the labour share equation, the time path of manufacturing industry's labour productivity is simulated over the sample period. As seen from Chart 6, the estimated equation does catch most of the turning points in labour productivity. However, our equation slightly over predicts the productivity down turn in 1974, but by 1975, the actual and estimated labour productivity levels are almost identical. This in turn suggests that our equation does not capture that well the movements in labour productivity to a sudden shock in factor prices in the very short-run, but over the medium run it does very well.

Table 12 compares the own-price elasticities of this study with the findings of other researchers for both the Canadian and U.S. manufacturing industry. Our estimates of own-price elasticities closely agree with that of MacRae(1979) for Ontario, and Fuss (1977).

In all the three studies, capital price elasticity is bigger than the elasticity of labour, energy, and

CHART 6

LABOUR PRODUCTIVITY - TOTAL MANUFACTURING

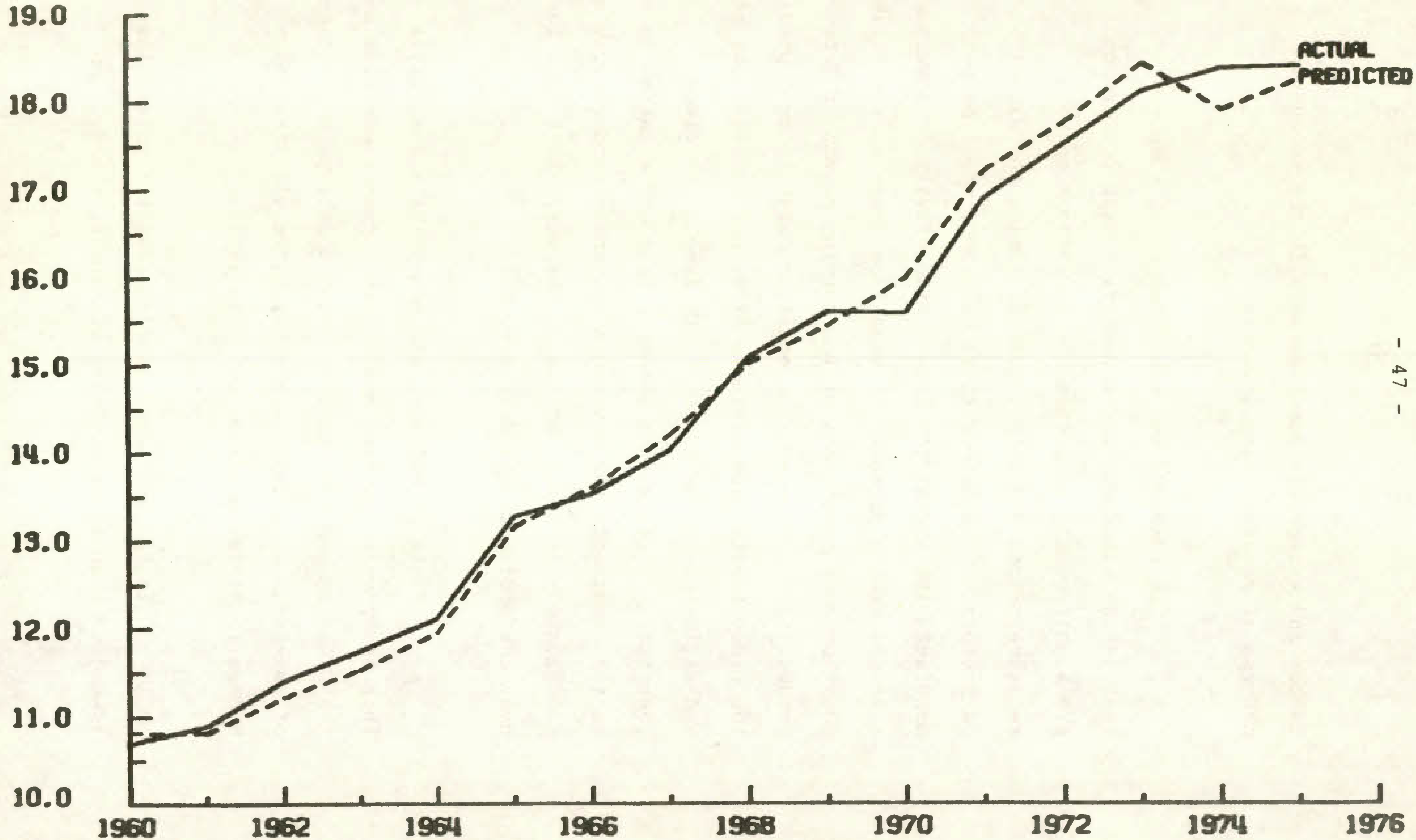


Table 12

Comparison of own and cross-price elasticities - Total Manufacturing

	This Study	McRae (Ontario)	Fuss (Canada)	Berndt and Others - U.S. Mfg (translog)
KK	-1.39	-1.06	-0.76	-0.36
LL	-0.68	-0.20	-0.49	-0.75
EE	-0.41	-0.64	-0.49	0.20
MM	-0.26	-0.23	-0.36	-0.35

materials and both energy and materials elasticities are quite small. The results for U.S. manufacturing given in Berndt and others (1979) are somewhat different from its Canadian counterpart -- capital elasticity is quite small and the own-price elasticity of energy is positive.

In Table 13, substitution elasticities among the four factors of production for the Canadian manufacturing industry are compared with their counterparts in U.S., West Germany and Japan. In all the four countries, there is a significant substitution between capital and the other three inputs. Similarly, material inputs are substituted for labour and energy in the production process. However, the capital-labour and capital-energy substitution elasticities are fairly big compared to the other countries. Energy and labour inputs are complementary in the production process of Canadian manufacturing industry. In contrast, energy and labour are substitutes in the other countries.[11]

In summation, our results suggest that the post-1973 labour productivity slowdown in the manufacturing industry is mostly caused by the developments in factor prices and in output growth -- bigger increases in the prices of nonlabour inputs and reduction in output growth have reduced labour productivity growth by increasing the

Table 13

International Comparison of Elasticities of Substitution - Total Manufacturing

	United States	West Germany	Japan	Canada (Model I)	Canada (Model II)
σ_{KL}	1.08	1.06	1.14	3.46	2.81
σ_{KE}	1.22	1.15	1.18	1.25	3.42
σ_{KM}	0.85	0.88	0.88	0.92	1.08
σ_{LE}	1.03	1.04	1.05	-0.54	-2.61
σ_{LM}	1.00	1.00	1.00	1.46	0.70
σ_{EM}	0.58	0.42	0.65	0.43	0.95

Source: For countries other than Canada, estimates are taken from Ozatalay, Grubaugh and Veach Long (1979) labour input in relation to the other inputs (especially the material inputs).

Durable Manufacturing Industries

The empirical results for the total durable manufacturing industries are given in Table 14. Like the total manufacturing industry, the assumption of homotheticity is also rejected for the durable manufacturing industries. All the four own-price elasticities are negative and statistically significant. With the exception of capital, all the price elasticities are less than one, Here too, the imposition of homotheticity assumption results in biased (upward) estimates of own-price elasticities for labour and material, and the substitution elasticity between labour and materials. Our results suggest that materials are significant substitutes for labour and capital. In contrast to the total manufacturing industry results, labour and energy are significant substitutes in the production process of durable manufacturing industries. The substitution elasticities between energy and capital, capital and labour, and energy and materials are not significantly different from zero.

In summation, our results suggest that factor proportions of the durable manufacturing industry are also

Table 14

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})
Durable Manufacturing INdustries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0123	-0.0140	-11.8090	-12.030	-1.0489	-1.06850
KL	-0.0205 (0.68)	-0.0247 (2.26)	-0.0073 (0.05)	-0.2148 (0.40)	-0.0016 (0.01)	-0.0493 (1.04)
KE	-0.0008 (0.31)	-0.0012 (1.35)	0.4026 (0.21)	0.0951 (0.14)	0.0063 (0.04)	0.0015 (0.03)
KM	0.0336 (3.99)	0.0399 (5.67)	1.5677 (11.04)	1.6758 (14.10)	1.0442 (82.79)	1.1163 (105.50)
LL	-0.0269 (0.79)	0.0654 (5.47)	-3.8703 (5.96)	-2.1153 (9.32)	-0.8881 (5.96)	-0.4854 (9.32)
LE	-0.0043 (1.44)	0.0056 (4.10)	-0.2104 (0.25)	2.5614 (6.73)	-0.0033 (0.02)	0.0400 (0.46)
LM	0.0518 (5.18)	-0.0463 (5.34)	1.3392 (20.44)	0.6972 (12.30)	0.8920 (59.32)	0.4644 (35.70)
EE	0.0097 (7.61)	0.0071 (8.09)	-23.1700 (4.43)	-34.0790 (9.55)	-0.3623 (4.43)	-0.5329 (9.55)
EM	-0.0046 (2.33)	-0.0114 (6.33)	0.5627 (3.00)	-0.0950 (0.54)	0.3748 (127.80)	-0.0633 (23.40)
MM	-0.0809 (15.65)	0.0177 (1.78)	-0.6830 (58.64)	-0.4614 (20.67)	-0.4550 (58.64)	-0.3073 (20.67)
KQ		0.0206				
LQ		-0.0595 (13.44)				
MQ		0.0451 (10.13)				
EQ		-0.0062 (9.52)				

explained by the variatons in relative factor prices and output growth.

The empirical results on translog coefficients, substitution, and own and cross-price elasticities for the manufacturing industries are recorded in the appendix (Tables Al - All). As shown in Discussion Paper No. 134, there is a considerable variation in factor shares across durable manufactruing industries -- materials share in gross output vary from 51% for nonmetallic mineral products industry to as high as 83% for the motor vehicle parts and accessories industry. Similar variation is observed for other factor shares.

In all the durable industries, output level is a significant determinant of factor shares. With the exception of wood, metal fabricating, nonauto transportation equipment, motor vehicle parts and accessories, and electrical products, the sum of the output coefficients on labour and materials share equations is close to zero, and output level depresses the share of labour in all the durable manufacturing industries. In the other durable manufacturing industries the reduction in labour share (caused by increases in output level) is matched by increases in capital and material shares. These results decisively reject the hypothesis of homotheticity. This in turn suggests that pure scale changes would alter the labour productivity growth by changing factor proportions.

For all the industries, the estimates of own-price elasticities of all four factors of production are smaller for Model II (nonhomotheticity), compared to Model I results. This result is consistent with our findings of the aggregate relationships for total manufacturing and total durable manufacturing industries -- the imposition of homotheticity assumption biases the estimates of own-price elasticities upward.

With the exception of wood, furniture and fixtures, iron and steel industries, and motor vehicle industries, the own-price elasticities are negative (Model II results). In the case of wood, furniture and fixtures, and iron and steel industries, the own-price elasticity of energy has perverse (positive) sign. However, in all the three cases the coefficient is not significantly different from zero. The own-price elasticity of labour input has a perverse sign for the motor vehicle industry. In all the cases, own-price elasticities of material and energy inputs are quite small. The own-price elasticity of capital input is well above unity for wood, nonauto transportation equipment and electrical products industries

In seven out of eleven durable manufacturing industries, capital and labour are substitutes in the production process. The substitution elasticity is negative for the following four durable manufacturing industries: furniture and fixtures, iron and steel, motor vehicles parts and accessories, and motor vehicle industries. However, in all the fair cases, this substitution elasticity is only marginally significant.

The substitution elasticity between capital and energy is negative (complementarity) only for the iron and steel industries, and, moreover, it is far from significant.[12] Hence, our results for that durable manufacturing industries do not support the hypothesis of complementarity between energy and capital inputs.

For all the eleven industries, the substitution elasticity between capital and material is positive and is highly significant in seven cases. This in turn suggests that materials and capital are good substitutes in the production process of durable manufacturing industries.

Our results also show that labour and materials are good substitutes (Model II results) -- only in three cases is the substitution elasticity negative and moreover it is not significantly different from zero in any of these industries (metal fabricating, motor vehicles, and nonmetallic mineral products).

In none of the eleven durable industries is the substitution elasticity between energy and labour negative and statistically significant. In general, our results indicate substitution between energy and labour input for these industries.

For a majority of the durable manufacturing industries our results indicate complementarity between energy and material inputs -- only in the case of motor vehicle industries is the substitution elasticity negative and significant.

In summary, the results of the individual durable manufacturing industries also strongly reject the hypothesis of homotheticity and factor proportions are significantly influenced by changes in relative factor prices.

Nondurable Manufacturing Industries

The empirical results for the total nondurable manufacturing industry are given in Table 15. Here too, output level has a significant effect on all the four factor shares, and the sum of the coefficients in labour and

Table 15

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})
Nondurable Manufacturing Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0349	-0.0096	-12.2590	-9.800	-1.2427	-0.9935
KL	0.0353 (2.11)	0.0071 (1.02)	2.8689 (3.24)	1.3783 (3.71)	0.5350 (5.96)	0.2570 (6.82)
KE	0.0053 (4.18)	0.0046 (3.33)	3.7997 (5.68)	3.4174 (4.71)	0.0710 (1.04)	0.0639 (0.87)
KM	-0.0057 (1.11)	-0.0021 (0.35)	0.9183 (12.51)	0.9699 (11.32)	0.6368 (85.60)	0.6726 (77.46)
LL	-0.0633 (3.90)	0.1076 (11.71)	-6.1844 (13.25)	-1.2692 (4.80)	-1.1532 (13.25)	-0.2367 (4.80)
LE	-0.0056 (4.28)	-0.0107 (5.03)	-0.5958 (1.60)	-2.0690 (3.39)	-0.0110 (0.16)	-0.0387 (0.34)
LM	0.0336 (7.47)	-0.1040 (18.55)	1.2596 (36.25)	0.1955 (4.51)	0.8735 (134.83)	0.1356 (16.77)
EE	0.0075 (5.42)	0.0056 (3.98)	-31.1390 (3.19)	-36.5590 (6.57)	-0.5819 (7.90)	-0.6831 (9.11)
EM	-0.0072 (3.99)	0.0005 (0.26)	0.4438 (3.19)	1.0418 (6.57)	0.3078 (118.29)	0.7225 (243.74)
MM	-0.0206 (6.32)	0.1056 (18.60)	-0.4849 (71.46)	-0.2224 (18.84)	-0.3363 (71.46)	-0.1543 (18.84)
KQ		-0.0277				
LQ		-0.0815 (18.02)				
MQ		0.1053 (26.98)				
EQ		0.0039 (3.50)				

materials share is close to zero. This in turn suggests, that during periods of high output growth firms will substitute materials for labour, independent of factor prices.

Like the durable manufacturing industry, all the own-price elasticities are negative and statistically significant, and with the exception of capital elasticity, these elasticities are well below unity. However, the magnitude of energy own-price elasticity for the non-durable manufacturing industry is slightly bigger than the durable manufacturing industry elasticity.

As in the durable manufacturing industry, capital is a good substitute for labour, energy and materials in the production process of nondurable manufacturing industry.

Similarly, materials are good substitutes for both labour and energy. In contrast to the durable industry, the substitution elasticity between energy and labour is negative and statistically significant. This in turn implies that labour and energy inputs are complimentary in the production process of nondurable manufacturing industry.[13]

The estimates for translog coefficients and substitution and price elasticites for the individual nondurable manufacturing industries are recorded in Tables A12 through A22. In all the eleven industries, the homotheticity assumption is again rejected -- output level affects factor proportions independent of factor prices. With the exception of tobacco products and leather industries, in all the nondurable manufacturing industries, output-growth increases the material-labour ratio growth, independent of factor prices.

For most of the industries, the own-price elasticities of four factors of production are negative and significant. Only in the case of leather industries, the capital elasticity is positive. Similarily, for this industry own-price elasticity of materials is positive and significant. We might also note, that these results are independent of the homotheticity assumption.[14] As mentioned earlier, paper and allied industry accounts for about 25% of the total energy consumption of the manufacturing industry. As seen from Table A18, for this industry own-price elasticity of energy is positive and is significant at 95% confidence level. (Model II results) However, if we impose the homotheticity assumption, the own-price elasticity is not only negative but also highly significant. This in turn suggests that the output growth of this industry will significantly increase the energy intensity, independent of energy prices and the energy prices will have slight perverse effect on the energy consumption of this industry.

In almost half of the nondurable manufacturing industries, the substitution elasticity between capital and labour is negative (complementarity), but is significant or close to significant only for the two industries: textiles, and rubber and plastic products. However, for most the major nondurable industries substitution elasticity is positive. This is consistent with our finding of significant substitution between labour and capital for the total nondurable manufacturing industry.

Our results for the individual nondurable manufacturing industries also suggests that capital and energy are substitutes. Only for rubber and plastic products, and chemical and chemical products is the substitution elasticity between capital and energy negative and significant (complementarity).

With the exception of leather indutries, capital and materials are good substitutes in all the nondurable manufacturing industries.

Like the durables, for most of the nonmanufacturing industries, our results indicate substitution between materials and labour, in response to changes in their prices. Only for petroleum and coal products is this substitution elasticity negative and significant.

With the exception of printing and publishing, the substitution of elasticity between labour and energy is positive in all the nondurable manufacturing industries. This is in sharp contrast with the findings for the total non-durable manufacturing industry. This in turn supports the hypothesis of substitution between labour and energy for both durable and nondurable manufacturing industries.

The results of individual nondurable industries for the substitution elasticity between materials and energy are also in sharp contrast to the aggregate results -- the results of individual industries suggest that materials and energy are complements in the production process of nondurable manufacturing industries.

In summary, our results for both the durable and nondurable industries show that factor proportions are significantly influenced by changes in relative factor prices and output growth. Due to the uneven distribution of energy among the manufacturing industries, the substitution of elasticities between energy and other factor inputs based on aggregate data are not reliable and the consistency of these aggregate relationships with the findings based on individual industries should be checked.

Mining Industries

Empirical results for the total mining industry are recorded in Table 16. As in the manufacturing industries, the assumption of homotheticity is also rejected for the total manufacturing industry. Here too, the sum of output coefficients in labour and material shares is close to zero -- our results imply that the increase in output level will increase the material-labour ratio independent of factor prices, and vice-versa. The estimates of substitution and own-price elasticities are biased upward for Model I (assumption of homotheticity). This result is consistent with our findings for the manufacturing industries.

All the four own-price elasticities are negative, but the materials price elasticity is not significant.

Our results show that capital is a substitute for all the other three inputs (labour, energy and materials):

Table 16

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})
Total Mining Industries

Variable	α_{iJ} Model I	α_{iJ} Model II	σ_{iJ} Model I	σ_{iJ} Model II	ε_{iJ} Model I	ε_{iJ} Model II
KK	-0.0303	-0.0111	-1.5742	-1.4637	-0.6561	-0.6100
KL	0.0293 (1.19)	0.1242 (5.80)	1.4080 (4.11)	2.7275 (9.15)	0.2429 (1.70)	0.4706 (3.79)
KE	-0.0053 (1.92)	-0.0051 (1.35)	0.5482 (2.32)	0.5686 (1.78)	0.0155 (0.16)	0.0160 (0.12)
KM	0.0063 (0.18)	-0.1080 (2.80)	1.0396 (4.64)	0.3225 (1.33)	0.3977 (4.26)	0.1234 (1.22)
LL	-0.0032 (0.19)	-0.0282 (1.86)	-4.9028 (8.48)	-5.7429 (11.30)	-0.8459 (8.48)	-0.9909 (11.30)
LE	-0.0032 (1.98)	-0.0070 (4.53)	0.3366 (1.01)	-0.4372 (1.38)	0.0095 (0.16)	-0.0123 (0.22)
LM	-0.0229 (1.35)	-0.0890 (5.44)	0.6527 (2.55)	-0.3489 (1.41)	0.2497 (5.64)	-0.1335 (3.12)
EE	0.0221 (11.25)	0.0167 (3.06)	-6.6360 (2.69)	-13.4200 (1.95)	-0.1873 (2.69)	-0.3787 (1.95)
EM	-0.0136 (5.40)	-0.0047 (1.60)	-0.2596 (1.11)	0.5677 (2.10)	-0.0993 (15.10)	0.2171 (28.44)
MM	0.0302 (1.10)	0.2017 (6.17)	-1.4080 (7.40)	-0.2359 (1.06)	-0.5386 (7.40)	-0.0902 (1.06)
KQ		-0.0288				
LQ		-0.0997 (10.43)				
MQ		0.1270 (7.39)				
EQ		0.0015 (0.69)				

in the case of the aggregate mining industry the substitution elasticity between labour and energy and labour and materials are negative (implying complementarity) but both of them are not significant even at 95% confidence. Our results imply that energy and materials are substitutes in the production process of mining industries. These results are in sharp contrast with our findings for the manufacturing industries. However, it should be pointed out that these results are not roboust in the two models (inclusion of output variable in the share equation has changed the sign for σ_{LE}, σ_{LM}, and σ_{EM}).

The results for the individual mining industries are recorded in Tables A23 through A26. In all the four mining industries, the assumption of homotheticity is rejected. In contrast to the manufacturing industries and other mining industries, the output level increases the labour share and reduces the material share for the coal mining industry. In the metal mining industry, output level reduces the share material and labour inputs and increases the share capital independent of factor prices. In the other two mining industries, output level increases the share of intermediate inputs and depresses the share of primary inputs.

In contrast to the aggregate relationship, own-price elasticity of energy input is positive in three of the four mining industries -- only for coal mining, the energy price elasticity is negative and significant. For both crude petroleum and natural gas, and nonmetal mining industries, the energy price elasticity is positive and significant at 95% confidence level.

Capital price elasticity is negative for all the four mining industries. Moreover, with the exception of crude petroleum and natural gas, capital elasticity is well above unity.

The own-price elasticity of labour is negative for three of the four mining industries (coal mining, metal mining and nonmetal mining). However, this elasticity is not significant for nonmetal mining industry. The own-price elasticity labour is positive for crude petroleum industry but it is not significantly different from zero.

With the exception of nonmetal mining industry, the materials price elasticity is negative and significant in all of the four mining industries.

Our results show that capital and labour are good substitutes for three of the four mining industries. Only for crude petroleum and natural gas mining industry, substitution elasticity between capital and labour is negative (complementarity). However, this coefficient is not significantly different from zero.

The substitution elasticity between energy and capital is negative and significant for coal mining and crude petroleum and natural gas mining industries -- implying complementarity between capital and energy inputs. For the remaining two industries, our results suggest that energy and capital inputs are good sustitutes in the production process.

With the exception of coal mining, the substitution elasticity between materials and capital stock is positive and significant in all the four mining industries.

Our results for the individual mining industries suggest that labour and materials are complementary in the production process. Similarly, labour and energy are also complements.

In three of the four mining industries, the substitution elasticity between energy and materials is negative and significant at least at 95% confidence level.

Only for the coal mining industry do our results suggest substitution between materials and energy inputs.

In summary, the results for the individual mining industries also reject the assumption of homotheticity. Our results suggest that the own-price elasticity of energy is slightly positive. Incidentally, this results is in sharp contrast with the results of the total mining industry. Our results show that in general capital is a good substitute for the other inputs (labour, materials, and energy). Our results imply that labour is a complement to both energy and materials in the production process of mining industries. Similarly, materials and energy inputs are complements.

Like the manufacturing industries, factor proportions of the mining industries are determined by both factor prices and output level -- an increase in output growth will change factor proportions in favour of intermediate inputs and the opposite is true in the case of reductions in output growth.

Transportation Industries

Table 17 gives the estimates of translog coefficients, substitution and own-price elasticities for the total transportation industry. The factor proportions

Table 17

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

<u>Transportation Industries - Total</u>

Variable	α_{iJ} Model I	α_{iJ} Model II	σ_{iJ} Model I	σ_{iJ} Model II	ε_{iJ} Model I	ε_{iJ} Model II
KK	-0.1514	-0.1587	-9.1290	-9.3569	-2.1124	-1.6954
KL	0.0524 (1.47)	0.0802 (2.66)	1.7274 (3.50)	2.1151 (5.05)	0.6861 (7.67)	0.8401 (11.06)
KE	-0.0044 (0.83)	-0.0145 (2.56)	0.6499 (1.54)	-0.1494 (0.33)	0.0451 (0.60)	-0.0104 (0.13)
KM	0.1034 (10.91)	0.0930 (5.96)	2.6206 (17.64)	2.4582 (9.60)	0.9229 (34.28)	0.8657 (18.66)
LL	-0.0938 (2.28)	0.0175 (0.45)	-2.1124 (8.11)	-1.4069 (5.66)	-0.8390 (8.11)	-0.5588 (5.66)
LE	0.0121 (1.93)	-0.0187 (2.68)	1.4378 (6.36)	0.3217 (1.27)	0.0999 (1.11)	0.0223 (0.22)
LM	0.0294 (2.93)	-0.0790 (2.96)	1.2101 (16.87)	0.4351 (2.28)	0.4262 (14.96)	0.1532 (2.02)
EE	0.0645 (32.33)	0.0730 (29.00)	-0.0185 (0.04)	1.7351 (3.33)	-0.0013 (0.04)	0.1205 (3.33)
EM	-0.0722 (34.30)	-0.0398 (7.68)	-1.9524 (22.72)	-0.6281 (2.96)	-0.6875 (115.16)	-0.2212 (15.03)
MM	-0.0606 (12.18)	0.0258 (1.11)	-2.3281 (58.04)	-1.6316 (8.73)	-0.8199 (58.04)	-0.5746 (8.73)
KQ		-0.0068				
LQ		-0.0836 (4.61)				
MQ		0.0655 (4.32)				
EQ		0.0249 (6.54)				

of this industry are also significantly affected by output and factor prices (nonhomotheticity). As in the manufacturing and mining industries, output growth reduces the share of primary inputs and vice versa.

With the exception of energy all the four own-price elasticities are negative.[12] In contrast to other inputs, energy price elasticity is not only positive but also significant.

Our results suggest that capital is a good substitute for all the other three inputs (except energy). The substitution elasticity between capital and energy is negative but not significant. Labour is also substitutable for materials and energy, and energy and materials are complements. All these findings are consistent wtih the substitution elasticities of manufacturing and mining industries.

The results for the individual transportation industries (air, rail, trucking, pipeline and other transportation) are given in Tables A27 through A31. In all the five cases, factor proportions are significantly a affected by the output variable (nonhomotheticity). Here, too the increases in output-growth reduces the share of primary inputs, and the opposite is true in the case of output slowdown.

For all the five industries (except pipeline) all the four own-price elasticities are negative. Even in the case of pipelines only the energy price elasticity is positive (See Table A30). This in turn suggests that the own-price elasticity of energy for the transportation industry is not positive as suggested by the aggregate equations.

The results of the individual industries support all the substitution elasticites (except σ_{KE}) derived from the aggregate equations -σ_{KL} , σ_{KM}, σ_{LE}, and σ_{LM} are positive, and σ_{EM} is negative. In contrast to the aggregate equation, the micro equations suggest that capital and energy are substitutes.

In summary, the results of the transportation industries also show that factor proportions are explained by variations in both output level and factor prices.

V Conclusions

The objective of this study has been to analyze the causes of variations in factor proportions over time, for manufacturing, mining, and transportation industries. For this purpose, we have estimated the four factor proportions (capital, labour, energy, and materials), based on the translog price possibility frontier approach first introduced by Christensen, Jorgensen and Lau.

For each industry, we have estimated the factor shares with and without the assumption of homotheticity. The following are some of the important findings of the present study.

1. For all the thirty-six industries studied, the homotheticity assumption is rejected. This implies that factor proportions are affected by output level, independent of factor prices.

2. In most of the industries, an increase in output growth reduces the share of primary inputs (primarily labour) and increases the share of intermediate inputs, and the opposite is true in the case of reduced output growth.

3. As seen from Table 18, with the exception of own-price elasticity of energy for the transportation industry, all the own-price elasticities of all the five major aggregate industries are negative and significant. Even in the case of transportation industry, the results of the component industries indicate a small negative price elasticity for the energy input.

In most cases, with the exception of capital, all the own price elasticites are below unity. Moreover, the energy and material price elasticites are quite small.

4. As seen from Table 19, in all the five aggregate industries, capital and labour are substitutes in the production process.

5. For all the five aggregate industries, our results imply that energy and capital are substitutes (see Table 19). Even in the case of energy intensive manufacturing industries, only in the cases of chemical and chemical products industry, the substitution elasticity between energy and materials is negative and significant (see Table 20).

Table 18

Comparison of Own Price Elasticities of Factors of Production (Based on Model II Results)

Industry	Variable			
	Capital	Labour	Energy	Materials
Total Manufacturing	-1.3860	-0.6840* (16.60)	-0.4080* (6.75)	-0.2620* (30.29)
Durables Manufacturing	-1.0685	-0.4854* (9.32)	-0.5329* (9.55)	-0.3070* (20.67)
Nondurables Manufacturing	-0.9935	-0.2367* (77.46)	-0.6831* (9.11)	-0.1543* (18.84)
Mining	-0.6100	-0.9909* (11.30)	-0.3787** (1.95)	-0.0902 (1.06)
Total Transportation	-1.6954	-0.5588* (5.66)	0.1205* (3.33)	-0.5746* (8.73)

* Significant at 99% confidence level

** Significant at 95% confidence level

Table 19

Substitution and Complementarity Relationship between Factors of Production (based on Model II Results) *

Variable	Industry				
	Total Mfg	Durables	Nondurables	Mining	Transportation
KL	substitutes	substitutes	substitutes	substitutes	substitutes
KE	substitutes	substitutes	substitutes	substitutes	substitutes
KM	substitutes	substitutes	substitutes	substitutes	substitutes
LE	substitutes	substitutes	substitutes	complements	substitutes
LM	substitutes	substitutes	substitutes	complements	substitutes
EM	complements	complements	complements	complements	complements

* These findings are based on the results of the aggregate and as well as the individual component functions.

Table 20

Substitution and Complementarity Relationship between Energy and Other Factors of Production -- Energy Intensive Manufacturing Industries: (based on Model II)

INDUSTRY	EE	EK	EL	EM
Iron & Steel	positive	complements	subsitutues**	complements**
Nonferrous Metals	negative	substitutes	complements	complements
Nonmetallic Prod	negative*	substitutes**	substitutes*	complements*
Paper & Allied Products	positive**	substitutes*	substitutes	complements*
Chemical & Chemical Products	negative*	complements*	substitutes*	substitutes*

* significant at 99% confidence level

** significant at 95% confidence level

6. With the exception of mining industry, labour is a good substitute for both materials and energy in the production process of all five aggregate industries.

7. In all the five aggregate industries, capital is a good substitute for materials (see Table 19).

8. Our results imply that materials and energy are complements in the production process of the industries studied.

9. For the manufacturing industry, labour productivity growth has declined from 4.0% for 1967-73 to 1.35% for 1974-76. Our simulation results suggest that changes in relative factor prices, and output growth account for 60% and 40% of this decline respectively.

In summary, our results strongly suggest that the post 1973 productivity slowdown is mainly caused by low output growth (due to lower growth in aggregate demand) and acceleration of nonlabour input prices (particularly energy and materials). We might also point out that the low growth in aggregate demand for the post-1973 period in most of the industrial economies is mainly initiated and mitigated by the quadrupuling of oil prices in 1974, and periodic increases thereafter. One of the major implications of this study is that the future prospects for productivity growth in Canada depend a great deal on the developments in relative factor prices and the growth of aggregate demand both in Canada and other industrial economies, particularly U.S.A.

Even though there is no structural break in trend productivity growth, in the future, continued slow growth of the Canadian economy, (partly caused by the slowdown in world aggregate demand) and continued acceleration of the prices of nonlabour inputs (mainly as a result of supply shortages of energy and other natural resources) in all likelihood will result in slow growth in aggregate labor productivity.

APPENDIX

DATA APPENDIX

1. Gross Output

Both current and constant dollar gross output data for the manufacturing industries is obtained from the Industry Product Division, Statistics Canada. This data is for the period 1957-76.

For both mining and transportation industries, the data on current and constant dollar gross output is obtained from the Input-Output Division, Statistics Canada. Here, the data is available only for the period 1961- 76.

Price of gross output is obtained by dividing the current dollar output by constant dollar

2. Intermediate Inputs

The data on current and constant dollar intermediate inputs (materials + energy) for the manufacturing industries, for the period 1957-76, is from the Industry Product Division of Statistics Canada.

In the case of mining and transportation industries, the data on intermediate input for the period 1961-76 is obtained from the Input-Output Division, Statistics Canada.

3. Energy Input

For all the manufacturing industries, data on current dollar energy consumption is directly taken from Statistics Canada Publication : General Review of the Manufacturing Industries of Canada, Catalogue No.31-203.

To obtain constant dollar consumption of energy, we need times series on energy prices by industry. Since this data is not readily available, we have constructed energy price indices making use of data on gross output price of these industries: coal mining, crude petroleum and natural gas, petroleum and coal products and utilities. First, we have obtained the deliveries of these industries for each of our manufacturing industries from the 1971 input-output tables. The sum of these values is approximately equal to the energy and fuel consumption given in census of manufacturing industries. This information is used to construct the weights and these in turn are used to construct a weighted energy price index by industry:

$$P_{Eit} = \alpha_{cli} P_{clt} + \alpha_{cpi} P_{cpt} + \alpha_{pci} P_{pct} + \alpha_{ui} P_{ut}$$

$$i = 1, \ldots, 22$$

where P_{Eit} is the price index of energy for the ith industry in the time t. α_{cli}, α_{cpi}, α_{pci}, and α_{ui} are the shares of coal crude petroleum, and natural gas, petroleum and coal products, and utilities in the energy input of the ith industry, respectively, and P_{clt}, P_{cpt}, P_{pct}, and P_{ut}, are the gross output price indices of coal, crude petroleum and natural gas mining, petroleum and coal products and utilities respectively.

Energy consumption data (both in current and constant dollars) for the mining and transportation industries, for the period 1961-76, is obtained from the Input-Output Division, Statistics Canada.

4. Material Inputs

For the manufacturing industries data on material inputs (current and constant dollars) is obtained by substracting energy input from the intermediate inputs.

In the case of mining and transportation industries data on both current and constant dollar material inputs is obtained from the Input-Output Division, Statistics Canada. This data is also availabel for the period 1961-76.

5. Labour Input

In the case of manufacturing, and mining industries data on average hourly earnings (price of labour) and total wagebill (labour income) is taken from the CANDIDE 2.0 data bank. For a detailed description of primary data series for the individual manufacturing industries, see Discussion Paper No. 134, pages 57-61.

Since the data on average hourly earnings for the individual transportation industries is not readily available, we have used the data on average hourly earnings for the total transportation and communication industry as a proxy for the price of labour in all the component industries.

6 User Cost of Capital

For the manufacturing and mining industries, data on user cost of capital is taken from the CANDIDE 2.0 databank. For a detailed description of the construction of these data series, see CANDIDE 2.0 Model Description, Vol. 1, Section 28.

Since the user cost of capital data is not available for the individual components, user cost of capital of the the total transportation industry is used as a proxy for the price of capital services in all the transportation industries equations.

Table A1

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})
Wood Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.1360	-0.1142	-50.9240	-45.1980	-3.1421	-2.7887
KL	0.0529 (2.99)	-0.0142 (0.43)	4.1293 (3.94)	0.1623 (0.08)	1.1317 (17.50)	0.0445 (0.37)
KE	-0.0026 (0.82)	-0.0026 (0.77)	-1.1766 (0.44)	3.1135 (1.13)	-0.0232 (0.14)	0.0613 (0.36)
KM	0.0857 (3.82)	0.1258 (4.93)	3.1551 (5.59)	4.1626 (6.58)	2.0335 (58.44)	2.6829 (67.88)
LL	0.0273 (2.37)	0.1556 (4.13)	-2.2851 (14.92)	-0.5713 (1.15)	-0.6263 (14.92)	-0.1582 (1.15)
LE	0.0139 (4.09)	-0.0004 (0.10)	3.5790 (5.67)	0.9234 (1.15)	0.0705 (0.41)	0.0182 (0.08)
LM	-0.0941 (8.29)	-0.1410 (6.67)	0.4670 (7.26)	0.2017 (1.68)	0.30101 (17.10)	0.1300 (3.96)
EE	0.0081 (3.40)	0.0194 (15.85)	-29.0080 (4.75)	0.2104 (0.06)	-0.5714 (4.75)	0.0041 (0.06)
EM	-0.0193 (4.79)	-0.0215 (8.14)	-0.5227 (1.65)	-0.6972 (3.34)	-0.3369 (53.79)	-0.4493 (109.32)
MM	0.0278 (1.62)	0.0368 (1.98)	-0.4847 (11.72)	-0.4630 (10.36)	-0.3124 (11.72)	-0.2984 (10.36)
KQ		0.0337				
LQ		-0.0775 (5.32)				
MQ		0.0276 (2.32)				
EQ		0.0162 (7.72)				

Table A2

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ}) -- Furniture and Fixture Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0917	0.0762	-1.4081	2.2682	-0.2019	-0.3252
KL	-0.0719 (1.79)	-0.0625 (2.29)	-0.7952 (0.80)	-0.5589 (0.82)	-0.2223 (1.54)	-0.1563 (1.60)
KE	0.0051 (3.05)	0.0020 (1.09)	3.5317 (2.86)	2.6846 (1.73)	0.0294 (0.17)	0.0224 (0.10)
KM	-0.0249 (2.18)	-0.0157 (0.91)	0.6941 (4.96)	0.8072 (3.82)	0.3948 (19.66)	0.4591 (15.14)
LL	0.0584 (1.40)	0.1270 (3.79)	-1.8299 (3.44)	-0.9523 (2.22)	-0.5116 (3.44)	-0.2662 (2.22)
LE	-0.0064 (3.70)	-0.0009 (0.35)	-1.7389 (2.35)	0.6153 (0.56)	-0.0145 (0.07)	0.0051 (0.016)
LM	0.0199 (1.70)	-0.0636 (3.10)	1.1255 (15.22)	0.6204 (4.81)	0.6401 (30.97)	0.3528 (9.78)
EE	0.0051 (3.05)	0.0089 (8.53)	-46.1350 (1.93)	8.7025 (0.58)	-0.3847 (1.93)	0.0726 (0.58)
EM	-0.0017 (0.74)	-0.0009 (0.35)	0.6409 (1.31)	-1.1068 (2.80)	0.3645 (89.54)	-0.6295 (155.50)
MM	0.0067 (0.92)	0.0893 (4.73)	-0.7377 (32.89)	-0.4822 (8.26)	-0.4195 (32.89)	-0.2742 (8.26)
KQ		0.0063				
LQ		-0.0446 (3.82)				
MQ		-0.0399 (4.03)				
EQ		-0.0016 (1.43)				

Table A3

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

Iron and Steel Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0543	0.0200	-2.8161	-8.6274	-0.2163	-0.6627
KL	-0.0894 (2.38)	-0.0513 (3.31)	-3.1967 (1.81)	-1.4069 (1.94)	-0.8868 (6.55)	-0.3903 (7.00)
KE	-0.0013 (0.45)	-0.0055 (1.06)	0.5447 (0.54)	-0.9601 (0.52)	0.0199 (0.26)	-0.0352 (0.25)
KM	0.0364 (3.14)	0.0368 (2.54)	1.7781 (7.16)	1.7864 (5.78)	1.0831 (56.76)	1.0881 (45.81)
LL	0.0992 (2.60)	0.1869 (11.50)	-1.3163 (2.66)	-0.1757 (0.83)	-0.3652 (2.66)	-0.0487 (0.83)
LE	0.0061 (2.48)	-0.0041 (0.81)	1.6036 (5.54)	0.6010 (1.21)	0.0588 (0.73)	0.0220 (0.16)
LM	-0.0159 (1.41)	-0.1316 (11.31)	0.9061 (13.59)	0.2212 (3.21)	0.5519 (29.84)	0.1348 (7.05)
EE	0.0046 (0.72)	0.0386 (10.65)	-22.841 (4.78)	2.4750 (0.92)	-0.8373 (4.78)	0.0977 (0.92)
EM	-0.0095 (1.46)	-0.0291 (6.84)	0.5756 (1.99)	-0.3016 (1.58)	0.3506 (33.00)	-0.1837 (26.35)
MM	-0.0112 (1.22)	0.1239 (9.23)	-0.6715 (27.44)	-0.3079 (8.52)	-0.4090 (27.44)	-0.1875 (8.52)
KQ		-0.0016				
LQ		-0.0809 (8.98)				
MQ		0.0716 (7.64)				
EQ		0.0109 (2.66)				

Table A4

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij})
Nonferrous Metal Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0605	0.0251	-2.6657	-6.9645	-0.2420	-0.6322
KL	-0.0816 (2.89)	0.0090 (0.43)	-2.9902 (2.17)	1.4412 (1.41)	-0.6739 (5.38)	0.3248 (3.50)
KE	-0.0266 (3.46)	0.0081 (0.83)	-5.0325 (2.88)	2.8279 (0.53)	-0.2448 (1.54)	0.1375 (0.69)
KM	0.0477 (2.36)	-0.0422 (1.45)	1.8269 (5.23)	0.2674 (1.28)	1.1605 (36.57)	0.1699 (3.70)
LL	0.1037 (3.09)	0.1190 (5.76)	-1.3946 (2.10)	-5.7812 (14.21)	-0.3143 (2.10)	-1.3028 (14.21)
LE	0.0251 (2.59)	-0.0163 (1.90)	3.2908 (3.73)	-0.4916 (0.63)	0.1600 (0.80)	-0.0239 (0.13)
LM	-0.0472 (1.97)	-0.1117 (5.89)	0.6701 (4.00)	0.9182 (6.93)	0.4257 (11.27)	0.5833 (19.54)
EE	0.0020 (0.43)	0.0408 (6.23)	-18.7060 (9.40)	-2.3121 (0.83)	-0.9096 (9.40)	-0.1124 (0.83)
EM	-0.0005 (0.06)	-0.0325 (3.07)	0.9835 (3.36)	-0.0527 (0.15)	0.6248 (43.85)	-0.0335 (2.00)
MM	0.000	0.1865 (6.08)	-0.5741 (9.39)	-0.1121 (1.47)	-0.3647 (9.39)	-0.0712 (1.47)
KQ		0.0012				
LQ		-0.1099 (8.10)				
MQ		0.1016 (5.10)				
EQ		0.0071 (0.94)				

Table A5

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})
Metal Fabricating

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0114	0.0593	-3.0573	-6.3168	-0.4500	-0.9297
KL	-0.0186 (1.19)	-0.0439 (1.36)	-0.1568 (0.18)	0.5091 (1.23)	-0.0404 (0.32)	0.1312 (2.16)
KE	0.0003 (0.12)	-0.0006 (0.53)	0.5253 (0.58)	1.2067 (0.69)	0.0047 (0.04)	0.0109 (0.04)
KM	0.0297 (1.42)	-0.0148 (1.16)	0.8287 (5.62)	1.3439 (5.56)	0.4856 (22.39)	0.7876 (22.14)
LL	0.1797 (8.54)	0.0687 (1.65)	-1.8458 (2.94)	-0.1754 (0.55)	-0.4758 (2.94)	-0.0452 (0.55)
LE	-0.0020 (0.74)	-0.0036 (2.33)	-0.5679 (0.84)	0.1492 (0.13)	-0.0051 (0.03)	0.0013 (0.0045)
LM	-0.1591 (9.10)	-0.0211 (1.21)	0.8601 (7.45)	-0.053 (0.46)	0.05040 (16.95)	0.0311 (1.04)
EE	0.0071 (5.86)	0.0025 (3.44)	-78.726 (8.72)	-22.808 (1.53)	-0.7107 (8.72)	-0.2059 (1.53)
EM	-0.0054 (1.95)	0.0017 (1.34)	1.3307 (5.38)	-0.0173 (0.03)	0.7798 (349.20)	-0.0102 (2.16)
MM	0.1348 (5.64)	0.0342 (2.95)	-0.6070 (17.98)	-0.3140 (4.51)	-0.3557 (17.98)	-0.1840 (4.51)
KQ		0.0455				
LQ		-0.0858 (9.12)				
MQ		0.0411 (2.93)				
EQ		-0.0008 (0.55)				

Table A6

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij})

Machinery (Excluding elec mach) Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0938	0.0331	1.1602	-5.9499	0.1072	-0.5499
KL	-0.0624 (1.23)	0.0180 (0.73)	-1.5706 (0.75)	1.7428 (1.71)	-0.4126 (2.14)	0.4579 (4.87)
KE	-0.0033 (1.59)	0.0005 (0.27)	-4.8014 (1.32)	1.9136 (0.56)	-0.0291 (0.10)	0.0116 (0.04)
KM	-0.0281 (1.60)	-0.0516 (3.14)	0.5237 (1.76)	0.1260 (0.45)	0.3345 (12.18)	0.0805 (4.87)
LL	-0.0430 (0.62)	0.0788 (2.97)	-3.4290 (3.41)	-1.6648 (4.32)	-0.9008 (3.41)	-0.4374 (4.32)
LE	0.0007 (0.26)	-0.0032 (1.55)	1.4202 (0.89)	-0.9848 (0.77)	0.0086 (0.02)	-0.0060 (0.02)
LM	0.1047 (4.02)	-0.0937 (5.44)	1.6240 (10.45)	0.4419 (4.31)	1.0374 (25.42)	0.2823 (10.48)
EE	0.0066 (7.11)	0.0039 (2.73)	15.644 (0.62)	-61.3780 (1.64)	0.0949 (0.62)	-0.3725 (1.64)
EM	-0.0040 (2.47)	-0.0011 (0.49)	-0.0379 (0.09)	0.7113 (1.20)	-0.0243 (9.50)	0.4544 (127.10)
MM	-0.0726 (5.96)	0.1464 (8.41)	-0.7433 (24.90)	-0.2067 (4.85)	-0.4748 (24.90)	-0.1320 (4.85)
KQ		0.0061				
LQ		-0.0921 (11.59)				
MQ		0.0874 (11.89)				
EQ		-0.0014 (1.55)				

Table A7

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ}) -- Nonauto Transportation Equipment Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0322	-0.0739	-6.6802	-27.6630	-0.4753	-1.9681
KL	-0.0390 (0.49)	0.0011 (0.02)	-0.7343 (0.21)	1.0500 (0.46)	-0.2322 (0.93)	0.3321 (2.04)
KE	-0.0018 (0.39)	-0.0019 (0.44)	-1.8212 (0.25)	-1.9897 (0.29)	-0.0165 (0.03)	-0.0180 (0.04)
KM	0.0086 (0.32)	0.0747 (2.45)	1.1995 (1.94)	2.7406 (3.86)	0.7240 (16.43)	1.6541 (32.74)
LL	-0.0399 (0.40)	0.0297 (0.45)	-2.5613 (2.56)	-1.8650 (2.85)	-0.8099 (2.56)	-0.5898 (2.85)
LE	-0.0057 (0.95)	0.00059 (0.12)	-0.9735 (0.50)	1.2068 (0.69)	-0.0088 (0.013)	0.0109 (0.02)
LM	0.0846 (2.31)	-0.0314 (0.84)	1.4432 (7.52)	0.8353 (4.28)	0.8710 (14.35)	0.5041 (8.18)
EE	0.0043 (1.91)	0.0017 (0.95)	-56.582 (2.05)	-88.2690 (4.00)	-0.5130 (2.05)	-0.8002 (4.00)
EM	0.0031 (0.86)	-0.0004 (0.10)	1.5746 (2.36)	0.9281 (1.12)	0.9504 (157.30)	0.5602 (74.65)
MM	-0.0963 (4.85)	-0.0429 (1.24)	-0.9212 (16.91)	-0.7147 (8.18)	-0.5560 (16.91)	-0.4675 (8.18)
KQ		0.0989				
LQ		-0.1237 (4.51)				
MQ		0.0331 (1.34)				
EQ		-0.0083 (3.12)				

Table A8

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij}) --
Motor Vehicle Parts and Accessories

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0230	0.0759	-8.7080	-2.0992	-1.0659	-0.2570
KL	-0.0478 (1.20)	-0.1078 (2.19)	-0.4652 (0.38)	-2.3043 (1.53)	-0.1240 (0.83)	-0.6144 (3.33)
KE	-0.0019 (1.41)	0.0022 (0.89)	-0.2364 (0.27)	2.4579 (1.50)	-0.0029 (0.03)	0.0303 (0.15)
KM	0.0727 (6.91)	0.0297 (1.76)	1.9927 (13.87)	1.4049 (6.10)	1.1929 (67.81)	0.8410 (29.85)
LL	0.0955 (2.29)	0.2114 (4.22)	-1.4071 (2.40)	0.2236 (0.32)	-0.3752 (2.40)	0.0596 (0.32)
LE	0.0001 (0.07)	-0.0038 (1.17)	1.0319 (2.34)	-0.1530 (0.16)	0.0127 (0.11)	-0.0189 (0.01)
LM	-0.0478 (4.29)	-0.0998 (5.02)	0.7006 (10.03)	0.3748 (3.01)	0.4194 (22.51)	0.2243 (6.76)
EE	0.0002 (0.27)	0.0064 (2.85)	-78.6720 (-15.28)	-38.0880 (2.58)	-0.9707 (15.28)	-0.4699 (2.58)
EM	0.0016 (1.68)	-0.0048 (1.61)	1.2102 (9.66)	0.3506 (0.87)	0.7245 (468.70)	0.2099 (42.10)
MM	-0.0265 (4.99)	0.0749 (50.29)	-0.7445 (50.29)	-0.4614 (8.99)	-0.4457 (50.29)	-0.2762 (8.99)
KQ		0.1009				
LQ		-0.1204 (11.58)				
MQ		0.0209 (4.23)				
EQ		-0.0014 (1.11)				

Table A9

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

Motor Vehicle Industries (Excluding Parts and Accessories)

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0690	0.0234	40.3030	-6.9302	1.2523	-0.2153
KL	-0.0642 (3.06)	-0.0336 (1.78)	-22.7100 (2.93)	-11.4100 (1.64)	-1.9786 (8.20)	-0.9941 (4.59)
KE	-0.0005 (0.83)	0.0005 (0.59)	-4.2479 (0.67)	6.3355 (0.70)	-0.0134 (0.07)	0.0199 (0.07)
KM	-0.0043 (0.38)	0.0097 (0.20)	0.8418 (2.01)	1.3537 (0.75)	0.7397 (57.10)	1.1895 (21.29)
LL	0.0038 (0.16)	0.1270 (5.10)	-9.9789 (3.30)	6.2561 (1.88)	-0.8694 (3.31)	0.5451 (1.88)
LE	-0.0031 (4.78)	-0.0010 (0.94)	-10.3620 (4.34)	-2.8021 (0.69)	-0.0326 (0.16)	-0.0088 (0.03)
LM	0.0635 (6.92)	-0.0924 (3.05)	1.8297 (15.27)	-0.2068 (0.52)	1.6077 (153.95)	-0.1817 (5.26)
EE	0.0013 (2.49)	-0.0008 (1.00)	-189.960 (3.73)	-397.360 (4.94)	-0.5983 (3.73)	-1.2515 (4.94)
EM	0.0024 (4.35)	0.0013 (0.88)	1.8587 (9.42)	1.4782 (2.72)	1.6331 (26.26)	1.2988 757.67)
MM	-0.0616 (4.19)	0.0814 (1.25)	-0.2179 (11.44)	-0.0327 (0.39)	-0.1914 (11.44)	-0.0180 (0.39)
KQ		0.0078				
LQ		-0.0568 (5.12)				
MQ		0.0507 (2.11)				
EQ		-0.0017 (3.41)				

Table A10

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij})

Electrical Products Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0152	-0.1872	-11.3360	-30.7580	-1.0669	-2.8940
KL	-0.0543 (1.41)	0.0724 (3.50)	-0.9784 (0.70)	3.6367 (4.83)	-0.2854 (2.17)	1.0608 (14.96)
KE	-0.0023 (1.62)	0.0015 (1.74)	3.0575 (1.23)	3.6856 (2.39)	-0.0184 (0.08)	0.0222 (0.15)
KM	0.0718 (7.10)	0.1133 (6.20)	2.2539 (12.72)	2.9790 (9.33)	1.3707 (82.22)	1.8117 (60.26)
LL	0.1010 (2.58)	0.0632 (4.19)	-1.2407 (2.69)	-1.6854 (9.50)	-0.3619 (2.70)	-0.4916 (9.50)
LE	0.0010 (0.70)	0.0019 (2.15)	1.5984 (1.87)	2.0832 (4.14)	0.0096 (0.04)	0.0126 (0.10)
LM	-0.0478 (4.71)	-0.1375 (12.10)	0.7306 (12.77)	0.2249 (3.51)	0.4443 (26.63)	0.1368 (7.31)
EE	0.0020 (2.63)	0.0023 (3.37)	-110.1300 (5.30)	-102.9200 (5.61)	-0.6643 (5.29)	-0.6209 (5.61)
EM	-0.0007 (0.89)	-0.0057 (5.88)	0.7989 (3.53)	-0.5487 (2.10)	0.4858 (355.71)	-0.3337 (209.86)
MM	-0.0232 (7.10)	0.0299 (2.15)	-0.7071 (54.16)	-0.5634 (14.95)	-0.4301 (54.16)	-0.3427 (14.95)
KQ		0.0705				
LQ		-0.0905 (11.63)				
MQ		0.0238 (2.69)				
EQ		-0.0038 (7.35)				

Table A11

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

Nonmetal Mineral Product Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0299	-0.0351	-6.1100	-6.3012	-1.0139	-1.0456
KL	-0.0246 (0.89)	-0.0152 (0.57)	0.4409 (0.70)	0.6541 (1.08)	0.1171 (1.13)	0.1738 (1.74)
KE	-0.0043 (0.99)	-0.0054 (1.49)	0.5769 (1.35)	0.4668 (1.31)	0.0352 (0.49)	0.0284 (0.48)
KM	0.0588 (3.79)	0.0557 (3.82)	1.6980 (9.22)	1.6621 (9.58)	0.8616 (28.28)	0.8434 (29.29)
LL	0.0720 (2.31)	0.1459 (4.88)	-1.7430 (3.95)	-0.6964 (1.64)	-0.4631 (3.95)	-0.1850 (1.64)
LE	0.0154 (3.72)	0.0070 (1.52)	1.9496 (7.63)	1.4304 (5.05)	0.1188 (1.75)	0.08716 (1.16)
LM	-0.0628 (4.10)	-0.1377 (8.25)	0.5344 (4.67)	-0.0211 (0.17)	0.2712 (8.92)	-0.0107 (0.33)
EE	0.0470 (21.72)	0.0507 (21.87)	-2.7548 (4.73)	-1.7631 (2.82)	-0.1679 (4.73)	-0.1074 (2.82)
EM	-0.0581 (12.89)	-0.0522 (13.10)	-0.8786 (6.03)	-0.6899 (5.34)	-0.4459 (50.22)	-0.3501 (44.43)
MM	0.0621 (4.00)	0.1342 (7.75)	-0.7295 (12.20)	-0.4497 (6.69)	-0.3702 (12.20)	-0.2282 (6.69)
KQ		-0.0123				
LQ		-0.0492 (4.10)				
MQ		0.0557 (6.65)				
EQ		0.0058 (2.26)				

Table A12

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{iJ}), and Cross-Price Elasticities (ε_{iJ}), Food and Beverage Industry

Variable	α_{iJ} Model I	α_{iJ} Model II	σ_{iJ} Model I	σ_{iJ} Model II	ε_{iJ} Model I	ε_{iJ} Model II
KK	-0.0286	0.0442	-15.0540	-4.6390	-1.2597	-0.3882
KL	0.0100 (1.16)	-0.0085 (1.44)	1.8988 (2.46)	0.2373 (0.45)	0.2537 (3.93)	0.0317 (0.71)
KE	-0.0035 (4.82)	-0.0001 (0.15)	-4.0413 (4.86)	0.8646 (0.93)	-0.0418 (0.61)	0.0894 (0.12)
KM	0.0230 (2.95)	-0.0356 (3.57)	1.3565 (11.24)	0.4499 (2.92)	1.0478 (103.73)	0.03476 (26.99)
LL	-0.0003 (0.04)	0.1055 (9.98)	-6.5046 (13.42)	-0.5716 (0.96)	-0.8687 (13.42)	-0.0763 (0.96)
LE	0.0017 (2.33)	0.0013 (1.08)	2.2585 (4.19)	1.9471 (2.22)	0.0234 (0.32)	0.0201 (0.17)
LM	-0.0115 (2.64)	-0.0983 (11.31)	0.8886 (21.11)	0.0470 (0.56)	0.6864 (122.10)	0.0363 (3.23)
EE	0.0067 (10.86)	0.0094 (12.88)	-32.6800 (5.63)	-8.0112 (1.18)	-0.3381 (5.63)	-0.0829 (1.18)
EM	-0.0050 (4.84)	-0.0106 (8.33)	0.3724 (2.87)	-0.3230 (2.03)	0.2877 (214.55)	-0.2495 (151.76)
MM	-0.0065 (0.96)	0.1443 (11.19)	-0.3056 (26.73)	-0.0525 (2,43)	-0.2360 (26.73)	-0.0406 (2.43)
KQ	-	-0.0673				
LQ	-	-0.0628 (10.06)				
MQ	-	0.1320 (14.37)				
EQ	-	-0.0019 (2.13)				

Table A13

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

Tobacco Products Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.2065	-0.0349	3.3750	-7.1076	0.5122	-1.0786
KL	-0.1224 (7.25)	-0.0313 (1.54)	-4.3754 (5.89)	-0.3757 (0.42)	-0.6562 (5.82)	-0.563 (0.42)
KE	0.0022 (2.56)	0.00016 (0.13)	4.6338 (3.26)	1.2623 (0.61)	0.0185 (0.09)	0.0050 (0.02)
KM	-0.0863 (3.94)	0.0661 (1.19)	0.18075 (0.87)	1.6274 (3.09)	0.1255 (3.98)	1.1299 (14.13)
LL	0.1042 (9.56)	0.1149 (13.31)	-1.0353 (2.14)	-0.5612 (1.47)	-0.1553 (2.14)	-0.0842 (1.47)
LE	-0.0003 (0.61)	0.0006 (0.81)	0.4402 (0.48)	1.9430 (1.67)	-0.0018 (0.01)	0.0078 (0.04)
LM	0.0186 (2.34)	-0.0841 (5.27)	1.1785 (15.44)	0.1922 (1.25)	0.8182 (71.50)	0.1334 (5.81)
EE	0.0008 (1.84)	0.0011 (2.45)	-198.96 (7.24)	-181.30 (6.51)	-0.7939 (7.24)	-0.7235 (6.51)
EM	-0.0027 (3.77)	-0.0018 (1.42)	0.0356 (0.14)	0.3464 (0.75)	0.0247 (24.22)	0.2405 (130.36)
MM	0.07040 (4.30)	0.01982 (0.43)	-0.2943 (8.66)	-0.3992 (4.18)	-0.2043 (8.66)	-0.2772 (4.18)
KQ		0.1480				
LQ		-0.1270 (7.69)				
MQ		-0.0220 (0.48)				
EQ		0.0010 (0.70)				

Table A14

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij})

Rubber and Plastics Products Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.4387	0.0692	27.3950	-2.3995	3.0507	-0.2672
KL	-0.0969 (3.89)	-0.0612 (3.11)	-2.5214 (2.78)	-1.2235 (1.71)	-0.6230 (6.17)	-0.3023 (3.80)
KE	-0.0021 (2.16)	-0.0055 (3.59)	-0.2353 (0.41)	-2.3415 (2.52)	-0.0035 (0.05)	-0.0349 (0.34)
KM	-0.3397 (21.73)	-0.0025 (0.18)	-3.8684 (17.27)	0.9646 (4.76)	-2.4241 (97.17)	0.6044 (26.78)
LL	0.1128 (4.46)	0.2097 (8.99)	-1.1991 (2.89)	0.3880 (1.02)	-0.2963 (2.89)	0.0959 (1.02)
LE	-0.0008 (0.77)	-0.0029 (1.25)	0.7862 (2.83)	0.2010 (0.31)	0.0117 (0.17)	0.0030 (0.02)
LM	-0.0151 (3.09)	-0.1456 (9.03)	0.9022 (28.49)	0.0596 (0.57)	0.5654 (72.26)	0.0374 (1.45)
EE	0.0037 (8.50)	0.0249 (23.02)	-49.306 (24.97)	46.383 (9.49)	-0.7349 (24.97)	0.6913 (9.49)
EM	-0.0009 (2.85)	-0.0165 (8.61)	0.9045 (27.02)	-0.7663 (3.74)	0.5668 (1135.90)	-0.4802 (157.10)
MM	0.3558 (28.10)	0.1646 (9.74)	0.3102 (9.62)	-0.1767 (4.11)	0.1944 (9.62)	-0.1107 (4.11)
KQ		0.0214				
LQ		-0.1135 (12.94)				
MQ		0.0972 (10.74)				
EQ		-0.0051 (4.93)				

Table A15

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij}) -- Leather Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.4387	0.4249	5.0799	4.8152	1.1557	1.0955
KL	-0.0969 (3.89)	-0.0943 (4.03)	-0.2399 (0.75)	-0.2071 (0.69)	-0.0824 (1.14)	-0.0711 (1.05)
KE	-0.0021 (2.16)	-0.0022 (2.85)	-0.2842 (0.48)	-0.3905 (0.80)	-0.0020 (0.03)	-0.0027 (0.02)
KM	-0.3397 (21.73)	-0.3284 (15.59)	-2.5389 (15.59)	-2.4211 (8.03)	-1.0780 (28.92)	-1.0216 (14.89)
LL	0.1128 (4.46)	0.1216 (5.36)	-0.9550 (4.45)	-0.8806 (4.58)	-0.3280 (4.45)	-0.3025 (4.58)
LE	-0.0008 (0.77)	0.0008 (0.97)	0.6733 (1.58)	1.3391 (0.38)	0.0047 (0.03)	0.0094 (0.01)
LM	-0.0151 (3.09)	-0.0281 (3.39)	0.8955 (26.48)	0.8063 (14.12)	0.3779 (32.52)	0.3402 (17.35)
EE	0.0037 (8.50)	0.0025 (6.46)	-65.7690 (7.38)	-91.41050 (11.78)	-0.4615 (7.38)	-0.6415 (11.78)
EM	-0.0009 (2.85)	-0.0011 (3.33)	0.6989 (6.62)	0.6406 (5.94)	0.2949 (397.96)	0.2703 (357.10)
MM	0.3558 (28.10)	0.3576 (15.44)	0.6282 (8.83)	0.6383 (4.91)	0.2651 (8.83)	0.2693 (4.91)
KQ		0.0572				
LQ		-0.0597 (1.70)				
MQ		0.0070 (0.07)				
EQ		-0.0045 (3.16)				

Table A16

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij}) -- Textile Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0255	0.0329	-8.7816	-6.1593	-0.4685	-0.3286
KL	-0.0513 (2.98)	-0.0469 (3.14)	-2.3850 (2.10)	-2.1013 (2.12)	-0.6771 (11.18)	-0.5966 (11.31)
KE	-0.0005 (0.92)	0.0012 (0.70)	0.5023 (0.92)	2.1631 (1.31)	0.0098 (0.34)	0.0424 (0.48)
KM	0.0263 (4.05)	0.0128 (0.84)	1.7658 (9.33)	1.3725 (3.10)	1.1357 (112.58)	0.8828 (37.40)
LL	0.0654 (4.08)	-1.7106 (6.03)	-1.7106 (8.61)	-1.2605 (6.03)	-0.4857 (8.61)	-0.3579 (6.03)
LE	-0.0006 (1.10)	-0.0024 (0.93)	0.5722 (9.94)	0.5722 (1.25)	0.0176 (0.68)	0.0112 (0.086)
LM	-0.0136 (2.31)	-0.523 (4.34)	0.9255 (28.71)	0.7133 (10.79)	0.5953 (65.05)	0.4587 (24.44)
EE	0.0030 (7.14)	0.0151 (10.58)	-42.210 (38.46)	-10.632 (2.85)	-0.8269 (38.46)	-0.2083 (2.85)
EM	-0.0019 (4.05)	-0.0139 (9.90)	0.8466 (22.39)	-0.1082 (0.97)	0.5445 (734.88)	-0.0695 (31.73)
MM	-0.0107 (2.32)	0.0535 (3.64)	-0.5808 (51.92)	-0.4254 (11.97)	-0.3735 (51.92)	-0.2736 (11.97)
KQ		0.0055				
LQ		-0.0709 (6.81)				
MQ		0.0695 (5.53)				
EQ		-0.004 (3.05)				

Table A17

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij})

Knitting and Clothing Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0255	0.0337	-7.0174	-5.97	-0.6243	-0.5314
KL	-0.0513 (2.98)	-0.0356 (2.37)	-0.8940 (1.41)	-0.3158 (0.57)	-0.2720 (4.81)	-0.0961 (1.95)
KE	-0.0005 (0.92)	-0.0001 (0.19)	-0.2685 (0.20)	0.7233 (0.49)	-0.0012 (0.01)	0.0033 (0.03)
KM	0.0263 (4.05)	0.0020 (0.17)	1.4905 (12.30)	1.0365 (4.72)	0.8975 (83.24)	0.6242 (31.95)
LL	0.0654 (4.08)	0.1338 (9.96)	-1.5806 (9.13)	-0.8413 (5.79)	-0.4810 (9.13)	-0.2560 (5.79)
LE	-0.0006 (1.10)	0.0002 (0.25)	0.6050 (1.68)	1.1497 (1.96)	0.0028 (0.03)	0.0053 (0.03)
LM	-0.0136 (2.31)	-0.0984 (10.34)	0.9258 (28.82)	0.4629 (8.91)	0.5575 (57.04)	0.2788 (17.64)
EE	0.0030 (7.14)	0.0032 (6.33)	-74.4310 (3.75)	-63.5450 (2.64)	-0.3431 (3.75)	-0.2929 (2.64)
EM	-0.0019 (4.06)	-0.0033 (5.40)	0.3037 (1.77)	-0.2014 (0.91)	0.1829 (231.10)	-0.1213 (118.28)
MM	-0.0107 (2.32)	0.0998 (8.48)	-0.6903 (54.10)	-0.3855 (11.89)	-0.4157 (54.10)	-0.2321 (11.89)
KQ		-0.0215				
LQ		-0.0854 (9.32)				
MQ		0.1081 (10.27)				
EQ		-0.0012 (1.87)				

Table A18

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij}) --

Paper and Allied Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0255	-0.1276	-4.7257	-12.1430	-0.6788	-1.7441
KL	-0.0513 (2.98)	0.0391 (2.65)	-0.5068 (1.00)	2.1487 (4.95)	-0.1200 (1.65)	0.5090 (8.17)
KE	-0.0005 (0.92)	0.0066 (1.10)	0.9340 (12.98)	1.8811 (2.35)	0.0513 (4.96)	0.1005 (0.90)
KM	0.0263 (4.05)	0.0819 (3.12)	1.3240 (16.54)	2.0096 (6.21)	0.7475 (65.00)	1.1346 (24.39)
LL	0.0654 (4.10)	0.1088 (6.16)	-2.0557 (7.20)	-1.2832 (4.08)	-0.4869 (7.20)	-0.3040 (4.08)
LE	-0.0006 (1.10)	-0.0102 (1.18)	0.9574 (24.71)	0.2194 (0.33)	0.0526 (5.73)	0.0120 (0.08)
LM	-0.0136 (2.31)	-0.1377 (8.37)	0.8983 (20.41)	-0.296 (-0.24)	0.5072 (48.65)	-0.0167 (0.57)
EE	0.0030 (7.14)	0.0678 (7.78)	-16.2170 (116.04)	5.2940 (1.83)	-0.8903 (116.04)	0.2906 (1.83)
EM	-0.0019 (4.06)	-0.0642 (5.66)	0.9377 (60.99)	-1.0727 (2.93)	0.5294 (627.20)	-0.6056 (30.13)
MM	-0.0136 (2.31)	0.1201 (4.69)	-0.8049 (55.45)	-0.3945 (4.91)	-0.4544 (55.45)	-0.2227 (4.91)
KQ		-0.0224				
LQ		-0.0817 (7.35)				
MQ		0.0840 (5.91)				
EQ		0.0201 (3.51)				

Table A19

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})
Printing, Publishing and Allied Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0001	-0.0072	-4.3312	-4.5317	-0.8131	-0.8508
KL	-0.0040 (0.16)	0.0049 (0.24)	0.9362 (2.35)	1.0797 (3.25)	0.3095 (4.14)	0.3569 (5.72)
KE	-0.0042 (0.61)	0.0016 (2.86)	-3.2073 (0.47)	2.5898 (4.66)	-0.0170 (0.013)	0.0138 (0.13)
KM	0.0083 (0.70)	0.0007 (0.20)	1.0930 (8.27)	1.0077 (25.46)	0.5207 (20.98)	0.4800 (64.60)
LL	-0.0324 (1.29)	0.0880 (3.89)	-2.3218 (10.10)	-1.2197 (5.89)	-0.7676 (10.10)	-0.4032 (5.89)
LE	0.0044 (0.62)	-0.0005 (0.43)	3.4794 (0.87)	0.7075 (1.04)	0.0185 (0.01)	0.0038 (0.02)
LM	0.0321 (2.69)	-0.0924 (11.05)	1.2035 (15.88)	0.4130 (7.77)	0.5733 (22.88)	0.1968 (11.20)
EE	0.01611 (4.09)	0.0053 (7.29)	383.430 (2.75)	-0.7467 (0.00)	2.0374 (2.75)	-0.0040 (0.00)
EM	-0.0163 (3.26)	-0.0063 (3.40)	-5.4276 (2.75)	-1.5033 (2.04)	-2.5855 (246.51)	-0.7161 (183.00)
MM	-0.0241 (2.46)	0.0981 (10.55)	-1.2054 (27.94)	-0.6670 (16.29)	-0.5742 (27.94)	-0.3177 (16.29)
KQ		-0.0073				
LQ		-0.0677 (7.76)				
MQ		0.0766 (17.98)				
EQ		-0.0016 (2.84)				

Table A20

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ}) -- Petroleum and Coal Products

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0008	-0.0870	-33.7020	-112.820	-1.0912	-3.6530
KL	-0.0017 (0.06)	0.0411 (7.26)	0.1251 (0.008)	22.2190 (7.60)	0.0775 (0.02)	1.3289 (14.04)
KE	0.0041 (5.68)	0.0047 (3.16)	5.0644 (2.51)	18.4560 (1.99)	0.0417 (0.64)	0.1520 (0.51)
KM	-0.0016 (1.20)	0.0412 (1.31)	1.1584 (8.72)	2.4146 (2.25)	1.0420 (242.30)	2.1721 (62.37)
LL	-0.0295 (0.94)	0.0213 (4.80)	-23.9540 (2.72)	-9.7641 (7.88)	-1.4327 (2.72)	-0.5840 (7.88)
LE	-0.0036 (5.83)	-0.0014 (1.00)	-6.3312 (5.04)	-1.9112 (0.66)	-0.0521 (0.69)	-0.0157 (0.10)
LM	0.0348 (7.58)	-0.0610 (16.60)	1.6461 (5.04)	-0.1330 (1.95)	1.4808 (290.38)	-0.1197 (29.31)
EE	0.0041 (5.68)	0.0022 (1.55)	-59.9690 (5.63)	-88.4380 (4.28)	-0.4940 (5.63)	-0.7285 (4.28)
EM	-0.0016 (1.20)	-0.0054 (3.79)	0.7878 (4.44)	0.2726 (1.42)	0.70864 (485.19)	0.2452 (154.98)
MM	-0.0378 (11.04)	0.02515 (0.91)	-0.1584 (37.42)	-0.0806 (2.35)	-0.1424 (37.42)	-0.0725 (2.35)
KQ		-0.0710				
LQ		-0.0529 (17.46)				
MQ		0.1251 (5.21)				
EQ		-0.0012 (1.89)				

Table A21

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

Chemical and Chemical Products

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0002	-0.0260	-6.7318	-8.2763	-0.8717	-1.0717
KL	-0.0039 (0.16)	0.0208 (2.68)	0.8307 (0.79)	1.8890 (5.70)	0.1500 (1.10)	0.3412 (7.95)
KE	-0.0042 (0.61)	-0.0175 (3.12)	0.0753 (0.05)	-2.8470 (2.31)	0.0026 (0.01)	-0.0998 (0.63)
KM	0.0083 (0.70)	0.0227 (1.34)	1.0981 (7.87)	1.2680 (6.35)	0.7191 (39.83)	0.8304 (32.10)
LL	-0.0324 (1.29)	0.0985 (11.54)	-5.5314 (7.15)	-1.5159 (5.79)	-0.9990 (7.15)	-0.2734 (5.79)
LE	0.0044 (0.62)	0.0062 (1.45)	1.6880 (1.52)	1.9756 (2.93)	0.0591 (0.29)	0.0692 (0.57)
LM	0.0321 (2.69)	-0.1255 (13.20)	1.2710 (12.60)	-0.0612 (0.76)	0.8323 (45.66)	-0.0400 (2.76)
EE	0.0161 (4.10)	0.0122 (2.96)	-14.4160 (4.49)	-17.600 (5.24)	-0.5053 (4.49)	-0.6169 (5.24)
EM	-0.0163 (3.26)	-0.0009 (0.12)	0.2912 (1.34)	0.9602 (2.81)	0.1907 (24.99)	0.6288 (52.47)
MM	-0.0163 (2.46)	0.1037 (4.74)	-0.5333 (25.54)	-0.2853 (5.59)	-0.3820 (25.54)	-0.1868 (5.59)
KQ		-0.0024				
LQ		-0.0898 (18.99)				
MQ		0.0835 (8.01)				
EQ		0.0087 (2.62)				

Table A22

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij}) -- Miscellaneous Manufacturing Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.0376	0.0853	-3.7439	-1.9194	-0.6062	-0.3108
KL	-0.0581 (2.81)	-0.0341 (1.95)	-0.4448 (0.86)	0.1513 (0.35)	-0.1105 (1.33)	0.0376 (0.53)
KE	0.0141 (5.10)	0.0121 (4.26)	13.9520 (5.46)	12.0600 (4.64)	0.0941 (0.23)	0.0814 (0.20)
KM	0.0064 (0.66)	-0.0633 (5.54)	1.0682 (10.36)	0.3292 (2.72)	0.6226 (37.28)	0.1919 (9.79)
LL	0.0545 (2.95)	0.1394 (7.89)	-2.1414 (7.15)	0.7671 (2.68)	-0.5320 (7.15)	-0.1906 (2.68)
LE	0.0117 (4.53)	-0.0095 (2.83)	-5.9559 (3.88)	-4.6943 (2.33)	-0.0408 (0.10)	-0.0317 (0.06)
LM	0.0152 (2.10)	-0.0957 (8.42)	1.1052 (21.75)	0.3392 (4.33)	0.6442 (51.03)	0.1977 (10.15)
EE	0.0072 (5.37)	0.0023 (1.48)	10.851 (0.37)	-96.8860 (2.84)	-0.0732 (0.37)	-0.6535 (2.84)
EM	-0.0097 (4.47)	-0.0048 (1.73)	-1.4630 (2.65)	-0.2285 (0.32)	-0.8528 (229.40)	-0.1332 (27.74)
MM	-0.0120 (2.02)	0.1638 (13.80)	-0.7508 (43.10)	-0.2334 (6.68)	-0.4377 (43.10)	-0.1360 (6.68)
KQ		-0.0574				
LQ		-0.0423 (5.75)				
MQ		0.1022 (15.99)				
EQ		-0.0025 (1.38)				

Table A23

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

Coal Mining Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-1.1304	-1.0059	-4.4991	-4.0921	-2.4896	-2.2644
KL	1.6579 (6.88)	1.7517 (4.30)	18.1950 (7.27)	19.1670 (4.54)	3.1704 (2.29)	3.3399 (1.43)
KE	-0.1971 (7.34)	-0.1602 (5.17)	-13.5320 (6.84)	-10.8150 (4.73)	-0.3316 (0.30)	-0.2651 (0.21)
KM	-0.3304 (1.68)	-0.5856 (2.62)	-1.4087 (0.99)	-3.2694 (2.00)	-0.3492 (0.44)	0.8105 (0.90)
LL	-1.8156 (9.13)	-2.2241 (6.32)	-64.5370 (9.86)	-77.9900 (6.73)	-11.2460 (9.86)	-13.5900 (6.73)
LE	0.0373 (1.96)	0.0236 (0.91)	9.7344 (2.18)	6.5232 (1.10)	0.2386 (0.31)	0.1599 (0.15)
LM	0.1204 (1.05)	0.4488 (2.78)	3.7870 (1.43)	11.3900 (3.04)	0.9388 (2.03)	2.8235 (4.33)
EE	-0.1081 (4.27)	-0.1216 (5.22)	-219.8100 (5.22)	-242.2600 (6.25)	-5.3871 (5.22)	-5.9374 (6.25)
EM	0.2679 (9.38)	0.2583 (9.59)	45.0960 (9.59)	43.5080 (9.81)	11.1790 (97.00)	10.7850 (99.28)
MM	-0.0579 (0.48)	-0.1214 (0.96)	-3.9759 (2.04)	-5.0099 (2.43)	-0.9856 (2.04)	-1.2419 (2.43)
KQ		-0.0874				
LQ		0.3033 (2.29)				
MQ		-0.2137 (3.17)				
EQ		-0.0022 (0.22)				

Table A24

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij})

Metal Mining Industries

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.1766	-0.6953	-4.4691	-10.5100	-1.3096	-3.0798
KL	-0.0557 (0.51)	0.1795 (1.93)	0.3467 (0.27)	3.1048 (2.85)	0.1009 (0.27)	0.9035 (2.83)
KE	0.0307 (2.10)	0.0646 (2.67)	3.0068 (3.14)	5.2186 (3.30)	0.1572 (0.56)	0.2728 (0.59)
KM	0.2016 (2.48)	0.4512 (2.65)	2.8912 (3.79)	5.2338 (3.27)	1.0515 (4.70)	1.9035 (4.06)
LL	0.0388 (0.47)	0.146 (0.30)	-1.9788 (2.03)	-2.2643 (3.96)	-0.5758 (2.03)	-0.6589 (3.96)
LE	-0.0070 (0.73)	-0.0284 (2.75)	0.5394 (0.86)	-0.8650 (1.28)	0.0282 (0.15)	-0.0452 (0.23)
LM	0.0240 (0.65)	-0.1657 (3.05)	1.2262 (3.54)	-0.5656 (1.10)	0.4460 (4.42)	-0.2057 (1.38)
EE	0.0051 (7.95)	0.0527 (7.20)	2.0253 (0.80)	1.1477 (0.42)	0.1059 (0.80)	0.0600 (0.42)
EM	-0.0788 (8.94)	-0.0889 (5.48)	-3.1453 (6.78)	-3.6778 (4.30)	-1.1439 (47.18)	-1.3375 (29.96)
MM	-0.1467 (3.17)	-0.1966 (1.70)	-2.8586 (8.19)	-3.2357 (3.70)	-1.0396 (8.19)	-1.1768 (3.70)
KQ		0.1859				
LQ		-0.1511 (3.77)				
MQ		-0.0275 (0.33)				
EQ		-0.0073 (0.65)				

Table A25

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

Crude Petroleum, Natural Gas and Service Incidental to Mining

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	0.2063	0.0712	-0.1656	-0.6789	-0.0849	-0.3483
KL	-0.1548 (4.88)	-0.0294 (0.86)	-4.9743 (4.07)	-0.1355 (0.10)	-0.2512 (0.40)	-0.0068 (0.01)
KE	-0.0383 (8.76)	-0.0153 (3.13)	-6.0678 (7.52)	-1.8179 (2.10)	-0.0641 (0.15)	-0.0192 (0.04)
KM	-0.0132 (0.50)	-0.0265 (1.00)	0.9396 (7.77)	0.8789 (7.32)	0.4002 (6.45)	0.3743 (6.10)
LL	0.1842 (6.70)	0.0998 (3.32)	53.4220 (4.95)	20.3390 (1.73)	2.6977 (4.95)	1.0271 (1.73)
LE	0.0446 (11.12)	-0.0016 (0.24)	84.7050 (11.25)	-2.0860 (0.16)	0.8942 (2.35)	-0.2202 (0.03)
LM	-0.0740 (7.61)	-0.0687 (7.09)	-2.4416 (5.40)	-2.1965 (4.86)	-1.0399 (45.56)	-0.9355 (41.10)
EE	0.0025 (2.29)	0.0238 (4.34)	-71.6490 (7.43)	120.0100 (2.43)	-0.7563 (7.43)	1.2669 (2.44)
EM	-0.0088 (7.73)	-0.0069 (5.80)	-0.9581 (3.78)	-05374 (2.00)	-0.4081 (152.70)	-0.2289 (81.86)
MM	0.0960 (5.30)	0.1021 (5.66)	-0.8186 (8.20)	-0.7849 (7.89)	-0.3486 (8.20)	-0.3343 (7.89)
KQ		-0.0406				
LQ		-0.0333 (5.69)				
MQ		0.0691 (7.15)				
EQ		0.0049 (2.29)				

Table A26

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

Nonmetal Mining Industries

Variable	α_{iJ} Model I	α_{iJ} Model II	σ_{iJ} Model I	σ_{iJ} Model II	ε_{iJ} Model I	ε_{iJ} Model II
KK	-0.1236	-0.0984	-3.7632	-3.4778	-1.1185	-1.0337
KL	0.1087 (1.17)	0.0632 (0.82)	2.0476 (2.29)	1.6091 (2.17)	0.7146 (2.69)	0.5616 (2.55)
KE	0.0295 (2.90)	0.0317 (2.86)	3.4136 (4.11)	3.5901 (3.97)	0.1405 (0.57)	0.1478 (0.55)
KM	-0.0146 (0.38)	0.0035 (0.10)	0.8425 (2.02)	1.0375 (2.10)	0.2634 (2.12)	0.3243 (2.12)
LL	0.0387 (0.41)	0.1918 (2.00)	-1.5476 (2.01)	-0.2906 (0.37)	-0.5402 (2.01)	-0.1014 (0.37)
LE	-0.0453 (5.23)	-0.0540 (4.77)	-2.1530 (3.57)	-2.7586 (3.50)	-0.0886 (0.42)	-0.1136 (0.41)
LM	-0.1021 (3.56)	-0.2010 (4.19)	0.0645 (0.25)	-0.8423 (1.91)	0.0202 (0.22)	-0.2633 (1.71)
EE	0.0623 (2.90)	0.0568 (5.10)	13.4850 (2.38)	10.2380 (1.55)	0.5551 (2.38)	0.4215 (1.55)
EM	-0.0466 (3.82)	-0.0345 (2.40)	-2.6178 (2.76)	-1.6819 (1.50)	-0.8183 (20.99)	-0.5258 (11.41)
MM	0.1632 (4.97)	0.2320 (4.38)	-2.1530 (1.57)	0.1755 (0.33)	-0.1652 (1.57)	0.0549 (0.33)
KQ		0.0089				
LQ		-0.0602 (2.30)				
MQ		0.0478 (1.71)				
EQ		0.0035 (0.68)				

Table A27

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})

Air Transportation

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0618	-0.2232	-5.9457	-10.3850	-1.1335	-1.9798
KL	0.0640 (0.80)	-0.0090 (0.10)	1.9134 (1.66)	0.8690 (0.61)	0.6963 (3.15)	0.3133 (1.16)
KE	0.0060 (0.39)	0.0223 (1.29)	1.3090 (1.65)	2.1477 (2.41)	0.1333 (0.88)	0.2188 (1.29)
KM	-0.0082 (0.27)	0.2099 (2.10)	0.8757 (1.90)	4.1726 (2.64)	0.3039 (3.45)	1.4478 (4.80)
LL	-0.0956 (0.97)	0.0282 (0.14)	-2.5090 (3.32)	-1.5566 (1.01)	-0.9045 (3.32)	-0.5612 (1.01)
LE	0.0339 (1.87)	0.0189 (0.73)	1.9247 (3.88)	1.5167 (2.14)	0.1961 (1.10)	0.1545 (0.61)
LM	-0.0024 (0.10)	-0.0382 (0.20)	0.9807 (3.28)	0.6946 (0.46)	0.3403 (3.16)	0.2410 (0.44)
EE	0.0830 (12.38)	0.0838 (13.51)	-0.8175 (1.26)	-0.7409 (1.24)	-0.0833 (1.26)	-0.0755 (1.24)
EM	-0.1230 (13.53)	-0.1251 (4.62)	-2.4800 (9.64)	-2.5384 (3.32)	-0.8601 (32.83)	-0.8808 (11.29)
MM	0.1336 (4.10)	-0.0466 (0.22)	-0.7723 (2.83)	-2.2691 (1.27)	-0.2680 (2.83)	-0.7873 (1.27)
KQ		0.0889				
LQ		-0.0155 (0.23)				
MQ		-0.0740 (0.96)				
EQ		-0.0006 (0.10)				

Table A28

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij})
Rail Transportation

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.1725	-0.2364	-105.5400	-136.7800	-4.7723	-6.1850
KL	0.0544 (0.87)	0.0776 (1.24)	3.2029 (1.27)	4.1421 (1.64)	1.7500 (15.36)	2.2632 (19.77)
KE	0.0242 (3.10)	0.0166 (2.20)	10.2930 (3.40)	7.3866 (2.56)	0.5927 (4.33)	0.4253 (3.25)
KM	0.0939 (4.24)	0.1422 (3.58)	6.9257 (4.96)	9.9671 (3.98)	2.4296 (38.45)	2.2632 (30.86)
LL	-0.0757 (1.10)	-0.1253 (1.53)	-1.0836 (4.54)	-1.2500 (4.55)	-0.5921 (4.54)	-0.6830 (4.54)
LE	-0.0047 (0.53)	-0.0252 (2.45)	0.8513 (30.54)	0.1961 (0.60)	0.0490 (3.22)	0.0113 (0.06)
LM	0.0259 (1.20)	0.0729 (1.53)	1.1352 (10.11)	1.3808 (5.55)	0.3982 (6.49)	0.4844 (3.57)
EE	0.0288 (10.79)	0.0404 (14.34)	-7.6908 (9.57)	-4.1686 (4.90)	-0.4428 (9.57)	-0.2011 (4.90)
EM	-0.0483 (13.60)	-0.0318 (4.48)	-1.3903 (7.91)	-0.5733 (1.64)	-0.4877 (48.20)	-0.2011 (9.95)
MM	-0.07163 (5.46)	-0.1835 (4.67)	-2.4327 (22.80)	-3.3413 (10.47)	-0.8534 (22.80)	-1.1722 (10.47)
KQ		0.0400				
LQ		0.0180 (0.50)				
MQ		-0.0786 (2.62)				
EQ		0.0206 (3.59)				

Table A29

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})
Trucking Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.1016	-0.0859	-4.7559	-4.4969	-1.679	-1.1043
KL	0.0052 (0.30)	0.0475 (1.85)	1.0586 (5.22)	1.5353 (5.30)	0.3822 (7.67)	0.5543 (7.79)
KE	-0.0471 (8.10)	-0.0349 (3.80)	-1.8827 (5.94)	-1.1340 (2.02)	-0.1253 (1.61)	-0.0755 (0.55)
KM	0.1435 (18.87)	0.0733 (3.22)	2.7872 (29.44)	1.9137 (6.75)	0.9110 (39.19)	0.6255 (8.98)
LL	0.0434 (2.03)	0.1059 (1.52)	-1.4370 (8.78)	-0.9574 (1.79)	-0.5188 (8.78)	-0.3456 (1.79)
LE	0.0169 (2.58)	0.0452 (2.26)	1.7056 (6.24)	2.8802 (3.47)	0.1135 (1.15)	0.1917 (0.64)
LM	-0.0655 (5.93)	-0.1985 (3.70)	0.4445 (4.75)	-0.6825 (1.50)	0.1435 (4.30)	-0.2230 (1.36)
EE	0.0773 (15.33)	0.0614 (7.25)	3.4236 (3.00)	-0.1661 (0.01)	0.2278 (3.00)	-0.0110 (0.01)
EM	-0.0471 (10.40)	-0.0717 (4.46)	-1.664 (5.59)	-2.2953 (3.10)	-0.3813 (27.48)	-0.7503 (15.25)
MM	-0.0308 (2.16)	0.1969 (3.60)	-2.3475 (17.62)	-0.2167 (0.42)	-0.7673 (17.62)	-0.0108 (0.42)
KQ		-0.0418				
LQ		-0.0776 (1.95)				
MQ		0.1440 (3.75)				
EQ		-0.0246 (1.90)				

Table A30

Estimates of Translog Coefficients (α_{ij}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{ij})
Pipeline Transportation

Variable	α_{ij}		σ_{ij}		ε_{ij}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.2889	-0.0116	-1.5000	-0.7154	-0.8915	-0.4252
KL	0.0376 (0.75)	0.0716 (1.61)	1.8765 (1.60)	2.6716 (2.57)	0.1353 (0.19)	0.1927 (0.31)
KE	-0.0154 (1.34)	0.0015 (0.12)	0.5672 ((1.75)	1.0415 (2.96)	0.0341 (0.18)	0.0626 (0.30)
KM	0.2667 (7.79)	-0.0615 (0.57)	2.6407 (12.54)	0.6407 (0.94)	0.6216 (5.77)	0.7221 (0.43)
LL	-0.0479 (0.89)	0.0431 (0.77)	-22.0870 (2.14)	-4.5848 (0.43)	-1.5928 (2.14)	-0.3306 (0.43)
LE	0.0336 (2.77)	0.0112 (0.89)	8.7610 (3.12)	3.5805 (1.23)	0.5264 (2.60)	0.2151 (1.00)
LM	-0.0232 (1.21)	-0.1259 (2.50)	-0.1788 (0.18)	-5.3840 (2.10)	-0.0489 (0.70)	-1.4723 (7.99)
EE	0.0754 (16.27)	0.0724 (14.77)	5.2403 (4.08)	4.4180 (3.25)	0.3149 (4.08)	0.2655 (3.25)
EM	-0.0936 (16.15)	-0.851 (5.66)	-4.6946 (13.31)	-4.1786 (4.57)	-1.2838 (60.60)	-1.427 (20.79)
MM	-0.1498 (3.70)	0.2725 (2.34)	-4.6607 (8.60)	0.9870 (0.64)	-1.2745 (8.60)	0.2699 (0.63)
KQ		-0.1476				
LQ		-0.0484 (2.40)				
MQ		0.1941 (3.87)				
EQ		0.0019 (0.31)				

Table A31

Estimates of Translog Coefficients (α_{iJ}), elasticity of substitution (σ_{ij}), and own and cross-price elasticities (ε_{iJ})
Other Transportation Industries

Variable	α_{iJ}		σ_{iJ}		ε_{iJ}	
	Model I	Model II	Model I	Model II	Model I	Model II
KK	-0.0948	0.0404	-17.2940	-4.8683	-1.8044	-0.5079
KL	-0.1129 (1.29)	-0.190 (0.24)	-1.5281 (0.78)	0.5734 (0.32)	-0.6538 (3.21)	0.2453 (1.33)
KE	0.0115 (1.96)	-0.0104 (1.19)	2.6676 (3.13)	-0.5130 (0.40)	0.1758 (1.98)	-0.0338 (0.25)
KM	0.1962 (7.65)	-0.0110 (0.16)	5.6787 (9.28)	0.7375 (0.46)	2.2824 (35.76)	0.2964 (1.77)
LL	0.1649 (1.60)	0.2158 (1.44)	-0.4362 (0.77)	-0.1584 (0.20)	-0.1866 (0.78)	-0.0678 (0.19)
LE	-0.0076 (1.19)	-0.0 314 (2.72)	0.7303 (3.22)	-0.1124 (0.27)	0.0481 (0.50)	-0.0074 (0.04)
LM	-0.0449 (1.45)	-0.1654 (1.48)	0.7413 (4.16)	0.0382 (0.06)	0.2979 (3.90)	0.0153 (0.05)
EE	0.0598 (27.22)	0.0605 (26.63)	-0.4149 (0.82)	-0.2368 (0.45)	-0.0273 (0.82)	-0.0156 (0.45)
EM	-0.0636 (19.99)	-0.0188 (1.65)	-1.4018 (11.67)	0.2916 (0.68)	-0.5634 (71.15)	0.1172 (4.15)
MM	-0.0881 (3.94)	0.1952 (1.85)	-2.0334 (14.72)	-0.2799 (0.43)	-0.8173 (14.72)	-0.1125 (0.43)
KQ		-0.2076				
LQ		-0.1091 (1.21)				
MQ		0.2773 (3.12)				
EQ		0.0394 (4.10)				

FOOTNOTES

1 See Rao (1978, 1979), Ostry and Rao (1979), Blain (1977), C.D. Howe Research Institute (1979-1978), and Sims & Stanton (1980).

2 Energy intensity is defined, as the share of energy consumption in total output.

3 Berndt and Wood (1975), Hudson and Jorgenson (1974), Griffin and Gregory (1976), Norsworthy (1979) and Griffin (1974).

4 We can also estimate the substitution elasticities by using production function rather than the cost function. However, in this study we use cost function since it is more appropriate to take prices as exogenous than quantities.

5 Examples of use of translog functions can be found in Berndt and Christensen (1973), Berndt and Wood (1975), Fuss (1977), Fuss and Waverman (1975), Griffin and Gregory (1976), Hudson and Jorgenson (1974), Humphrey and Moroney (1977) and various other studies.

6 See Christensen, Jorgenson and Lau (1973).

7 A detaile description of the data sources is given in the Appendix.

8 For example, Hudson and Jorgenson (1974), Berndt and Wood (1975) have imposed the homothecity assumption.

9 In the tables α_{iJ} , σ_{iJ}, and ε_{iJ} represent translog coefficients, substitution elasticities and price elasticities respectively. For these estimates, t-ratios are recorded in parenthesis.

10 In the time-series regressions, output variable might also pick-up some of the cyclical variations in factor shares, and leads to more reliable estimates of long-run elasticities.

11 However, as pointed out in Section II, the uneven distribution of energy consumption among the manufacturing industries, might give biased estimates of aggregate relationships between energy and other factors of production. Therefore, conclusions about these relationships should be based on the estimates of energy intensive industries.

12 As reported in Section II durable industries account for 60% of the total energy consumption in the manufacturing industry. This suggests that in drawing the final

conclusions about the relationships between energy and other inputs, we should carefully examine these relationships for the energy intensive manufacturing industries. In Section V, we will provide a summary of these relationships for the energy intensive industries.

13 For this industry, there is very little difference between Model I and Model II results.

14 However, this finding is not consistent with the results of the individual transportation industries. This in turn implies that the positive price energy elasticity is the result of aggregation bias.

References

Allen, R.G.D. (1938), Mathematical Analysis for Economists, London: The Macmillan Co., 1938.

Berndt, E.R. and L. Christensen (1973), "The Translog Function and the Substitution of Equipment, Structures, and Labour in U.S. Manufacturing, 1929-1968", Journal of Econometrics, 1 March 1973, pp. 81-114.

__________ (1973), "The Internal Structure of Functional Relationships: Separability, Substitution and Aggregation", Review of Economic Studies, 40, July, 1973, pp. 403-10.

__________ and D. Wood (1975), "The Technology, Prices, and the Derived Demand for Energy", Review of Economics and Statistics, 57, August 1975, pp. 259-68.

__________, M.A. Fuss and L. Waverman (1979), "A Dynamic Model of Costs of Adjustments and Interrelated Factor Demands, with an Empirical Application to Energy Demand in U.S. Manufacturing", EPRI, Final Report, 1979.

Blain, L. (1977), "Recent Developments in Aggregate Labour Productivity", Bank of Canada Review, 1977, pp. 3-15.

Burgess, D.F. (1975), "Duality Theory and Pitfalls in the Specification of Technologies", Journal of Econometrics, 3, 1975.

C.D. Howe Research Institute (1979), "Policy Review and Outlook, 1979: Anticipating the Unexpected."

Carmicheal, E.A. (1979), "Reassessing Canada's Potential Economic Growth", The Conference Board in Canada, 1979.

Christensen, L.R., D. Jorgenson and L. Laù (1973), "Transcendental Logarithmic Production Frontiers", the Review of Economics and Statistics, 55, Feb. 1973, pp. 28-45.

Diewert, W.E. (1971), "An Application of the Shephard Duality Theorem: A Generalized Leonties Production Function", Journal of Political Economy, 79, 1971, pp. 481-507.

Fuss, M.A. (1977), "The Demand for Energy in Canadian Manufacturing", Journal of Econometrics, 5, 1977.

__________ and L. Waverman (1975), "The Demand for Energy in Canada", Working Paper, Institute for Policy Analysis, University of Toronto, 1975.

Griffin, J.M. (1974), "The Effects of Higher Prices on Electricity Consumption", The Bell Journal of Economics and Management Science, Autumn 1974.

Hudson, E.A. and D.W. Jorgenson (1974), "U.S. Energy Policy and Economic Growth, 1975-2000", The Bell Journal of Economics and Management Science, Autumn 1974.

Humphrey, D.B. and A. Toevs (1977), "Factor Costs and Factor Use: An Analysis of Labour Capital and Natural Resource Inputs", Southern Economic Journal, Vol. 44, No. 2, October 1977, pp. 222-239.

______________ and J.R. Morney (1975), "Substitution among Capital, Labour, and Natural Resource Products in American Manufacturing", Journal of Political Economy 83, Feb. 1975.

McRae, R.N. (1978), "Regional Demand for Energy by Canadian Manufacturing Industries", Canadian Energy Research Institute, Working Paper 78-7.

Norsworthy, J.R. and Harper (1979), "The Role of Capital Formation in the Recent Slowdown in Productivity Growth", Working Paper 87, U.S. Department of Labour, Bureau of Labour Statistics, 1979.

Ostry, S. and P.S. Rao (1979), "Productivity Trends in Canada", paper presented at the Conference on Lagging Productivity Growth, Toronto, May 24, 1979.

Parks, R.W. (1971), "Price Responsiveness of Factor Utilization in Swedish Manufacturing, 1890-1950", The Review of Economics and Statistics, 1971, Vol. LII, No. 2, pp. 129-139.

Pindyck, R.S. (1979), "Interfuel Substitution and the Industrial Demand for Energy: an International Comparison", The Review of Economics and Statistics.

Rao, P.S. (1978), "An Econometric Analysis of Labour Productivity in Canadian Industries", Economic Council of Canada, 1978 Discussion Paper No. 125.

__________ (1979), "An Econometric Analysis of Labour Productivity in Canadian Industries: Some Further Results", Economic Council of Canada, 1979, Discussion Paper No. 134.

Samuelson, P.A. (1947), "Foundations of Economic Analysis", Cambridge: Harvard University Press, 1947.

Shephard, R.W. (1953), "Cost and Production Functions", Princeton: Princeton University Press, 1953.

Sims, H. and J. Stanton (1980), "Recent Changes in Patterns of Productivity Growth in Canada", unpublished paper, Department of Finance, Canada, 1980.

Tatom, J.A. (1979), "Energy Prices and Capital Formation: 1972-1977", Federal Reserve Bank of St. Louis, May 1979.

Uzawa, H. (1962), "Production Functions with Constant Elasticities of Substitution", Review of Economic Studies, 29, 1962, pp. 291-299.

Zellner, A.M. (1962), "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias", Journal of American Statistical Association, 57, June 1962, pp. 585-612.

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Rao, P. Someshwar 1947-
Factor prices and
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