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THE SLOWDOWN IN PRODUCTIVITY GROWTH IN THE 1975-83 PERIOD: A SURVEY OF POSSIBLE EXPLANATIONS

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ABSTRACT

The growth rates of both aggregate factor and labour productivity in Canada fell substantially during the period 1975-83. This paper examines this phenomenon and reviews a number of possible explanations for it.

First, the productivity growth slowdown is examined at various levels of industry disaggregation. It is apparent from this analysis that the slowdown varied widely across industries, with resource-based and energy-related industries generally experiencing the largest declines.

Next, some possible explanations for the productivity slowdown are discussed. Factors related to labour productivity in an immediate accounting sense, such as changes in the capital/labour ratio, are analyzed first. Although some slowing in the growth rate of capital/labour ratios was found in selected industries, this was not universal. Problems with capital stock measurements, which may have become worse in recent years, are also noted.

More fundamental explanations for the productivity slowdown can be subsumed under the general subject of changes in the economic environment faced by firms. One of these changes was the rise in the relative price of energy. Econometrically, nearly half of the slowdown in labour productivity growth in the non-energy commercial sector can be explained by the energy price shock. However, the exact nature of the mechanism linking productivity to energy costs is not clear.

The role played by lower rates of growth of aggregate demand and lower capacity utilization rates is also examined. It is suggested that, at most, 25 per cent of the productivity slowdown can be explained by this factor.

The increase in the rate of inflation that took place during the early 1970s is also considered as a reason for the slowdown. While there is some statistical evidence of a causal relationship from inflation to productivity growth, the empirical evidence is weak. However, this factor may account for a sizeable proportion of the remaining 25 per cent of the slowdown in labour productivity growth in the non-energy commercial

sector. As well, the effects of increased regulation and resource depletion may have played a role in selected sectors such as mining. Other factors considered include intersectoral movements of labour and changes in work force characteristics. These do not appear to have played more than a marginal role in explaining the productivity slowdown.

RÉSUMÉ

Le taux de croissance de la productivité tant de l'ensemble des facteurs que du travail au Canada s'est ralenti substantiellement entre la période 1954-1974 et la période 1975-1983. La présente étude vise à examiner ce phénomène et à passer en revue certaines hypothèses qui ont été avancées ces derniers temps pour l'expliquer.

En premier lieu, nous examinons le ralentissement de la croissance de la productivité à la lumière de divers découpages du secteur industriel. Il est clair que la ralentissement de la productivité a varié fortement d'une industrie à l'autre et que c'est dans les industries d'exploitation des ressources naturelles et celles du secteur énergétique qu'il a été le plus prononcé.

Nous passons ensuite en revue quelques facteurs susceptibles d'expliquer le ralentissement de la productivité, en commençant par ceux qui, comme les modifications du ratio capital-travail, influencent la productivité du travail au sens comptable le plus étroit. Il convient de faire remarquer que si la progression de ce ratio s'est quelque peu ralentie dans certains secteurs industriels, ce n'est pas le cas pour toutes les industries. Nous nous intéressons aussi aux problèmes de mesure du stock de capital, qui ont peut-être été aggravés ces dernières années.

Les causes plus profondes du ralentissement de la productivité peuvent être groupées sous le thème général des modifications de la conjoncture économique auxquelles ont fait face les entreprises. L'une de ces modifications est la hausse du prix de l'énergie. Sur le plan économétrique, près de la moitié du ralentissement de la productivité du travail dans le secteur commercial non énergétique pourrait s'expliquer par le choc des prix de l'énergie. Cependant, la nature exacte du mécanisme liant ces phénomènes n'est pas très claire.

Nous examinons également le rôle qu'ont joué la décélération de la demande globale et la baisse des taux d'utilisation des capacités. Nous

croyons que ces facteurs peuvent expliquer tout au plus 25% du ralentissement de la productivité.

Nous retenons en outre l'accroissement du taux d'inflation enregistré depuis le début des années soixante-dix comme facteur possible du ralentissement de la productivité. Même si les tests statistiques corroborent en quelque sorte l'hypothèse d'un lien de causalité entre l'inflation et la croissance de la productivité, les résultats empiriques obtenus à ce sujet sont plutôt incomplets. Toutefois, ce facteur peut expliquer une bonne partie des 25% du ralentissement de la productivité du travail dans le secteur commercial non énergétique qui restent à expliquer. Les effets d'une réglementation accrue et de l'épuisement des ressources ont pu également rejaillir sur la productivité dans certains secteurs tels que celui de l'extraction minière. Enfin, nous prenons en considérons des facteurs secondaires comme les déplacements intersectoriels des travailleurs et les modifications des caractéristiques de la main-d'oeuvre. Aucun de ces facteurs ne semble constituer une cause importante du ralentissement de la productivité.

1 INTRODUCTION

In its most general sense,[1] productivity may be defined as output per weighted unit of input. This concept is normally linked to the theory of production, which describes how scarce resources are used to produce goods and services. We illustrate this concept with the following simple production function:

$$Q = F*K^{b}*L^{1-b} \quad (1)$$

where Q = output,
F = total factor productivity,
K = capital input, and
L = labour input.

In this production function, total factor productivity (hereafter referred to simply as "factor productivity") measures the efficiency with which capital and labour are used to produce output. Over time, the level of factor productivity might be expected to rise because of, for instance, increases in scientific knowledge and subsequent improvements in technology.

The simple concept of labour productivity (output per employee or output per man-hour) is also often used. In the production function framework used in equation (1), the following can be shown:

$$Q/L = F*(K/L)^{b} \quad (2)$$

In this example, it is clear that labour productivity depends both on factor productivity and the capital/labour ratio. While both concepts of productivity are discussed in this report, the emphasis will be on labour productivity.

It has been evident that the trend rate of labour productivity growth in many developed economies has fallen substantially since the early

1. For general discussions of the concept of productivity, see for instance Rees (1980), Berndt and Watkins (1981) and Denny and Fuss (1982).

1970s. In Canada, the average annual rate of growth of real GNE per employed person was about 2.2 per cent through the two decades from 1954 to 1974 but declined to about 0.3 per cent over the 1975-83 period.

In this paper some recently suggested explanations for the slowdown in productivity growth are reviewed.[2] In Section 2 the stylized facts for aggregate productivity growth performance in Canada are outlined, as well as the reasons for our concern with productivity growth. In Section 3, we examine the productivity growth slowdown phenomenon at the industry level. Here we wish to find out whether most industries experienced a slowdown in productivity growth after the early 1970s. In the following sections, various possible explanations for the slowdown are discussed and some statistical evidence on the validity of each is given. In the spirit of the discussion at the beginning of this section, we begin in Section 4 with an examination of evidence on the rate of growth of capital/labour ratios, both at the aggregate and the industry level. This is followed by a discussion of factors that could have influenced factor productivity growth and/or the relative use of capital, labour and other inputs. In Section 5 the facts on the cyclical behaviour of labour productivity are reviewed, as well as the hypothesis that cyclical weakness in aggregate demand was at least partly responsible for the slowdown in productivity growth. In Sections 6-11, we review a number of economy-wide structural factors that may have contributed to the productivity growth slowdown; these include medium-term output growth, intersectoral movements of labour, increases in the relative price of energy, spending on research and development, work force characteristics and inflation. For example, the mining sector experienced a particularly pronounced slowdown in productivity growth and in Section 12, we examine whether structural characteristics peculiar to this sector might be partly responsible for this phenomenon. In Section 13, hypotheses presented in earlier sections are drawn together to see to what extent the productivity slowdown in the

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2. Other recent surveys of the productivity slowdown literature include Denny and Fuss (1982) and Sharpe (1982).

manufacturing sector can be explained. The paper concludes with a summary of the results of this analysis.

2 IMPORTANCE OF PRODUCTIVITY GROWTH

Using the framework presented in the previous section, the trend rate of economic growth can be decomposed into growth of both labour and capital, as well as an unexplained residual, which is generally termed total factor productivity (or simply factor productivity) growth. In Table 1, aggregate growth performance in Canada is shown for three periods: 1929-53, 1954-74 and 1975-83.[3] The annual growth of real GNE increased from 3.6 per cent over the 1929-53 period to 4.9 per cent over the 1954-74 period, an increase which is more than wholly accounted for by faster growth of both employment and the capital stock. The annual growth of factor productivity fell from 1.8 per cent over the 1929-53 period to 1 per cent over the 1954-74 period. For the 1975-83 period, real GNE increased at an annual rate of 2.1 per cent, a slowdown which resulted from lower growth of employment, the capital stock, and factor productivity. In fact, factor productivity fell at an annual rate of 0.8 per cent during the 1975-83 period.

Trends in both factor and labour productivity growth for various subperiods over the 1929-83 period are shown in Table 2.[4] As can be

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3. In Table 1, the following years were chosen as business cycle peaks: 1928, 1953 and 1974. In the year following each designated peak, there was either a decline in real GNE or at least a substantial decline in the rate of growth of real GNE. The year 1974 was used as a cyclical peak instead of 1973, because the annual growth of real GNE in 1974 was not unusually low by comparison with postwar experience. The year 1983 was also chosen as an end point in order to give a fairly current picture of productivity performance. Data on real GNE, nominal gross domestic product at factor cost and labour income are taken from Statistics Canada's System of National Accounts, National Income and Expenditure Accounts (13-201) and earlier publications. The data on real GNE and gross domestic product do not include the revisions which were scheduled to be released in the summer of 1986. Employment data are taken from Statistics Canada's The Labour Force (71-001) and earlier publications. Capital stock data are taken from Statistics Canada's Fixed Capital Flows and Stocks (13-211). An average value for the shares of labour and capital in aggregate nominal output for each period shown in Table 1 was calculated using the data for nominal gross domestic product at factor cost and labour income. These average factor shares were then used with the data for the labour and capital inputs to calculate an index of the aggregate factor input (K^b*L^{1-b}), as shown in equation (1) of the previous chapter. Finally an index of total factor productivity was calculated as the ratio of real GNE and the aggregate factor input, again using equation (1) in the previous chapter.

4. For this and subsequent analyses, the following years have been chosen as business cycle peaks: 1928, 1937, 1944, 1953, 1974, 1979 and 1981. The 1967-74 period was chosen in order to facilitate comparisons of two alternative measures of aggregate factor productivity growth.

Table 1

AGGREGATE ECONOMIC GROWTH IN CANADA
(Compound annual growth rate - %)

	1929-53	1954-74	1975-83
Real GNE	3.6	4.9	2.1
Employment	1.3	2.6	1.8
Capital stock	2.5	5.6	4.4
Aggregate factor input	1.8	3.9	2.9
Factor productivity	1.8	1.0	-0.8

Source: Statistics Canada

seen, the rate of factor productivity growth for the total economy over the 1975-83 period was lower than at any time since the 1929-37 period. There is also a slowdown after 1974 in the rate of growth of aggregate factor productivity for the private business sector, as measured in the Bank of Canada RDXF model database.

As noted in the previous section, labour productivity measures represent the combined effect of the relative use of capital and labour -- the capital/labour ratio -- and total factor productivity (see equation (2)). Table 2 reveals that growth of aggregate labour productivity has differed somewhat from that of aggregate factor productivity. For instance, labour productivity grew at virtually the same rate in both in the 1929-53 and 1954-74 periods. A slower rate of growth of factor productivity was virtually offset by faster growth of the capital stock per employee during the 1954-74 period. However, the slowdown in labour productivity growth between the 1954-74 and 1975-83 periods largely results from a reduction in the growth of factor productivity.

Table 2

TRENDS IN PRODUCTIVITY GROWTH AT THE AGGREGATE LEVEL
(Compound annual growth rate - %)

	1929-1937	1938-1944	1945-1953	1929-1953	1954-1974	1967-1974	1975-1979	1975-1981	1975-1983
Factor productivity-total economy	-1.0	7.2	0.5	1.8	1.0	1.2	-0.3	-0.6	-0.8
Factor productivity-private business sector	N/A	N/A	N/A	N/A	N/A	2.1	0.1	-0.4	-0.5
Labour productivity - real gross national expenditure per employed worker	-1.2	7.5	1.8	2.3	2.2	2.1	0.5	0.1	0.3
Capital stock per employee	-0.4	0.8	3.0	1.2	2.9	2.3	2.0	1.9	2.6

Source: Statistics Canada and Bank of Canada.

Why should we be concerned about the recent deceleration in the rate of growth of productivity? Over the longer run, increases in productivity are generally considered to be the main source of improvement in the living standards of workers.[5] A slowdown in productivity growth may also make it more difficult to raise the living standards of the poorer segments of the population through income transfers and increased government spending, since such policies are more likely to necessitate a reduction in the material well-being of the remainder of the population. The lower rate of growth of productivity may have adversely affected Canada's international competitiveness and hence foreign demand for Canadian goods. Some have suggested that lower productivity growth has led to higher employment, though the notion of a long-run trade-off between employment and productivity growth was discounted in the report of the Royal Commission on the Economic Union and Development Prospects for Canada (1985).

The measurement of longer-run productivity growth, an important element in the determination of the growth of potential output, may also have implications for macroeconomic policy. For example, difficulties in measuring the gap between actual and potential output could lead to policy error. Misperceptions about productivity growth by private economic agents may also affect macroeconomic performance. For instance, if workers continue to expect increases in real wages during periods of zero productivity growth, these demands could result in either an increase in the inflation rate (given an accommodating monetary policy) or an increase in the unemployment rate if the authorities resist the increased inflationary pressures.

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5. The growth of per capita living standards may be influenced by other factors. For instance, a larger proportion of the population may become employed. For further discussion of this question, see Freedman (1977) and Bank of Canada (1983). Rising living standards may also be associated with increasing non-quantifiable costs such as environmental damage. For a general discussion of the relationship between economic welfare and the environment, see Hueting (1980).

3 THE PRODUCTIVITY SLOWDOWN AT THE INDUSTRY LEVEL

In this section, we provide a comprehensive picture of the productivity slowdown phenomenon at the industry level. We wish to see whether there has been a wide variation in the degree of deceleration in productivity growth among different industries. Such information might provide some clues as to the factors behind the decline in productivity growth. Trends in labour productivity growth are examined first, since historical trends can be observed over long periods and relatively up-to-date statistics generated. In the second part of this section, the performance of factor productivity growth at the industry level will be examined.

Labour productivity trends are first examined at the broad sectoral level using data published by Statistics Canada (Table 3). From this point on, attention will generally be focused on the commercial non-farm sector (manufacturing, other goods-producing industries,[6] and commercial services-producing industries[7]) because output and productivity developments in the farm sector are often severely affected in the short term by weather changes. The information published by Statistics Canada also enables us to measure labour productivity either in terms of output per employee or of output per man-hour worked.

As previously noted for the aggregate economy, the general tendency for the growth of labour productivity to fall in both the 1975-81 and 1975-83 periods is also evident in the commercial non-farm sector. While there was some variation in labour productivity growth from cycle to cycle in the 1954-74 period in this sector, the post-1974 experience is far different. All three of the major components of the commercial non-farm sector contributed to this drop in productivity growth. When one compares the 1954-74 and 1975-81 periods, as well as the 1954-74 and 1975-83 periods, other goods-producing industries experienced the largest fall in productivity growth, while the decline in the commercial services sector was smallest. However, it should be noted that the growth of productivity

6. This group consists of forestry, fishing and trapping, mining, construction and electric power and gas distribution utilities.

7. This group is comprised of transportation (excluding highway and bridge maintenance), storage, communications, trade, finance, insurance and real estate, and business and personal services.

Table 3

LABOUR PRODUCTIVITY GROWTH
(Compound annual growth rate - %)

	1954-1956	1957-1959	1960-1969	1970-1974	1954-1974	1975-1979	1975-1981	1975-1983
Commercial non-farm:								
Per employee	4.2	2.1	2.8	2.4	2.8	1.0	0.5	0.5
Per man-hour worked	4.6	2.5	3.4	3.0	3.3	1.5	1.1	1.2
Commercial services:								
Per employee	2.1	0.4	1.7	1.9	1.6	0.9	0.4	0.3
Per man-hour worked	2.4	0.9	2.6	2.6	2.3	1.6	1.1	1.1
Commercial non-farm goods:								
Per employee	5.7	4.0	4.1	3.2	4.1	1.3	0.8	1.1
Per man-hour worked	6.4	4.3	4.4	3.6	4.5	1.7	1.2	1.5
Manufacturing:								
Per employee	4.8	2.9	4.4	3.8	4.1	1.9	1.2	1.4
Per man-hour worked	5.0	3.2	4.5	4.3	4.3	2.2	1.6	1.7
Other commercial non-farm goods:								
Per employee	6.6	5.3	3.7	2.0	3.9	0.2	0.0	0.4
Per man-hour worked	8.3	5.8	4.3	2.2	4.6	0.6	0.3	1.0

Source: Statistics Canada, Aggregate Productivity Measures (14-201) in other goods-producing industries has been declining in each business cycle since 1954, and the deceleration from 1970-74 to 1975-81 (as well as 1970-74 to 1975-83) may be partly associated with a longer-term trend. By contrast, there would seem to have been a major break in the trend rate of productivity growth in the manufacturing sector between 1970-74 and 1975-81 (and 1975-83). In the services-producing industries, the rate of productivity growth in 1975-81 (and in 1975-83) was substantially below the long-term trend but was about the same as in the late 1950s.

Productivity trends at the one-digit industry level are shown in Table 4. This level of disaggregation is concerned with broad types of activity such as mining and manufacturing. A net output measure (Gross Domestic Product in constant dollars, hereafter referred to as GDP) is used, while the labour input is measured with all-establishment employment data.[8] This information enables us to make an initial probe within the other goods-producing and services-producing sectors discussed above.[9]

Among the other goods-producing industries, it can be seen from Table 4 that the largest slowdown in labour productivity growth between 1962-74 and 1975-81 took place in the mining industry, followed by forestry. There is evidence of a sizeable rise in labour productivity in the forestry industry during 1983, though this development should be discounted given the preliminary nature of the output data for 1983 and the break in the employment series in March 1983. Over the same period there was little evidence of any change in trend growth rates in the construction industry. With respect to the services-producing industries, transportation, communications and other utilities, and trade experienced the largest declines in productivity growth between 1962-74 and 1975-81, while there was an actual improvement in productivity growth in the finance, insurance and real estate sector. Any observations for the

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8. Employment data in Table 4 are based on Statistics Canada's Estimates of Employees by Province and Industry (72-008). Data from a new employment survey (Employment, Earnings and Hours (72-002)) were used beginning in March 1983 and were linked to data from the old employment survey at the Bank of Canada. The employment data used in Table 4 differ from those used in Table 3 and consequently the estimates of labour productivity (output per employee) growth for the manufacturing sector in the two tables are not the same.

9. Electric power and gas distribution utilities are included in Transportation, Communications and Other Utilities in Table 4.

Table 4

LABOUR PRODUCTIVITY* GROWTH AT ONE-DIGIT INDUSTRY LEVEL
(Compound annual rates - %)

	1967-69	1970-74	1962-74	1975-79	1975-81	1975-83
Goods-producing:						
Manufacturing	4.7	3.3	3.7	2.1	1.1	1.6
Forestry	9.0	2.1	4.7	-0.2	0.3	4.1
Fishing and trapping	4.2	-3.2	-0.9	-1.8	-2.8	N/A
Mining	5.0	3.4	4.0	-4.0	-5.4	-2.7
Construction	2.6	0.3	0.8	1.1	1.2	1.9
Services-producing:						
Transportation, communications and other utilities	5.9	4.1	4.8	3.3	2.7	2.5
Trade	0.7	2.1	1.8	1.0	-0.1	0.4
Finance, insurance and real estate	-0.9	-0.7	-0.5	0.5	0.7	0.9
Other commercial services	1.4	0.8	0.5	0.2	0.1	0.3
Commercial non-farm	3.1	2.1	2.4	1.3	0.6	1.1

Source: Statistics Canada

* Labour productivity is defined as output per employee.

service sector should, however, be tempered by the remark that the quality of output data for many services-producing industries is rather poor.[10] The above remarks for the various services-producing industries also hold when comparing the 1962-74 and 1975-83 periods.

An examination of labour productivity trends at the two-digit industry level using large-establishment employment data to measure the labour input (Tables 5, 5A and 5B)[11] follows next. This includes a look at major manufacturing and mining industries. This information shows that there have been some striking variations in the extent to which the trend rate of growth of productivity fell after 1974.

Within the manufacturing category, there are only a few industries that exhibit a sharp break with past trends in productivity performance after 1974. These industries are: rubber, oil and coal products, and transportation equipment. In each case, output per employee actually fell between 1974 and 1981. However, in the case of transportation equipment, labour productivity increased between 1974 and 1983. Productivity growth rates during the 1975-81 period were also somewhat lower than for any subperiod during 1954-74 in the following industries: food and beverages, tobacco, paper and allied products, chemicals, and non-metallic mineral products. For most other manufacturing industries, productivity growth in the 1975-81 period was within the range of (sometimes) extremely variable levels for different cycles within the 1954-74 period.

In the other goods-producing industries category, metal mining exhibited a decline in the trend rate of growth of productivity beginning in the 1960-69 period, followed by oil and gas mining in the 1970-74 period. Output per employee actually declined between 1974 and 1983 in both of these industries. Another point of interest is the sharp break in productivity growth after 1974 in the utilities sector.

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10. For an evaluation of the quality of output data in different industries, see Statistics Canada's, Gross Domestic Product by Industry 1983 (61-213), pp. 195-215.

11. Employment data in Table 5 are taken from Statistics Canada's Employment, Earnings and Hours (72-002). A link between the old and new employment surveys (which began in March 1983) was constructed at the Bank of Canada.

Table 5

LABOUR PRODUCTIVITY* GROWTH AT TWO-DIGIT INDUSTRY LEVEL
(Compound annual rates - %)

	1929-37	1938-44	1945-53	1929-53	1954-56	1957-59	1960-69	1970-74	1954-74	1962-74	1975-79	1975-81	1975-83
Manufacturing:	0.90	1.60	1.95	1.48	4.60	2.83	4.26	3.82	4.00	4.15	2.86	1.94	2.23
Non-durables	N/A	1.31	2.82	N/A	4.48	3.56	3.63	3.62	3.74	3.68	2.66	1.92	2.19
Food and beverages	N/A	N/A	1.22	N/A	2.93	3.55	3.51	2.63	3.22	3.20	1.69	1.48	1.93
Tobacco	N/A	N/A	5.15	N/A	7.27	7.82	4.53	5.02	5.50	4.05	2.84	2.12	1.69
Rubber	N/A	N/A	3.90	N/A	3.68	6.27	2.84	3.59	3.62	4.48	1.42	-0.51	-0.25
Plastics	N/A	N/A	N/A	N/A	N/A	N/A	5.65	7.21	N/A	9.71	7.11	6.24	5.35
Leather	N/A	N/A	-0.82	N/A	5.52	2.08	1.96	1.55	2.38	1.66	4.33	3.32	3.18
Textiles	N/A	N/A	1.76	N/A	6.25	7.21	5.61	2.75	5.25	4.42	6.82	4.54	3.71
Clothing and knitting mills	N/A	N/A	-0.07	N/A	4.89	1.89	3.01	3.48	3.22	2.87	3.94	2.57	3.77
Clothing	N/A	N/A	N/A	N/A	N/A	N/A	2.16	3.15	N/A	2.40	4.04	2.20	3.64
Knitting mills	N/A	N/A	N/A	N/A	N/A	N/A	6.83	4.69	N/A	4.93	3.72	4.34	4.41
Paper and allied products	N/A	N/A	3.21	N/A	1.01	1.73	3.13	2.50	2.48	3.00	.65	0.46	1.35
Printing and publishing	N/A	N/A	3.71	N/A	5.13	1.04	1.76	4.93	2.88	3.11	3.24	2.94	1.95
Oil and coal products	N/A	N/A	4.19	N/A	9.02	4.08	4.92	6.39	5.73	5.26	-9.48	-7.82	-7.53
Chemicals	N/A	N/A	4.78	N/A	6.01	5.15	5.89	5.31	5.66	5.74	3.00	1.47	2.06
Miscellaneous manufacturing	N/A	N/A	N/A	N/A	N/A	N/A	2.94	3.31	N/A	2.96	4.13	2.40	3.14
Rubber, plastics and miscellaneous manufacturing	N/A	N/A	5.27	N/A	4.58	4.92	3.37	3.70	3.51	3.38	4.65	2.92	3.26

Source: Statistics Canada

* Labour productivity is defined as output per employee.

Table 5A

LABOUR PRODUCTIVITY* GROWTH AT TWO-DIGIT INDUSTRY LEVEL
(Compound annual rates - %)

	1929-37	1938-44	1945-53	1929-53	1954-56	1957-59	1960-69	1970-74	1954-74	1962-74	1975-79	1975-81	1975-83
Manufacturing:													
Durables	N/A	2.42	1.11	N/A	4.72	2.30	4.93	3.95	4.29	4.60	3.05	2.00	2.26
Wood products	N/A	N/A	1.48	N/A	0.94	3.37	2.99	1.60	2.42	2.61	4.68	4.64	5.75
Furniture and fixtures	N/A	N/A	2.75	N/A	5.03	1.82	3.74	0.69	2.91	2.38	4.64	4.17	4.16
Primary metals, metal-fabricating and machinery	N/A	N/A	-0.12	N/A	6.56	1.88	4.08	3.12	3.88	3.40	2.60	2.33	1.77
Primary metals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.19	N/A	2.90	1.01	0.07	0.84
Metal-fabricating	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.13	N/A	3.44	2.04	2.21	1.42
Machinery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.78	N/A	4.55	5.74	5.19	3.25
Transportation equipment	N/A	N/A	0.44	N/A	0.71	1.71	6.99	6.57	5.21	7.92	1.94	-0.45	1.39
Electrical products	N/A	N/A	1.97	N/A	5.52	1.46	4.73	4.60	4.34	4.31	3.84	3.08	2.73
Non-metallic mineral products	N/A	N/A	3.16	N/A	4.61	2.92	3.09	4.50	3.62	3.65	2.80	1.03	1.17
Other Goods-Producing:													
Mining	2.61	0.20	3.83	2.36	11.25	8.26	4.85	4.14	6.05	4.50	-3.39	-4.71	-2.44
Metals	N/A	N/A	-0.11	N/A	5.80	10.54	2.43	0.84	3.64	2.47	-3.26	-3.91	-1.68
Oil and gas	N/A	N/A	9.37	N/A	13.08	2.48	8.33	4.98	7.33	5.59	-9.72	-12.63	-9.80
Coal	N/A	N/A	3.13	N/A	8.82	4.36	6.23	9.01	6.98	6.60	2.41	3.42	4.19
Other	N/A	N/A	11.47	N/A	14.50	2.69	3.99	4.93	5.46	3.56	-.25	-0.63	0.60
Non-metals	N/A	N/A	N/A	N/A	N/A	N/A	5.58	3.06	N/A	4.89	-1.17	-1.34	-0.47
Miscellaneous	N/A	N/A	N/A	N/A	N/A	N/A	2.57	5.91	N/A	1.88	2.43	1.33	2.38
Forestry	N/A	-1.46	4.69	N/A	0.21	7.70	7.67	2.04	5.22	5.30	2.32	2.93	6.02
Utilities	6.31	5.11	-0.97	3.30	6.36	7.39	5.72	6.34	6.20	5.64	2.00	1.63	2.16
Construction	N/A	2.72	1.43	N/A	4.77	5.04	3.37	3.93	3.94	3.11	5.92	4.60	5.32

Source: Statistics Canada

* Labour productivity is defined as output per employee.

Table 5B

LABOUR PRODUCTIVITY* GROWTH AT TWO-DIGIT INDUSTRY LEVEL
(Compound annual rates - %)

	1929-37	1938-44	1945-53	1929-53	1954-56	1957-59	1960-69	1970-74	1954-74	1962-74	1975-79	1975-81	1975-83
Trade	N/A	2.12	0.80	N/A	3.28	0.65	1.55	3.08	2.03	2.32	1.79	0.94	1.42
Transportation, communications and storage	N/A	5.68	-1.18	N/A	5.11	1.65	5.70	4.59	4.76	5.01	3.25	2.56	2.22
Finance, insurance and real estate	N/A	N/A	0.56	N/A	0.21	0.97	0.91	1.65	0.99	1.10	0.70	1.01	1.32
Other commercial services	N/A	5.85	-2.03	N/A	3.23	-0.43	0.35	2.01	1.04	1.05	1.99	1.84	2.14
Industrial composite	N/A	N/A	1.90	N/A	4.45	1.65	3.35	3.47	3.29	3.31	2.43	1.83	2.08

Source: Statistics Canada

* Labour productivity is defined as output per employee.

Table 6

CONTRIBUTION TO PRODUCTIVITY GROWTH DECLINE BETWEEN 1954-74 AND 1975-81

	Point contribution	Per cent of total decline in productivity growth for commercial non-farm sector	Per cent of total output in 1981
Manufacturing	0.85	36.5	26.2
Food and beverages	0.11	4.5	3.3
Petroleum and coal products	0.03	1.4	0.3
Primary metals, metal fabricating and machinery	0.15	6.3	5.9
Transportation equipment	0.17	7.2	3.1
Electrical products	0.06	2.0	1.9
Non-metallic mineral products	0.03	1.5	0.9
Other Commercial Goods-Producing:	0.60	25.8	15.4
Metal mining	0.13	5.5	1.1
Oil and gas mining	0.28	12.1	1.3
Forestry	0.03	1.2	0.8
Utilities	0.06	2.5	3.9
Commercial Services	0.88	37.6	58.4
Trade	0.38	16.2	15.3
Transportation, storage and communications	0.14	6.1	13.0
Total Commercial Non-Farm	2.33	100.0	100.0

Some rough calculations of the contributions by different industries to the slowdown in productivity growth between 1954-74 and 1975-81 are shown in Table 6.[12] Selected energy-related and other resource-based

12. The method of calculating industry contributions is based on that used by Rao (1979) and takes account of variations in relative productivity levels, as well as in labour input shares. Because different sources of data had to be used when making these calculations, the estimates should be treated only as rough approximations.

industries (these would include petroleum and coal products, metal mining, oil and gas mining, and forestry) have accounted for a disproportionate share of the overall slowdown in the commercial non-farm sector, relative to their share of aggregate output. As well, many durable goods manufacturing industries (especially transportation equipment) also accounted for an unusually large part of the slowdown.

With regard to the manufacturing sector, we should make note of other sources of data on productivity change. Alternative data on employment and man-hours worked for the 1961-81 period are available from the Census of Manufactures[13] and alternative measures of labour productivity change (output per employee and output per man-hour) are shown in Tables 7 and 7A, respectively. These data (especially those for output per man-hour) confirm that the slowdown in productivity growth after 1974 in this sector did not affect all industries to the same extent. Most of the manufacturing industries described previously in this section as exhibiting a large decline in productivity growth after 1974 also show the same tendency with these data (refer to Table 7A): food and beverages, tobacco, rubber and plastics, paper and allied products, oil and coal products, chemicals, transportation equipment, and non-metallic mineral products. There was also a substantial weakening in productivity growth between the 1966-74 and 1975-81 periods in miscellaneous manufacturing, primary metals, metal fabricating, machinery, and electrical products.

We now turn to an analysis of trends in factor productivity growth at the industry level. At this level of disaggregation, an industry may make use of inputs purchased from other industries ("intermediate inputs") as well as capital and labour in the production process. In a production function framework, this may be summarized as follows:

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13. Statistics Canada, Manufacturing Industries of Canada: National and Provincial Areas (31-203).

Table 7

GROWTH OF LABOUR PRODUCTIVITY (OUTPUT PER EMPLOYEE) IN MANUFACTURING: CENSUS OF MANUFACTURES DATA
(Compound annual growth rates - %)

	1962-74	1966-69	1966-74	1970-74	1975-79	1975-81
Food and beverages	3.65	4.14	3.65	3.26	1.15	1.07
Tobacco	3.95	3.08	3.89	4.54	2.06	1.72
Rubber and plastics	4.39	5.52	3.87	2.56	2.35	1.05
Leather	2.76	2.08	2.74	3.28	2.56	1.31
Textiles	4.58	6.76	4.77	3.21	5.71	4.00
Knitting mills	5.16	5.35	4.54	3.90	4.78	4.33
Clothing	2.68	1.50	2.51	3.33	3.49	2.00
Paper and allied products	2.97	2.97	2.88	2.80	0.69	0.22
Printing and publishing	2.97	2.52	3.36	4.04	2.39	2.50
Oil and coal products	5.77	2.76	4.49	5.90	8.29	-7.79
Chemicals	5.17	4.91	4.48	4.14	2.49	1.49
Miscellaneous manufacturing	3.17	3.03	2.98	2.94	0.98	0.34
Wood products	2.69	2.89	2.27	1.77	2.66	2.18
Furniture	2.51	3.27	1.92	0.84	1.10	1.25
Primary metals	3.04	2.17	2.39	2.57	-0.25	-0.30
Metal fabricating	3.24	3.36	3.30	3.26	-0.16	0.20
Machinery	4.47	3.64	4.88	5.89	3.40	2.62
Transportation equipment	7.32	8.61	6.87	5.50	1.78	-0.68
Electrical products	4.58	3.52	3.86	4.13	2.68	1.90
Non-metallic mineral products	3.63	1.76	3.28	4.51	1.73	-0.05

Source: Statistics Canada

Table 7A

GROWTH OF LABOUR PRODUCTIVITY (OUTPUT PER MAN-HOUR) IN MANUFACTURING: CENSUS OF MANUFACTURES DATA
(Compound annual growth rates - %)

	1962-74	1966-69	1966-74	1970-74	1975-79	1975-81
Food and beverages	3.89	4.31	3.99	3.74	1.21	1.35
Tobacco	4.86	3.80	4.68	5.38	1.74	1.55
Rubber and plastics	4.71	5.72	4.44	3.44	1.92	1.02
Leather	2.78	2.06	2.71	3.24	2.99	1.88
Textiles	4.96	7.16	5.28	3.80	5.92	4.31
Knitting mills	5.48	5.64	5.13	4.72	5.26	4.54
Clothing	2.91	1.40	2.90	4.12	3.43	2.28
Paper and allied products	3.89	3.34	3.37	3.40	1.04	0.60
Printing and publishing	3.01	2.56	3.61	4.47	2.82	2.90
Oil and coal products	5.68	2.22	4.22	5.84	-8.22	-7.74
Chemicals	5.31	4.85	4.69	4.57	2.57	1.57
Miscellaneous manufacturing	3.39	3.05	3.05	3.06	1.35	0.65
Wood products	2.69	3.47	2.78	2.23	2.85	3.09
Furniture	2.62	3.89	2.17	0.82	1.25	1.76
Primary metals	3.06	2.83	2.57	2.37	0.12	0.15
Metal fabricating	3.28	3.58	3.65	3.71	0.12	0.44
Machinery	4.58	4.05	5.28	6.28	3.50	2.79
Transportation equipment	7.36	9.10	7.28	5.84	2.60	-0.12
Electrical products	4.72	3.83	4.13	4.37	2.88	2.17
Non-metallic mineral products	4.01	2.31	3.97	5.32	2.06	0.57

Source: Statistics Canada

$$Q = F*f(K,L,M), \tag{1}$$

where Q = gross output,
F = index of factor productivity,
K = measure of capital input,
L = measure of labour input, and
M = measure of intermediate inputs (such as energy).

In our particular implementation of this framework, we will use the capital stock to measure the capital input, man-hours to measure the labour input, and intermediate inputs will be disaggregated into energy, raw materials and other intermediate inputs. This is summarized as follows:

$$Q = F*f(K,L,E,R,\phi) \tag{2}$$

where Q = gross output,
F = index of factor productivity,
K = capital stock,
L = man-hours worked,
E = energy input,
R = raw materials input, and
ϕ = other intermediate inputs.

The energy input includes crude oil and natural gas, refined oil products and electric power, while the raw materials input includes all non-energy primary goods and selected goods produced by the manufacturing sector (e.g., pulp and paper, chemicals, lumber, steel). Other intermediate inputs consist mainly of business services and other manufactured goods.[14]

A particularly convenient accounting framework for showing the relationship between labour and factor productivity growth is given below:[15]

$$\begin{aligned} PCLP = {} & PCF + ASK*(PCK-PCL) + ASE*(PCE-PCL) \\ & + ASR*(PCR-PCL) + AS\ *(PC\phi-PCL), \end{aligned} \tag{3}$$

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14. Special input-output matrices provided by Statistics Canada were used to generate data for the following variables: gross output, energy input, raw materials input and other intermediate inputs. The sources for the capital stock and labour input data are given in footnotes 3 and 13 respectively. For non-manufacturing industries, both industry census and all-establishment employment data from Statistics Canada were used to construct labour input data.

15. For more details on this topic, see Berndt and Watkins (1981).

where PC = per cent change,
LP = labour productivity,
AS = average cost share (two-year moving average), and
F,K,L,E,R,ϕ are as defined above.

Hence we can explain movements in labour productivity in terms of variations in factor productivity and the four types of factor intensity growth. This type of exercise is illustrated with data for the metal fabricating industry in Table 8. For completeness, the growth rate of gross output is also shown. The rate of growth of labour productivity fell from 3.9 per cent in the 1966-74 period to 0.5 per cent in the 1975-79 period. This decline was partly due to a drop in the rate of growth of factor productivity but there were also large declines in the growth of the raw materials/labour, energy/labour, capital/labour and other intermediate inputs/labour ratios. It is also of interest to observe that the rate of growth of gross output fell substantially. Similar information for other two-digit manufacturing industries and other selected goods-producing industries is given in Appendix A. In an alternative form of presentation, total factor productivity growth may be expressed as a weighted average of the average productivity growth of each input (Berndt and Watkins (1981)). Information expressed on this basis for various goods-producing industries for the 1962-79 period and certain subperiods is given in Appendix B.

A qualitative summary of the information in Appendix A is given in Table 9. Certain patterns among those industries experiencing slowdowns in their rates of labour productivity growth are evident. First, practically all of these industries experienced a decline in the growth rate of output and/or of the raw materials/labour ratio. Corresponding declines in the growth of factor productivity and the capital/labour ratio were somewhat less common. While the growth rate of the energy/labour ratio fell in many of these industries, its cost share was so small as to have little direct effect on the overall slowdown in labour productivity growth.

As well, the productivity slowdown phenomenon appears less pervasive when the total factor productivity measure is used instead of labour

Table 8

METAL FABRICATING: GROWTH OF LABOUR PRODUCTIVITY* (% except for shares)

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	(Capital/ labour)	Average share	(Energy/ labour)	Average share	(Raw materials/ labour)	Average share	(Other inputs/ labour)	
1962-79	2.97	1.26	0.14	0.98	0.012	2.15	0.32	3.43	0.17	2.49	5.63
1962-65	3.97	2.86	0.14	-5.10	0.012	0.27	0.32	4.32	0.18	2.66	12.29
1966-74	3.92	1.25	0.15	3.86	0.011	3.78	0.31	4.96	0.18	2.74	5.13
1975-79	0.51	0.02	0.14	0.89	0.014	0.78	0.35	0.04	0.16	1.92	1.44

* Labour productivity is defined as output per man-hour.

Table 9

CHANGES IN PRODUCTIVITY AND FACTOR INTENSITY GROWTH BETWEEN 1966-74 AND 1975-79 IN MANUFACTURING INDUSTRIES*

	Substantial** decline in growth of:					
	Labour productivity	Factor productivity	Capital/labour ratio	Raw materials/ labour ratio	Energy/labour ratio	Output
Food and beverages	Yes	No	Yes	Yes	No	No
Tobacco	Yes	No	Yes	Yes	No	Yes
Rubber and plastics	No	No	Yes	No	No	Yes
Leather	No	No	No	No	No	No
Textiles	No	No	No	No	No	No
Knitting mills	No	No	Yes	No	No	Yes
Clothing	No	No	No	No	No	No
Paper and allied products	Yes	Yes	Yes	Yes	No	Yes
Printing and publishing	No	No	Yes	Yes	No	No
Oil and coal products	Yes	No	Yes	No	Yes	Yes
Chemicals	No	Yes	No	Yes	No	No
Miscellaneous manufacturing	Yes	No	Yes	Yes	No	Yes
Wood products	No	No	Yes	No	No	No
Furniture	Yes	No	Yes	Yes	No	Yes
Primary metals	Yes	Yes	No	Yes	Yes	Yes
Metal fabricating	Yes	Yes	Yes	Yes	No	Yes
Machinery	No	No	No	Yes	No	No
Transportation equipment	Yes	Yes	Yes	Yes	No	Yes
Electrical products	Yes	No	No	Yes	No	Yes
Non-metallic mineral products	Yes	Yes	No	Yes	Yes	Yes

* If the cost-share of a given input is very small, it is not included in the "Yes" group.
** More than one percentage point.

productivity. For example, the food and beverages, tobacco, oil and coal products, miscellaneous manufacturing, furniture, and electrical products industries all experienced a substantial decline in labour productivity growth but only a small decline or no decline at all in factor productivity growth. Whatever drop in labour productivity growth was experienced in these industries seems to have been primarily the result of a marked deceleration in the long-term trend of substitution of capital and/or raw materials for labour. The question of what could account for this shift in factor substitution trends will be analyzed in greater depth in subsequent sections, but two conventional explanations may be mentioned: (i) changes in relative factor prices and (ii) cyclical factors. For instance, if capital and raw materials were both substitutes for labour, then increases in the prices of both capital and raw materials relative to that of labour would induce a shift to relatively more use of labour and relatively less of both raw materials and capital. As well, a slowdown in output growth might lead to some slowing of the rate of growth of the capital/labour ratio, given that it is generally assumed that the capital stock is adjusted more slowly than the labour input.

4 CAPITAL INTENSITY

The concept that increases in the capital stock per worker lead to increases in labour productivity is an old one in economics. In examining this question,[16] it is worth noting that there is still a good deal of controversy over the quantitative role of capital formation in economic growth.[17] For instance, Denison (1979) has assigned a relatively small role to capital investment in fostering productivity growth, while Fraumeni and Jorgenson (1980) consider it to be the single most important factor in explaining this variable. Let us begin the discussion with a Cobb-Douglas production function:

$$Q = A*e^{gt}*K^{b}L^{1-b} \qquad (1)$$

where Q = net output,
g = rate of technical progress,
t = time,
K = capital stock,
L = labour input,
A = constant, and
b = the share of capital in nominal net output.

$$q = Q/L = A*e^{gt}k^{b} \qquad (2)$$

where k = K/L, and

$$rq = g + b*rk \qquad (3)$$

where rq = growth rate of labour productivity, and
rk = growth rate of capital intensity.

In this model, labour productivity growth can result only from g (technical progress) or growth in capital intensity. It should be noted that the assumption that technical progress can be presumed to follow a time trend was used only for convenience and in fact there is no reason to suppose that productivity growth resulting from economies in the use of

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16. A review of recent research is found in Fromm (1980).

17. See Davenport (1979, pp. 4-11) for further discussion on this matter.

all inputs is necessarily of a regular, continuous nature. This kind of technical progress is referred to as "disembodied" because the economies arising from (say) increased knowledge affect all inputs equally. The point has been made elsewhere (OECD, 1979, p. 29) that this type of technical progress may be associated with gradual improvement in the organization of production, whereas radical changes in technology will require new investment and hence may tend to be capital-using.[18]

In equation (3), the significance of changes in capital intensity is dependent on the estimates made for b. Based on the assumptions of perfect competition in factor markets and constant returns to scale, (though these assumptions are not strictly necessary (see Daly (1972)) it has been the conventional practice in work based on U.S. data to suppose that b is equal to the share of capital in national income. For instance, Denison (1979, p. 49) estimated the average weight associated with capital (non-residential structures and equipment and inventories) in the United States to be 15.1 per cent in the postwar period. Denison (1979, p.2) also estimated that the contribution of the growth of capital intensity to the growth of real net national income per employee was about 16.7 per cent over the 1948-73 period. A slowdown in capital intensity growth accounted for less than 7 per cent of the slowdown in productivity growth between the 1948-73 and 1973-76 periods. However, in a study employing a similar "growth accounting" framework, Norsworthy, Harper and Kunze (1979, pp. 420-21) note that a decline in the growth rate of capital intensity between 1973 and 1978 was a major factor in the deceleration of the rate of growth of labour productivity over that period. This explanation does not, however, hold true for the 1965-73 period. Norsworthy et al. speculate that increases in the relative price of energy and a deceleration in the rate of increase of the price of labour relative to capital from 1973 to 1978 explain in part the slowdown in the growth rate of capital intensity. Still greater importance is attributed to the capital intensity factor by Fraumeni and Jorgenson (1980, p. 163) who

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18. Jarrett (1981) examined the issue of whether technical progress tends to be biased towards the use of certain inputs for selected manufacturing industries. Muller (1981) in an aggregate study, found technical change to have been capital-using especially after 1974.

estimate the value share of the capital input as ranging from about 37 to 43 per cent over the 1948-76 period. This greater weight attributed to capital results partly from a more comprehensive definition of capital to include consumer durables, residential structures and land. It is also useful to note here that output and the capital income share include depreciation. As noted previously, Fraumeni and Jorgenson consider growth in capital input (including quality changes) to be the single most important factor contributing to economic growth. They do add, however, that a decline in the rate of technical change figured more importantly in the productivity slowdown during the years from 1969-1973 to 1973-1976 (pp. 174-75).[19]

With respect to some Canadian research, a Department of Finance study (Sims and Stanton, 1980, p. 48) suggested that about one-quarter of the recent labour productivity slowdown could be attributed to a decline in the growth rate of capital intensity. Based on the Davenport (1979) study, it was noted that if certain cyclical adjustments were made, the growth of the capital/labour ratio slowed from 1957-72 to 1973-78. In contrast, the Economic Council of Canada (1980, pp. 98-99) has suggested that aside from the primary and construction industries, changes in the growth rate of capital intensity have not been an important factor in the slowing of productivity growth.

Data on the growth rates of capital/labour ratios for various Canadian industry groupings are given in Tables 10 through 14.[20] It

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19. Among U.S. studies that have found a slowing in the rate of growth of capital intensity to be a significant factor in explaining the post-1973 productivity slowdown are: Kopcke (1980), Nadiri (1980a), Siegel (1979), Tatom (1979), and Kendrick (1980b). Bennett (1979) suggested that a slowing of the growth of capital intensity may have contributed to the decline in productivity growth in mining and construction between the 1948-67 and 1967-78 periods. Andrew Sharpe has suggested that most of these studies were biased by the slowdown in investment spending during the mid to late 1970s, with this period not covering a complete business cycle. Clark (1978), making use of cyclically adjusted measures of labour productivity and labour inputs, found that a fall in the rate of growth of the (adjusted) capital/labour ratio helped explain the slowing of productivity growth in the 1965-73 period, but was much less significant in explaining the post-1973 slowdown. Sargent (1982) found that a slowdown in labour productivity growth between the 1960-73 and 1973-79 periods was not always associated with a decline in the growth rate of capital intensity in five OECD countries.

20. For Tables 10-14, the basic data source was Statistics Canada's Fixed Capital Flows and Stocks (13-211). Capital stock information for oil and gas mining is taken from unpublished data. Data for the labour inputs are described in the previous section. For an evaluation of the available data base for the capital stock in Canada, see Garston (1983).

Table 10

GROWTH OF CAPITAL/LABOUR RATIOS IN MANUFACTURING: MAN-HOURS AS LABOUR INPUT MEASURE
(Compound annual growth rates - %)

	1954-74	1962-74	1954-56	1957-59	1960-69	1970-74	1975-79	1975-81
Capital Stock Measure:								
Total net fixed (mid-year)	4.01	2.76	5.71	7.43	2.69	3.64	3.24	3.67
Total gross fixed (mid-year)	4.03	2.85	5.20	7.02	2.93	3.80	3.48	3.89
Non-residential structures (net stock)	3.41	2.27	4.52	6.86	2.09	3.36	2.78	3.05
Machinery and equipment (net stock)	4.47	3.11	6.70	7.88	3.13	3.83	3.55	4.09

Source: Statistics Canada

should be noted that net capital stock data have been used in Tables 11 through 14.[21] The trends in capital intensity in manufacturing for both gross and net definitions of the capital stock are very similar over the postwar period (Table 10). There was some slowing of the growth rate of capital intensity in manufacturing between 1954-74 and 1975-81. However, the relationship between changes in the growth rate of capital intensity and labour productivity over different subperiods of the 1954-81 period is not terribly consistent. For instance, the growth of capital intensity accelerated in the 1957-59 period, whereas there was a marked slowdown in labour productivity growth in the same period. (See Table 3.) It is also worth noting that the deceleration in the growth of capital intensity between 1954-74 and 1975-81 took place both in non-residential structures and in machinery and equipment.

In Table 11, rates of change in capital intensity for the manufacturing, other commercial goods and commercial services sectors over various subperiods of the 1954-81 period are shown, with labour input data taken from Statistics Canada's productivity statistics. The rate of growth of capital intensity in the commercial non-farm sector did decline between 1954-74 and 1975-81, with this trend being evident in all three component sectors. This tendency is, however, much less apparent if one compares growth rates in either the 1960-69 or 1970-74 periods with the 1975-81 period. In contrast, the growth of the capital/labour ratio in the private non-farm sector in the United States is estimated to have fallen from about 3 per cent per year over the 1961-74 period to about 1.5 per cent per year over the 1975-81 period; in this case information on the net fixed capital stock was taken from data produced by the Bureau of Economic Analysis of the U.S. Department of Commerce, while information on man-hours was taken from data produced by the Bureau of Labor Statistics of the U.S. Department of Labor. Information on growth rates of capital/labour ratios at the one-digit industry level is shown in Table 12. A major decline in the growth of capital intensity between 1962-74 and 1975-81 is evident only in the forestry and mining industries.

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21. For these net capital stock measures, capital assets are written off by straight-line depreciation over their service lives. For the gross capital stock measure, assets are included at their initial value over the life of the asset.

Table 11

GROWTH OF CAPITAL/LABOUR RATIOS: LABOUR MEASURE FROM OFFICIAL PRODUCTIVITY STATISTICS
(Compound annual growth rates - %)

	1954-74	1962-74	1954-56	1957-59	1960-69	1970-74	1975-79	1975-81
Employees as labour input:								
Manufacturing	3.77	2.58	5.48	7.20	2.57	3.17	2.93	3.22
Other commercial goods	5.66	3.75	6.86	11.20	4.96	3.13	4.69	4.72
Commercial services	3.52	2.31	4.61	6.56	3.02	2.08	3.23	2.89
Commercial non-farm	3.92	2.55	5.65	7.61	3.10	2.40	3.23	3.16
Man-hours as labour input:								
Manufacturing	4.01	2.76	5.71	7.43	2.69	3.64	3.24	3.67
Other commercial goods	6.32	4.11	8.62	11.66	5.59	3.33	5.06	5.04
Commercial services	4.24	3.14	4.93	7.13	3.92	2.78	3.91	3.57
Commercial non-farm	4.47	3.11	6.11	8.00	3.70	2.98	3.80	3.77

Source: Statistics Canada

Table 12

GROWTH OF CAPITAL/LABOUR RATIOS:
LABOUR MEASURE FROM ALL-ESTABLISHMENT EMPLOYMENT STATISTICS
(Compound annual growth rates - %)

	1962-74	1975-79	1975-81
Commercial non-farm	2.25	3.53	3.25
Manufacturing	2.05	3.12	3.26
Forestry	4.59	0.63	1.81
Fishing and trapping	4.22	5.28	5.46
Mining	6.13	3.38	2.93
Construction	-0.55	6.45	5.51
Transportation, communications and other utilities	4.02	4.59	4.10
Trade	-1.34	0.67	0.29
Finance, insurance and real estate	4.22	5.28	5.46
Other commercial services	3.28	5.31	4.48

Source: Statistics Canada

In Table 13, data on the growth of capital intensity for selected industries are shown for selected subperiods within the 1929-81 period, with large-establishment employment statistics being used as the labour input measure. For those industries for which data are available (mining, manufacturing and utilities), labour productivity growth improved substantially between 1929-53 and 1954-74, consistent with a large rise in the growth rate of the capital/labour ratio in all three cases. Between 1954-74 and 1975-81, declines in the growth of capital intensity are limited only to mining, utilities, forestry, and finance, insurance and real estate (though the latter industry did not experience a decline in labour productivity growth between the same two periods).

At the two-digit industry level (Table 14), one finds that there is a positive relationship between a slowdown in labour productivity growth between 1954-74 and 1975-81 and slower growth in capital intensity in many non-durable manufacturing industries (with the major exception of

Table 13

GROWTH OF CAPITAL/LABOUR RATIOS: LABOUR MEASURE FROM LARGE-ESTABLISHMENT EMPLOYMENT STATISTICS (Compound annual growth rates - %)

	1929-37	1938-44	1945-53	1929-53	1954-74	1962-74	1975-79	1975-81
Mining	1.99	1.59	3.84	2.54	9.19	6.63	4.01	3.71
Manufacturing	-1.67	-5.54	4.83	-0.50	3.66	2.45	3.89	4.05
Non-durables	N/A	-5.11	5.68	N/A	3.83	3.14	4.09	3.73
Durables	N/A	-4.69	3.53	N/A	3.55	1.72	3.53	4.37
Utilities	3.87	-0.29	0.82	1.59	4.57	3.88	3.40	3.17
Forestry	-5.60	1.67	11.47	2.32	6.19	5.18	3.20	4.53
Construction	-4.49	3.01	0.75	-0.55	4.36	1.75	11.50	9.10
Trade	-0.78	-2.32	2.44	-0.07	1.12	-0.81	1.48	1.37
Transportation, communications and storage	2.94	-4.67	-1.66	-0.90	3.42	2.14	3.67	3.25
Other commercial services	-1.20	-6.15	-0.19	-2.26	2.86	3.78	7.00	6.11
Finance, insurance and real estate	N/A	N/A	-1.68	N/A	7.17	5.93	5.44	5.77
Industrial composite	N/A	N/A	3.93	N/A	4.41	3.15	4.70	4.57

Source: Statistics Canada

Table 14

GROWTH OF CAPITAL/LABOUR RATIOS:
LABOUR MEASURE FROM LARGE-ESTABLISHMENT EMPLOYMENT STATISTICS
(Compound annual growth rates - %)

	1945-53	1954-74	1962-74	1975-79	1975-81
Food and beverages	4.96	3.61	3.31	1.93	2.15
Tobacco	4.67	4.92	3.30	3.52	2.72
Rubber, plastics and miscellaneous manufacturing	5.62	3.21	3.18	2.07	2.34
Leather	1.01	1.81	2.61	2.39	1.96
Textiles	3.88	1.97	1.47	3.47	2.51
Knitting mills	4.36	2.17	2.19	0.33	1.41
Clothing	1.87	0.90	0.14	3.22	3.34
Paper and allied products	2.73	3.22	2.80	1.52	2.20
Printing and publishing	-0.67	2.61	2.29	1.01	0.72
Oil and coal products	10.48	5.01	3.33	0.65	-0.49
Chemicals	13.29	4.38	3.88	9.95	7.60
Wood products	-0.82	4.06	4.42	4.47	6.76
Furniture and fixtures	-4.41	2.83	2.49	4.59	3.14
Primary metals	N/A	N/A	1.62	2.91	2.57
Metal fabricating	N/A	N/A	1.14	2.84	3.56
Machinery	N/A	N/A	1.25	4.81	5.20
Transportation equipment	6.51	4.59	1.82	1.38	5.20
Electrical products	9.95	3.35	1.53	4.95	3.93
Non-metallic mineral products	-1.43	3.62	2.29	4.67	4.49
Primary metals, metal fabricating and machinery	2.57	2.95	1.12	3.13	3.44
Clothing and knitting mills	1.87	0.90	1.15	1.27	1.83
Oil and gas mining	N/A	N/A	4.38	-0.68	-1.31
Other mining	N/A	N/A	6.47	2.49	1.92

Source: Statistics Canada

chemicals). However, for many durable manufacturing industries, the relationship tends to be perverse. The change in labour productivity growth between 1954-74 and 1975-81 was regressed on the change in capital intensity growth, using data for selected manufacturing industries from Tables 5 and 14. The results are shown below:

CROSS-SECTIONAL REGRESSION OF CHANGE IN LABOUR PRODUCTIVITY GROWTH BETWEEN 1954-74 AND 1975-81 FOR SELECTED MANUFACTURING INDUSTRIES

Explanatory variable	Coefficient	t-statistic
Constant	1.91	2.49
Change in growth rate of capital intensity	1.06	2.74

$\bar{R}^2$ = .302

Number of observations = 16

While the explanatory power of the regression is low (it must be remembered that we are trying to explain a change in a growth rate rather than a level or a growth rate), the coefficient on the capital intensity term is statistically significant and positive. Moreover, the size of the coefficient is larger than might have been expected on a priori grounds (one might have expected a value close to the average share of capital in the manufacturing sector).

It should be noted, however, that conventional measures of the capital stock may have been overstated in recent years. For example, energy price shocks may have led to more rapid scrapping of capital equipment, the lag between investment expenditures and actual additions to capacity may have lengthened (owing to shifts in the composition of investment), and investment in "non-productive" pollution-control equipment may have become increasingly important.[22] Bilkes (1980) found

22. Baily (1981) gives still another reason for supposing that the measured capital stock (in the United States) is overstated, insofar as the Q-ratio (market valuation relative to replacement cost of capital stock) has systematically been less than one since about 1968. If one accepts this point, most of the slowdown in labour productivity growth between the 1959-69 and 1969-78 periods can be explained.

that capital/output ratios have tended to rise in recent years after falling during the 1962-74 period, and more current data continue to confirm this phenomenon (Table 15).[23]

In the work on estimating potential capital/output ratios for the Bank of Canada's measure of capacity utilization rates,[24] it has been noted that in the second half of the last decade there were sharp shifts in the trends of actual capital/output ratios in a number of industries (oil and gas mining, oil and coal products, chemicals, and construction). The first three industries all experienced substantial declines in their productivity growth rates. However, it must be admitted that major changes in the trend growth of capital/output ratios did not occur in other industries that also experienced declines in productivity growth (e.g., food and beverages, primary metals, and metal fabricating). Nevertheless, problems with capital stock data probably account for part of the difficulty in establishing a significant correlation between capital intensity and the slowdown in productivity growth at the aggregate level and in many individual sectors.

In certain industries, there is some reason to believe that a decline in capital intensity growth may help explain a drop in labour productivity growth. It is another matter to explain why a decrease in the rate of growth of capital/labour ratios may have taken place. One suggestion, which has received some emphasis in the literature, is a change in the trend of the price of capital relative to that of labour. With respect to U.S. data, Thurow (1981) placed a great deal of emphasis on a change in the longstanding tendency for the price of capital to fall relative to that of labour. A study by James McIntosh (1980) using Canadian data makes a similar point regarding the relative price of capital, and attributes the decline in productivity growth since 1973 to a slowdown in the adoption of capital-intensive techniques resulting from a decline in the rate of growth of the price of labour relative to that of capital.

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23. Capital stock and net output data are taken from the RDXF model data base. The energy and non-commercial sectors are excluded in the measurement of the capital stock, while the agricultural and non-commercial sectors are excluded in the measurement of output.

24. For further discussion of the methodology used to calculate capacity utilization rates at the Bank of Canada, see Schaefer (1980).

Table 15

SELECTED CAPITAL INPUT DATA: PRIVATE NON-FARM SECTOR
(Growth rates except where noted)

	1962-74	1975-81
Non-energy capital/output ratio	-1.1	1.9
Price deflator for machinery and equipment relative to labour price	-2.6	0.4
Price deflator for non-residential construction relative to labour price	-1.0	-0.5

	1961-67	1968-74	1975-81
Rental price of machinery and equipment relative to labour price (average)	0.156	0.133	0.134
Rental price of non-residential construction relative to labour price (average)	0.112	0.112	0.120

Source: Bank of Canada

Employing a more appropriate capital price definition (rental price of capital instead of investment price deflators), Bilkes (1980) also found a similar tendency. An examination of rental price data indicates some slowing in the decline of the relative price of capital in recent years, especially for machinery and equipment (Table 15).[25,26] This tendency is much more pronounced when price deflators are used as the capital price variable. The question of explanations for a change in the rate of growth of capital intensity will be examined again later in this paper, especially with respect to the effect of changes in the energy price on the capital stock.

25. Because of sharp annual fluctuations in the rental price variables, I show averages for the 1961-67, 1968-74 and 1975-81 periods. Data on price deflators, rental prices and labour prices are all taken from the RDXF data base. All three variables exclude the non-commercial sector.

26. It has been suggested by William White that the rate of increase of investment deflators for machinery and equipment may have been overstated in recent years because of problems in measuring quality change for items such as computers and office equipment. This would of course mean that the rate of growth of capital intensity would have been understated. It is known that Statistics Canada and other statistical agencies have had major problems in measuring output of the industries producing these goods. For a brief discussion of this issue, see Clark (1982).

5 CYCLICAL BEHAVIOUR OF LABOUR PRODUCTIVITY

One of the stylized facts regarding the cyclical behaviour of the economy is a tendency for the growth of labour productivity to slow during recessions and then to increase during the expansion phase. Hence, it is often suggested that the high costs incurred by a firm in hiring and training new employees could lead to a tendency to hoard labour (especially skilled labour) in a recession. An alternative explanation involves the use of dynamic production models in which one or more factors of production are treated as quasi-fixed (Morrison and Berndt (1979, 1981)). If demand increases, a firm would tend to use relatively more of those variable inputs (such as materials) that were substitutable with the quasi-fixed input (such as capital). In the longer run, the levels of the quasi-fixed input and those variable inputs that were complementary with it would be increased and there would be a decline in the use of other variable inputs. Hence if labour was complementary with capital, this could explain why the short-run elasticity of demand for labour with respect to output might be smaller than the long-run elasticity. It is interesting to observe that Morrison and Berndt found that complementarity between capital and aggregate labour in U.S. manufacturing was consistent with both capital-skilled labour complementarity and capital-unskilled labour substitutability.

In a previous analysis of the labour productivity slowdown (Blain (1977)), this cyclical factor was identified as an important cause of the decline in labour productivity growth over the 1974-76 period.[27] In more recent work, Helliwell (1984) found that over one half of the decline in labour productivity between 1973 and 1982, relative to a steady growth scenario, was the result of unexpectedly low demand and low profitability. In turn, these latter developments were caused by increases in world oil prices and related changes in external inflation

27. The Economic Council of Canada (1980) attributed over one quarter of the slowdown in productivity growth in the 1974-76 period to cyclically weak demand. See also Rao (1979) and Ostry and Rao (1980). Nadiri (1980a) and Nadiri and Schankerman (1981) found weak demand to have been a factor in explaining the productivity slowdown in the United States. More recently, Helliwell, Sturm and Salou (1985) found that cyclical factors were important in explaining the slowdown in productivity growth between 1962-73 and 1973-82 in the United States and other selected industrial economies.

and output. Helliwell, Sturm and Salou (1985) were able to attribute most of the slowdown in the growth of output per employee in Canada between the 1962-73 and 1973-82 periods to cyclical factors.

The work of Helliwell and his colleagues starts with the observation that it is costly for firms to make adjustments to factor input levels, especially for capital and labour. In response to unexpected shocks to demand or costs, firms may vary factor utilization levels in the short run, leading to changes in measured factor productivity. Capacity utilization for Canada as measured in Helliwell's model rises almost uninterruptedly between 1961 and 1973 and then falls almost continuously between 1973 and 1982. This latter phenomenon appears to be mainly attributable to a slow rate of adjustment of actual factor input levels to desired levels, a common result in econometric studies. However, there is some reason to believe that the speed of adjustment of factor input usage might also vary with economic conditions. For instance, there is some anecdotal evidence that firms reacted much more quickly than usual to adjust labour and other inputs during and after the 1981-82 recession, in the face of unfavourable relative price movements. In Canada, the average annual growth of real GNE per employee was about 1.2 per cent during the 1981-84 period, about the same as over the 1974-77 period. On the other hand, real GNE growth was only 1.2 per cent per year during the 1981-84 period, compared to 3 per cent per year during the 1974-77 period. Rao and Preston (1984) have also addressed this issue, attributing the slowdown in total factor productivity growth at the industrial level in part to a decline in the rate of growth of world aggregate demand. Sectoral cost functions are estimated in which allowance is made for the possibility of increasing or decreasing returns to scale. Increasing returns to scale are found for most non-manufacturing industries. Thus the decline in output growth after 1973 would have led to lower factor productivity growth. In focusing exclusively on returns to scale, Rao and Preston implicitly assumed that, aside from random errors, production and factor usage are always in equilibrium. Helliwell (1984) has suggested that they may have mixed up capacity utilization effects with longer-run scale economy effects, by not allowing for a dynamic adjustment process for factor usage. One other general point about the above studies may be made. The slowdown in productivity growth has lasted more than one full business cycle, which might indicate that a non-cyclical explanation is needed in addition, although peak aggregate utilization rates in the 1978-79 period were apparently substantially lower than in 1973-74.

We will now examine some descriptive material on the behaviour of labour productivity in various industrial sectors during recent business cycles.[28] In Tables 16-18, data on average annual per cent changes in output and labour productivity for various industrial sectors are presented for peak-to-peak, peak-to-trough, and trough-to-peak periods. It may be remarked that the 1966-68 and 1969-70 "recessions" shown in Table 17 were periods when output growth slowed rather than fell in absolute terms.

If we begin with Table 16, the evolution of labour productivity and output growth over recent complete business cycles can be observed. For example, a distinct break in the trend rate of both output and labour productivity growth between the 1966Q1-1974Q1 and 1974Q1-1981Q2 periods is quite apparent in the commercial sector. As well, the mining, manufacturing, transportation and other utilities, and trade sectors all experienced substantial slowdowns in productivity growth between the same two periods.

The procyclical nature of labour productivity growth is quite apparent in Tables 17 and 18. In the last three recessions, both output and labour productivity in the commercial sector have declined. It is of interest to observe that in the latest recession (1981-82) the decline in the rate of productivity growth was lower than in the 1974-75 and 1979-80 recessions, even though the output decline was much larger. In fact, labour productivity in the mining industry actually increased during the 1981-82 recession, even though output declined; in the previous two recessions, there were substantial decreases in labour productivity in this sector. While output per man-hour in the manufacturing sector fell

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28. Most of the dates for cyclical peaks and troughs are taken from Blain (1977) and Cross (1982). GDP statistics were used for output data, while all-establishment employment data were used as the main labour input indicator. Data after February 1983 were taken from the revised monthly Survey of Employment, Payrolls and Hours, and were linked to the old series at the Bank of Canada. For several sectors (mining, manufacturing and construction), data on man-hours were constructed using average hours paid from large-establishment data.

Table 16

AVERAGE ANNUAL CHANGES (%) IN LABOUR PRODUCTIVITY AND OUTPUT OVER VARIOUS PHASES OF RECENT CYCLES

	Peak to peak			
	1966Q1-1969Q4	1969Q4-1974Q1	1974Q1-1979Q4	1979Q4-1981Q2
Mining:				
Output per employee	4.5	5.0	-4.7	-11.3
Output per man-hour	5.4	5.2	-4.9	-10.1
Output	5.1	6.7	-1.0	-3.7
Manufacturing:				
Output per employee	3.5	4.3	1.4	0.2
Output per man-hour	4.5	4.4	1.7	-0.2
Output	4.6	6.4	1.8	1.0
Construction:				
Output per employee	0.8	1.4	0.9	0.2
Output per man-hour	2.8	1.1	0.8	1.6
Output	0.6	4.9	1.6	2.7
Transportation and other utilities:				
Output per employee	5.5	4.2	2.9	1.5
Output	7.0	7.2	4.7	3.8
Trade:				
Output per employee	-0.2	3.4	0.1	-0.5
Output	3.8	8.2	2.8	2.9
Finance, insurance and real estate:				
Output per employee	-0.6	-0.6	0.3	2.1
Output	5.3	5.6	4.7	4.7
Other commercial services:				
Output per employee	1.3	0.4	0.2	0.2
Output	7.1	7.1	5.8	6.3
Commercial (excluding agriculture, fishing and trapping):				
Output per employee	2.3	2.8	0.8	-0.1
Output	4.8	6.6	3.1	3.0

Source: Statistics Canada

Table 17

AVERAGE ANNUAL CHANGES (%) IN LABOUR PRODUCTIVITY AND OUTPUT OVER VARIOUS PHASES OF RECENT CYCLES

	Peak to trough				
	1966Q1-1968Q1	1969Q4-1970Q4	1974Q1-1975Q1	1979Q4-1980Q2	1981Q2-1982Q4
Mining:					
Output per employee	5.3	8.0	-13.7	-9.1	4.9
Output per man-hour	5.8	8.0	12.8	-8.5	7.5
Output	6.3	13.8	-11.6	2.5	-10.5
Manufacturing:					
Output per employee	2.4	0.5	-4.6	-4.3	-2.4
Output per man-hour	3.6	0.5	-2.2	-3.2	0.1
Output	2.6	-3.0	-8.3	-9.6	-13.5
Construction:					
Output per employee	1.2	7.8	-2.8	3.4	5.1
Output per man-hour	2.0	8.2	-0.7	7.1	5.1
Output	-1.2	1.7	-2.7	-9.3	-9.6
Transportation and other utilities:					
Output per employee	4.6	5.1	-1.0	-3.5	-1.7
Output	6.5	4.9	1.9	0.6	-5.5
Trade:					
Output per employee	0.09	1.8	-4.2	-0.4	-2.9
Output	3.2	1.6	-1.0	-0.8	-7.3
Finance, insurance and real estate:					
Output per employee	-1.3	2.3	-1.6	0.5	1.1
Output	4.5	2.5	4.3	3.4	0.8
Other commercial services:					
Output per employee	1.1	1.0	0.4	-1.5	0.6
Output	6.7	2.3	6.2	2.3	0.3
Commercial (excluding agriculture, fishing and trapping)					
Output per employee	2.0	2.7	-3.0	-1.9	-0.1
Output	3.7	1.5	-1.7	-2.3	-6.4

Source: Statistics Canada

Table 18

AVERAGE ANNUAL CHANGES (%) IN LABOUR PRODUCTIVITY AND OUTPUT OVER VARIOUS PHASES OF RECENT CYCLES

	Trough to peak			
	1968Q1-1969Q4	1970Q4-1974Q1	1975Q1-1979Q4	1980Q2-1981Q2
Mining:				
Output per employee	3.5	4.1	-2.7	-12.3
Output per man-hour	4.9	4.4	-3.2	-10.9
Output	3.7	4.5	1.3	-6.8
Manufacturing:				
Output per employee	4.7	5.4	2.6	2.6
Output per man-hour	5.6	5.6	2.5	1.3
Output	7.0	9.3	3.9	6.3
Construction:				
Output per employee	0.3	-0.3	1.7	-1.4
Output per man-hour	3.8	-0.8	1.1	-1.2
Output	2.7	6.5	2.5	8.5
Transportation and other utilities:				
Output per employee	6.5	4.5	3.7	4.0
Output	7.6	7.9	5.0	5.3
Trade:				
Output per employee	-0.6	3.9	1.0	-0.5
Output	4.5	10.2	3.6	4.7
Finance, insurance and real estate:				
Output per employee	0.3	-1.5	0.7	3.0
Output	6.2	6.5	4.8	5.9
Other commercial services:				
Output per employee	1.7	0.3	0.2	1.0
Output	7.7	8.6	5.7	8.4
Commercial (excluding agriculture, fishing and trapping):				
Output per employee	2.8	2.8	1.6	0.8
Output	6.2	8.2	4.2	5.7

Source: Statistics Canada

during the 1974-75 and 1979-80 recessions, this measure of labour productivity was practically unchanged in the 1981-82 recession, even though the fall in production was larger than in the previous two recessions. Similarly, the decline in labour productivity relative to the output decline in the transportation and other utilities sector has been much smaller in the latest recession. One might speculate that the very tight financial positions of many firms in the most recent recession induced a greater than normal degree of cost-cutting. As well, the procyclical tendency of labour productivity in the construction industry appears to have disappeared in the late 1970s.

From Table 18, it is evident that labour productivity growth in Canada tends to accelerate during the expansionary phases of the cycle. However, the average annual rate of productivity growth in the commercial sector has tended to be smaller in the two most recent full expansions. Among individual sectors, this slowdown has been evident in the mining (also accompanied by a much lower rate of output growth) and manufacturing sectors.

The cyclical behaviour of labour productivity is also shown in Figures 1-11. Output per employee is shown for the following sectors: commercial (excluding agriculture, fishing and trapping), mining, manufacturing, construction, transportation, communications and other utilities, trade, finance, insurance and real estate, and other commercial services. Output per man-hour is also shown for the mining, manufacturing, and construction sectors. In each figure, productivity (solid line) and output (dashed line) are shown for the following cycles: 1966Q1-1969Q4, 1969Q4-1974Q1, 1974Q1-1979Q4 and 1979Q4-1984Q2 (or 1979Q4-1983Q1). (We treat the brief expansion from mid-1980 to mid-1981 as an interruption of the recession that began at the end of 1979.)

The procyclical nature of labour productivity in the commercial sector (Figure 1) has been especially evident in the last two business cycles. However, the cyclical rebound in the expansionary phase has tended to become weaker during the second half of the 1970s. Indeed, during the 1980-81 recovery, output per employee remained virtually flat after a substantial decline earlier in 1980. This figure also confirms that the growth in productivity tends to end before the output peak. Gordon (1979) speculates that this "end-of-expansion phenomenon" results in part from expectational errors and lags in adjusting employment to output changes. As well, there may be differences in the timing of cyclical peaks in various industries. Perhaps most importantly, productivity gains arising from the underutilization of the capital stock will eventually be exhausted during the course of the expansion and it may only be possible to increase output by installing additional machines and hiring inexperienced and presumably lower quality workers; the role of changes in the quality of the work force as an influence on productivity over the cycle has recently been emphasized by Blakemore and Hoffman (1984). The increase in productivity that began well before the end of the last recession was highly unusual and may have reflected the need to cut costs as a result of the extremely weak financial positions of many corporations and the extremely long duration of the recession.

Data on output per employee and per man-hour for the mining sector are shown in Figures 2 and 3. Output per man-hour increased practically continuously over the 1966-72 period and then fell almost uninterruptedly between 1972 and 1981. Some of the factors that may have influenced productivity performance after 1972-73 are as follows. First, a substantial part of the work force has been engaged in activities designed to find and develop new reserves of natural resources rather than in functions directly related to current production. After 1974, demand for most natural resources tended to be more restrained, either because of increases in relative prices or possibly because of structural shifts in the composition of demand. Secondly, depletion of easily accessible reserves may have had an adverse effect on labour (and factor) productivity in this sector. Profitability in the oil and gas mining industry was relatively high after 1973 and may have masked an underlying trend towards lower rates of growth of factor efficiency. Finally, given anecdotal evidence (at least before mid-1981) with respect to the high level of difficulty in retaining skilled workers in this industry, it would seem logical to suppose that labour would be hoarded for longer periods than is normal in other sectors. More recently, there seems to have been an improvement in labour productivity since 1982Q4, as firms have cut costs in order to improve profitability in the face of relatively modest increases in the prices of many mining products. However, productivity data based on recent labour force survey employment data for non-farm primary industries do not support this development, so it is possible that the large increase in labour productivity shown in Figure 2 is partly a statistical artifact related to the break in the all-establishment employment series.

Information on the manufacturing sector is shown in Figures 4 (output per employee) and 5 (output per man-hour). In the 1974-75 recession, it is apparent that part of the adjustment in labour input took the form of a reduction in average hours worked rather than a reduction in employment, suggesting that manufacturing firms were trying to retain employees (Blain, 1977, p. 9). In the latest recession, output per man-hour reached a trough in 1982Q1, whereas total output continued to decline up to 1982Q4. Experience in previous cycles had suggested more of a synchronization of troughs in output and labour productivity. However, the severity of the 1981-82 downturn may have led to increased efforts at improving efficiency given extremely low levels of profitability, and these efforts were probably responsible for a sizeable improvement in output per man-hour in the second half of the recession. According to the data for output per employee, further increases in productivity have taken place so far in the recovery. However, if an alternative employment measure from the labour force survey is used, the recovery in labour productivity appears less pronounced.

Productivity in the construction industry has sometimes followed a procyclical pattern, either measured in terms of output per employee (Figure 6) or of output per man-hour (Figure 7). In the early and late 1970s, productivity tended to decline in absolute terms. However, since the beginning of 1981, there has been some growth in measured labour productivity, even though output levels fell sharply after mid-1981.

Output in the transportation, communications and other utilities sector has displayed little of the cyclical volatility so apparent in most goods-producing industries, with the exception of the present cycle (Figure 8). Similarly, output per employee has exhibited little variation, though the trend rate of growth has been declining (Table 16). The trough in labour productivity was reached well before the trough in output during the 1981-82 recession. In the recovery during 1983, the increase in output per employee was very pronounced. As in the other sectors, lower levels of profitability have led to unusually intensive efforts to reduce costs, partly explaining the rise in labour productivity.

Since 1966, the trade sector (Figure 9) has experienced only one period of sustained productivity growth (1971-1973). Output per employee was procyclical over the 1974-76 period, but remained relatively flat thereafter in spite of sizeable gains in output. The declines in output and productivity were sizeable and of comparable orders of magnitude in the most recent recession. The per cent recovery in productivity since the end of 1982 has been almost as large as the per cent increase in output, which might be suggestive of special efforts to improve efficiency.

Output in the finance, insurance and real estate sector has shown little volatility since 1966, and there has been relatively little change in the measured level of labour productivity (Figure 10). Productivity in the other commercial services sector was relatively flat over the entire 1966-1983 period (Figure 11).

Further analysis of the cyclical behaviour of labour productivity was carried out with simple specifications for labour productivity equations for the commercial (excluding energy) and manufacturing (excluding energy) sectors. The energy sector was defined to include mineral fuels, petroleum and coal products, electric power, gas distribution and pipelines. The variables used in various equations are shown below:

Y = output,
L = man-hours,
K = capital stock,
CAPU = rate of capacity utilization,
PE = price of energy,
PY = output price,
T = time trend,
RNU = national unemployment rate,
RNUTϕ = unemployment rate at trend output,

GAPL = a measure of the labour market gap which equals (100-RNU)/ (100-RNUTϕ), and

GAP is either CAPU or GAPL.[29]

The specification bears some similarity to models developed by Rasche and Tatom (1981) and Tatom (1980):

log(Y/L) = a + b*log(K/L) + c*log(PE/PY) + d*log(GAP) + e*T.

The specification is essentially derived from a constant-returns-to-scale Cobb-Douglas production function with three factors of production: labour, capital and energy. The relative energy price, instead of the real energy input, was used as an additional explanatory variable, as in Rasche and Tatom (1981). Finally, a measure of the output (labour market) gap was included to allow for cyclical influences on labour productivity. The estimation results (Table 19) are supportive of the view that the capital stock/labour ratio and the relative energy price are important determinants of labour productivity. As expected, the coefficient on the capital stock/labour ratio is positive, though the size of the estimated coefficient for the manufacturing excluding energy sector seems much larger than would have been expected on the basis of cost-share considerations. An additional equation for the manufacturing excluding

29. Data sources were as follows. Output for the 1961-80 period was defined as the sum of value added by labour and capital (measured in constant prices) and the energy input and was obtained from input-output matrices supplied to the Bank of Canada by Statistics Canada. These data were extended over the 1956-60 and 1981-83 periods employing the growth rate of the following proxy-gross domestic product in constant prices from Statistics Canada, Gross Domestic Product by Industry (61-213) and earlier publications. Man-hours data were taken from Statistics Canada, Aggregate Productivity Measures (14-201); employment data from Statistics Canada, Employment, Earnings and Hours (72-002) were used to construct a proxy for the share of total man-hours of the non-energy components of the commercial and manufacturing sectors. Capital stock information was taken from Statistics Canada, Fixed Capital Flows and Stocks (13-211) and unpublished data. Rates of capacity utilization were derived from data published in the Bank of Canada Review; the rate of capacity utilization in the commercial excluding energy sector was proxied by that for the goods excluding energy sector. These data were extended over the 1956-60 period using unpublished data at the Bank of Canada. Data on the energy price, output price and real energy input for the 1961-80 period were obtained from the input-output matrices mentioned above. The energy price series were extended over the 1956-60 and the 1981-83 periods using the growth rate of the CPI for energy. The output price for manufacturing excluding energy was extended over the same periods employing proxies derived from Stuber (1983), as well as the industry selling price index for manufacturing for 1982 and 1983 (Statistics Canada). The output price for the commercial excluding energy sector was extended over the same periods using data in Statistics Canada's National Income and Expenditure Accounts (13-201), Gross Domestic Product by Industry (61-213), and earlier publications. Data on RNU and RNUTϕ were taken from the RDXF data base.

Table 19

ESTIMATION OF LABOUR PRODUCTIVITY EQUATIONS
(t-statistic in brackets)

log (Y/L) = a + b*log(K/L) + c*log(PE/PY) + d*log(GAP) + e*T

Coefficient	Commercial excluding energy		Manufacturing excluding energy	
	Output gap	Labour market gap	Output gap: No constraint	Output gap: Constraint on b
a	0.454 (31.8)	0.393 (24.5)	-0.019 (-0.5)	0.149 (3.6)
b	0.504 (4.4)	0.397 (2.4)	0.945 (9.3)	0.327
c	-0.074 (-2.6)	-0.109 (-2.7)	-0.016 (-0.7)	-0.077 (-2.3)
d	0.426 (4.8)	1.295 (2.5)	1.063 (10.5)	0.549 (6.3)
e	0.011 (2.3)	0.014 (2.2)	0.001 (0.2)	0.023 (26.3)
$\bar{R}^2$	0.998	0.997	0.997	0.993
S.E.E.	0.009	0.012	0.014	0.022
D.W.	1.00	1.31	1.10	0.51

Estimation period: 1956-1983 (annual)

Ordinary least squares

energy sector was also estimated in which the coefficient b was constrained to be consistent with cost-share information. The coefficient on the relative energy price variable is negative in all cases, presumably reflecting substitutability between energy and the other two factors of production. In the case where a labour market gap variable was used (as opposed to an output gap variable), it is also worth noting that the coefficients of the equation for the commercial excluding energy sector were much more stable when estimated over different sample periods. For instance, the coefficient on the relative energy price variable was positive when estimated over the 1956-73 period in the case of the equation with an output gap variable; on the other hand, the coefficient of this variable was virtually unchanged when estimated over the same period for the equation with the labour market gap variable. This suggests that greater confidence should be given to the equation using the labour market gap variable; perhaps one reason for this finding is that this measure of the gap variable does not directly depend on actual output.

The model shown by the equation with a labour market gap estimated for the commercial excluding energy sector is illustrated in Figure 12. The solid line in this graph displays actual values of labour productivity in this sector over the 1956-83 period. The simulated values using equation (3) are shown as the "Model" line. Finally, if one sets the labour market gap measure to its average value over the 1956-83 period and uses equation (3), the "Cyclically Neutral" line is obtained. Given the model being used, this implies that the "Cyclically Neutral" line would be below (above) the "Model" line during periods of high (low) capacity utilization. The model is able to explain just over 90 per cent of the slowdown in labour productivity growth between the 1956-74 and 1975-81 periods; about 40 per cent of the actual slowdown is attributable to low rates of capacity utilization. The rise in the relative price of energy accounts for nearly half of the slowdown, while a decline in the rate of growth of the capital/labour ratio accounts for about 4 per cent of the fall in labour productivity growth. A similar kind of exercise was carried out for the manufacturing sector using the version of equation (3) with a constraint on the coefficient of the capital/labour ratio

(Figure 13). Though the weight given to low rates of capacity utilization is about the same as for the commercial sector, the model is much less successful in explaining the overall slowdown in labour productivity growth between the 1956-74 and 1975-81 periods.

While the model used above is quite crude, the results from it are in accord with a number of other studies that give an important role to low rates of capacity utilization and the energy price shock as explanations for the productivity slowdown. With regard to the use of cyclically weak demand as an explanation of the slowdown, one must note that there is reason to be skeptical about the quality of reported rates of aggregate capacity utilization (or for that matter of measures of the labour market gap) in recent years. Increased difficulties in measuring the capital stock (an important input into the Bank of Canada measure of capacity utilization) may have led for instance to an understatement of aggregate operating rates. As well, if capacity utilization remained at a low level for a sustained period, one might ask why firms would not adjust factor inputs (and operating rates) so as to raise labour productivity levels back to pre-shock levels.

One other area of interest with respect to the cyclical behaviour of labour productivity concerns the distinction between production and overhead labour. As an example, recent data for hourly paid and salaried employees in the manufacturing sector were examined (Figure 14).[30] As might be expected, the employment changes during recessions for hourly paid workers are much larger than for salaried workers. Further, hourly paid workers also experience reductions in average weekly hours during recessions (Figure 15). The employment and labour productivity data (Figure 16) indicate that increases in output during the early stages of an expansion are met mainly through a rise in productivity and to a lesser extent by an increase in average hours worked. In the last major expansion, from 1975 to 1979, major increases in the level of the labour input took place only in a later stage of the recovery.

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30. Data on employment and average hours worked are taken from Statistics Canada's Employment, Earnings and Hours (72-002). Employment of hourly paid workers refers to the number of wage-earners (hours reported). Output is measured as described in the preceding footnote. The employment data were seasonally adjusted at the Bank of Canada.

6 MEDIUM-TERM OUTPUT GROWTH AND PRODUCTIVITY CHANGE

It has also been suggested that changes in the medium-term rate of growth of output might have an important impact on the rate of productivity growth.[31] For instance, there may be scale economies that can be exploited at higher output levels through plant expansion or longer production runs.[32] As well, if more advanced technology is embodied in new capital equipment, higher rates of output growth should lead to a more rapid use of best-practice technology in the existing capital stock. On the other hand, high rates of output growth may also have an adverse effect on productivity growth if it results, for example, in higher rates of inflation and price variability.

In practice, there may be serious difficulties in measuring the effects of output growth. First, there is a causality problem: does output growth result in productivity growth or does productivity growth (and the growth of factor inputs) cause output growth? Up to the present, it has been very difficult to distinguish empirically between the contributions of increasing returns to scale and technological progress.[33] The whole question of measurement of scale economies, especially with aggregated data, has been a major source of controversy.[34]

In previous work, Blain (1977) investigated the effect of scale economies on productivity growth through the use of crude proxies such as concentration ratios and the number of employees per establishment, and found no significant correlation between the proxy variables and productivity growth. I have updated data on the number of workers per

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31. A discussion of some of the literature on this subject is given in Sharpe (1982). Sharpe (1983) presents cross-sectional statistical evidence on strong positive correlations between large declines in output growth and in productivity growth between the 1961-73 and 1974-79 periods as well as correlations between output and productivity growth over cyclically neutral periods.

32. For a detailed discussion of the concept of economies of scale, see Scherer (1980), pp. 81-118.

33. This question is analyzed in considerable depth in Sato and Calem (1983).

34. For a recent statement on the issue, see Gold (1981). Also see Scherer (1974, 1980) and McGee (1974).

establishment,[35] in the hope that this might tell us something about the scale of plants (Table 20). In the 1966-74 period, the average number of workers per establishment increased in most manufacturing industries, which may have indicated a trend towards larger plant size. This tendency was reversed after 1974. When the change in the growth rate of labour productivity between the 1966-74 and 1975-81 periods[36] was regressed on the change in the growth rate of the above proxy variable over the same periods for all two-digit manufacturing industries, the coefficient of the scale economy variable was positive but statistically insignificant (regression results are shown below).

CROSS-SECTIONAL REGRESSION OF CHANGE IN GROWTH RATE OF LABOUR PRODUCTIVITY BETWEEN THE 1966-74 AND 1975-81 PERIODS IN THE MANUFACTURING SECTOR

	Coefficient (t-statistic in brackets)
Constant	-0.3 (-1.1)
Economies of scale proxy (average number of workers per establishment)	0.4 (1.3)

$\bar{R}^2 = 0.03$
Weighted observations

I have some doubts about the accuracy of using the average number of workers per establishment as a scale proxy and would at least suggest looking at average output per establishment, though there is still the fundamental problem of differentiating changes in scale from changes in efficiency. In practically every industry, there was a substantial drop in the rate of growth of average output per establishment between 1966-74 and 1975-81 (Table 21).[37] A cross-sectional regression of the change in

35. This proxy was also used in Postner (1971).

36. Data are taken from Table 7A.

37. GDP data are used to measure output.

Table 20

NUMBER OF WORKERS PER ESTABLISHMENT
(Compound annual rate of change - %)

	1962-81	1962-65	1966-74	1975-79	1975-81
Food and beverages	3.29	3.17	4.04	1.92	2.41
Tobacco	1.10	-1.00	4.47	-3.52	-1.89
Rubber and plastics	-1.13	2.11	-0.98	-2.08	-2.08
Leather	0.27	0.02	0.24	-1.33	0.45
Textiles	0.03	2.20	0.49	-2.40	-1.77
Knitting mills	1.10	1.14	2.17	-1.19	-0.29
Clothing	0.55	1.30	1.06	-0.33	-0.53
Paper and allied products	-0.04	1.41	1.03	-2.65	-2.20
Printing and publishing	0.45	1.05	0.72	0.63	-0.24
Oil and coal products	0.62	-3.04	0.47	1.37	2.98
Chemicals	1.32	1.47	2.53	-0.66	-0.29
Miscellaneous manufacturing	0.64	1.60	2.53	-1.83	-2.26
Wood	3.87	8.66	5.24	2.11	-0.47
Furniture	1.53	2.74	2.90	0.23	-0.88
Primary metals	1.28	4.94	1.55	-1.36	-1.09
Metal fabricating	-0.38	2.35	0.34	-2.57	-2.81
Machinery	-1.61	2.65	-2.37	-3.91	-3.02
Transportation equipment	-0.34	3.95	-0.27	-1.83	-2.79
Electrical products	-1.90	3.27	-1.26	-8.12	-5.53
Non-metallic mineral products	0.17	3.14	2.43	-5.36	-4.29

Source: Statistics Canada Census of Manufactures

Table 21

AVERAGE OUTPUT PER ESTABLISHMENT
(Compound annual rate of change - %)

	1962-81	1962-65	1966-74	1975-79	1975-81
Food and beverages	6.1	6.9	7.8	3.1	3.5
Tobacco	4.3	3.1	8.5	-1.5	-0.2
Rubber and plastics	2.0	5.8	2.8	0.2	-1.1
Leather	2.5	2.8	3.0	1.2	1.8
Textiles	4.4	6.5	5.3	3.2	2.2
Knitting mills	6.0	7.8	6.8	3.5	4.0
Clothing	3.0	4.5	3.6	3.1	1.5
Paper and allied products	2.0	4.6	3.9	-2.0	-2.0
Printing and publishing	3.3	3.1	4.1	3.0	2.3
Oil and coal products	1.4	5.4	5.0	-7.0	-5.0
Chemicals	5.2	8.3	7.1	1.8	1.2
Miscellaneous manufacturing	2.8	5.2	5.6	-0.9	-1.9
Wood	6.5	12.6	7.6	4.8	1.7
Furniture	3.6	6.7	4.9	1.3	0.4
Primary metals	3.2	9.7	4.0	-1.6	-1.4
Metal fabricating	1.8	5.6	3.6	-2.7	-2.6
Machinery	2.1	6.3	2.4	-0.6	-0.5
Transportation equipment	4.1	12.6	6.6	-0.1	-3.5
Electrical products	1.7	9.7	2.6	-5.7	-3.7
Non-metallic mineral products	2.5	7.7	5.8	-3.7	-4.3

Source: Statistics Canada

the rate of labour productivity growth between these two periods on the change in the rate of growth of average output per establishment between the same two periods reveals a strong positive correlation (regression results shown below).

CROSS-SECTIONAL REGRESSION OF CHANGE IN GROWTH RATE OF LABOUR PRODUCTIVITY BETWEEN THE 1966-74 AND 1975-81 PERIODS IN THE MANUFACTURING SECTOR

	Coefficient (t-statistic in brackets)
Constant	0.16(1.1)
Economies of scale proxy (average output per establishment)	0.63(6.2)

$\bar{R}^2 = 0.66$
Unweighted observations

If one makes the (perhaps dubious) proposition that average output per establishment can be treated as an accurate proxy for plant scale, then one could make the inference that a reduction in the rate of exploitation of scale economies may have contributed to the slowdown in productivity growth.

Another aspect of the problem concerns product-specific economies of scale associated with the accumulated volume of output of a single product (Scherer (1980)). Productivity may improve with longer production runs through such mechanisms as learning by doing (Daly (1979)). Baldwin and Gorecki (1983) have measured product diversity and the average length of production runs at the manufacturing plant level in Canada and found an increase in the average length of production run and greater plant specialization between 1974 and 1979. It would appear that comparable data are not available for the pre-1974 period, so that one does not know whether the trends observed over the 1974-79 period were different from those for the pre-1974 period. However, at least in Canada, average production run length does seem to increase with plant size (Baldwin and Gorecki (1983)), so that the earlier evidence on plant size might be applicable to speculation on changes in the average length of production runs and product diversity before 1974.

Much of the empirical research up to 1980 is summarized in Gollop (1980). The electric power and other regulated industries have been favoured for research on scale economies. For instance, Gollop reports on one study (Gollop and Roberts (1980)) that indicated that a reduction in scale economies contributed to the drop in productivity growth between the 1958-66 and 1973-75 periods. The decline in scale economies in these industries in turn seemed to be partly related to a rise in relative fuel prices. Greene (1983) also suggests that scale economies became less important between the late 1950s and the early 1970s in the U.S. electric power industry. Daly and Rao (1983), in a study of Ontario Hydro, found the existence of substantial scale economies and concluded that the decline in productivity growth between the 1967-73 and 1974-80 periods was partly due to a lower rate of growth of aggregate demand.

7 STRUCTURAL SHIFTS

One of the standard factors included in an explanation of productivity change is the shift of resources between economic sectors with differences in absolute levels of productivity and/or rates of growth of productivity. The classic example of such a structural shift is the movement of labour from the low-productivity agricultural sector to other areas of the economy. Earlier studies (Lithwick (1970) and Walters (1970)) had emphasized the importance of this shift in contributing to Canada's economic growth over both the 1926-56 and 1950-67 periods. A 1979 OECD study (p. 38) indicated that for Canada the shift of employment from agriculture to the non-agricultural sectors of the economy accounted for roughly 10 per cent of the growth in output per worker over the 1960-73 period. This source of productivity growth subsequently disappeared between 1973 and 1978. This study also suggested that employment shifts within the non-agricultural sector have contributed about 10 per cent to productivity growth over 1973-1978 (compared with 0 per cent in the 1960-73 period). With respect to the United States, Thurow (1981) identified the end of the employment shift from farming to the non-farming sector as accounting for about 14 per cent of the slowdown in productivity growth between the 1948-65 and 1972-78 periods.

Productivity levels for 1953, 1974, 1979, 1981 and 1983 for the four major industry groups within the commercial sector are shown in Table 22. In 1953, the level of productivity in agriculture was far below the average level for the commercial sector, while productivity levels in commercial services and other commercial goods were above average. Since that time, the productivity level in commercial goods has risen faster than average, while that for commercial services has grown more slowly than average. The effect of shifts of labour in both the commercial and the non-farm commercial sectors has been determined in the following manner. Aggregate output was recalculated over various periods between 1953 and 1983, based on actual sectoral labour productivity levels and on the sectoral composition of employment in place at the beginning of each period. This of course presumes that the composition of demand would have changed to meet this varying composition of output and that marginal

Table 22

PRODUCTIVITY LEVELS: OUTPUT PER MAN-HOUR (1971 dollars)*

	1953	Per cent of total commercial	1974	Per cent of total commercial	1979	Per cent of total commercial	1981	Per cent of total commercial	1983	Per cent of total commercial
Agriculture	0.90	31	1.96	31	2.25	32	2.76	39	2.94	41
Manufacturing	2.80	98	6.84	109	7.63	110	7.61	109	7.88	109
Other commercial goods	3.20	112	8.20	130	8.41	121	8.37	120	9.12	126
Commercial services	3.91	137	6.33	101	7.05	101	7.04	101	7.19	99
Total commercial	2.85	100	6.29	100	6.96	100	7.00	100	7.23	100

* It should be noted that there is a break in the official productivity series in 1975 so that the level of productivity for 1979 is not absolutely comparable with that for 1974.

Source: Statistics Canada's Aggregate Productivity Measures (Cat. no. 14-201)

Table 23

IMPACT OF MAN-HOUR SHIFTS ON LABOUR PRODUCTIVITY GROWTH

	1954-56	1957-59	1960-69	1970-74	1954-74	1975-79	1975-81	1975-83
Commercial:								
Actual labour productivity growth (compound annual rate - %)	4.87	2.96	4.08	3.28	3.84	1.72	1.32	1.39
Contribution of changes in sectoral composition of output to aggregate productivity growth ("shift factor" - percentage points)	1.43	1.08	0.59	0.32	0.51	0.09	0.10	0.02
Commercial non-farm:								
Labour productivity growth (compound annual rate - %)	4.62	2.48	3.42	2.96	3.35	1.54	1.03	1.16
Shift factor (%)	0.27	0.13	-0.06	-0.07	-0.07	-0.05	-0.07	-0.09

Source: Bank of Canada calculations based on Statistics Canada data productivity levels would be equal to average productivity levels. The results are shown in Table 23.

In the commercial sector, the effect of shifts of labour between sectors, principally the slowing in the transfer of labour resources out of agriculture, had an adverse impact on the change in the rate of productivity growth between 1954-74 and 1975-81, accounting for 16 per cent of the slowdown. However, as observed by Thurow, these labour transfers had to end at some point in time. Further, the magnitude of the shift factor has been steadily declining through the whole period since 1954 and no sharp break in the trend was evident in the 1975-81 period. If attention is restricted to the commercial non-farm sector, it can be observed that the shift factor tended to depress productivity growth over the 1954-74 period,[38] as labour moved into commercial services, a sector with a low level of productivity relative to that of the commercial non-farm goods-producing sector.[39] The magnitude of this shift factor did not change very much during the 1975-81 period.[40]

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38. If one looks at subperiods within the 1954-74 period, the shift to the services sector has only had a depressing effect on aggregate productivity growth since the early 1960s when the absolute level of productivity in the service sector began to be lower than the aggregate productivity level in the commercial non-farm sector.

39. It should be mentioned that there are many conceptual problems in measuring output in certain service industries, so that the slow rate of growth in the commercial services sector could be a statistical artifact. For an evaluation of the quality of GDP measures in various industries, see Statistics Canada, Gross Domestic Product by Industry (61-213).

40. Rao and Preston (1984) have found that about 15 per cent of the post-1973 slowdown in aggregate factor productivity growth was due to a movement of resources from the goods sector to the services sector. There is a question as to whether the shift factor is also measuring a movement of labour and other inputs from the agricultural to the non-agricultural sector. As well, there is a need for more evidence on whether the break in the impact of the shift factor is really as abrupt as presented in Rao and Preston (1984). Sharpe (1982) suggests that about one quarter of the slowdown in aggregate productivity growth is due to the end of the shift out of the agricultural sector and an increase in the shift of employment into the personal services sector.

8 ENERGY PRICES AND PRODUCTIVITY

The notion that the energy price shock has had an adverse effect on the level of (and possibly the medium-term growth path of) labour productivity has won increasing acceptance in recent years. Rasche and Tatom (1977) present a classic test of this hypothesis with a formulation in which the flow of energy resources enters as an additional argument in a Cobb-Douglas production function.[41]

For example:

$$Y = A*e^{rt}*L^{a}*K^{b}*E^{c} \tag{1}$$

where Y = gross output (including energy but not other intermediate inputs)
L = man-hours,
K = capital stock * capacity utilization rate, and
E = flow of energy resources.

In their empirical implementation of this model, data on E were not available, so a variable representing the relative price of energy was used in conjunction with the following argument:

$$\frac{DY}{DE} = A*e^{rt}*L^{a}*K^{b}*cE^{c-1} = c*Y/E \tag{2}$$

where $\frac{DY}{DE}$ refers to the derivative of Y with respect to E.

Profits will be maximized when

$$\frac{DY}{DE}*P_B = P_E \tag{3}$$

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41. It should be remarked that the introduction of the energy input flow into a value-added production function (instead of a gross production function, as in the text) is incorrect, as energy is not a primary factor of production. However, it may still be appropriate to include the relative energy price in a value-added production function because of its possible influence on the rate of technical progress. See Kopcke (1980) for further discussion on these points.

where P_B = price of output, and
P_E = price of energy.

Or $c*Y*P_B/E = P_E$, so $E = c*Y*P_B/P_E$ (4)

Then

$$Y = (A*c^c*e^{rt}*L^a*K^b*P^{-c})^{(1/1-c))} \quad (5)$$

where $P = P_E/P_B$.

Their work suggested that the relative energy price variable did have a statistically significant negative impact on output. A comparable equation was estimated by Bilkes (1980, p. 13) with similar results.[42]

In Section 5, a somewhat similar kind of productivity equation was estimated for both the commercial excluding energy and manufacturing excluding energy sectors (Table 19). After calculating a control solution with actual values for the exogenous variables, a counter-factual simulation was undertaken in which it was assumed that the relative price of energy would continue to decline at a rate of 0.6 per cent per year in the commercial excluding energy sector over the 1974-83 period, the same rate as in the 1953-73 period. This kind of simple model suggested that about 48 per cent of the forecast decline in labour productivity growth in the commercial excluding energy sector between the 1954-74 and 1975-81 periods was due to the rise in the relative price of energy (see Figure 17). Similarly, another simulation was undertaken in which the relative price of energy in the manufacturing excluding energy sector was assumed to rise at a rate of 0.3 per cent per year over the 1974-83 period, the same rate as in the 1953-73 period. In this sector, about 21 per cent of the fall in labour productivity growth between the same two periods was calculated as arising from the energy price shock (see Figure 18).

There are a number of problems with these kinds of simple production models. First, very restrictive assumptions are made about the degree of substitutability between different factor inputs. Second, firms use other

42. More recent work by Rasche and Tatom (1981) continues to confirm their hypothesis. See also Tatom (1981).

inputs besides labour, capital and energy in the production process. Third, the models tell us little about how the price of energy actually influences labour productivity, whether through changes in the relative use of different inputs or changes in the rate of technical progress.

In Canada, a considerable amount of modelling work on the production structure of Canadian industries has been undertaken at the Economic Council of Canada (Rao (1981a and 1981b), Rao and Preston (1983)). Static translog cost functions were used to estimate the degree of substitutability between different factor inputs (capital, labour, energy, and raw materials). One of the general conclusions of this research was the importance of the effect of changes in the relative prices of energy and materials on factor proportions (and subsequently on labour productivity) as an explanation of the overall productivity slowdown. The relative price shock has also been viewed as having a further indirect adverse influence on productivity growth through its effect on the growth of aggregate demand in the industrial world.

Berndt (1980), however, investigated the effects of energy price increases on the productivity slowdown in U.S. manufacturing during the 1973-1977 period and found them to be relatively minor. He argued that energy costs are a small proportion of total costs, that there has been little change in energy/output ratios, and that the indirect impact on capital-labour substitution has been relatively small. Berndt and Watkins (1981) arrived at similar conclusions when investigating the productivity slowdown in the Canadian manufacturing sector during 1973-76. On the other hand, Helliwell (1984) found that 30 per cent of the drop in labour productivity between 1973 and 1982, in relation to a steady growth scenario, was the result of substitution of labour for energy.[43] Extending the analysis to include materials other than energy, Bruno (1982, 1984) presented evidence that the raw materials price shock that took place in the early 1970s helps to explain the labour productivity slowdown in the manufacturing sectors of various industrial economies. One major source of controversy in this literature has been the relationship between energy and capital. If energy price increases tended

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43. Helliwell (1984) used the MACE econometric model in which a capital-energy bundle is combined with efficiency labour units in a Cobb-Douglas production function.

to reduce the use of capital (energy-capital complementarity), this could lead to a reduction in labour productivity -- in addition to that generated by the generally accepted finding of substitutability between energy and labour. However, empirical results thus far have been mixed.[44] One possibility is that capital and energy are complements in the short to medium run but substitutes in the long run.[45]

I will now discuss some further modelling work on the production structure of the Canadian manufacturing sector. I used a "third-generation" production model in which capital (and possibly other factors of production) are treated as fixed in the short run and in which there is an explicit theory for the adjustment of quasi-fixed factors towards their long-run levels. Work by E.R. Berndt and others has been at the forefront of this research area.[46]

I will now outline estimation results for one version of a dynamic production model for the Canadian manufacturing sector. A list of the equations and mnemonics is given in Table 24. The equations are derived from the following quadratic normalized restricted cost function:

```
FRML EQCOST G = MGPK*(A0+B0*ATT+B1*RPRE3+B2*RPØ3
                +B3*RPØ3*ATT+B4*RPRE3*ATT+0.5*C0*(RPRE3**2)
                +0.5*C1*(RPØ3**2)+C2*RPRE3*RPØ3+D1*J1L(MKNEI)
                +0.5*D0*((J1L(MKNEI))**2/MGPK)
                +D2*J1L(MKNEI)*ATT+D3*RPRE3*J1L(MKNEI)
                +D4*RPØ3*J1L(MKNEI)+0.5*D9*((J1D(MKNEI))**2/MGPK
                +D20*J1L(MMHNPI)
                +0.5*D21*((J1L(MMHNPI))**2/MGPK
                +D23*J1L(MMHNPI)*ATT+D24*RPRE3*J1L(MMHNPI)
                +D25*RPØ3*J1L(MMHNPI)+0.5*D26*(((J1D(MMHNPI))**2/MGPK)
                +E0*DV73AA+E1*ATT*DV73AA
```

44. A study by Rao (1981a) suggests that capital and energy and labour and energy are substitutes. This result is confirmed by Waverman (1980). Rao (1981a) ascribes the post-1973 productivity slowdown to both cyclically weak demand and an acceleration in the rate of growth of prices of energy and materials inputs.

45. For instance, Norsworthy (1980) is of this opinion. "Within U.S. manufacturing, the evidence for energy-capital complementarity before 1973 is very strong. There are, however, other aspects to the energy-capital complementarity issue which make it a dubious basis for describing the future" (p. 177). Mohr (1980) supports this idea, suggesting that a substantial part of the post-1966 slowdown in productivity growth in the United States can be attributed to an incomplete adjustment to a number of shocks, such as energy price increases and government policy changes.

46. A general introduction to this research is given in Berndt, Morrison and Watkins (1981). Related studies include Berndt (1980), Morrison and Berndt (1981) and Berndt and Watkins (1981).

Table 24

**EQUATIONS FOR A DYNAMIC PRODUCTION MODEL
OF THE MANUFACTURING SECTOR**

```
EQTRE4     REQ = B1+B4*ATT+C0*RPRE3+C2*RPØ3+(D3*J1L(MKNEI))/MGPK
           +(D24*J1L(MMHNPI))/MGPK

EQTØ4      ØQ = B2+B3*ATT+C1*RPØ3+C2*RPRE3+(D4*J1L(MKNEI))/MGPK
           +(D25*J1L(MMHNPI))/MGPK

EQTP4DW    PWQ = A0+B0*ATT-(.5*C0*RPRE3*RPRE3)-(.5*C1*RPØ3*RPØ3)
           -(C2*RPRE3*RPØ3)+(D1*J1L(MKNEI))/MGPK+(D20(J1L(MMHNPI))/MGPK
           +.5*D0*(J1L(MKNEI)/MGPK)**2)+.5*D21*((J1L(MMHNPI)/MGPK**2.)
           +(D2*J1L(MKNEI)*ATT)/MGPK+(D23*J1L(MMHNPI)*ATT)/MGPK
           +.5*D9*((J1D(MKNEI)/MGPK)**2.)
           +.5*D26*((J1D(MMHNPI)/MGPK)**2.)+E0*DV73AA+E1*ATT*DV73AA

EQTK4      KQ = -.5*(RRWA**2.+4.*(D0/D9))**.5))*((-1./D0)*(D1+D2*ATT
           +D3*RPRE3+D4*RPØ3+RPK3A)-(J1L(MKNEI)/MGPK))
           +J1L(MKNEI)/MGPK

EQTN4E     NPQ = -.5*(RRWA-((RRWA**2.+4.*(D21/D26))**.5))
           *((-1./D21)*(D20+D23*ATT+D24*RPRE3+D25*RPØ3+RPNP3)
           -(J1L(MMHNPI)/MGPK))+J1L(MMHNPI)/MGPK
```

MNEMONICS

G	=	Total costs in terms of the price of production labour
REQ	=	Ratio of real (energy and raw materials) inputs to gross output
ØQ	=	Ratio of real other intermediate inputs to gross output
NPQ	=	Ratio of non-production labour input to gross output
PWQ	=	Ratio of production labour input to gross output
KQ	=	Ratio of capital input to gross output
ATT	=	Time trend
RPRE3	=	Normalized* price of raw materials and energy
RPØ3	=	Normalized* price of other intermediate inputs
RPNP3	=	Normalized* price of nonproduction labour
RPK3A	=	Normalized* price of capital
MKNEI	=	Capital stock
MMHNPI	=	Non-production labour input
MGPK	=	Gross output
RRWA	=	Real interest rate
DV73AA	=	Dummy variable with value of 0 for 1926-1973 and value of 1 thereafter.

* Normalized by price of production labour

A more detailed discussion of the definition of these variables and data sources is given in Stuber (1983a, 1983b).

In this model, the following inputs are needed for production: raw materials and energy (RE), other intermediate inputs (ϕ--these consist mainly of business services), production labour (PW), non-production labour (NPW or MMHNPI) and capital (K or MKNEI). The levels of raw materials and energy, other intermediate inputs and production labour can be adjusted instantaneously, while the levels of non-production labour and capital are fixed in the short run. Given cost minimization,[47] the equations in Table 24 can be derived.[48] The level of each of the variable inputs depends on relative variable input prices and on the level of each of the quasi-fixed inputs.[49] In the intermediate and long run, the level of each quasi-fixed input depends on relative variable input prices and its own relative price.[50] It may also be observed that the rate of adjustment of each quasi-fixed input depends inversely on the real interest rate.

The basic set of estimation results is shown in Table 25.[51] In order to obtain economically meaningful results,[52] it was necessary to impose two parameter constraints, as is shown in the table. A summary of the input relationships is shown in Table 26. The most interesting finding was that capital and production labour are substitutes, in

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47. Use of the cost-minimization assumption presumes that factor prices are exogenous and cost functions are estimated, whereas profit maximization is consistent with an approach where factor input quantities are exogenous and production functions are estimated. If one is interested in analyzing the behaviour of firms, it is probably more reasonable to assume exogeneity of factor prices. For a brief discussion of this issue, see Meredith (1982).

48. A general discussion of the derivation of input-output equations from dynamic production models is given in Morrison and Berndt (1981) and in Berndt and Watkins (1981). Also see Stuber (1983a).

49. Constant returns to scale in the long run is assumed implicitly.

50. In order to make this version of the dynamic production model tractable, the assumption must be made that the adjustment of capital is independent of the adjustment of non-production labour. This implies that the long-run cross-price elasticity of demand between capital and non-production labour is zero. For a recent study in which the assumption that the adjustment paths of two quasi-fixed inputs are independent of each other is tested, see Epstein and Denny (1983).

51. I would like to acknowledge advice from John Armstrong on the estimation of this kind of multi-equation model.

52. In the estimation of this kind of model, it generally proved to be the case that the implied own-price elasticity of some inputs (especially other intermediate inputs) was positive when no constraints were placed on the parameters.

Table 25

THIRD-GENERATION PRODUCTION MODEL: MANUFACTURING — SUMMARY OF ESTIMATION RESULTS (Five factors of production, capital and non-production labour quasi-fixed, t-statistic in parentheses)

Parameter	No parameter constraints	Parameter constraints: C1 = 0; D26 = D21
B1	0.555 (14.5)	0.462 (11.0)
B4	-0.005 (-7.7)	-0.006 (-7.4)
C0	-0.016 (-4.2)	-0.015 (-3.4)
C2	0.008 (3.0)	0.006 (2.5)
D3	0.046 (0.4)	0.897 (5.6)
D24	-0.430 (-3.5)	-0.467 (-3.5)
B2	0.070 (2.0)	0.075 (3.4)
B3	0.003 (4.7)	0.002 (4.3)
C1	0.011 (1.5)	0
D4	-0.582 (-7.1)	-0.284 (-3.3)
D25	0.335 (4.1)	0.313 (4.3)
A0	-1.777 (-4.9)	4.223 (11.2)
B0	0.055 (7.8)	-0.032 (-3.8)
D1	-11.476 (-7.3)	-21.517 (-8.0)
D20	23.693 (9.3)	-8.523 (-3.3)
D0	60.963 (5.2)	109.744 (6.0)
D21	-58.968 (-7.3)	21.421 (2.8)
D2	-0.020 (-1.2)	-0.015 (-0.7)
D23	-0.308 (-11.8)	0.099 (3.0)
D9	58.436 (5.3)	61.727 (6.2)
D26	-179.453 (-5.8)	21.421
E0	0.712 (9.6)	-1.231 (-5.0)
E1	-0.015 (-10.2)	0.026 (5.3)
Log of likelihood function	680.935	642.069
R2 - REQ	0.903	0.955
ØQ	-0.070	0.230
NPQ	0.993	0.991
PWQ	0.986	0.915
KQ	0.909	0.864

Estimation period: 1947-1980. Non-linear iterative Zellner.

Table 26

THIRD-GENERATION PRODUCTION MODEL: MANUFACTURING — SUMMARY OF INPUT RELATIONSHIPS (Five factors of production, capital and non-production labour quasi-fixed)

Price elasticities	C1=0; D26=D21	
RE-RE	Negative	
RE-PW	S	
PW-RE	S	
RE-Ø	S	
Ø-RE	S	
RE-NP	S	
NP-RE	S	
RE-K	C	
K-RE	C	
Ø-Ø	Negative	(0 in short run)
Ø-PW	C	(S in LR for 1968-72)
PW-Ø	C	(S in LR for 1958-80)
Ø-NP	C	
NP-Ø	C	
Ø-K	S	
K-Ø	S	
PW-PW	Negative	
PW-NP	S	
NP-PW	S	
PW-K	S	
K-PW	S	
NP-NP	Negative	
NP-K	0	
K-NP	0	
K-K	Negative	
Output elasticities		
RE	$0 \leq E \leq 1.2$	
Ø	$0 \leq E \leq 1.2$	
NP	$0 \leq E \leq 1$	
PW	$0 \leq E \leq 5$	
K	$0 \leq E \leq 1$	

S = substitutes
C = complements

accordance with similar results for the U.S. manufacturing sector in Morrison and Berndt (1981).[53] The relationship between raw materials and energy and the two types of labour appears to be one of substitutability, while that between raw materials and energy and capital is one of complementarity.[54] One probably dubious implication of the above results is that the estimated own-price and cross-price elasticities for most input relationships are almost always very small, even in the long run (Table 27).[55]

Finally, I used the above model to estimate the impact of changes in the relative prices of raw materials and energy and of capital on factor and labour productivity growth in the Canadian manufacturing sector during the 1975-80 period (Table 28). In the first shock, it was assumed that the normalized price of raw materials and energy continued to decline by 2.8 per cent per year over the 1974-81 period instead of actually increasing by 2 per cent per year. The results shown in Table 28 indicate that the raw materials and energy price shock could have accounted for about 18 per cent of the decline in labour productivity growth between 1954-74 and 1975-80 and about 4 per cent of the decline in total factor productivity growth between the same two periods. In the second shock, the trend in the normalized price of capital over the 1954-73 period was assumed to continue over the 1974-81 period but this shock accounted for a very small proportion of the decline in labour productivity growth. The third shock was simply a combination of the first and second shocks. However, the results reported for this version of the dynamic production

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53. In another model where non-production labour was assumed to be a variable input, the estimation results indicated a complementary relationship between capital and non-production labour (Stuber (1983b)).

54. In another version of the model where aggregate labour was treated as a variable input, the relationship between raw materials and energy and both labour and capital was almost always one of substitutability (Stuber (1983a)).

55. For a discussion of the derivation of price and output elasticities for dynamic production models, see Morrison and Berndt (1981) and Stuber (1983a). In a two-equation model (only aggregate labour and capital equations were estimated), estimated own-price and cross-price elasticities were much larger (Stuber (1983a)).

Table 27

THIRD-GENERATION PRODUCTION MODEL: MANUFACTURING — ELASTICITY ESTIMATES (Five factors of production, capital and non-production labour quasi-fixed (C1=0 and D26=D21))

Elasticity (1971 value)	Short run	Intermediate run	Long run
Price			
RE-RE	-0.06	-0.07	-0.07
RE-PW	0.03	0.04	0.02
PW-RE	0.04	0.06	0.07
RE-Ø	0.02	0.03	0.06
Ø-RE	0.04	0.05	0.06
RE-NP	0	0.02	0.08
NP-RE	0	0.03	0.16
RE-K	0	-0.01	-0.03
K-RE	0	-0.02	-0.05
Ø-Ø	0	-0.01	-0.03
Ø-PW	-0.04	-0.03	0.01
PW-Ø	-0.02	-0.01	0.05
Ø-NP	0	-0.02	-0.09
NP-Ø	0	-0.02	-0.10
Ø-K	0	0.01	0.02
K-Ø	0	0	0.01
PW-PW	-0.04	-0.13	-0.36
PW-NP	0	0.19	1.01
NP-PW	0	0.05	0.28
PW-K	0	0.04	0.12
K-PW	0	0.03	0.08
NP-NP	0	-0.06	-0.33
NP-K	0	0	0
K-NP	0	0	0
K-K	0	-0.02	-0.05
Output			
RE	0.70	0.85	1.00
Ø	1.04	0.98	1.00
NP	0	0.20	1.00
PW	3.49	2.60	1.00
K	0	0.34	1.00

model are somewhat suspect, given the small size of many of the price elasticities and the necessity to impose two parameter constraints.[56]

The above discussion by no means exhausts the channels through which energy (or more generally raw materials) price changes could affect the level or growth of productivity. Jorgenson and Fraumeni (1981)

Table 28

EFFECT OF RELATIVE FACTOR PRICE CHANGES ON FACTOR AND LABOUR PRODUCTIVITY (Five factors of production: capital and non-production labour quasi-fixed) (Annual rate of change (%))

	1954-74		1975-80	
	Factor	Labour	Factor	Labour
Actual	1.96	3.66	0.30	1.19
Model:				
Control	2.01	3.58	1.04	2.91
Shock 1	-	-	1.11	3.36
Shock 2	-	-	0.98	3.00
Shock 3	-	-	1.07	3.45

Shock 1: Normalized price of raw materials and energy declines at 2.8 per cent per year over 1974-81 (same rate of change as over 1954-73). Actually increased by 2 per cent per year over this period.

Shock 2: Normalized price of capital falls at 3.2 per cent over 1974-81 (same rate of change as over 1954-73). Actually no change (on average) over this period.

Shock 3: Combination of Shocks 1 and 2.

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56. In the two-equation version of the model noted in the previous footnote, the raw materials-energy price shock is estimated to have accounted for over 50 per cent of the slowdown in labour productivity growth. However, it should be pointed out that the two-equation model as a whole does not explain the decline in productivity growth. A recent study by Taher et al. (1983) suggests that the impact of changes in natural resource input prices on labour and capital usage in the Canadian manufacturing sector may be much larger than are changes in energy prices.

constructed a model where total factor productivity growth depends on relative prices. For most sectors of the U.S. economy, it would seem that multi-factor productivity is inversely related to the relative energy price, which helps to explain why productivity growth slowed after 1973.[57] In a related argument, Schurr (1982) has suggested that abundant, relatively cheap energy between 1920 and 1970 helped promote the development of energy-using technologies, as well as the use of more flexible, efficient production processes based on the special qualities of electricity and fluid fuels. One could speculate that the rise in energy prices after 1973 helped slow this process of innovation and may even have rendered part of the stock of technology obsolete. The slower rate of innovation would probably be more closely associated with uncertainty caused by a high variance of relative energy prices; eventually, the rate of technological progress would increase as the stock of technology became less energy-intensive on average. Among Canadian studies, work by Rao and Preston (1984) and Berndt and Watkins (1981) has suggested that an increase in the price of energy reduces factor productivity growth (termed "energy-using") in the manufacturing sector. Muller (1981) found that technical change became energy-using after 1974 in the non-energy, non-primary sector of the economy. On the other hand, Denny, Fuss and Waverman (1979), using a Jorgensonian-type model, reported that technical progress tended to be energy-saving in the Canadian manufacturing sector. In my own estimates of a dynamic production model for Canadian manufacturing, technical progress was also found to be energy and raw materials-saving, insofar as the coefficient B4 in Table 25 was negative, suggesting that increases in the prices of energy and raw materials increase the rate of growth of total factor productivity (which is equivalent to saying that the trend rate of increase in total real costs is lower). The failure to differentiate between the short-run and long-run responses of the innovation process to relative energy price changes may explain the lack of consistency of the results reported for this type of model.

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57. Berndt (1982) suggests that the size of this effect may be small, though understated, in the Jorgenson-Fraumeni model. In recent work, Jorgenson (1984) has treated the electrical energy input separately from non-electrical forms of energy and found that greater use of non-electrical energy was a more important factor than increased use of electricity in explaining productivity growth.

Large changes in relative energy (or other factor) prices may also have an important impact on the structure of demand. Hudson and Jorgenson (1974, 1978a, 1978b) explored this issue with U.S. data and found that energy price increases shifted demand towards more labour-intensive sectors and away from energy-intensive sectors.[58] Shocks to the demand structure may also induce supply-side effects, such as accelerated obsolescence of capital equipment and structures, a temporarily less efficient labour force as a result of changes in industrial and occupational mix, and so on. For example, I suspect that these kinds of effects may help explain the sizeable decline in labour productivity growth in the transportation equipment, oil and gas mining and oil and coal products industries.

Berndt and Wood (1985) have recently suggested that an increase in the relative price of energy would have reduced utilization rates of energy-intensive plant and equipment. This development explains most of the slowdown in factor productivity growth in U.S. manufacturing between the 1965-73 and 1973-81 periods.

It seems reasonable to conclude that the kinds of effects discussed above would be most evident in energy-intensive industries, which would likely have experienced a more pronounced decline in productivity growth after 1973. In Table 29, the average energy share of gross output for the 1966-74 and 1975-79 periods and the change in the rate of growth of the energy/labour ratio between those periods are shown for each two-digit manufacturing industry. These variables were used to explain the change in the rate of labour productivity growth (using data from Table 7A) between the same two periods in two cross-sectional regressions as shown in the table on page 76; this follows a similar kind of exercise carried out in Baily (1982) with U.S. data.

The coefficient for the energy share variable was highly statistically significant, which is not surprising given that highly energy-intensive industries such as oil and coal products, chemicals, and

58. "Energy intensity" refers to input usage. It may also be the case that demand would be shifted away from consumer goods that require relatively large amounts of energy to operate (such as cars).

Table 29

SELECTED ENERGY DATA FOR MANUFACTURING SECTOR

Industry	Energy share of nominal gross output 1966-74	Energy share of nominal gross output 1975-79	Change in rate of growth of energy/labour ratio between 1966-74 and 1975-79 (%)
Food and beverages	0.012	0.015	-1.3
Tobacco	0.005	0.006	-0.5
Rubber and plastics	0.02	0.02	-0.7
Leather	0.01	0.01	4.0
Textiles	0.02	0.03	-0.4
Knitting mills	0.008	0.012	-0.3
Clothing	0.003	0.004	-1.0
Paper and allied products	0.07	0.09	-0.5
Printing and publishing	0.007	0.008	-3.6
Oil and coal products	0.76	0.86	-3.2
Chemicals	0.09	0.14	1.3
Miscellaneous mfg.	0.011	0.012	-3.7
Wood	0.018	0.023	-0.9
Furniture	0.009	0.01	-0.9
Primary metals	0.065	0.11	-1.5
Metal fabricating	0.011	0.014	-3.0
Machinery	0.008	0.012	-3.9
Transportation equipment	0.01	0.012	-5.3
Electrical products	0.009	0.012	-0.4
Non-metallic mineral products	0.061	0.089	-2.4

Source: See the tables on labour productivity change for manufacturing industries in Appendix A.

CROSS-SECTIONAL REGRESSION FOR CHANGE IN RATE OF LABOUR PRODUCTIVITY GROWTH BETWEEN 1966-74 AND 1975-79 IN THE MANUFACTURING SECTOR

	Coefficient (t-statistic in brackets)	
	(1)	(2)
Constant	-1.2(-3.6)	-1.3(-1.8)
Energy share of gross output	-14.7(-7.4)	-
Change in rate of of growth of energy/ labour ratio	-	0.6(2.0)
$\bar{R}^2$	0.74	0.13
Unweighted observations		

primary metals all experienced substantial declines in labour productivity growth after 1974. The t-statistic was, however, much lower (-2.7) when observations were weighted. The coefficient for the variable measuring the change in the rate of growth of the energy/labour ratio was just statistically significant at the 5 per cent level. These results are offered as additional evidence for the hypothesis that increases in the relative price of energy were partly responsible for the decline in labour productivity growth after 1974 in the manufacturing sector.[59]

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59. Baily (1982) also found "a statistically significant correlation between the size of the slowdown by industry and energy intensity... Energy intensity was measured by the ratio of expenditure on energy to value added in 1973, both in current dollars." (p. 443). He was analyzing data for the U.S. manufacturing sector.

9 RESEARCH AND DEVELOPMENT (R&D), THE INNOVATION PROCESS AND TECHNOLOGICAL CHANGE

Increases in the knowledge base and the application of this knowledge to the production process are generally considered the fundamental contributing factors to improvements in factor productivity. In this sense, technological advance may include not only applications of new scientific developments but also day-to-day improvements in the organization and process of production. As has recently been emphasized by the Economic Council of Canada (1983), the actual application of innovations is a crucial part of the mechanism of technological advance. In many cases, they have found that the diffusion of innovations into and within Canadian industry can be very slow.[60] The Economic Council has also emphasized that firms have to be able to use international technology profitably. As has been shown by Terleckyj (1980, p. 376), an industry may benefit indirectly by buying capital and intermediate inputs from industries where research and development activity is relatively high.

In the context of the productivity slowdown, technological change has already been discussed in the section on energy prices, where it was suggested that the large rise in the relative price of energy may have rendered part of the existing stock of technology economically inefficient and temporarily slowed down the process of technological change. Some researchers have also examined the issue of whether a possible slowing in the rate of growth of spending on R&D has been a factor in the productivity slowdown. While there are many pitfalls in this research area,[61]

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60. This is not to say that it would necessarily be better in all cases if the process of diffusion were more rapid. There are, after all, risks associated with the application of new technology, and different kinds of technology may be best adapted to certain situations.

61. An analysis of some of the difficulties involved in determining the impact of R&D spending on productivity growth, such as problems in measuring output in R&D-intensive industries and in measuring R&D capital, is given in Griliches (1979).

there seems to be some evidence that increased spending on research and development does result in stronger productivity growth.[62]

At the aggregate level it is evident that beginning in the early 1970s spending on R&D fell relative to GNP (Figure 19).[63] Given that there is likely to be a long lag between the actual investment and its impact on productivity performance, this development may have contributed to the slowdown in productivity growth, especially in manufacturing.[64,65] As well, even if R&D spending results in an innovation in a particular industry, it may take a long time for it to become commonly used throughout the industry.[66] There is some evidence that diffusion rates for new technology are slower in Canada than in the United States and other countries (Economic Council of Canada (1983)) although I am unaware of any evidence that there was a further slowdown in the technological diffusion rate in Canada relative to other countries after 1973. The other point of interest shown in Figure 19 is the

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62. Some of this evidence is described by Mansfield (1980a, pp. 569-70). Mansfield (1980b) has presented some empirical work suggesting that spending on basic research as well as on applied research may contribute to productivity growth; however, the suggestion is made that spending on basic research may serve as a proxy for long-term research and development spending. Much of the recent research on the relationship between spending on R&D and productivity growth is described in Griliches (1984). Two recent Canadian studies of this relationship include Postner and Wesa (1983) and Longo (1984). Postner and Wesa (1983) take a consumption-oriented approach towards the measurement of productivity, attempting to account for indirect labour embodied in the purchases of intermediate inputs from other industries; they find a statistically significant relationship in selected manufacturing industries between this measure of productivity growth and the growth of the R&D net stock included in purchases of inputs from other industries (where the R&D spending is actually carried out by the firm selling the inputs).

63. The source for the data in Figure 19 is Statistics Canada's Science Statistics Service Bulletin (13-003), vol. 7, no. 3 and vol. 4, no. 9. Also see Statistics Canada's Industrial Research and Development Statistics 1982 (with 1984 forecasts) (88-202).

64. The bulk of R&D spending by business is done by the manufacturing sector. In turn, electrical products, transportation equipment, chemicals, oil and coal products, machinery, and primary metals account for most R&D spending within manufacturing.

65. Several recent U.S. studies (for instance Griliches (1980), Kendrick (1980b), Nadiri (1980a, 1980b), and Nadiri and Schankerman (1981)) have presented evidence indicating that a slowing of the growth of spending on research and development may have been one factor contributing to the decline in productivity growth in that country. However, in Griliches (1984) it is suggested that there is a consensus that the slowdown in the growth of spending on R&D was not directly responsible for the worldwide slowdown in factor productivty growth which began around 1974-75. There is a possibility that the decline in productivity growth that began in the late 1960s may be partly linked to a slowdown in the growth of spending on R&D.

66. Some examples of diffusion rates of new technologies are given in Daly and Globerman (1976) and the Economic Council of Canada (1980), pp. 114-120. Boucher (1981) provides an interesting discussion of the diffusion of innovations in U.S. metalworking industries.

substantial increase in spending on research and development relative to GNP beginning in 1980. To the extent that spending on R&D inputs is related to technological change,[67] this development may remove at least one adverse influence on productivity growth. As a caveat, it is worth emphasizing that a small country like Canada relies heavily on imported technology and would subsequently still be exposed to a worldwide slowdown in the rate of technological advance.

Another point worth noting is that U.S. data suggest a fundamental shift in the composition of R&D expenditure towards less risky projects with shorter pay-back periods (OECD, 1980, p. 35).[68] An Economic Council of Canada study (DeMelto, McMullen and Wills, 1980, p. 261) surveyed a sample of innovations in five Canadian three-digit industries and suggested the same kind of development in Canada, especially with respect to more emphasis on the implementation of innovations with shorter pay-back periods. If such a trend has been common among Canadian industries recently, one could speculate that it might be caused partly by changes in the economic environment that have lowered incentives for risk-taking. Over the longer run, this trend could weaken productivity growth.

This leads to another interesting area of research pioneered by Olson (1982), who suggested that an increase in the number of special interest groups has led to a reduction in economic growth. He believes that in relatively stable societies these groups increase in number and influence over time, and focus their efforts on redistribution rather than the creation of new wealth:

> Distributional coalitions slow down a society's capacity to adopt new technologies and to reallocate resources in response to changing conditions, and thereby reduce the rate of economic growth. (Olson (1982), p. 65.)

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67. A discussion of some of the problems involved in making aggregate R&D/GDP comparisons on an international basis is given in Palda and Pazderka (1982).

68. A survey conducted by Mansfield (1980b) showed that the proportion of total R&D spending allocated to basic research and to relatively risky projects fell in most industries in the United States in the 1967-77 period. The firms in Mansfield's survey attributed these developments partly to an increase in government regulation and to high inflation rates.

This kind of activity may also result in a rise in the complexity of regulation and a larger role for government. Unfortunately, evidence needed to back up this provocative theory is still lacking. Also, it would seem that the hypothesis would be more consistent with a gradual decline rather than a sharp break in the rate of productivity growth.

Mensch (1979) has suggested that crucial innovations in technology tend to be bunched. Over time, the rate of technological advance associated with a maturing industry is assumed to decline. While he does offer some evidence that basic innovations occur in clusters, the link between this tendency and the rate of productivity growth has not been subjected to rigorous empirical testing. However, Baily (1982) tested one aspect of this hypothesis -- that the rate of productivity growth should eventually decline as an industry matures. If so, then the slowdown in productivity growth should have been larger in precisely those industries that had experienced strong productivity growth before 1973. The statistical support for this notion was weak with U.S. data. In order, to test this hypothesis for Canadian two-digit manufacturing industries, I estimated a cross-sectional regression of the change in labour productivity growth between 1966-74 and 1975-81 on the annual change in labour productivity growth in the 1966-74 period (the results are shown below). There is some, at best weak, statistical support for Baily's hypothesis.

CROSS-SECTIONAL REGRESSION FOR CHANGE IN LABOUR PRODUCTIVITY GROWTH BETWEEN 1966-74 AND 1975-81 IN THE MANUFACTURING SECTOR

	Coefficient (t-statistic in brackets)	
Constant	1.2	(0.6)
Annual rate of growth of labour productivity growth in 1966-74	-1.0	(-2.0)
$\bar{R}^2$	0.13	
Unweighted observations		

10 CHARACTERISTICS OF THE WORK FORCE

The question of whether changes in the work force have contributed to the productivity slowdown has been reviewed by Bilkes (1980, p. 12).[69] Briefly, the key proposition is that the influx of inexperienced and/or less skilled persons into the work force has led to a deterioration in productivity performance. A conventional, though not necessarily accurate, measure of the quality of the labour force is the proportion of adult females and youths. The age-sex composition of the work force is illustrated in Table 30.[70]

There has been a trend over the entire postwar period for the employment share of adult females to rise. On the other hand, the employment share of youths has only increased slightly since 1953 and in fact has been falling since 1974. What is of special interest is that the adult female-youth employment share increased most rapidly from 1960 to 1974, the period when productivity growth was strongest. This evidence thus supports the views of Sims and Stanton (1980, pp. 39-43) and the Economic Council of Canada (1980, p. 93) that this factor has not been significant in explaining the slowdown.

The aspect of work force quality that figured most importantly in the above discussion was job experience, as proxied by the proportion of adult females and youths. It might be argued that labour productivity has been adversely affected by a decline in average job tenure. More direct

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69. Studies of the impact of labour force characteristics on productivity levels and growth rates include Perry (1977), Lichtenberg (1981), and Perloff and Wachter (1980). The Perry and Perloff-Wachter articles do not seem to ascribe a major role to changes in labour force characteristics as an explanatory factor for the slowdown in productivity growth. However, Chinloy (1981) attributes part of the fall in labour productivity growth in the United States during the 1967-74 period to a decline in labour quality, mainly arising from occupational effects (a shift towards unskilled occupations). Darby (1984) has suggested that there has been little change in the trend rate of labour productivity growth in the United States between the 1900-29, 1929-65 and 1965-79 periods, if adjustments to hours worked are made for changes in age-sex composition, immigration and education. A large part of the slowdown in labour productivity growth between the 1965-73 and 1973-79 periods is attributed to output measurement errors associated with the 1971-74 price-control program.

70. The data in Table 30 are based on Statistics Canada's The Labour Force (71-001).

Table 30

AGE-SEX COMPOSITION OF EMPLOYED WORK FORCE (% shares)

Year	Youth 15-24	Female 25 +	Sub-total	Male 25 +	Compound growth rate of share of youth-female employment (%)
1953	23.3	14.0	37.3	62.7	
1959	21.1	17.8	38.9	61.2	0.7 (1954-1959)
1969	24.4	22.2	46.6	53.3	1.8 (1960-1969)
1974	26.0	24.0	50.0	50.0	1.4 (1970-1974)
1975	25.6	24.8	50.4	49.6	
1979	25.1	27.2	52.4	47.6	0.9 (1975-1979)
1981	24.2	29.0	53.3	46.7	0.9 (1975-1981)
1983	21.8	31.3	53.0	47.0	0.6 (1975-1983)

Source: Statistics Canada

evidence on this is given in the job tenure data published by Statistics Canada (Table 31).[71] Unfortunately, this information is only available from 1975 on, so it is impossible to determine if there has been a change in the trend of average job tenure since the 1960s. The data do not offer much support for this hypothesis insofar as the only significant shift in employment has been from the group with 20-plus years of experience to the group with 6 to 20 years of experience.

Another significant characteristic of the work force is the relative importance of part-time employment. Over most of the postwar period, there has been a strong increase in the share of part-time employment in total employment, as shown below in Table 32.[72]

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71. Data on job tenure are from Statistics Canada's Labour Force Annual Averages 1975-1983 (71-529). Job tenure is defined in terms of the length of time that an employee works consecutively for the same employer.

72. The data in Table 32 are based on Statistics Canada's The Labour Force (71-001).

Table 31

JOB TENURE
(% share of total employment)

Year	Months 1-6	Months 7-12	Years 1-5	Years 6-10	Years 11-20	Years 20+
1975	17	9	31	16	13	13
1976	17	9	34	16	14	10
1978	16	9	34	17	14	10
1979	17	9	32	17	15	10
1980	17	9	32	18	15	9
1981	17	9	31	18	15	9
1983	16	7	32	19	17	9

Source: Statistics Canada

Table 32

GROWTH OF SHARE OF PART-TIME EMPLOYMENT
(% - compound growth rate)

1954-1974	6.0
1954-1959	8.8
1960-1969	6.3
1970-1974	2.0
1976-1981	4.1
1976-1983	4.8

Source: Statistics Canada

It should be noted that in 1975 there is a break in the part-time employment series arising from the implementation of the Revised Labour Force Survey. In Table 32 it can be seen that there was a rise in the relative growth of part-time employment in the second half of the last decade compared to the early 1970s, although the rate of growth was still well below that of the 1954-69 period. Again the relationship between these trends and the productivity slowdown is rather tenuous.

As well, I have investigated movements in part-time employment at a more disaggregated level. It is worth noting that part-time employment is concentrated in the trade and community-business-personal services sectors, as is illustrated in Table 33.[73]

Table 33

COMPOUND GROWTH OF PART-TIME EMPLOYMENT (%)

Industry	1967-1974	1976-1981	Share of part-time employment in total employment: 1981	1983
Goods-producing (excluding agriculture)	3.50	5.56	3.7	4.6
Services-producing	3.53	3.73	17.3	19.1
Of which:				
Trade	4.39	2.19	22.2	24.9
Finance, insurance and real estate	2.91	4.67	9.4	10.8
Community, business and personal services	2.71	4.21	22.8	23.5

Source: Statistics Canada

The main point of interest here is whether the evolution of part-time employment in the major service sectors was correlated with fluctuations in productivity growth. The productivity slowdown was especially pronounced in the trade sector, but the amount of part-time employment in that sector increased at a lower rate from 1976 to 1981 than over the 1967-74 period.

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73. Data on disaggregated part-time employment are from the following sources: 1975-1983 (Revised Labour Force Survey), Statistics Canada's Labour Force Annual Averages 1975-1983 (71-529), and 1966-1975 (former Labour Force Survey), Statistics Canada, unpublished data.

Next, I examined the educational attainment levels of the work force on the assumption that there is some relationship between this variable and skill levels. Data on this subject are collected regularly in the Revised Labour Force Survey. Prior to 1975, data were gathered on an irregular basis and unfortunately there have been changes in the definitions of "educational attainment" and "post-secondary education", so that the figures are not strictly comparable over the 1960-83 period (Table 34).[74]

Table 34

EDUCATIONAL ATTAINMENT OF WORK FORCE
(Per cent of total; compound growth rate in parentheses)

	Elementary school or less	High school or some high school	Some post-secondary education
1960	42.8	49.0	8.1
1965	38.3 (-2.2)	52.1 (1.2)	9.6 (3.5)
1970	27.2 (-6.6)	57.7 (2.1)	15.1 (9.5)
1975	20.0	46.6	33.3
1981	15.0 (-4.7)	52.3 (1.9)	32.7 (-0.3)
1983	13.4 (-5.5)	50.1 (-2.1)	36.5 (5.7)

Source: Statistics Canada. There is a break in the data between 1970 and 1975.

The one interesting tendency shown in Table 34 is a stabilization in the proportion of the work force having some post-secondary education between 1975 and 1981. This might suggest that a slowing of the rate of growth of average skill levels was another contributing factor to the slowdown in productivity growth. Since 1981, the proportion of the work

74. Data on the educational attainment of the labour force came from various Statistics Canada publications: Educational Attainment of the Canadian Population and Labour Force: 1960-65 (F.J. Whittingham, Special Labour Force Study No. 1), 1966; "The Educational Attainment of the Canadian Labour Force: 1960-70" (Ian Macredie), in Notes on Labour Statistics 1971 (72-207); and Labour Force Annual Averages 1975-1983 (71-529).

force having some post-secondary education has, however, begun to grow once again.

Finally, I examined the behaviour of the share of non-production workers in total employment in each of the 20 two-digit manufacturing industries.[75] There is a substantial amount of variation in this variable among different industries (Table 35)[76] and one might suppose that industries experiencing higher rates of technical change or industries that are more capital-intensive might have a higher proportion of their work force engaged in activities not directly related to current production. If the productivity slowdown were the result of an exhaustion of possibilities for innovation in certain industries or of a slower rate of growth of demand,[77] then one might expect the share of non-production workers in total employment to be negatively correlated with the change in labour productivity growth between the 1966-74 and 1975-81 periods. This does seem to be the case when a cross-sectional regression is estimated:

CROSS-SECTIONAL REGRESSION FOR CHANGE IN LABOUR PRODUCTIVITY GROWTH BETWEEN THE 1966-74 AND 1975-81 PERIODS IN THE MANUFACTURING SECTOR

	Coefficient (t-statistic in brackets)
Constant	1.3 (1.0)
Average share of non-production workers in total employment	-14.3 (-3.4)

$\bar{R}^2 = 0.36$

75. An early study of the role of non-production workers is given in Delehanty (1968). He found that industries characterized by the largest increases in the ratio of non-production to production workers also tended to have high rates of productivity growth. As well, capital and non-production labour seemed to be complementary inputs.

76. The data in Tables 35 and 36 are based on Statistics Canada's Manufacturing Industries of Canada: National and Provincial Areas (31-203).

77. If the productivity slowdown were the result of a lower rate of growth of demand, then one might expect the extent of the decline in productivity growth to be relatively worse in those industries with a relatively high proportion of non-production workers in total employment. This hypothesis would be based on the presumption of relatively higher hiring and training costs for non-production workers, so that firms would be more hesitant to lay off these employees, perhaps even over the medium term.

Table 35

AVERAGE SHARE OF NON-PRODUCTION WORKERS IN TOTAL EMPLOYMENT IN THE MANUFACTURING SECTOR: 1966-1974 (%)

Food and beverages	36.0
Tobacco	26.5
Rubber and plastics	25.0
Leather	14.1
Textiles	20.3
Knitting mills	12.3
Clothing	11.9
Paper and allied products	24.6
Printing and publishing	42.5
Oil and coal products	56.8
Chemicals	48.0
Miscellaneous manufacturing	28.8
Wood products	14.2
Furniture	18.0
Primary metals	23.6
Metal fabricating	24.6
Machinery	37.7
Transportation equipment	26.1
Electrical products	37.2
Non-metallic mineral products	26.3

Source: Statistics Canada

I also examined the rate of growth of this share variable for each two-digit manufacturing industry in the 1966-74 and 1975-81 periods (Table 36), but changes in the growth rate were not correlated with the change in labour productivity growth.

Table 36

COMPOUND RATE OF GROWTH OF SHARE OF NON-PRODUCTION WORKERS IN TOTAL EMPLOYMENT (%)

	1966-74	1975-81
Food and beverages	-1.1	-1.3
Tobacco	2.1	4.0
Rubber and plastics	2.1	-0.5
Leather	-0.8	0.2
Textiles	0.8	0.4
Knitting mills	0.3	0.8
Clothing	-2.0	1.7
Paper and allied products	-0.1	0.0
Printing and publishing	0	-0.8
Oil and coal products	-0.1	1.8
Chemicals	0.6	0.0
Miscellaneous manufacturing	-1.8	1.5
Wood products	2.5	0.0
Furniture	-0.5	-0.2
Primary metals	-0.1	2.1
Metal fabricating	-0.9	0.4
Machinery	-1.7	0.7
Transportation equipment	-0.9	-0.2
Electrical products	-1.3	0.2
Non-metallic mineral products	0	1.0

Source: Statistics Canada

11 INFLATION AND REGULATION

In addition to the line of causation running from productivity growth to the rate of price inflation, the notion that higher rates of inflation could adversely affect productivity growth has also been tested at the Bank of Canada.

Recent research by Jarrett and Selody (1981, 1982) with aggregate Canadian data has led to the conclusion that there is a statistically significant feedback relationship from the inflation rate to productivity growth. They specify a model in which the inflation rate is a function of wage inflation, productivity growth, excess demand and U.S. inflation, while productivity growth is assumed to depend on inflation, growth of the capital/labour ratio and excess demand. This model would appear to be able to explain virtually all of the decline in labour productivity[78] growth between the pre-1973 and the 1976-79 periods. As is shown in Jarrett and Selody (1982), this kind of hypothesis would also seem to be consistent with a supply shock view of the slowdown, insofar as relative factor price shocks were accommodated by the monetary authorities, leading to a higher inflation rate and eventually to even less productivity growth. Clark (1982) carried out similar tests with U.S. data, and came to the conclusion that higher inflation rates may be responsible for a sizeable part of the productivity slowdown.[79]

As discussed in Jarrett and Selody (1981),[80] there are a number of channels through which higher inflation rates could result in lower productivity growth. For instance, higher inflation rates may lead to increased uncertainty about the future and could adversely influence the morale and work performance of the labour force. In addition, information-gathering activities (e.g., monitoring price changes) which are essentially non-productive, may make up a greater portion of a firm's activity. Inflation can also lead to increased inefficiencies through a

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78. Labour productivity is defined as total RDP per man-hour worked and the price index is defined as the ratio of Gross Domestic Product to RDP, as in Jarrett and Selody (1982).

79. Ram (1984) also found a causal relationship running from inflation to productivity change.

80. Jarrett and Selody (1981) found anticipated inflation played a more important role than unanticipated inflation in explaining the productivity slowdown.

reduction in the information content of absolute price changes and to reduced investment (for example, because of distortions in the tax system).[81] Jarrett and Selody (1981) and Clark (1982) also suggest that inflation may have led to a downward bias in the measurement of output and hence to a downward bias in the measurement of labour productivity growth in the recent period.

Examination of the impact of high inflation rates on productivity performance is illustrative of a more frequent tendency in the economic literature to examine changes in the economic environment as a fundamental cause of the productivity slowdown (Nelson (1981)). Lindbeck (1983) also points to rising inflation rates as one of a number of fundamental changes in the world economic system which became apparent in the 1970s. It must be admitted that there is still a considerable amount of skepticism about the inflation hypothesis (see for instance Nordhaus (1980)), mainly because a detailed quantitative analysis of the channels through which inflation could affect productivity has yet to be done.

Increased government regulation is another important change in the economic environment that may have influenced productivity growth. U.S. studies of this issue include Christainsen and Haveman (1981) and Denison (1980). The basic conclusion of this research is that, in the United States, increased regulations have had an adverse effect on productivity growth acting through such channels as delays in investment projects and delays in the introduction of new technology. The quantitative importance of increased regulation as a cause of the slowdown has, however, been disputed by Scherer (1981). Some firm level studies have recently been conducted for the electric power industry in the United States (Gollop and Roberts (1983)) and for the brewing industry in Canada (Sims and Smith (1983)). These studies have found a significant negative relationship between environmental regulation and factor productivity growth.

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81. Kopcke (1980) emphasizes the effect in the United States of higher inflation rates on the understatement of capital consumption costs, leading to higher rates of corporate tax and lower investment spending. In Canada, Bossons (1980, 1981) found that the adverse effects on investment of a higher effective rate of corporate tax arising from higher rates of inflation to be significant, accounting for about one-quarter of the decline in productivity growth in the second half of the 1970s. A recent theoretical study by Auerbach (1981) suggests that increases in the inflation rate would tend to lengthen the time that capital goods are used and raise the user cost of capital. Gilson (1984) presents data showing a substantial decline in the inflation-adjusted real after-tax rate of return on corporate debt and equity in Canada during the 1970s -- at the same time there was a large increase in the inflation rate.

12 MINING SECTOR

In the examination of productivity trends by industry in Section 3, it was evident that the mining sector experienced a very major change in its productivity performance around 1973. We will now examine some possible explanations for this development, starting with the oil and gas mining industry.

Labour productivity[82] in oil and gas mining is estimated to have grown by about 4.3 per cent per year over the 1966-74 period but to have declined by about 8.4 per cent per year over the 1975-81 period (Table 37). There were also sizeable declines in factor productivity[83] over the latter period. The declines in labour and factor productivity began in the 1972-73 period and continued at least up to 1982 (Figure 20). As noted by Sims and Stanton (1980), total output of oil and natural gas declined or stagnated between 1973 and 1978; these trends continued up to 1983 (Figures 21 and 22).[84] This decline partly reflects conservation measures induced by the rise in the relative prices of oil and natural gas, as well as a lower rate of growth of aggregate demand. Quantitative restrictions on exports of oil and gas also played an important role over much of the period since 1973. In recent years, capacity constraints on oil output and restrictions on the export price of natural gas may have been more important factors than the quantitative controls in explaining the lack of growth in exports.

The oil and gas mining industry is highly capital-intensive and is a prime example of an industry in which it is difficult to change factor inputs or increase capacity in the short run or even over the medium term. A large part of the work force in this industry is engaged in activity that has no effect on current production, such as exploration and development of new reserves. Thus, the number of production workers is

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82. A value-added output measure (GDP) is used, while man-hours paid is used as the labour input measure. A direct measure of man-hours paid is available for production and related workers, while a fixed work week of 37.5 hours was assumed for other employees.

83. Only the net capital stock and labour are considered in this measure of factor productivity, though allowance is made for shifting factor share weights.

84. Data on production and exports of crude oil and natural gas are taken from Statistics Canada's Canadian Statistical Review (11-003E).

much lower than that of other employees; in fact the growth of non-production workers has been stronger than that of production workers in recent years (Figure 23).[85] As well, price signals have been such as to draw more resources into this sector. The gross output price[86] of oil and gas mining increased sharply relative to that for the aggregate economy after 1973 (Figure 24), while profit margins in the mineral fuels sector rose substantially relative to those for the industrial sector (Figure 25).[87] Given the relatively long lags between investment and resulting production, the profit-induced increase in the capital stock could be another factor accounting for the decline in factor productivity. One might also speculate that the rise in relative prices and the resulting government intervention may have also led to some inefficiency through, for instance, increased uncertainty associated with unexpected policy changes.

There are also a number of factors related to the resource nature of the industry that may help explain past and future developments in factor and/or labour productivity. First, most major oil discoveries in conventional regions had been made by the mid-1960s and it is likely that increasing resources have been and will continue to be required to maintain production levels in existing oil fields through, for instance, enhanced recovery methods.[88] Second, increasing levels of factor inputs have been and are likely to continue to be needed to find new reserves of oil and natural gas, either through drilling deeper wells or moving to more remote areas. Finally, an increasing proportion of total production

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85. Employment data are taken from Statistics Canada's Crude Petroleum and Natural Gas Industry (26-213).

86. Data for the 1971-82 period are taken from Statistics Canada's Gross Domestic Product by Industry (61-213). Data for the 1961-70 period were constructed using information in Statistics Canada's The Input-output Structure of the Canadian Economy, 1961-1974 (15-508E) and The Input-Output Structure of the Canadian Economy in Constant Prices, 1961-1974 (15-509E). (Total output of crude mineral oils and natural gas from Make (Output) Matrix).

87. Data for total profits (defined as base profits less depreciation) and sales are taken from Statistics Canada's Industrial Corporations, Financial Statistics (61-003). The industrial sector includes all privately owned corporations excluding those in the agriculture, fishing, construction, finance, and real estate industries.

88. Beginning in 1978, there has been a substantial rise in spending on secondary recovery and pressure maintenance. See Canadian Petroleum Association Statistical Handbook (CPASH), Section IV, Table 2B.

has come from the tar sands[89] and production methods in these activities are characteristically more labour-intensive than more conventional production methods (Sims and Stanton (1980)).

Table 37

PRODUCTIVITY PERFORMANCE IN SELECTED MINING INDUSTRIES
(Compound annual growth (%))

	1966-74	1975-79	1975-81
Oil and gas mining:			
Labour productivity	4.3	-6.7	-8.4
Factor productivity	-2.1	-10.9	-9.3
Metal mining:			
Labour productivity	1.5	-1.6	-2.7
Factor productivity	-2.5	-4.8	-4.2
Non-metal mining (including coal):			
Labour productivity	4.7	-0.5	-0.1
Factor productivity	-0.2	-2.1	-1.5
Structural materials:			
Labour productivity	3.0	5.1	4.4
Factor productivity	1.6	0.2	-0.2

Sources: Output: Statistics Canada's, Gross Domestic Product by Industry (61-213). Employment and hours paid: Statistics Canada's General Review of the Mineral Industries (26-201); Crude Petroleum and Natural Gas Industry (26-213). Net Capital Stock: Statistics Canada (unpublished data).

Labour and factor productivity growth also slowed in the metal mining industry between the 1966-74 and 1975-81 periods, though not to the same extent as in the oil and gas mining industry (Table 37). The slowdown in

89. Synthetic crude oil production accounted for about 2.3 per cent and 9 per cent of total liquid hydrocarbons production in 1974 and 1983, respectively.

productivity growth between the 1966-74 and 1975-79 periods is considerably smaller if gross output is used instead of value-added output (Table A:24). While the decline in labour productivity in the metal mining industry began in 1974, factor productivity began to fall as early as 1971 (Figure 26). It may also be of interest to observe that the level of factor productivity in the metal mining industry was relatively stable between 1961 and 1971, unlike oil and gas mining. This industry has also been characterized by declining output levels since 1973, with production falling by almost 34 per cent between 1973 and 1983. In the short run or even in the medium run, it would likely be difficult to change factor inputs, though it would be less difficult than in the case of oil and gas mining because a much larger proportion of the work force in the metal mining industry is engaged directly in production and related activity. Nevertheless, given reports of labour shortages, there may have been some incentive to retain skilled production workers through much of the 1970s. The industry did experience two major upward price shocks in the 1973-74 and 1979-80 periods, which probably helped draw additional resources into the industry.

One explanation of a longer-term fall in factor productivity levels in the mining industry involves declining ore grades, as discussed in Wedge (1973), Pye (1981), and in Stollery (1985). As Pye observes, there has been a view expressed in the mining industry that ore grades have been declining in Canada over recent decades. This would certainly seem to be the case in the metal mining industry over the 1961-82 period (Figure 27).[90] The original factor productivity index can be adjusted for ore grade by dividing it by the ore grade measure, as is shown in Figure 28. Adjusted factor productivity is estimated to have increased by about 2.7 per cent per year over the 1966-74 period and then remained almost unchanged over the 1975-81 period. Thus, even after the adjustment, there is a decline in total factor productivity growth between the two periods.

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90. Metal mining output is measured by GDP, while the quantity of ore is the physical tonnage mined. Data for the latter series are taken from Statistics Canada's General Review of the Mineral Industries and, after 1976, Statistics Canada's Metal Mines (26-223). As Pye (1981) notes, this procedure introduces an index number problem, since the ore tonnage data are not price-weighted.

It is also worth pointing out that there are substantial differences in the pattern of ore grade declines for different types of metal mines.[91]

Steady decreases in ore grades have taken place in the following types of metal mines over the 1961-82 period: gold extraction from gold quartz mines, copper extraction from copper-gold-silver mines,[92] and lead extraction from silver-lead-zinc mines. Stollery (1985) found a significant increase in costs related to ore-grade declines in the copper-gold-silver, gold, and silver-lead-zinc industries (as well as non-metal mining). The decline in ore grade for iron ore mines was largely completed by 1965 and was apparently associated with a shift towards larger and lower-grade deposits in the Labrador Trough (Pye (1981)). It is more difficult to discern a trend in the case of zinc extraction from silver-lead-zinc mines, while ore grades at nickel-copper mines have been increasing since 1971. This suggests that either the decline in factor productivity since 1971 was restricted to certain types of metal mines or that other factors besides ore grade declines are needed to explain this phenomenon.

Pye (1981) has also suggested that two other factors may have had some impact on productivity in the mining industry in the 1970s: the ending of a wave of technological innovations and increased health and safety regulations. With respect to technology, major changes in ore-handling methods and increased use of open-pit mining took place largely during the 1960s. Increased regulation of health and safety standards for workers and more stringent pollution controls were put in place during the late 1960s and early 1970s and could have had an adverse effect on productivity levels.

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91. Metal output is measured by the physical volume of metal extracted from each ore type. The quantity of ore mined is again the physical tonnage mined. Data for the period before 1977 are taken from the following Statistics Canada publications: Gold Quartz and Copper-Gold-Silver Mines (26-209), Iron Mines (26-210), Nickel-Copper Mines (26-211) and Silver-Cobalt Mines and Silver-Lead-Zinc Mines (26-216). Data for the period after 1976 are taken from Statistics Canada's Metal Mines (26-223). Data are available on request from the author.

92. However, the decline ceased around 1973. Pye (1981) indicates that this development was largely associated with increased use of low-grade open-pit copper deposits, especially in British Columbia.

Rapid labour productivity growth in the non-metal (including coal) mining industry came to an end around 1974 (Figure 29). This change is partly associated with a shift in the rate of capital-labour substitution, as the decline in the rate of growth of factor productivity between the 1966-74 and 1975-81 periods was much smaller than that for labour productivity (Table 37). There is also little evidence of a major break in the factor productivity series around the 1973-74 period -- if anything, there has been a modest downward trend in factor productivity over the 1961-82 period. The growth of factor productivity in the structural materials industry appears to have ended in the early 1970s (Figure 30).

13 MANUFACTURING SECTOR

In this section, hypotheses presented in earlier sections, partly related to work by Baily (1982), will be drawn together in an attempt to present some explanations for the productivity slowdown in the two-digit manufacturing industries.

Shown first (Table 38) are statistical results from some multiple cross-sectional regressions in which the dependent variable is the change in labour productivity growth between the 1966-74 and 1975-81 periods. Explanatory variables include the average share (proportion between 0 and 1) of non-labour income in value-added (the latter measuring the contribution of labour and capital), the annual rate of labour productivity growth in 1966-74 (per cent), the change in the rate of growth of the capital/labour ratio between the 1966-74 and 1975-81 periods (per cent), the change in the rate of growth of the number of workers per establishment between 1966-74 and 1975-81 (per cent), the average energy share in gross output during 1966-74 (proportion between 0 and 1), the change in the rate of growth of the energy/labour ratio between 1966-74 and 1975-79 (per cent), the share of non-production workers in total employment during 1966-74 (proportion between 0 and 1), and the change in the growth rate of the share of non-production workers in total employment between 1966-74 and 1975-81 (per cent). I have implicitly made the assumption that the rate of capacity utilization in each industry was roughly equal in 1966, 1974 and 1981, though this may be open to criticism. Parameter estimates for both unweighted and weighted regressions are shown in Table 38. Regressions were also estimated after deleting those variables for which the t-statistics associated with the parameter estimates were less than one or for which the coefficients did not make economic sense. The average energy share of gross output during 1966-74 was found to be highly statistically significant in unweighted regression (2) (Table 38).

The parameter estimates from equation (2) in Table 38 were used to make a crude calculation of the contribution[93] of each explanatory variable to the change in labour productivity growth between 1966-74 and 1975-81 in each two-digit manufacturing industry, as shown in Table 39. It should be emphasized that the contribution values are to be treated as only very rough order-of-magnitude estimates. In addition to the usual residual equation error, the presence of a constant term also indicates that part of the change in labour productivity growth between the two periods is not explained by the various variables in the equation.

It can be observed that some industries experienced a very pronounced slowdown in productivity growth between 1966-74 and 1975-81 (petroleum and coal products, transportation equipment, rubber and plastics, non-metallic mineral products, chemicals and metal fabricating), while other industries showed little or no change in productivity growth between the two periods (leather, textiles, knitting mills, clothing, printing and publishing, wood and furniture). Does the above empirical work in any way assist in explaining this phenomenon? The average share of non-labour income in value added is a measure of capital intensity and is meant to account for the impact of possible accelerated obsolescence of capital on productivity growth. The productivity slowdown does tend to be concentrated in the more capital-intensive industries such as petroleum and coal products and chemicals. The labour productivity growth rate in the pre-slowdown period is supposed to be a proxy for the introduction of new technologies or other special phenomena peculiar to the earlier period, which did not carry over to the later period. A visual inspection of the contribution estimates does not really suggest that this hypothesis can explain the variability of the slowdown in productivity growth rates, with the important exception of transportation equipment. Here, one may suggest that the Auto Pact led to rationalization of operations and exploitation

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93. The contribution of each explanatory variable is the product of the parameter estimate and the value of the explanatory variable. For instance, the variable measuring labour productivity growth in the 1966-74 period in the food and beverages industry would have accounted for a decline of 2.2 percentage points in labour productivity growth between the 1966-74 and 1975-81 periods in that industry, according to regression (2) in Table 38.

Table 38

CROSS-SECTIONAL REGRESSIONS FOR CHANGE IN LABOUR PRODUCTIVITY GROWTH BETWEEN 1966-74 AND 1975-81 IN MANUFACTURING SECTOR
Parameters (t-statistics in brackets)

		Constant	Average share of non-labour income in value-added	Annual rate of labour productivity growth in 1966-74	Change in growth of capital/labour ratio between 1966-74 and 1975-81	Change in growth of number of workers per establishment between 1966-74 and 1975-81	Average energy share of gross output during 1966-74	Change in growth of energy/labour ratio between 1966-74 and 1975-79	Share of non-production workers in total employment during 1966-74	Change in growth of share of non-production workers in total employment between 1966-74 and 1975-81	$\bar{R}^2$
Unweighted											
	(1)	4.2 (2.0)	-10.2 (-1.8)	-0.6 (-1.9)	0.01 (0.04)	-0.3 (-1.4)	-10.6 (-4.2)	0.4 (2.1)	2.8 (0.7)	-0.1 (-0.6)	0.83
	(2)	3.7 (2.1)	-7.6 (-1.7)	-0.5 (-2.1)	-	-0.2 (-1.2)	-10.4 (-5.1)	0.3 (2.3)	-	-	0.85
Weighted											
	(3)	0.5 (1.6)	-10.2 (-2.8)	-0.001 (-1.2)	-0.2 (-1.4)	-0.2 (-0.8)	-12.5 (-3.3)	0.6 (3.7)	4.5 (1.1)	-0.0001 (-0.001)	0.73
	(4)	0.7 (2.4)	-9.7 (-2.9)	-0.001 (-1.4)	-	-	-12.3 (-3.4)	0.6 (4.1)	4.0 (1.0)	-	0.75

Table 39

ACCOUNTING FOR THE PRODUCTIVITY SLOWDOWN IN THE MANUFACTURING SECTOR
Contribution of:

	Change in labour productivity growth between 1966-74 and 1975-81 (%)	Average share of non-labour income in value-added	Labour productivity growth for 1966-74	Change in growth of number of workers per estabishment between 1966-74 and 1975-81	Energy share in gross output	Change in growth of energy/labour ratio between 1966-74 and 1975-79
Food and beverages	-2.6	-4.3	-2.2	0.3	-0.1	-0.5
Tobacco	-2.1	-5.1	-2.5	1.3	-0.1	-0.2
Rubber and plastics	-3.4	-3.8	-2.4	0.2	-0.2	-0.2
Leather	-0.8	-2.9	-1.5	0.0	-0.1	1.4
Textiles	-1.0	-3.5	-2.9	0.5	-0.2	-0.1
Knitting mills	-0.6	-3.1	-2.8	0.5	-0.1	-0.1
Clothing	-0.6	-2.9	-1.6	0.3	0	-0.3
Paper and allied products	-2.8	-3.9	-1.8	0.7	-0.7	-0.2
Printing and publishing	-0.7	-3.4	-2.0	0.2	-0.1	-1.3
Petroleum and coal products	-12.0	-5.0	-2.3	0.5	-7.9	-1.1
Chemicals	-3.3	-4.7	-2.5	0.6	-0.9	0.5
Miscellaneous manufacturing	-2.4	-3.7	-1.7	1.0	-0.1	-1.3
Wood	0.3	-3.2	-1.5	1.2	-0.2	-0.3
Furniture	-0.4	-3.1	-1.2	0.8	-0.1	-0.3
Primary metals	-2.4	-3.6	-1.4	0.5	-0.7	-0.5
Metal fabricating	-3.2	-3.5	-2.0	0.6	-0.1	-1.0
Machinery	-2.5	-3.5	-2.9	1.1	-0.1	-1.4
Transportation equipment	-7.4	-3.9	-4.0	0.6	-0.1	-1.8
Electrical products	-2.0	-3.6	-2.2	0.9	-0.1	-0.1
Non-metallic mineral products	-3.4	-4.1	-2.2	1.4	-0.6	-0.8

of scale economies in the auto sector,[94] contributing to an unusually high rate of growth of labour productivity in the transportation equipment industry during the 1966-74 period. The coefficient of the scale economies proxy (change in growth of number of workers per establishment between 1966-74 and 1975-81) is consistent with diseconomies of scale but does not help to explain the variability of the slowdown in productivity growth rates. Energy-intensive industries tended to experience greater slowdowns in productivity growth, though the estimated contributions of the two energy variables would generally only explain a modest proportion of the productivity slowdown.

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94. This hypothesis is supported in Wilton (1976).

14 SUMMARY

In Canada, the growth of both factor and labour productivity at the aggregate level fell substantially after 1974. In this study, I first examined the phenomenon of the slowdown in productivity growth after 1974 at successively more detailed levels of industry disaggregation. The slowdown in labour productivity growth varied widely across different industries, with resource-based and energy-related industries generally experiencing the largest declines in productivity growth. Oil and gas mining, metal mining, petroleum and coal products, and transportation equipment all experienced sizeable declines in the rate of growth of labour productivity. There is some evidence that the slowdown in labour productivity growth in the oil and gas mining and metal mining industries began before 1974. Among manufacturing industries, those experiencing drops in labour productivity growth also tended to undergo declines in the rates of growth of output and in the raw materials/labour ratio. More generally, industries with large declines in labour productivity growth tended to be characterized by high levels of capital intensity, with a smaller proportion of their staff engaged in activity directly related to current production.

In the remainder of the paper, I surveyed a wide range of explanations for the productivity slowdown. These included factors related to labour productivity in an immediate accounting sense, such as the capital/labour ratio. Some slowing of the rate of growth of capital/labour ratios was found in selected industries, although this was not a universal phenomenon; capital stock measurement problems, which may have been exacerbated in recent years, were also noted. Analysis of changes in rates of change of factor productivity and factor intensities led naturally to a consideration of underlying determinants. As Nelson (1981) observed, this would include major changes in the economic environment faced by firms. The large rise in the relative price of energy (and more generally all raw materials) would certainly stand high on the list of such changes. One econometric approach implied that nearly half of the slowdown in labour productivity growth in the commercial excluding energy sector could be explained by the energy price shock. A number of studies by other researchers also point to the increase in the relative price of energy as a major reason for the productivity slowdown in various industrial economies. It is less clear as to how this occurred. In further econometric work for the manufacturing sector, special attention was paid to the impact of energy and other factor price changes on factor substitution but I found this channel of influence could only account for a modest proportion of the slowdown in productivity growth. It may well be that the energy price shock has mainly influenced productivity growth through its impact on the structure of demand and on the stock of economically useful technology.

Many researchers have also emphasized the role played by lower rates of growth of aggregate demand and lower rates of capacity utilization. One set of econometric results implied that about 40 per cent of the slowdown in labour productivity growth between the 1956-74 and 1975-81 periods in the commercial excluding energy sector could be explained by low rates of capacity utilization. However, the quality of most capacity utilization measures is not very good and the issue of disentangling lines of causation between output growth and productivity growth is difficult. As well, the energy price shock may of itself have contributed to cyclical weakness in demand. For these reasons, I suspect that low rates of capacity utilization may at most explain about 25 per cent of the productivity slowdown.

An increase in the underlying rate of inflation was another major change in the economic environment over much of the 1970s and early 1980s. While there is some statistical evidence for a causal relationship from inflation to productivity growth, empirical evidence on the mechanisms through which this could occur still remains a subject for further research. The impact of inflation on the innovation process and, more generally, on risk-taking may be an important channel of influence, as perhaps implied by some recent studies of research and development and of distributional coalitions. This factor may account for a sizeable proportion of the remaining 25 per cent of the slowdown in labour productivity growth in the commercial excluding energy sector. One other fundamental change in the environment that has received special attention in the United States has been increased government regulation. While I have not undertaken detailed analysis of this issue, regulation seems to have been a contributing factor in selected Canadian industries, such as oil and gas mining. Resource depletion effects may have also played a role in the mining sector. Other factors studied included intersectoral movements of labour and changes in work force characteristics, but neither factor appeared to play more than a marginal role in an explanation of the slowdown.

The increase in the relative price of energy, cyclically weak demand and a rise in the inflation rate are very likely the main factors behind the slowdown in productivity growth. However, the nature of the mechanisms through which these factors affected productivity growth requires further investigation.

[illegible] have been an accelerating factor in rates of [illegible] [illegible] [illegible] [illegible] [illegible] labour [illegible] more [illegible] [illegible] [illegible] slowdown.

The decline in the relative price of energy [illegible] and a rise in the inflation rate are very likely the main factors behind the slowdown in productivity growth. However, [illegible] of the mechanisms through which these factors affect productivity [illegible] require further investigation. [illegible] between the 1950-74 and 1973-81 [illegible] could be explained by [illegible] the quality of such capacity [illegible] in disentangling these [illegible] growth is difficult. [illegible] in capital [illegible] types of [illegible] the [illegible]

An [illegible] change in the [illegible] rates. While there is some [illegible] from inflation to productivity growth, analytical evidence [illegible] mechanisms through which this could operate [illegible] further research. The impact of inflation on the [illegible] more generally, on [illegible] may be an important [illegible] as perhaps implied by some recent studies of research and development [illegible] of international [illegible]. This factor may account for a sizeable proportion of the [illegible] of the slowdown in labour productivity growth in the commercial excluding energy sector. The other fundamental change in the environment that has received special attention

FIGURES 1-30

Figure 1

OUTPUT PER EMPLOYEE AND TOTAL OUTPUT: COMMERCIAL SECTOR
(EXCLUDING AGRICULTURE, FISHING AND TRAPPING)

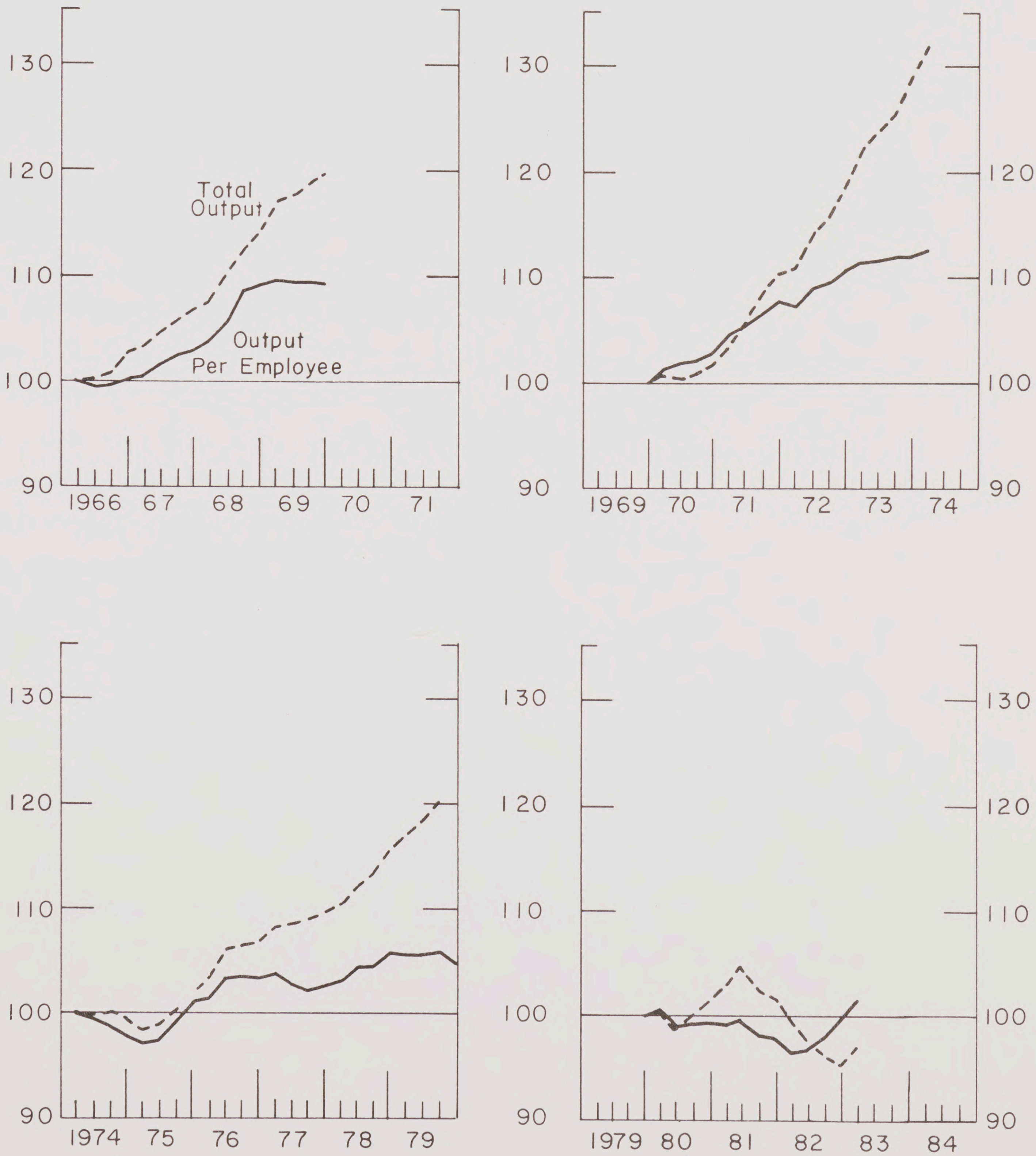


Figure 2

OUTPUT PER EMPLOYEE AND TOTAL OUTPUT:
MINING SECTOR

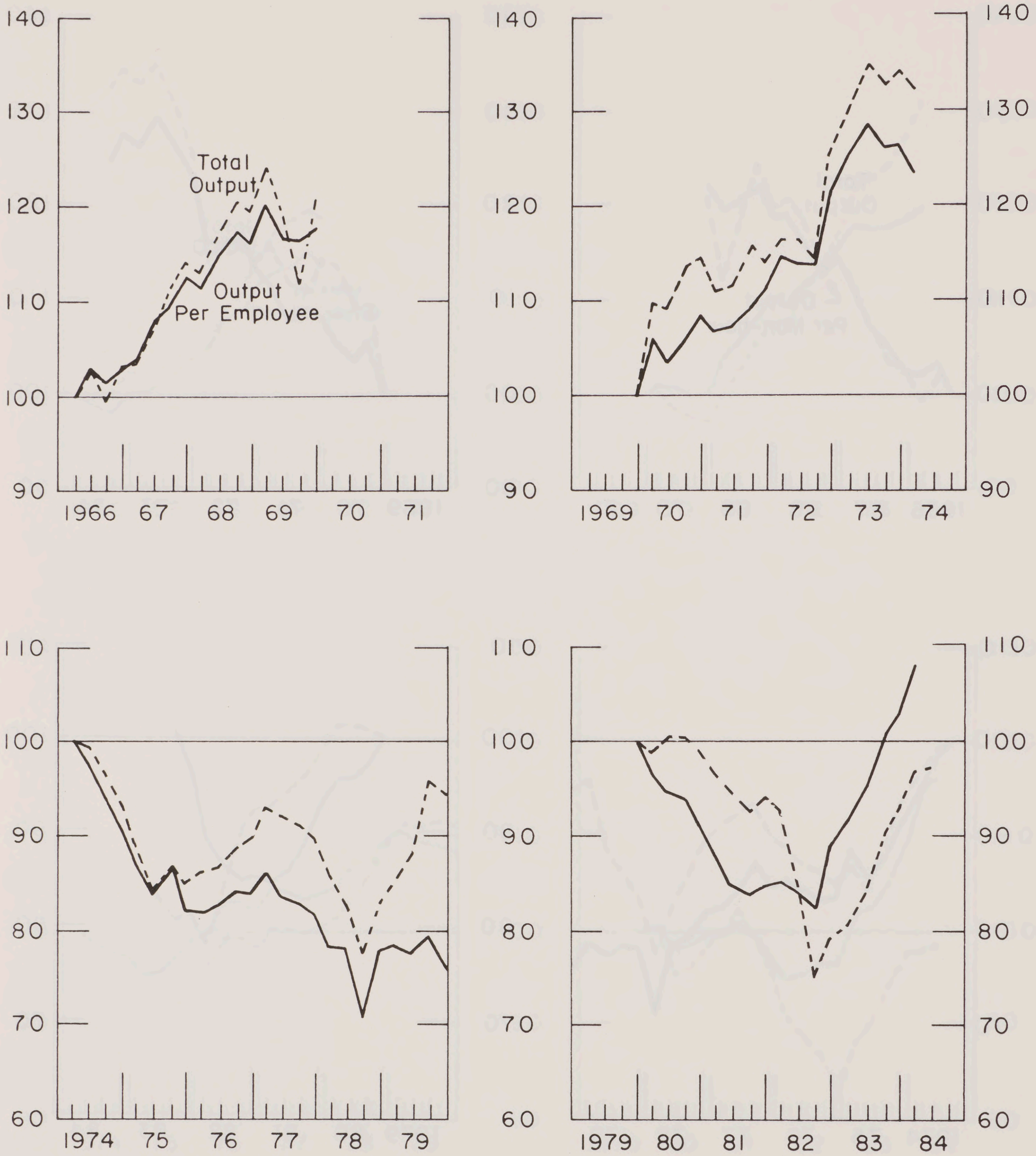


Figure 3

OUTPUT PER MAN-HOUR AND TOTAL OUTPUT:
MINING SECTOR

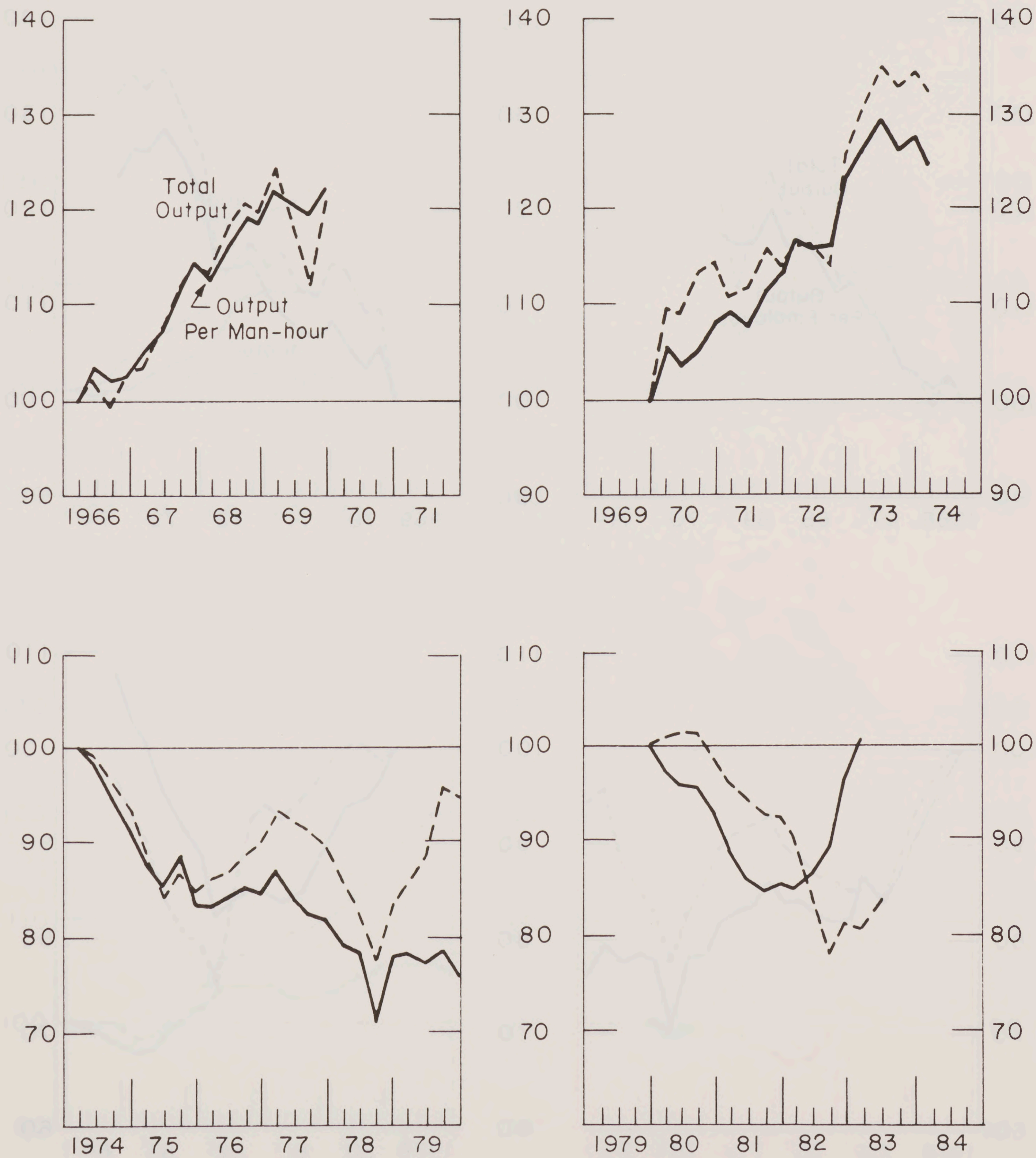


Figure 4

OUTPUT PER EMPLOYEE AND TOTAL OUTPUT: MANUFACTURING SECTOR

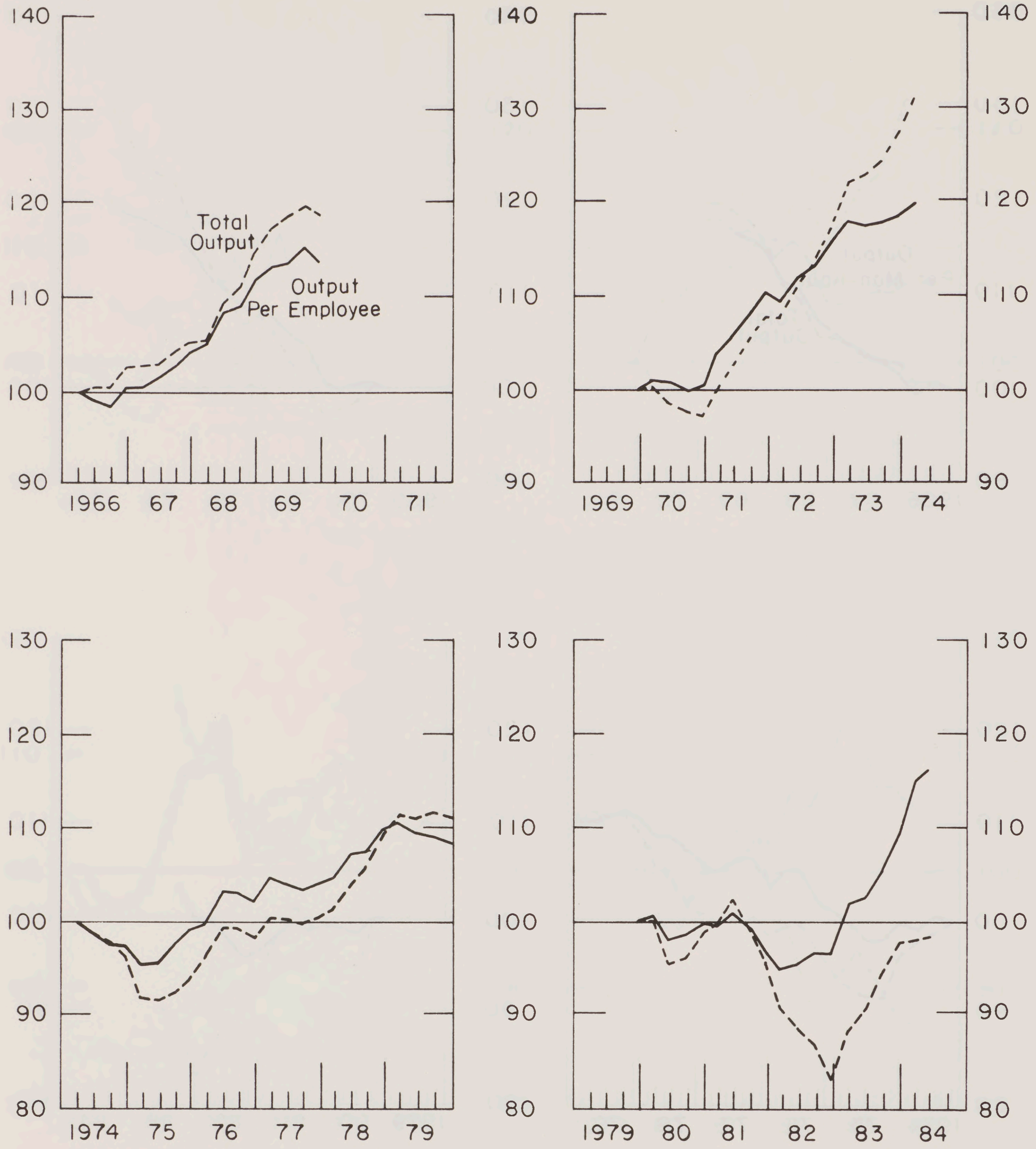


Figure 5

OUTPUT PER MAN-HOUR AND TOTAL OUTPUT:
MANUFACTURING SECTOR

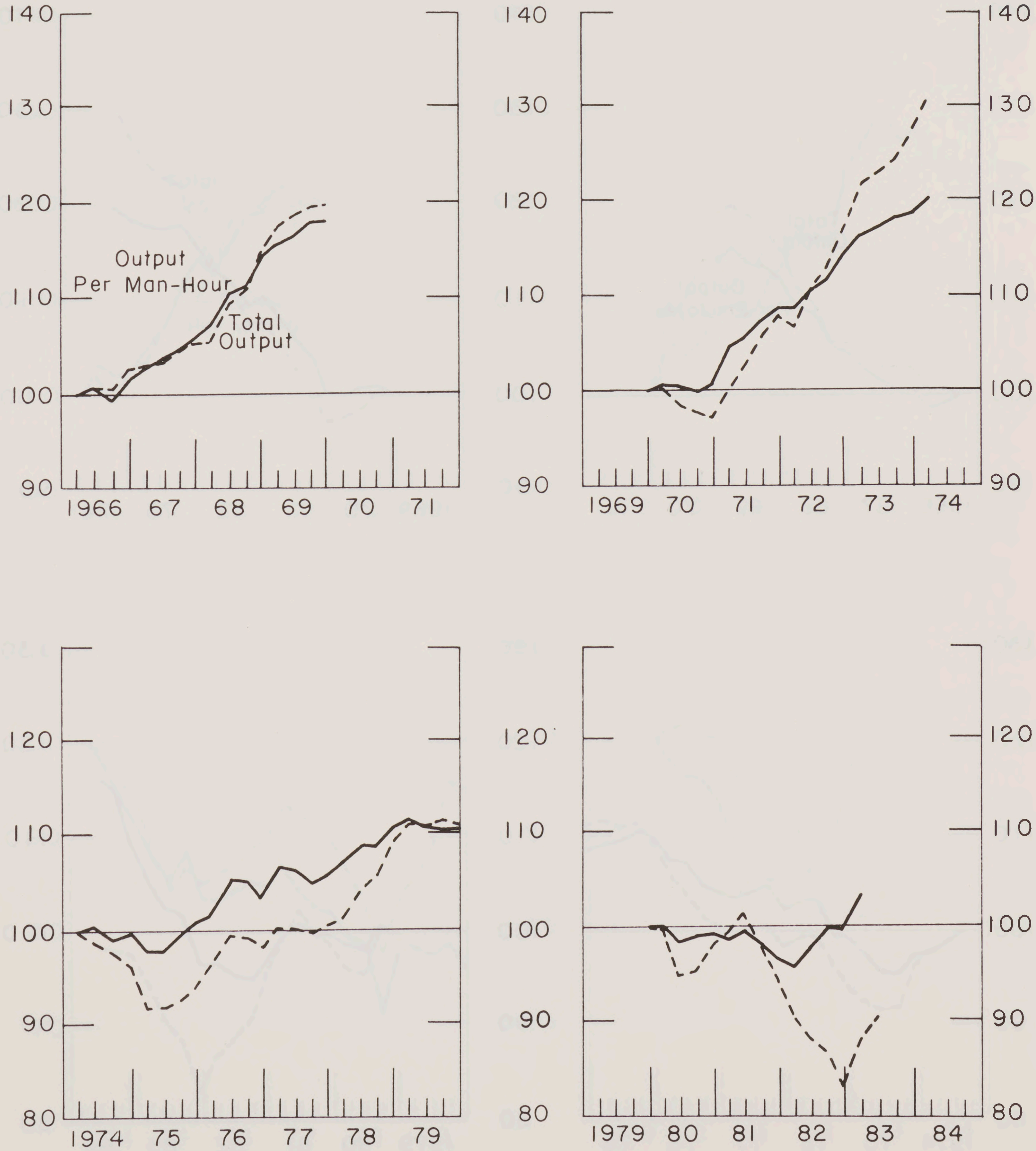


Figure 6

OUTPUT PER EMPLOYEE AND TOTAL OUTPUT: CONSTRUCTION SECTOR

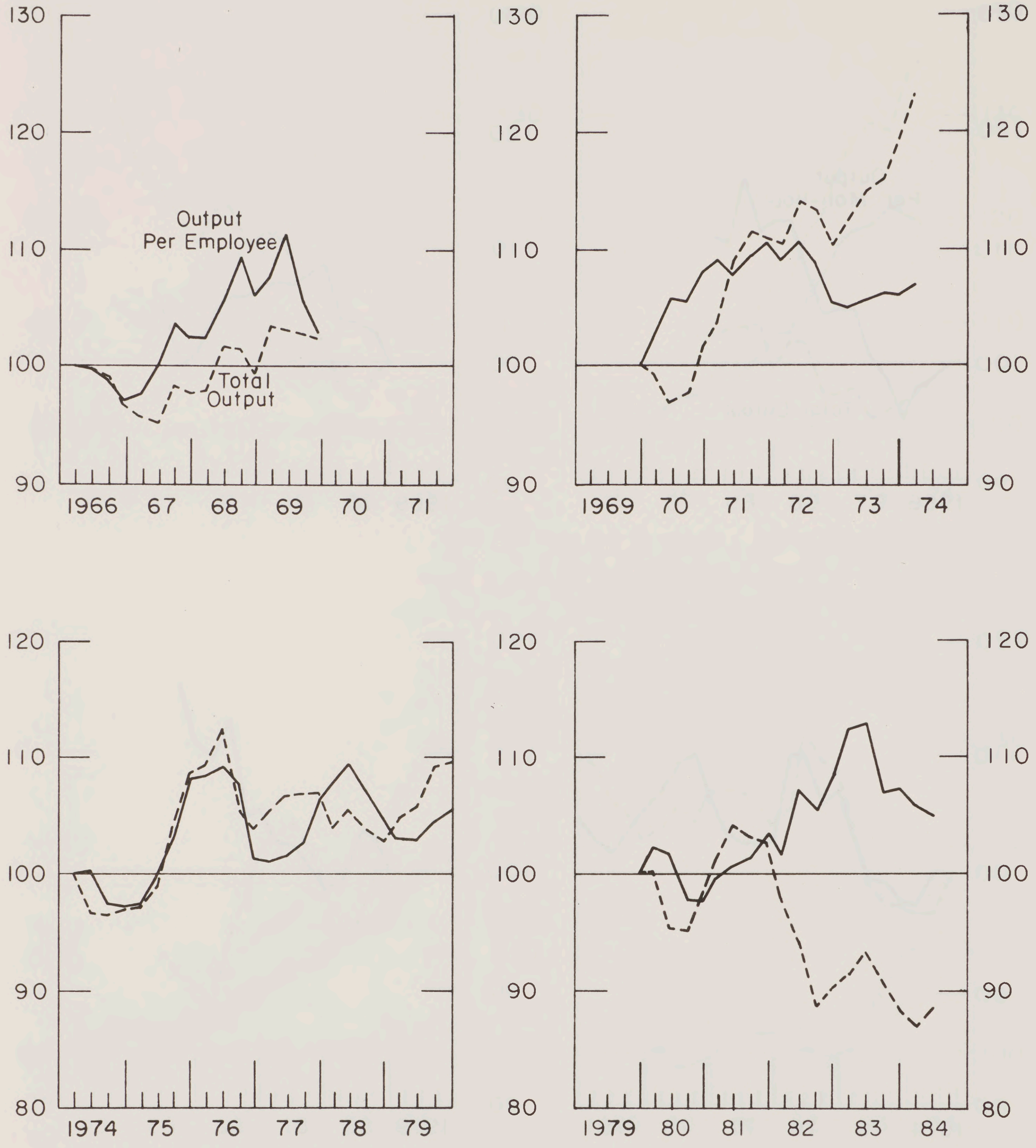


Figure 7

OUTPUT PER MAN-HOUR AND TOTAL OUTPUT:
CONSTRUCTION SECTOR

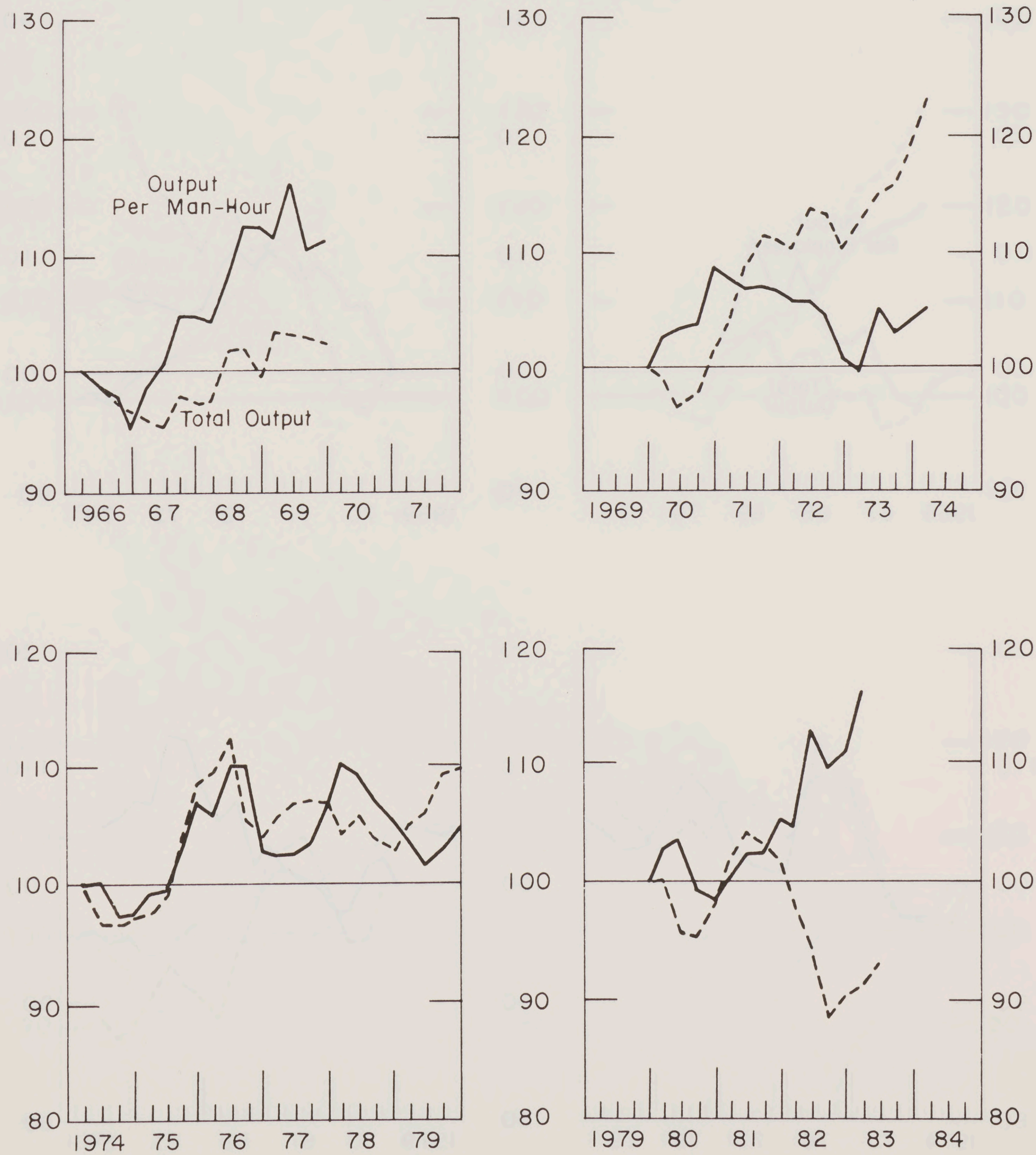


Figure 8

OUTPUT PER EMPLOYEE AND TOTAL OUTPUT:
TRANSPORTATION, COMMUNICATIONS AND OTHER UTILITIES SECTOR

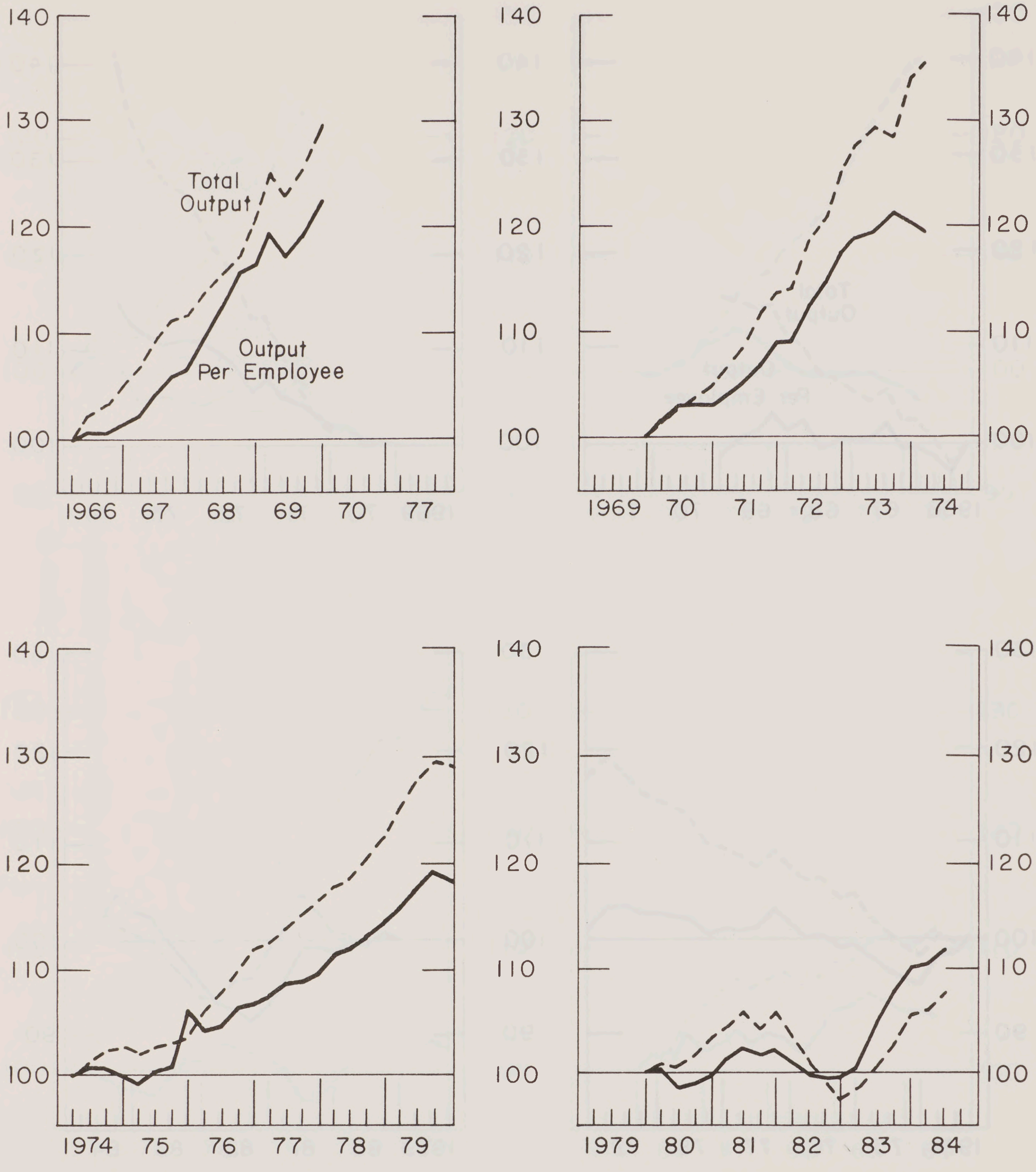


Figure 9

OUTPUT PER EMPLOYEE AND TOTAL OUTPUT:
TRADE SECTOR

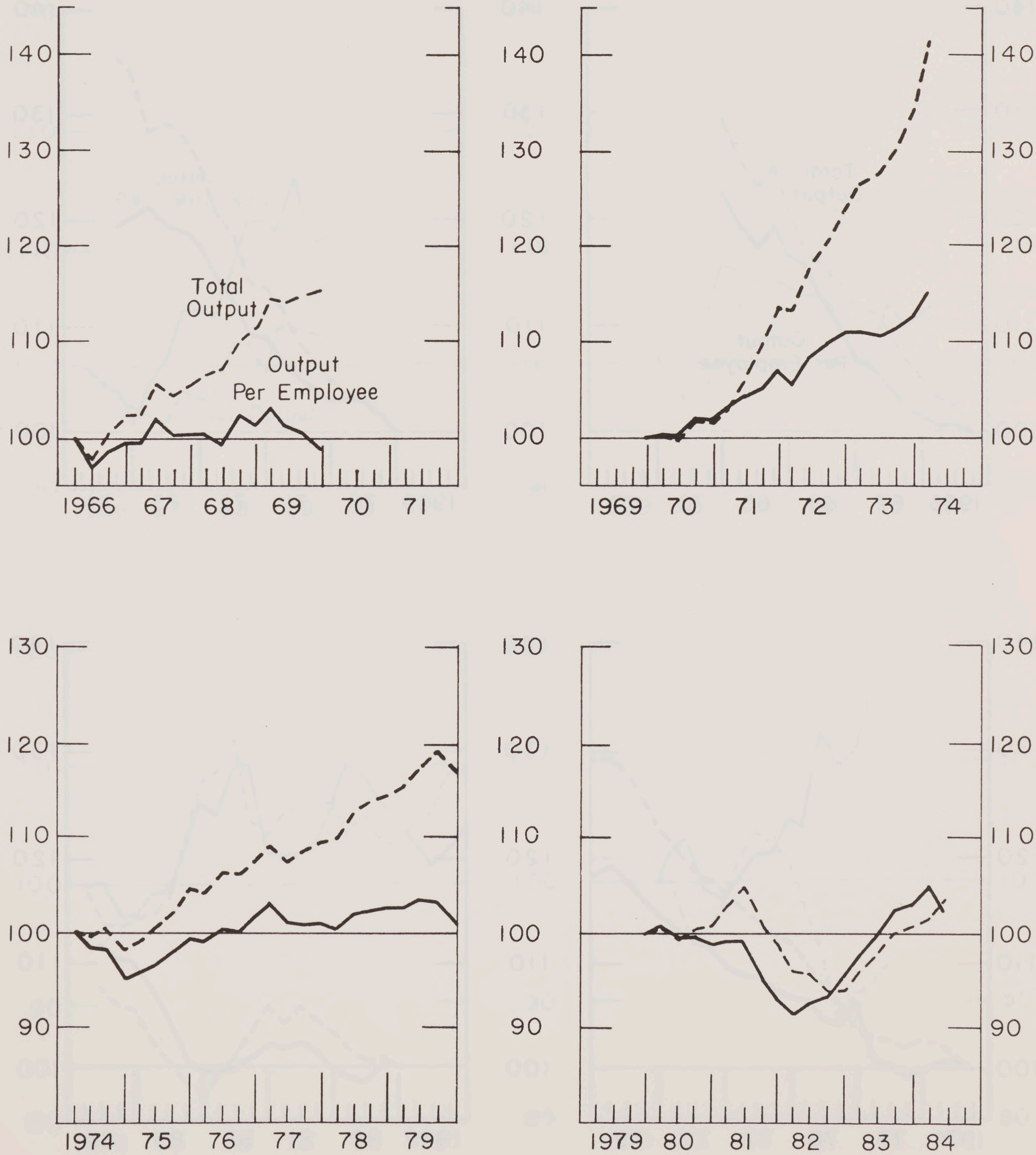


Figure 10

OUTPUT PER EMPLOYEE AND TOTAL OUTPUT:
FINANCE, INSURANCE AND REAL ESTATE SECTOR

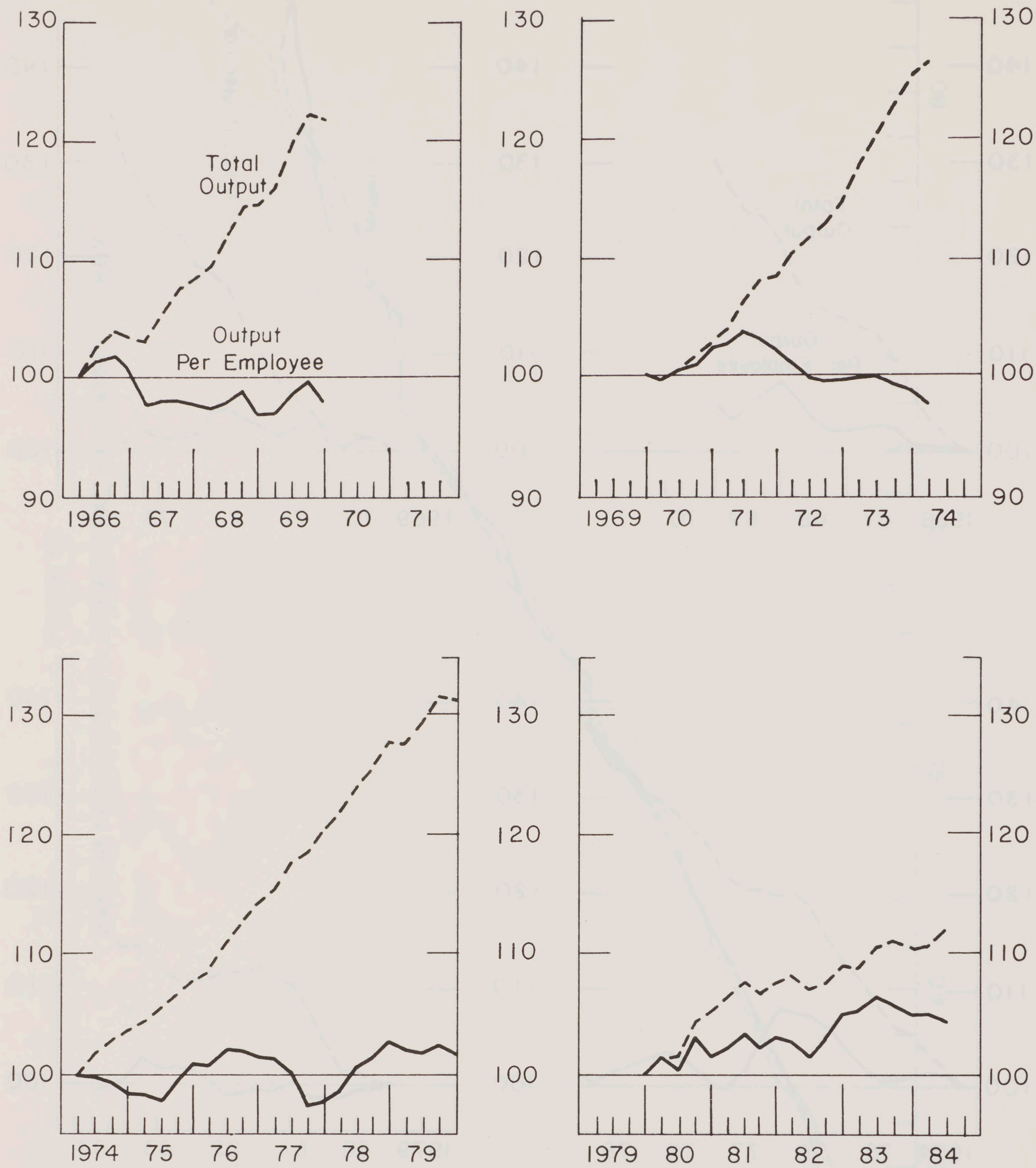


Figure 11

OUTPUT PER EMPLOYEE AND TOTAL OUTPUT:
OTHER COMMERCIAL SERVICES SECTOR

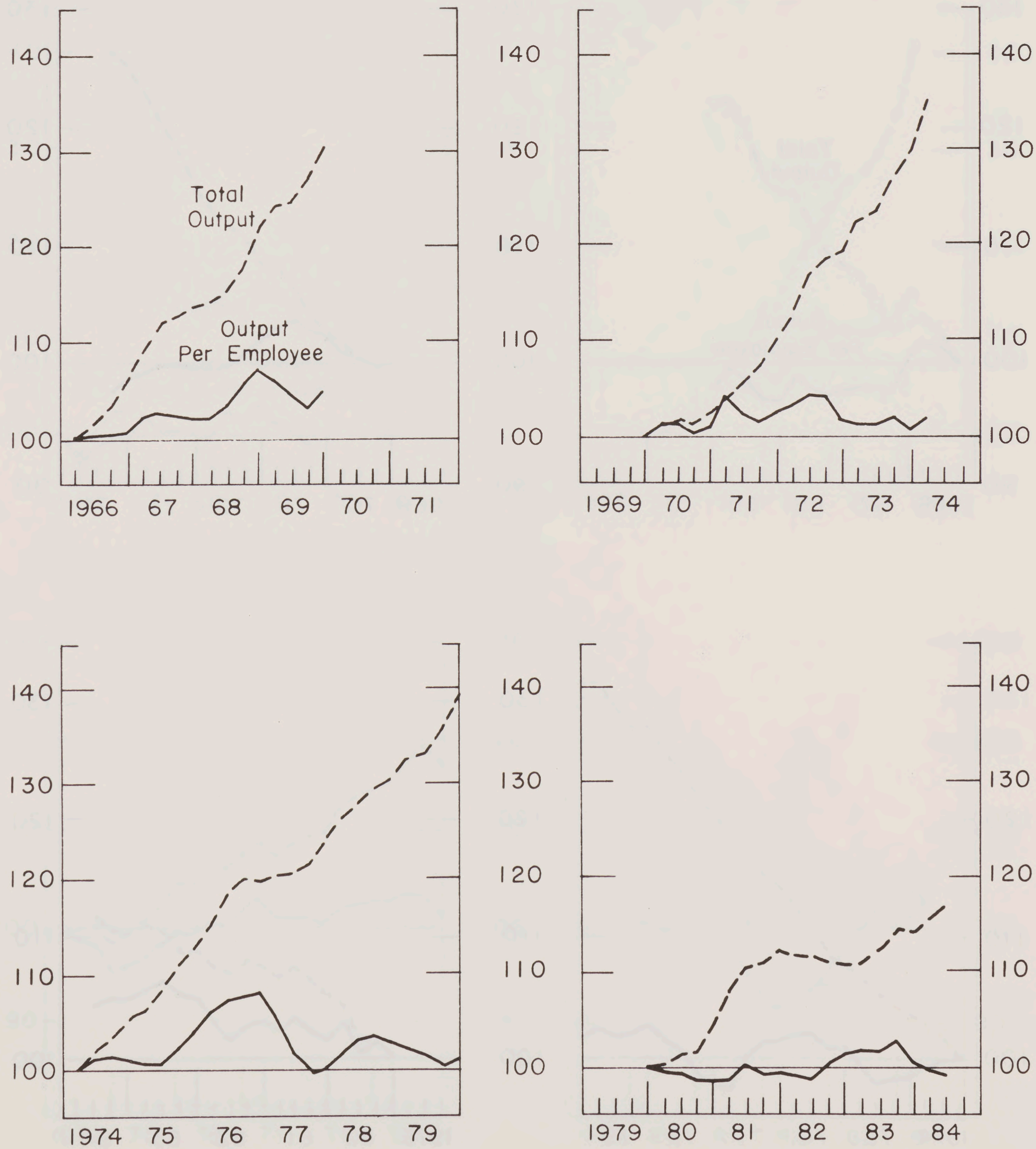


Figure 12

LABOUR PRODUCTIVITY: COMMERCIAL EXCLUDING ENERGY

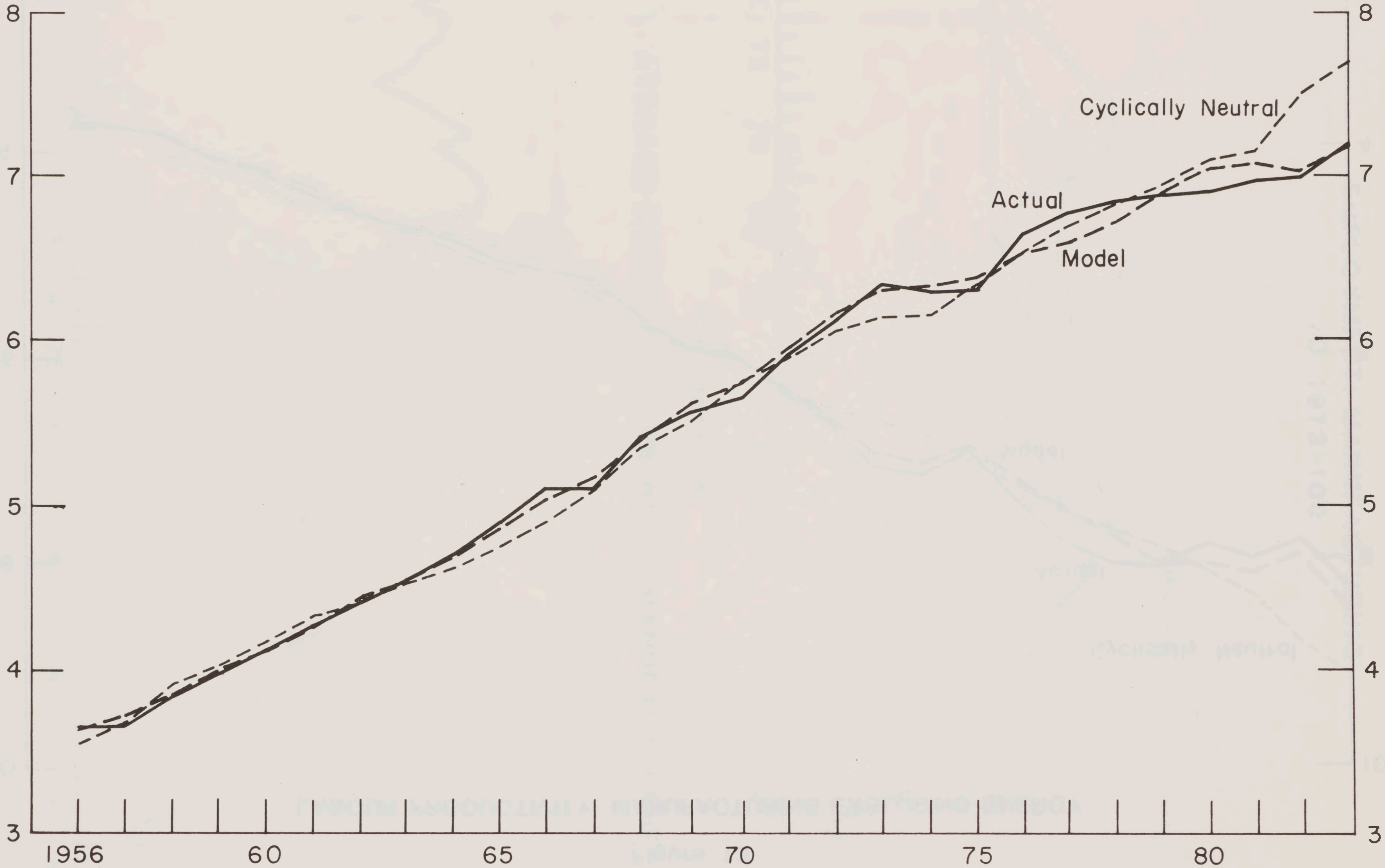


Figure 13

LABOUR PRODUCTIVITY: MANUFACTURING EXCLUDING ENERGY

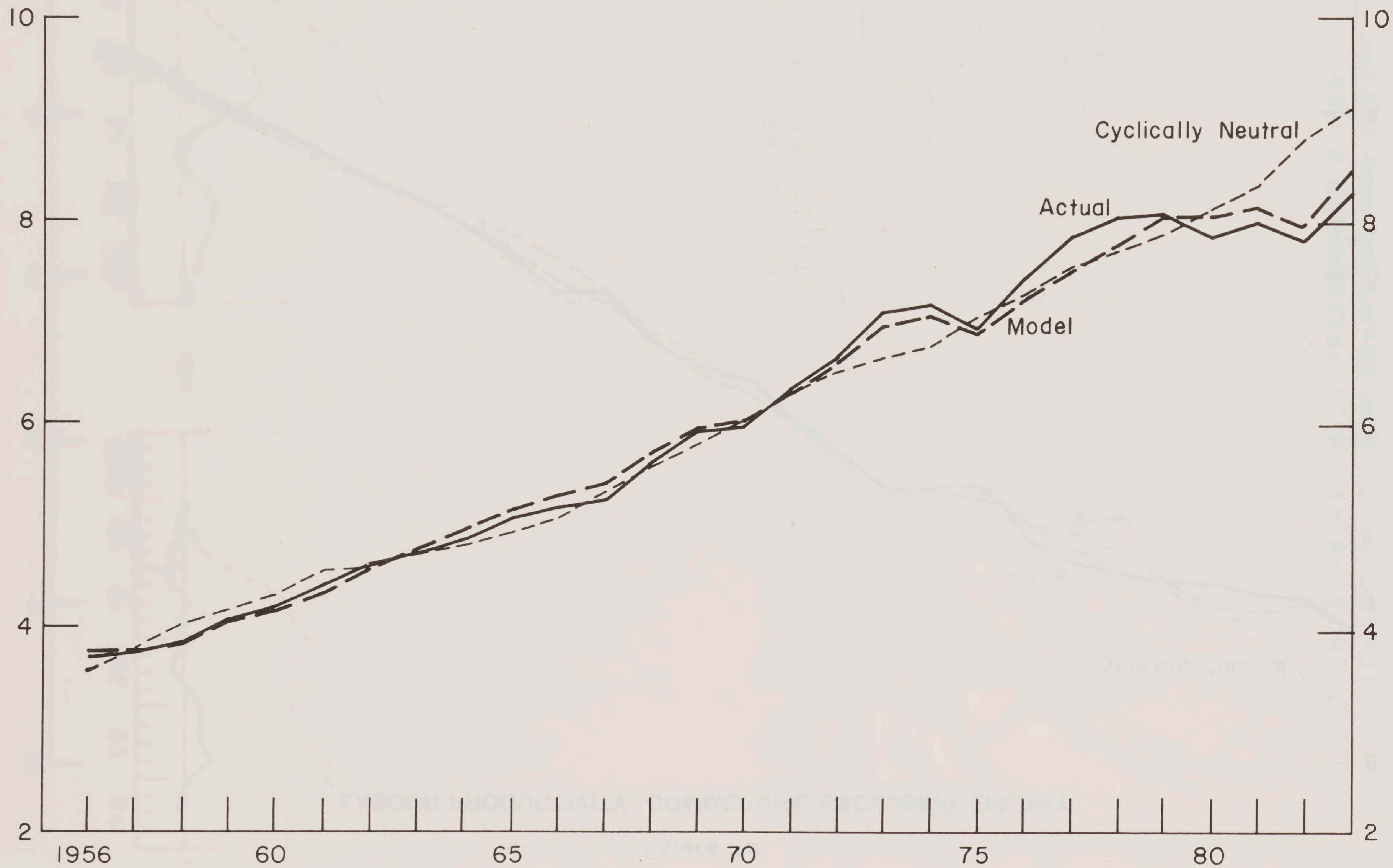


Figure 14

EMPLOYMENT: MANUFACTURING
1Q 1972=100

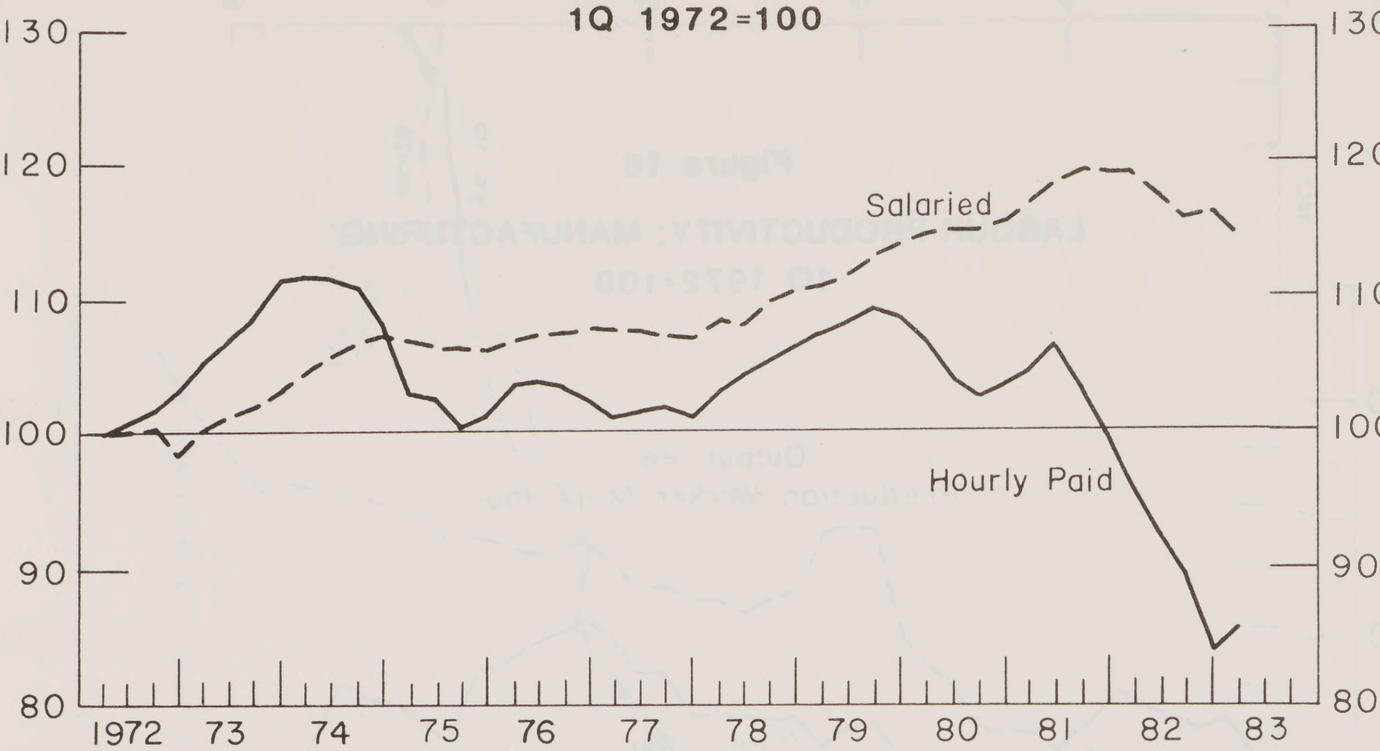


Figure 15

AVERAGE HOURS PAID PER WEEK: MANUFACTURING

Figure 16

LABOUR PRODUCTIVITY: MANUFACTURING
1Q 1972=100

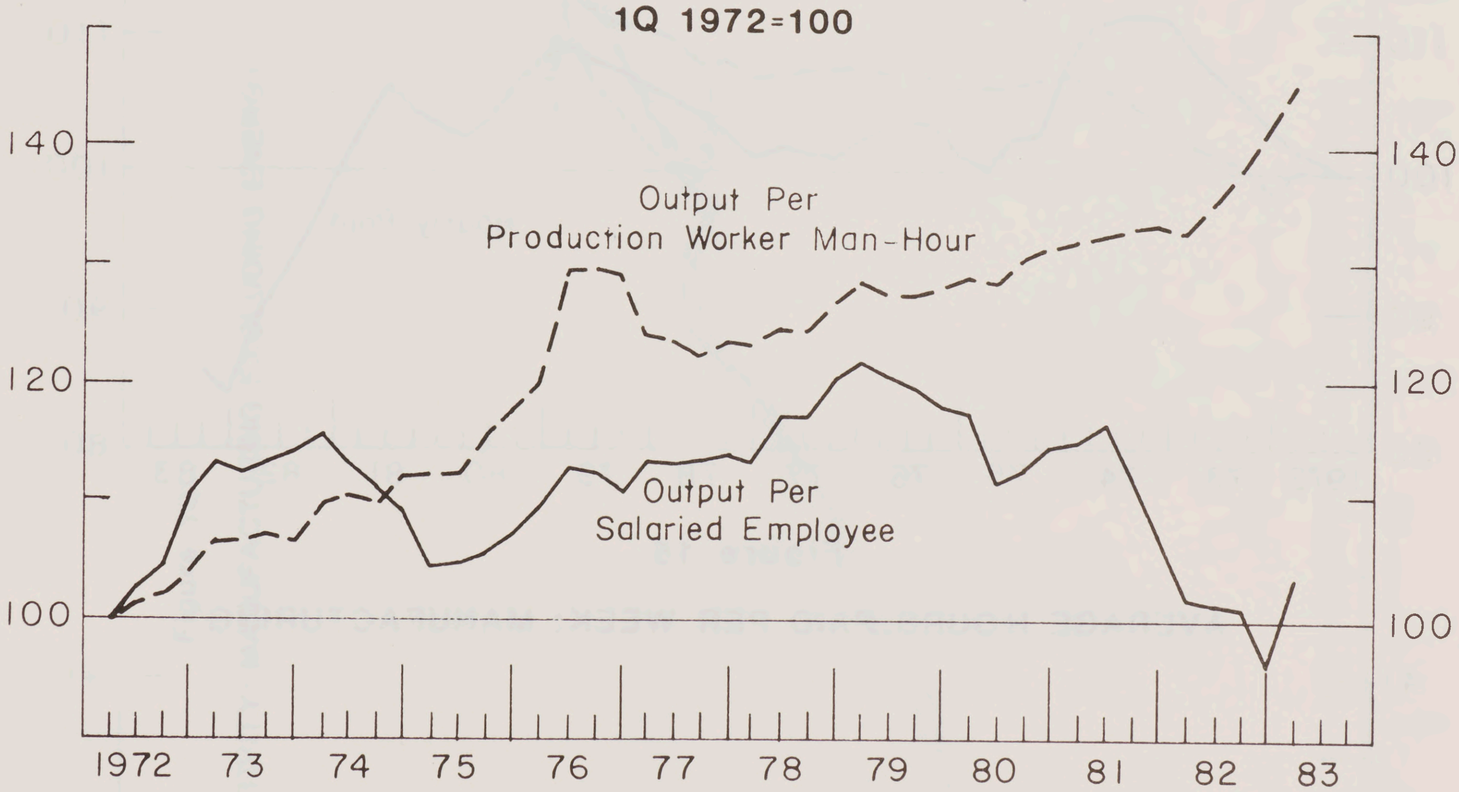


Figure 17

LABOUR PRODUCTIVITY: COMMERCIAL EXCLUDING ENERGY

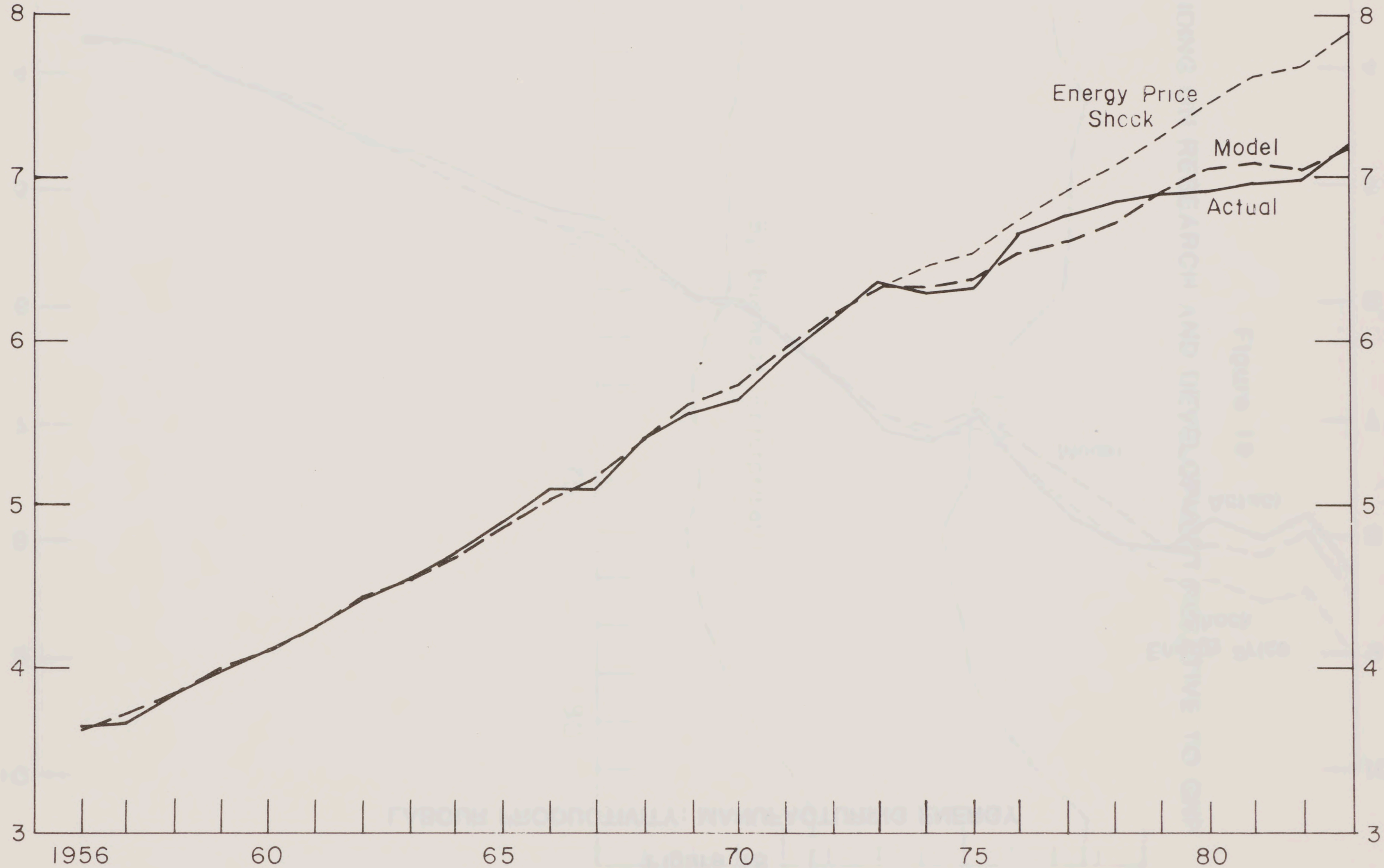


Figure 18

LABOUR PRODUCTIVITY: MANUFACTURING ENERGY

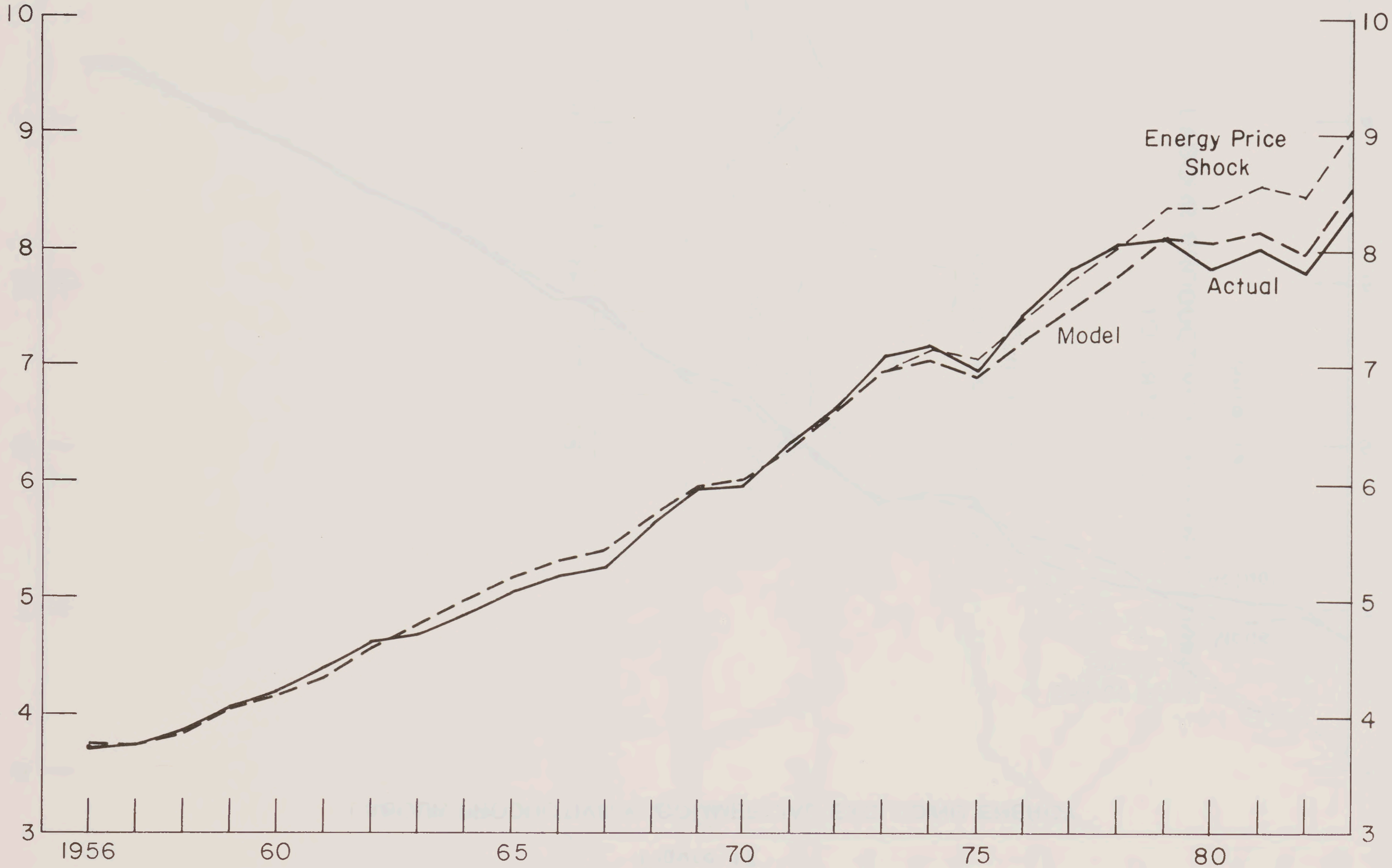


Figure 19

SPENDING ON RESEARCH AND DEVELOPMENT RELATIVE TO GNP

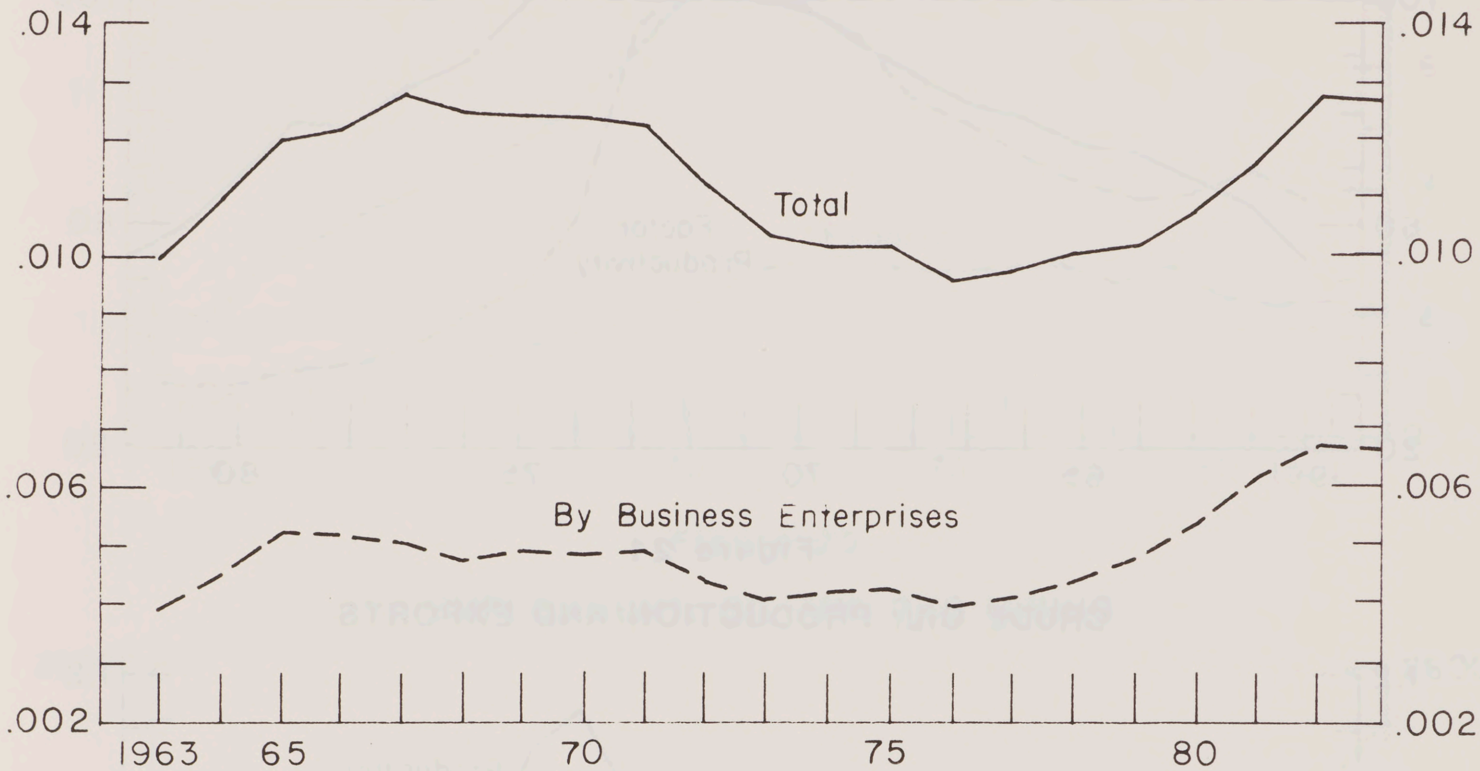


Figure 20

PRODUCTIVITY: OIL AND GAS MINING
1971=100

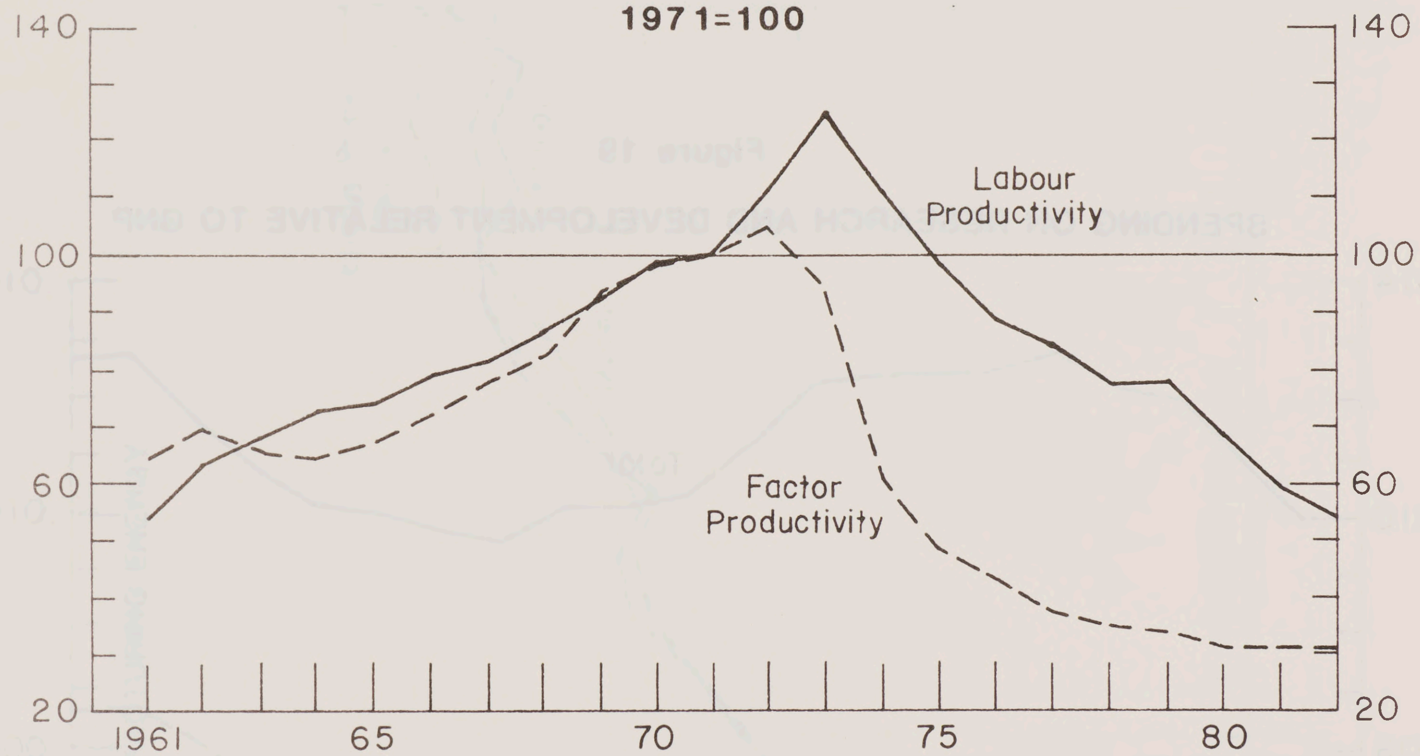


Figure 21

CRUDE OIL: PRODUCTION AND EXPORTS

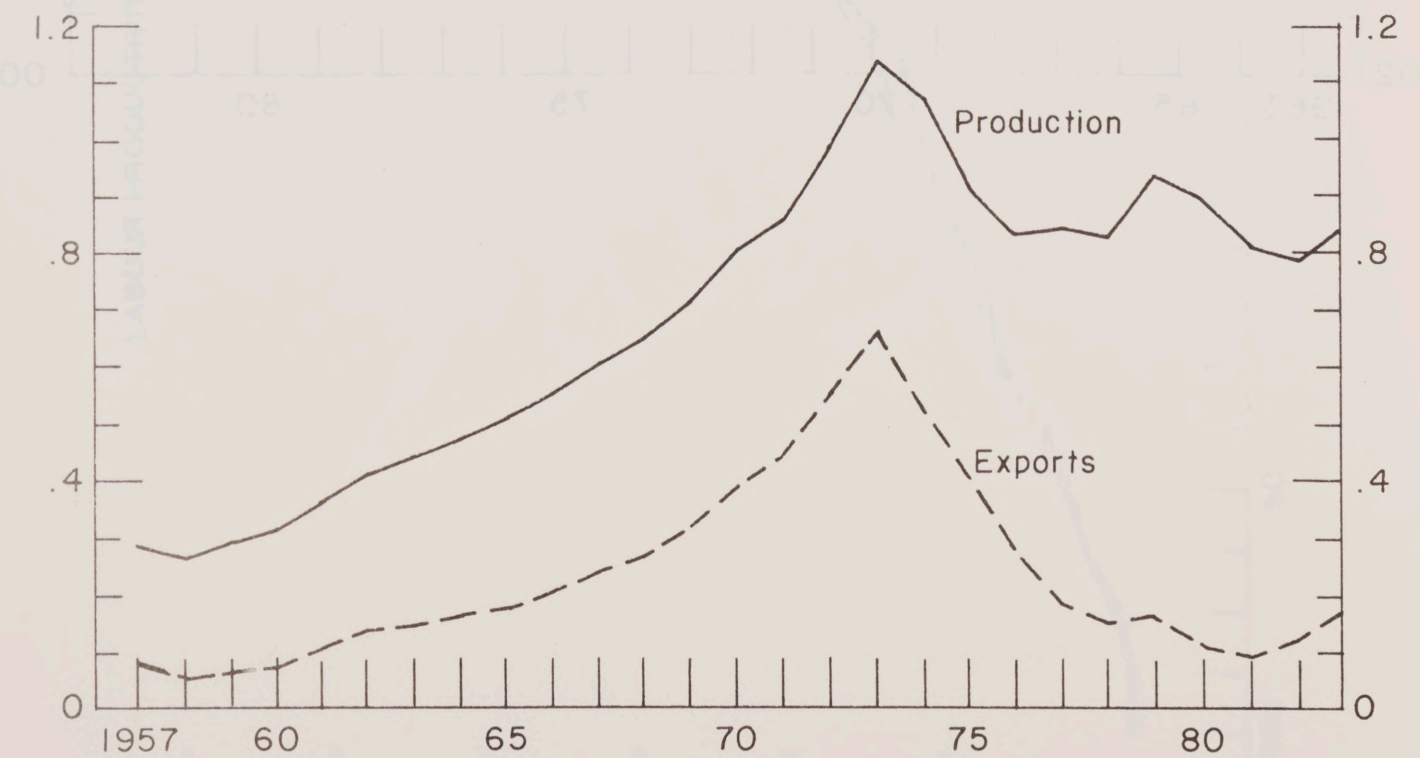


Figure 22

NATURAL GAS: PRODUCTION AND EXPORTS

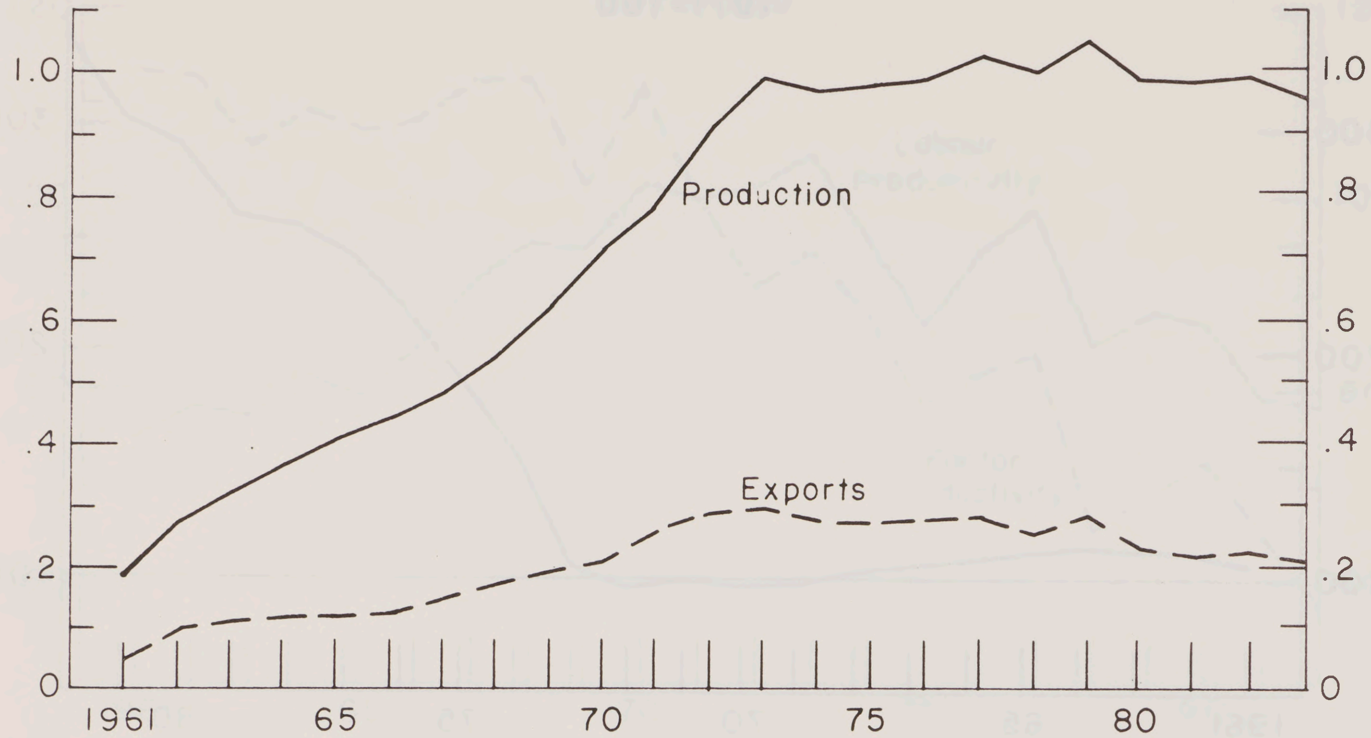


Figure 23

EMPLOYMENT: OIL AND GAS MINING

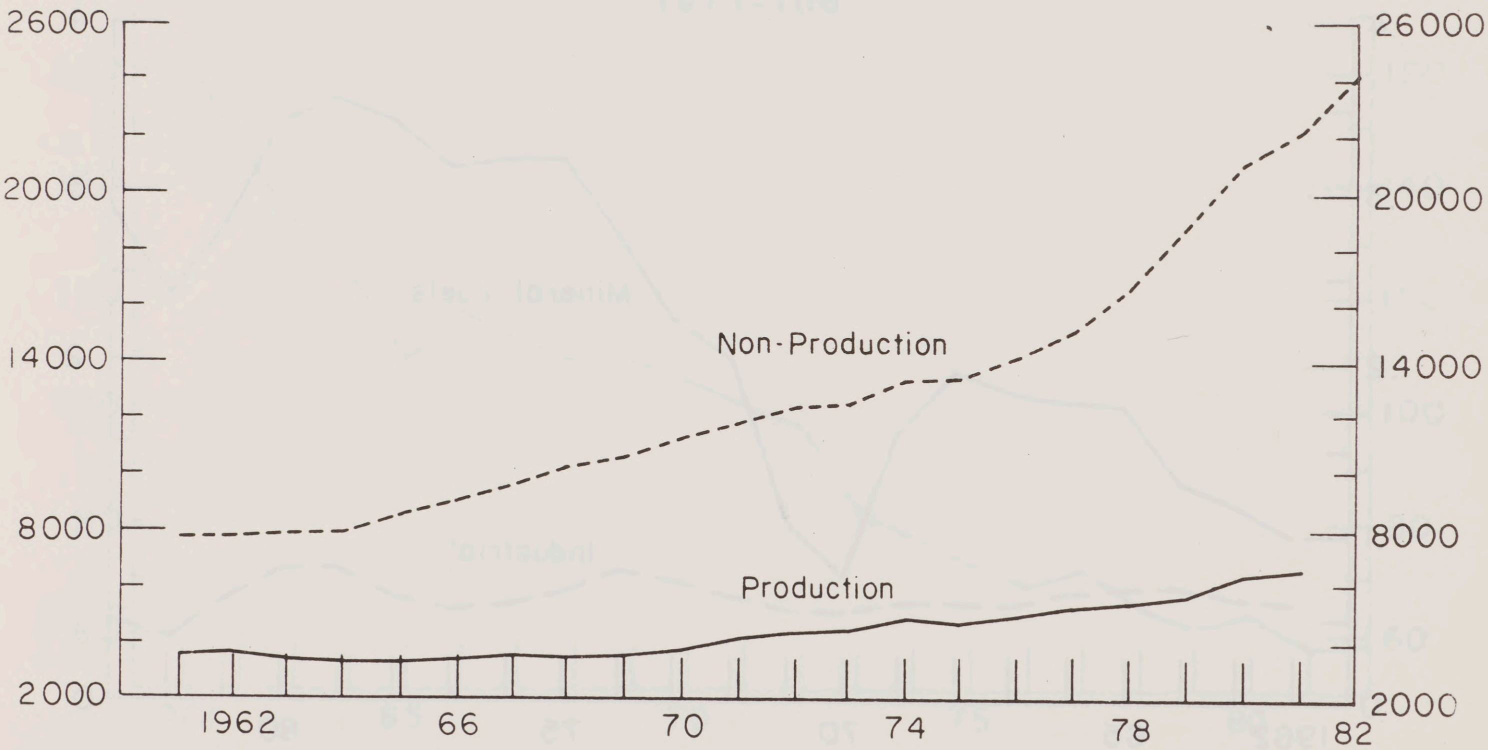


Figure 24

RELATIVE OUTPUT PRICE: OIL AND GAS MINING
1971=100

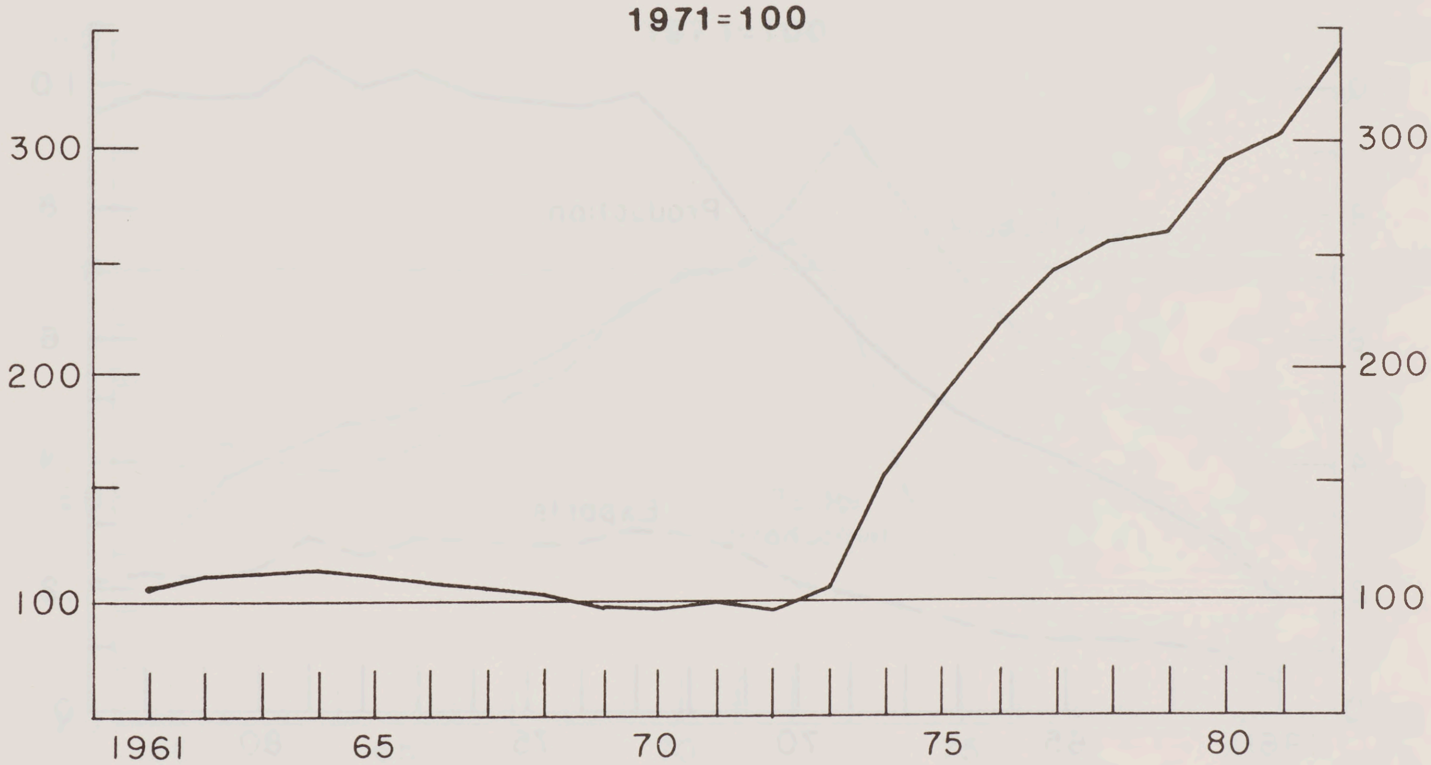


Figure 25

PROFIT MARGINS

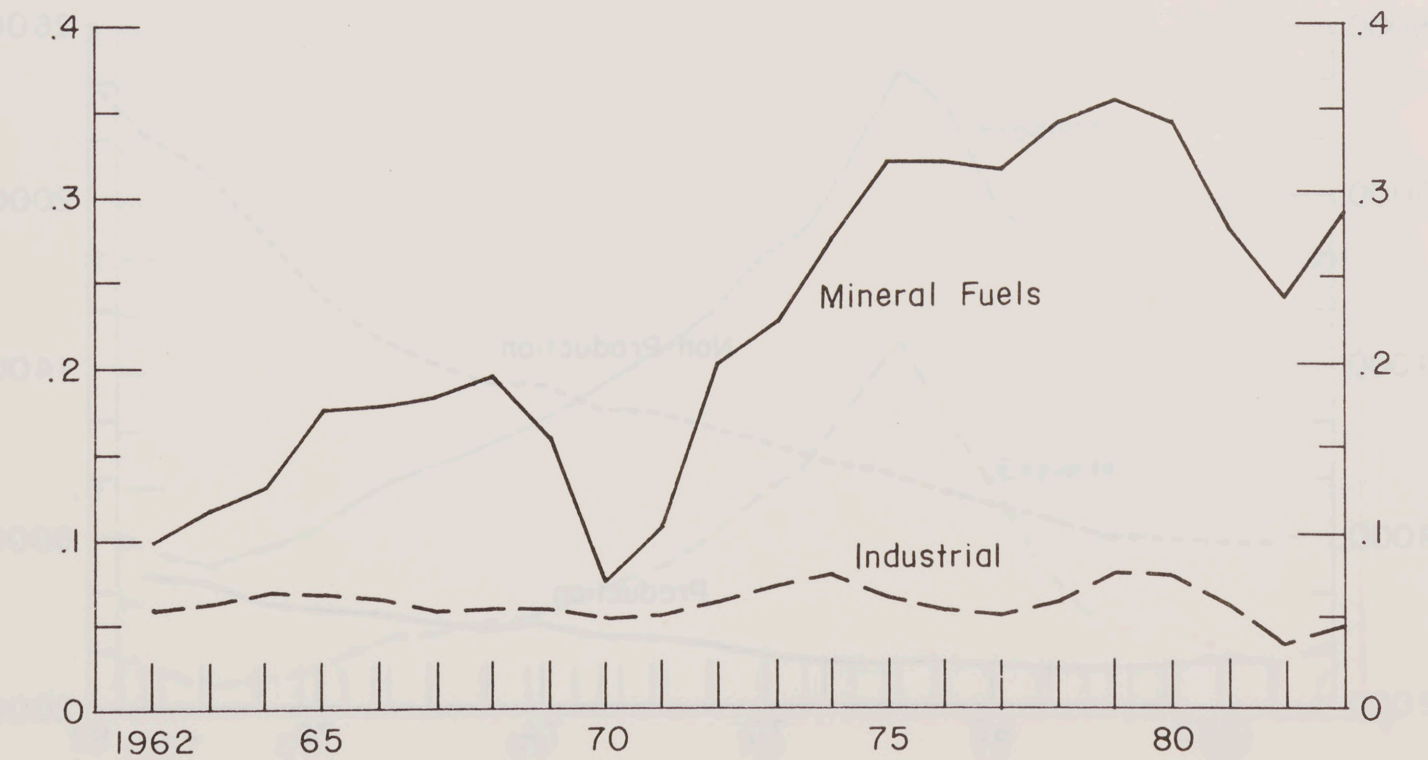


Figure 26

PRODUCTIVITY: METAL MINING
1971=100

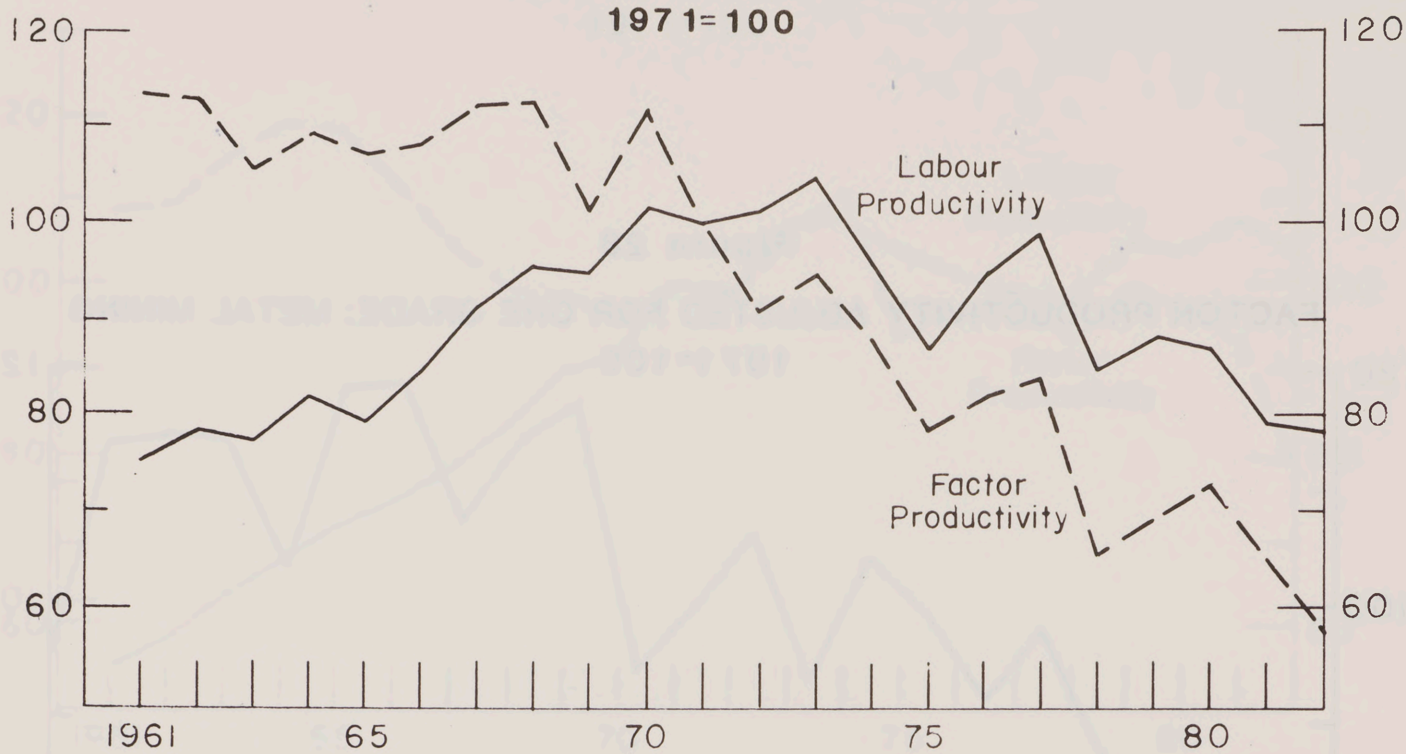


Figure 27

AVERAGE ORE GRADE: METAL MINING
1971=100

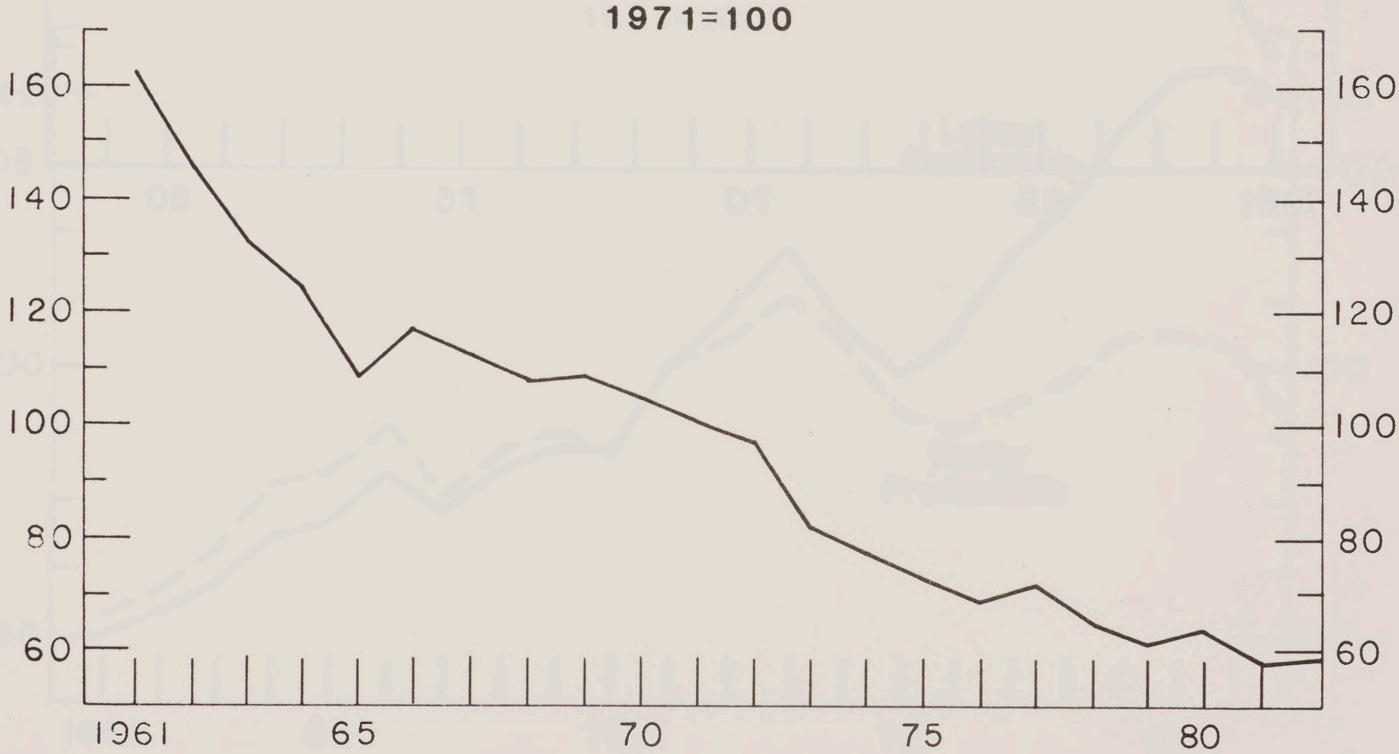


Figure 28

FACTOR PRODUCTIVITY ADJUSTED FOR ORE GRADE: METAL MINING
1971=100

Figure 29

PRODUCTIVITY: NON-METAL MINING (INCLUDING COAL)
1971=100

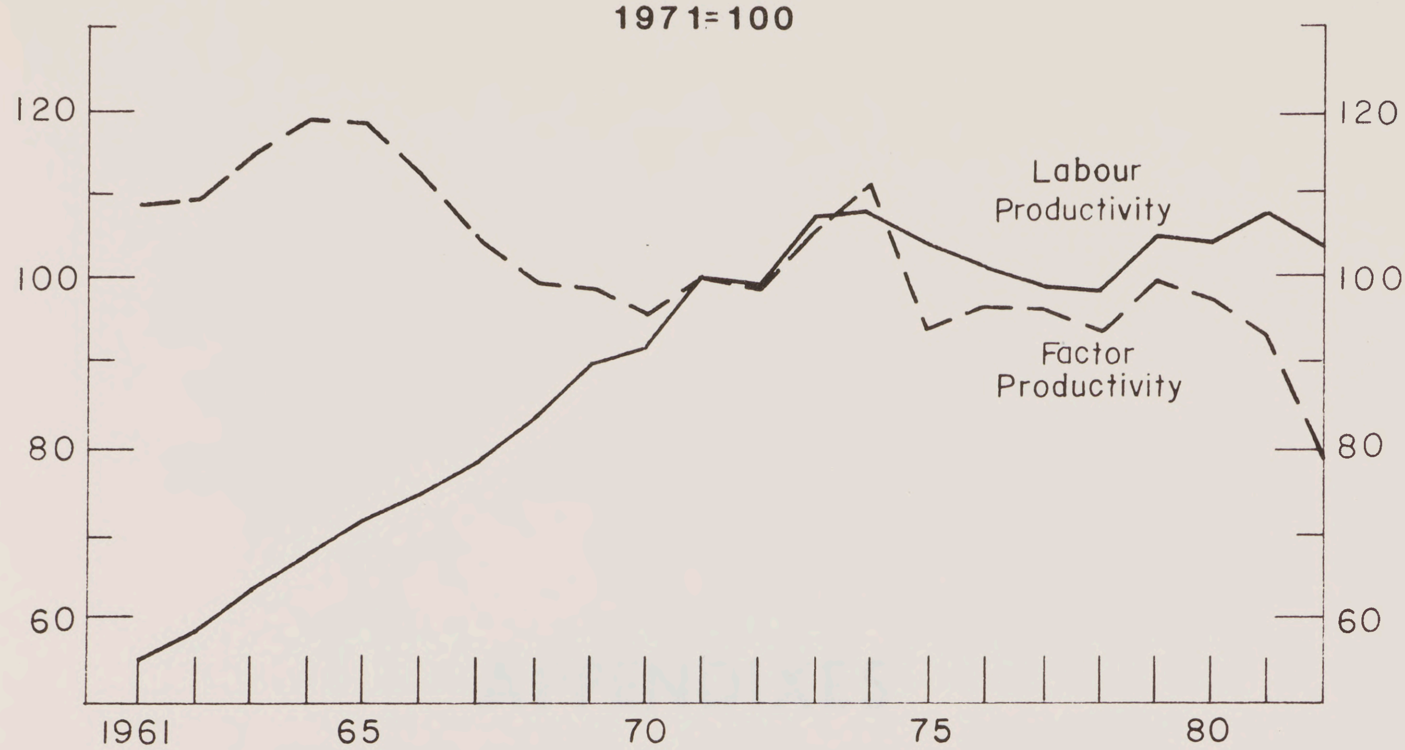
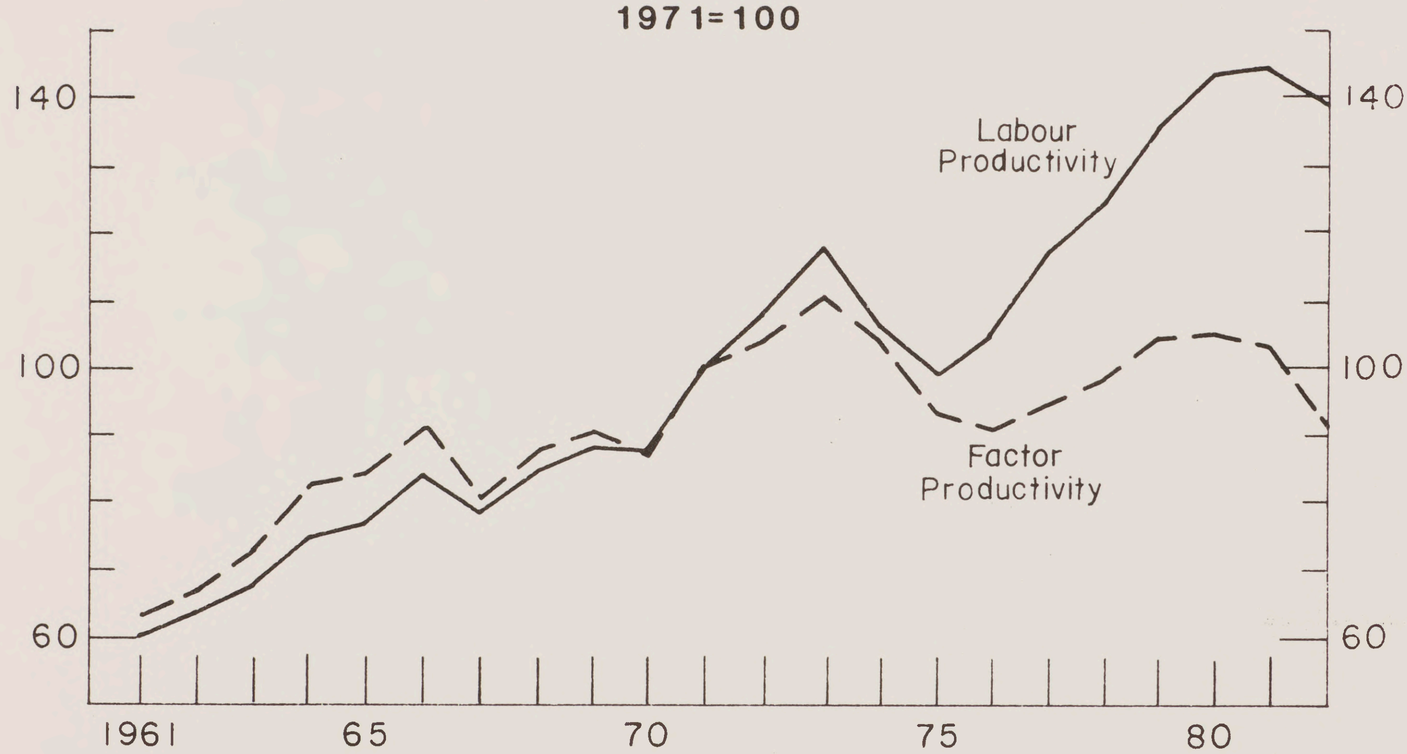


Figure 30

PRODUCTIVITY: STRUCTURAL MATERIALS
1971=100



APPENDIXES

APPENDIX A: GROWTH OF LABOUR PRODUCTIVITY

TABLE A:1 FOOD AND BEVERAGES

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	2.7	0.7	0.129	3.2	0.013	2.2	0.472	2.5	0.193	2.7	3.2
1962-65	3.4	0.8	0.128	3.0	0.013	3.1	0.473	3.1	0.198	3.2	4.6
1966-74	3.2	1.0	0.131	4.4	0.012	2.8	0.468	2.3	0.195	2.8	2.9
1975-79	1.3	0.2	0.125	1.0	0.015	1.5	0.484	1.1	0.184	2.0	2.7

TABLE A:2 TOBACCO

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	4.1	0.8	0.20	3.6	0.005	4.9	0.43	4.0	0.18	4.3	2.5
1962-65	3.6	0.7	0.20	3.9	0.005	9.8	0.43	2.6	0.18	4.8	2.1
1966-74	5.0	1.2	0.20	4.2	0.005	3.8	0.43	5.3	0.18	3.3	3.5
1975-79	2.8	0.2	0.21	2.4	0.006	3.3	0.41	2.8	0.18	5.5	1.1

TABLE A:3 RUBBER AND PLASTICS

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	4.0	1.6	0.14	1.6	0.02	3.0	0.3	4.9	0.3	2.2	8.6
1962-65	4.9	2.6	0.14	-2.6	0.02	1.2	0.3	6.3	0.3	3.0	12.0
1966-74	3.8	1.0	0.16	5.5	0.02	3.7	0.3	4.9	0.2	1.9	8.1
1975-79	3.6	2.0	0.12	-1.9	0.02	3.0	0.3	3.9	0.2	2.0	6.9

TABLE A:4 LEATHER

			Capital		Energy		Raw materials		Other intermediate inputs		
	Labour productivity	Factor productivity	Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	Output
1962-79	4.36	1.92	0.07	4.02	0.01	3.58	0.07	4.06	0.43	4.26	1.71
1962-65	3.00	1.40	0.06	1.24	0.01	4.29	0.07	4.18	0.42	2.81	2.31
1966-74	3.24	0.99	0.06	4.89	0.01	1.98	0.07	2.44	0.43	4.11	0.91
1975-79	7.54	4.04	0.07	4.73	0.01	5.95	0.07	6.92	0.44	5.72	2.68

TABLE A:5 TEXTILES

			Capital		Energy		Raw materials		Other intermediate inputs		
	Labour productivity	Factor productivity	Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	Output
1962-79	5.29	2.88	0.16	2.11	0.02	3.39	0.18	2.62	0.26	5.57	5.74
1962-65	11.07	8.86	0.18	-.64	0.02	2.95	0.21	5.25	0.22	4.55	15.81
1966-74	2.74	0.41	0.17	3.19	0.02	3.68	0.18	0.88	0.26	6.08	2.73
1975-79	5.42	2.72	0.14	2.41	0.03	3.23	0.16	3.71	0.29	5.46	3.55

TABLE A:6 KNITTING MILLS

			Capital		Energy		Raw materials		Other intermediate inputs		
	Labour productivity	Factor productivity	Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	Output
1962-79	6.13	2.73	0.10	2.47	0.009	4.12	0.03	3.29	0.57	5.16	5.39
1962-65	7.13	3.14	0.09	-1.01	0.008	4.26	0.03	1.71	0.58	6.78	8.88
1966-74	5.63	1.81	0.11	4.42	0.008	4.20	0.03	5.33	0.57	5.42	5.90
1975-79	6.22	4.06	0.09	1.82	0.012	3.87	0.03	0.94	0.56	3.43	1.80

TABLE A:7 CLOTHING

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	3.59	1.40	0.08	1.19	0.004	2.77	0.04	1.98	0.54	3.63	3.86
1962-65	3.36	0.90	0.07	-1.93	0.004	4.98	0.04	3.22	0.56	4.40	4.93
1966-74	3.42	1.01	0.08	1.82	0.003	2.50	0.04	2.53	0.55	3.91	3.39
1975-79	4.08	2.51	0.09	2.63	0.004	1.52	0.04	0.04	0.51	2.51	3.85

TABLE A:8 PAPER AND ALLIED PRODUCTS

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	3.05	0.47	0.19	3.19	0.07	3.92	0.26	3.28	0.19	4.41	3.85
1962-65	4.18	0.66	0.23	3.74	0.06	6.59	0.26	4.56	0.18	6.07	5.28
1966-74	3.58	0.94	0.17	3.66	0.07	3.34	0.27	3.76	0.20	4.21	5.10
1975-79	1.24	-0.52	0.19	1.91	0.09	2.86	0.26	1.42	0.18	3.46	0.53

TABLE A:9 PRINTING AND PUBLISHING

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	2.61	1.10	0.15	1.75	0.008	1.96	0.22	3.08	0.18	3.01	4.23
1962-65	1.69	0.14	0.15	3.03	0.008	3.67	0.21	1.40	0.19	4.24	3.29
1966-74	2.67	1.11	0.15	1.83	0.007	2.76	0.22	4.09	0.18	2.02	4.26
1975-79	3.23	1.84	0.16	0.60	0.008	-0.79	0.25	2.62	0.18	3.81	4.93

TABLE A:10 PETROLEUM AND COAL PRODUCTS

	Labour productivity	Factor productivity	Capital: Average share	Capital: Capital/labour	Energy: Average share	Energy: Energy/labour	Raw materials: Average share	Raw materials: Raw materials/labour	Other intermediate inputs: Average share	Other intermediate inputs: Other inputs/labour	Output
1962-79	4.27	0.48	0.056	3.27	0.78	4.11	0.033	4.60	0.085	4.73	5.22
1962-65	9.37	2.26	0.10	4.04	0.72	7.75	0.036	7.50	0.089	8.88	5.42
1966-74	3.93	0.16	0.05	3.61	0.76	4.26	0.037	7.03	0.097	2.45	6.50
1975-79	0.93	-0.33	0.03	2.06	0.86	1.02	0.023	-1.80	0.058	5.62	2.81

TABLE A:11 CHEMICALS

	Labour productivity	Factor productivity	Capital: Average share	Capital: Capital/labour	Energy: Average share	Energy: Energy/labour	Raw materials: Average share	Raw materials: Raw materials/labour	Other intermediate inputs: Average share	Other intermediate inputs: Other inputs/labour	Output
1962-79	3.41	0.73	0.21	5.10	0.10	5.46	0.09	1.98	0.33	2.79	5.48
1962-65	4.83	2.02	0.24	2.18	0.07	3.58	0.09	5.79	0.33	4.54	7.61
1966-74	3.18	0.94	0.20	4.04	0.09	5.56	0.09	2.36	0.33	2.15	5.04
1975-79	2.72	-0.67	0.19	9.48	0.14	6.81	0.09	-1.64	0.31	2.56	4.58

TABLE A:12 MISCELLANEOUS MANUFACTURING

	Labour productivity	Factor productivity	Capital: Average share	Capital: Capital/labour	Energy: Average share	Energy: Energy/labour	Raw materials: Average share	Raw materials: Raw materials/labour	Other intermediate inputs: Average share	Other intermediate inputs: Other inputs/labour	Output
1962-79	2.71	1.05	0.13	2.24	0.011	2.65	0.22	1.39	0.30	3.61	4.59
1962-65	3.49	0.35	0.14	3.75	0.009	4.45	0.22	4.80	0.29	5.51	6.22
1966-74	3.04	1.50	0.13	2.70	0.011	3.49	0.21	1.84	0.30	2.63	5.69
1975-79	1.51	0.81	0.11	0.22	0.012	-0.24	0.22	-2.06	0.30	3.90	1.37

TABLE A:13 WOOD PRODUCTS

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	2.51	0.47	0.11	4.02	0.020	4.03	0.36	1.92	0.18	4.62	4.76
1962-65	2.31	0.99	0.10	-0.34	0.020	4.55	0.39	0.47	0.17	6.64	6.40
1966-74	2.58	0.22	0.11	6.74	0.018	4.22	0.37	1.95	0.18	4.32	3.88
1975-79	2.56	0.52	0.12	2.76	0.023	3.28	0.35	3.02	0.19	3.55	5.06

TABLE A:14 FURNITURE

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	2.17	0.64	0.11	2.31	0.009	1.62	0.17	0.69	0.36	3.10	4.49
1962-65	3.85	1.62	0.10	0.21	0.009	4.04	0.18	1.91	0.37	4.97	9.11
1966-74	2.38	0.34	0.11	3.88	0.009	1.25	0.18	2.86	0.36	3.04	4.94
1975-79	0.45	0.41	0.10	1.20	0.011	0.40	0.17	-4.02	0.37	1.75	0.15

TABLE A:15 PRIMARY METALS

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	1.53	0.22	0.14	1.85	0.078	2.27	0.11	0.11	0.19	4.28	3.36
1962-65	3.17	1.26	0.16	-0.70	0.066	2.70	0.36	2.36	0.18	5.90	8.21
1966-74	2.72	0.56	0.14	2.91	0.065	2.68	0.95	1.95	0.20	4.50	4.02
1975-79	-1.86	-1.21	0.11	2.01	0.110	1.20	-4.81	-4.81	0.21	2.63	-1.50

TABLE A:16 METAL FABRICATING

			Capital		Energy		Raw materials		Other intermediate inputs		
	Labour productivity	Factor productivity	Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	Output
1962-79	2.97	1.26	0.14	0.98	0.012	2.15	0.32	3.43	0.17	2.49	5.63
1962-65	3.97	2.86	0.14	-5.10	0.012	0.27	0.32	4.32	0.18	2.66	12.29
1966-74	3.92	1.25	0.15	3.86	0.011	3.78	0.31	4.96	0.18	2.74	5.13
1975-79	0.51	0.02	0.14	0.89	0.014	0.78	0.35	0.04	0.16	1.92	1.44

TABLE A:17 MACHINERY

			Capital		Energy		Raw materials		Other intermediate inputs		
	Labour productivity	Factor productivity	Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	Output
1962-79	3.67	1.67	0.15	1.65	0.009	2.08	0.15	3.36	0.33	3.92	7.63
1962-65	6.21	2.76	0.19	-2.71	0.008	-4.99	0.14	9.10	0.32	8.83	16.03
1966-74	2.81	0.62	0.15	3.12	0.008	5.62	0.14	4.68	0.34	2.64	5.07
1975-79	3.21	2.71	0.13	2.57	0.012	1.70	0.16	-3.25	0.34	2.42	5.83

TABLE A:18 TRANSPORTATION EQUIPMENT

			Capital		Energy		Raw materials		Other intermediate inputs		
	Labour productivity	Factor productivity	Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	Output
1962-79	5.59	2.29	0.13	1.51	0.011	2.25	0.15	4.73	0.40	6.23	9.20
1962-65	7.53	3.05	0.13	-3.27	0.011	0.91	0.15	10.75	0.35	9.46	17.04
1966-74	6.41	2.44	0.14	3.40	0.010	4.56	0.15	4.73	0.40	7.07	8.87
1975-79	2.63	1.41	0.11	2.04	0.012	-0.74	0.15	0.14	0.43	2.27	3.88

TABLE A:19 ELECTRICAL PRODUCTS

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	4.14	2.33	0.15	2.49	0.010	2.59	0.20	3.46	0.26	2.83	5.69
1962-65	5.27	3.58	0.15	-2.70	0.009	1.07	0.19	5.55	0.26	3.78	11.92
1966-74	4.30	1.81	0.14	4.04	0.009	3.18	0.21	4.71	0.27	3.65	5.92
1975-79	2.97	2.29	0.16	4.02	0.012	2.76	0.21	-0.36	0.25	0.63	0.57

TABLE A:20 NON-METALLIC MINERAL PRODUCTS

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	3.44	1.28	0.22	2.82	0.070	3.41	0.14	3.34	0.24	3.45	4.80
1962-65	4.78	2.70	0.22	-1.05	0.063	3.00	0.14	5.49	0.25	5.42	9.60
1966-74	4.04	1.61	0.23	4.24	0.061	4.40	0.13	3.79	0.24	2.81	4.78
1975-79	1.31	-0.44	0.21	3.46	0.089	1.99	0.14	0.86	0.23	3.06	1.14

TABLE A:21 AGRICULTURE

	Labour productivity	Factor productivity	Capital		Energy		Raw materials		Other intermediate inputs		Output
			Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	
1962-79	5.0	-0.2	0.538	5.3	0.053	5.2	0.052	9.0	0.271	5.7	3.0
1962-65	12.0	5.0	0.549	5.4	0.055	9.8	0.044	15.6	0.264	8.9	8.4
1966-74	3.6	-1.6	0.538	5.4	0.052	4.8	0.047	6.2	0.275	6.2	1.0
1975-79	2.1	-1.9	0.539	5.0	0.053	2.4	0.064	8.8	0.266	2.4	2.5

TABLE A:22 FORESTRY

	Labour productivity	Factor productivity	Capital: Average share	Capital: Capital/labour	Energy: Average share	Energy: Energy/labour	Raw materials: Average share	Raw materials: Raw materials/labour	Other intermediate inputs: Average share	Other intermediate inputs: Other inputs/labour	Output
1962-79	3.6	1.0	0.141	4.7	0.030	4.0	0.005	1.6	0.376	5.1	2.5
1962-65	3.8	1.2	0.160	4.4	0.029	7.0	0.006	0.1	0.360	4.5	3.6
1966-74	3.6	1.0	0.141	5.0	0.028	5.3	0.005	2.5	0.379	4.7	2.7
1975-79	3.7	0.9	0.124	4.4	0.037	-0.6	0.004	1.1	0.383	6.2	1.4

TABLE A:23 FISHING AND TRAPPING

	Labour productivity	Factor productivity	Capital: Average share	Capital: Capital/labour	Energy: Average share	Energy: Energy/labour	Raw materials: Average share	Raw materials: Raw materials/labour	Other intermediate inputs: Average share	Other intermediate inputs: Other inputs/labour	Output
1962-79	-0.7	-2.0	0.462	1.5	0.053	4.6	0.019	1.0	0.223	2.0	2.3
1962-65	-2.5	-4.3	0.472	2.0	0.042	7.3	0.022	4.0	0.228	2.2	2.8
1966-74	0.6	-2.3	0.459	4.7	0.049	4.2	0.019	1.8	0.224	3.0	-0.5
1975-79	-1.4	0.4	0.456	-4.3	0.068	3.3	0.019	-2.6	0.219	-0.1	7.0

TABLE A:24 METAL MINING

	Labour productivity	Factor productivity	Capital: Average share	Capital: Capital/labour	Energy: Average share	Energy: Energy/labour	Raw materials: Average share	Raw materials: Raw materials/Labour	Other intermediate inputs: Average share	Other intermediate inputs: Other inputs/labour	Output
1962-79	3.1	-1.2	0.391	5.8	0.042	7.0	0.081	5.5	0.212	7.7	2.9
1962-65	5.7	1.0	0.461	4.2	0.032	11.3	0.068	4.7	0.174	12.7	7.4
1966-74	3.2	-1.2	0.403	6.7	0.038	6.1	0.078	7.0	0.208	6.0	4.2
1975-79	0.7	-3.0	0.328	5.5	0.057	5.4	0.093	3.3	0.246	7.0	-2.7

TABLE A:25 OIL AND GAS MINING

			Capital		Energy		Raw materials		Other intermediate inputs		
	Labour productivity	Factor productivity	Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	Output
1962-79	2.1	-1.9	0.602	4.0	0.020	5.0	0.055	6.3	0.213	5.1	6.6
1962-65	8.4	0.1	0.590	8.6	0.022	9.8	0.051	12.4	0.209	8.1	10.0
1966-74	4.5	1.7	0.578	2.7	0.020	5.2	0.060	4.6	0.222	4.0	9.6
1975-79	-6.8	-9.5	0.660	2.7	0.017	0.8	0.048	4.5	0.195	4.9	-1.1

TABLE A:26 NON-METAL MINING

			Capital		Energy		Raw materials		Other intermediate inputs		
	Labour productivity	Factor productivity	Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	Output
1962-79	4.2	-0.1	0.354	7.0	0.056	4.8	0.056	3.3	0.224	7.1	5.8
1962-65	8.0	2.1	0.332	7.7	0.052	9.2	0.059	7.2	0.203	11.8	8.6
1966-74	4.3	-0.5	0.342	9.4	0.056	4.0	0.054	2.1	0.228	5.9	6.1
1975-79	1.2	-1.4	0.408	2.4	0.058	2.6	0.055	2.3	0.229	5.7	3.2

TABLE A:27 OTHER MINING

			Capital		Energy		Raw materials		Other intermediate inputs		
	Labour productivity	Factor productivity	Average share	Capital/ labour	Average share	Energy/ labour	Average share	Raw materials/ labour	Average share	Other inputs/ labour	Output
1962-79	8.1	2.8	0.205	8.4	0.051	7.8	0.056	11.1	0.326	7.6	7.1
1962-65	1.7	2.0	0.207	-1.8	0.049	-1.4	0.043	5.5	0.324	-0.5	6.5
1966-74	6.3	1.2	0.198	11.4	0.047	5.5	0.057	10.2	0.342	6.0	5.6
1975-79	17.0	6.5	0.221	11.2	0.059	20.1	0.063	17.6	0.298	17.6	10.6

TABLE A:28 CONSTRUCTION

	Labour Productivity	Factor Productivity	Capital		Energy		Raw Materials		Other Intermediate Inputs		Output
			Average Share	(Capital/ Labour)	Average Share	(Energy/ Labour)	Average Share	(Raw Material/ Labour)	Average Share	(Other Inputs/ Labour)	
1962-78	1.2	-0.1	.104	1.5	.014	0.2	.198	1.5	.348	2.1	3.8
1962-65	-0.7	0.7	.085	-7.1	.016	-5.9	.216	-2.7	.362	-0.2	5.8
1966-74	1.9	0.3	.102	2.5	.012	0.7	.191	2.0	.352	2.6	4.1
1975-78	1.6	-1.6	.130	8.5	.016	5.3	.194	4.9	.323	3.4	1.0

TABLE A: 29 TRANSPORTATION, STORAGE AND COMMUNICATION

	Labour Productivity	Factor Productivity	Capital		Energy		Raw Materials		Other Intermediate Inputs		Output
			Average Share	(Capital/ Labour)	Average Share	(Energy/ Labour)	Average Share	(Raw Material/ Labour)	Average Share	(Other Inputs/ Labour)	
1962-78	4.4	2.4	.272	4.3	.051	4.5	.005	4.1	.209	3.0	6.3
1962-65	6.1	3.5	.293	4.9	.041	3.5	.005	5.8	.207	4.3	7.7
1966-74	4.1	2.2	.283	3.9	.043	7.0	.005	3.2	.213	2.4	6.5
1975-78	3.4	1.7	.230	4.6	.076	-0.1	.005	4.4	.204	3.2	4.3

TABLE A:30 ELECTRIC POWER AND OTHER UTILITIES

	Labour Productivity	Factor Productivity	Capital		Energy		Raw Materials		Other Intermediate Inputs		Output
			Average Share	(Capital/ Labour)	Average Share	(Energy/ Labour)	Average Share	(Raw Material/ Labour)	Average Share	(Other Inputs/ Labour)	
1962-78	4.0	1.3	.601	3.4	.063	12.1	.002	16.0	.097	1.8	6.9
1962-65	4.8	2.1	.641	2.7	.033	46.2	.001	15.4	.101	-2.2	7.6
1966-74	4.5	1.8	.603	3.8	.058	1.6	.002	26.8	.098	3.0	7.3
1975-78	2.1	-0.8	.561	3.3	.103	7.5	.005	-4.6	.089	3.4	5.5

TABLE A:31 TRADE

	Labour Productivity	Factor Productivity	Capital: Average Share	Capital: (Capital/ Labour)	Energy: Average Share	Energy: (Energy/ Labour)	Raw Materials: Average Share	Raw Materials: (Raw Material/ Labour)	Other Intermediate Inputs: Average Share	Other Intermediate Inputs: (Other Inputs/ Labour)	Output
1962-78	0.9	1.1	.228	-0.8	.028	1.8	.039	-2.6	.229	0.3	4.9
1962-65	1.8	1.7	.246	-1.5	.026	5.0	.047	-2.1	.242	1.7	6.2
1966-74	0.6	1.3	.228	-1.3	.026	-0.2	.039	-2.7	.232	-1.4	5.2
1975-78	0.7	-0.1	.209	1.0	.033	3.3	.032	-2.8	.211	2.9	2.9

TABLE A:32 FINANCE, INSURANCE AND REAL ESTATE

	Labour Productivity	Factor Productivity	Capital: Average Share	Capital: (Capital/ Labour)	Energy: Average Share	Energy: (Energy/ Labour)	Raw Materials: Average Share	Raw Materials: (Raw Material/ Labour)	Other Intermediate Inputs: Average Share	Other Intermediate Inputs: (Other Inputs/ Labour)	Output
1962-78	0.1	-1.9	.405	4.4	.014	3.4	.001	-0.2	.218	1.2	5.6
1962-65	0.4	-2.8	.438	6.2	.012	4.4	.001	3.7	.223	2.6	5.6
1966-74	-0.6	-1.9	.404	3.3	.013	2.8	.001	0.9	.219	-0.1	5.3
1975-78	1.4	-1.0	.365	5.0	.018	3.8	.001	-6.2	.215	2.6	6.2

TABLE A:33 OTHER COMMERCIAL SERVICES

	Labour Productivity	Factor Productivity	Capital: Average Share	Capital: (Capital/ Labour)	Energy: Average Share	Energy: (Energy/ Labour)	Raw Materials: Average Share	Raw Materials: (Raw Material/ Labour)	Other Intermediate Inputs: Average Share	Other Intermediate Inputs: (Other Inputs/ Labour)	Output
1962-78	-1.2	-0.9	.169	3.9	.011	0.9	.064	-3.3	.586	-1.4	5.2
1962-65	-0.6	-1.1	.160	1.0	.009	2.7	.074	1.6	.612	0.3	6.9
1966-74	-1.4	-0.9	.169	4.3	.010	-0.3	.066	-4.0	.588	-1.6	5.1
1975-78	-1.5	-0.7	.177	6.1	.015	2.0	.053	-6.4	.544	-2.6	3.6

APPENDIX B: GROWTH OF COMPONENTS OF FACTOR PRODUCTIVITY (% EXCEPT FOR SHARES)

TABLE B:1 FOOD AND BEVERAGES

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	0.7	0.129	-0.4	0.190	2.7	0.013	0.2	0.472	0.5	0.193	0.1	3.2
1962-65	0.8	0.128	0.3	0.186	3.4	0.013	0.3	0.473	0.2	0.198	0.1	4.6
1966-74	1.0	0.131	-1.2	0.192	3.2	0.012	0.4	0.468	0.8	0.195	0.4	2.9
1975-79	0.2	0.125	0.3	0.190	1.3	0.015	-0.2	0.484	0.2	0.184	-0.7	2.7

TABLE B:2 TOBACCO

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	0.8	0.20	0.4	0.19	4.1	0.005	-0.8	0.43	0.1	0.18	-0.2	2.5
1962-65	0.7	0.20	-0.3	0.19	3.6	0.005	-5.6	0.43	1.0	0.18	-1.1	2.1
1966-74	1.2	0.20	0.8	0.19	5.0	0.005	1.2	0.43	-0.3	0.18	1.6	3.5
1975-79	0.2	0.21	0.4	0.20	2.8	0.006	-0.5	0.41	-0.0	0.18	-2.6	1.1

TABLE B:3 RUBBER AND PLASTICS

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	1.6	0.14	2.4	0.3	4.0	0.02	1.0	0.3	-0.93	0.3	1.8	8.6
1962-65	2.6	0.14	7.7	0.3	4.9	0.02	3.6	0.3	-1.3	0.3	1.9	12.0
1966-74	1.0	0.16	-1.7	0.3	3.8	0.02	0.1	0.3	-1.1	0.2	1.8	8.1
1975-79	2.0	0.12	5.6	0.3	3.6	0.02	0.5	0.3	-0.3	0.2	1.5	6.9

TABLE B:4 LEATHER

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Output
1962-79	1.92	0.07	0.33	0.42	4.36	0.01	0.75	0.07	0.29	0.43	0.10	1.71
1962-65	1.40	0.06	1.73	0.43	3.00	0.01	-1.24	0.07	-1.14	0.42	0.18	2.31
1966-74	0.99	0.06	-1.57	0.42	3.24	0.01	1.24	0.07	0.78	0.43	-0.83	0.91
1975-79	4.04	0.07	2.68	0.40	7.54	0.01	1.50	0.07	0.57	0.44	1.72	2.68

TABLE B:5: TEXTILES

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Output
1962-79	2.88	0.16	3.11	0.37	5.29	0.02	1.83	0.18	2.60	0.26	-0.26	5.74
1962-65	8.86	0.18	11.79	0.37	11.07	0.02	7.89	0.21	5.54	0.22	6.24	15.81
1966-74	0.41	0.17	-0.43	0.37	2.74	0.02	-0.91	0.18	1.84	0.26	-3.15	2.73
1975-79	2.72	0.14	2.94	0.37	5.42	0.03	2.12	0.16	1.64	0.29	-0.04	3.55

TABLE B:6 KNITTING MILLS

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Output
1962-79	2.73	0.10	3.57	0.29	6.13	0.009	1.92	0.03	2.75	0.57	0.92	5.39
1962-65	3.14	0.09	8.23	0.29	7.13	0.008	2.75	0.03	5.33	0.58	0.33	8.88
1966-74	1.81	0.11	1.16	0.28	5.63	0.008	1.37	0.03	0.29	0.57	0.21	5.90
1975-79	4.06	0.09	4.32	0.31	6.22	0.012	2.26	0.03	5.23	0.56	2.69	1.80

TABLE B:7 CLOTHING

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	1.40	0.08	2.37	0.34	3.59	0.004	0.80	0.04	1.58	0.54	-0.04	3.86
1962-65	0.90	0.07	5.39	0.33	3.36	0.004	-1.55	0.04	0.13	0.56	-1.00	4.93
1966-74	1.01	0.08	1.58	0.34	3.42	0.003	0.90	0.04	0.87	0.55	-0.47	3.39
1975-79	2.51	0.09	1.42	0.34	4.08	0.004	2.53	0.04	4.04	0.51	1.53	3.85

TABLE B:8 PAPER AND ALLIED PRODUCTS

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	0.47	0.19	-0.13	0.29	3.05	0.07	-0.83	0.26	-0.22	0.19	-1.30	3.85
1962-65	0.66	0.23	0.42	0.27	4.18	0.06	-2.26	0.26	-0.36	0.18	-1.78	5.28
1966-74	0.94	0.17	-0.08	0.30	3.58	0.07	0.23	0.27	-0.17	0.20	-0.60	5.10
1975-79	-0.52	0.19	-0.66	0.28	1.24	0.09	-1.58	0.26	-0.18	0.18	-2.15	0.53

TABLE B:9 PRINTING AND PUBLISHING

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	1.10	0.15	0.84	0.43	2.61	0.008	0.63	0.22	-0.46	0.18	-0.39	4.23
1962-65	0.14	0.15	-1.30	0.44	1.69	0.008	-1.91	0.21	0.28	0.19	-2.45	3.29
1966-74	1.11	0.15	0.83	0.44	2.67	0.007	-0.09	0.22	-1.36	0.18	0.63	4.26
1975-79	1.84	0.16	2.62	0.41	3.23	0.008	4.05	0.25	0.60	0.18	-0.55	4.93

TABLE B:10 PETROLEUM AND COAL PRODUCTS

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	0.48	0.056	0.96	0.063	4.27	0.78	0.15	0.033	-0.32	0.085	-0.44	5.22
1962-65	2.26	0.10	5.12	0.063	9.37	0.72	1.51	0.036	1.74	0.089	0.45	5.42
1966-74	0.16	0.05	0.31	0.073	3.93	0.76	-0.32	0.037	-2.90	0.097	1.44	6.50
1975-79	-0.33	0.03	-1.10	0.041	0.93	0.86	-0.08	0.023	2.79	0.058	-4.44	2.81

TABLE B:11: CHEMICALS

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	0.73	0.21	-1.61	0.28	3.41	0.10	-1.94	0.09	1.41	0.33	0.61	5.48
1962-65	2.02	0.24	2.59	0.27	4.83	0.07	1.21	0.09	-0.91	0.33	0.28	7.61
1966-74	0.94	0.20	-0.83	0.28	3.18	0.09	-2.25	0.09	0.79	0.33	1.01	5.04
1975-79	-0.67	0.19	-6.18	0.26	2.72	0.14	-3.84	0.09	4.43	0.31	0.15	4.58

TABLE B:12 MISCELLANEOUS MANUFACTURING

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	1.05	0.13	0.47	0.35	2.71	0.011	0.06	0.22	1.31	0.30	-0.87	4.59
1962-65	0.35	0.14	-0.25	0.35	3.49	0.009	-0.91	0.22	-1.25	0.29	-1.91	6.22
1966-74	1.50	0.13	0.33	0.35	3.04	0.011	-0.44	0.21	1.17	0.30	0.40	5.69
1975-79	0.81	0.11	1.29	0.35	1.51	0.012	1.76	0.22	3.65	0.30	-2.29	1.37

TABLE B:13 WOOD PRODUCTS

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	0.47	0.11	-1.45	0.32	2.51	0.020	-1.46	0.36	0.59	0.18	-2.01	4.76
1962-65	0.99	0.10	2.66	0.32	2.31	0.020	-2.14	0.39	1.84	0.17	-4.06	6.40
1966-74	0.22	0.11	-3.90	0.32	2.58	0.018	-1.58	0.37	0.61	0.18	-1.67	3.88
1975-79	0.52	0.12	-0.20	0.32	2.56	0.023	-0.70	0.35	-0.45	0.19	-0.96	5.06

TABLE B:14 FURNITURE

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	0.64	0.11	-0.14	0.35	2.17	0.009	0.53	0.17	1.46	0.36	-0.91	4.49
1962-65	1.27	0.10	3.64	0.34	3.85	0.009	-0.18	0.18	1.91	0.37	-1.06	9.11
1966-74	0.34	0.11	-1.44	0.34	2.38	0.009	1.12	0.18	-0.47	0.36	-0.63	4.94
1975-79	0.41	0.10	-0.75	0.35	0.45	0.011	0.05	0.17	4.65	0.37	-1.28	0.15

TABLE B:15 PRIMARY METALS

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	0.22	0.14	-0.31	0.25	1.53	0.078	-0.72	0.34	1.42	0.19	-2.64	3.36
1962-65	1.26	0.16	3.90	0.24	3.17	0.066	0.46	0.35	0.79	0.18	-2.57	8.21
1966-74	0.56	0.14	-0.18	0.25	2.72	0.065	0.05	0.35	0.76	0.20	-1.70	4.02
1975-79	-1.21	0.11	-3.79	0.25	-1.86	0.110	-3.02	0.31	3.10	0.21	-4.38	-1.50

TABLE B:16 METAL FABRICATING

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	1.26	0.14	1.97	0.34	2.97	0.012	0.80	0.32	-0.44	0.17	0.47	5.63
1962-65	2.86	0.14	9.57	0.35	3.97	0.012	3.70	0.32	-0.33	0.18	1.28	12.29
1966-74	1.25	0.15	0.06	0.35	3.92	0.011	0.14	0.31	-0.99	0.18	1.15	5.13
1975-79	0.02	0.14	-0.38	0.33	0.51	0.014	-.27	0.35	0.47	0.16	-1.38	1.44

TABLE B:17 MACHINERY

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	1.67	0.15	1.99	0.36	3.67	0.009	1.55	0.15	0.30	0.33	-0.24	7.63
1962-65	2.76	0.19	9.17	0.35	6.21	0.008	11.79	0.14	-2.65	0.32	-2.41	16.03
1966-74	0.62	0.15	-0.30	0.36	2.81	0.008	-2.66	0.14	-1.78	0.34	0.17	5.07
1975-79	2.71	0.13	0.62	0.36	3.21	0.012	1.48	0.16	6.68	0.34	0.77	5.83

TABLE B:18 TRANSPORTATION EQUIPMENT

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	2.29	0.13	4.02	0.32	5.59	0.011	3.27	0.15	0.83	0.40	-0.60	9.20
1962-65	3.05	0.13	11.17	0.36	7.53	0.011	6.56	0.15	-2.91	0.35	-1.76	17.04
1966-74	2.44	0.14	2.91	0.31	6.41	0.010	1.77	0.15	1.60	0.40	-0.62	8.87
1975-79	1.41	0.11	0.58	0.30	2.63	0.012	3.39	0.15	2.49	0.43	0.36	3.88

TABLE B:19 ELECTRICAL PRODUCTS

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	2.33	0.15	1.60	0.37	4.14	0.010	1.51	0.20	0.66	0.26	1.27	5.69
1962-65	3.58	0.15	8.19	0.38	5.27	0.009	4.15	0.19	-0.27	0.27	1.43	11.92
1966-74	1.81	0.14	0.24	0.37	4.30	0.009	1.08	0.21	-0.39	0.27	0.63	5.92
1975-79	2.29	0.16	-1.01	0.37	2.97	0.012	0.21	0.21	3.34	0.25	2.33	0.57

TABLE B:20 NON-METALLIC MINERAL PRODUCTS

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	1.28	0.22	0.60	0.32	3.44	0.070	0.02	0.14	0.09	0.24	-0.01	4.80
1962-65	2.70	0.22	5.90	0.32	4.78	0.063	1.73	0.14	0.67	0.25	-0.60	9.60
1966-74	1.61	0.23	-0.19	0.33	4.04	0.061	-0.34	0.13	0.23	0.24	1.20	4.78
1975-79	-0.44	0.21	-2.07	0.32	1.31	0.089	-0.67	0.14	0.45	0.23	-1.69	1.14

TABLE B:21 AGRICULTURE

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	-0.2	0.538	-0.3	0.072	5.0	0.053	-0.2	0.052	-3.7	0.271	-0.7	3.0
1962-65	5.0	0.549	6.2	0.072	12.0	0.055	2.0	0.044	-3.1	0.264	2.8	8.4
1966-74	-1.6	0.538	-1.8	0.072	3.6	0.052	-1.2	0.047	-2.5	0.275	-2.5	1.0
1975-79	-1.9	0.539	-2.8	0.069	2.1	0.053	-0.3	0.064	-6.2	0.266	-0.3	2.5

TABLE B:22 FORESTRY

	Factor productivity	Capital: Average share	Capital: Productivity	Labour: Average share	Labour: Productivity	Energy: Average share	Energy: Productivity	Raw materials: Average share	Raw materials: Productivity	Other intermediate inputs: Average share	Other intermediate inputs: Productivity	Output
1962-79	1.0	0.141	-1.0	0.439	3.6	0.030	-0.3	0.005	2.0	0.376	-1.4	2.5
1962-65	1.2	0.160	-0.6	0.436	3.8	0.029	-3.0	0.006	3.7	0.360	-0.7	3.6
1966-74	1.0	0.141	-1.3	0.437	3.6	0.028	-1.7	0.005	1.0	0.379	-1.1	2.7
1975-79	0.9	0.124	-0.7	0.443	3.7	0.037	4.3	0.004	2.5	0.383	-2.4	1.4

TABLE B:23 FISHING AND TRAPPING

	Factor productivity	Capital: Average share	Capital: Productivity	Labour: Average share	Labour: Productivity	Energy: Average share	Energy: Productivity	Raw materials: Average share	Raw materials: Productivity	Other intermediate inputs: Average share	Other intermediate inputs: Productivity	Output
1962-79	-2.0	0.462	-2.2	0.231	-0.7	0.053	-5.0	0.019	-1.7	0.223	-2.6	2.3
1962-65	-4.3	0.472	-4.4	0.226	-2.5	0.042	-9.1	0.022	-6.2	0.228	-4.6	2.8
1966-74	-2.3	0.459	-3.9	0.235	0.6	0.049	-3.4	0.019	-1.1	0.224	-2.3	-0.5
1975-79	0.4	0.456	2.9	0.229	-1.4	0.068	-4.5	0.019	1.2	0.219	-1.4	7.0

TABLE B:24 METAL MINING

	Factor productivity	Capital: Average share	Capital: Productivity	Labour: Average share	Labour: Productivity	Energy: Average share	Energy: Productivity	Raw materials: Average share	Raw materials: Productivity	Other intermediate inputs: Average share	Other intermediate inputs: Productivity	Output
1962-79	-1.2	0.391	-2.8	0.272	3.1	0.042	-3.7	0.081	-2.3	0.212	-4.3	2.9
1962-65	1.0	0.461	1.4	0.263	5.7	0.032	-5.0	0.068	1.0	0.174	-6.3	7.5
1966-74	-1.2	0.403	-3.2	0.271	3.2	0.038	-2.7	0.078	-3.6	0.208	-2.6	4.2
1975-79	-3.0	0.328	-4.5	0.272	0.7	0.057	-4.4	0.093	-2.5	0.246	-5.8	-2.7

TABLE B:25 OIL AND GAS MINING

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	-1.9	0.602	-1.8	0.109	2.1	0.020	-2.8	0.055	-4.0	0.213	-2.9	6.6
1962-65	0.8	0.590	-0.2	0.126	8.4	0.022	-1.3	0.051	-3.5	0.209	0.3	10.0
1966-74	1.6	0.586	1.8	0.118	4.5	0.020	-0.7	0.060	-0.1	0.222	0.5	9.6
1975-79	-9.5	0.660	-9.3	0.078	-6.8	0.017	-7.5	0.048	-10.8	0.195	-11.2	-1.1

TABLE B:26 NON-METAL MINING

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	-0.1	0.354	-2.6	0.307	4.2	0.056	-0.5	0.056	0.9	0.224	-2.7	5.8
1962-65	2.1	0.332	0.3	0.352	8.0	0.052	-1.1	0.059	0.7	0.203	-3.4	8.6
1966-74	-0.5	0.342	-4.7	0.316	4.3	0.056	0.2	0.054	2.1	0.228	-1.6	6.1
1975-79	-1.4	0.408	-1.2	0.246	1.2	0.058	-1.4	0.055	-1.1	0.229	-4.3	3.2

TABLE B:27 OTHER MINING

	Factor productivity	Capital		Labour		Energy		Raw materials		Other intermediate inputs		Output
		Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	Average share	Productivity	
1962-79	2.8	0.205	-0.3	0.353	8.1	0.051	0.3	0.056	-2.7	0.326	0.5	7.1
1962-65	2.0	0.207	2.9	0.370	1.7	0.049	3.1	0.043	-3.6	0.324	2.2	6.5
1966-74	1.2	0.198	-4.6	0.347	6.3	0.047	0.7	0.057	-3.5	0.342	0.3	5.6
1975-79	6.5	0.221	5.2	0.351	17.0	0.059	-2.6	0.063	-0.6	0.298	-0.5	10.6

TABLE B:28 CONSTRUCTION

Growth of Components of Factor Productivity (% except for shares)

		Capital		Labour		Energy		Raw Materials		Other Intermediate Inputs		Output
	Factor Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	
1962-78	-0.1	.104	-0.4	.336	1.2	.014	1.0	.198	-0.4	.348	-0.9	3.8
1962-65	0.7	.085	6.8	.321	-0.7	.016	5.5	.216	2.0	.362	-0.5	5.8
1966-74	0.3	.102	-0.7	.344	1.9	.012	1.2	.191	-0.1	.352	-0.7	4.1
1975-78	-1.6	.130	-6.4	.337	1.6	.016	-3.5	.194	-3.2	.323	-1.8	1.0

TABLE B:29 TRANSPORTATION, STORAGE AND COMMUNICATION

		Capital		Labour		Energy		Raw Materials		Other Intermediate Inputs		Output
	Factor Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	
1962-78	2.4	.272	0.1	.463	4.4	.051	-0.1	.005	0.3	.209	1.4	6.3
1962-65	3.5	.293	1.2	.453	6.1	.041	2.5	.005	0.2	.207	1.7	7.7
1966-74	2.2	.283	0.3	.456	4.1	.043	-2.7	.005	0.9	.213	1.7	6.5
1975-78	1.7	.230	-1.1	.484	3.4	.076	3.5	.005	-0.9	.204	0.2	4.3

TABLE B:30 ELECTRIC POWER AND OTHER UTILITIES

		Capital		Labour		Energy		Raw Materials		Other Intermediate Inputs		Output
	Factor Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	
1962-78	1.3	.601	0.6	.236	4.0	.063	-7.3	.002	-10.3	.097	2.1	6.9
1962-65	2.1	.641	2.1	.224	4.8	.033	-28.3	.001	-9.2	.101	7.2	7.6
1966-74	1.8	.603	0.7	.237	4.5	.058	2.9	.002	-17.5	.098	1.5	7.3
1975-78	-0.8	.561	-1.2	.242	2.1	.103	-5.0	.005	7.0	.089	-1.3	5.5

TABLE B:31 TRADE

	Factor	Capital		Labour		Energy		Raw Materials		Other Intermediate Inputs		Output
	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	
1962-78	1.1	.228	1.7	.477	0.9	.028	-0.9	.039	3.6	.229	0.6	4.9
1962-65	1.7	.246	3.4	.439	1.8	.026	-3.1	.047	3.9	.242	0.1	6.2
1966-74	1.3	.228	1.9	.476	0.6	.026	0.8	.039	3.4	.231	2.0	5.2
1975-78	-0.1	.209	-0.3	.515	0.7	.033	-2.5	.032	3.6	.211	-2.1	2.9

TABLE B:32 FINANCE, INSURANCE AND REAL ESTATE

	Factor	Capital		Labour		Energy		Raw Materials		Other Intermediate Inputs		Output
	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	
1962-78	-1.9	.405	-4.1	.362	0.1	.014	-3.2	.001	0.3	.218	-1.1	5.6
1962-65	-2.8	.438	-5.5	.326	0.4	.012	-3.8	.001	-3.3	.223	-2.2	5.6
1966-74	-1.9	.404	-3.8	.363	-0.6	.013	-3.3	.001	-1.4	.219	-0.5	5.3
1975-78	-1.0	.365	-3.4	.401	1.4	.018	-2.3	.001	8.1	.215	-1.2	6.2

TABLE B:33 OTHER COMMERCIAL SERVICES

	Factor	Capital		Labour		Energy		Raw Materials		Other Intermediate Inputs		Output
	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	Average Share	Productivity	
1962-78	-0.9	.169	-5.0	.171	-1.2	.011	-2.1	.064	2.1	.586	0.2	5.2
1962-65	-1.1	.160	-1.5	.145	-0.6	.009	-3.2	.074	-2.2	.612	-0.9	6.9
1966-74	-0.9	.169	-5.5	.167	-1.4	.010	-1.1	.066	2.7	.588	0.2	5.1
1975-78	-0.7	.177	-7.1	.202	-1.5	.015	-3.4	.053	5.3	.554	1.2	3.6

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