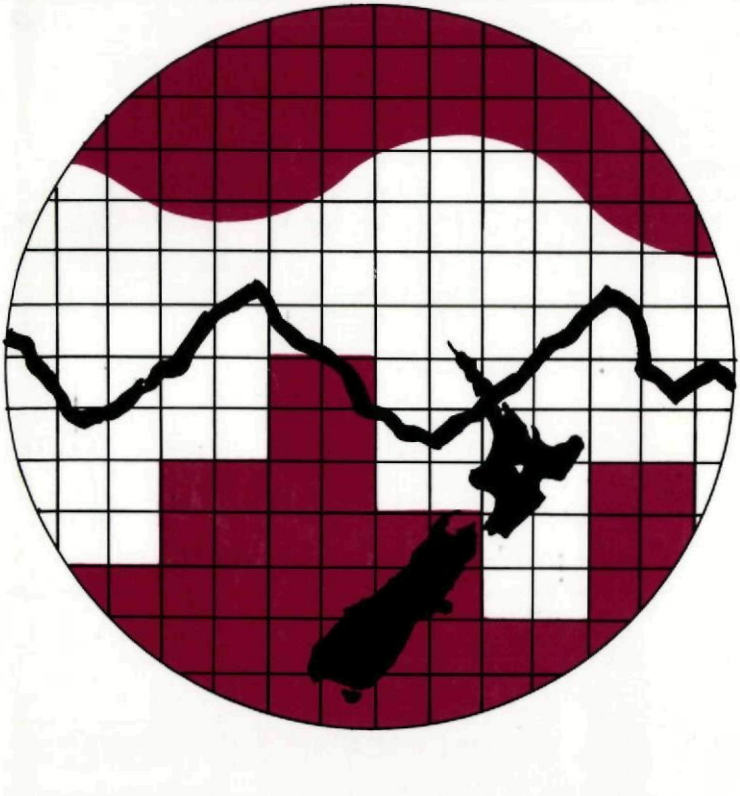
Productivity Trends & Cycles in New Zealand:

A Sectorial & Cyclical Analysis 1961-1987

Adrian Orr



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Contents

ABSTRACT

This study is part of the joint research programme on productivity with the Institute of Policy Studies, Victoria University, Wellington, for the Ministry of Commerce. Its objectives are:

i) estimates of sectoral productivity growth rates over recent years;
ii) plausible projections of future productivity movements by sector
iii) contribute an analysis of the proximate determinants of these productivity changes.

The first two tasks have been accomplished using two sources of data. One provided the basis for annual productivity measures of total factor, labour and capital productivity from 1960 to 1986. The other provided the basis for quarterly measures of productivity for the period 1977(2)-1987(4). Models of the trend and cyclical movements in these measures of productivity provided estimates of the future growth of productivity for the 22 S.N.A sectors of the New Zealand economy.

The final task was accomplished through a literature survey of the empirical techniques used internationally in analysing and accounting for productivity movements. A comparative analysis of OECD and New Zealand productivity movements over the past two decades is presented and potential areas for future research are detailed.

In detailing the determination of productivity movements in the economy, a summary of recent literature is presented. This literature predominantly relied upon 'growth accounting' techniques to explain fifty per cent of the movement in aggregate labour productivity in New Zealand. It is from this point that we propose further research, involving the analysis of 'supply' determined movements in productivity growth, with the use of the formal framework detailed by Bruno and Sachs (1984).

Our research has lead us to conclude that productivity growth has not followed **two distinct linear time trends**, that of pre and post 1973, as previous international and New Zealand literature imposes ex-ante. Instead productivity has moved in a long-term trend, with a

breakdown in the cyclical influence occuring in the mid-1970s. Again we indicate the direction future research should take to clarify this issue.

The report also makes preliminary in-roads into the effects of **inflation on productivity growth**. From this we conclude the direction of causality runs from inflation to productivity growth, with no evidence of 'feed-back' occuring. We indicate where future research should be undertaken to test not only this bivariate relationship but also the trivariate relationship between inflation, productivity growth and output.

Finally, indications of **future growth rates** in sectoral productivity are given via the provision of graphs and tables displaying annual average percentage changes in productivity (see appendix 3), enhanced by time series estimations of the cyclical movements in productivity. In doing this we highlight some of the perils that exist for future researchers in analysing data of this sort in the New Zealand context.

We stress that this report provides a very preliminary analysis of productivity movements and their determination. We provide a discussion of the issues involved with the measurement of productivity and conclude more research is necessary in the following areas: the measurement of output in the 'service' industries, and the measurement of the 'utilisation' rates of our stock variables- labour and capital.

The report is set out as follows:

Section I discusses the relevance and importance of sustained productivity growth. This takes the form of a literature survey and discussion of past trends and policy implications for New Zealand. This is highlighted with a comparison of New Zealands experience with that of the O.E.C.D.
Section II analyses the conceptual and technical problems researchers face when measuring and attempting to explain productivity growth movements. This leads into **Section III** which includes a discussion of the empirical techniques widely used to overcome the conceptual issues raised. This section is concluded with a discussion of past international estimations of productivity growth. Stressed in this

section is the split between structural and supply-side explanations and empirical techniques in explaning productivity movements.

Section IV introduces the competing sources of New Zealand data. Again, a discussion of the conceptual problems is raised. Presented in this section is annual data, at the 22 sector level, for the period 1961-1986, and quarterly data, at the 9 sector level, for the period 1977-1987. The section concludes with a brief discussion of some of the more unusual movements in productivity within specific sectors of the economy.

Section V briefly discusses and then empirically tests the direction of causality between inflation and productivity variability. Concluded in this section is that the direction of causality runs from inflation to productivity in the New Zealand manufacturing sector. That is, variations in price movements precede variations in productivity.

Section VI details the trend and cyclical components of productivity movements. Emphasis is placed on whether there exist two distinct linear time trends in productivity growth, that of pre and post the mid 1970s. This is formally tested and concluded that only one long run trend exists.

Finally, the monograph is completed with a brief discussion of the cyclical components of sectoral productivity movements, **Section VIII**, and a summary of our findings in **Section IX**.

SECTION I:

WHY ARE WE CONCERNED WITH PRODUCTIVITY GROWTH?

The growth of total factor productivity determines the scope for non-inflationary increases in real incomes, hence it provides a major source of change in the standard of living, as well as providing a source for the projection of GDP growth. For OECD countries as a whole, productivity growth rates have been falling during the past 15 to 20 years. They averaged 3% per annum from the mid 1960s to early 1970s, fell to just 0.5% per annum during 1973-1979, and have been slightly less than this since. Hence governments have become more concerned with promoting productivity growth in order to improve the potential for economic expansion without the threat of renewed inflationary pressure. Much debate exists however as to the causes of productivity slowdowns in OECD countries since the 1970s. Explanations range from '**structural**' (such as less innovation) to '**supply-side**' price explanations (such as the oil price shock in the early 1970s).

Total factor productivity is important since it represents the amount of extra output available for distribution between the providers of labour and capital. When total factor productivity grows, both owners of capital and labour can expect higher returns to their inputs. Hence, only by estimating the joint productivity trends of all inputs at the same time can the overall improvement in economic efficiency be gauged. When total factor productivity rises, growth rates rise, usually with wages responding only partially and often with a lag. Thus advances in productivity result in a fall in inflation. This allows more expansionary and less inflationary options to become available to policy makers, in turn leading to higher investment and lower unemployment.

In broad terms the OECD underwent at least two periods of economic change which have led us to our present position. Productivity growth started to decline prior to 1973 in most OECD countries. Some tentative reasons for this were posited by Nadiri 1970; Denison 1974; Norsworthy, Harper and Kunze 1979; Mooman 1987, these being summarised as;

-the 1960s was the end of the post-war reconstruction, hence the end of rapid economic expansion; this was coupled with a period of less expansionary world trade, as new markets had been established and barriers to free trade were rapidly being erected; there existed less scope for less developed countries to "catch-up" to the market leaders, such as occurred with Japans phenomenal growth in the 1950s and 1960s; and there have been agruements for the case that there is a slow-down in the pace of technical change.

These structural developments occurred simultaneously with rising real wages, creating disequilibrium in the labour market and fueling inflation, a break down in the relationship between a workers "marginal product" and real wage.

The mid and late 1970s saw a consolidation of the trend developing in productivity growth throughout the 1960s. Higher inflation was promoted with the commodity price hikes of 1973, coupled with generally accommodating government policy, creating an environment for falling capacity utilisation and declining investment. This had further ramifications for longer term productivity growth as expenditure on research and development dwindled. Much structural rigidity was also exposed within markets in the 1970s, which was initially hidden during the 1960s by high economic growth. These rigidities were reinforced with governments creating trade barriers and lessening competition.

Thus for the OECD as a whole, slow growth in the capital-labour ratio meant a larger fall in labour productivity compared to capital productivity, and an aging capital stock. The protectionist policies and structural rigidities of the 1970s are highlighted by the fact that productivity in the manufacturing sectors of the OECD economies generally grew at a more rapid pace than the non-tradeable sectors (OECD Outlook 1987), indicating international competition has been a stimulus for productivity growth.

The importance of structural factors are further highlighted by the fact that medium term total factor productivity developments tend to be more industry specific as opposed to country specific (Lindbeck 1983). Similar industries in different countries throughout the OECD have shown more of a uniform response to research and development, than have different industries in the same country.

This led to conclusions that the initial cause of productivity slowdowns in the 1970s was the lessened scope for further technology leaps. This could be a misleading statement, since a move from innovation in heavy industry to light high technology fields occurred during this period. This light technology is predominantly used in the service industries, where the least growth in productivity has been measured. Some possible scenarios as to why no service growth has been measured, as a result of the increased technology, are; measurement problems involved with the output of the service sector, that is, the difficulty involved with quantifying intangible output, this is discussed in more detail in the theoretical section; over investment in high technology hardware, which has not been matched with the software and 'user' training, constraining the technologies full advantages; and this technology may require longer periods of training in its use, which again slows the growth in measured productivity.

Generally however, countries whose capital stock has been growing the fastest, have higher economic growth rates (OECD 1987). Since investment is the vehicle to increasing capital stock, then slower investment leads to a downward spiral in productivity.

On the supply-side, the slowdown in productivity growth rates have been accounted for by the sharp energy price rises in 1973 and 1979. In a study of 19 OECD countries, Grubb, Jackman and Layard (1982) concluded stagflation was equally caused by rising relative import prices and the fall in productivity growth (New Zealand was included in the study). This study ignored the possibility that rising relative import costs could be the cause of slowing productivity growth, as indicated by Bruno and Sachs (1984). Using factor-price frontiers, they clarified the analogy of an increase in raw material prices being similar to a technological regression, attributing much of the slowdown in manufacturing productivity (in the U.S, U.K, Germany and Japan) to the rise in the relative price of raw materials. There is, however, considerable disagreement as to the validity of this argument. OECD (1987) research concluded that there is no 'energy price' effect in the bulk of the OECD countries. The reasons for this conclusion are stated as; the relatively small weight energy has in most OECD economies output and production; the present failure of recent falls in energy prices to produce total factor productivity reversals; ' and the diversity of the timing in movements of total factor productivity between countries.

The OECDs' study concluded that most structural changes relate to factors beyond economic control, these being predominantly social and political. Hence policies aimed at specific sectors or activities had little success in promoting productivity increases. They emphasised instead the importance of a "level playing field", that is, a push towards free trade amongst low inflation countries. This is hoped to be the necessary arena for steadily growing investment and increased research and development. New Zealand's present economic policies would seem to be consistent with this approach, with economic liberalisation and restructuring occurring. The chosen path to recovery is seen as fully taking aboard OECD policy, in the hope that 'x-efficiency' will improve markedly with the introduction of more competition.

The focus of these reforms is to increase productivity growth. Easton (1987) postulates New Zealands past poor performance may be a combination of two different factors; (a) GDP growth being consistently underestimated in a major way due to the difficulties involved in measuring changes in composition and quality of output, this is especially strong in the non-tradeable sector. Hence it is more a statistical aberration than an actuality, but is combined with; (b) Some sectors of the economy performing more poorly than others, and there international equivalents; assigning 20% of this poor performance to the tradeable sector, a result of little competition.

This second point has been fiercely debated, with some commentators, Easton (1980) claiming there are few allocative gains to be made from the elimination of protection in the manufacturing sector. This is coupled with the belief that the higher productivity gains in manufacturing may be attributed to high protection areas (Cambell 1980).

Using growth accounting techniques, described in section III of this paper, Easton (1987) finds very small "Solow-Denison" residuals, once the growth in capital and labour accumulation has been accounted for in productivity growth. That is, there is little evidence of technically induced productivity growth. The explanation offered is that, from the 1960 onwards, New Zealand did not stand to gain as much as other countries from the advance of new technologies or from copying international examples because of our market structure. New Zealands' markets were small-scale, limiting gains from "economies of scale". Also, most of the international improvement in productivity has come from the reduction of employment in low growth areas (such as peasant agriculture) and expansion of high growth areas (such as manufacturing). New Zealand was already at a high level of development in the agricultural sector and stood to gain less in this case. Philpott (1977) supports this, computing a "Solow-Dennison" residual of 3.0 for the agricultural sector during 1950-1970, and a negative residual for the period 1971-1976. The explanation offered by Philpott is that low investment in the early 1970s with less embodied technical progress occurring, increased farmer pessimism, especially as protection levels began to be threatened and EEC agriculture links became uncertain. This residual has grown since 1976 as a consequence of the horticultural expansion.

Productivity movements, in the New Zealand economy and internationally,can largely be explained by cyclical movements. The New Zealand business cycle, since the early 1960s up until the mid 1970s was characterised by troughs (recessions) of 3 to 4 quarters, followed by peaks (booms) of 4 to 8 quarters (Haywood 1978). This cycle changed for the 1975 - 1983 period, with peaks being 4 quarters long. This latter period coincides with the greatest economic growth and most marked stagnation in recent economic history. The cyclical expansions have historically been associated with rising exports, followed by a rise in investment. As demand expands with rising domestic incomes, so have imports, especially as capacity is reached. This has resulted in a draining of domestic liquidity, cutting off the boom, often reinforced by fiscal policy directed at protecting our balance of payments. Longer peaks have occurred when export demand is strong, with increased investment expanding domestic production capacity, and real exchange rate movements discouraging import penetration. This has not been the post-1986 model however, with high real exchange rates creating high levels of import penetration, undercutting our domestic manufacturing base.

Marks'(1984) explains 50% of New Zealands labour productivity movement with movements in the business cycle. Further emphasised in her study is the small role redistribution of resources has played in spurring productivity growth in New Zealand. Analysing the effect of intersectoral shifts in employment, Marks found there had been a net shift of employment from high to low productivity growth areas (services sector), but the net effect on total productivity was minimal, since all sectors productivity growth slowed in the 1970s.

Briefly, other factors analysed by Mark's as possible explanations for our poor productivity performance are:

The *capital-labour ratio*; this ratio grew faster for the period 1973-1979 than it did for the 1961-1974 period. This ratio is subject to countercyclical effects, with Mark's cyclically adjusted capital-labour ratio growing 1.21% per annum for 1961-1974 and 0.96% per annum 1975-1979. This is a reversal from the estimates gained from the raw data. Marks' found that for the period 1972-1979, only 0.08% of the labour productivity decline was attributable to movement in the capital-labour ratio. Doubt is cast upon these results however, since real gross capital formation fell 7.5% per annum for the period 1975-1979 and substantial falls in company profitability occurred during the same period (Horsfield and O'Dea 1983).

Labour force composition; by no longer assuming the labour force is a homogenous group, allowance can be made for some individuals being more productive than others. Human capital theory argues that an individuals' productivity is a function of their education and length of time spent in the labour force. Marks tested this hypothesis using census data for the periods 1960, 1971, 1976 and 1981. She concluded that the average skill level in the New Zealand population had only risen slightly and that the increase in female participation in the labour force had little affect on productivity. The change in the age distribution of the New Zealand workforce, with the proportion of older male workers (aged over 45 years) declining since 1971, also exerted a small negative effect on the average skill level.

Overall, the most prominent influence on the growth in productivity in New Zealand has been that of business cycle effects, explaining 50 per cent of the total variation in productivity growth from 1960-1984. The major gap in the analysis of productivity movements in New Zealand has been "supply-side" explanations, that is the role of inflation and supply-shocks. It is this issue we discuss in detail in later sections.

SECTION II :

THEORETICAL CONSIDERATIONSI

This section highlights some of the conceptual problems researchers encounter when measuring and analysisng productivity movements. The measurement and interpetation of 'productivity' behaviour at the microeconomic and macroeconomic levels requires the untangling of many complex factors. Productivity change being both the cause and the consequence of many dynamic forces in the economy such as institutional arrangements, the accumulation of human and physical capital and technical progress.

'Productivity' is often measured as the ratio of outputs to inputs, with as many indices of productivity as there are factors of production. The most commonly referred to productivity concepts being 'partial' productivity indices of labour and capital and the total or multifactor productivity index. The former concepts are usually measured as average products of labour or capital, wheras total factor productivity is output per unit of labour and capital combined.

These partial and total productivity measures are summarised as:

a) Partial Index

Average Product of Labour: $AP_L = Q/L$

Average Product of Capital $AP_K = Q/K$

where Q = Total Output L = Total Labour Input K = Total Capital Input

b) Total Factor Productivity Index: $AP_{KL} = Q/(wL + rK)$

where w and r are appropriate weights, usually the share of factor returns in total income.

Provided sufficient data were available, measurement of the marginal productivity of labour or capital would utilise a production function of the general form:

$$Q = AL^{z} K^{(1-z)} \qquad (1)$$

where: A = constant term, often written as : $A = Ae^{rt}$, to represent the effect of technology, with A representing a positive constant, e the natural e from mathematics, r the growth rate of technology and t time. The partial elasticities of output with respect to labour and capital are z and (1-z), respectively.

Dividing equation (1) by labour we gain Labour Productivity as specified:

$$Q/L = (AL^{z}K^{1-z})/L = A(K/L)^{1-z} \qquad (2)$$

Thus, labour productivity is determined by the level of technological development (A) and the degree of capital intensity, (K/L).

Total Factor Productivity is specified as:

$$Q/L^{z}K^{1-z} = A \qquad (3)$$

This represents the overall efficiency of an economy, reflecting such things as the allocation of resources, the diligence of labour, and the skill of management. The other determinant of labour productivity is the capital intensity -the amount of capital per worker.

The implications of these production relationships for the growth in labour productivity is:

$$d_{l}\ (Q/L) = d_{l}\ A + (1-z)\, d_{l}\ (K/L) \qquad (4)$$

Where d_l is the first difference operator. Any change in labour productivity can thus be broken down into a change in total factor productivity and a weighted change in capital intensity. Alternatively, the change in total factor productivity can be computed as the difference between the change in labour productivity and the change in capital intensity (weighted by capitals share in total output).

The partial derivative of output with respect to labour (z) (or capital (1-z)) gives us an estimate of the marginal productivity of additional units of labour (or capital) while allowing for changes in all the other factors in the production process.

The most commonly used measure in practice however is Kendrick's (1961) arithmetic measure. He implicitly assumes a homogeneous production function and the Euler condition to obtain:

$$\frac{dA}{A} = \frac{Q_1/Q_0}{(wL_1 + rK_1)/(wL_0 + rk_0)} - 1 \qquad (5)$$

Where w and r are the wage rate and the rate of return on capital respectively, these can change over time. Subscript 1 and 0 refer to the current and base period respectively. This is the method we adopt when considering total factor productivity.

Once we have assumed an aggregate production function exists and is specified accurately, and that the inputs are 'correctly' measured, we must then explain the movements in factor productivity. Separating these is an immense task, with two main factors usually the determinants of 'productivity'; *technical characteristics* and movements of *relative factor price changes.*

Technical change debates predominantly focus on:

i) the efficiency of production - and reducing unit costs.
ii) the scale of operation - emphasising economies and diseconomies that may arise due to scale changes.
iii) bias in technical change - whether greater savings are made in one input rather than another.
(v) the elasticity of substitution between factors of production and,
v) the homotheticity of the production function - that is, whether returns to scale are evenly distributed amongst the factors of production.

These characteristics are interdependent and can not easily be distinguished in practice and conceptually. For example, there is no agreement as to the definition of bias in technical change, with the Hicks definition measuring bias along a constant capital-labour ratio; the Harrod definition along a constant capital-output ratio and Solow's definition along a constant labour-output ratio. Furthermore, the technical characteristics do not remain constant overtime or over different productive units, raising problems of 'aggregation', discussed in the data section of this paper. The nature of *technical change* also highlights many problems in 'productivity' measurement. The bulk of the literature assumes technical change is autonomous, neutral and growing at a constant rate.

An important question is whether one can say apriori, that there exists an inherent labour-saving bias in technical progress or, that capital intensity is simply due to a substitution effect induced by the cheapening (relative to labour) of capital. It is claimed, however, that the observed labour-saving character of modern technology is more apparent than real, since capital is also saved, this often being underestimated due to poor capital stock measurement (Baily 1981).

Also, it is most unlikely to believe all technological change is determined outside the economic system. Considerable resources are devoted to research and development, with the production of knowledge and other forms of information accumulation being both highly durable and uncertain in its potential impact, as well as being subject to large economies of scale. Once information is produced, its long-run cost of transmission is almost zero (public good). The most important impediment to the diffusion of new techniques inter-firm is the existence of old capital stock, with strong complementarity among elements of the existing stock of capital goods making it difficult to replace only part of a plant.

Finally, the industrial structures of the different sectors of the economy will also be an important source for productivity changes. Productivity measures in one industry will be transmitted to other industries in the form of improved quality of materials or external economies, especially if these industries are tightly linked by input-output relationships. To analyse this we would need data on interindustry linkages (forward and backward) and account for the quality of material inputs.

SECTION III : EMPIRICAL TECHNIQUES AND RESULTS

Setting aside the 'conceptual' problems of productivity measurement we focus on various practical attempts to estimate factor productivity, using both aggregate production functions and 'growth accounting' techniques. This section also discusses explanations of both productivity movements and causes, assuming away incorrect measurement and the existence of the conceptual problems.

PRODUCTION FUNCTIONS

In principle, if all the inputs are correctly measured and the function governing their interaction is precisely specified, then any unexplained 'residual' should be near zero. This is dependent upon the correct specification of the production function and thus worthy of discussion.

The two-factor (capital and labour) Constant Elasticity of Substitution, (CES), production function is the most widely used, since it has the properties of the neo-classical production function and includes the Cobb-Douglas production function as a special case. The usual CES function is of the form:

$$Q = \gamma[\delta K^{-p} + (1-\delta)L^{-p}]^{-u/p}$$

where γ , δ, p and u are respectively, the parameters of efficiency (scaling), distribution, substitution and degree of returns of scale.

The average labour productivity depends on the capital intensity, K/L and the magnitudes of γ,δ,p and u. Nadiri (1970) shows the CES production function is highly sensitive to changes in the data, the measurement of variables and the estimation techniques. The point estimates of σ, the elasticity of substitution between capital (K) and labour (L) (being equal to $\sigma = 1/(1 + p)$) varies considerably for different sets of data, countries, industries and levels of aggregation, as well as being sensitive to cyclical fluctuations of demand. The only tentative conclusion being σ is usually below unity.

The major problems identified with using this approach for estimating and explaining productivity (Fellner *et al* 1966) are; the parameters of the production function often move together meaning their seperate effects can not be identified and estimation problems arise due to simultaneity and non-linearities existing between the production function and marginal productivity conditions.

Bodkin and Klein (1967) attempt to clarify which estimation technique of the production function is most efficient and are inconclusive, except to clearly establish the fact that the parameter estimates were very sensitive to different methods of estimation (such as ordinary least squares as opposed to two stage least squares estimation) and the specification of the production function.

GROWTH ACCOUNTING

This technique does not estimate production functions but instead uses them as an accounting framework to isolate the contribution of various factors to the growth in output. Denison (1974) pioneered this technique. His study of US productivity uses this approach to reduce the magnitude of the unexplained 'residual' to a pure technological progress effect, after making proper adjustments for labour force characteristics and the magnitude of capital and labour inputs. The approach can be summarised as:

$$dQ = u[\sum_{i=1}^{n} \alpha_i dx_i + \sum_{j=1}^{m} y_j + J]$$

where: dQ = growth rate of national income
- u = measure of economies of scale
- α_i = shares of factors represented by X_i
- y_j = growth rate of disequilibrium factors, adjustment factors due to sectoral misallocation of resources etc.
- dx_i is specified by such factors as, the changes in employment, level of inventories, non-residential land, quality of international assets etc.
- J is the residual left after the total contributions of dx_i and y_i are deducted from dQ.

The residual is interpreted as the change in productivity that cannot be attributed to capital accumulation directly, or other less directly measurable factors. The residual, which is usuallly attributed to 'advances in knowledge', accounted for more than half of the economic growth and increases in productivity in the US between 1948-1973.

This technique was applied by Marks(1984), in her analysis of factors contributing to NZ productivity growth, with similar results. Marks attempted to quantify seperately the contributions of : cyclical demand changes, changes in the labour force composition, the capital-labour ratio and the sectoral distribution of employment, to explain the post-1974 decline in labour productivity growth rates. The study implied that the mid-1970s aggregate cyclical downturn in the New Zealand economy accounted for approximately 50% of the observed decline in labour productivity growth rates in that period. The other factors were not found to have contributed significantly to the slowdown.

SOME RESULTS

General concensus amongst economists exists in the assigning of the slowdown in average labour productivity growth to the decline in the growth rate of total factor productivity, that is, developments other than changes in quantities of capital and labour used in production.

Structural

Baily (1981) interprets this as meaning either a) the rate of technical change is now slower than it was, or b) the effective flows of capital and labour services have grown more slowly than the measured quantities of these inputs. Baily assigns more weight to the latter, claiming that the rate of obsolescence of capital has increased due to the diversion of some part of capital saving expenditure to saving energy or product conversion. Hence, so long as normal rates of depreciation are assumed, capital investment appears as a growth in the capital stock as opposed to replacement investment. Thus, he claims, capital stock measures overstate the size of the capital service inputs to production. He concludes by indicating that investment may do more for productivity than conventional analysis suggests, with his estimation for the U.S being that the addition of one percent to the growth of the capital stock will add 0.42 percent to output and productivity growth. Unfortunately the investment data required to test this theory for New Zealand does not to our knowledge exist.

The role of economic cycles in the determinantion of productivity growth was emphasised by Dickens (1981), claiming that losses in productivity during an economic downswing (recession) are not recovered in an upswing. The permanent loss is explained by the losses in skilled labour through longterm unemployment and sunk human capital. Dickens claims that these losses account for most of the recent slowdown in productivity in the U.S. For the New Zealand case, although research has been undertaken analysisng the role of cyclical behavour in determining productivity movements, no one has attempted to identify the relative importance of losses in human capital and the extent of the 'permanent' loss incurred during an economic downswing.

Lindbeck (1983) attributes the slowdown of productivity to the longterm deterioration in the efficiency and flexibility of the 'basic' mechanisms of economic, social and political systems. This is partly due to the exposure of the major economies to unusually severe macro-economic disturbances in the 1970s and what is described as the fading of the uniquely favourable circumstances of the 1950s and 1960s, a long-term trend explanation. The major system changes are described as; the fall in profitability as a longterm trend, as international competition increased with more newly industrialised nations; a deterioration in the functioning of international markets, with inefficiency created due to high and variable inflation and finally; the slowdown in investment growth due to the slowdown in output growth. Lindbeck argues that the main effects on productivity growth of the relative price increase of raw materials are indirect, via capacity slack, slower output growth and capital accumulation.

Giersch and Walters (1983) observe for the U.S that the growth of labour productivity slowed down more than the growth of the capital-labour ratio. This is seen as support for Baily's hypothesis that the gross additions to capital have become less efficient. This arguement was not found to be significant in the New Zealand case, with Marks(1984) demonstrating that the decline of the capital-labour ratio was negligible in explaining the decline in labour productivity. These results were suprising since there was a dramatic decline (estimated at 7 percent per annum) in real gross capital formation from 1976-1981. Horsfield and O'Dea (1983) also cite evidence showing company profitability to have fallen steadily from 1974-1981, concluding that investment growth also suffered.

Giersch and Walters (1983) present a combination of the above arguments in a historical *acceleration-deceleration* framework. They claim that throughout the 1960s, an *acceleration* process was operating. Long-term investment in plant and equipment was being boosted by improvements in the relationship between expected profits and the real rate of return, predominantly due to: technological catchup, underpriced labour, economies of scale, specialisation and Keynesian style demand policies. This was enivitably unsustainable as the opporunuties for catchup became limited, coupled with world export growth declining in the early 1970s, energy supplies becoming limited in supply and often misleading accomodating monetary policies.

The matching real wage and productivity growth of the 1960s came to an end in the 1970s, with real wages remaining rigid and productivity growth falling. This *deceleration* period has led us into the early 1980s, with a swing in OECD economic thought seeing the implementation of non-accomodating monetary policy, creating high real interest rates, thus, warranting more efficient use of capital and wage restraint, in the aim of increasing productivity growth.

Relative Prices

Brunner, Cuikerman and Meltzer (1983) use a neoclassical framework in their analysis of stagflation (rising inflation and unemployment) to highlight many of the points Giersch and Walter raised. They show that stagflation can occur whether prices are set in an equlilibrium market fashion (neoclassical model) or without regard to any market conditions. Their theoretical analysis seperates the *permanent* from *transitory* changes to productivity that can result from supply shocks, with unemployment being a positive function of the gap between 'actual' productivity growth and the 'permanent' rate of productivity growth. Thus, if people perceive the permanent rate of productivity growth to be higher than the actual level, (after a supply shock has driven the actual growth rate down), they may refuse offers of employment at wages below what they believe should prevail, creating unemployment. If the economic shock is permanent, but perceived as transitory, the expected unemployment rate is positive and highest immediately after the decrease in permanent productivity, decreasing monotonically towards zero as the information about the productivity level accrues. The length of time this unemployment persists depends on the relative variances of the permanent and transitory shocks. Infrequent permanent shocks (such as the oil shock of 1973) lengthen the period of stagflation, as expectations are slower to adjust to the new permanent levels. Excess demand drives inflation in this scenario since output will fall with the impact of the economic shock but perceived real incomes remain at their previous higher levels until expectations adjust.

Bruno and Sachs(1984) follow on from the '**supply shock**' framework and use a **Factor Price Frontier (FPF)** to explain the post 1973 productivity growth slowdown registered in most O.E.C.D. countries. This framework has been developed due to discontent with the explanatory power of the growth accounting techniques, and the observation that the beginning of the productivity slowdown phenomena can be dated at 1973/4 for most OECD countries, with N.Z. being no exception (Bruno and Sachs 1984). This prompted the question, to what extent have the worldwide economic shocks of the 1970s been responsible for this phenomena. Bruno and Sachs link the major macro-economic shocks of the last fifteen years to those that have taken place in the real cost of the factors of production (real wages, real interest rates and the real cost of raw materials). An input price shock with full market clearing, causes a fall in output, productivity, real wages and real equity prices on impact, leading to a continued decline in the capital stock and output overtime. These effects will be further magnified with 'sticky' real wages, since investment is squeezed resulting in higher levels of unemployment. The oil price shocks are seen not only to cause factor substitution, but also set in motion contractionary forces on the demand side, and classical unemployment on the supply side.

Bruno and Sachs show that if profits are maximised and the factors of production are paid their real marginal products, then the **FPF** will represent the maximum rate of return that can be paid to capital for a given real wage, independent of the level of activity. As long as the technological options obey homogeneity, i.e. constant returns to scale, then there exists only one **FPF** summarising all there is to know about an economies level of technology and alternative factor rewards. For example, with a given lower real rate of interest, production, under profit maximisation, will take place with a higher capital/labour ratio, allowing a higher real wage to be paid. Likewise, in a system where the real wage may be the dominant force, a rise in real wages will lead to capital 'deepening' and a fall in the rate of profit. Any technology progress is seen as an outward move of the FPF, assuming it is 'neutral', namely both factor rewards rise in the same proportion. This is the equivalent to a proportional (homothetic) inward shift of a classical unit isoquant, that is, less of both capital and labour are needed to produce the same output. This technological progress is termed 'Hicks-neutral'.

Since the assumption of constant relative raw material prices is very restrictive and unrealistic historically, Bruno and Sachs developed the FPF to take explicit account of this and the change in the cost share. The analogy being, that an increase (decrease) in raw material prices cuts real income in a way that is analogous to negative (positive) technical progress on output in a two-factor world. Their conclusion, supported by U.K. data for the manufacturing sector, is that the interaction of depressed output levels (and greater output variability) with the direct effects of higher input prices will lead to the bulk of the explanation for the aggregate productivity slowdown.

In summary, with respect to New Zealand, the major work analysing productivity movements has focussed on 'growth accounting' techniques. This leaves a large gap in our understanding of the determinants of productivity movements. With New Zealand being a small and open economy it is susceptible to international economic events. Hence, the importance of relative prices and the role of exogonous economic shocks must be emphasised in their possible determination of productivity growth.

Perhaps it is from this point future research should begin.

SECTION IV :

THE NEW ZEALAND DATA; PRACTICAL AND CONCEPTUAL ISSUES

Annual and quarterly data is available for the study of sectoral productivity growth in New Zealand. The annual data is available for March years from 1961 until 1986, whilst a shorter consistent quarterly series exists for the period 1977(2)-1987(3). The data comes from two sources, both with severe shortcomings.

Annual Data:

The annual data heralds from the Research Project on Economic Planning, (P.E.P), Victoria University database and is used as the input to the PEP's macroeconomic input-output model. This annual data is disaggregated to 22 S.N.A sectors described in Appendix 1, with the PEP Internal Paper 184 (1985) explaining how the data is compiled.

The series deemed relevant for the productivity study are as follows:

1. Real Gross Output 1981/82 $ millions.
2. Real Net Output 1981/82 $millions.
3. Labour Employed (000's)
4. Real Capital Stock in plant and equipment, 1981/82 $million.
5. Total Real Capital Stock 1981/82 $ million.

From this data we can gain for all 22 sectors of the economy the following productivity measures:

a) Gross Labour Productivity:
   = Real gross Output/Numbers Employed
b) Net Labour Productivity:
   = Real Net Output/Numbers Employed
c) Gross Capital Productivity:
   = Real gross Output/Total (Plant and Equipment) Capital Stock
d) Net Capital Productivity
   = Real Net Output/Total (Plant and Equipment) Capital Stock

e) Total Factor Productivity
= Gross or Net Output/Capital (total or Plant and Equipment) plus Labour employed.

The importance of the distinction between 'gross' and 'net' output is that the latter has intermediate inputs removed. This enables us to measure the 'value-added' concept of output (commonly known as GDP), and avoid the problem of output rising in a sector purely due to more intermediate inputs as opposed to higher productivity. This issue is discussed in more detail later in this section.

The capital and labour series have been combined as indices using the normalised ratios of (a) compensation of employees/GDP and (b) operating surplus/GDP as the respective weights for labour and capital.

Strictly speaking, we are interested in the marginal product of labour or capital, i.e. the change in output that results from a unit change in one of these inputs. In a competitive system, the returns to these factors are equal to their marginal products, (marginal product of labour = wages), and the numerators of the above ratios would be the aggregated factor rewards. A major drawback of this approach is that it assumes that a given percentage increase in all inputs will increase output by that same percentage. This ignores issues such as 'increasing returns to scale', causing factor returns to rise more rapidly than factor inputs and the fact that the New Zealand economy is far from a perfectly competitive system. This problem means factor rewards are not equal to their marginal products, especially during periods of wage and price freezes. Thus, strictly speaking we are interested in 'marginals', but in practice we must content ourselves with 'averages'.

Some Problems Compiling the Annual Data

Capital Stock: The sectoral capital stock series were generated as follows. The starting figures for the capital stock at March 1960, were obtained from the following sources:

(i) Manufacturing sector, (SNA 5-13) Campbell's (1977) wealth stock estimates. These starting values are an estimation of the net stock of capital, valued at market prices. Two assumptions should be noted with regard to the valuation of the initial stock assets and the rate of capital consumption, depreciation rates. The initial valuation of the stock of assets was found to be very uncertain for plant and equipment, with the ratio of replacement cost to book valuation deviating greatly from that predicted by a simulation model. The result is Campbell's simulation model is seen to over-estimate the wealth stock (market value) measure, the over-estimation being greater for plant and equipment than for land and buildings. Campbell (1977) concludes that the assumptions incorporated in the simulations of plant and equipment assets do not accurately represent the behaviour of these stocks in real life, and in particular are unable to cope with the diversity of stocks subsumed into this overall category, hence there are large possibilities of error in the initial valuations of plant and equipment stocks.

(ii) For the service sectors, (SNA 16, 19 and 21-25), the plant and equipment and land and buildings figures for total services came from Philpott, B. and Lucus, H. (1979), and were apportioned separately using 0.32 (trade), 0.15 (finance), 0.05 (private services) and 0.48 (public services). These were calculated from the 1965/66 and 1971/72 input-output tables after allowing for the differing classifications, they were also weighted by the plant and equipment and land and buildings proportion for each sector.

(iii) Details of the starting values for the remaining sectors are in Philpott and Lucus (1979).

The relevant *price indices* for the investment goods series are from Shinawatra (1978) for the years up to 1976/77, these series are then updated to 1982/83 using the farm capital expenditure price index in the Monthly Abstract of Statistics. Further updating was accomplished using the relevant combined capital expenditure price index for plant and equipment and land and buildings, since the farm capital expenditure index was discontinued in 1983.

These indices are dubious since they come from three separate sources and are largely the combination of many indices, themselves difficult to accurately gauge. A major problem stems from the fact that frequent changes are being made to products, making pricing very difficult and also the lack of uniformity in the components being built into buyer specifications.

Finally, nominal gross investment series were taken from the SNA accounts from 1971/72 onwards, prior to this their sources were as for the capital stock series. The following procedure was used to create the capital stock series starting from 1960/61.

$$K_t = (1 - \delta) K_{t-1} + I_t$$

where: K = real value of capital stock at time t

I = real value of investment between time t and t-1, (Real fixed capital formulation)

δ = depreciation rate of existing capital stocks.

The major assumptions made to an already dubious starting position is that of the depreciation rates, fixed at 10% per annum for plant and equipment and 2% per annum for land and buildings, for all 22 sectors. These depreciation rates are very arbitrary and extremely difficult to gauge. It could be argued for example, that as the pace of technological change accelerates, the depreciation rates on plant and equipment, and to a lesser extent land and buildings, will be greater. The depreciation rates are also likely to differ greatly between sectors, with the service sector for example, having much higher depreciation rates (on computer equipment) than the farm sector (on tractors). Consequently, we are very uncertain as to the relevance of the capital stock series, but they are all we have.

A further problem with the capital stock is measuring its input into the production function, with capital's ability to perform services changing during its service life. This problem is not so extreme if we use the 'plant and equipment' stock as the denominator, rather than 'total capital' (including land and buildings) stock, since this by definition gives us a truer measure of 'productive' capital. The weighting system discussed earlier for combining capital and labour should further reduce this problem, assuming that the relative factor rewards are paid according to their marginal productivities.

This does not avoid the issue of 'utilisation' rates however, with no allowance being made for the number of hours capital is being employed. This utilisation rate will naturally fluctuate with demand pressure and in the long-run with technological change. Hence, we could be grossly overestimating the capital input into the production process.

Conceptual problems also exist within the analysis of capital stock figures (paralleled by labour), in that the capital stock is an aggregate of elements that are basically heterogeneous with divergent characteristics. They differ in their longevity, mobility, productive qualities and impermanence, with these heterogeneity properties often being the cause and consequence of technical progress in an economy. The problem of how to group these capital goods arises, the neoclassical answer being; that the necessary and sufficient conditions for grouping variables are (a) that the marginal rates of substitution between two types of capital be constant (perfect substitutes) and (b) that the rate of substitution between capital goods of different types be independent of the quantity of labour used with them. These two conditions should ensure the malleability characteristics of capital goods of the neoclassical production function. The contrary view (Robinson 1954) is that it is impossible to construct a quantity index of capital and that it is a value concept, affected by wages, interest rates and relative factor prices, unless we have an economy of one-type machine with no technical change. This is coupled with the technical fact that most machinery is complimentary, hence not perfect substitutes. The conclusion is that aggregation of such variables is a serious problem affecting the stability, magnitude and the dynamic changes of total factor productivity, hence caution is needed in interpreting any results.

Labour: The labour series were derived from the Labour Department estimates as published in the Labour and Employment Gazzette. From 1979/80 onwards these are intercensal estimates of labour employment, by industry, in February of each year (commencing 1980).

For the years 1971/72 to 1979/80, the Labour department's April and October survey estimates were used to obtain figures for yearly *growth* in employment. The weights 0.25, 0.5 and 0.25 were applied to the April, October and the following April to obtain the March year figures.

For the period prior to 1971/72 growth rates from an adjusted employment series discussed in PEP Internal paper 12(1975) were used to backcast the Labour department's 1971/72 figure. This procedure warranted the assumption of constant growth rates across all the nine manufacturing sectors. The intercensal figures used as the benchmark for the labour series includes all people working at least 20 hours per week in one and two person establishments for all sectors of the economy. This has an advantage over the Employment survey data used to backcast the series for the 1970s, which defines full-time employed as 30 hours per week or more in at least two people establishments. Unfortunately, however, the intercensal data ignores any concept of hours worked or the part-time labour force, these becoming very relevant in 'productivity' studies (with the rise of female participation in the workforce). What we are in effect measuring then is some average productivity of the stock of labour, which means the same criticisms apply as for capital with regard to 'utilisation' rates and aggregation, as well as severly underestimating the labour force with part-time workers rising in numbers. The problem is accentuated in sectors such as agriculture, where estimating the size of the labour force is extremely difficult, with families often being unregistered employees, with non-paid family workers rarely registered on the census data. The problem of undercoverage in the Employment Survey data is very important when related to the growing significance of part-time workers. The Labour Employment survey covers just over 80% of the census of population employment. The survey excludes the following:

(a) establishments with less than two workers and
(b) employment in agriculture, fishing, hunting and trapping, waterfront and seagoing work, domestic services in households and the armed forces.

The bulk of the undercoverage does not necessarily significantly bias growth rates in employment, but it can understate the labour productivity index. Since our data series uses the growth rates of the employment survey to backcast the intercensal employment series from 1980, a large proportion of undercoverage is avoided. Work, however, is presently being undertaken at the Reserve Bank of New Zealand (RBNZ) to create a series for total employment, consistent with the SNA Compensation of Employees aggregate, to gain an unbiased estimate of the wage rate per employee. (RBNZ Data Memorandum D84/7). Unfortunately again the resources are not available to us within this contract to re-estimate this data at the sectoral level and we are not guaranteed any significant gains in information at the annual level for so doing, since we have used the growth rates of the Employment Survey. The greatest weakness in our employment data exists prior to 1971/72, with the assumption of constant employment growth rates across the nine manufacturing sectors.

Output Measures: We must also be wary of the output measures used as the numerator in our productivity measures. The sources for these series are described in the PEP Internal Paper 184 (1985), and largely stem from the Monthly Abstract of Statistics (MAS) and PEP Internal Paper 106 (1981). The real net output (gross domestic product) series relies heavily upon the Department of Statistics growth rates prior to 1976/77, but uses the Aggregated Morgan Database (PEP Internal Paper 106 (1981)) estimates to obtain disaggregated data. The conceptual issues underlying the gross output measures are important, since gross output will fail to account for changes in other factors bearing on productivity, such as changes in the quantity or quality of investment or raw materials. Gross output can be increased simply by increasing the level or quality of intermediate goods and selling them with no change to the 'value-added' measure. Similarly, labour could be more productive without value-added or gross output changing, simply by maintaining the same output with less of one input, namely capital. This will often occur if for example labour-hoarding is practiced, in times of economic difficulty labour will be shed with little change to output, also when 'factor substitution' occurs, often due to changes in relative factor prices or technology.

A very important conceptual problem with the output data is dealing with the measurement of 'services' in a quantitative sense. Classical economists predominantly focussed on the production of goods, but since the times of Alfred Marshall it has been recognised that both goods and services satisfy the wants of consumers and that both should be included in the measurement of national production. Based on the product criterion, the services sector broadly comprises the rest of the business economy outside of the goods producing sectors. Their measurement is carried out often arbitrarily in the MAS National Accounts.

For example, the Finance sector's output is a volume index based upon deflated values of borrowing and lending, including numbers of debit and credit transactions and the deflated values of deposits received and withdrawn respectively. Education services are measured as an extrapolation by an index of pupil weeks taught in private schools. These measures often miss quality changes as well as changes in the nature of the service, for example, the increased diversity of the services offered in the banking sector. The problem is further accentuated with technological progress making these measurement techniques obsolete. We are left with two broad questions:

(i) What constitutes a service? The common definition is based on the intangible nature of the output. The problem arises that not all services are intangible, for example, buildings. The measurement of the services sectors output is hence left to the residual, being the productive units which are neither manufacturing or extractive industries. This is unsatisfactory when considering over two-thirds of New Zealands production is in the 'service' sector.

(ii) How do we measure the output of the service sector? As mentioned above, presently output measures are very arbitrary and examination of the output data will show this as obvious for the service sector. There has been demand (Haywood 1984) for the services to be split into four distinct groups for their measurements e.g.

- distribution (e.g. transport and storage)
- producers (e.g. banking and insurance)
- social (e.g. medical and education)
- personal (e.g. domestic and hotels).

These classifications are still problematic, for example, banks provide services to industry and individuals alike, with the services being regarded as intermediate consumption in the former case and final consumption in the latter. Hence, we can not easily define their output as final value-added or merely an intermediate input.

Also relevant to the measurement and analysis of the services sector is the fact that a significantly higher ratio of net to gross output exists in service industries compared to 'goods' producing industries. A smaller relative volume of intermediate product purchases exists, these being space rental and fuels, rather than raw materials and semi-finished goods or components. Hence, final output could be deflated without serious consequences as in the goods market as a measure of output. The lesser importance of intermediate inputs in services also means that less opportunity is available for productivity gains from product improvements made by suppliers. The income elasticity of demand is for most services is also higher than for most goods, and the price elasticity lower, which helps explain the stronger growth in the production of services than of goods in recent times.

A further problem arises when the concept of value-added in output is dependent not only on the levels of capital and labour employed, but also some exogenous factor, such as the weather. This is obviously important for agricultural output. The influences allow output to fluctuate irrespective of our measured factor inputs.

Quarterly Data

Of the 22 SNA sectors, there is a more aggregated quarterly series for labour, capital and value-added (gross domestic product), for 9 sectors of the economy.

The same conceptual problems exist for the quarterly data but we feel that the data is more reliable and consistent than the annual data. Quarterly employment data from the Quarterly Employment Survey (QES) exists from 1980 to 1988. The survey months are February, May, August and November. Prior to 1980, the survey data was bi-annual for the months April and October as detailed earlier in the annual data section. The February QES is a full coverage survey of over 70,000 establishments in all, employing over

80% of the total New Zealand workforce. The May, August and November surveys are sample surveys covering only 15,000 units, this is designed to produce estimates that closely proximate the full-survey results. Employment, hours and pre-tax pay earnings are collected for the paye week immediately preceding the survey date of 20th of each month respectively. The survey data as stated earlier has the definition of full-time employed being 30+ hours per week, part-time being less than 30 hours. From the data we set up labour data as follows:

Labour Numbers = Full-time employees + (0.5 x Part-time employees)
Labour Hours = Labour Numbers x (Average Ordinary + Overtime Paid Hours)

The use of the labour hours series allows us to gauge the 'factor utilisation' of the labour force rather than just measuring the stock of labour. The major drawbacks with the employment data are:

(a) It is not directly comparable with the annual data (as discussed in the annual section).
(b) The data only covers one survey week per quarter, and is inferior to an average of these measures over the quarter.
(c) The most significant drawback is the aggregation to nine sectors of the economy. This is further constrained due to our quarterly output measures being directly comparable to only four of these nine sectors (Manufacturing, Electricity, Gas and Water, Wholesale and Retail Trade and Construction).

The output measures are quarterly Gross Domestic Product indices (March 1982/82 = 100) from the MAS, for the period 1977(2) - 1987(3). These output measures are then aggregated for Forestry and Logging plus Mining and Quarrying (SNA = 2,3 and 4), Community and Personal Services, Finance and Insurance and Transport and Communications (SNA = 17, 18, 19, 21 and 24). This has meant a large information loss. For example, Financial Sector output and employment are known to have expanded rapidly in the 1980s. However, due to the aggregation of the output indices, it is combined with less expansionary sectors and the result is a rapidly expanding employment series and only moderately growing output series, hence the 'productivity' measure for the aggregated sector declines rapidly.

The capital stock series is simply the annual series described earlier, linearly interpolated between March years to give us a quarterly series. We feel this is not an unreasonable method since so little is known about the quarterly rate of capital accumulation. Again Labour and Capital have been combined using indices growth rates and the weighting system discussed earlier. Four quarterly productivity measures are presented here:

1) Gross Labour Productivity =GDP/Labour Numbers
2) Gross Labour Productivity (hours) =GDP/Labour Hours
3) Gross Capital Productivity =GDP/Capital Stock (Total and Plant and Equipment)
4) Total Productivity =GDP/Labour & Capital

(estimated separately for both labour numbers and hours and capital total and plant and equipment).

In the following sections, we refer only to the value-added concept of productivity for both the annual and quarterly data series discussions. We also use the labour-hours definition of labour whenever possible in our discussion of both labour and total factor productivity, i.e. in the case of the quarterly data.

Specific Data Anomalies

In tandem with the presentation of our annual and quarterly productivity measurements, coupled with our discussion of the trends and cyclical behaviour of the different sectors of the economy, it seems relevant that a brief discussion of some of the more radical data movements within these sectors are discussed. Often these, usually one-off occurrences, have drastically changed the estimate of underlying trends/cycles in the data, as the graphs (refer to appendix 3) of Food and Beverages, Textiles, Chemicals and Petroleum and to a lesser extent, Agriculture and Construction sectors indicate. This section highlights the problems associated with the interpretation of final outputs and intermediate inputs. When combined, productivity growth can change dramatically purely due to definitional issues, as opposed to structural change, distorting the final results.

Agricultural . The most noticeable movement in this series is the drastic fall in productivity during the years 1972-1974. This movement in productivity is due to the fall in the value-added measure. In this instance, value added falls dramatically during 1972-74 and again in 1977-1980. We relate this movement predominantly to the difficulty in defining **intermediate inputs** in the agricultural sector, and hence their sensitivity to policy changes. Real gross output throughout these two periods remained stable relative to value-added, with intermediate inputs rising dramatically between 1972-74 by 14% (a fall in value-added), and then falling dramatically in 1975 by -18% (a rise in value-added), only to rise by 18% in the following year. This highlights the difficulty of measuring productivity movements when using a value-added concept. For example, fertilizer can be registered either as an intermediate input or as a capital expenditure, raising the long-term productive stock of capital. Fertilizer production rose 22% and 23% per annum between the years 1971/2 and 1972/3 respectively, as a result of a subsidy of $5/tonne improved in mid 1970. Production then stabilised and fell dramatically by 28% in 1974, coinciding with the introduction of legislation ruling that the subsidy was only available for the first 30 tonnes. Fertilizer production rose 18% in the following year, during 1975, once further legislation was introduced, fixing fertilizer prices as at 30 July 1974.

Mining and Quarrying. The most notable movement in this sector was the steep fall in productivity (capital and total factor productivity) during 1975 - 1977, followed by a rapid rise in all three productivity measures post 1981. The first period is that of intensive capitalisation in this industry, which was due to the increased exploration activity in the Kapuni and Maui gas fields, off the coast of Taranaki. The latter period of rapidly increasing output and value added coincides with the introduction of the Huntly Coalmine. This discussion reflects the sensitive nature of the sectoral data base to single events in the New Zealand economy.

Food, Beverages and Tobacco. Value-added increased dramatically during the period 1972 - 1974. This we attribute to a price phenomenon, with dairy prices rising 65% 1971/2 and meat prices increasing by 29% in 1972/3. The deflator used for this series has failed to account for such large price movements and hence resulted in large real gains in value-added.

Textiles, Apparel and Leather also indicate a marked break in trend during the period 1972-1974, with value-added falling, whilst real gross output remained steadily growing. This is again attributable to movements in intermediate inputs. A rapid increase in the value of intermediate inputs, with wood prices increasing 100% were again not reflected in the deflator series, creating real increases of 25% and 19% for 1973/4 and 1974/5 respectively in intermediate consumption.

Wood and Wood Products display a marked increase in value-added during 1975/76, with a matching fall in 1976/77. This highlights the boom/bust period that the New Zealand construction sector was subject to, with the bulk of the domestic wood demand being met by diverting overseas exports. The graphical representation of productivity in the construction sector maps very closely to that of wood and wood products during this period.

The **Paper Products, Printing and Publishing** sector shows a marked drop in capital productivity post 1972, recovering again in 1978. This results from the increased capitalisation of the sector, with the introduction of pulp and paper mills in the late 1960s and early 1970s. The labour productivity graphs perhaps reflect a more accurate measure of productivity in this sector.

The final sector discussed in relation to unusual movements in productivity is the **Chemicals, Petroleum, Rubber and Plastic Industry**. The most obvious movement in the data is the massive fall in productivity, when measured using value-added as the numerator, in 1964. When using gross output as the numerator, our three productivity measures follow a stable trend throughout the entire period, with intermediate inputs causing the movements in productivity measurement. Coinciding with this fall in value-added in 1964 is the commissioning of the Marsden Point refinery. This saw real intermediate consumption leap 56% over the year, indicating definitional changes in the data. Crude Oil imports were registered as intermediate inputs, drastically altering value-added measures, as well as increasing the price deflator by 28%. The post 1980 fall in productivity in this sector is attributable to massive expansion of the capital stock, with the synfuels plant and other related projects dominating the 'Think Big' projects of the time. This is highlighted by the marked difference between our labour and capital productivity measures.

The above discussion is not definitive in explaining the sectoral movements in our presented annual productivity measures. They instead highlight the difficulty in measuring the concept of 'productivity'. A lot of the problem stems from the magnitude of our data base, enabling output in sectors to fluctuate simply by the introduction of a single new plant.

The other major problem is 'definitional', that is, separating accurately intermediate consumption from final output and investment, as highlighted in the agricultural and oil sectors.

Finally, problems can arise through the timing of these measures, with capital investment being registered during the construction of plant, with no increase in output. One-off leaps in output then occur once the new plant comes into use, such as the oil exploration industry, or more specifically Huntly coalmine and power station. Obviously a closer sectoral analysis is warranted than that of above, but it is hoped this discussion highlights some of the major problems associated with the measurement and interpretation of the data.

SECTION V:

INFLATION AND PRODUCTIVITY GROWTH

The **inflation-productivity** nexus, mentioned in passing in Mark's (1984) study, has not been closely examined in New Zealand. This is naturally tied into the Bruno and Sachs (1984) framework of input price shocks, but introduces other conceptual issues. Basically, high rates of inflation are thought to reduce 'productivity' by increasing uncertainty and reducing the information content of price signals.

The first issue of debate concerned with inflation is that of the direction of causality between inflation and productivity. Arguments supporting the direction of causality runs from **inflation to productivity** are the following:

Inflation creates a severe tax burden on the private sector due to non-neutral tax structures, with the value of depreciation allowances calculated on a historic cost basis being reduced, thereby distorting business behaviour. Furthermore, high inflation rates increase the 'noise' in price systems, making it more difficult to distinguish between relative price changes and absolute price changes. This increases the likelihood of businesses making incorrect production decisions and reduces operating efficiency. Also, high levels of inflation are usuallly associated with a high variance in inflation rates, creating more uncertainty about relative prices. This results in resources being diverted into activities directed at resolving the uncertainty as against raising productivity.

Counter arguments for the direction of causality to run from **productivity growth to inflation** stem from firms faced with a productivity decline, having few short-run options, they can either reduce nominal wages (unrealistic), increase their output prices (maintaining nominal wages and profits), squeeze their profits or contract their output by lowering labour inputs.

Of these options, increasing their output prices seems the most likely occurance, with all four options leading to a 'vicious circle' effect, resulting in further falls in productivity once '**feedback**' has occurred, making the identification of cause-effect difficult.

Jarret and Selody (1982) test the hypothesis that there exists a feedback relationship between inflation and labour productivity growth in Canada, with the conclusion that inflation increases explain almost all of the productivity slowdown in Canada. On the other hand, productivity changes only partially explained the increase in inflation. They expand the **bivariate** relationship that exists between inflation and productivity growth to a **trivariate** situation, of interaction between inflation, productivity and output. This stems from the observation that relative factor price shocks induce a substitution towards labour, reducing output per man-hour. If the 'supply shock' is accommodated by monetary authorities, a feed-back will then occur from inflation back to productivity growth. This **'supply-side'** story suggests employment growth is exogonous, with output growth and inflation following, and some feed-back occurring if inflation leads to relative price variability, and further falls in productivity.

The **'demand side'** story is that output growth is exogonous, (influenced by demand shocks), and employment growth and inflation follow. Hence demand shocks affect employment first and output with a lag. Employment in this case can be independent of output growth if labour hoarding occurs. Their concern as to the direction of causality in the trivariate case stems from previous conflicting results in econometric testing. Houthaker(1979) found a negative correlation between output growth and inflation, this being consistent with both the demand and supply shock scenarios, where a positive response of inflation and a negative response of output to relative factor price movements supports the supply side story, or it could reflect economies of scale, the demand side story. Blejer and Leiderman(1980) found that real output and employment were adversely affected by relative price variability, and Amihud (1981) found a positive association between employment and inflation, but independence between inflation and output.

Hence, Jarret and Selody attempt to identify the relationship between inflation, output and man-hour growth. They make use of the Granger and Sims(1972) technique to identify the direction of causality and find support for the supply-side explanation, indicating the strong role inflation has played in the slowdown of productivity growth. For the bivariate relationship between inflation and productivity growth, they estimate the implied multiplier associated with a one percent increase in inflation to be a 0.3 percent decline in the growth rate of productivity.

The trivariate relationship identified the inflation induced decline in productivity growth initially with the increase in man-hour growth and later reduced output growth. This analysis was extended to show that anticipated inflation figured more prominently than unanticipated inflation in explaining the fluctuations in productivity growth.

Using similar techniques, Clark(1982) investigated the timing of the relationship between inflation and productivity growth in the U.S. The conclusion being initially that the direction of causality in the *Granger* sense runs from prices to productivity and that almost all of the observed correlation between inflation and productivity growth is contemporaneous. If productivity increases in one quarter, prices fall in the same quarter and vice versa. He concludes that the simple causal model probably arises from the strong autocorrelation that allows past price differences to act as proxies for current prices. Since the economic explanations of prices causing productivity are all long-run, this result may indicate measurement error and the necessity of a more complete model explaining productivity movements. The only evidence that exists for N.Z. is presented by Dick (1982), analysing the impact of variability in rates of inflation on aggregate production and investment expenditures. No significant relationship was found between inflation variability and output or investment.

In this section, we test the **direction of 'causality'** between inflation and productivity growth in the New Zealand manufacturing sector, using our measure of labour productivity (as described in the data section) and the consumer price index.

We conclude that the direction of causality, in the Granger sense, runs from prices to productivity, with no evidence of 'feedback' occuring. Hence, variations in price movements precede productivity movements.

We endeavoured to test the direction of causality between inflation and productivity growth, with the use of a bivariate Granger causality test, applied to labour productivity (using the labour hours+working proprietors definition) in the manufacturing sector on a quarterly basis, through 1977(2)-1987(3).

The results displayed in **Table (4a)** are derived from the regressions of general form:

$$(1)\quad \ln(V/L)_t = \text{constant} + a\,\text{Time} + \sum_{s=1}^{4} C_s \ln(V/L)_{t-s} + \sum_{s=0}^{4} D_s P_{t-s} + e_t$$

$$(2)\quad \ln(V/L)_t = \text{constant} + \sum_{s=1}^{4} C_s \Delta_t \ln(V/L)_{t-s} + \sum_{s=0}^{4} D_s \Delta_t P_{t-s} + v_t$$

Where $\ln(V/L)_t$ is the log of labour productivity in the manufacturing sector at time t; P_t is the consumer price index at time t, and time is a time trend. We have used the consumer price index in order that the results remain comparable to the studies mentioned above, but acknowledge that the producer price index of inputs peculiar to this sector may be more technicallly correct.

If productivity is determined in a system that does not include prices, then given its own history, the history of P_t should not further help explain productivity movements. Thus an F-test of the null hypothesis that all coefficients $[D_s]$ are zero is a test of the hypothesis that prices do not 'cause' (or at least occur before) productivity. To test the proposition that productivity does not cause prices, the role of ln(V/L) and P_t in equations (1) and (2) can be reversed, hence an F-test of the null hypothesis that the coefficients $[C_s]$ are zero.

The results in Table (4a) clearly indicate the direction of causation runs from prices to productivity in the bivariate case. Prices have helped explain productivity, but productivity does not help explain prices. The "best" models, after dropping variables which were insignificant at the 5 percent level from the equation (equations 5-8) further highlights this.

This conclusion is reinforced when the model is estimated in first differences, with price changes being significant in the determination of productivity movements (equations 3 and 7) but the converse not holding (equations 4 and 8). We are left to conclude that the arguments postured above supporting the hypothesis that inflation, or at least variations in price movements, **precede** variations in productivity, outweigh those arguements to the contrary for the case of the New Zealand manufacturing sector. Further research is warranted to consolidate this conclusion, since at present we indicate the direction of causality, but do not formally test any causal model (e.g. a model analysing the effect of variable prices on output). It is also be important to run the same causation tests using the output prices from the sector (manufacturing) concerned, as opposed to a general rate of inflation. This will avoid the possibility of the results being distorted due to exogonous price movements. It is, however, from this point that future research should begin, either estimating a factor-price frontier for NZ in order to test the effect of relative import price movements on productivity growth, or, developing a general model to test the trivariate relationship between prices, output and productivity growth.

SECTION VI:

ESTIMATING THE TREND ANNUAL RATE OF GROWTH OF PRODUCTIVITY

Marks' (1984) study of labour productivity in New Zealand estimated trend/cycle regressions for the period 1961-1974. One of the purposes was to evaluate the influence on New Zealand productivity growth decline after 1974. The apriori assumption being that the set of factors which caused the post 1974 decline in labour productivity simultaneously caused a fall in capacity utilisation and labour productivity growth rates. The split date of 1974 was supported by a Chow test, indicating structural change in the data

The contention that secular productivity growth is composed of distinct linear trends, pre and post 1974, has met little opposition. One of the few objections in the literature to assuming, apriori, distinct time trends is Nordhaus (1979), who suggests that a downward trend in productivity growth in the US may have characterised most of the postwar period, and that the process had none of the distinct breaks that subperiod analysis seems to show. The gradual slowdown is assigned to the depletion of resources and 'great' inventions.

Hence, both the existence and starting points of these trends are very important to the study of productivity. If distinct time trends exist, then researchers examining the cause of productivity slowdowns must look for events that could cause structural shifts in the productivity relationship at the point of the time break. If structural shifts have not occurred and separate phases are imposed ex-ante, or if separate phases are imposed ex-ante at the wrong point in time, the results of the analysis may be seriously biased. Thus, much of the debate on the cause of the productivity slowdown may be wrong due to the arbitrary dating of the slowdowns and hence the arbitrary dating of the causal factors.

In view of Nordhaus's comment about the possibility of a continuous and gradual slowdown in productivity, as opposed to one-time events that cause structural breaks, we test the validity of non-linear trends. Recursive Chow tests, with no apriori assumptions about the possible existence of structural changes overtime, are used to test for structural instability. This is superior to the adhoc procedures employed in previous New Zealand productivity analysis, where apriori, a date is chosen as to when the structural break may have occurred and then tested for.

Before these tests can be employed, a model of secular productivity growth should be specified and estimated. This means the cyclical component in measured productivity must be empirically removed, otherwise an unusually large cyclical movement may be mistaken for a 'structural' break.

CYCLICAL FACTORS:

It is well established empirically that both labour and total factor productivity growth vary with the business cycle, accelerating in booms and stalling in slumps. There is though disagreement (Hall 1987) about the causal relation between output fluctuations and productivity growth. Some view productivity growth as the prime moving force of the entire economy (the real business-cycle school), others conclude that causality runs in the opposite direction, with labour and other factors being able to produce more output per unit of input when demand is strong.

A simple explanation of cyclical movements in labour productivity was given by Oi (1962), arguing that labour is a semi-fixed factor of production. In a recession, employers hoard labour, rather than laying them off. This will occur due to the fixed costs associated with hiring and firing labour. It follows then, that the number of workers employed in a particular firm will be less sensitive to changes in demand conditions than output, thus the ratio of output to labour employed will vary. The same scenario is perhaps even more compelling for capital. Capacity utilisation of capital changes with the business cycle as firms resist scrapping existing capital during recessions and whilst long delays exist in putting into place new capital stock in times of economic upswings. Dickens (1982) claims that productivity is permanently lost during business cycle downturns, and states that once this loss is taken into account, there is little or nothing left to be explained by secular movements.

The traditional approach for cyclically adjusting labour productivity is the labour-hoarding approach. The starting point is a Cobb-Douglas production function. A relationship is postulated between potential man-hours and actual man-hours, and total capital services and utilised capital services. An estimable equation is then formed that expresses the log of the output per factor input as a function of labour market conditions, a time trend and possible dummy variables to account for shifts in the trend. The unemployment rate indicates the labour market condition, specifying the divergence of the actual employment rate from potential full employment.

A simple linear time trend, T, and possibly a second, time squared, T^2, (to account for productivity growing at a decreasing rate), can be added. Haywood (1978) regressed average labour productivity against time and the rate of registered unemployed for N.Z. over the period 1964 -1978 and found, surprisingly, cyclical effects to be statistically insignificant. It was later shown by Braae and Gallacher (1983) that the registered rate of unemployment is a poor proxy for the number of people seeking work, and hence a poor cyclical indicator of excess capacity

We adopt Marks (1984) procedure by using the NZIER's measure of capacity utilisation, based on the QSBO. The results of this exercise allows us to create cyclically adjusted measures of productivity, by subtracting the cylical component, as measured by the capacity utilisation variable, from the unadjusted productivity measure.

We have estimated log linear models of labour, capital and total factor productivity for the annual data, 1962 - 1986, for all 22 SNA sectors of the economy. The log of productivity was regressed against a number of time variables and the log of capacity utilisation. Independent variables with coefficients insignificantly different from zero at the 5 percent significance level were dropped from the regression, with the results being reported in Table 1a.

A brief discussion of the capacity utilisation variable obtained from QSBO is perhaps useful before analysing the results. The measure of capacity utilisation, here after called CUBO, is constructed from data supplied by manufacturers and builders, avoiding the problems involved with specifying production functions in order to differentiate potential from actual output, in the more traditional fashion, (for example, the Reserve Bank of New Zealand's measure, defined to equal the ratio of actual to normal private sector output).

The data collected by QSBO and used to construct CUBO gives the percentage increase in output that is possible for QSBO respondents to achieve without raising their unit production costs. Defining the medium percentage values of these data to be m, the medium percentage level of capacity utilisation equals 1/1 + m, Kay (1983) gives full details of this construction. CUBO has, however,been demonstrated to be a biased measure of capacity utilisation, see Wells (1983), and further problems are caused by the fact that data used to construct it are not weighted by firm size. However, CUBO is favoured as it avoids the problems associated with the use of a possibly misspecified production function.

Unfortunately we are restricted to using the one cyclical indicator for all 22 sectors of the economy. If any sector should display a business cycle different to that in aggregate we will not be adequately isolating the cycle in that sectors productivity growth. Again, data and time limitations have meant we must persist in this fashion, however the results are still interesting in terms of which sectors indicated cyclical variation similar to CUBO. The cyclically adjusted data for total labour, capital and total factor productivity can be seen in table (1). The regressions have been estimated over the full period, 1962 - 1986, as opposed to ex-ante imposing a sample split in 1974.

Graphs of the actual versus the fitted data from the models are also presented in appendix 3 for all of the 22 sectors, combined with the growth rate of actual and trend (secular and cyclical) productivity, again for labour, capital and total factor productivity.

The final regressions for total, labour and capital productivity can be seen for the 22 sectors in the appendix also. The three regressions for the total economy are as follows:

Table (1):Cyclical Regressions (1963-1986)

(1) **Total Factor Productivity**

$$\ln[V/L + K] = -0.024 + 0.0053\ \text{Time} + 0.33 \ln \text{CUBO}$$
$$\quad (-0.67) \quad (2.98) \quad (2.46)$$

$\hat{p} = 0.73$ (4.5) $\quad R^2 = 0.86 \quad SSE = 0.0053$

(2) **Labour Productivity**

$$\ln[V/L] = -0.12 + 0.008\ \text{Time} + 0.28 \ln \text{CUBO}$$
$$\quad (-4.01) \quad (5.7) \quad (2.5)$$

$\hat{p} = 0.68$ (4.44) $\quad R^2 = 0.96 \quad SSE = 0.003$

(3) **Capital Productivity**

$$\ln[V/K] = 0.2 - 0.004\ \text{Time} + 0.47 \ln \text{CUBO}$$
$$\quad (5.18) \quad (-2.63) \quad (3.09)$$

$\hat{p} = 0.69$ (5.06) $\quad R^2 = 0.85 \quad SSE = 0.006$

Figures in parenthesis are t-statistics
$\hat{p}$ = First order serial correlation coefficient.

All three measures of productivity show strong procyclical movements, with a one percent increase in capacity utilisation resulting in a 0.33, 0.28 and 0.47 percent increase in total factor, labour and capital productivity respectively.

These results differ significantly from Marks (1984) results, estimated over the shorter 1961-1974 period. She obtained a coefficient of 0.72 on ln CUBO in a comparable labour productivity model. A regression using our annual data but estimated over the same time period as Marks is presented:

Labour Productivity 1963 - 1974

$$\ln [V/L] = -0.12 + 0.011 \text{ Time} + 0.57 \ln \text{CUBO}$$
$$(-4.84) \quad (11.02) \quad (2.74)$$

$$R^2 = 0.93 \qquad SSE = 0.001$$

The coefficient on the cyclical variable over this shorter time period is significantly larger than over the full 1963-1986 period, indicating a stronger cyclical influence throughout the 1960s (although lower than Marks estimated). A possible indication of a structural change occurring in productivity between the two-periods. As to exactly when this occurred is still uncertain however. This is evaluated in the second section of this discussion. Capital productivity shows the strongest cyclical movement of our three productivity measures, indicating its rigidity, with movements in this measure being dominated by the numerator.

The time trend is significant in all three regressions, with the time trend in the capital productivity model being of similar magnitude, but of opposite sign to that of the other productivity measures. The time coefficient in the capital productivity function is positive for the period 1962-1968, and then insignificant up until 1979. Post 1979, the coefficient on the time trend becomes significantly negative. This perhaps coincides with the implementation of the 'Think Big' projects of the early 1980s, with the capital stock series increasing, without any comparable increase in output, especially during the implementation stages. This is however not clear, as the graph of capital productivity indicates a marked fall in the level of productivity dated back to 1975. What we are perhaps witnessing is a fall in domestic value-added, whilst New Zealands' capital stock continues to expand, thus the coefficient on this time trend for the whole period must be treated with caution. A closer examination of the split in this series is conducted in the next section.

The annual average growth rate of total capital productivity fell 0.28 percent during the period 1963-1974, once **cyclically adjusted**. This reversed by 0.45 percent for the period 1975-1986, with the annual average growth rate in total factor productivity increasing from 0.12% to 0.57% once adjusted for the cycle. For the period 1980-1986, only a slight decline in total factor productivity occurred once the cyclical influence was removed, with the annual average growth rate falling from 1.77% to 1.62%.

The most interesting period of all is 1984-1986, during which the largest increases in total factor productivity occurred in the annual data. This registered a marked fall of 0.5 percent once decycled, falling from an annual average growth rate of 2.21% to 1.78%, approximately one-quarter of the increase in total factor productivity in the period 1984 to 1986 being attributable to cyclical affects.

In summary, for the periods 1961-1974, and 1984-1986, cyclical effects accounted for approximately one quarter of the growth in total factor productivity, whilst for the period 1975 - 1984, the cyclical effects account for nearly 80 percent of the fall in total factor productivity. For the period as a whole, 1963-1986, the annual average growth rates for our three productivity measures differ very little once the cycle is accounted for. Indicating productivity gains in an economic upswing are accounted for during a recession, balancing out in the long-run.

Table (2) displays actual and cyclically adjusted rates of change for our three productivity variables in total.

Table (2): Annual Average Percentage Rates of Productivity Growth

	Total		Labour		Capital	
	Actual	Adj	Actual	Adj	Actual	Adj
1963-1974	1.30	1.02	1.68	1.48	0.79	0.42
1975-1986	0.12	0.57	0.63	1.25	-0.87	-0.55
1980-1986	1.77	1.62	2.51	2.27	0.59	0.53
1984-1986	2.21	1.78	3.28	3.02	0.70	0.08
1963-1986	0.74	0.76	1.27	1.29	-0.2	-0.15

Where; Adj refers to the series once the cyclical component has been removed.

All three measures follow the same pattern throughout the periods specified, with a marked fall in productivity for the post 1974 period. As Marks (1984) comments, since 1974, levels of capacity utilisation and rates of GDP growth have been lower on average than those experienced in the earlier period. Thus firms have had longer to adjust the size of the labour force and capital endowment to the reduced growth in output. Hence, these cyclically adjusted productivity growth rates may be biased upwards.

SECTION VII:

TESTS FOR STRUCTURAL STABILITY

As already indicated, the question of shifts in the secular growth rate of productivity is an important issue. In international literature, shift terms in the mid 1960s and early 1970s generally appear in productivity studies based on ex-ante presumptions (Nordhaus 1979).

In this section, we present a statistical method to test for structural stability of the regression equations for total factor, labour and capital productivity, over time. The method assumes no prior knowledge as to where possible structural changes occur, but instead lets the data determine when the structure switchs. This is preferred to the adhoc method of simply imposing shift terms at predetermined dates.

The method used is that of recursive Chow tests, searching for a date when the structural change in productivity may occur. Initially we estimate the model over the full sample period 1963-1986, for our three productivity measures, as described in the previous section. We then re-estimate the same equations keeping the initial starting point for the time series, but adjusting the end period, shifting this progressively from 1970 back out to 1986. In each period a Chow test is conducted to indicate when it passes or fails (indicating a structural change does or does not occur respectively).

In the case of *total factor productivity*, the model was initially estimated over the period 1962-1986. The model, as described earlier, failed a Chow test when split from 1974 and annually until 1979, with estimation dates post 1979 all passing the specification test. We then reestimated the model over the period 1962-1981, and split the data beginning in 1972 for recursive Chow tests, this model failed all of the specification tests up until 1980. This led us to the conclusion that Marks' (1984) arbitrary splitting of the data in 1974 was misleading, in the sense that the model estimated over this time period would have failed the Chow test at any period in time post 1972, an indication of an unstable model.

The only periods for which we could create stable models were for 1962-1976, and then 1977-1986, indicating that for total factor productivity, the structural shift occurred in 1977 as opposed to 1973/4 for New Zealand. The coefficient most affected in the model is that of the cyclical variable (ln CUBO). The coefficient on this variable is approximately 0.7 for models pre 1973, falling to 0.62 for the period 1974-1978. This indicating that cyclical influences played a smaller role in productivity growth during the mid 1970s.

The conclusion is very similar for *labour productivity*. The model is initially estimated over the period 1962-1984. Chow tests indicate structural breaks initially in 1973/4, with a significantly different structure for the period 1975-1979. Once the model was estimated over the period 1962- post 1979, the parameters became stable. These results lead us to believe that apart from the year of 1973, the major structural change in cyclical patterns of labour productivity became evident in 1975, lasting until 1979. Again the coefficient most affected is that for the cyclical variable, falling from approximately 0.65 to 0.55 for the periods 1973 and 1975-1978, again indicating a much weaker cyclical influence throughout this period.

Similar tests for *capital productivity* indicate a structural break in the trend rate of productivity for the period 1974-1977, slightly earlier than that for labour and total factor productivity. The coefficient on the cyclical variable (ln CUBO) falling from 0.7 to 0.65 during this period.

In summary, our three productivity measures showed similar patterns of cyclical behaviour over the time period analysed. Hence, there seems to be a breakdown of the cyclical model for the period 1975-1978 for both labour and total factor productivity. The structural change occurrs in the period 1974-1977 for capital productivity. In all three cases, the coefficient on the cyclical variable (ln CUBO) dropped in size significantly, suggesting a temporary collapse in the cyclical influence during the mid-1970s, as opposed to a permanent structural change in the trend rate of growth in productivity.

These are tentative conclusions and a more sophisticated support test is warranted to confirm these conclusions. Blakemore and Schlagenhauf (1983) suggest the use of 'switching' regression techniques. Again this is a test as to whether the parameters of the functional system given by the regression lines are constant, or whether the time series can be subdivided into two (or more) regimes. This would indicate whether the regime changes we have indicated through the Chow statistics are correct, supported by the use of likelihood ratio tests, first suggested by Quandt (1960).

From this, we conclude that the arbitrary splitting of sample periods when estimating trend/cyclical models of productivity can be misleading. There does not appear to be two distinct linear time trends in productivity measurements for New Zealand, instead the tests indicate a 3 to 4 year period when the business cycle is interrupted in its determination of productivity growth. This indicates that the model of productivity growth is not fully specified, and that some other variables must be added in order to account for the productivity changes in this period 1974-1978. Again due to time constraints, further testing of structural shifts in productivity growth and the specification of a more complete model of productivity growth could not be implimented. A possible explanation for the shift in productivity behaviour in relation to the cycle could be the massive change in relative prices generated by the oil price hikes. This highlighting the need to futher empirically test for relative price effects, perhaps estimating factor price frontiers as described by Bruno and Sachs 1984.

SECTION VIII:

SECTORAL ANALYSIS OF ANNUAL AND QUARTERLY PRODUCTIVITY GROWTH

Annual data is available for the 22 SNA sectors covering the period 1961-1986. Quarterly data is available for sectoral analysis, but over a shorter time period 1977(2) to 1987(4) from which we can also estimate labour, capital and total productivity. The labour series includes both part-time workers and hours worked, as described in the data section, but uses the linearly interpolated capital stock series from the P.E.P. data base, which unfortunately finishes in 1986 (1). Hence, only labour productivity exists up until 1987 (4).

As previously mentioned, we were restricted to using a common aggregate cyclical variable to adjust for the business cycle in all 22 sectors. This, however, allowed a pattern to be developed between our three measures of productivity for the annual data. Table (3) outlines the sectors in which a statistically significant cyclical influence was found (the full set of sectoral productivity functions are listed in Table 1a of the appendix). There is very little obvious overlap in significant coefficients between sectors for our three measures of factor productivity. Total factor and labour productivity have significant cyclical influences in the transport sector only, whilst total factor and capital productivity are significant in both the wood and wood products and electricity, gas and water sectors. The remaining sectors showed no sign of cyclical movement in productivity, with the majority of these being described simply by some quadratic function of time.

Table (3) Sectors Influenced by Cyclical Trends (CUBO)

	Capital Productivity	Labour Productivity	Total Productivity
Wood & Wood Prods.	*		*
Electricity, Gas and Water	*		*
Trade, Restaurants and Hotels		*	*
Finance, Insurance and Real Estate		*	*
Basic and Fabricated Metal		*	*
Transport	*	*	

* indicates when cyclical variation is significant, as displayed by ln CUBO.

Evidence of no cyclical effect may indicate the 'isolation' of the sector to movements in the economy as a whole, or that the CUBO variable is not a suitable aggregate cyclical variable, or even that cycles in certain sectors are quite different.

The service sector for all three measures of productivity were best descibed as negatively sloping linear time trends. This highlighted the expansion of the sector in terms of inputs, but not coupled with tangibly measured outputs. It remains unclear as to whether this is more a problem in the measurement of services. Some possible explanations for the absence of cyclical effects in many of the SNA sectors are:

(1) These sectors are, or have been, sheltered from competition in the past, as perhaps the agricultural and service sectors in the recent past.

(2) Some sectors' output moves irrespective of cycles, instead being determined by technological 'breakthroughs' (e.g. the mining industry in the 1980s) or due to direct government

intervention expanding capital stock (e.g. the chemicals, petroleum, rubber and plastics sector were all influenced by 'Think Big' projects and the introduction of the Marsden Point refinery in the early 1960s).

(3) The size of these sectors, in absolute terms, is small enough for movements in output to be radically changed simply with the introduction of a new production unit. This is supported by the fact that with the exclusion of the wood and wood products and electricity gas and water sectors, all of the sectors showing significant cyclical influences in their productivity movements were in the top seven when ranked according to real net output as a percentage of the economies total output.

A fuller analysis at the sectoral level is needed to ascertain whether productivity movements, as seen in the graphs, are actual structural shifts, invalidating some of the 'decycling' models. The coefficients on our cyclical variable, when significant, range between 0.37 and 1.65, indicating a wide variation in inter-sectoral reaction to economic cycles. The transport and the wood and wood products sectors show the greatest cyclical variation, with a one percent change in CUBO causing a 1.9 and 1.6 percent change in total factor and capital productivity respectively in the wood and wood product sector, and a 1.20 and 1.34 percentage change in labour and capital productivity in the transport sector. A very large coefficient of 3.56 was found for ln CUBO for the combined basic and fabricated metals sectors' labour productivity. This coefficient implies very high cyclical variation and could be misleading if CUBO is not proxying cyclical variation for this sector.

In summary, from our initial models for total labour, capital and total factor productivity, we see that when the 22 sectors are aggregated, the cyclical variable becomes very important, indicating that those sectors influenced by cyclical movements outweigh the others once aggregated. A further area of research determining each sectors weight in total productivity movement is warranted. Hall(1987) notes that total productivity in the US is biased towards being procyclical when there is 'market power', that is, when an industry has the ability to mark-up prices above their marginal costs, rejecting the real business cycle model. He goes on to show that once the 'market power' is accounted for, productivity shifts are still quite cyclical. This analysis decomposes total productivity growth by industry, for productivity growth computations that take account of market power, with the result that, 75% of the variation in total productivity comes from manufacturing and trade combined. It is important to note that aggregate productivity is much less procyclical when the adjustment for market power is made, the coefficient from the regression of aggregate productivity growth on aggregate output growth fell from 0.375 to 0.188 once the adjustment was made in the US.

The adjustments discussed in Halls' paper would be relevant in New Zealand's context to fully understand which sectors drive productivity growth and to more accurately assess true movements in productivity. It is highly likely in New Zealand that price mark-ups above marginal costs are prevalant in recent history, hence any productivity measures constructed under perfect competition assumptions, as ours are, overstate productivity gains in an economic upswing, and understates productivity growth in a slump.

Another simple but interesting task to complete is that of updating Mark's (1984) sectoral analysis. This was an attempt to quantify the effect of sectoral shifts in employment and capital stock an aggregate factor productivity growth rates. This is conducted by comparing these growth rates with a constant weight labour, capital and total factor productivity index, i.e. the constant weight index in year t,

$$LP^*_t = {}_{i=1} W_i LP_{it}$$

where: W_i = factor share of sector i in year t
LP_{it} = factor productivity for sector i in year t.

Thus we can isolate changes in aggregate factor productivity that are due to changes in W_i or LP_i. Whenever LP_t grows faster (slower) than actual aggregate factor productivity, we can say there has been a movement in factors (capital and labour) from high (low) to low (high) productivity growth sectors. Marks (1984) showed that for the period 1961-1981, labour had shifted from high to low productivity growth areas. This exercise would also help determine the extent of factor substitution between labour and capital during this time period.

QUARTERLY DATA : A BRIEF ANALYSIS

Presented, as discussed in the data section of this paper, are competing measures of labour productivity as well as capital and total factor productivity for the period 1977(2) to 1987(3).

We are able to present a labour productivity measure which includes the measurement of 'labour hours worked', a 'capacity' measure of labour use. This has enabled us to quickly test the hypothesis as to whether, employers use labour hours as a means of varying labour inputs in response to cyclical changes. If this is true, one would observe less cyclical variation in labour productivity growth when using labour input defined to include 'hours worked' as the denominator.

The regressions for the nine quarterly sectors displayed in Table (2a), support this hypothesis for the Manufacturing, Trade, Restaurants and Hotels, Finance, Real Estate and Insurance, and finally Personal and Community Services sector of the economy. The smaller values of capacity utilisation coefficients in these equations, using the 'labour hours' definition of labour inputs, indicate less cyclical variability of productivity, once some utilisation rate of factor inputs is accounted for in the measurement of productivity.

Neither the Utilities sector (Electricity, Gas and Water) nor the Building and Construction sector showed any cyclical variation, with productivity growing according to simply some quadratic function of time. This is surprising for the Utilities sector, since at the annual level, cyclical variation was found significant in both the capital and total factor productivity measurements. This may be due to the inadequacy of our capital stock series in registering quarterly movements in cyclical variation (it is a linear interpolation of the annual series).

In the case of both the Forestry and Logging sector and the Mining and Quarrying sector (both of which use the combined quarterly measure of GDP as their numerator), significantly negative coefficients appear on the cyclical variable, suggesting productivity movements are counter cyclical. This may be caused by output moving irrespective of the business cycle, and instead being dominated by technology or 'discoveries'. It is suspicious that these variables are so significant in the negative direction and further analysis is necessary before treating the cyclical coefficent as accurate. Again it may be an indication that CUBO is not a good cyclical indicator for these sectors.

The Finance, Real Estate and Insurance, and Wholesale and Retail Trade sectors are directly comparable between the annual and quarterly data in tems of sector definition, (see the appendix to the data section). The cyclical models of these sectors show similar results between the annual and quarterly measures, with the cyclical coefficient being marginally smaller for the Wholesale and Retail Trade in the quarterly measure. However, in terms of direction and fit, these models are very comparable.

We have not attempted to isolate dates in which 'regime' changes have occurred formally, with the use of Chow tests, as we did for the annual data. We do however present annual, and average annual, percentage rates of change for our competing productivity measures, these are presented in appendix 2. We have split the time periods in an attempt to capture pre and post 1984 election movements in the productivity data to identify any direct policy effect.

With reference to labour productivity, all competing measures (using labour numbers, labour hours and working proprietors), showed similar patterns of movement within each time period for the individual sectors. All sectors except for Trade, Restaurants and Hotels, registered productivity growth over the entire period, ranging from 0.01%/annum (Finance, Insurance and Real Estate) to 7.20%/annum (Mining and Quarrying), for our output/labour hours, inclusive of working proprietors. The slowest growing sectors are service industries, with as already mentioned, the Trade sector registering negative growth of 0.40%/annum growth in labour productivity. Community and Personal Services registered moderate growth, in comparison to the non-service sectors. This result must be viewed with caution, due to the difficulty in measuring output from these service sectors. Also a reminder is necessary in that, Transport and Communications, Finance, Insurance and Real Estate and Community and Personal Services all use the same GDP measure at the quarterly level.

Forestry, Mining, Construction, Transport and Community and Personal service sectors all showed increased growth in productivity post 1984. In the case of Forestry and Community and Personal services, this is due to labour shedding, with state owned forests coming under severe rationalisation procedures post 1986. The figures are misleading for employment in the Forestry and Logging sector however, due to a redefinition of employment in this area, with most work now being subcontracted to small operators.

The annual average percentage change figures can be misleading in terms of the overall scenario. The graph of productivity in the manufacturing sector tells a very different story, what we see is more varied movement in productivity post 1984, with productivity growing steadily pre 1984 to peak in 1984(4), and then falling dramatically until 1986(1). A recovery then occurred, peaking at a new high in 1987(1) and since then remaining near this level. The fall in employment has been the source of most of the gain in productivity, with employment changes lagging two quarters behind output changes, creating a procyclical productivity movement. Also, although the fall in hours worked since mid 1985 and during 1986 appear to be of similar proportion to that of other recessions, the fall in labour numbers has been extremely high. Thus the remaining stock of labour is being used more intensively is this downward phase of the cycle. Much structural change has occurred in the economy, and there is evidence (Williams 1987) that the relative impact on the traded and non-traded sectors has been different.

When we include labour hours in our productivity measure for the manufacturing sector we see post 1984 gains in productivity have been less than labour numbers. Overall, doubt is cast on the extent to which productivity gains have occured in the manufacturing sector since liberalisation, it does however appear we are in an upswing at present in productivity for this sector.

Those remaining sectors registering a downturn in productivity post 1984 are, suspiciously, the service industries. In the case of the Finance sector, there has undoubtedly been growth since its deregulation, however the measurement of its output has remained unaffected in volume terms, thus coupled with increasing employment in this area, we are left with a falling productivity measure.

SECTION IX:

SUMMARY & CONCLUSIONS

For the O.E.C.D as a whole, productivity growth rates have declined during the last 20 years. Governments have thus become increasingly concerned as the scope for non-inflationary increases in real incomes have become limited. Much debate, however, exists as to the causes of productivity movements, with explanations ranging from 'structural' arguments to 'supply-side' explanations.

This analysis of New Zealand's productivity movements aids the general understanding by providing firstly, a measure of total factor, labour and capital productivity, and secondly, an analysis of the movements in these series. The most prominent influence on productivity growth in New Zealand is undoubtedly that of the business cycle. However, the most obvious gap in past analysis has been 'supply-side' studies -the formal analysis of the role of factor prices and supply shocks.

We indicate where research might begin in the context of New Zealand, highlighting the role inflation plays in the determination of productivity growth. Initially we have shown the direction of causality, in the Granger sense, runs from price variation to productivity variation. This indicates that a fuller understanding of past productivity trends would be gained through an analysis of factor-price shocks, perhaps within the framework formalised by Bruno and Sachs (1984).

Secondly, we refute past empirical work which has claimed there exists a structural break in productivity growth in the mid 1970s. Both the existence and starting points of these time trends are important to the study of productivity. If structural shifts have not occurred, as indicated by our research, and seperate phases are imposed ex-ante, the results of past studies may be seriously biased. Our estimates show that cyclical effects accounted for approximately one quarter of the growth in total factor productivity for the periods 1961-1974 and 1984-1986. For the period 1975-1984, however, the cyclical component accounted for nearly 80 per cent of the fall in total factor productivity. Using recursive Chow tests, we did not, however, find any proof of a structural break in the long-run trend of productivity growth. Rather, a temporary breakdown in the cyclical behaviour of productivity occurred during the period 1975-1978. We suggest that the massive change in relative prices, generated by the oil price hikes, are the cause of the cyclical breakdown. Further tests for structural shifts in productivity growth and the specification of a more complete model of productivity growth is necessitated to clarify this.

Finally, the preliminary nature of this research can not be stressed enough. Further research is needed in both; the direction of causality between inflation and productivity growth, perhaps via the estimation of factor price frontiers and; the analysis of the trend rate of growth of productivity. This will ultimately be hindered by the lack of reliable data for both value-added output and the nations capital stock. We have emphasised that more research is necessary in measuring the output of the 'service' sectors of the economy and in determining the utilisation rates of both the labour force and capital stock. It is perhaps from this more fundamental point of contention that future research should begin from for New Zealand.

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APPENDIX ONE

22 SNA Sectors

1) Agriculture
2) Fishing and Hunting
3) Forestry and Logging
4) Mining and Quarrying
5) Food, Beverages and Tobacco
6) Textiles, Apparel and Leather
7) Wood and Wood Products
8) Paper, printing and Publishing
9) Chemicals Petroleum and Plastics
10) Non-Metallic Industries
11) Basic Metal Industries
12) Fabricated Metal Products and Machinery
13) Other manufacturing
14) Electricity, Gas and Water
15) Building and Construction
16) Wholesale and Retail Trade
17) Transport and Storage
18) Communications
19) Finance, Insurance, Banking and Real Estate
20) Ownership of Owner Occupied Dwellings
21) Private Services (SNA= 21, 24 & 25)
22) Public Services (SNA= 22 & 23)

APPENDIX 2

QES Data	Output Data(SNA Sectors)	
1)Forestry and Logging	1)	SNA=2,3 and 4
2)Manufacturing	2)	SNA=5-13
3)Mining and Quarrying	3)	SNA=2,3 and 4
4)Electricity, Gas and water	4)	SNA=14
5)Construction	5)	SNA=15
6)Wholesale and Retail Trade	6)	SNA=16
7)Community and Personal Services	7)	SNA=17,18,19,21,24 and 25
8)Finance Insurance and Real Estate	8)	SNA=17,18,19,21,24 and 25
9)Transport, Storage and Communications	9)	SNA=17,18,19,21,24 and 25

TABLE (1a)

Table (1a): Annual Productivity: Sectoral Cyclical Regressions with significant CUBO (1963-1986)

Dependent Variable	Constant	ln(CUBO)	Time	$Time^2$	AR(1)	
<u>Total Factor Productivity</u>						
Wood & Wood Pds	-0.52	1.65	0.07	-0.002		R^2=0.88
	(-6.4)	(2.60)	(8.7)	(-6.46)		
Elect. Gas. Water	-1.33	0.91	0.09	-0.001		R^2=0.99
	(-3.4)	(2.88)	(21.1)	(-8.5)		
Trade,Rests',Hotels	0.10	0.80			0.78	R^2=0.74
	(2.09)	(3.27)			(6.6)	
Finance,Ins,Real Est.	0.01	0.37			0.91	R^2=0.97
	(0.14)	(2.46)			(22.5)	
<u>Labour Productivity</u>						
Basic & Fab Metal	-0.09	3.56	0.077	-0.002		R^2=0.67
	(-0.65)	(3.06)	(5.24)	(-4.22)		
Trade,Rests', Hotels	0.08	0.69			0.78	R^2=0.75
	(2.05)	(2.74)			(5.34)	
Transport	0.19	1.18	0.02		0.47	R^2=0.91
	(-3.65)	(3.16)	(7.89)		(2.41)	
Finance,Ins,Real Est.	0.06	0.43			0.73	R^2=0.79
	(3.35)	(3.31)			(6.60)	
<u>Capital Productivity</u>						
Wood & Wood Pds	-0.37	1.98	0.07	-0.082	0.56	R^2=0.77
	11.46	(2.46)	(2.30)	(-2.07)	(2.94)	
Transport	-0.24	1.34			0.55	R^2=0.90
	(2.34)	(2.77)			(7.50)	

AR (1) = 1st order auto-regressive term, adjustment for first-order serial correlation.
Figures in parenthesis are t-statistics

Table (2a): Quarterly Productivity: Sectoral Cyclical Regressions with Significant CUBO (1977(2)-1987(4))

Dependent Variable	Constant	ln(CUBO)	Time	$Time^2$	AR(1)	
<u>ln [V/Labour Hours]</u>						
Forestry & Logging	-0.49	-2.98	0.03	0.0012		R^2=0.78
	(-3.98)	(-3.65)	(-4.97)	(7.40)		
Mining & Quarrying	-0.50	-1.99		0.003		R^2=0.84
	(-6.14)	(-3.14)		(13.99)		
Manufacturing	-0.07	0.53	0.007			R^2=0.86
	(-1.61)	(1.79)	(13.62)			
Finance,Ins,Real Est.	0.07	0.32			0.72	R^2=0.63
	(2.27)	(1.40)			(5.83)	
Trade,Rests',Hotels	0.09	0.37	-0.001			R^2=0.13
	(2.3)	(1.40)	(-2.32)			
Personal,Comm.Serv.	-0.02	0.25		0.0002	0.51	R^2=0.99
	(-1.29)	(1.87)		(25.4)	(4.11)	
<u>ln [V/Labour Numbers]</u>						
Forestry & Logging	-0.4	-2.15	-0.03	0.0012	0.34	R^2=0.81
	(-2.31)	(-2.15)	(-3.32)	(5.09)	(1.95)	
Mining & Quarrying	-0.6	-2.2		0.00034	0.38	R^2=0.85
	(-5.04)	(-2.67)		(9.26)	(2.70)	
Manufacturing	-0.06	0.59	0.007			R^2=0.85
	(-1.29)	(1.95)	(12.93)			
Finance,Ins,Real Est.	0.08	0.33			0.69	R^2=0.64
	(2.7)	(1.5)			(5.41)	
Trade,Rests',Hotels	0.15	0.57	-0.002			R^2=0.35
	(3.62)	(2.13)	(-4.57)			
Personal,Comm.Serv.	-0.02	0.29		0.0002		R^2=0.98
	(-0.89)	(2.10)		(27.5)		

SAMPLE 1977(1) - 1986 (1)

ln [V/Labour Hours + K (PMTE)]

Forestry & Logging	-0.38	-2.38	-0.03	0.001		R^2=0.78
	(-3.4)	(-3.23)	(-4.73)	(7.15)		
Mining & Quarrying	-0.48	-1.39		0.004		R^2=0.72
	(-4.03)	(-2.02)		(8.58)		
Manufacturing	0.05	0.98	0.004			R^2=0.77
	(1.09)	(3.33)	(6.47)			
Finance,Ins,Real Est.	0.09	0.35			0.58	R^2=0.51
	(3.07)	(1.68)			(3.50)	
Trade,Rests',Hotels	-2.29		0.23	-0.005	0.37	R^2=0.59
	(-4.23)		(3.67)	(-3.19)	(2.58)	
Personal,Comm.Serv.	0.02	0.39		0.00013	0.47	R^2=0.96
	(0.88)	(2.39)		(11.59)	(2.78)	

AR (1) - First order auto-regressive term, to adjust for first order serial correlation.
- Figures in parenthesis are t-statistics

Table (3a): Real Sectoral Output, Labour and Capital as a Per Centage of the Total

Sectors	Total		Labour		Capital	
	1970/1	1985/6	1970/1	1985/6	1970/1	1985/6
AGR	8.0	8.0	11.4	9.8	19.0	14.7
FISH	0.2	0.3	0.3	0.4	0.1	0.15
FOR	0.9	1.0	0.6	0.8	0.4	0.4
MIN	0.8	1.2	0.5	0.4	0.4	1.4
FOODBEV	1.8	6.0	6.2	5.7	2.5	3.1
TEXTILE	3.3	2.6	4.4	3.4	0.8	0.6
WOODPDS	1.5	1.6	1.9	1.8	0.6	0.5
PAPPUB	3.1	2.9	2.6	2.6	1.3	1.3
CHEM	1.0	2.3	2.1	2.0	0.7	2.5
NONMET	1.6	0.9	0.9	0.8	0.4	0.4
BASMET	0.6	0.8	6.9)	6.5)	0.3	1.0
FABMET	8.5	6.3	)	)	1.9	1.6
OTHMFG	0.4	0.3	0.4	0.4	0.2	1.5
ELECT	1.7	2.8	1.15	1.2	8.0	8.3
CONST	6.3	4.9	8.2	6.8	1.5	1.2
TRADRES	22.8	19.7	17.8	17.1	6.6	5.6
TRANSP	5.9	5.3	6.6	5.3	5.4	5.3
COMMUNI	1.4	3.0	2.6	2.7	1.9	1.6
FINANCE	9.2	10.4	5.8	7.6	3.9	6.6
OWNDWEL	2.8	3.2			28.0	27.2
PRISERV	4.9	4.2	20.0)	24.3)	1.3	1.4
PUBSERV	13.0	11.5	)	)	14.1	14.2

Table (4a): Causation Tests for Inflation-Productivity Trade-offs. Manufacturing Sector 1977(2)-1987(3)

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(1) $\ln(V/L)_t = -0.22 - 0.001\,\text{Time}$
(3.44) (1.39)
$+0.14C_1 - 0.034C_2 - 0.031C_3 + 0.41C_4$
(0.86) (0.22) (0.21) (2.65)
$+0.26D_0 - 0.15D_1 - 0.78D_2 + 0.50D_3 + 1.75D_4$
(0.76) (-0.27) (-1.47) (-0.86) (3.47)

$R^2 = 0.90$ DW=1.50 $F_{(4,28)} = 4.79$

(2) CPI= $39.5 + 4.14\,\text{Time}$
(0.95) (1.06)
$+1.19D_1 + 0.07D_2 - 0.32D_3 - 0.08D_4$
(6.1) (0.22) (0.97) (0.24)
$+0.84C_0 + 0.34C_1 - 0.44C_2 - 0.30C_3 - 0.56C_4$
(0.76) (0.38) (0.50) (0.35) (0.58)

$R^2 = 0.99$ DW=2.03 $F_{(4,28)} = 0.52$

(3) $d_1\ln(V/L)_t = 0.014 - 0.22C_1 - 0.17C_2 - 0.15C_3$
(0.66) (1.53) (1.22) (1.12)
$+0.49C_4$
(3.68)
$+0.008D_0 + 0.072D_1 - 1.13D_2 - 1.28D_3 + 2.2D_4$
(0.02) (0.18) (2.83) (1.28) (3.81)

$R^2 = 0.72$ DW=2.30 $F_{(4,28)} = 4.12$

$$(4)\quad d_1CPI = 0.016 + 0.34D_1 + 0.188D_2 - 0.15D_3 + 0.03D_4$$
$$\qquad (1.55)\ (1.78)\ (0.83)\ (0.58)\ (0.08)$$
$$+0.002C_0 + 0.04C_1 + 0.04C_2 + 0.034C_3 + 0.06C_4$$
$$(0.02)\ (0.61)\ (0.57)\ (0.49)\ (0.69)$$

R^2=0.21 DW=2.02 $F_{(4,28)}$=0.21

"Best" Fit Equations:

$$(5)\quad \ln(V/L)_t = -0.21 - 0.06\,Time$$
$$(4.03)\ (1.14)$$
$$+0.34C_4$$
$$(2.49)$$
$$+0.005D_2 - 0.001d_2CPI_{-2}$$
$$(2.60)\ (4.79)$$

R^2=0.89 DW=1.37

$$(6)\quad CPI = 11.56 + 0.12Time$$
$$(0.39)\ (0.04)$$
$$+1.01D_1$$
$$(13.98)$$
$$+0.18C_0 + 0.63C_1 - 0.06C_2 - 0.16C_3 - 0.15C_4$$
$$(0.2)\ (0.7)\ (0.07)\ (0.18)\ (0.17)$$

R^2=0.99 DW=1.55

$$(7)\quad d_1\ln(V/L)_t = -0.004 + 0.62C_1$$
$$(0.02)\ (6.57)$$
$$-1.14D_2 - 1.09D_3 + 2.55D_4$$
$$(3.23)\ (2.68)\ (5.08)$$

R^2=0.69 DW=2.10

$$
\begin{aligned}
(8)\quad d_1CPI =\; & 0.017 \;+0.37D_1 \\
& (2.85) \quad (2.17) \\
& \quad -0.006C_0 \;+0.05C_1 \;+0.05C_2 \;+0.04C_3 \;+0.07C_4 \\
& \quad (0.09) \quad (0.83) \quad (0.82) \quad (0.66) \quad (1.04)
\end{aligned}
$$

R^2=0.18 DW=2.10

TABLE 1B: ANNUAL DATA -Average Annual Per Cent Change.
Total, Labour and Capital Productivity.

REAL NET OUTPUT/TOTAL INPUT (PMTE)

ANNUAL AVERAGE RATES OF CHANGE

YEARS	AGR	FISH	FOR	MINING	FOOD/BEV
1961-74	2.40	-1.06	0.70	4.94	0.41
1975-81	4.70	3.08	1.38	-0.34	15.53
1975-84	3.61	5.52	1.45	2.39	10.96
1981-84	3.91	10.35	4.19	4.35	0.92
1981-86	4.10	5.80	7.54	13.63	-0.99
1984-86	3.06	2.97	9.14	13.17	-3.92

YEARS	TEXT	WOODPDS	PAPPUBL	CHEM	NONMET
1961-74	2.26	3.60	4.73	8.27	0.75
1975-81	1.66	1.00	-0.94	-0.06	-6.35
1975-84	1.91	1.45	0.09	0.05	-4.03
1981-84	1.83	1.28	2.55	-1.72	-0.50
1981-86	2.18	0.21	2.85	-2.17	1.59
1984-86	1.52	-0.01	5.22	-3.35	3.52

YEARS	BASFAB	OTHRMFG	ELECT	CONST	TRADERES
1961-74	-0.59	-4.17	5.75	2.31	0.08
1975-81	-3.54	4.34	3.92	-0.85	-1.48
1975-84	-1.13	4.45	3.77	0.36	-0.78
1981-84	1.86	3.82	1.91	3.40	0.39
1981-86	1.19	9.40	3.09	3.86	-0.54
1984-86	1.84	12.94	5.77	3.91	-1.36

YEARS	TRANSPT	COMM	FIN	SERV	TOTAL
1961-74	3.34	1.66	-1.37	-0.74	1.30
1975-81	-2.78	6.64	-1.35	-2.11	-0.57
1975-84	-0.70	7.26	-0.80	-1.60	0.12
1981-84	2.43	8.44	0.28	-0.58	1.47
1981-86	1.26	6.72	-0.18	-0.07	1.77
1984-86	2.79	5.56	0.58	0.45	2.21

REAL NET OUTPUT/TOTAL INPUT
ANNUAL AVERAGE RATES OF CHANGE

YEARS	AGR	FISH	FOR	MINING	FOOD/BEV
1961-74	2.71	-1.06	-0.21	5.65	0.72
1975-81	5.72	3.03	1.08	-6.87	15.97
1975-84	4.62	5.44	1.03	-2.88	11.41
1981-84	4.84	10.17	3.55	2.84	1.44
1981-86	4.79	5.65	7.44	14.13	-0.58
1984-86	3.48	2.85	9.52	16.27	-3.74

YEARS	TEXT	WOODPDS	PAPPUBL	CHEM	NONMET
1961-74	3.03	3.24	5.12	8.38	0.62
1975-81	2.01	1.38	-0.91	0.49	-6.27
1975-84	2.21	1.55	0.08	-2.34	-3.73
1981-84	1.84	0.73	2.44	-9.06	-0.02
1981-86	2.42	0.09	2.78	-7.10	2.78
1984-86	2.01	0.27	5.10	-4.04	5.19

YEARS	BASFAB	OTHRMFG	ELECT	CONST	TRADERES
1961-74	0.77	-3.38	4.66	1.68	-0.03
1975-81	-3.25	3.67	4.21	-1.04	-1.44
1975-84	-1.95	3.67	3.42	0.17	-0.71
1981-84	-0.69	2.73	0.39	3.15	0.47
1981-86	-2.02	8.43	1.21	3.74	-0.29
1984-86	-3.52	12.17	3.41	3.96	-0.85

YEARS	TRANSPT	COMM	FIN	SERV	TOTAL
1961-74	3.21	1.91	-1.38	-0.97	1.21
1975-81	-2.61	6.51	-1.87	-1.57	-0.45
1975-84	-0.52	7.48	-0.98	-1.06	0.17
1981-84	2.45	9.18	0.76	-0.07	1.34
1981-86	1.66	7.90	0.50	0.64	1.92
1984-86	3.31	7.56	1.49	1.25	2.57

REAL NET OUTPUT/TOTAL CAPITAL

ANNUAL AVERAGE RATES OF CHANGE

YEARS	AGR	FISH	FOR	MINING	FOOD/BEV
1961-74	1.85	-0.89	0.49	1.23	-0.26
1975-81	5.53	-3.38	2.57	-17.54	13.59
1975-84	4.37	0.36	1.98	-9.95	8.93
1981-84	5.13	6.99	2.67	3.39	-1.58
1981-86	4.81	4.12	4.29	15.22	-2.71
1984-86	3.22	4.38	5.69	17.55	-4.64

YEARS	TEXT	WOODPDS	PAPPUBL	CHEM	NONMET
1961-74	2.99	4.26	3.58	7.72	0.90
1975-81	0.49	0.14	-0.60	-1.75	-7.26
1975-84	1.26	1.07	0.37	-8.39	-4.85
1981-84	1.03	1.97	2.61	-21.83	-0.72
1981-86	1.75	0.41	3.01	-17.07	4.46
1984-86	1.59	0.24	5.51	-11.43	8.86

YEARS	BASMET	FABMET	OTHRMFG	ELECT	CONST
1961-74	-6.10	2.27	-4.83	3.41	0.54
1975-81	-0.14	-5.72	5.67	3.01	-2.65
1975-84	-4.44	-2.85	6.22	2.56	-0.75
1981-84	-13.46	1.40	4.79	1.55	3.11
1981-86	-15.62	2.41	5.65	2.28	3.05
1984-86	-18.37	3.12	5.74	4.02	2.77

YEARS	TRADERES	TRANSPT	COMM	FIN	OWNDWEL
1961-74	-1.17	3.27	-0.10	-3.00	-1.13
1975-81	-1.67	-4.24	7.74	-3.91	3.34
1975-84	-0.82	-2.17	7.76	-2.49	2.49
1981-84	0.56	1.18	8.08	0.93	0.63
1981-86	0.21	0.03	5.97	0.81	0.51
1984-86	0.19	1.80	3.62	1.86	0.27

YEARS	PRISERV	PUSERV	TOTAL
1961-74	-2.68	-1.76	0.62
1975-81	-1.43	-0.82	-1.26
1975-84	-0.99	-0.50	-0.61
1981-84	0.09	0.07	0.66
1981-86	0.37	-0.31	1.08
1984-86	0.24	-0.72	1.65

REAL NET OUTPUT/CAPITAL (PMTE)

ANNUAL AVERAGE RATES OF CHANGE

YEARS	AGR	FISH	FOR	MINING	FOOD/BEV
1961-74	1.04	-0.89	2.70	0.50	-1.00
1975-81	2.67	-3.24	3.50	-1.55	12.43
1975-84	1.60	0.49	3.17	3.48	7.74
1981-84	2.59	7.31	4.39	8.27	-2.95
1981-86	2.84	4.33	4.72	14.71	-3.78
1984-86	1.94	4.38	5.05	9.82	-5.09

YEARS	TEXT	WOODPDS	PAPPUBL	CHEM	NONMET
1961-74	1.25	5.05	2.84	7.52	1.26
1975-81	-0.44	-0.80	-0.61	-3.16	-7.29
1975-84	0.46	0.88	0.42	-3.61	-5.53
1981-84	1.01	3.54	2.91	-6.42	-1.96
1981-86	1.16	0.91	3.22	-6.72	1.09
1984-86	0.37	-0.30	5.82	-10.12	3.96

YEARS	BASMET	FABMET	OTHRMFG	ELECT	CONST
1961-74	-6.56	-0.43	-6.33	6.75	1.98
1975-81	0.05	-7.40	7.75	2.41	-2.01
1975-84	0.19	-4.49	8.59	3.65	-0.15
1981-84	-2.11	0.09	7.90	5.78	3.79
1981-86	-0.77	0.82	8.19	7.44	3.40
1984-86	6.71	1.65	7.43	10.35	2.65

YEARS	TRADERES	TRANSPT	COMM	FIN	OWNDWEL
1961-74	-0.93	3.54	-0.61	-3.00	ERR
1975-81	-1.79	-4.67	8.12	-2.48	ERR
1975-84	-1.02	-2.62	7.31	-1.95	ERR
1981-84	0.37	1.15	6.34	-0.30	ERR
1981-86	-0.44	-0.89	3.24	-0.96	ERR
1984-86	-1.13	0.63	-0.97	-0.47	ERR

YEARS	PRISERV	PUSERV	TOTAL
1961-74	-2.14	-1.21	0.79
1975-81	-3.99	-1.31	-1.58
1975-84	-3.26	-1.20	-0.87
1981-84	-1.49	-1.15	0.69
1981-86	-1.28	-2.30	0.59
1984-86	-0.75	-3.63	0.70

REAL NET OUTPUT/LABOUR

ANNUAL AVERAGE RATES OF CHANGE

YEARS	AGR	FISH	FOR	MINING	FOOD/BEV
1961-74	2.66	-1.03	-0.78	9.40	1.45
1975-81	5.88	7.88	0.37	0.93	17.27
1975-84	4.81	8.54	0.60	2.37	12.84
1981-84	4.77	10.36	4.02	2.57	3.23
1981-86	4.78	6.46	9.61	13.50	0.69
1984-86	3.52	1.82	12.41	15.48	-3.13

YEARS	TEXT	WOODPDS	PAPPUBL	CHEM	NONMET
1961-74	3.06	2.48	6.47	8.93	0.48
1975-81	2.90	2.18	-1.04	1.81	-5.66
1975-84	2.80	1.94	-0.05	2.53	-2.98
1981-84	2.37	0.18	2.34	1.72	0.61
1981-86	2.88	0.10	2.63	1.10	2.03
1984-86	2.32	0.38	4.84	1.91	3.27

YEARS	BASFAB	OTHRMFG	ELECT	CONST	TRADERES
1961-74	5.75	-2.02	5.67	2.85	0.90
1975-81	-3.06	2.71	4.95	-0.07	-1.31
1975-84	-0.11	2.47	3.94	0.73	-0.69
1981-84	3.87	1.85	-0.16	3.14	0.29
1981-86	2.13	11.52	0.65	4.20	-0.68
1984-86	0.54	18.38	3.02	4.80	-1.51

YEARS	TRANSPT	COMM	FIN	SERV	TOTAL
1961-74	3.13	3.58	-0.10	0.06	1.68
1975-81	-1.69	5.90	-0.68	-1.77	0.01
1975-84	0.43	7.45	-0.10	-1.21	0.63
1981-84	3.21	10.03	0.70	-0.13	1.76
1981-86	2.70	9.27	0.34	1.06	2.51
1984-86	4.33	10.29	1.26	2.22	3.28

TABLE 2: Quarterly Data: Annual Average Per Cent Changes
Total, Labour and Capital Productivity.

FORESTRY & LOGGING

ANNUAL AVG % CHG	Q/L.HRS	Q/L.WRK	Q/HR+WRK	Q/WRK+WP	Q/KP+LHR	Q/KP+WRK	Q/KP
1978.2-1987.3	14.56	14.71	13.77	13.91	6.02	5.97	4.86
1978.2-1984.3	1.15	1.04	1.29	1.18	1.03	0.97	1.43
1984.3-1987.3	43.61	44.32	40.80	41.49	27.64	27.65	19.69
1978.2-1981.4	-2.62	-3.20	-2.20	-2.77	-2.64	-3.13	-2.41
1982.1-1987.3	24.36	25.03	22.85	23.51	12.56	12.95	10.51

MINING & QUARRYING

ANNUAL AVG % CHG	Q/L.HRS	Q/L.WRK	Q/HR+WRK	Q/WRK+WP	Q/KP+LHR	Q/KP+WRK	Q/KP
1978.2-1987.3	7.10	6.78	7.23	6.90	5.61	5.28	7.40
1978.2-1984.3	2.60	1.22	2.79	1.40	3.34	2.67	5.76
1984.3-1987.3	16.85	18.82	16.86	18.84	15.47	16.59	14.51
1978.2-1981.4	2.03	0.23	2.23	0.43	2.13	1.22	3.22
1982.1-1987.3	9.32	10.47	9.43	10.56	7.69	8.37	10.91

MANUFACTURING

ANNUAL AVG % CHG	Q/L.HRS	Q/L.WRK	Q/HR+WRK	Q/WRK+WP	Q/KP+LHR	Q/KP+WRK	Q/KP
1978.2-1987.3	3.32	3.39	3.19	3.18	1.99	1.88	0.59
1978.2-1984.3	4.02	4.13	3.94	3.88	3.18	3.17	1.66
1984.3-1987.3	1.79	1.79	1.59	1.65	-3.21	-3.73	-4.05
1978.2-1981.4	3.65	3.30	3.43	3.03	2.77	2.51	1.62
1982.1-1987.3	3.13	3.65	3.08	3.43	1.44	1.64	-0.07

ELECTICITY GAS & WATER

ANNUAL AVG % CHG	Q/L.HRS	Q/L.WRK	Q/HR+WRK	Q/WRK+WP	Q/KP+LHR	Q/KP+WRK	Q/KP
1978.2-1987.3	3.45	3.45	3.45	3.44	4.37	4.46	6.82
1978.2-1984.3	3.85	3.89	3.85	3.89	4.66	4.67	6.50
1984.3-1987.3	2.57	2.49	2.56	2.47	3.09	3.54	8.21
1978.2-1981.4	4.52	4.30	4.52	4.31	4.50	4.43	5.03
1982.1-1987.3	2.36	2.78	2.36	2.78	3.85	4.35	8.16

COMMUNITY & PERSONAL SERVICES

ANNUAL AVG % CHG

	Q/L.HRS	Q/L.WRK	Q/HR+WRK	Q/WRK+WP	Q/KP+LHR	Q/KP+WRK	Q/KP
1978.2-1987.3	3.27	3.19	3.17	3.08	2.07	2.03	0.90
1978.2-1984.3	2.62	2.68	2.47	2.53	2.14	2.16	1.25
1984.3-1987.3	4.69	4.30	4.69	4.28	1.79	1.49	-0.61
1978.2-1981.4	1.66	1.11	1.52	0.97	1.30	0.89	0.42
1982.1-1987.3	4.27	4.49	4.17	4.39	2.77	3.04	1.42

KEY

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Q = GDP (value-added)

L.HRS = Labour Hours

L.WRK = Labour Numbers

HRS+WRK = Labour Hours + Working Proprietors

WRK+WP = Labour Numbers + Working Proprietors

KP = Capital Stock (PMTE)

Table 38: TOTAL FACTOR PRODUCTIVITY

Annual Per Cent Change

Real Net Output/Total Input (PHTE)

	AGR	FISH	FOR	MINING	FOOD/BEV	TEXT	WOODPDS	PAPPUBL	CHEM	NONMET	BASFAB	OTHRMFG	ELECT
1960													
61	7.09	10.03	-3.80	21.29	10.49	-1.15	3.10	10.55	6.36	10.65	15.48	0.79	-17.04
62	-9.39	-9.00	-4.24	1.22	31.73	1.46	-3.54	-2.41	6.11	-6.74	-27.01	-4.84	2.75
63	16.15	3.85	-10.16	20.85	-15.21	-1.03	7.73	-0.43	6.31	-13.61	32.96	-6.87	14.73
64	18.10	-0.87	-1.74	5.65	-7.87	7.68	-1.26	11.58	7.43	6.92	3.45	-5.47	6.36
65	8.98	-1.89	1.92	7.75	-20.87	5.43	19.84	10.01	-72.62	-4.68	-7.52	7.37	7.64
66	5.99	-2.72	-5.98	-3.30	14.48	9.32	-2.52	3.54	-40.99	-4.70	9.14	-11.34	11.67
67	1.48	-0.94	-2.17	2.53	-4.17	6.88	8.86	17.42	-16.48	-0.80	-2.92	3.35	4.65
68	3.19	-0.47	-1.30	-12.01	-12.65	8.38	2.45	8.27	23.07	0.10	-19.11	-6.24	2.01
69	3.39	7.26	12.10	-16.38	-8.39	-3.83	4.28	-4.02	-36.80	-0.23	-7.76	-9.55	4.70
1970	-0.42	-15.71	9.59	-4.22	-25.74	10.78	14.95	14.97	101.88	19.14	-19.86	5.62	7.90
71	1.50	1.48	7.51	5.15	2.10	-3.05	-6.23	5.31	55.32	-3.61	-1.39	-7.24	7.24
72	0.22	4.19	-1.20	10.03	-10.38	-2.12	7.67	-6.97	14.52	-11.77	0.72	-0.60	11.70
73	-14.47	-6.57	-0.04	15.29	17.03	2.45	-0.64	-8.47	12.08	9.94	7.21	-8.90	9.91
74	-8.27	-3.53	9.35	15.26	35.11	-9.57	-4.29	6.83	49.64	9.94	8.37	-14.38	6.31
75	14.12	3.77	-2.66	-13.35	18.87	-23.02	3.45	-12.81	-3.35	-18.47	20.09	-30.60	1.57
76	5.82	-0.16	-3.59	-6.65	89.73	27.22	20.31	7.67	10.44	-12.26	-40.61	64.89	5.27
77	1.13	6.50	11.26	38.03	-2.86	-5.46	-6.53	-1.54	18.35	-13.09	17.14	-8.99	3.77
78	-5.50	-10.69	-9.29	20.88	2.51	2.93	-21.01	-9.46	-19.27	7.82	-16.99	4.04	-1.12
79	-9.93	-3.88	1.30	-8.30	3.30	-0.64	5.30	-1.51	0.90	-1.00	0.58	-0.51	5.19
1980	14.83	18.23	0.73	-24.09	-5.66	10.76	7.88	8.34	0.37	-1.33	1.05	0.44	15.33
81	12.40	7.80	11.90	-8.91	2.78	-0.14	-2.40	2.74	-7.87	-6.13	-6.04	1.11	-2.61
82	-5.79	11.59	3.43	11.01	-0.52	4.81	9.01	2.23	5.04	7.12	6.46	9.53	2.92
83	8.80	6.48	2.46	40.18	3.57	3.86	-5.29	-3.52	-0.12	-2.03	1.23	6.95	0.88
84	0.23		-1.05	-24.86	-2.17	-1.21	3.81	8.76	-3.93	-0.98	5.78	-2.34	6.45
85			15.32	28.40	-0.81	8.03	3.92	9.11	2.07	8.14	9.06	41.85	5.38
86			13.16	35.97	-8.78	-2.26	-7.76	-2.20	-8.19	3.39	-9.32	-0.69	5.49

	CONST	TRADERES	TRANSPT	COMM	FIN	SERV	TOTAL
1960							
61	-5.07	1.99	1.44	10.25	4.34	1.37	4.31
62	8.44	1.71	4.47	4.34	-2.09	1.41	0.43
63	-6.13	0.86	-0.82	5.57	-0.58	0.32	2.72
64	4.25	3.24	4.94	1.95	-5.23	0.23	4.27
65	10.25	-1.23	5.43	-0.45	-1.00	-0.59	-0.29
66	1.36	-9.10	4.52	-3.01	-4.21	0.13	-0.82
67	1.89	-1.71	2.86	0.71	-1.96	-1.89	0.41
68	-2.31	-7.53	-2.70	-1.40	-0.52	0.48	-1.61
69	0.68	-1.05	6.24	0.01	-0.40	-0.81	1.31
1970	8.87	2.09	4.44	1.98	0.99	-1.97	2.45
71	2.00	1.60	2.34	-10.18	-0.40	-3.16	1.00
72	-1.08	-0.48	-1.20	1.34	-1.07	0.03	0.53
73	10.38	5.90	3.12	8.51	-2.94	-1.76	1.09
74	-1.19	4.80	11.69	3.61	-4.13	-4.15	2.44
75	1.15	0.35	-13.73	23.73	-3.90	-7.15	-0.17
76	1.50	-2.24	-1.03	-13.22	-2.67	-2.40	-0.82
77	-15.18	-1.86	-3.02	9.78	-1.35	-0.56	-1.42
78	5.69	-5.12	-5.75	12.58	-2.70	-1.36	-3.27
79	-0.95	1.08	2.32	2.04	1.46	-0.17	-0.06
1980	-2.21	-1.60	4.53	3.94	0.08	-2.00	1.07
81	4.07	-1.00	-2.82	7.62	-0.34	-1.10	0.68
82	8.02	6.13	0.50	9.65	0.55	0.13	2.41
83	-0.63	-4.29	1.53	6.39	-3.05	-0.81	0.71
84	2.14	0.73	10.50	10.07	3.97	-0.55	1.62
85	0.97	1.51	6.76	5.43	1.56	2.50	
86	8.61	-6.33	-8.89	1.17	-3.80	-0.59	

Table 48: LABOUR PRODUCTIVITY

Annual Per Cent Change

Real Net Output/Labour Employed

	AGR	FISH	FOR	MINING	FOOD/BEV	TEXT	WOODPDS	PAPPUBL	CHEM	NONMET	BASFAB	OTHRMFG	ELECT
1960													
61	1.05	12.71	-5.41	16.41	10.03	1.46	0.43	10.50	4.89	7.13	15.22	4.11	2.54
62	-9.58	-7.69	-6.13	-1.24	31.90	1.61	-6.05	-1.88	4.67	-4.94	-25.19	-1.56	0.77
63	15.72	4.07	-12.58	20.15	-14.79	-0.07	6.79	12.38	7.85	-15.24	36.81	0.13	12.14
64	17.99	0.22	-4.37	4.69	-8.82	8.47	-3.78	9.57	6.99	4.54	7.53	-1.67	4.36
65	9.01	-0.38	0.92	3.91	-20.81	5.35	16.99	7.36	-72.29	-0.56	-5.33	10.28	7.02
66	7.38	-0.91	-8.16	8.34	15.92	9.71	-4.40	4.82	-39.04	-1.10	10.63	-8.99	11.13
67	2.16	-4.02	-3.46	13.91	-2.27	7.13	9.39	18.64	-11.58	-0.38	-0.89	6.95	4.65
68	3.37	1.09	-3.69	0.31	-10.70	10.07	2.62	9.38	26.20	0.25	-0.29	-1.93	0.06
69	3.48	6.75	8.74	-5.51	-5.96	-3.57	2.80	-4.63	-37.77	-1.33	14.21	-6.14	2.19
1970	-0.28	-19.06	5.34	14.23	-25.50	11.67	13.20	15.96	98.63	16.02	2.42	9.71	5.80
71	1.64	2.04	6.55	8.80	3.31	-1.19	-7.18	3.70	52.73	-3.81	-3.38	-7.33	3.46
72	2.41	4.23	1.19	13.89	-8.44	-1.49	7.30	-5.99	15.36	-12.16	12.59	-2.50	10.05
73	-10.75	-7.94	-2.24	17.84	19.37	3.72	0.78	-0.74	14.70	9.76	10.45	-11.19	9.42
74	-6.37	-5.52	12.38	15.91	37.06	-10.08	-4.21	11.55	53.63	8.57	5.78	-18.09	5.84
75	14.51	2.51	-0.98	-2.08	23.35	-21.93	5.76	-10.56	-1.53	-17.76	19.39	-32.87	0.13
76	7.42	0.05	-4.38	-7.33	93.03	32.11	23.23	7.18	15.99	-8.89	-40.25	64.55	6.54
77	4.65	14.07	8.67	39.93	-1.84	-6.64	-3.98	-0.90	20.97	-9.53	19.29	-12.72	8.08
78	-5.50	-8.37	-10.96	19.33	1.89	4.74	-18.44	-11.15	-18.46	7.08	-15.89	3.25	1.36
79	-8.99	-5.92	0.56	-13.15	3.68	1.51	6.95	-1.52	2.76	-0.75	1.07	-1.06	5.27
1980	16.96	41.61	-3.02	-23.27	-4.69	8.76	5.20	7.13	-1.29	-2.41	-0.13	-3.85	18.70
81	12.09	11.24	12.71	-6.92	5.47	1.76	-3.46	2.53	-5.79	-7.36	-4.88	1.70	-5.46
82	-5.01	16.10	4.15	4.50	2.83	3.35	6.07	2.12	6.59	7.65	8.94	3.86	1.41
83	11.07	5.98	3.57	36.95	5.24	5.19	-3.17	-3.38	0.11	2.08	7.07	8.40	-1.10
84	0.95		-4.35	-24.24	-0.61	-0.83	1.29	8.10	5.97	0.07	4.33	-6.56	4.51
85			19.44	28.89	-1.39	6.85	2.43	9.03	5.50	6.87	5.06	61.42	2.07
86			22.15	41.80	-7.38	0.94	-2.57	-2.62	-5.75	2.85	-7.77	0.26	2.49

	CONST	TRADERES	TRANSPT	COMM	FIN	SERV	TOTAL
1960							
61	1.31	3.32	0.57	10.85	5.71	2.69	4.60
62	13.33	2.29	3.53	4.77	-1.48	2.00	0.64
63	-4.01	1.53	-2.74	7.33	0.09	0.99	3.02
64	5.19	5.71	3.25	3.91	-3.05	2.61	4.22
65	9.90	0.70	4.06	0.63	1.10	1.47	-0.27
66	0.69	-8.26	4.56	-2.08	-3.35	1.05	-0.35
67	2.43	-1.06	1.37	3.17	-1.31	-1.99	0.80
68	-0.11	-7.66	-2.16	2.18	-0.70	1.08	-0.93
69	0.25	0.26	5.85	4.74	0.90	0.48	1.73
1970	7.24	2.06	4.24	8.00	1.00	-1.98	2.48
71	-1.12	2.79	2.03	-4.49	0.72	-2.06	0.95
72	-2.01	-0.20	-0.35	0.53	1.80	0.51	1.34
73	8.66	6.17	5.22	6.98	-0.21	-1.55	2.40
74	-1.83	5.00	14.37	3.60	-2.64	-4.48	2.87
75	1.69	0.56	-12.03	22.92	-2.75	-6.17	0.79
76	2.71	-1.57	1.89	-13.96	-1.34	-0.97	0.52
77	-11.41	-1.41	-1.37	9.28	0.63	-1.01	-0.04
78	4.16	-4.82	-4.89	12.58	-2.22	-0.49	-2.97
79	-3.02	1.19	3.54	1.46	1.66	-0.79	-0.03
1980	0.56	-2.04	4.28	2.13	0.20	-2.11	0.97
81	4.83	-1.06	-3.25	6.86	-0.97	-0.87	0.81
82	7.35	1.07	2.84	9.77	1.01	0.38	2.73
83	-1.37	0.42	3.63	8.12	-1.78	0.16	1.71
84	1.77	0.73	9.63	15.35	4.52	-0.18	1.80
85	-0.08	0.37	7.60	8.60	1.74	4.67	
86	12.71	-5.63	-4.24	6.92	-2.48	2.17	

Table 58: CAPITAL PRODUCTIVITY
Annual Per Cent Change

Real Net Output/Capital Stock (PHTE)

	AGR	FISH	FOR	MINING	FOOD/BEV	TEXT	WOODPDS	PAPPUBL	CHEM	NONMET	BASMET	FABMET	OTHRMFG	ELECT
1960														
61	1.40	7.05	-1.86	27.53	11.04	-4.02	6.40	10.62	8.12	15.05	23.89	8.80	-2.83	-32.14
62	-9.15	-10.56	-1.78	4.45	31.52	1.27	-0.22	-3.05	7.95	-8.89	-30.58	-30.16	-8.63	5.33
63	16.67	3.58	-7.06	21.70	-15.71	-2.16	8.88	-12.40	4.53	-11.57	38.82	23.07	-14.08	17.98
64	18.22	-2.12	1.51	6.79	-6.75	6.77	1.84	14.00	7.95	9.83	-3.54	1.37	-9.54	8.78
65	8.94	-3.62	3.14	12.70	-20.95	5.52	23.42	13.34	-73.00	-9.16	-12.08	-9.76	4.11	8.39
66	4.33	-4.84	-3.17	-14.55	12.77	8.85	-0.13	2.02	-43.22	-8.77	14.96	1.86	-14.05	12.33
67	0.60	3.45	-0.41	-9.39	-6.55	6.56	8.18	15.86	-22.15	-1.35	-4.72	-7.47	-1.02	4.64
68	2.95	-2.49	2.08	-24.40	-15.12	6.21	2.22	6.82	19.13	-0.11	-49.38	-6.62	-11.44	4.73
69	3.28	7.93	16.84	-27.35	-11.38	-4.17	6.30	-3.20	-35.48	1.24	-42.82	9.77	-13.68	8.18
1970	-0.60	-10.80	15.81	-21.18	-26.06	9.62	17.38	13.68	106.38	23.57	-56.50	4.65	0.62	10.82
71	1.30	0.65	8.99	0.10	0.33	-5.72	-4.76	7.84	59.40	-3.31	4.27	-1.48	-7.11	13.48
72	-2.98	4.13	-4.69	4.56	-13.22	-3.09	8.25	-8.44	13.23	-11.16	-26.80	8.78	2.49	14.36
73	-19.34	-4.52	3.34	11.81	13.80	0.67	-2.62	-17.74	8.49	10.18	17.27	-4.80	-5.37	10.64
74	-11.03	-0.35	5.03	14.28	32.24	-8.78	-4.42	0.36	43.96	12.10	35.37	-4.00	-8.05	7.02
75	13.39	6.27	-5.70	-28.98	11.15	-25.02	-0.71	-16.83	-6.64	-19.80	42.74	3.84	-25.80	4.45
76	2.92	-0.55	-2.08	-5.32	83.78	18.87	15.13	8.62	1.25	-18.02	-46.54	-35.80	65.55	2.95
77	-4.12	-3.87	15.73	35.04	-4.47	-3.47	-10.40	-2.55	14.33	-18.33	32.96	-2.82	-2.19	-2.54
78	-5.49	-14.80	-5.92	23.93	3.72	-0.36	-25.47	-6.07	-20.78	9.26	-27.63	-8.38	5.59	-5.52
79	-11.69	0.31	2.74	2.79	2.57	-4.54	2.26	-1.49	-2.51	-1.48	3.41	-3.95	0.57	5.03
1980	10.68	-11.69	9.41	-25.70	-7.60	15.10	13.82	10.90	3.95	0.95	5.42	1.84	10.59	8.99
81	13.02	1.63	10.35	-12.58	-2.12	-3.68	-0.25	3.16	-11.69	-3.62	-10.02	-6.49	-0.03	3.54
82	-7.21	3.97	2.09	25.82	-6.29	7.68	15.03	2.43	2.24	6.15	-4.56	9.22	22.11	5.90
83	5.39	7.27	0.76	45.61	1.04	1.83	-8.44	-3.73	-0.49	-7.87	-10.17	-2.75	4.74	4.17
84	-0.84	16.37	4.35	-25.77	-4.43	-1.78	7.83	9.76	-15.75	-2.52	16.31	0.37	4.76	9.49
85	5.20	-6.06	9.56	27.65	0.08	9.87	6.28	9.23	-2.75	10.14	18.27	13.53	19.72	10.86
86	1.47	2.83	1.23	27.57	-10.93	-6.98	-15.01	-1.52	-11.85	4.26	-14.44	-8.96	-2.18	10.68

	CONST	TRADERES	TRANSPT	COMM	FIN	PRISERV	PUSERV	TOTAL
1960								
61	-11.55	0.48	2.49	9.57	2.78	0.76	-1.14	3.97
62	2.93	1.00	5.65	3.82	-2.83	1.48	-0.24	0.18
63	-8.55	0.08	1.57	3.53	-1.37	-0.27	-0.70	2.36
64	3.18	0.52	6.97	-0.23	-7.65	-2.09	-2.76	4.33
65	10.68	-3.43	7.12	-1.70	-3.39	-2.64	-3.30	-0.32
66	2.20	-10.10	4.46	-4.13	-5.25	-0.69	-1.29	-1.39
67	1.19	-2.55	4.90	-2.36	-2.80	-4.11	0.85	-0.10
68	-5.09	-7.36	-3.41	-5.80	-0.28	0.29	-0.67	-2.50
69	1.26	-2.72	6.75	-5.80	-2.05	-3.74	-1.00	0.75
1970	11.14	2.14	4.70	-5.07	0.97	-2.48	-1.33	2.40
71	7.10	-0.15	2.82	-17.58	-2.04	-5.68	-3.75	1.09
72	0.39	-0.92	-2.49	2.61	-5.21	-1.71	0.37	-0.70
73	12.97	5.51	0.23	10.80	-6.63	-1.05	-3.02	-0.74
74	-0.19	4.49	7.84	3.64	-6.31	-8.00	1.07	1.78
75	0.15	-0.04	-16.81	25.29	-6.04	-12.59	-5.12	-1.95
76	-0.72	-3.50	-6.13	-11.78	-5.10	-6.45	-3.37	-3.27
77	-20.68	-2.58	-5.58	10.60	-4.42	3.25	-2.79	-3.59
78	8.74	-5.69	-7.34	12.56	-3.59	-8.06	2.52	-3.82
79	3.31	0.86	0.05	3.18	1.07	-0.56	2.73	-0.13
1980	-7.45	-0.69	5.05	7.85	-0.19	-2.17	-1.39	1.30
81	2.61	-0.88	-1.96	9.15	0.91	-1.37	-1.75	0.42
82	9.30	4.67	-3.65	9.43	-0.30	-1.35	0.70	1.81
83	0.56	-3.02	-1.62	3.78	-4.98	-2.70	-1.89	-0.82
84	2.59	0.73	11.83	3.00	3.15	-0.56	-1.66	1.35
85	2.62	3.30	5.52	0.94	1.28	0.33	-1.69	3.94
86	2.63	-7.43	-15.45	-6.83	-5.85	-2.01	-7.53	-3.18

Table 6B: 'Fitted' Data from Decycling Regressions.
TOTAL FACTOR PRODUCTIVITY
Annual Per Centage Change

	AGR	FISH	FOR	MIN	FOOD	TXT	WOOD	PAPER	CHEM	NMET	BFAB	OTHMFG	ELE
1962													
63	3.66	-4.62	0.49	0.55	-4.86	1.28	10.03	9.33	0.81	8.11	3.35	-8.78	10.59
64	3.44	-4.16	0.63	0.71	-4.13	1.28	7.73	7.03	1.04	3.71	0.05	-8.13	9.27
65	3.23	-3.71	0.77	0.87	-3.40	1.28	6.02	5.32	1.27	0.69	-2.23	-7.48	8.26
66	3.01	-3.25	0.91	1.03	-2.66	1.28	4.85	4.17	1.51	-1.07	-3.57	-6.82	7.56
67	2.79	-2.79	1.05	1.19	-1.91	1.28	2.93	2.25	1.74	-4.51	-6.19	-6.16	6.43
68	2.57	-2.33	1.19	1.35	-1.16	1.28	-2.39	-3.11	1.97	-15.08	-14.41	-5.49	3.33
69	2.36	-1.87	1.33	1.51	-0.40	1.28	10.96	10.49	2.21	16.12	9.28	-4.82	10.85
1970	2.14	-1.41	1.47	1.67	0.37	1.28	6.19	5.67	2.44	5.51	1.40	-4.15	8.15
71	1.93	-0.94	1.61	1.83	1.14	1.28	2.12	1.57	2.68	-3.00	-5.04	-3.47	5.81
72	1.71	-0.47	1.76	2.00	1.91	1.28	-1.87	-2.45	2.92	-11.00	-11.21	-2.78	3.47
73	1.50	0.00	1.90	2.16	2.69	1.28	9.49	9.14	3.15	16.43	9.51	-2.09	9.87
74	1.28	0.48	2.04	2.32	3.48	1.28	3.32	2.89	3.39	2.31	-1.00	-1.40	6.37
75	1.07	0.96	2.18	2.48	4.28	1.28	-2.62	-3.12	3.63	-10.33	-10.69	-0.70	2.92
76	0.85	1.43	2.32	2.64	5.08	1.28	1.68	1.29	3.87	0.22	-2.59	0.01	5.36
77	0.64	1.91	2.47	2.80	5.88	1.28	2.09	1.74	4.11	2.05	-1.20	0.72	5.55
78	0.43	2.40	2.61	2.97	6.69	1.28	-8.01	-8.50	4.35	-19.61	-17.99	1.43	-0.37
79	0.22	2.88	2.75	3.13	7.51	1.28	6.97	6.78	4.59	15.97	9.17	2.15	8.22
1980	0.01	3.37	2.90	3.29	8.34	1.28	1.23	0.96	4.83	2.62	-0.77	2.88	4.94
81	-0.20	3.86	3.04	3.46	9.17	1.28	-6.25	-6.62	5.07	-13.73	-13.34	3.61	0.56
82	-0.42	4.35	3.18	3.62	10.01	1.28	5.71	5.60	5.31	15.71	8.98	4.34	7.39
83	-0.63	4.85	3.33	3.78	10.85	1.28	-6.78	-7.10	5.55	-13.41	-13.10	5.08	0.17
84	-0.84	5.35	3.47	3.95	11.70	1.28	7.50	7.50	5.80	22.48	13.92	5.83	8.30
85	0.00	5.85	0.00	4.11	12.56	1.28	0.27	0.15	6.04	4.73	0.81	6.58	4.19
86	0.00	6.35	0.00	4.28	13.42	1.28	-5.95	-6.17	6.28	-9.27	-9.87	7.34	0.54

ANNUAL AVERAGE SMOOTHED SERIES

DATE	AGR	FISH	FOR	MIN	FOOD	TXT	WOOD	PAPER	CHEM	NMET	BFAB	OTHMFG	ELE
1963-74	2.47	-2.09	1.26	1.43	-0.74	1.28	4.95	4.36	2.09	1.52	-1.67	-5.13	7.50
1975-86	0.11	3.63	2.83	3.38	8.79	1.28	-0.35	-0.62	4.95	-0.22	-3.06	3.27	3.98
1980-86	-0.42	4.85	2.27	3.78	10.86	1.28	-0.61	-0.81	5.55	1.30	-1.91	5.09	3.73
1984-86		5.85		4.11	12.56	1.28	0.60	0.49	6.04	5.98	1.62	6.58	4.35

	CST	TRAD	TST	COM	FIN	SERV	TOT
1963	5.11	1.35	7.70	-2.29	-1.23	-1.57	2.30
64	3.72	0.44	5.03	-1.80	-1.75	-1.57	1.39
65	2.71	-0.20	3.16	-1.32	-2.10	-1.57	0.75
66	2.06	-0.59	1.97	-0.83	-2.27	-1.57	0.37
67	0.90	-1.35	-0.20	-0.34	-2.70	-1.57	-0.39
68	-2.63	-3.83	-6.70	0.16	-4.33	-1.57	-2.87
69	6.62	2.93	10.98	0.65	0.42	-1.57	3.88
1970	3.54	0.81	5.01	1.15	-0.94	-1.57	1.76
71	0.91	-1.01	0.01	1.65	-2.10	-1.57	-0.06
72	-1.72	-2.84	-4.86	2.15	-3.28	-1.57	-1.88
73	6.22	2.99	10.41	2.66	0.84	-1.57	3.94
74	2.15	0.14	2.53	3.17	-1.02	-1.57	1.09
75	-1.84	-2.68	-4.93	3.68	-2.89	-1.57	-1.73
76	1.30	-0.31	1.01	4.19	-1.14	-1.57	0.65
77	1.73	0.09	1.86	4.71	-0.78	-1.57	1.04
78	-5.26	-4.96	-11.03	5.22	-4.21	-1.57	-4.00
79	5.38	2.90	9.07	5.74	1.36	-1.57	3.85
1980	1.55	0.21	1.67	6.27	-0.41	-1.57	1.16
81	-3.60	-3.50	-7.90	6.79	-2.91	-1.57	-2.54
82	4.95	2.85	8.38	7.32	1.61	-1.57	3.80
83	-3.72	-3.42	-8.02	7.85	-2.67	-1.57	-2.46
84	6.48	4.13	11.51	8.39	2.68	-1.57	5.07
85	1.58	0.65	1.98	8.92	0.37	-1.57	1.60
86	-2.72	-2.44	-6.06	9.46	-1.70	-1.57	-1.48

DATE	CST	TRAD	TST	COM	FIN	SERV	TOT
1963-74	2.47	-0.10	2.92	0.42	-1.70	-1.57	0.86
1975-86	0.49	-0.54	-0.20	6.55	-0.89	-1.57	0.41
1980-86	0.65	-0.22	0.22	7.86	-0.43	-1.57	0.74
1984-86	1.78	0.78	2.48	8.93	0.45	-1.57	1.73

Table 78: 'Fitted' Data from Decycling Regressions.

LABOUR PRODUCTIVITY

Annual Per Cent Change

	AGR	FISH	FOR	MIN	FOOD	TXT	WOOD	PAPER	CHEM	NMET	BASFAB	OTHMFG	ELE
1963	2.56	-6.22	-1.88	10.07	1.00	0.34	5.36	11.92	0.91	6.51	14.74	-6.24	6.83
64	2.56	-5.55	-1.59	9.71	1.40	0.48	5.07	9.25	1.28	3.00	10.03	-5.83	6.66
65	2.56	-4.87	-1.30	9.36	1.80	0.61	4.79	7.25	1.65	0.56	6.67	-5.41	6.50
66	2.56	-4.19	-1.01	9.00	2.20	0.75	4.50	5.89	2.02	-0.87	4.52	-4.99	6.33
67	2.56	-3.50	-0.72	8.65	2.61	0.89	4.22	3.67	2.39	-3.66	0.80	-4.56	6.17
68	2.56	-2.81	-0.43	8.30	3.02	1.02	3.94	-2.42	2.76	-12.40	-9.76	-4.14	6.01
69	2.56	-2.11	-0.14	7.95	3.42	1.16	3.65	12.86	3.13	12.87	19.29	-3.71	5.84
1970	2.56	-1.41	0.16	7.60	3.84	1.30	3.37	7.34	3.51	4.44	8.91	-3.28	5.68
71	2.56	-0.71	0.45	7.25	4.25	1.44	3.09	2.66	3.89	-2.43	0.49	-2.85	5.52
72	2.56	0.00	0.75	6.90	4.66	1.58	2.81	-1.91	4.26	-9.00	-7.44	-2.42	5.36
73	2.56	0.72	1.05	6.56	5.08	1.71	2.53	11.07	4.64	13.11	17.54	-1.98	5.19
74	2.56	1.44	1.34	6.21	5.49	1.85	2.26	3.96	5.02	1.87	4.10	-1.54	5.03
75	2.56	2.17	1.64	5.87	5.91	1.99	1.98	-2.82	5.40	-8.45	-8.01	-1.10	4.87
76	2.56	2.90	1.94	5.53	6.33	2.13	1.70	2.05	5.79	0.18	1.30	-0.66	4.71
77	2.56	3.64	2.24	5.19	6.76	2.27	1.43	2.50	6.17	1.66	2.53	-0.22	4.55
78	2.56	4.38	2.54	4.85	7.18	2.41	1.15	-8.95	6.56	-16.20	-17.74	0.22	4.39
79	2.56	5.13	2.85	4.51	7.60	2.55	0.88	8.03	6.95	12.75	14.13	0.67	4.22
1980	2.56	5.88	3.15	4.17	8.03	2.69	0.60	1.45	7.34	2.12	1.73	1.12	4.06
81	2.56	6.64	3.45	3.83	8.46	2.83	0.33	-7.04	7.73	-11.27	-13.44	1.57	3.90
82	2.56	7.40	3.76	3.49	8.89	2.97	0.06	6.53	8.12	12.54	12.43	2.02	3.74
83	2.56	8.17	4.06	3.16	9.32	3.11	-0.22	-7.67	8.51	-11.01	-13.90	2.48	3.58
84	2.56	8.95	4.37	2.83	9.76	3.25	-0.49	8.53	8.90	17.84	17.35	2.94	3.42
85	0.00	9.73	5.52	2.49	10.19	3.39	-0.76	0.26	9.30	3.81	1.41	3.39	3.27
86	0.00	10.51	0.00	2.16	10.63	3.53	-1.03	-6.80	9.70	-7.58	-11.33	3.86	3.11

LABOUR PRODUCTIVITY

Annual Average Smoothed Series

DATE	AGR	FISH	FOR	MIN	FOOD	TXT	WOOD	PAPER	CHEM	NMET	BASFAB	OTHMFG	ELE
1963-74	2.56	-2.43	-0.28	8.13	3.23	1.09	3.80	5.96	2.95	1.17	5.82	-3.91	5.93
1975-86	2.56	6.29	3.00	4.01	8.26	2.76	0.47	-0.33	7.54	-0.30	-1.13	1.36	3.99
1980-86	2.56	8.18	3.76	3.16	9.33	3.11	-0.21	-0.68	8.51	0.92	-0.82	2.48	3.58
1984-86		9.73		2.49	10.19	3.39	-0.76	0.66	9.30	4.69	2.48	3.40	3.27

	CST	TRADE	TSPT	COM	FIN	SERV	TOT
1963	1.22	1.72	5.45	0.81	0.32	-1.03	2.63
64	1.22	0.80	3.55	1.13	-0.22	-1.03	1.83
65	1.22	0.15	2.22	1.45	-0.60	-1.03	1.26
66	1.22	-0.24	1.43	1.78	-0.80	-1.03	0.92
67	1.22	-1.00	-0.13	2.11	-1.25	-1.03	0.24
68	1.22	-3.51	-5.14	2.44	-2.85	-1.03	-1.97
69	1.22	3.32	8.81	2.76	1.63	-1.03	4.04
1970	1.22	1.18	4.33	3.10	0.30	-1.03	2.16
71	1.22	-0.66	0.56	3.43	-0.85	-1.03	0.54
72	1.22	-2.51	-3.16	3.76	-2.01	-1.03	-1.09
73	1.22	3.38	8.93	4.09	1.86	-1.03	4.09
74	1.22	0.50	2.94	4.43	0.04	-1.03	1.56
75	1.22	-2.35	-2.84	4.76	-1.77	-1.03	-0.95
76	1.22	0.05	2.01	5.10	-0.16	-1.03	1.17
77	1.22	0.44	2.82	5.44	0.14	-1.03	1.51
78	1.22	-4.66	-7.39	5.78	-3.16	-1.03	-2.99
79	1.22	3.29	8.75	6.12	2.08	-1.03	4.01
1980	1.22	0.57	3.07	6.46	0.36	-1.03	1.62
81	1.22	-3.17	-4.48	6.80	-2.05	-1.03	-1.67
82	1.22	3.24	8.64	7.14	2.19	-1.03	3.97
83	1.22	-3.10	-4.32	7.49	-1.90	-1.03	-1.61
84	1.22	4.53	11.38	7.83	3.11	-1.03	5.10
85	1.22	1.01	3.99	8.18	0.88	-1.03	2.02
86	1.22	-2.10	-2.35	8.53	-1.11	-1.03	-0.73

DATE	CST	TRADE	TSPT	COM	FIN	SERV	TOT
1963-74	1.22	0.26	2.48	2.61	-0.37	-1.03	1.35
1975-86	1.22	-0.19	1.61	6.63	-0.12	-1.03	0.95
1980-86	1.22	0.14	2.28	.7.49	0.21	-1.03	1.24
1984-86	1.22	1.15	4.34	8.18	0.96	-1.03	2.13

Table 8: Decycled Data: Total, Labour and Capital Productivity

	TOTAL	LABOUR	CAPITAL	annual % chg TOTAL FACTOR	LABOUR PROD	CAPITAL PROD
1960	0.633	0.605	0.631			
61	0.654	0.635	0.656			
62	0.958	0.870	1.113			
63	0.973	0.896	1.134	1.51	3.00	1.90
64	1.011	0.924	1.171	3.94	3.18	3.25
65	1.011	0.924	1.170	-0.06	-0.05	-0.08
66	1.001	0.924	1.151	-0.93	0.08	-1.66
67	1.015	0.938	1.157	1.42	1.44	0.55
68	1.008	0.938	1.148	-0.69	0.06	-0.81
69	1.006	0.939	1.138	-0.22	0.04	-0.85
1970	1.033	0.966	1.162	2.63	2.90	2.12
71	1.046	0.968	1.177	1.26	0.22	1.27
72	1.056	0.997	1.183	0.98	2.98	0.50
73	1.053	1.007	1.151	-0.29	0.98	-2.69
74	1.082	1.036	1.169	2.74	2.89	1.54
75	1.092	1.054	1.163	0.92	1.78	-0.50
76	1.081	1.054	1.131	-0.97	-0.02	-2.75
77	1.058	1.053	1.086	-2.09	-0.14	-3.97
78	1.046	1.038	1.071	-1.15	-1.42	-1.34
79	1.033	1.027	1.052	-1.24	-1.05	-1.76
1980	1.042	1.035	1.060	0.79	0.82	0.70
81	1.065	1.057	1.079	2.26	2.07	1.78
82	1.073	1.077	1.081	0.74	1.91	0.24
83	1.097	1.098	1.089	2.20	2.00	0.74
84	1.099	1.103	1.084	0.20	0.44	-0.46
85	1.146	1.161	1.120	4.31	5.26	3.31
86	1.156	1.200	1.091	0.82	3.37	-2.61

DECYCLED DATA

Annual Average Per Cent Change.

	TOTAL	LABOUR	CAPITAL
1963-74	1.02	1.48	0.42
1975-86	0.57	1.25	-0.55
1980-86	1.62	2.27	0.53
1984-86	1.78	3.02	0.08

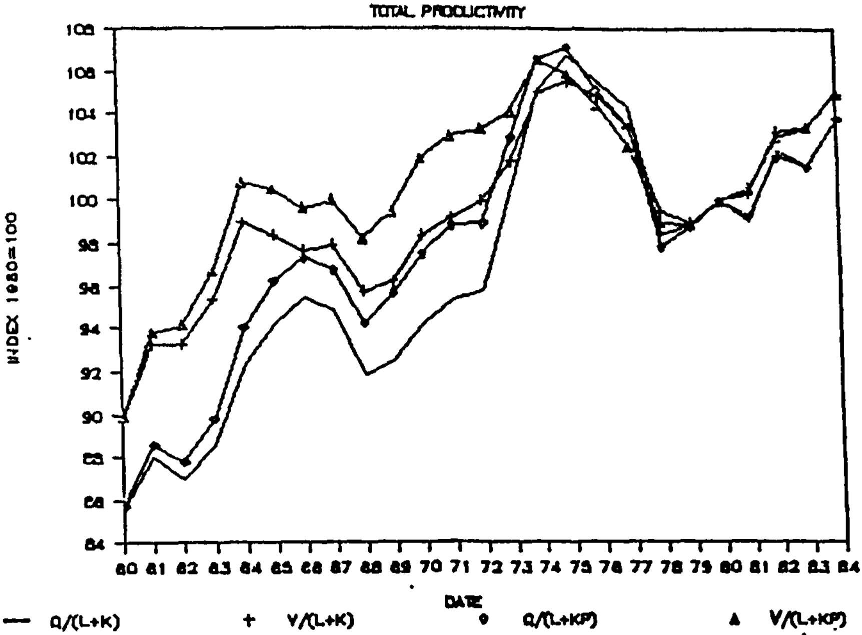
APPENDIX 3: Annual graphs Total Factor and Labour Productivity for 22 SNA sectors of the economy.

Provided are both 'real gross output' and 'value-added' measures of productivity, using both the Total Capital and Plant and Machinery definitions of capital stock.

Key

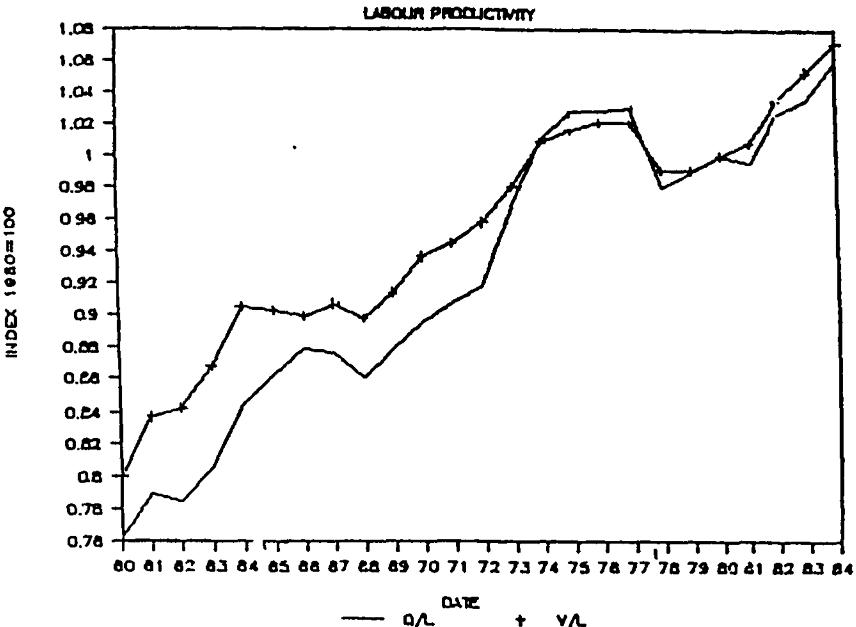
Q=Real Gross Output
V=Real Net Output (value-added)
L=Labour Employed (number)
K=Total Capital Stock
KP=Plant and Equipment Capital Stock.

TOTAL

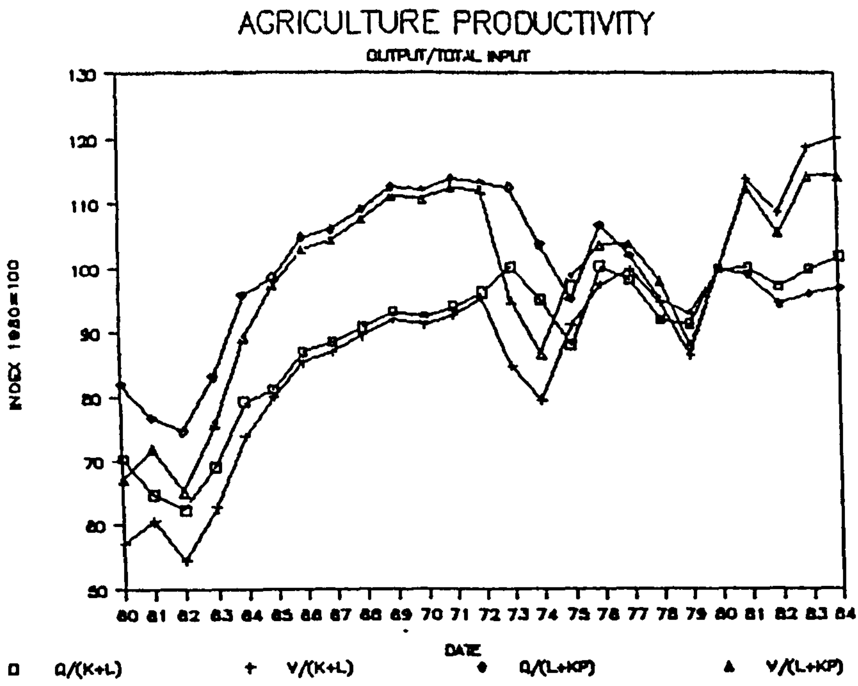


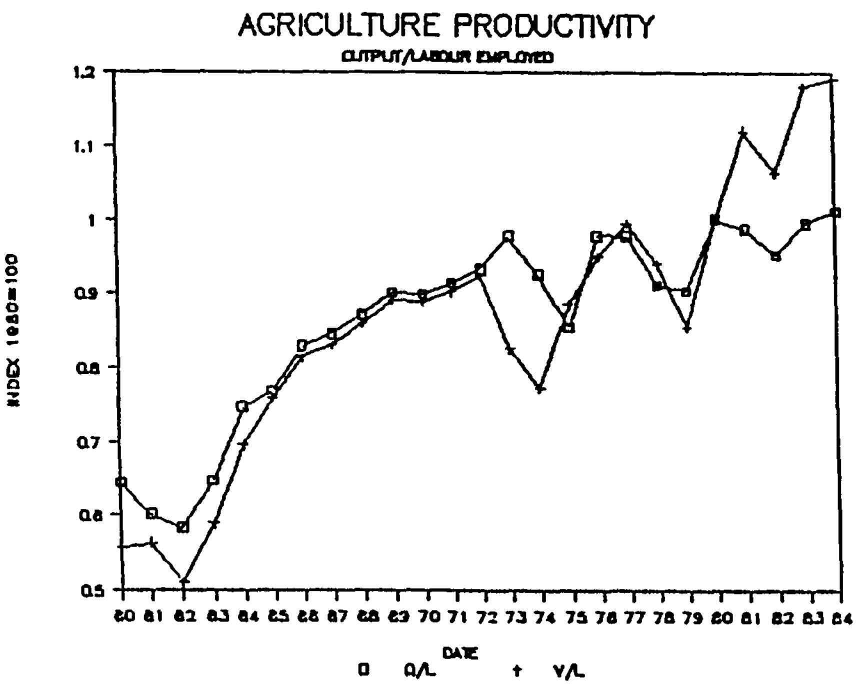
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)

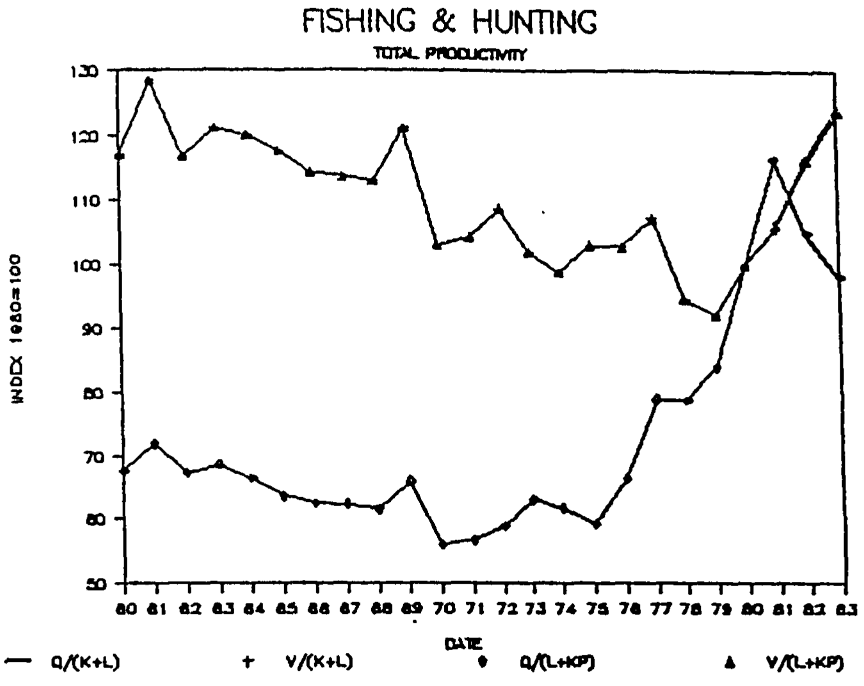
TOTAL

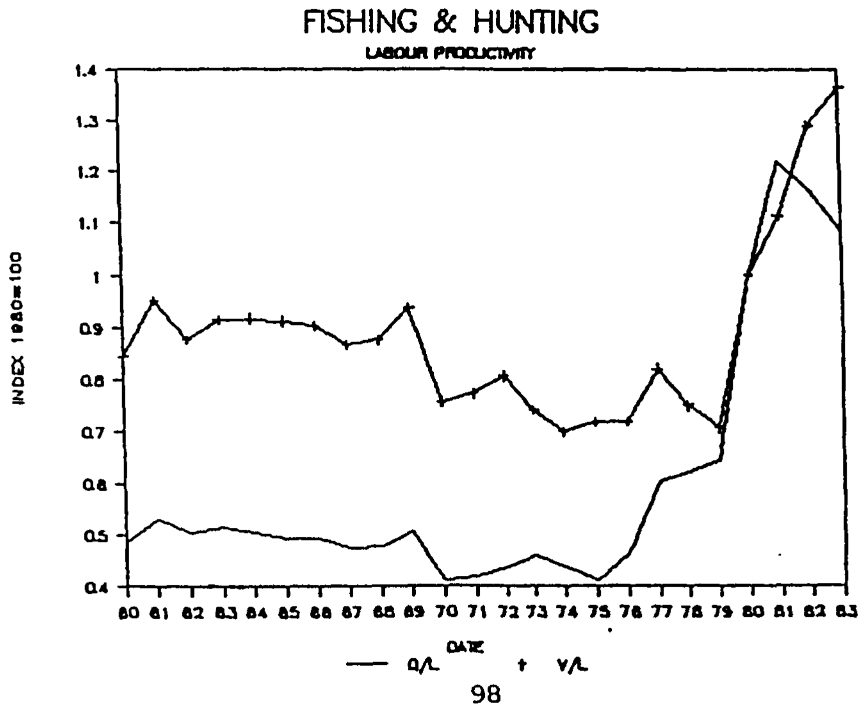


LABOUR PRODUCTIVITY
INDEX 1980=100
DATE
Q/L
V/L

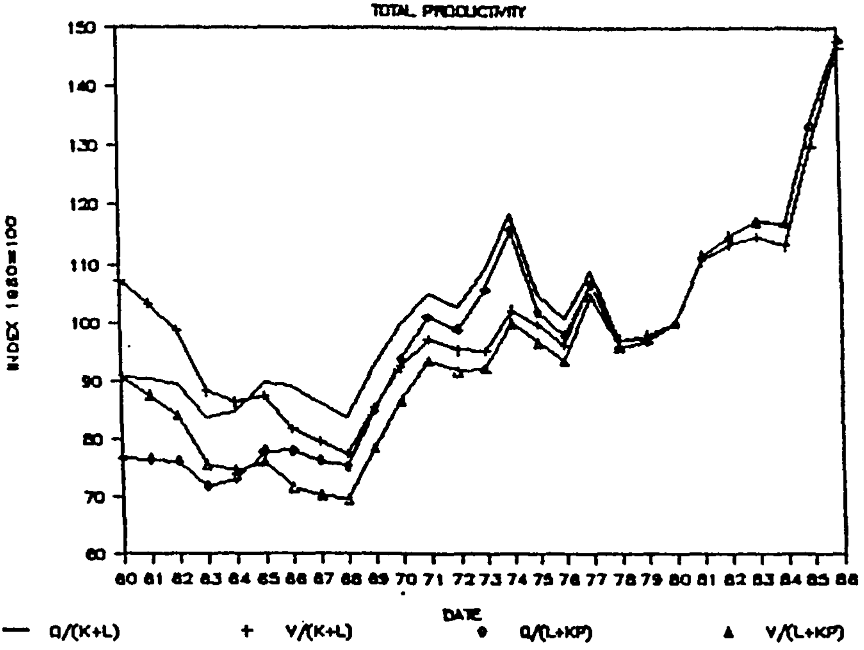

AGRICULTURE PRODUCTIVITY
OUTPUT/TOTAL INPUT
INDEX 1980=100
DATE
Q/(K+L)
V/(K+L)
Q/(L+KP)
V/(L+KP)


AGRICULTURE PRODUCTIVITY
OUTPUT/LABOUR EMPLOYED
INDEX 1980=100
DATE
Q/L
V/L

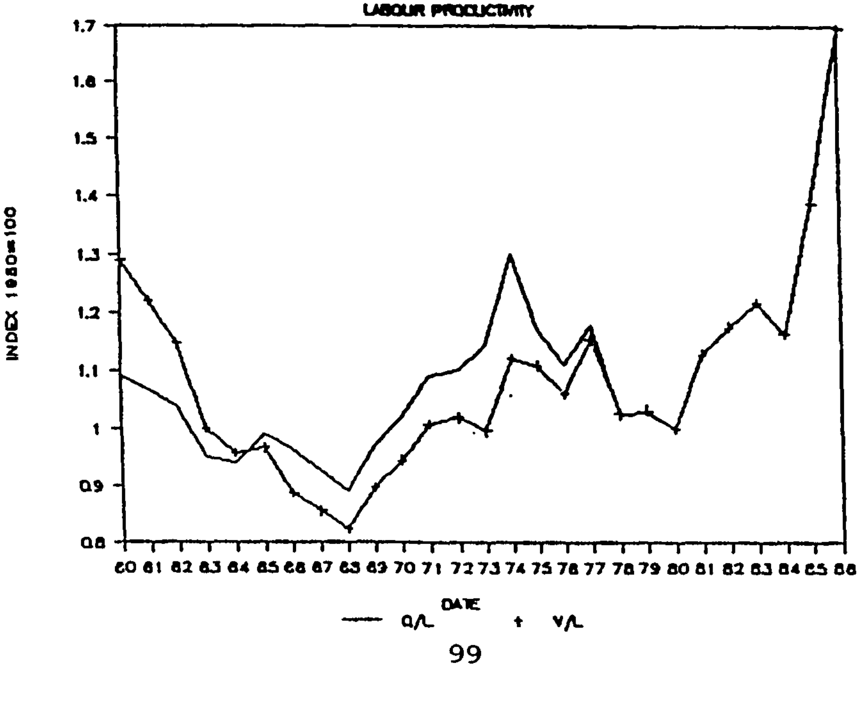

FISHING & HUNTING
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/(K+L)
V/(K+L)
Q/(L+KP)
V/(L+KP)


FISHING & HUNTING
LABOUR PRODUCTIVITY
INDEX 1980=100
DATE
Q/L
V/L

FORESTRY & LOGGING

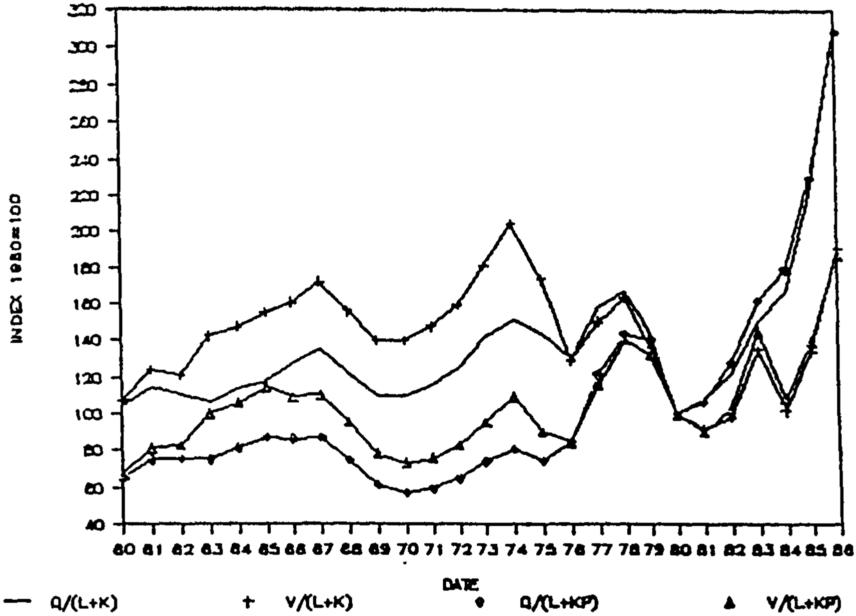


FORESTRY & LOGGING



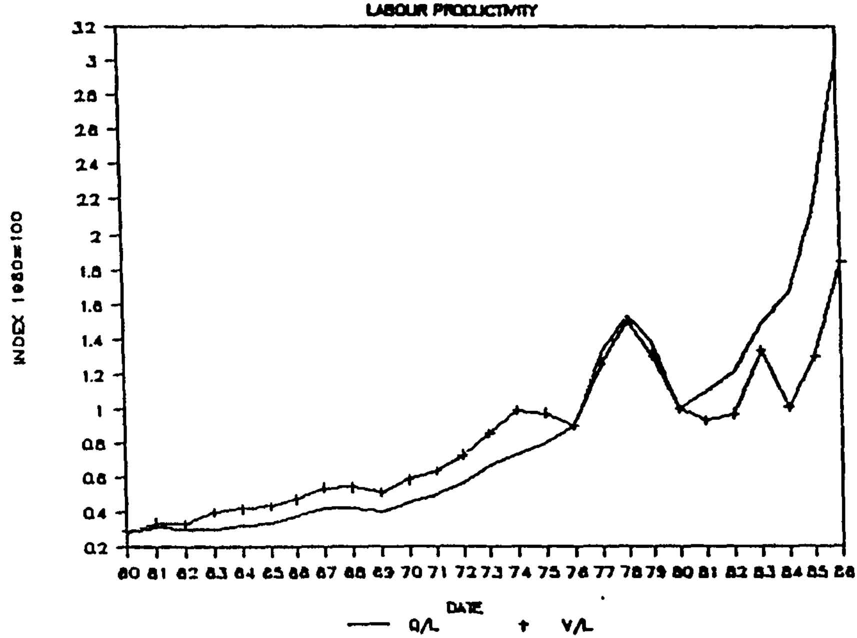
MINING & QUARRYING

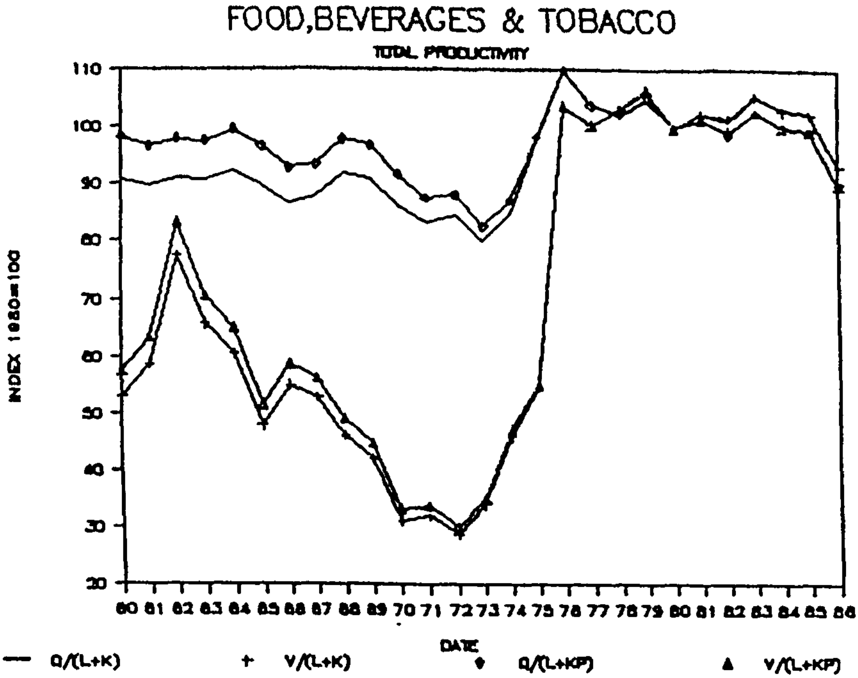
TOTAL PRODUCTIVITY

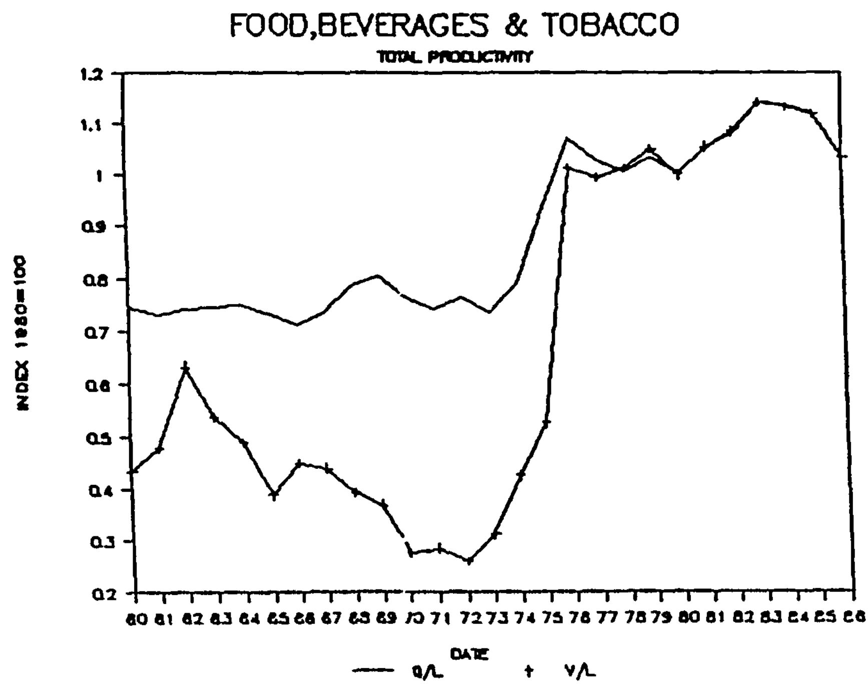


MINING & QUARRYING

LABOUR PRODUCTIVITY

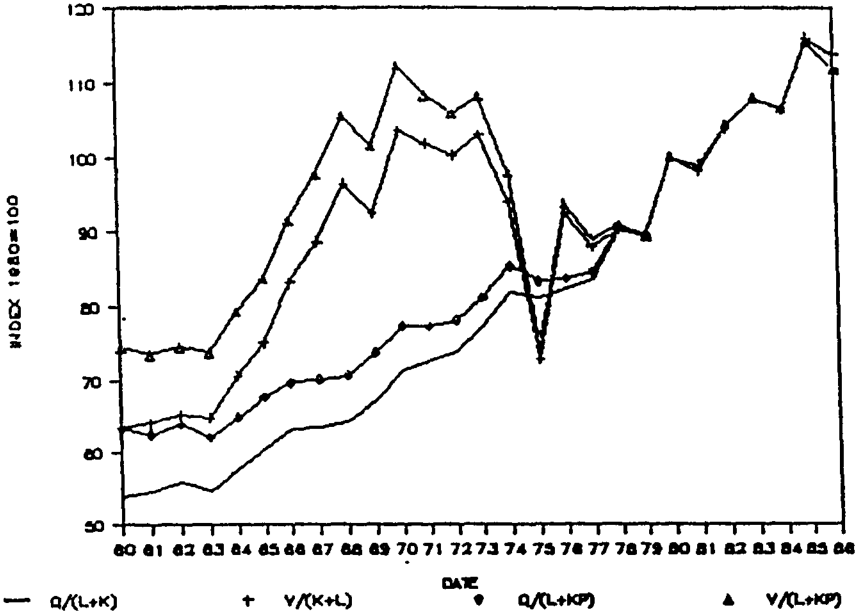



FOOD,BEVERAGES & TOBACCO
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)


FOOD,BEVERAGES & TOBACCO
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/L
V/L

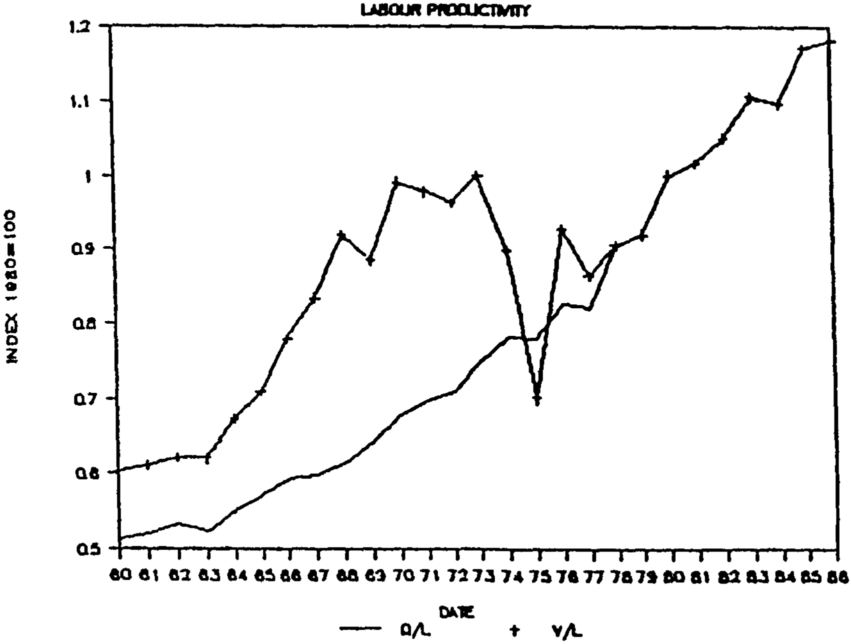
TEXTILES, APPAREL & LEATHER

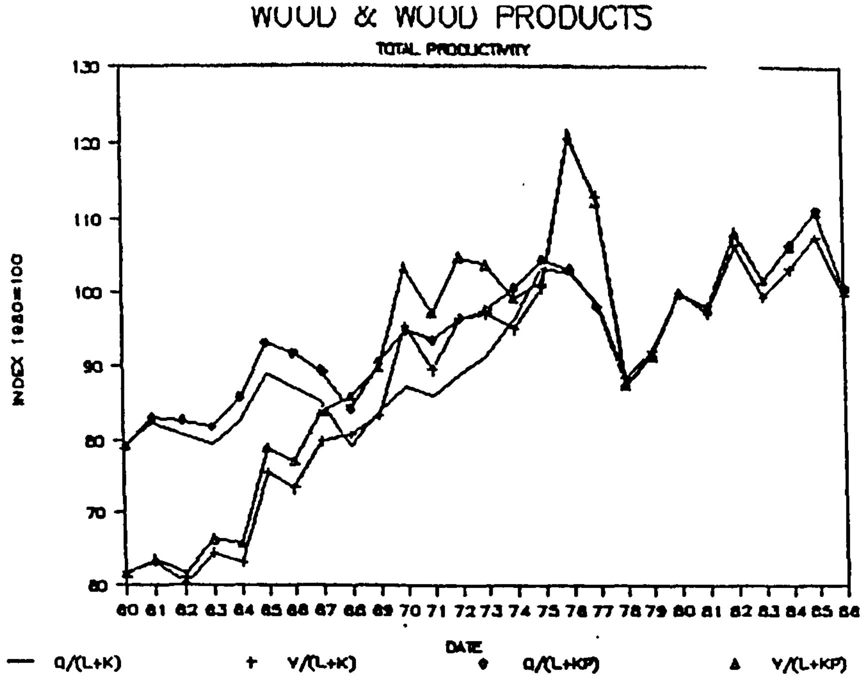
TOTAL PRODUCTIVITY



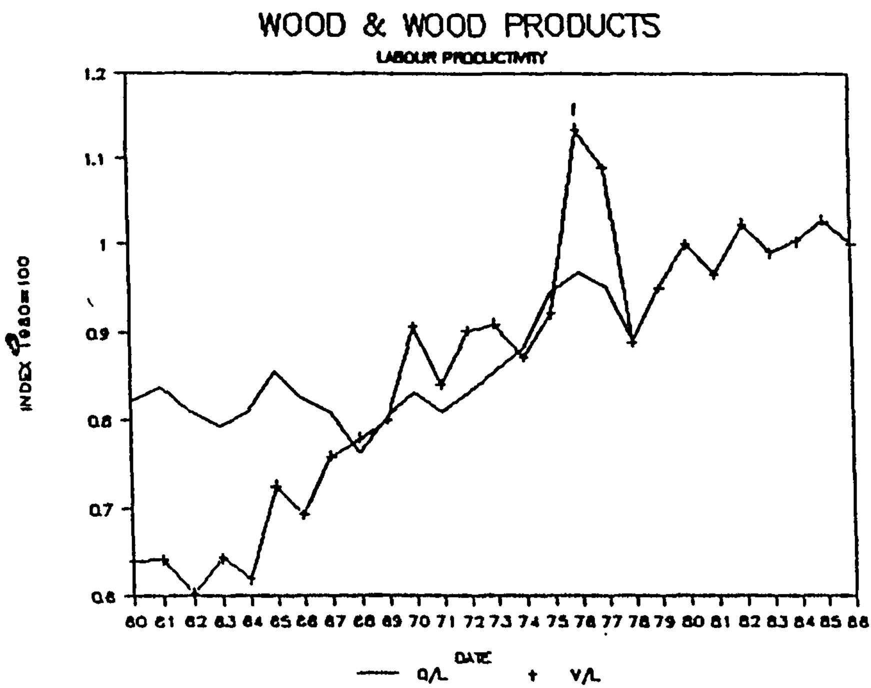
TEXTILES, APPAREL & LEATHER

LABOUR PRODUCTIVITY

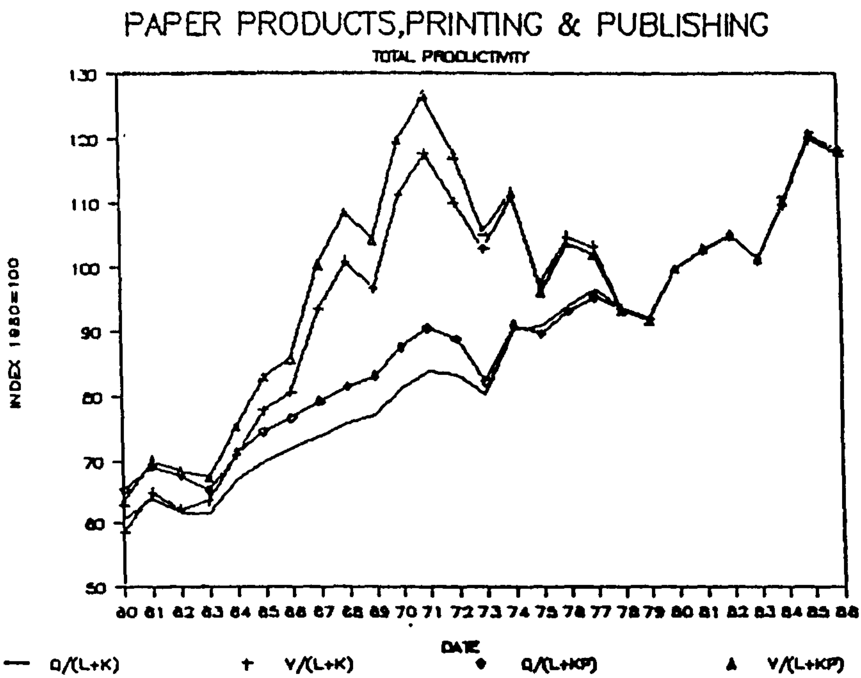


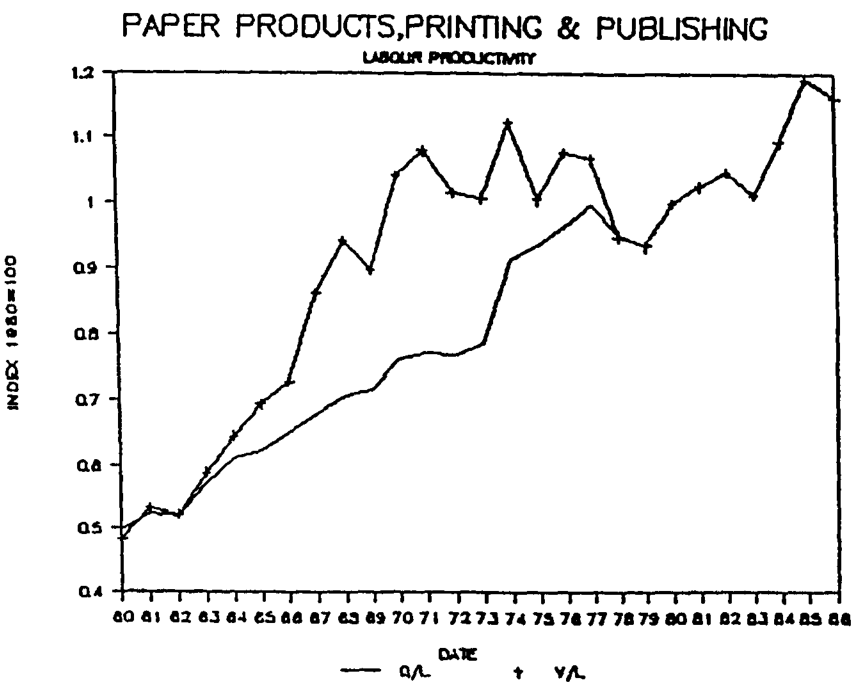


WOOD & WOOD PRODUCTS
TOTAL PRODUCTIVITY
INDEX 1980=100
130
120
110
100
90
80
70
60
60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)



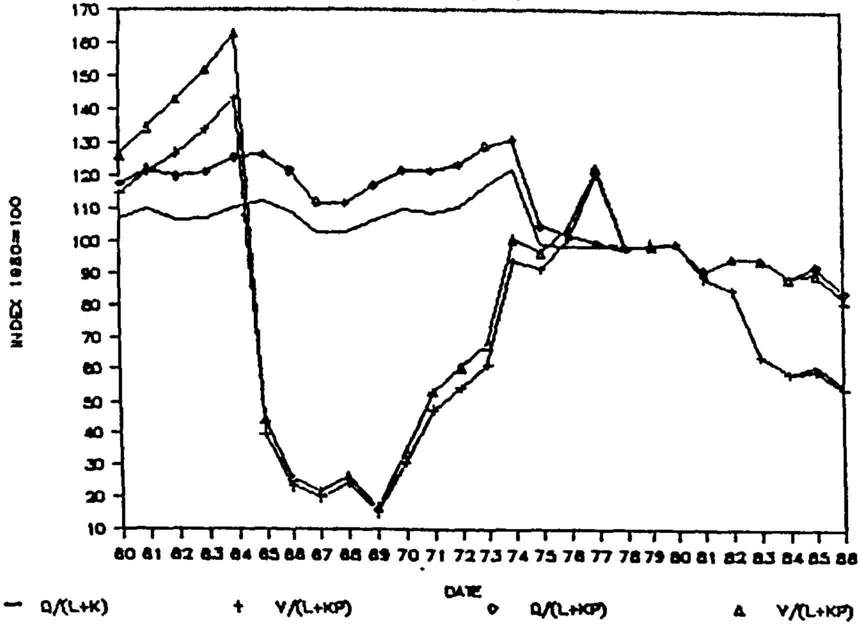
WOOD & WOOD PRODUCTS
LABOUR PRODUCTIVITY
INDEX 1980=100
1.2
1.1
1
0.9
0.8
0.7
0.6
60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
DATE
Q/L
V/L


PAPER PRODUCTS,PRINTING & PUBLISHING
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)


PAPER PRODUCTS,PRINTING & PUBLISHING
LABOUR PRODUCTIVITY
INDEX 1980=100
DATE
Q/L
V/L

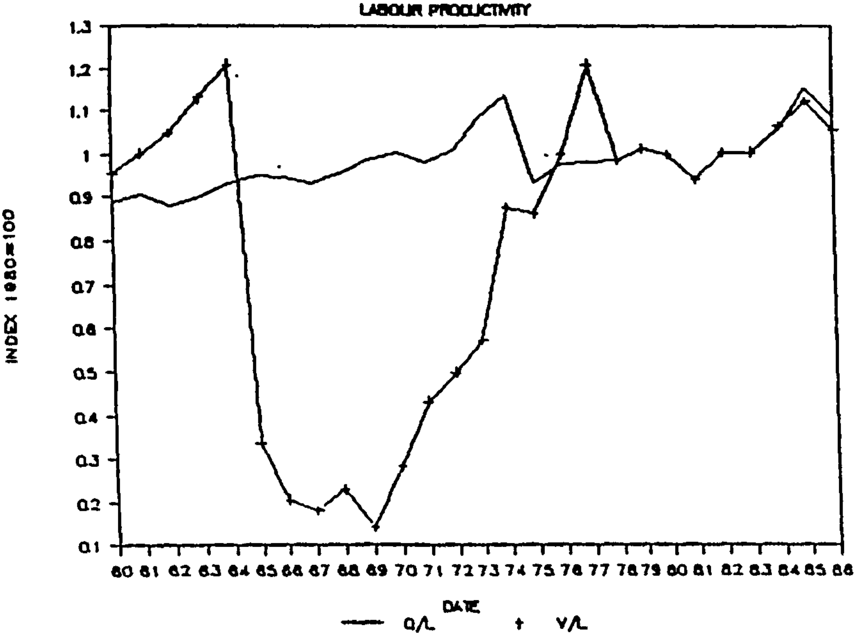
CHEM,PETROL,RUBBER & PLASTICS

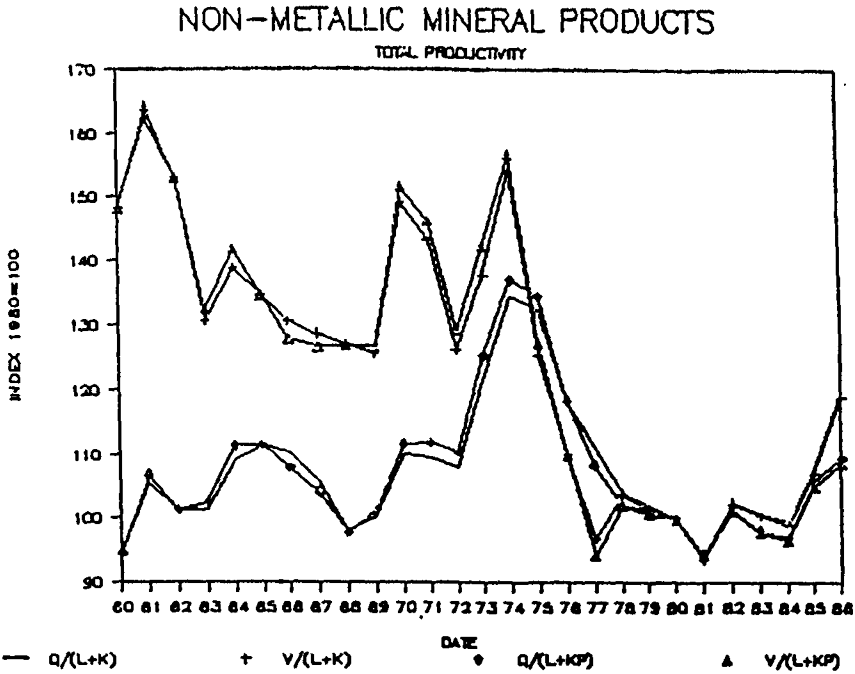
TOTAL PRODUCTIVITY

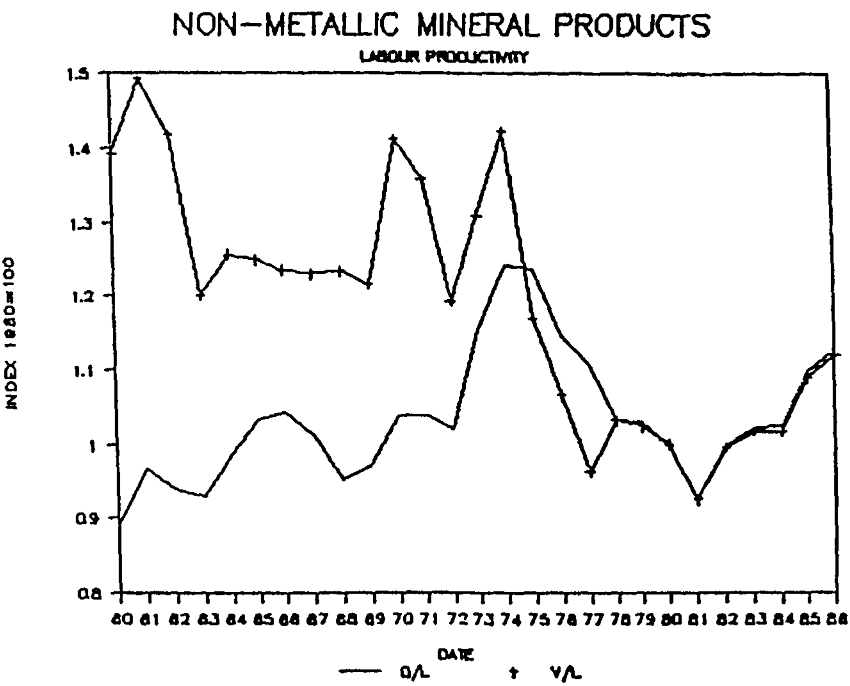


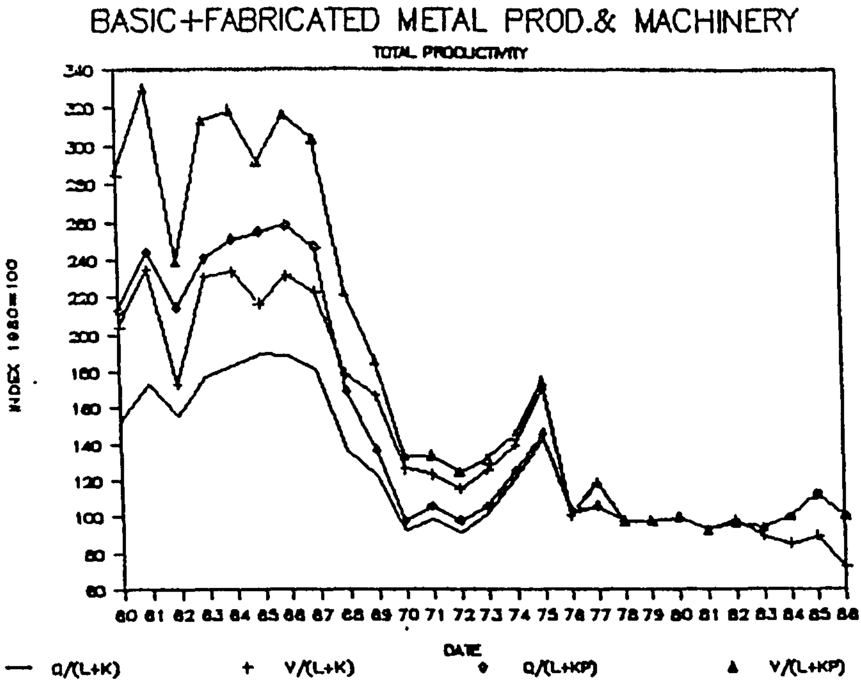
CHEM,PETROL,RUBBER & PLASTICS

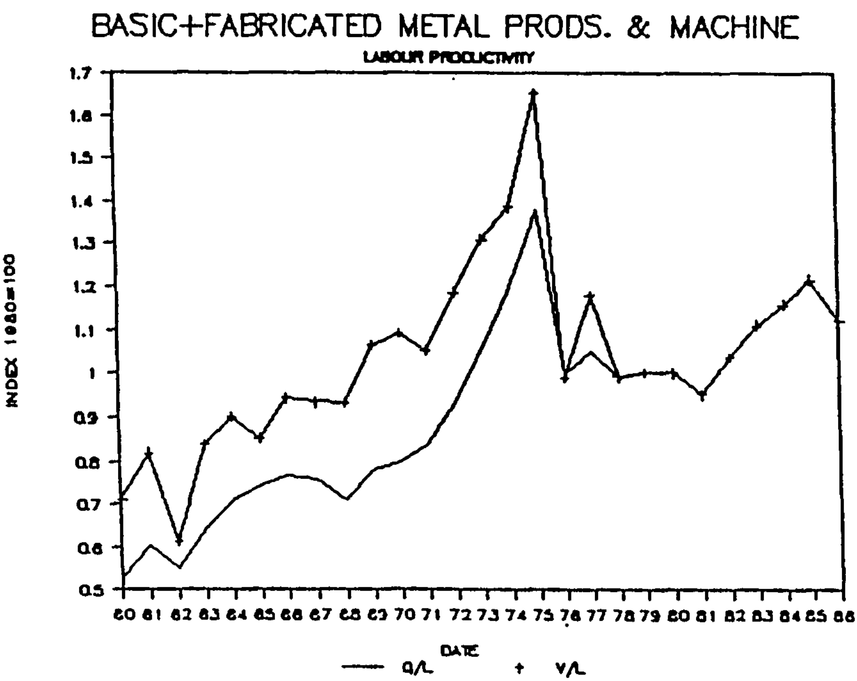
LABOUR PRODUCTIVITY




NON-METALLIC MINERAL PRODUCTS
TOTAL PRODUCTIVITY
INDEX 1980=100
170
160
150
140
130
120
110
100
90
60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)

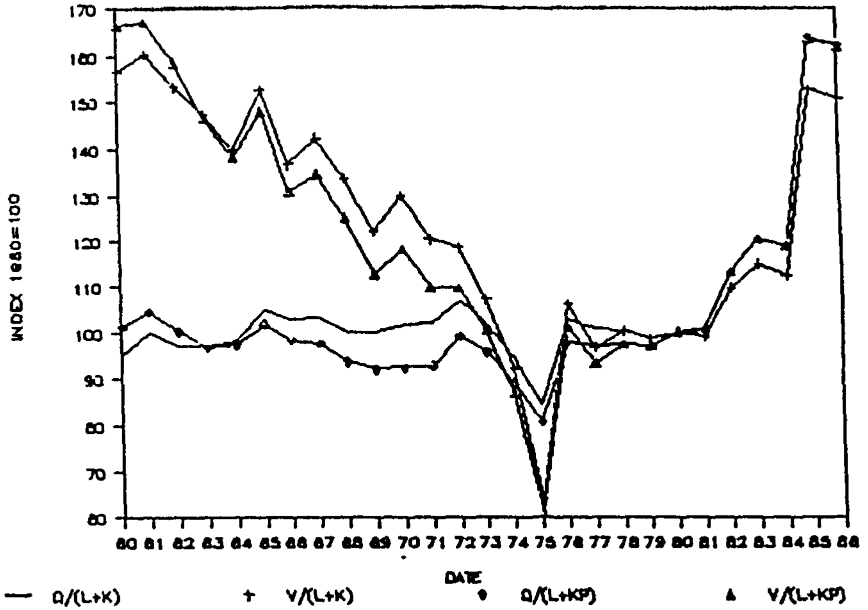

NON-METALLIC MINERAL PRODUCTS
LABOUR PRODUCTIVITY
INDEX 1980=100
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
DATE
Q/L
V/L


BASIC+FABRICATED METAL PROD.& MACHINERY
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)


BASIC+FABRICATED METAL PRODS. & MACHINE
LABOUR PRODUCTIVITY
INDEX 1980=100
DATE
Q/L
V/L

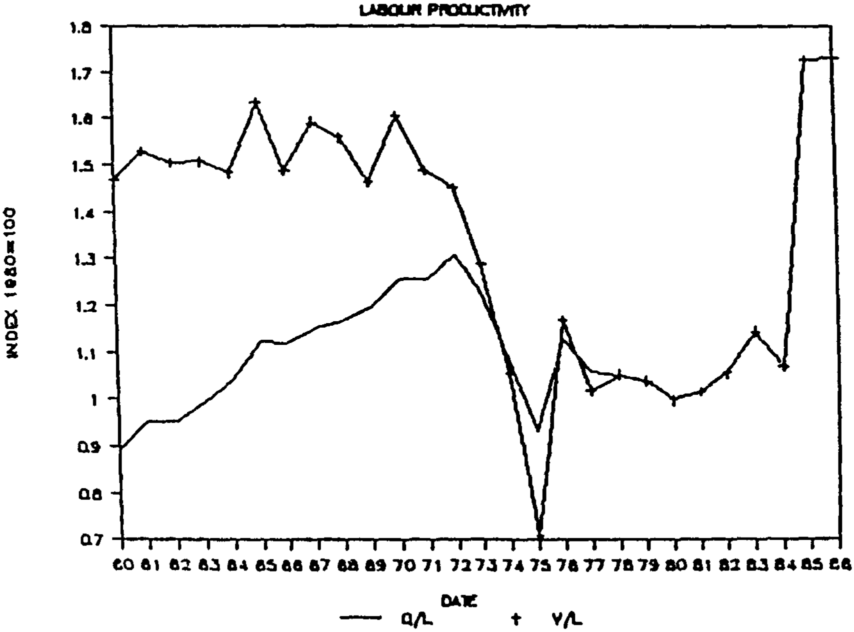
OTHER MANUFACTURING

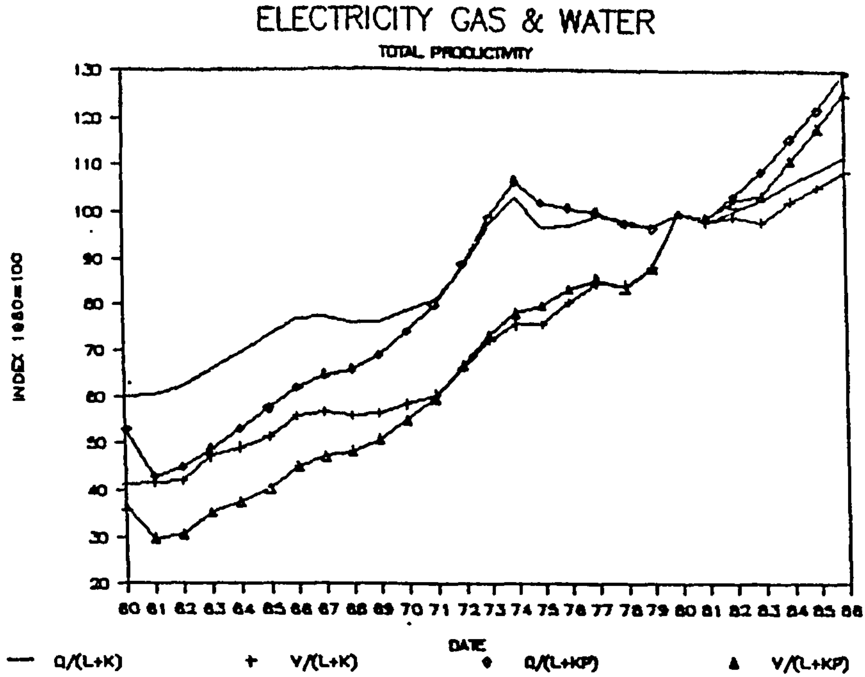
TOTAL PRODUCTIVITY

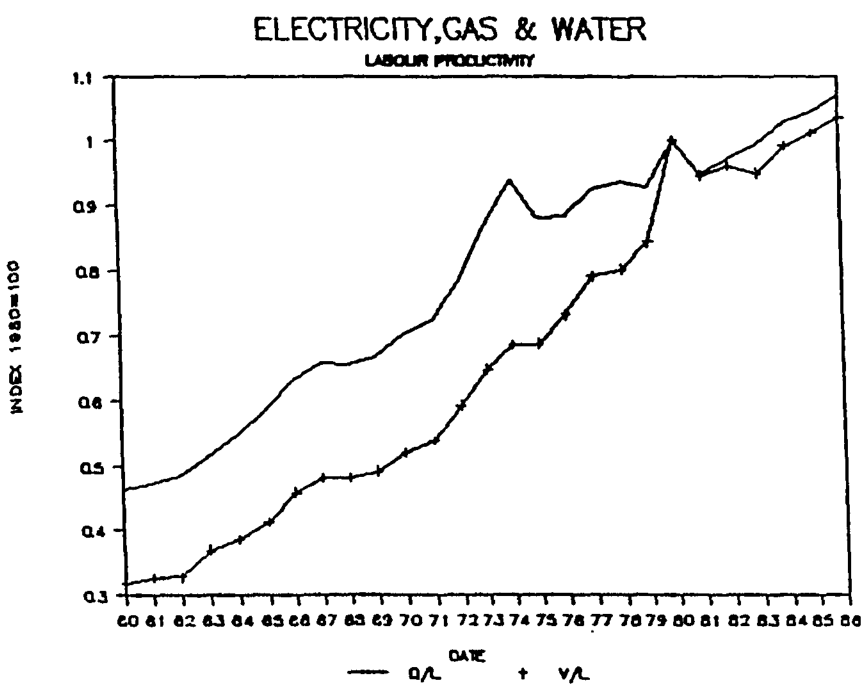


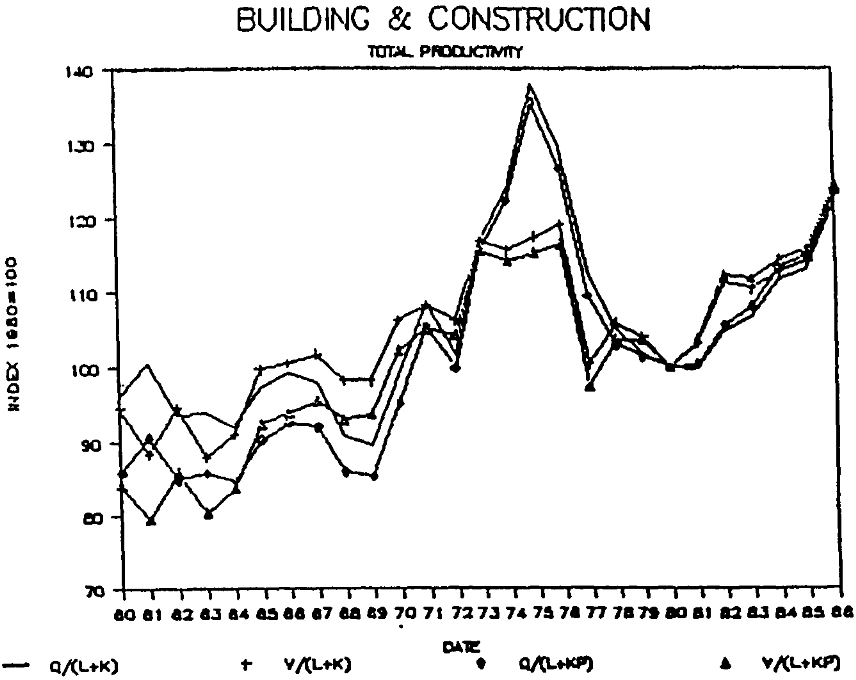
OTHER MANUFACTURING

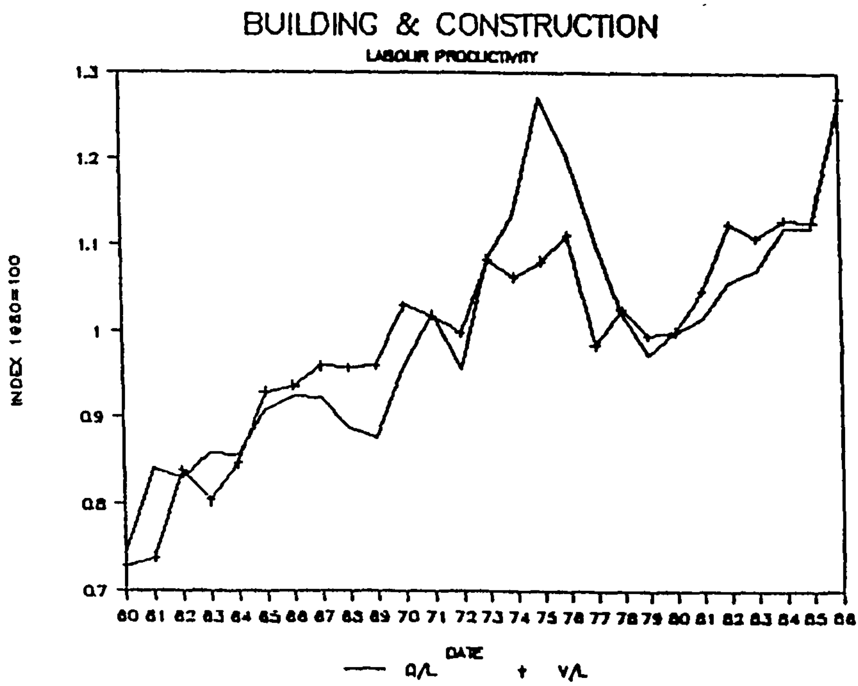
LABOUR PRODUCTIVITY




ELECTRICITY GAS & WATER
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)

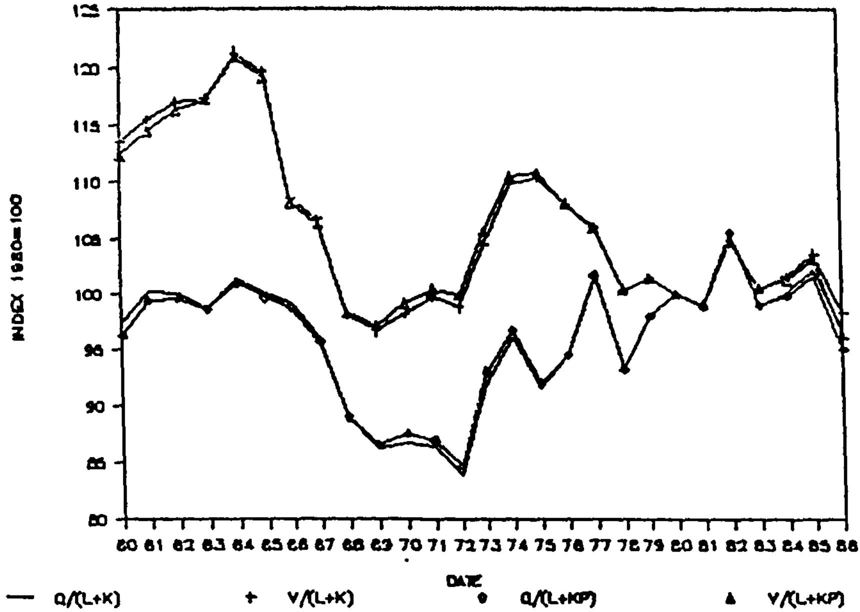

ELECTRICITY,GAS & WATER
LABOUR PRODUCTIVITY
INDEX 1980=100
DATE
Q/L
V/L


BUILDING & CONSTRUCTION
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)


BUILDING & CONSTRUCTION
LABOUR PRODUCTIVITY
INDEX 1980=100
DATE
Q/L
V/L

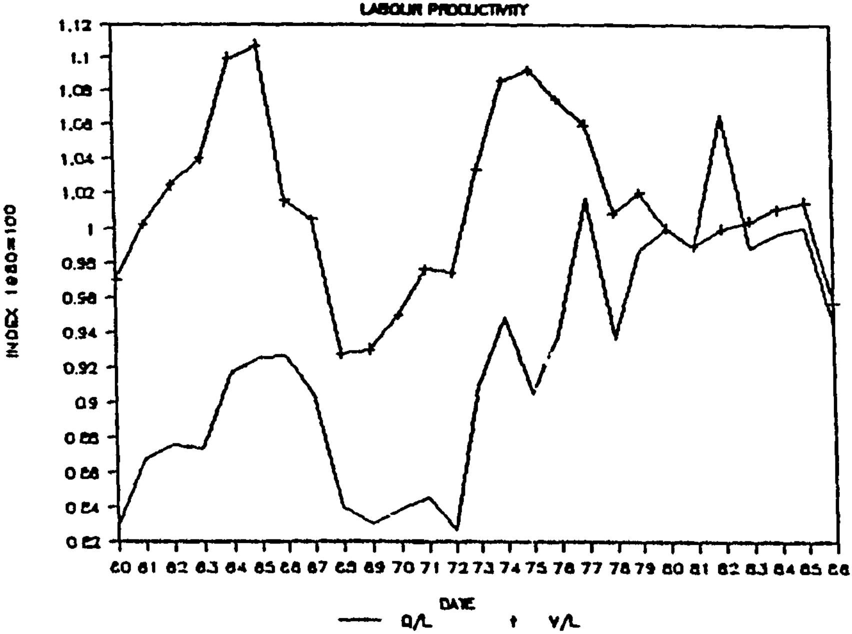
WHOL. RETAIL TRADE,RESTAURANT & HOTELS

TOTAL PRODUCTIVITY

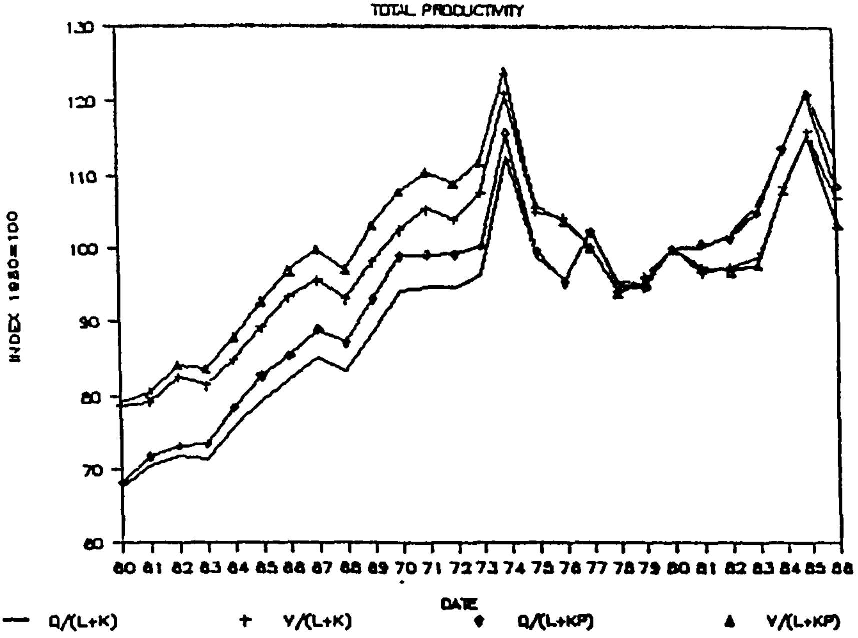


WHOL,RETAIL TRADE,RESTAURANTS,HOTELS

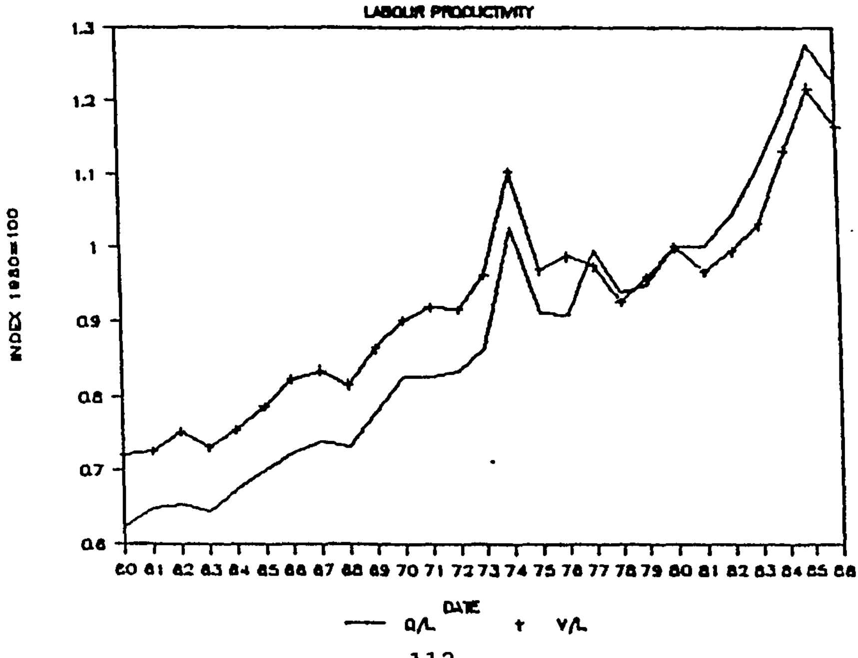
LABOUR PRODUCTIVITY



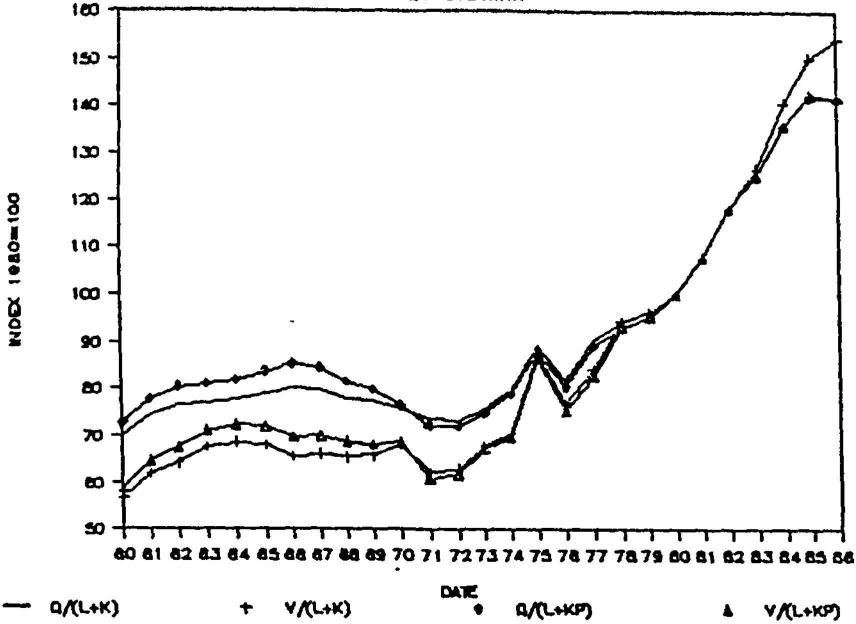
TRANSPORT & STORAGE



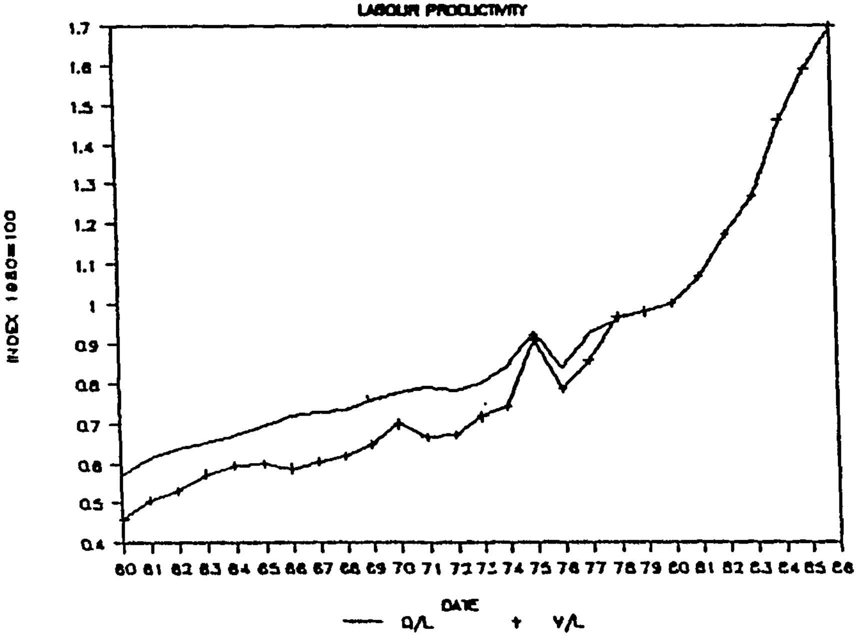
TRANSPORT & STORAGE

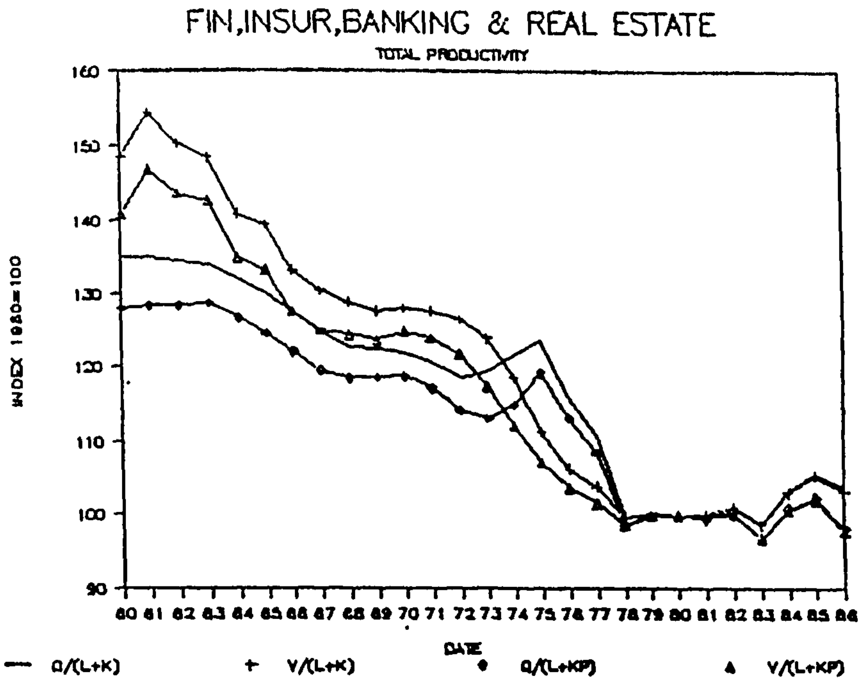


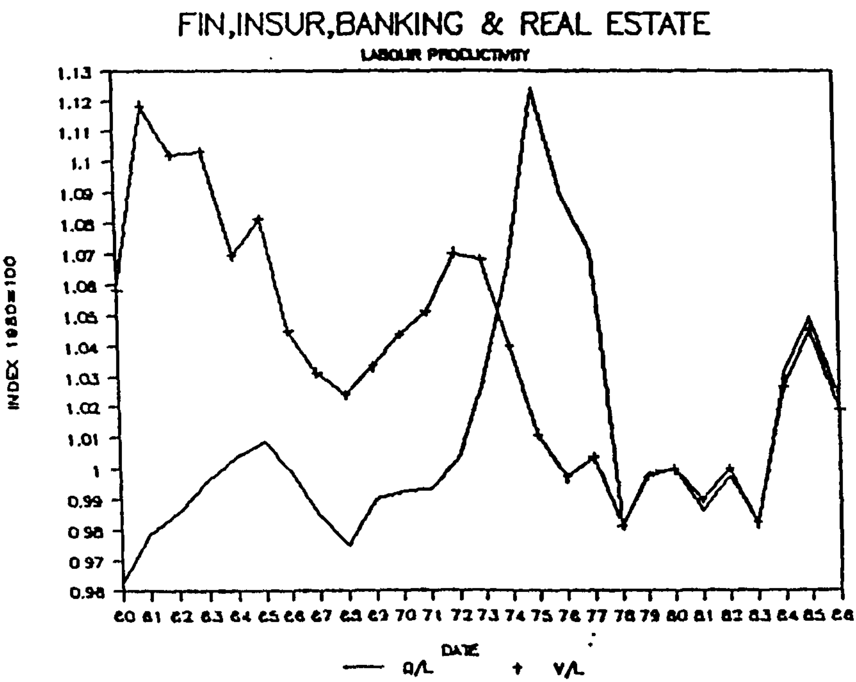
COMMUNICATIONS
TOTAL PRODUCTIVITY

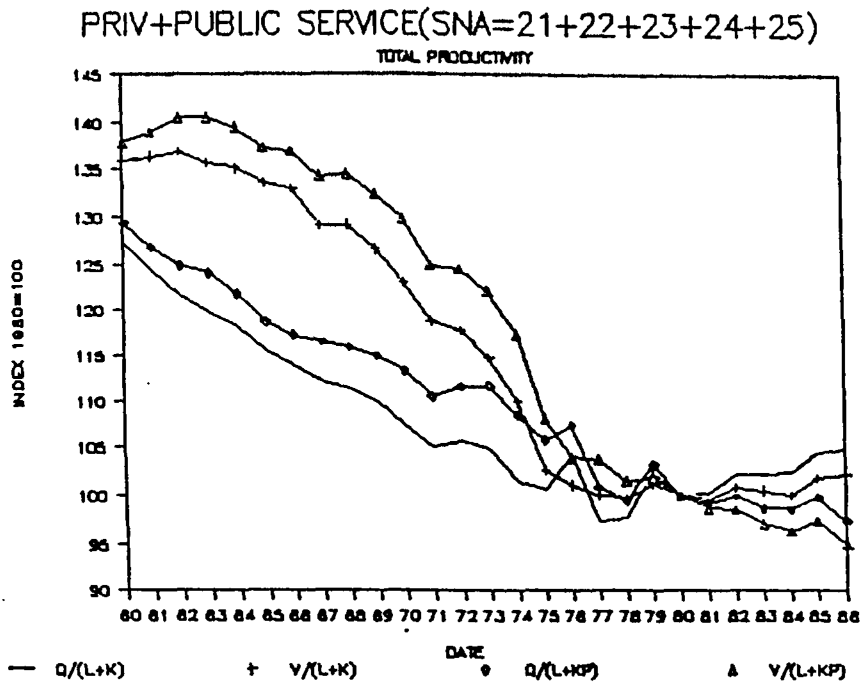


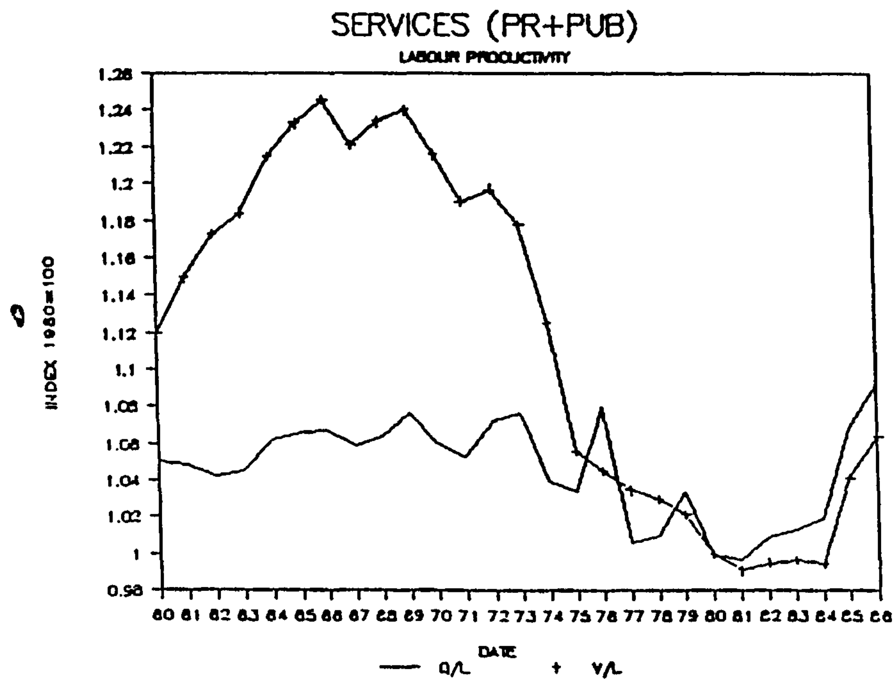
COMMUNICATIONS
LABOUR PRODUCTIVITY




FIN,INSUR,BANKING & REAL ESTATE
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)


FIN,INSUR,BANKING & REAL ESTATE
LABOUR PRODUCTIVITY
INDEX 1980=100
DATE
Q/L
V/L

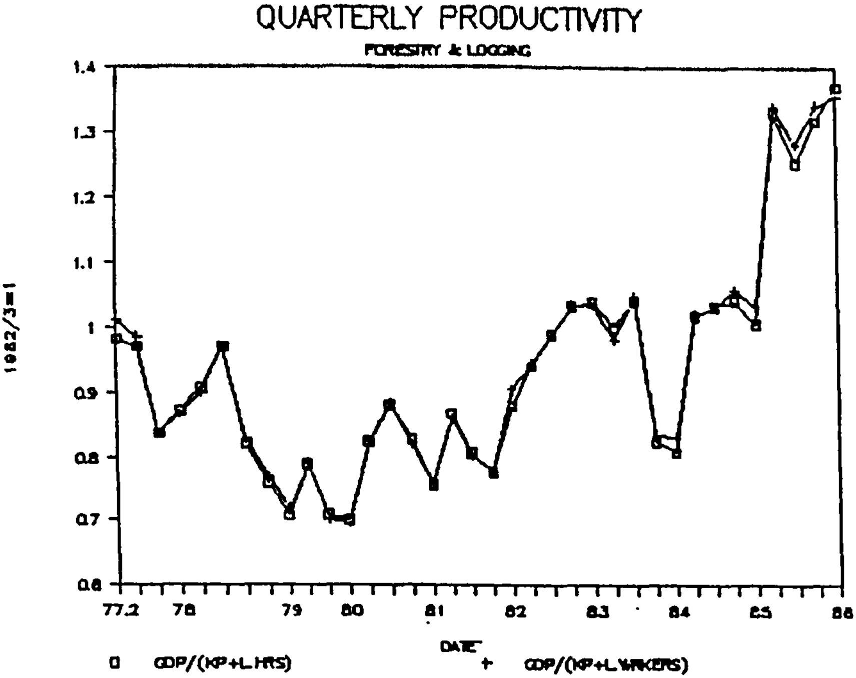

PRIV+PUBLIC SERVICE(SNA=21+22+23+24+25)
TOTAL PRODUCTIVITY
INDEX 1980=100
DATE
Q/(L+K)
V/(L+K)
Q/(L+KP)
V/(L+KP)

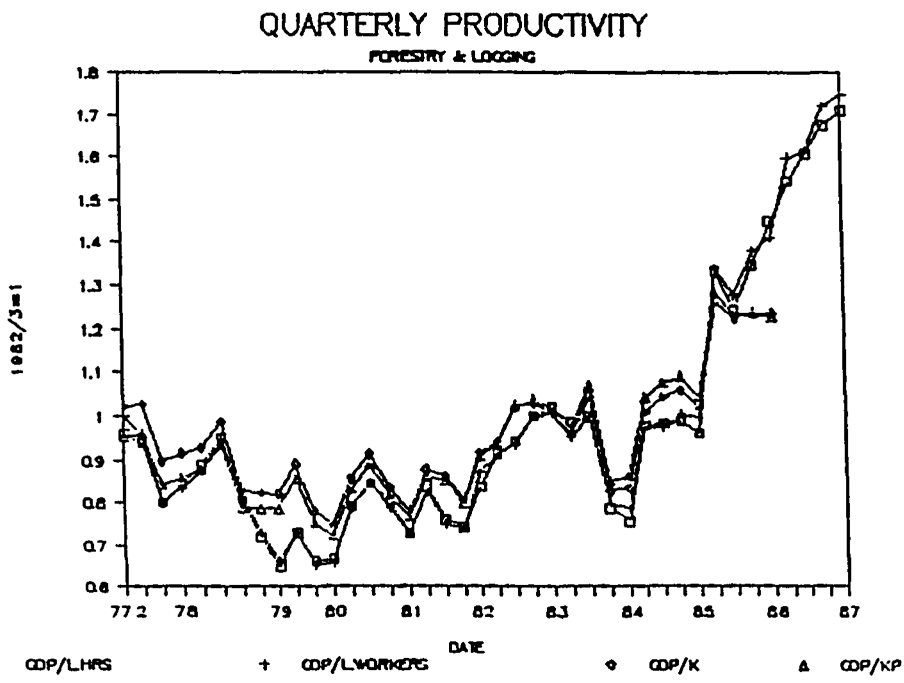

SERVICES (PR+PUB)
LABOUR PRODUCTIVITY
INDEX 1980=100
DATE
Q/L
V/L

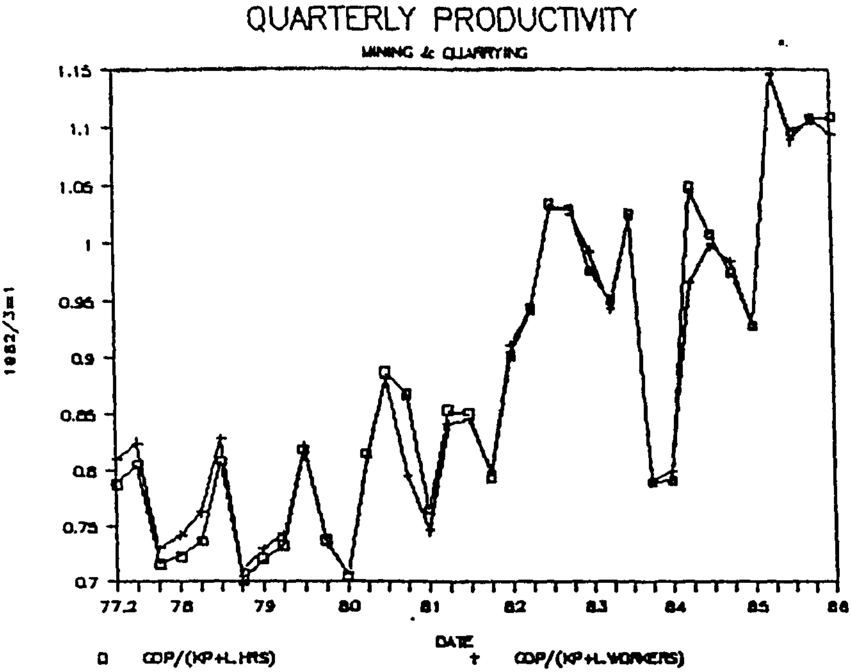
Quarterly Graphs: Graphs for Total, Labour and Capital productivity for the 9 quarterly SNA sectors of the economy.

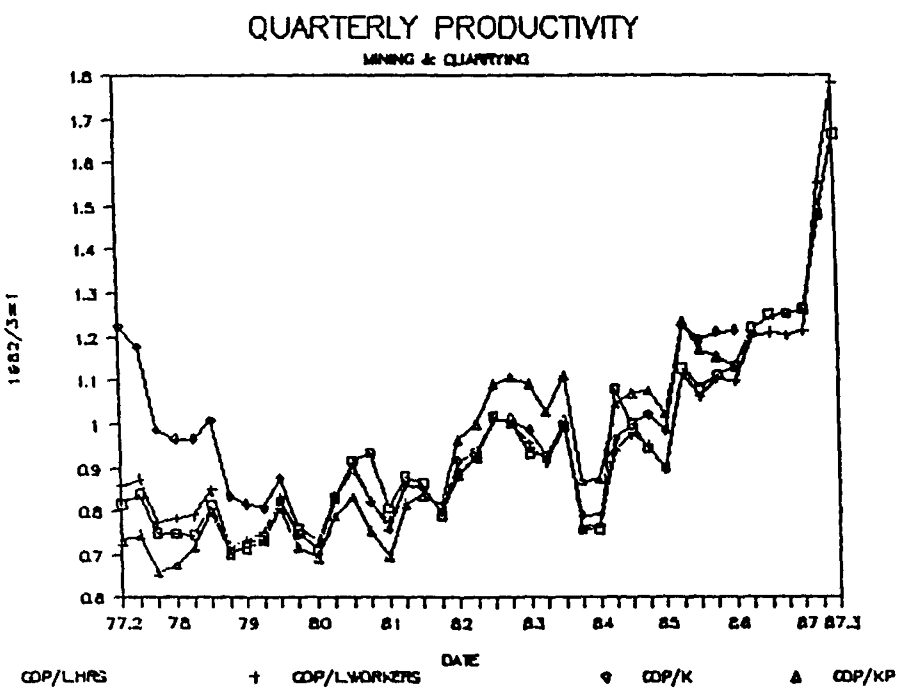
The key to these graphs is the same as that presented in table (2b), with the addition that:

K=Total Capital Stock.


QUARTERLY PRODUCTIVITY
FORESTRY & LOGGING
1982/3=1
DATE
GDP/(KP+L.HRS)
GDP/(KP+L.WRKERS)

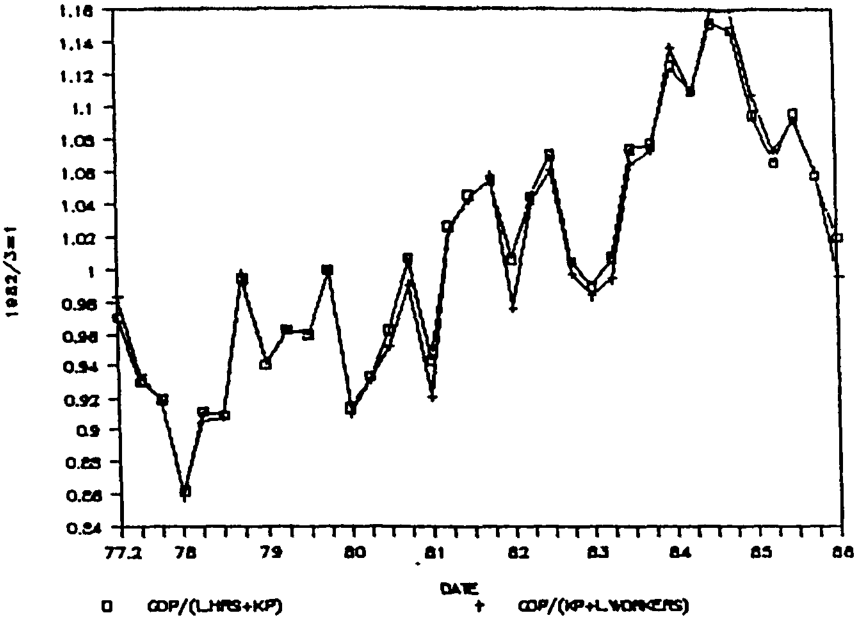

QUARTERLY PRODUCTIVITY
FORESTRY & LOGGING
1982/3=1
DATE
GDP/L.HRS
GDP/L.WORKERS
GDP/K
GDP/KP


QUARTERLY PRODUCTIVITY
MINING & QUARRYING
1982/3=1
DATE
GDP/(KP+L.HRS)
GDP/(KP+L.WORKERS)


QUARTERLY PRODUCTIVITY
MINING & QUARRYING
1982/3=1
DATE
GDP/L.HRS
GDP/L.WORKERS
GDP/K
GDP/KP

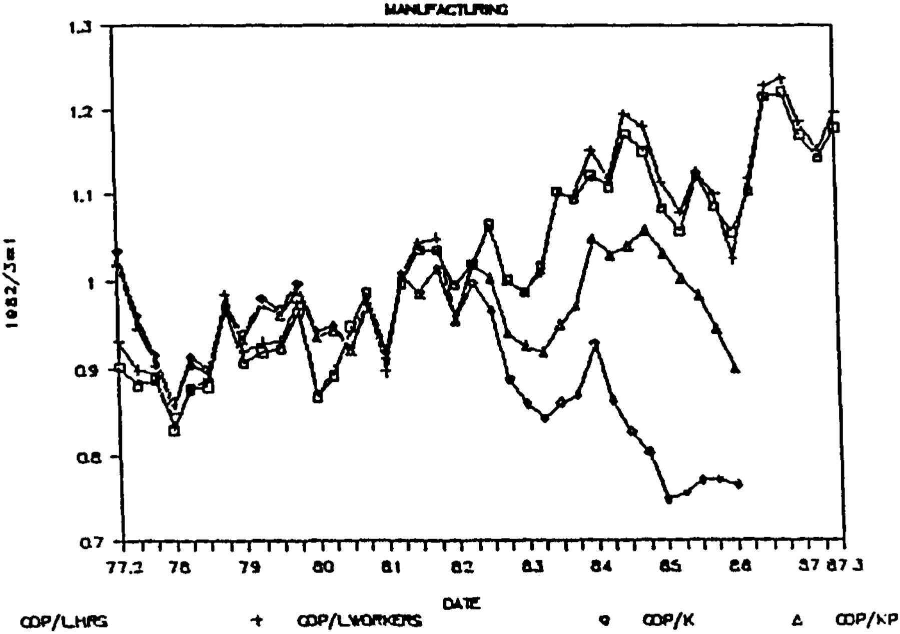
QUARTERLY PRODUCTIVITY

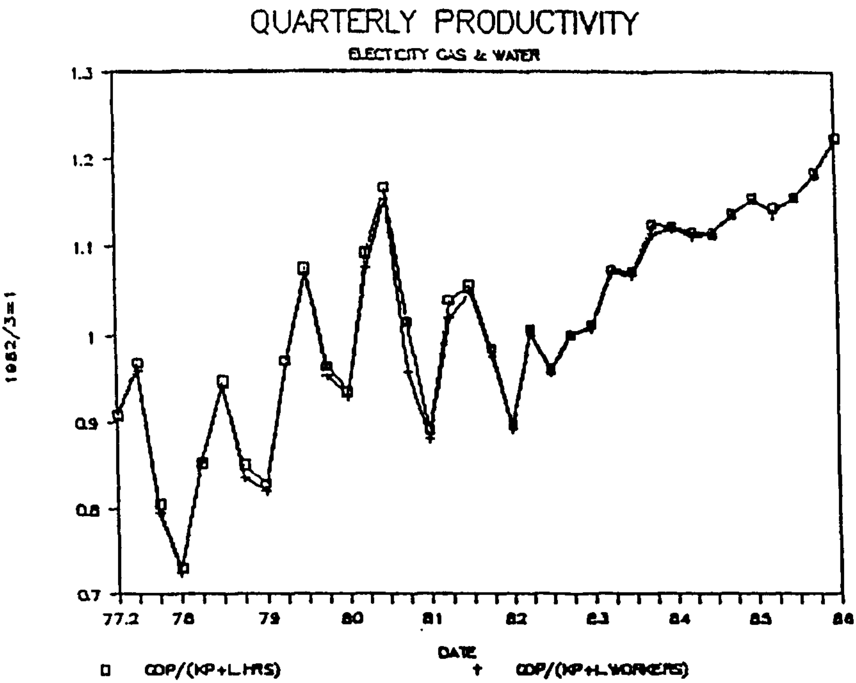
MANUFACTURING

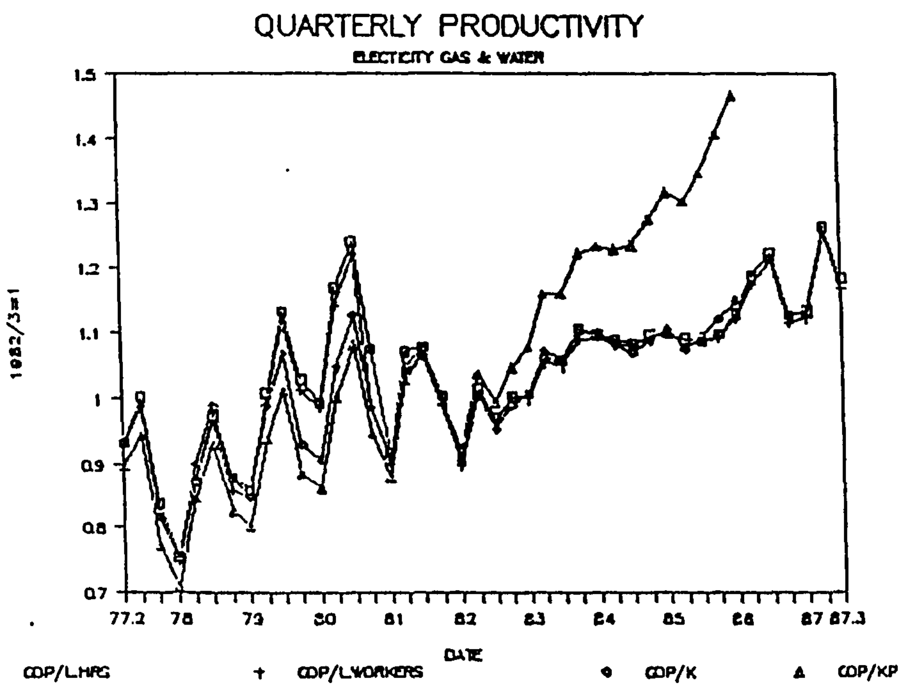


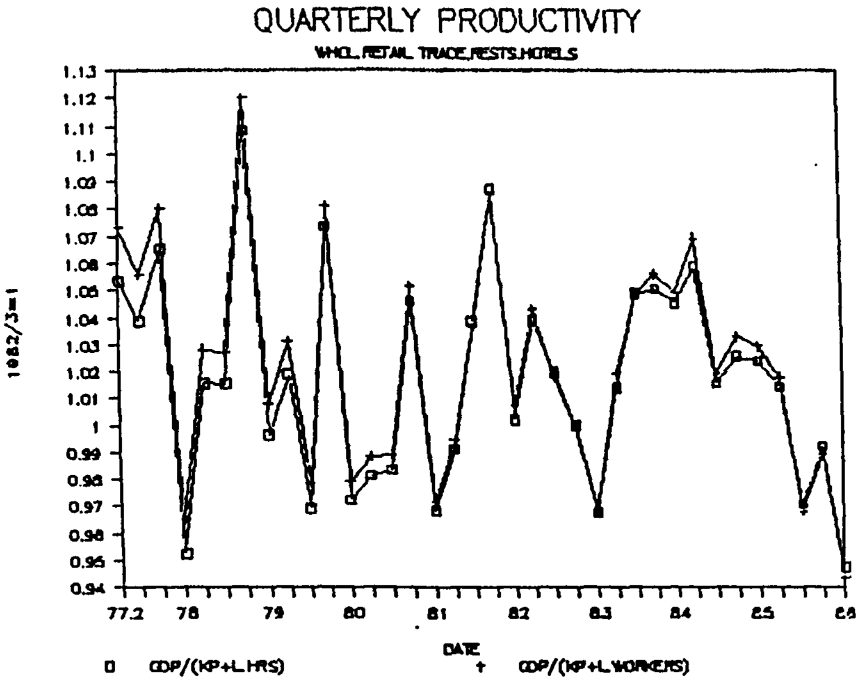
QUARTERLY PRODUCTIVITY

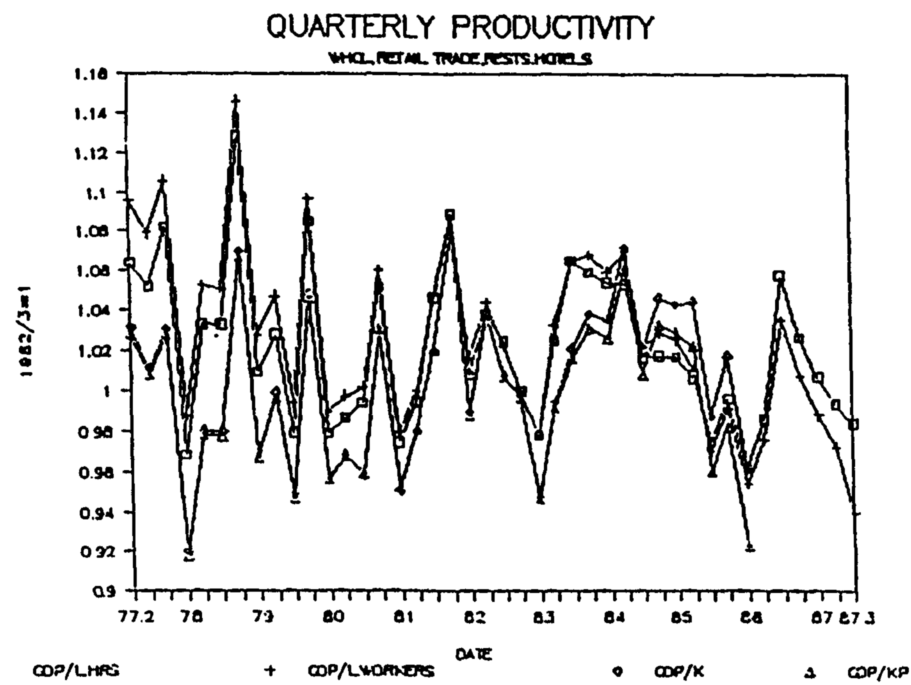
MANUFACTURING

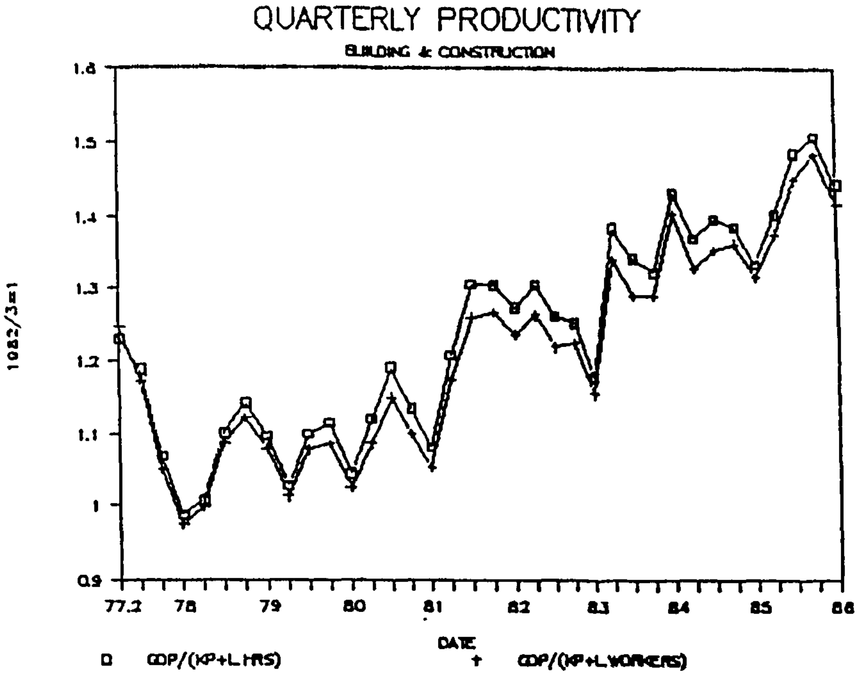


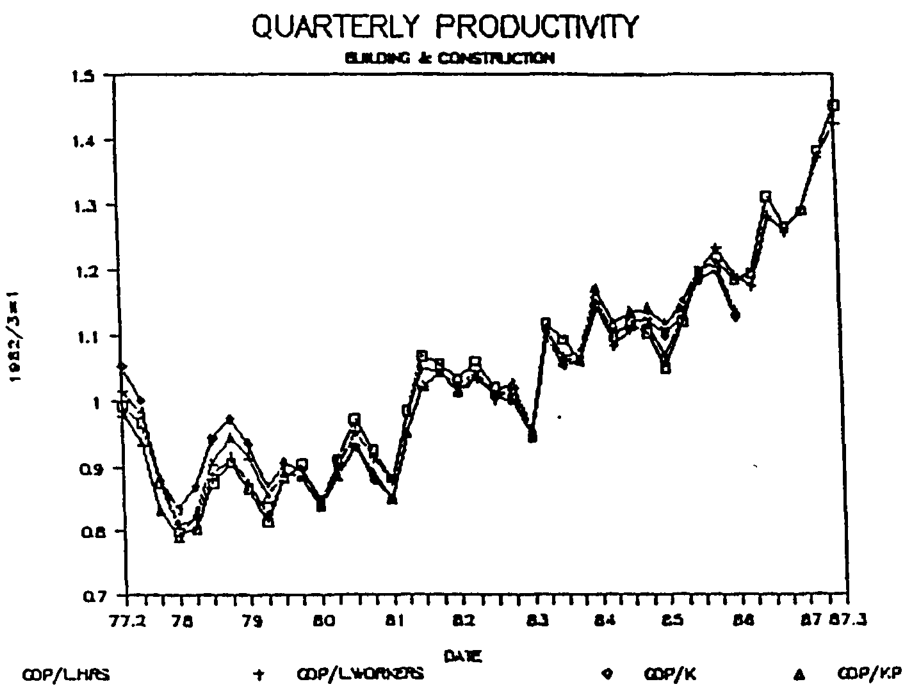

QUARTERLY PRODUCTIVITY
ELECTICITY GAS & WATER
1.3
1.2
1.1
1
0.9
0.8
0.7
1982/3=1
77.2
78
79
80
81
82
83
84
85
86
DATE
COP/(KP+L.HRS)
COP/(KP+L.WORKERS)

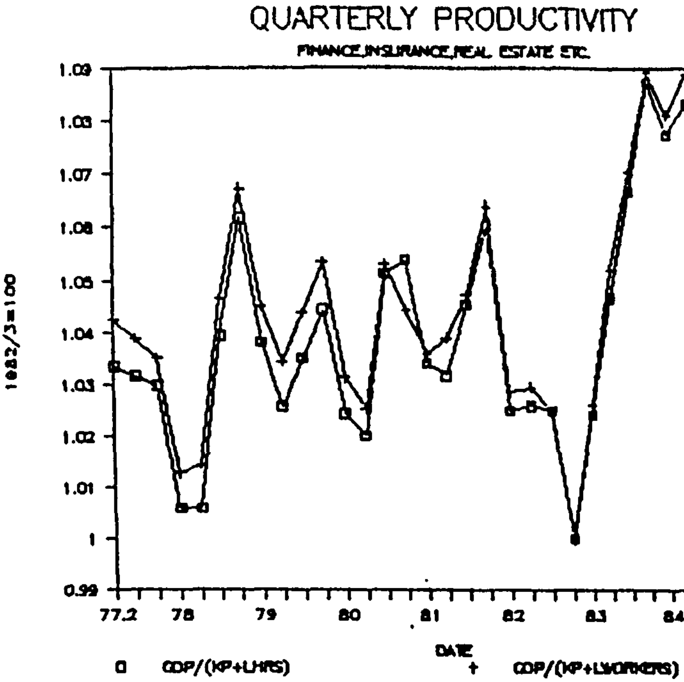

QUARTERLY PRODUCTIVITY
ELECTICITY GAS & WATER
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
1982/3=1
77.2
78
79
80
81
82
83
84
85
86
87
87.3
DATE
COP/L.HRS
COP/L.WORKERS
COP/K
COP/KP

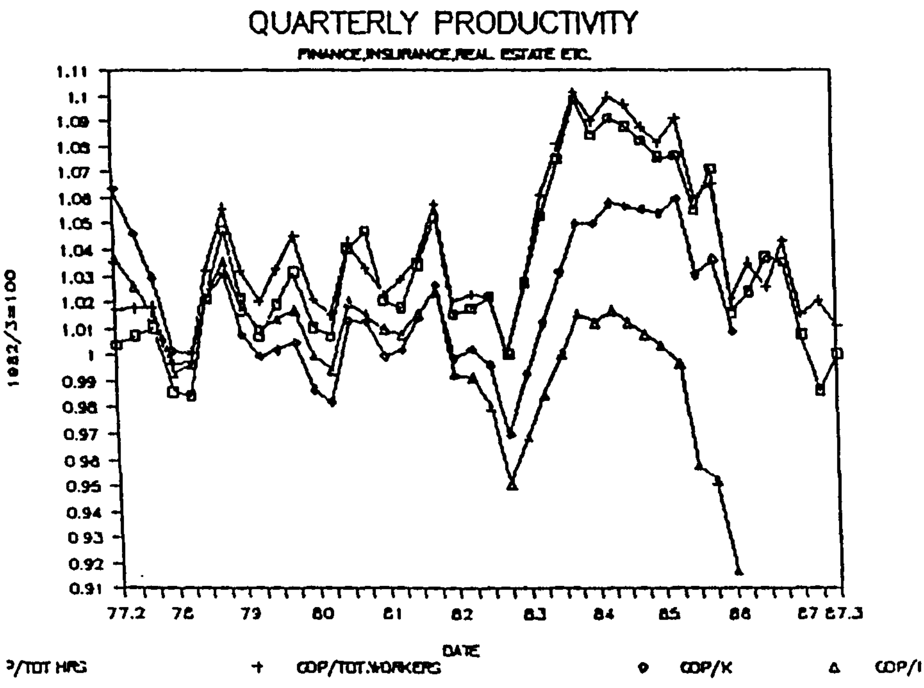

QUARTERLY PRODUCTIVITY
WHOL, RETAIL TRADE,RESTS,HOTELS
1982/3=1
DATE
GDP/(KP+L.HRS)
GDP/(KP+L.WORKERS)

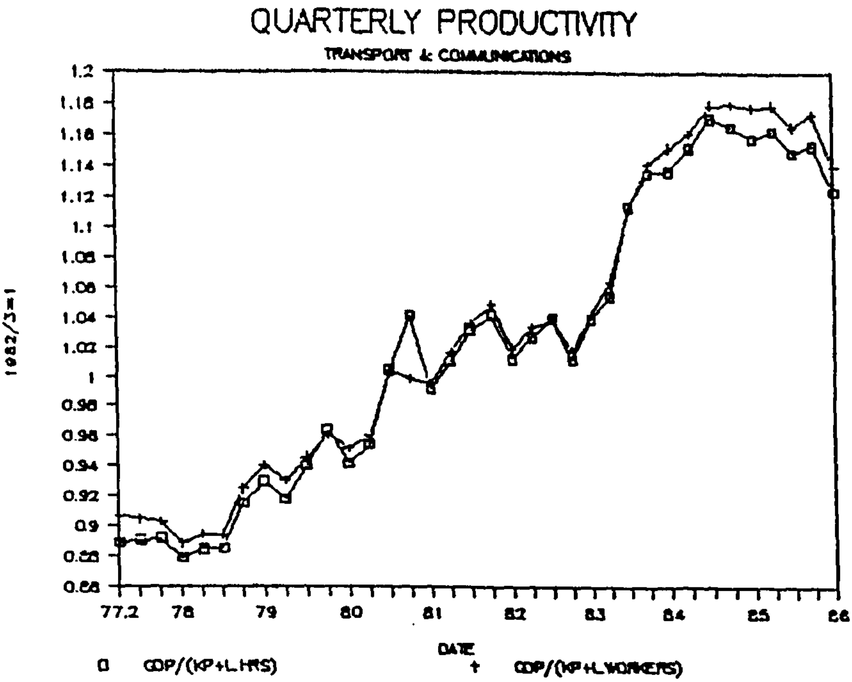

QUARTERLY PRODUCTIVITY
WHOL, RETAIL TRADE,RESTS,HOTELS
1982/3=1
DATE
GDP/L.HRS
GDP/L.WORKERS
GDP/K
GDP/KP


QUARTERLY PRODUCTIVITY
BUILDING & CONSTRUCTION
1982/3=1
DATE
GDP/(KP+L.HRS)
GDP/(KP+L.WORKERS)

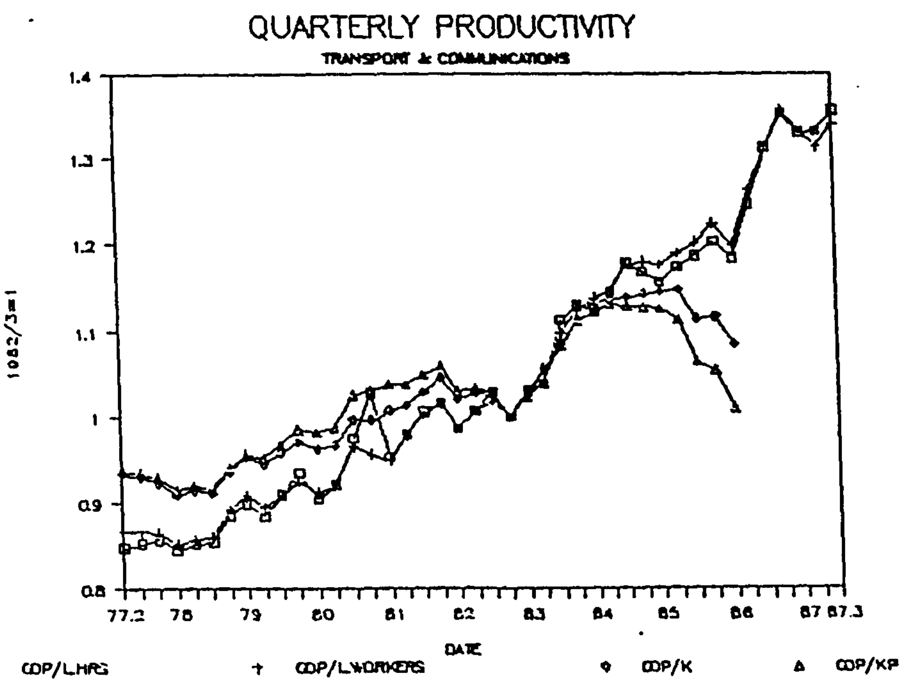

QUARTERLY PRODUCTIVITY
BUILDING & CONSTRUCTION
1982/3=1
DATE
GDP/L.HRS
GDP/L.WORKERS
GDP/K
GDP/KP


QUARTERLY PRODUCTIVITY
FINANCE,INSURANCE,REAL ESTATE ETC.
1982/3=100
DATE
GDP/(KP+LHRS)
GDP/(KP+LWORKERS)

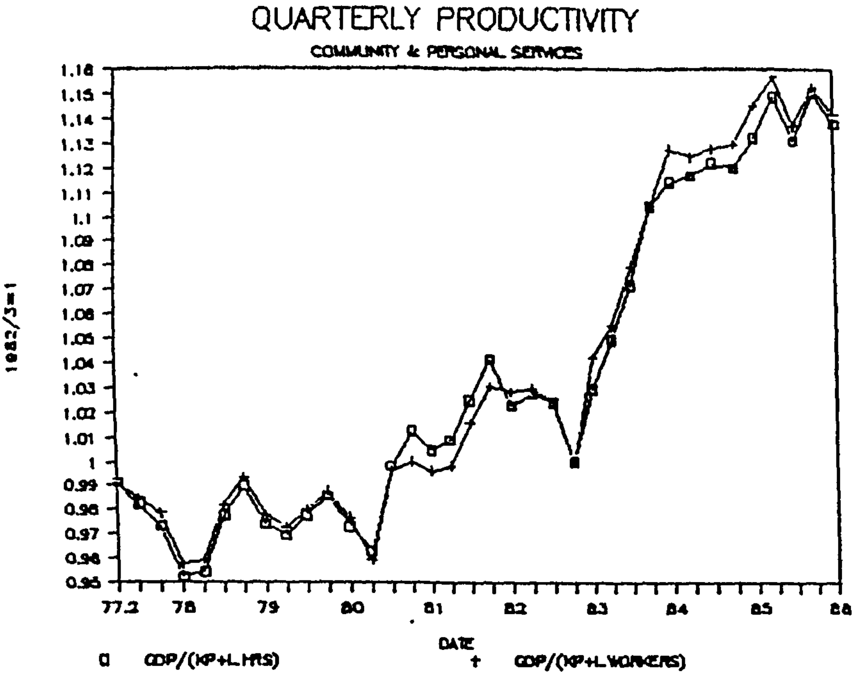

QUARTERLY PRODUCTIVITY
FINANCE,INSURANCE,REAL ESTATE ETC.
1982/3=100
DATE
P/TOT HRS
GDP/TOT.WORKERS
GDP/K
GDP/I

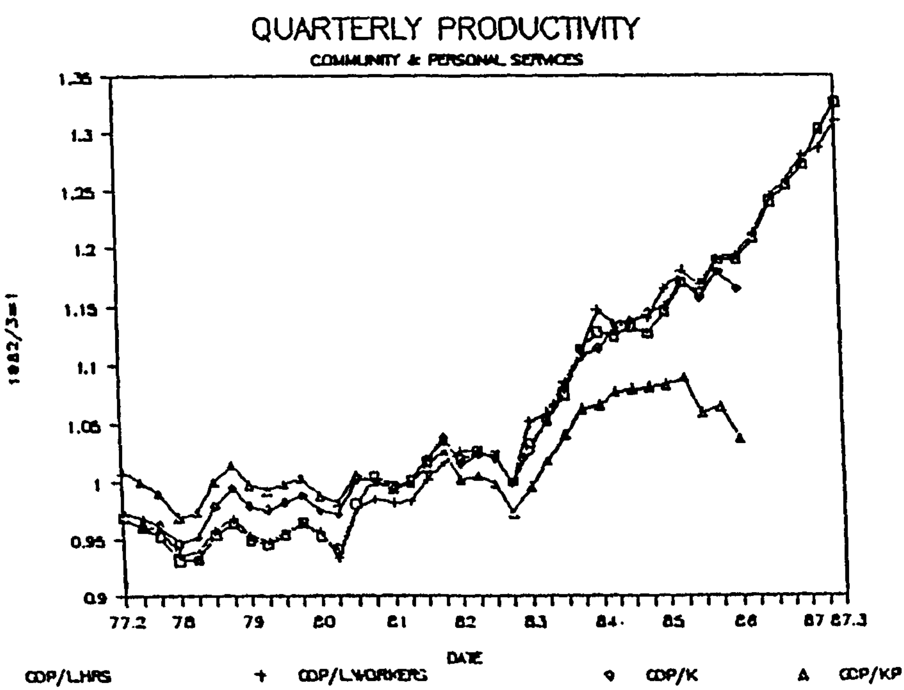


QUARTERLY PRODUCTIVITY
TRANSPORT & COMMUNICATIONS
1.2
1.18
1.16
1.14
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
0.88
0.86
1982/3=1
77.2
78
79
80
81
82
83
84
85
86
DATE
GDP/(KP+L.HRS)
GDP/(KP+L.WORKERS)



QUARTERLY PRODUCTIVITY
TRANSPORT & COMMUNICATIONS
1.4
1.3
1.2
1.1
1
0.9
0.8
1982/3=1
77.2
78
79
80
81
82
83
84
85
86
87
87.3
DATE
GDP/L.HRS
GDP/L.WORKERS
GDP/K
GDP/KP


QUARTERLY PRODUCTIVITY
COMMUNITY & PERSONAL SERVICES
1982/3=1
DATE
GDP/(KP+L.HRS)
GDP/(KP+L.WORKERS)


QUARTERLY PRODUCTIVITY
COMMUNITY & PERSONAL SERVICES
1982/3=1
DATE
GDP/L.HRS
GDP/L.WORKERS
GDP/K
GDP/KP

Annual Graphs Actual vs Fitted Data from the decycling/trend regressions.

The actual productivity measures are the 'value-added' measures:

$$V/(L+KP)$$

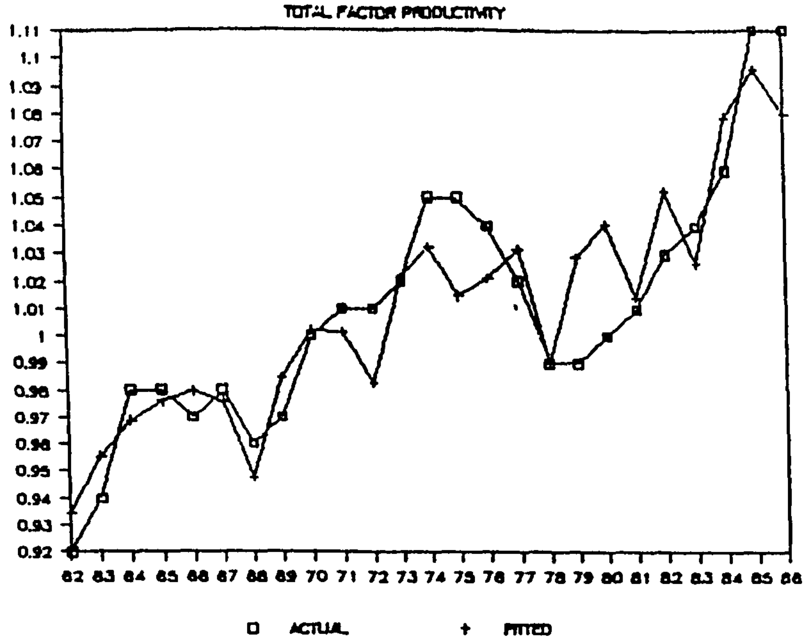
and $$V/L$$

as detailed in section IV of this report.

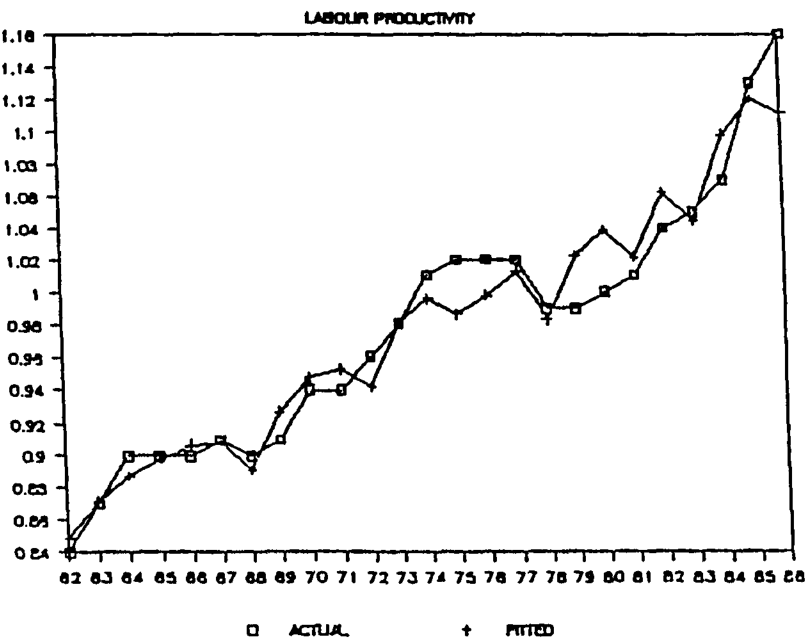
The 'fitted' values herald from the regressions discussed in section VI and presented in tables 6b-8b in the appendix.

Similar graphs for capital productivity are also available.

ALL SECTORS

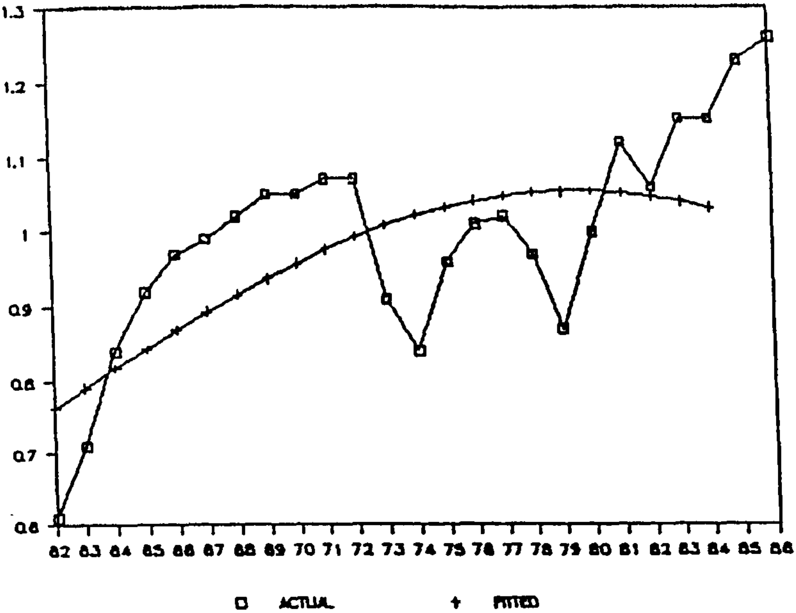


TOTAL



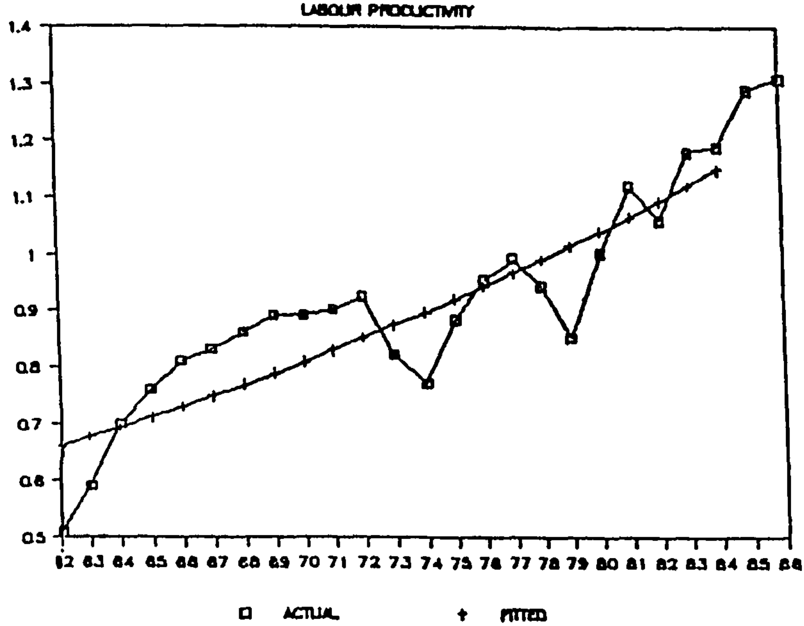
AGRICULTURE

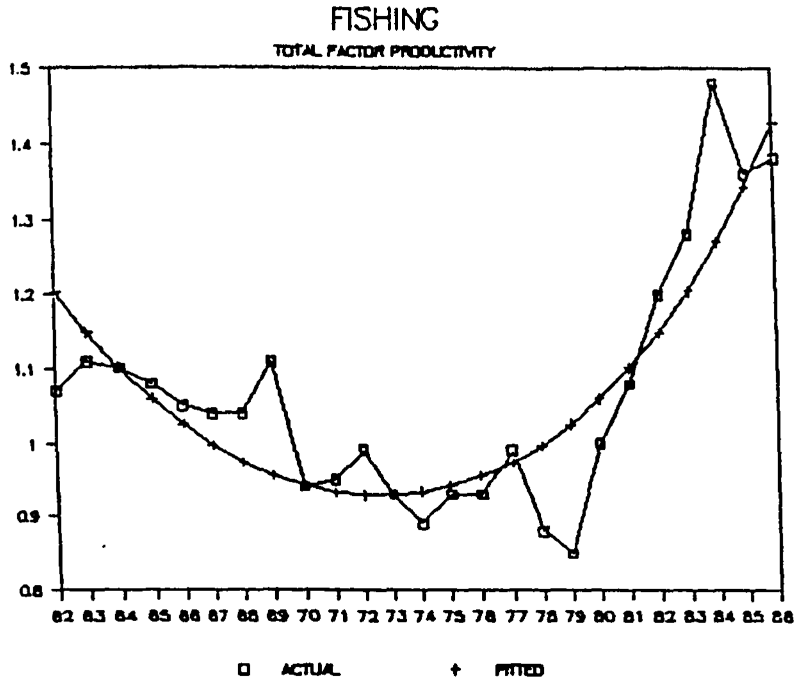
TOTAL FACTOR PRODUCTIVITY

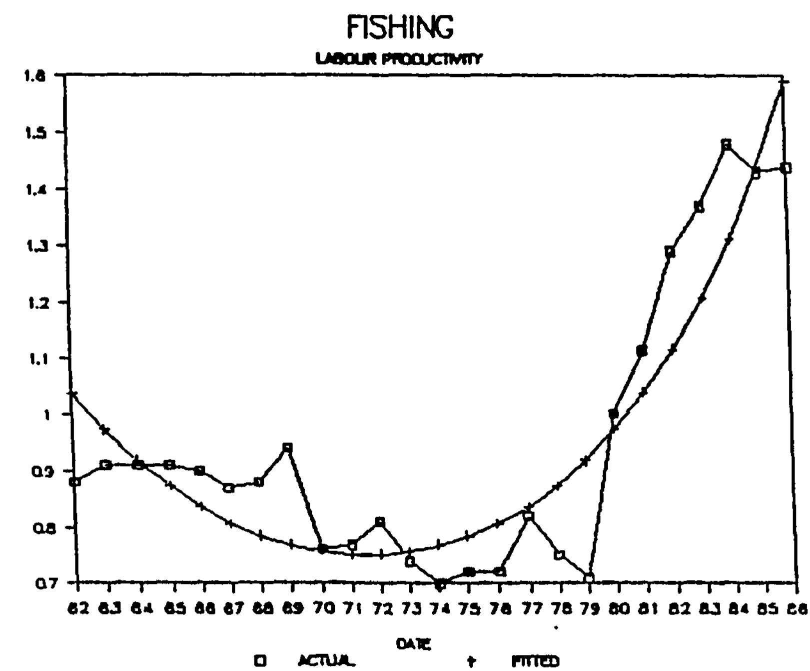


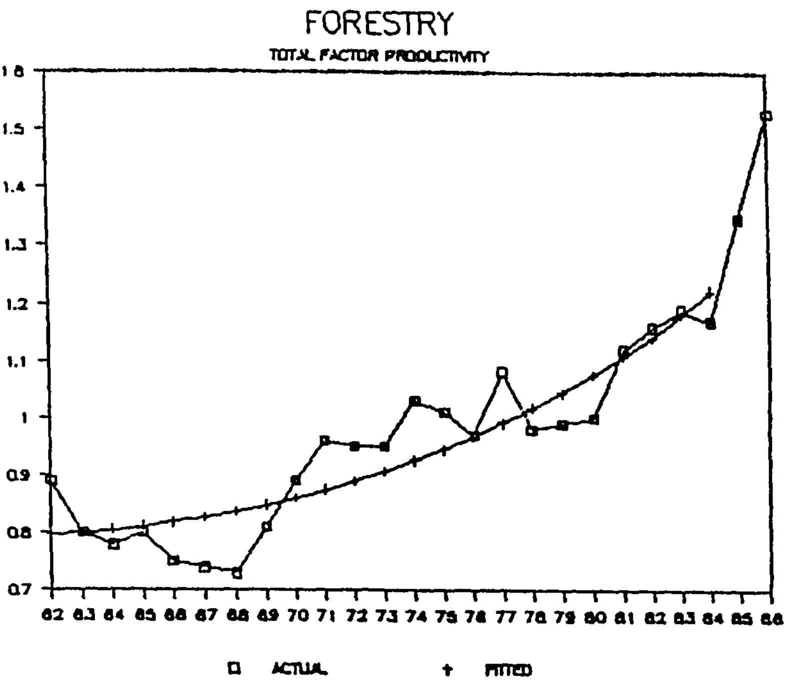
AGRICULTURE

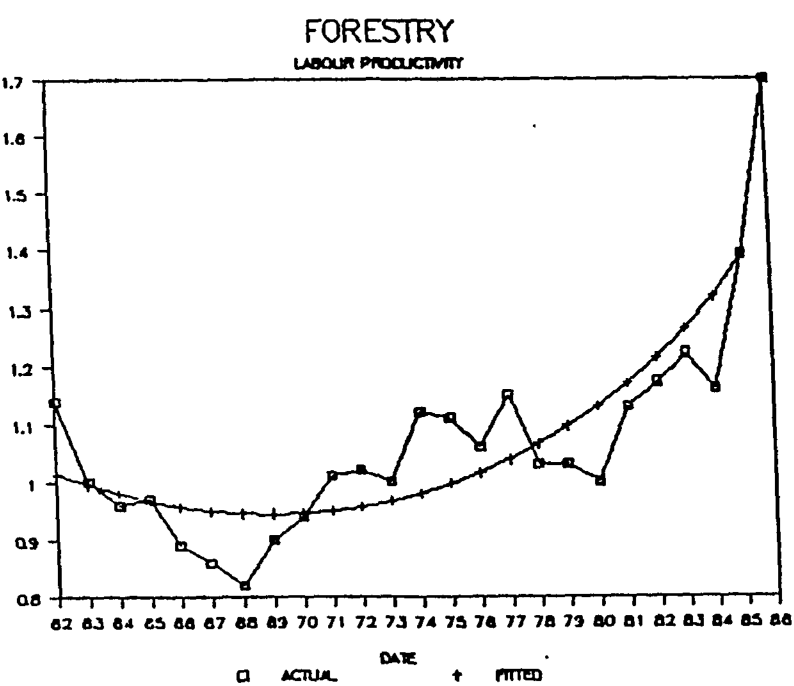
LABOUR PRODUCTIVITY




FISHING
TOTAL FACTOR PRODUCTIVITY
ACTUAL
FITTED

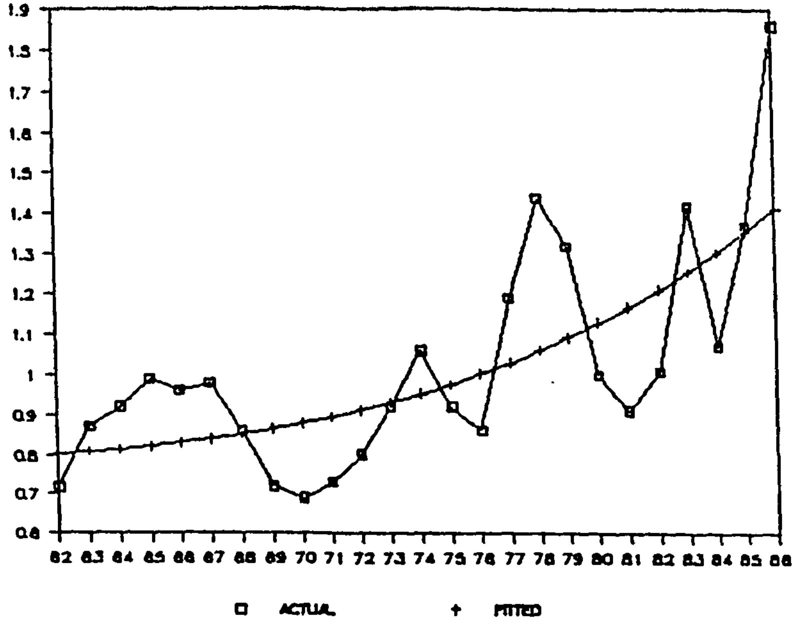

FISHING
LABOUR PRODUCTIVITY
DATE
ACTUAL
FITTED


FORESTRY
TOTAL FACTOR PRODUCTIVITY
ACTUAL
FITTED


FORESTRY
LABOUR PRODUCTIVITY
DATE
ACTUAL
FITTED

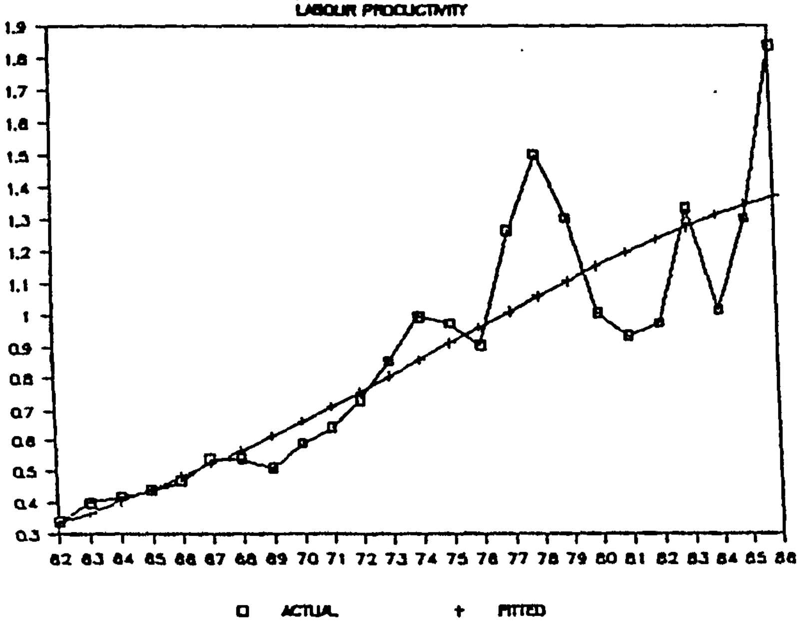
MINING

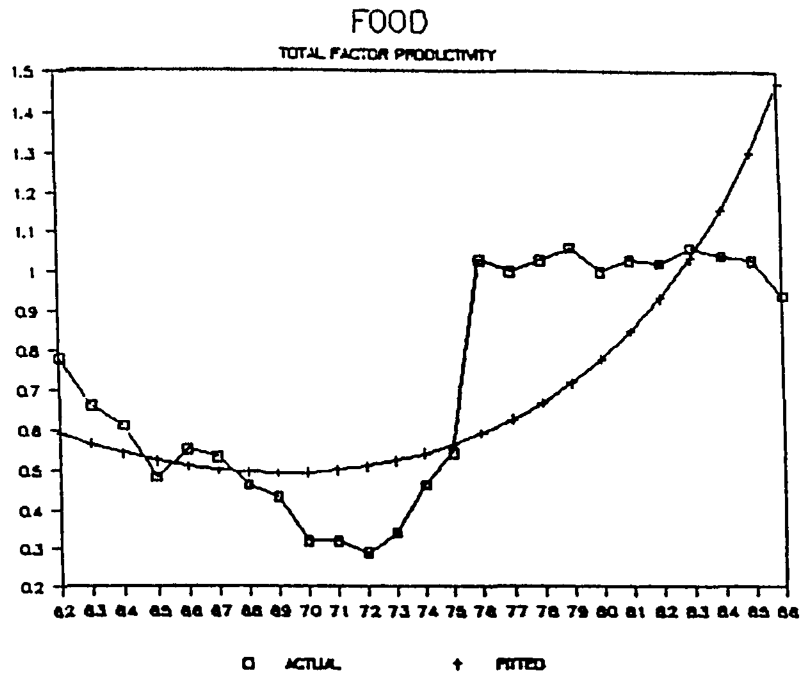
TOTAL FACTOR PRODUCTIVITY

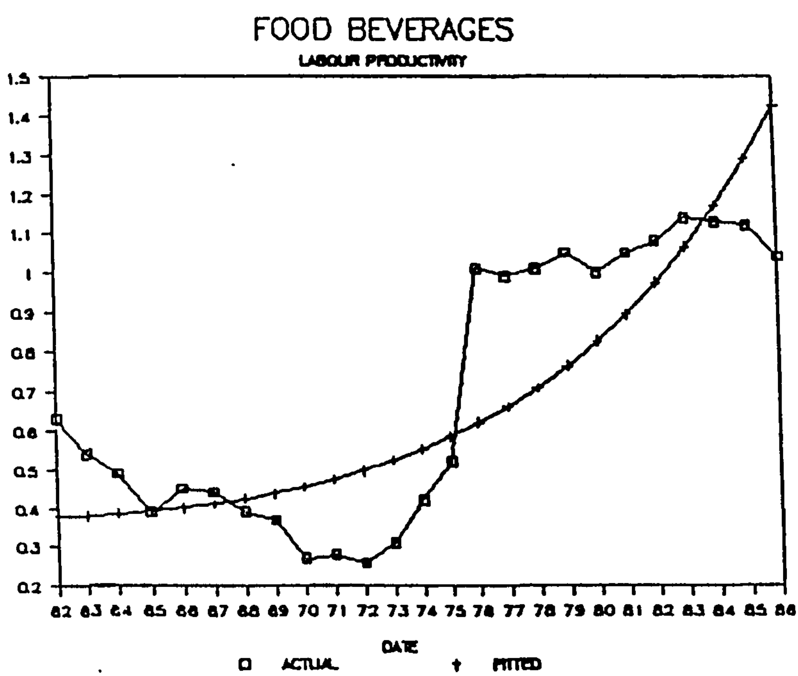


MINING

LABOUR PRODUCTIVITY

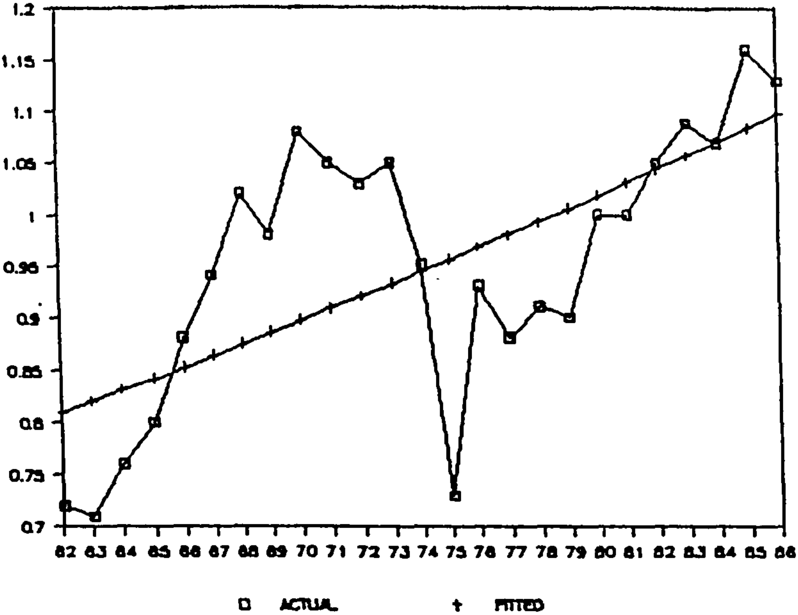



FOOD
TOTAL FACTOR PRODUCTIVITY
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED


FOOD BEVERAGES
LABOUR PRODUCTIVITY
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
DATE
ACTUAL
FITTED

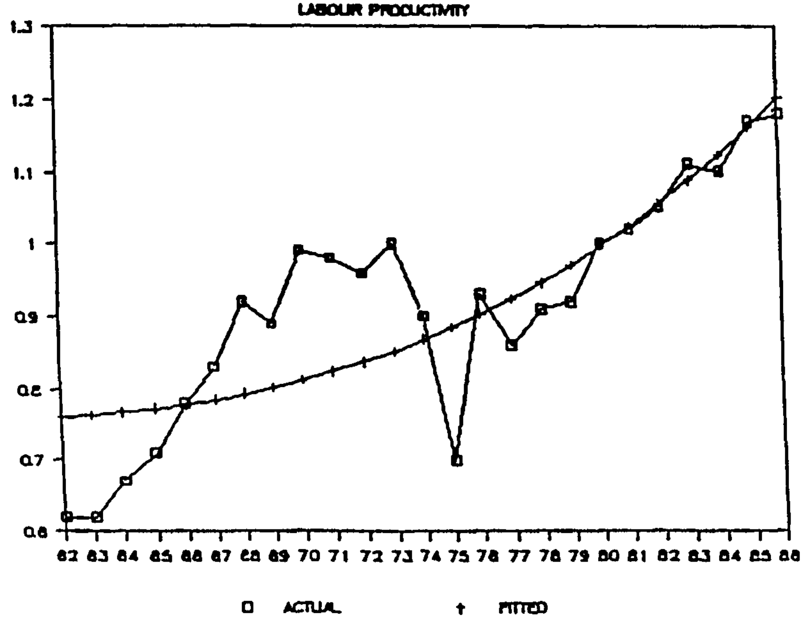
TEXTILES

TOTAL FACTOR PRODUCTIVITY



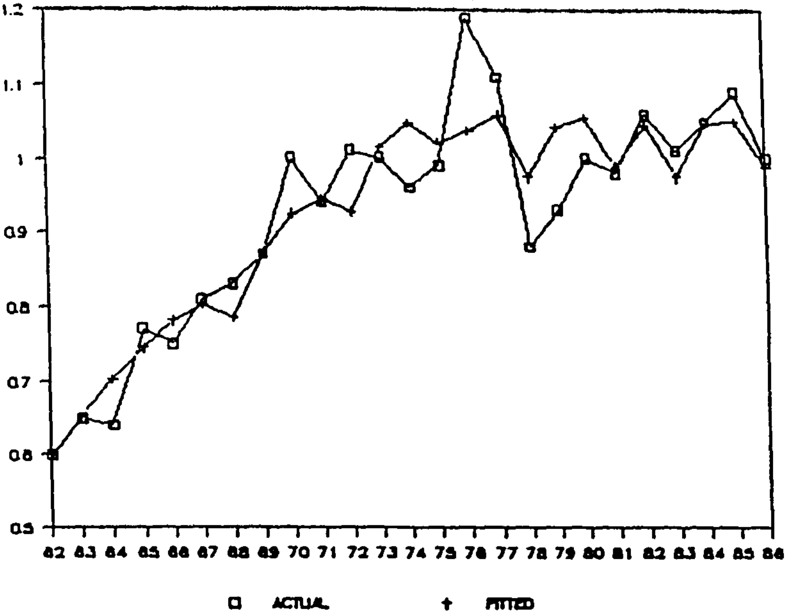
TEXTILES

LABOUR PRODUCTIVITY



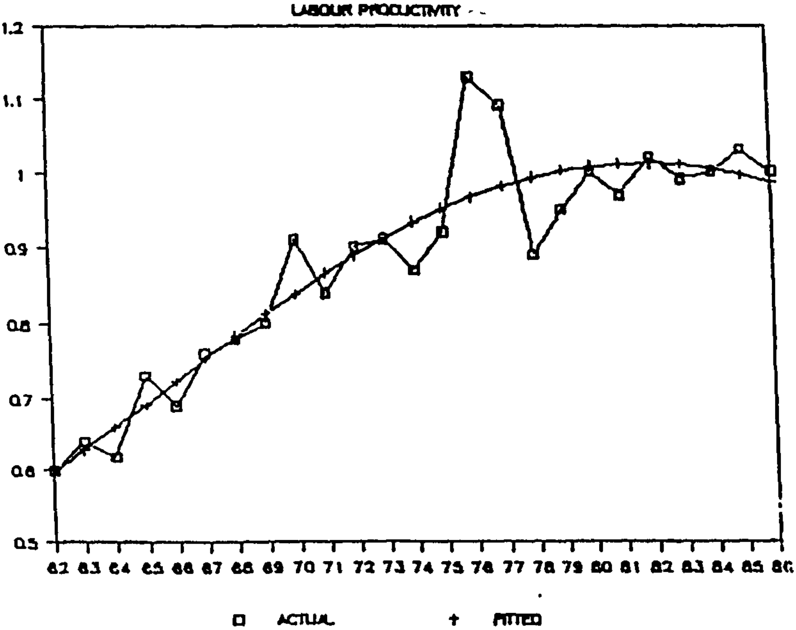
WOOD

TOTAL FACTOR PRODUCTIVITY

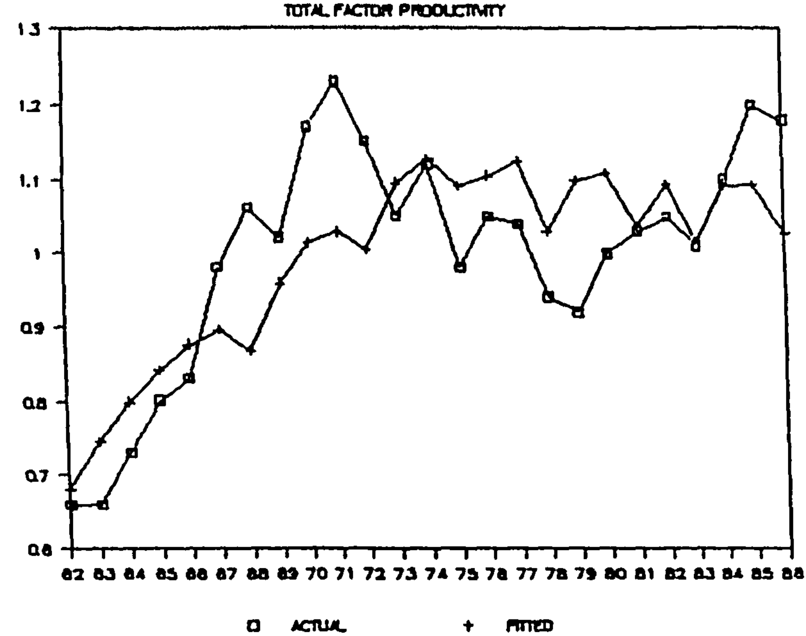


WOOD PRODUCTS

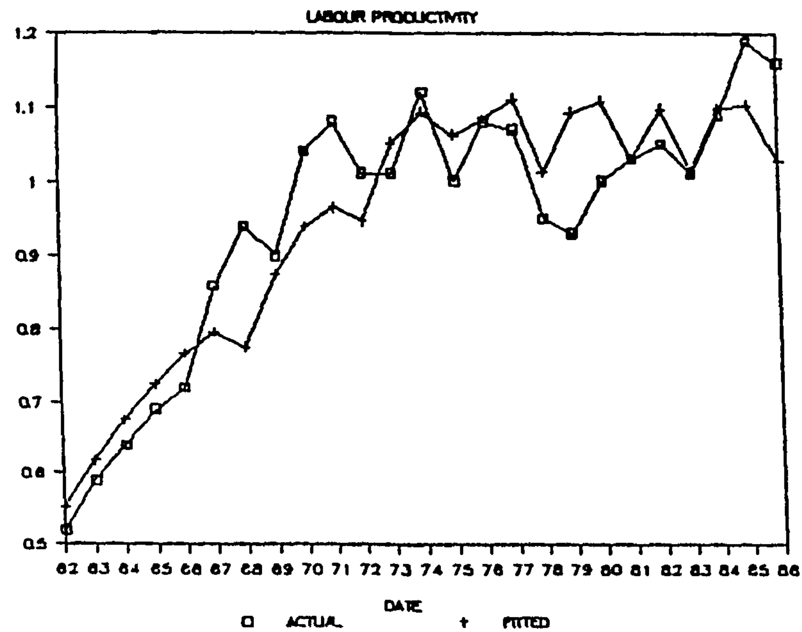
LABOUR PRODUCTIVITY

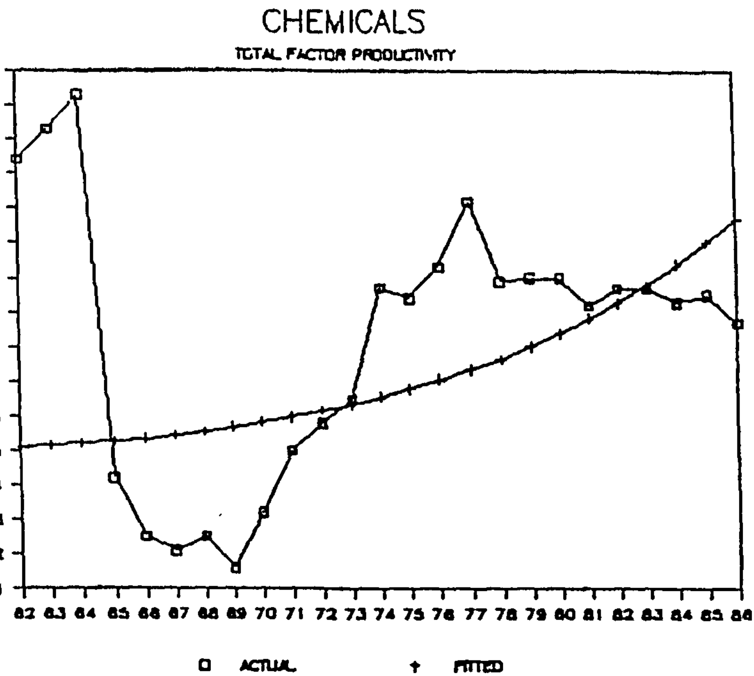


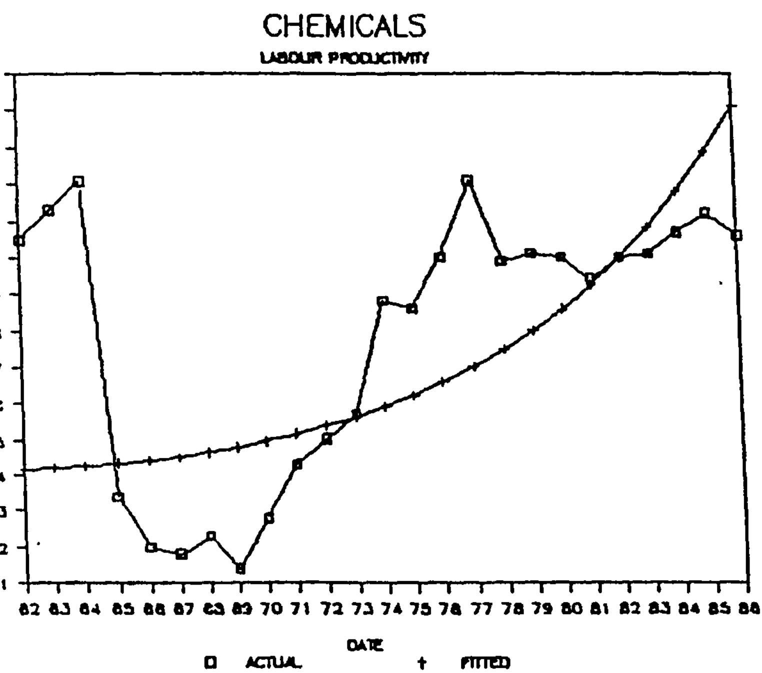
PAPER

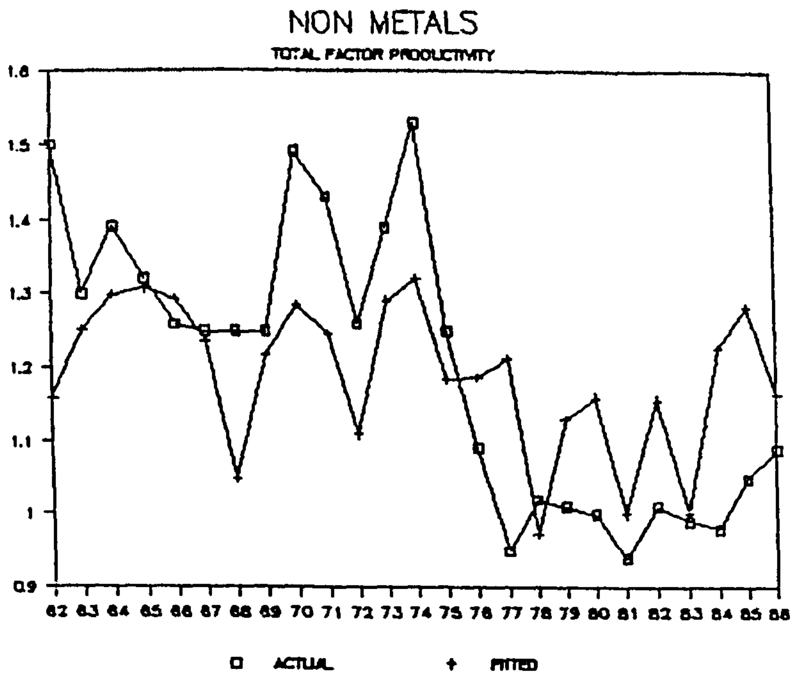


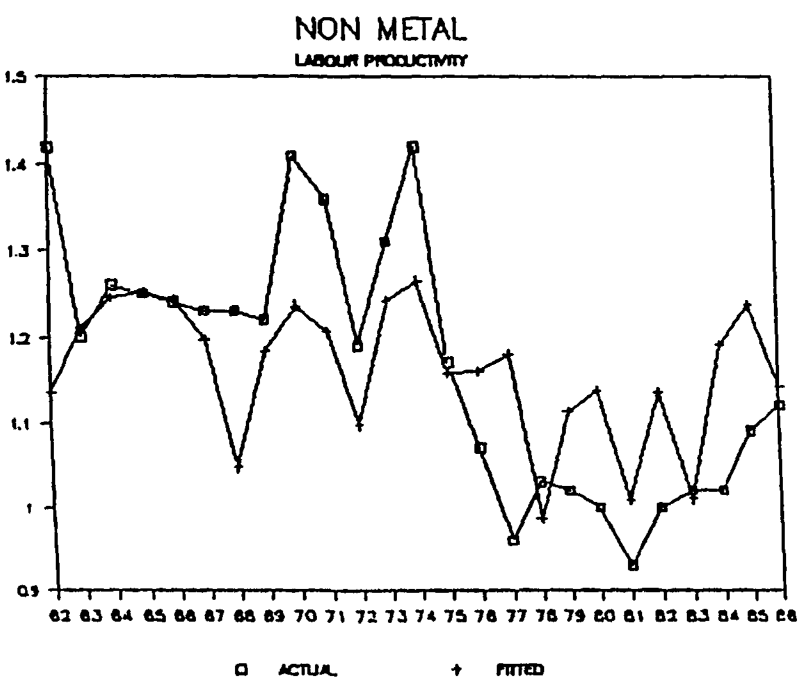
PAPER PRODUCTS

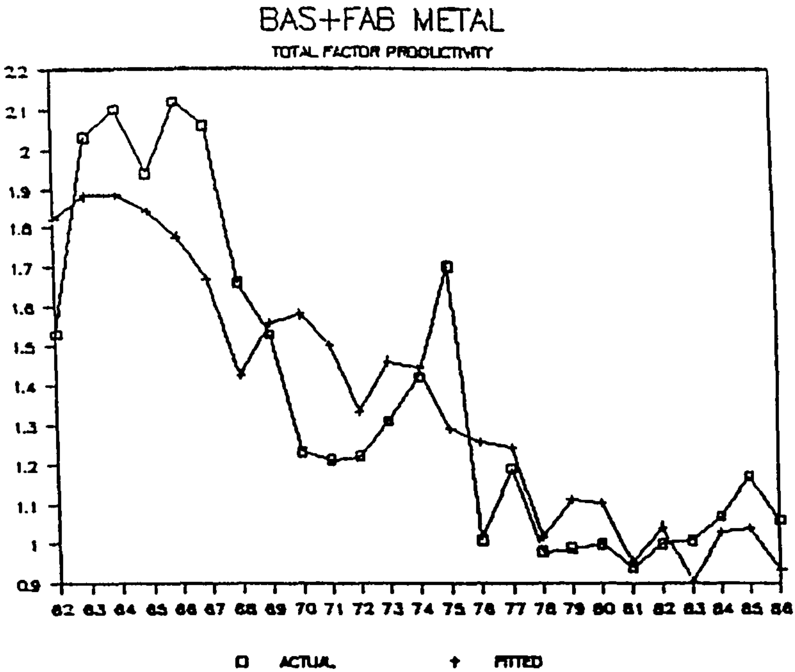


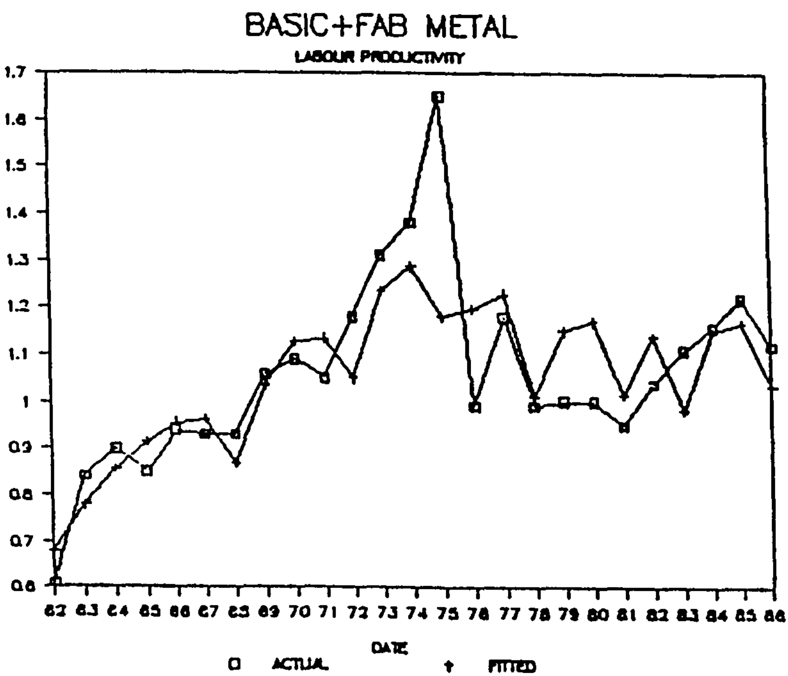

CHEMICALS
TOTAL FACTOR PRODUCTIVITY
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED

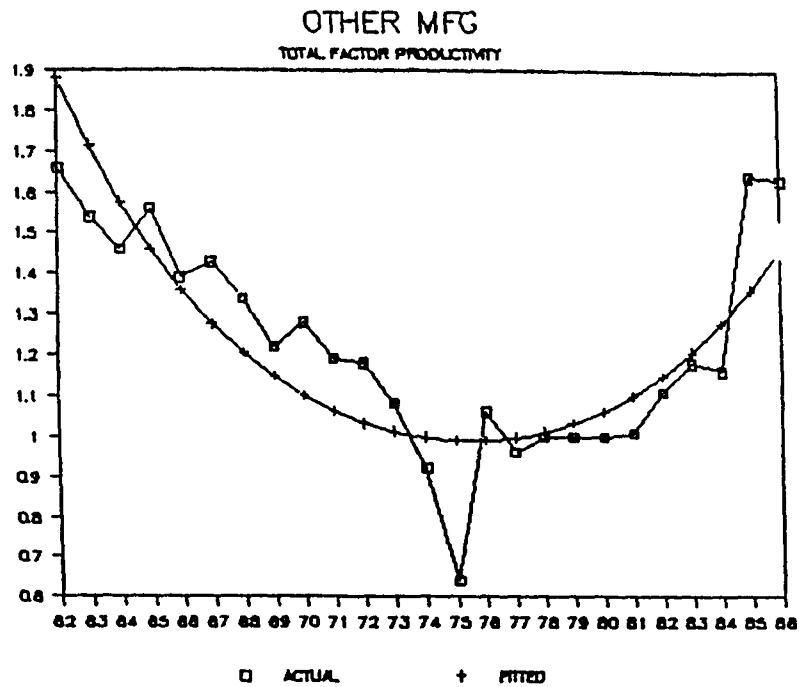

CHEMICALS
LABOUR PRODUCTIVITY
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
DATE
ACTUAL
FITTED

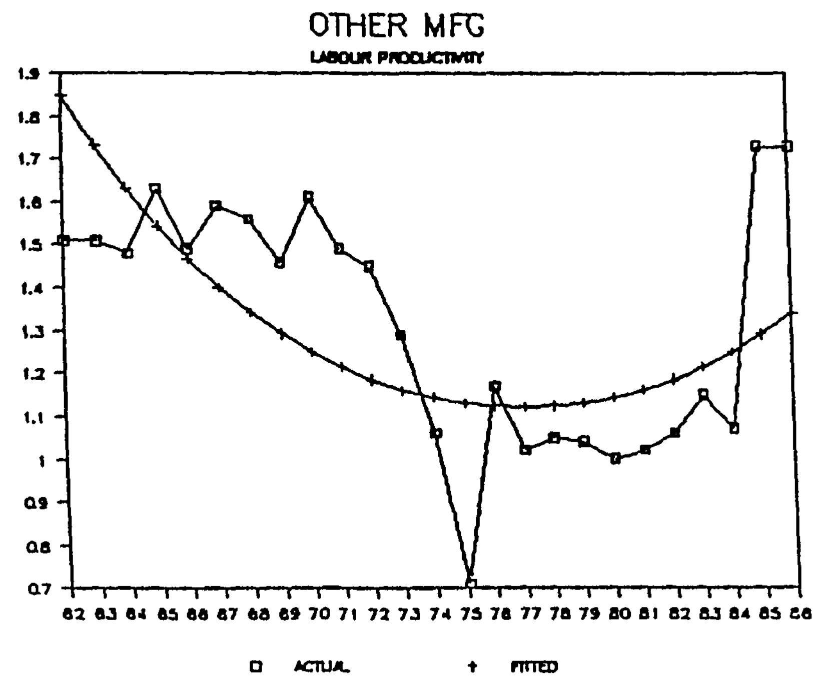

NON METALS
TOTAL FACTOR PRODUCTIVITY
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED

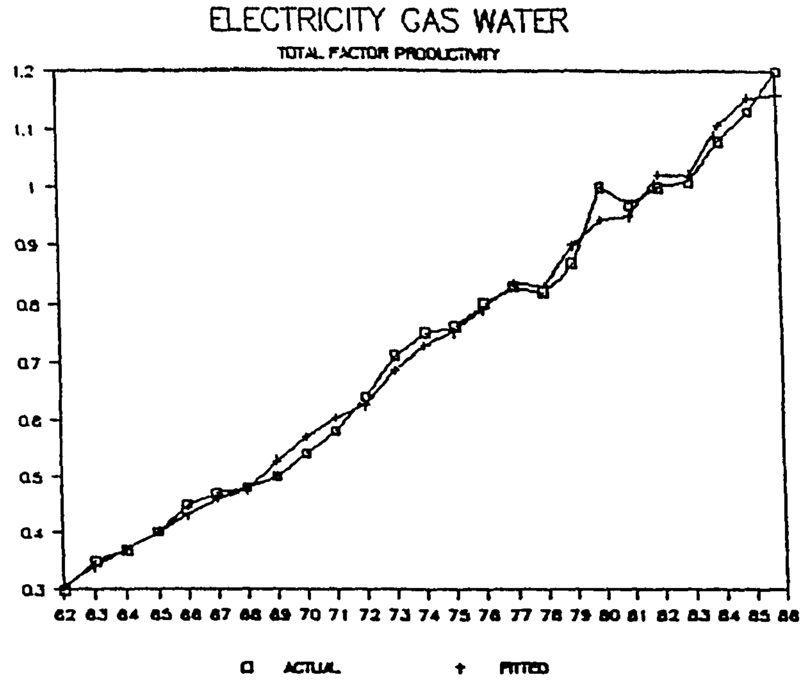

NON METAL
LABOUR PRODUCTIVITY
1.5
1.4
1.3
1.2
1.1
1
0.9
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED

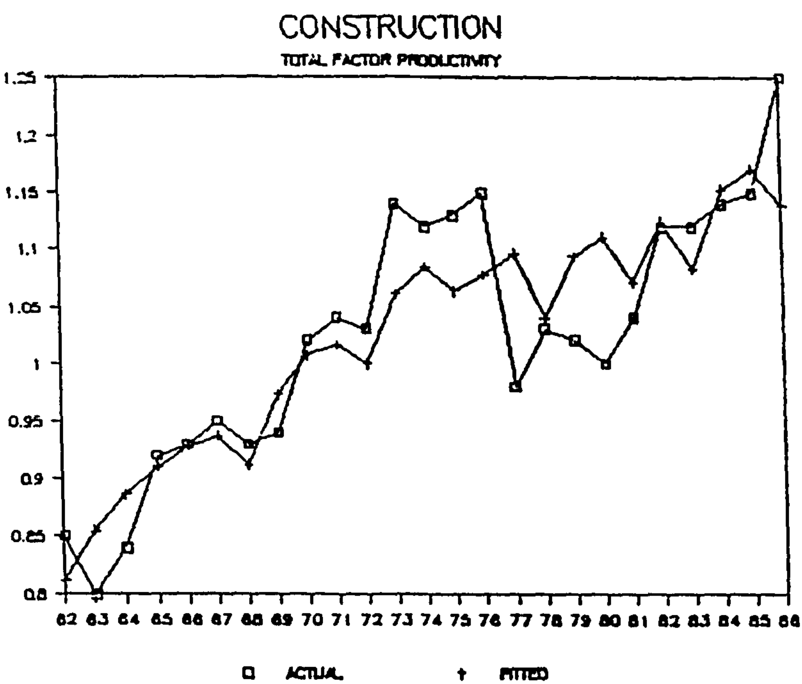

BAS+FAB METAL
TOTAL FACTOR PRODUCTIVITY
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED

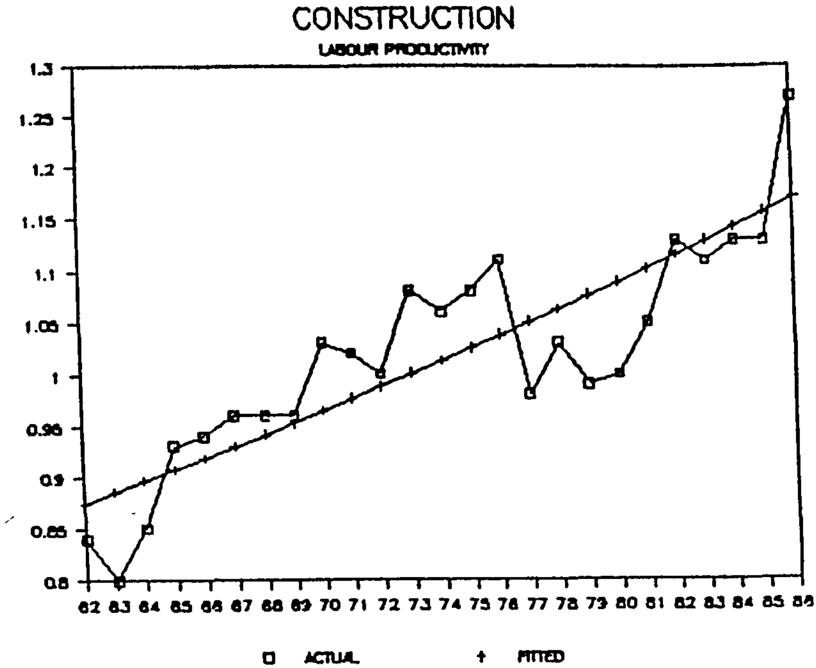

BASIC+FAB METAL
LABOUR PRODUCTIVITY
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
DATE
ACTUAL
FITTED

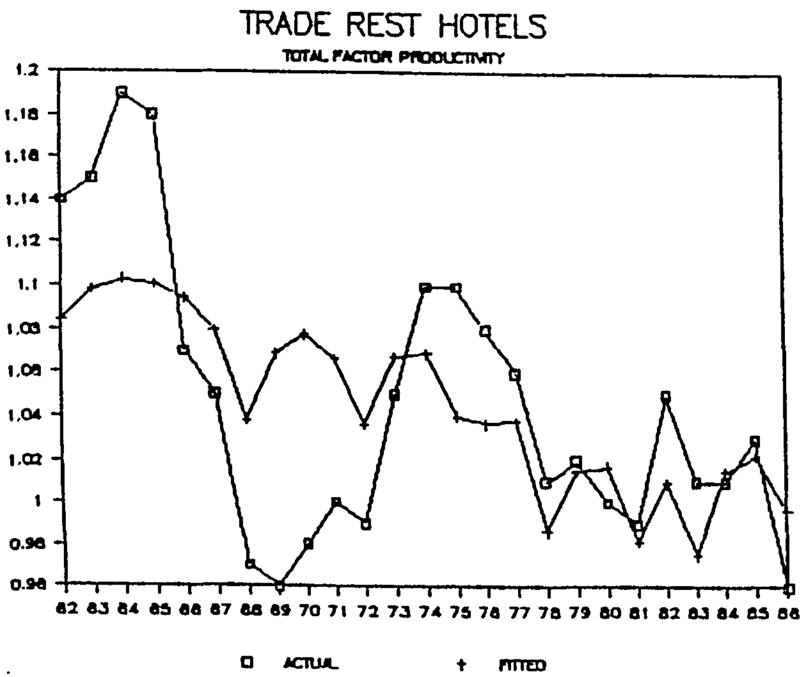

OTHER MFG
TOTAL FACTOR PRODUCTIVITY
ACTUAL
FITTED

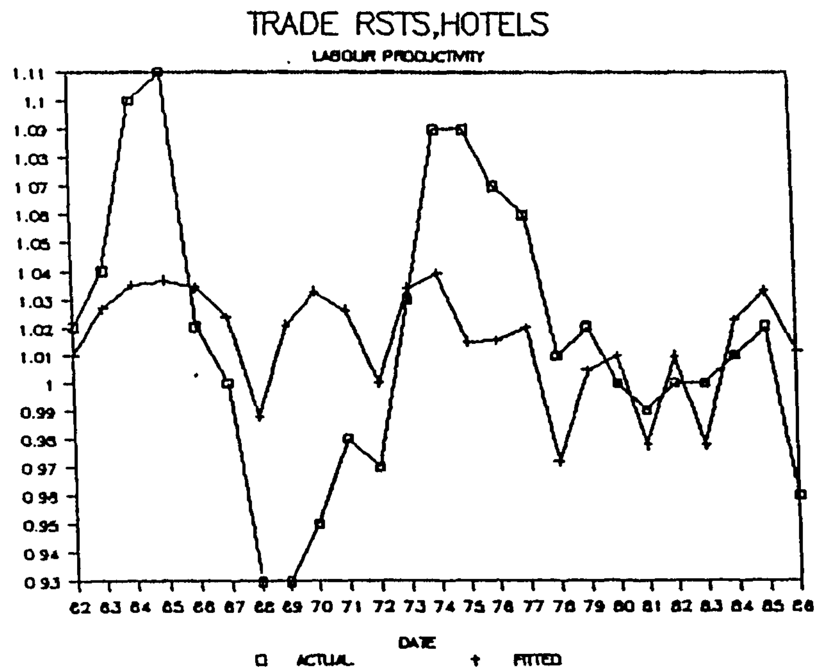

OTHER MFG
LABOUR PRODUCTIVITY
ACTUAL
FITTED

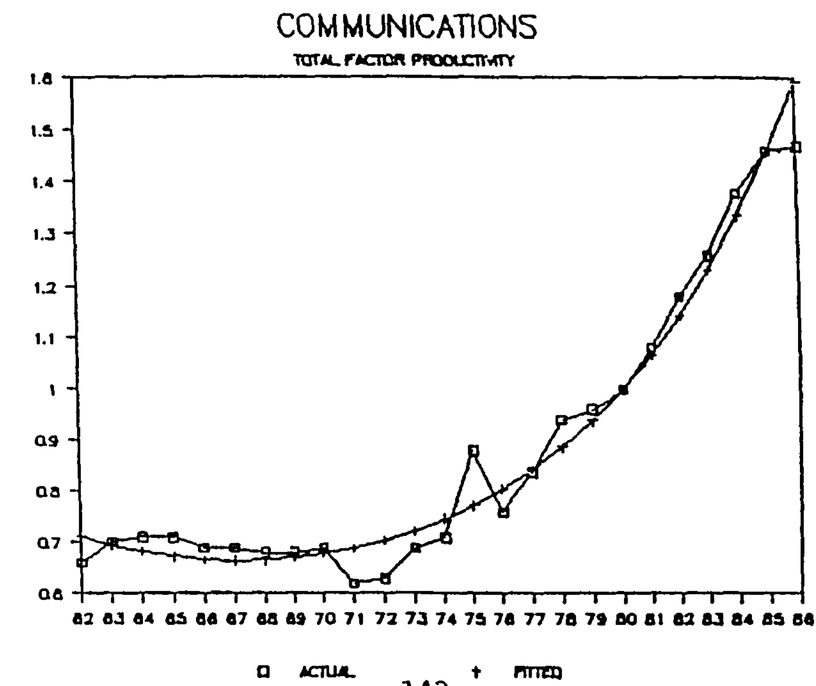

ELECTRICITY GAS WATER
TOTAL FACTOR PRODUCTIVITY
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED


CONSTRUCTION
TOTAL FACTOR PRODUCTIVITY
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED


CONSTRUCTION
LABOUR PRODUCTIVITY
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED

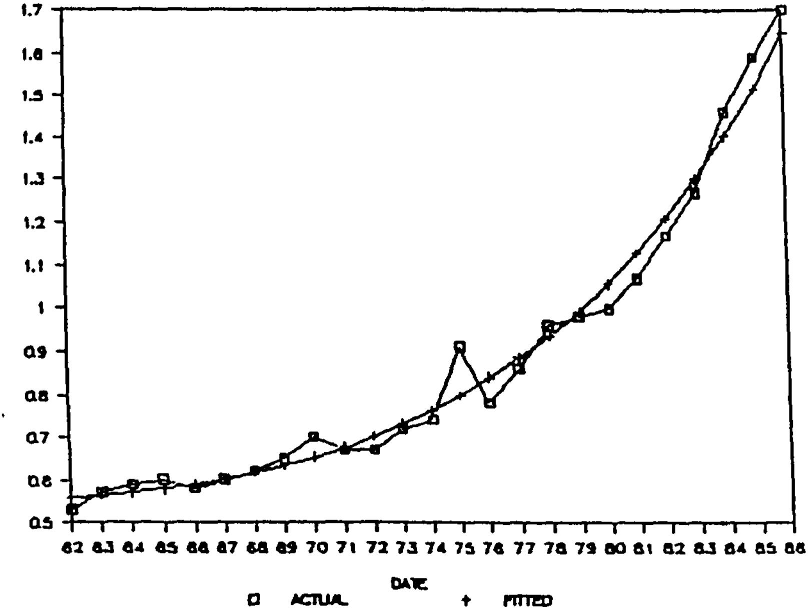

TRADE REST HOTELS
TOTAL FACTOR PRODUCTIVITY
1.2
1.18
1.16
1.14
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED


TRADE RSTS,HOTELS
LABOUR PRODUCTIVITY
DATE
ACTUAL
FITTED


COMMUNICATIONS
TOTAL FACTOR PRODUCTIVITY
ACTUAL
FITTED

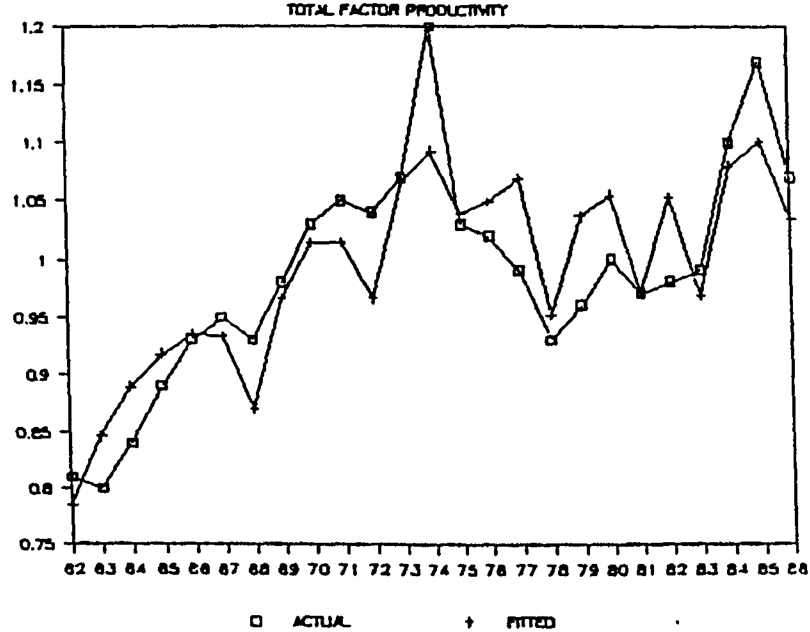
COMMUNICATIONS

LABOUR PRODUCTIVITY



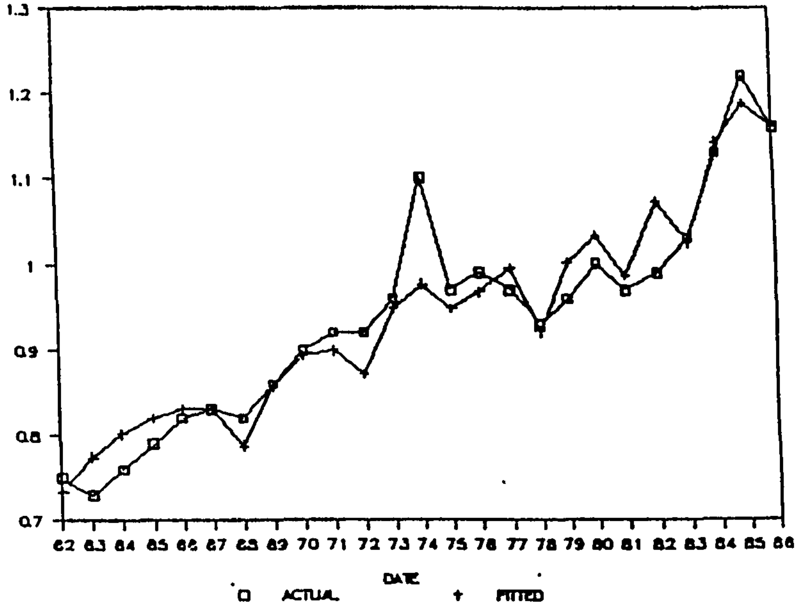
TRANSPORT

TOTAL FACTOR PRODUCTIVITY



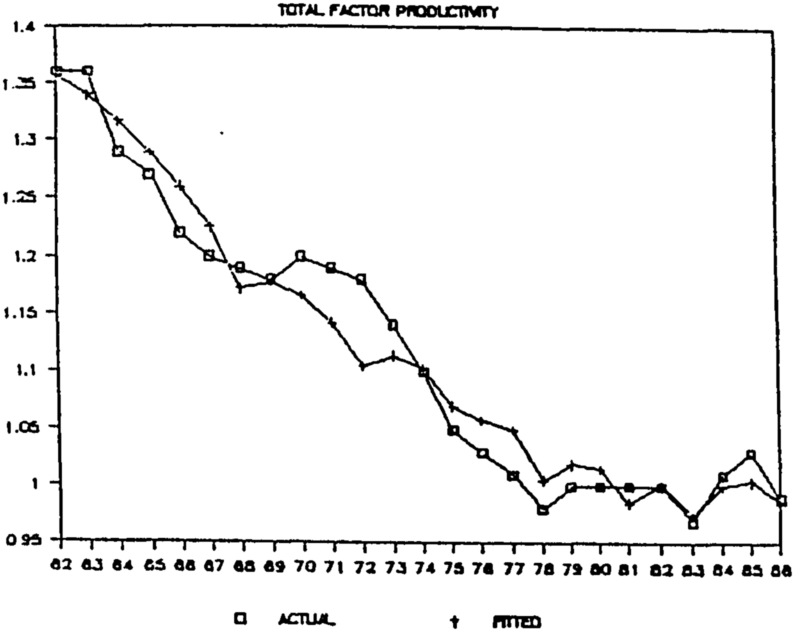
TRANSPORT

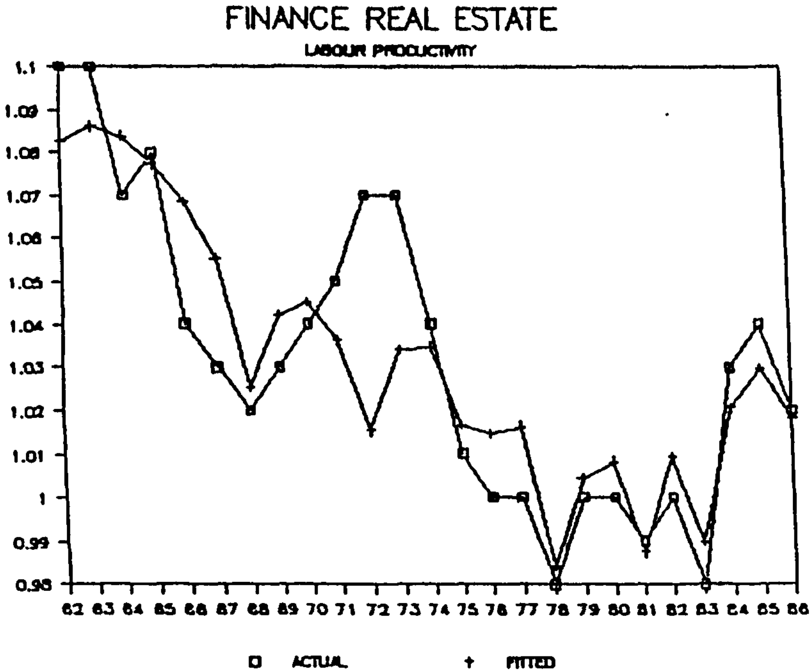
LABOUR PRODUCTIVITY



FINANCE INSURANCE REAL ESTATE

TOTAL FACTOR PRODUCTIVITY




FINANCE REAL ESTATE
LABOUR PRODUCTIVITY
1.1
1.09
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
0.98
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
ACTUAL
FITTED

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