Productivity, Wages and Employment in South Africa's Manufacturing Sector, 1970-2002

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Abstract

This paper investigates the relationship between labour productivity, average real wages and employment in South Africa's manufacturing sector, using cointegrating VAR and VECM econometric techniques. A long-run equilibrium relationship was found between real wages and productivity, with an elasticity of 0,38 indicating that productivity has grown more rapidly than wages. However, the econometric tests proved to be highly sensitive to specification and sample period. Nevertheless, the main result is consistent with the finding that labour's share of gross output has been shrinking over the past three decades, which has negative implications for income distribution. These trends may plausibly be explained by capital intensification and possibly the adoption of labour-saving technology. The implication is that growth in the manufacturing sector cannot realistically be relied upon to create significantly more jobs for South Africa's millions of unemployed. Policy-makers are urged to consider alternative strategies which promote local economy and protect key labour-intensive sectors.

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1. Introduction

There has been considerable debate in recent years surrounding the question of whether (and if so, why) South Africa has been experiencing 'jobless growth'. A number of studies in the past decade or so have explicitly or implicitly addressed this question in an attempt to understand the macroeconomic functioning of the labour market (see, for example, Lewis, 2002; Fedderke & Mariotti, 2002; Du Toit & Koekemoer, 2003). Many of these studies have principally focused their attention on the demand for labour, although some have been more general in scope, estimating various other relationships including wage equations and labour supply functions.

Whether South Africa has been experiencing 'jobless growth' has been debated mainly in terms of which set of available employment figures most accurately represent the South African situation: those generated by Statistics South Africa's (StatsSA's) *Survey of Employment and Earnings* (SEE) or by its *Labour Force Survey* (LFS). These two data sources have yielded inconsistent estimates of total employment since 2000; according to the SEE, total formal sector employment has declined since around 1990, while the LFS has shown increasing aggregate employment levels (see Altman, 2003). Either way, what is abundantly clear is that the economy has failed to create sufficient new jobs to absorb a growing labour force, with the result that the unemployment rate has increased steadily since the mid 1980s (see Wakeford, 2004). In addition, both SEE and LFS data show that certain key sectors of the formal economy, such as mining and manufacturing, have been shedding jobs at an alarming rate for more than a decade. Meanwhile, the economy (in terms of real GDP) has continued to grow, albeit with a lacklustre performance.

If we accept that growth has been labour-shedding – or at the very least insufficiently labour-absorbing – this begs the question of 'why'? A common argument, especially amongst those working within a neoclassical paradigm, is that rising real wage rates – mainly thanks to strong trade unions, but supported by minimum wage and affirmative action legislation – have been the major cause of declining employment levels. There can be little doubt that this factor has contributed to poor job creation, particularly amongst low skilled workers, but to lay the blame on organised workers and labour legislation is overly simplistic. Rather, the phenomenon of 'jobless growth' is the result of a complex set of factors, including the skills shortage, trade liberalisation and international competition, and the adoption of new technologies in addition to rising real wage rates.

This paper aims to contribute to this debate by analysing empirically the relationship between real wages, labour productivity and employment in the context of the South African manufacturing sector. As such, it builds on a previous paper by the author which analysed similar variables in the formal, non-agricultural sector of the economy (see Wakeford, 2004). The current paper employs the same time series econometric methodology as the earlier study, but uses employment rather than the unemployment rate, for two reasons. Firstly, the unemployment rate relates to the entire economy, not just manufacturing. Secondly, the labour force participation rate has changed markedly in the post-Apartheid era, which adds another layer of complexity to the relationship between unemployment on the one hand, and productivity and wages on the other. The scope is also narrowed here to the manufacturing sector. This is partly as a result of recent revisions by StatsSA to its employment data in certain sectors, notably services, which render aggregate historical time series data on employment and wages obsolete.[1] In addition, variables representing fixed capital stock and technological progress are included in the analysis, as they potentially play a significant role in explaining structural changes in the labour market.

The paper tackles the following specific empirical questions. First, is there a long-run equilibrium (cointegrating) relationship between productivity, real wages, employment, capital stock and technological progress (or a subset of these) in the manufacturing sector? Second, what are the short-term or dynamic relationships among these variables? Third, can econometric techniques shed any light on the directions of causality among the variables? These questions will be explored via graphs, descriptive statistics, and the cointegrating vector autoregression (VAR) and vector error correction (VECM) modelling techniques. A set of possible theoretical linkages between the five variables will be established prior to the empirical modelling, although the latter will not be constrained by any particular theoretical or ideological viewpoint.

The format of the paper is as follows. Section 2 establishes the appropriate background by defining the variables, reviewing some recent applicable empirical evidence, and developing hypothesised relationships among the variables. Section 3 describes the data used in the study and outlines the empirical methodology. Section 4 analyses the data and reports the results of cointegration tests, error correction models and causality tests. Section 5 discusses the implications of the empirical results. Finally, Section 6 summarises the main findings and offers some conclusions.

2. Background

2.1 Variable definitions

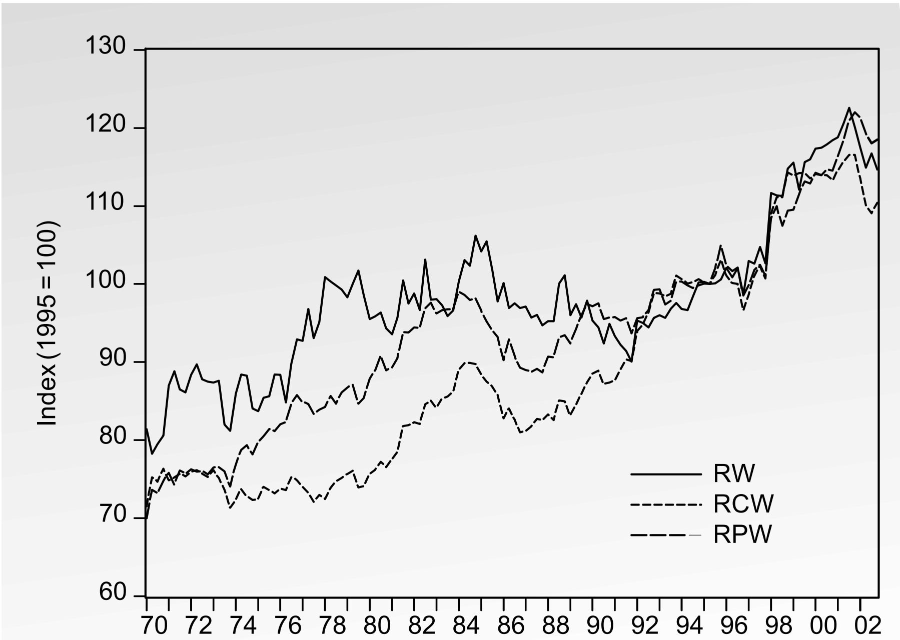
Employment (L) is defined simply as the total number of employees in the manufacturing sector.

Deriving an average real wage series for manufacturing involves dividing the total wage and salary bill by total employment. The resulting average nominal wage series must then be divided by an appropriate price deflator. The choice of deflator has potentially important implications for the interpretation of the resulting real wage series, as well as the specific values obtained. Real wages are defined either as real consumption wages (RCW), where nominal wages are deflated by the consumer price index (CPI) to provide a measure of workers' real purchasing power, or as real product wages (RPW), where nominal wages are deflated by the producer price index (PPI) to provide a measure of the labour cost of production. The appropriate choice of wage measure depends on the purpose of the investigation, and may be ambiguous. For example, in a situation of contract bargaining, workers are concerned with their real purchasing power (hence consumption wages), while management is more concerned with the production costs (hence product wages). This study

1 It is important to note that this data revision means that several other recent empirical studies of the labour market which use StatsSA's employment data may be similarly misleading.

focuses on a variant of real product wages, where the manufacturing gross domestic product (GDP) deflator is used to deflate the nominal wage rate (the resulting series is named RW). The main reason for this choice is consistency: the measure of productivity also implicitly involves the GDP deflator. This allows us to compare the estimated long-run wage–productivity elasticity with the wage bill/value added ratio (see Section 5). However, these results are checked for sensitivity by using both the economy-wide CPI and the manufacturing PPI as deflators. Figure 1 shows the three real wage series. The movements are broadly in line with each other, although RW rises slightly more slowly over the period, and is somewhat more volatile on a quarterly basis. The correlation coefficient between RW and RCW is 0.91, while that between RW and RPW is 0.83. The correlation between RCW and RPW is 0.94.

Figure 1: Average wage deflated by GDP deflator (RW), CPI (RCW) and PPI (RPW), 1970–2002



Source: Own calculations based on StatsSA (2003) and SARB (2004)

Whichever deflator is used, this measure of average real wages is rather blunt, given the wide distribution of wage rates corresponding to different skill levels and occupations in South African manufacturing. Unfortunately, however, reliable wage and employment time series disaggregated by skill level are hard to come by. More seriously, it is not possible to disaggregate productivity by skill level.

This paper adheres to the South African precedent in using a measure of average labour productivity rather than marginal productivity (see Wakeford, 2004, for a more detailed discussion). Specifically, productivity is derived as the ratio of real gross value added to total employment in the manufacturing sector. Clearly, this ‘productivity’ series is affected both by value added (positively) and by employment levels (negatively). It is a very crude measure of productivity, in that it does not necessarily reflect the inherent productive capacity of individual workers, due for example to their level of skill or work effort, but could rather reflect the amount of capital per worker or the degree of technological sophistication in the production process.

In fact, capital stock and technology seem likely to have a very significant impact on labour market dynamics in general. For example, it was argued in Wakeford (2004) that technological improvements may have been driving the rapid upward trend in both real wages and labour productivity in the latter 1990s. In the current paper, this hypothesis will be addressed by including the levels of real gross fixed capital stock and a proxy for technological progress as potential control variables.

2.2 Recent South African empirical evidence

Wakeford (2004) presents a brief review of some international and South African literature concerning the relationship between wages, productivity, and unemployment. This section augments that review by considering several recent empirical studies of the South African labour market. Most of these studies have analysed the non-agricultural formal sector of the economy, although Fedderke & Mariotti (2002) restrict their scope to the manufacturing sector, as does this paper.

Du Toit & Koekemoer (2003) derive a neoclassical model of the labour market and estimate its equations separately using a single equation residual based procedure, presumably applying the Engle & Granger (1987) approach. Their model includes separate labour demand and wage determination equations for skilled and unskilled labour, as well as equations explaining total and skilled labour supply. Both skilled and unskilled (real consumption) wages are specified as a function of aggregate labour productivity and the economy-wide unemployment rate. In both cases they find a negative long-run relationship between real wages and the unemployment rate, and a positive relationship with productivity; both signs are what one might expect (see Wakeford, 2004).

However, Du Toit & Koekemoer's (2003) estimations have several weaknesses. Firstly, it is inconsistent to separate wage rates into skilled and unskilled categories, but to use the overall unemployment rate and aggregate productivity as regressors in both wage equations. Surely the unemployment rate for skilled workers is far lower than for unskilled workers (one constantly hears about the skills shortage), and their average productivity much higher? Secondly (perhaps partly as a result of the previous point), the magnitudes of the long-run coefficients (elasticities) on the productivity terms in both wage equations seem implausibly high at 5.88 and 2.18 for skilled and unskilled workers, respectively. In contrast, Wakeford (2004) estimated a wage–productivity elasticity of approximately 0.57 for a similar time period. It may be that Du Toit & Koekemoer have committed McCloskey & Ziliak's (1996) "standard error of regression", i.e. not distinguishing between economic and statistical significance. Thirdly, no *t*-statistics are reported for any of the long-run coefficients, and so the reader has no way of knowing whether or not they are statistically significant (this is particularly relevant to the unemployment rate, which was found to be statistically insignificant in Wakeford, 2004). Fourthly, the single-equation Engle–Granger approach to cointegration has serious short-comings, and most researchers currently use the more reliable Johansen (1988) procedure or the autoregressive distributed lag (ARDL) approach of Pesaran & Shin (1995).

Havemann (2004), in an attempt to include a wide range of relevant variables representing both the neoclassical and structuralist views of the labour market, as well as feedback effects from wages to output, estimates a six-equation model of the formal, non-agricultural South African labour market. These include a demand for labour equation and a real wage equation. His key findings for the private sector are a wage–employment elasticity of –0.6 (when feedback effects are incorporated), and a real wage–productivity elasticity of 0.74 (which is somewhat higher than the 0.58 found by Wakeford, 2004). Although he also includes variables such as strike activity, the output gap (instead of the usual unemployment rate) and unanticipated inflation in his wage equation, none of these are significant in the long run. While Havemann (2004) makes a useful contribution to the debate surrounding macroeconomic dynamics in the labour market, it would have been helpful if he had provided a description of his data series and sources. As discussed in Section 3.1 below, official employment data provided by StatsSA and the South African Reserve Bank (SARB) for the formal, non-agricultural private sector have recently been substantially revised, which renders the historical time series (and therefore any econometric estimations based on them) of highly dubious value.

Fedderke & Mariotti (2002) analyse the relationship between productivity, employment and real wages in a panel of 48 South African economic sectors, using descriptive statistics and econometric estimation of a labour demand function. Fedderke & Mariotti (2002: 862) argue that "supply side features, internal to the labour market, are a far more probable cause of sluggish employment growth [than recent macroeconomic policy changes], and the relationship of real wage and labour productivity growth is an obvious candidate". While it may have been the case that real wage growth outstripped productivity growth in certain three-digit manufacturing subsectors, the current paper clearly shows that it is not the case in the manufacturing sector as a whole (Figure 5, which shows the declining wage bill/value added ratio, clearly demonstrates this). Therefore, one has to look for alternative explanations for the decline in employment levels. Fedderke & Mariotti's (2002) econometric approach is somewhat limited by the use of a labour demand function. In addition, their labour demand function is derived from a production function which assumes a constant rate of technological progress. However, Fedderke (2002: 626) himself states that "the single strongest contributor to output growth during the course of the 1990's is the augmentation in technology."

It must be said, though, that the preceding finding is for the economy as a whole, while Fedderke (2002) finds that total factor productivity growth in the manufacturing sector was negative in the 1980s and 1990s. However, this finding seems implausible in the light of South Africa's recent shift towards high-technology manufactured exports (see Kaplan, 2004). A possible reason for this counter-intuitive result is that a large portion of technology is imbedded in capital equipment, particularly in a sector such as manufacturing. While Fedderke (2002) takes into account differences in the quality of labour inputs by disaggregating by skill level, he makes no such adjustment for changes in the quality of capital inputs (machines get better over time due to improved technology). Since capital stock is measured in value and not physical volume, this measure reflects improvement in the *quality* of fixed capital inputs, not just *quantity* of machines, factories, etc. Moreover, Fedderke's (2002) results belie the massive role of the so-called 'information revolution', particularly since the mid 1990s. Fedderke (2002) also finds that within manufacturing sub-sectors, the contribution of 'technological progress' is highly volatile over time, and yet he offers no plausible explanation for this. These results could say more about the questionable reliability of the data, methodology and underlying assumptions than about the actual economic processes at work. All in all, it seems doubtful that Fedderke's (2002) measures of total factor productivity based on growth accounting are accurate proxies for technological progress.

This paper adopts a more flexible econometric approach than those adopted by Fedderke & Mariotti (2002), Du Toit & Koekemoer (2003) and Havemann (2004), on two counts. First, it does not impose *a priori* assumptions about causal directions between key variables, but rather tests for them empirically (albeit against a backdrop of various theoretical possibilities). Second, it includes two important variables which arguably have a strong bearing on the relationship between employment, labour productivity and real wages, namely capital stock and technological progress.

As argued in Wakeford (2004), it seems likely that technological change has been a key driver in recent structural changes in the labour market and associated variables (in addition to overall economic growth). Increasing international competition following South Africa's integration into the global economy from 1994 appears to have prompted firms simultaneously to become more capital-intensive, adopt more advanced technologies, hire more skilled workers, and retrench unskilled workers. The well-documented shift in skill composition of production (see for example Edwards, 2001; Lewis, 2002) would naturally be accompanied by rising *average* real wage rates. Moreover, Lewis (2002: 757) argues that "trade liberalisation and increased openness have induced a structural change in production towards capital-intensive sectors." He reports that the unskilled labour component of manufacturing exports is very low compared with certain other labour-abundant countries, and this share has been declining in recent years. Comparing the performance of South African manufacturing to that of the United States (US) and other selected countries, Van Dijk (2003) finds that South Africa's labour productivity declined relative to that of the US between 1970 and 1999. Furthermore, he argues that the high wage level in South Africa makes us uncompetitive relative to certain other developing countries, which could be another reason why SA firms have continued to invest in capital and technology while decreasing their use of unskilled labour in particular. A key question, then, is whether real wages have grown more rapidly than labour productivity, and hence may be viewed as driving the restructuring, or whether the opposite is the case, in which case rising real wages would seem not to be the primary factor causing employment losses.

To summarise the discussion in this section, it seems that an analysis of the relationship between employment, real wages and labour productivity is incomplete without consideration of the role of capital stock and technology. The following section addresses the theoretical linkages between these five variables in more detail, while Section 4 analyses the relationships empirically.

2.3 Specification of relationships with possible causal linkages

As detailed in Wakeford (2004), the relationship between productivity and real wages is usually estimated within a wage equation framework. This paper, in contrast, adopts a more flexible framework which treats all the variables as potentially endogenous, and therefore the determinants of each variable are considered in turn. Economic theory and intuition, as well as prior empirical evidence, suggest several possible causal linkages among real wages, productivity, employment, fixed capital stock and technological progress. This is not to suggest that other variables do not have an important influence on these variables, but the econometric methodology adopted here places limits on the number of variables which can reasonably be included.

2.3.1 Determinants of productivity

Labour productivity (PROD) – or output per worker – is determined by several different factors. In the first place, it depends (positively) on the quality of the workforce, in terms of their skills and effort or work ethic. Such aspects are however difficult to quantify, and are not captured in this study. Second, according to efficiency wage theory a rise in real wages (RW) may induce higher worker effort – and hence productivity – by raising the costs of job loss. Third, a higher capital/labour ratio is also expected to raise labour productivity, as each worker has more capital equipment at his or her disposal. Thus we hypothesise a positive relationship between productivity and capital (K), but a negative relationship with employment (L). Furthermore, as less productive workers are usually the first to be retrenched, decreased employment may be associated with higher average productivity among the remaining workers. Fourth, technological progress (TP) would clearly raise the level of output per worker. These factors are summarised below in the form of a productivity equation (1), where the expected signs appear below the explanatory variables:

$$PROD=f(\underset{+}{RW},\ \underset{-}{L},\ \underset{+}{K},\ \underset{+}{TP}) \qquad (1)$$

2.3.2 Determinants of real wages

Increases in productivity may cause (positive) changes in real wages for at least two reasons: if individuals' pay is performance based; and if labour unions bargain for real wage increases on the basis of past improvements in productivity. If the level of employment were to rise as a result of factors other than real wage or productivity increases (e.g. a boom in exports in labour-intensive sectors following an exchange rate depreciation), one may expect this to strengthen union bargaining power and therefore real wages. An increase in the capital stock and/or technological progress may have an indirect positive effect on wages via their effect on productivity. It could also prompt a shift from unskilled to skilled workers (to operate the more advanced equipment), which would tend to raise average wages.

$$RW = f(\underset{+}{PROD},\ \underset{+}{L},\ \underset{+}{K},\ \underset{+}{TP}) \qquad (2)$$

Other factors (not included here) which could have an impact on real wages include union activity (e.g. strikes), the output gap and unanticipated inflation (see Havemann, 2004). However, the VECM methodology places limits on the number of variables one can include;

in any case, other studies have not found these variables to be significant, albeit in the formal sector as a whole (e.g. Wakeford, 2004; Havemann, 2004).

2.3.3 Determinants of employment

Considering the vast pool of unemployed workers in South Africa, observed employment levels may be taken to reflect the demand for labour rather than the supply of labour. Within the neoclassical framework, the demand for labour is typically derived from a production function (e.g. see Fedderke & Mariotti, 2002), and depends on factor prices (negatively on wages and positively on the cost of capital, which is not included here) as well as the quantity of output. In this analysis we substitute labour productivity in place of output. The effect of an increase in average labour productivity on employment is ambiguous. It could reduce the demand for labour, as workers are more efficient. Alternatively, a rise in productivity could have a positive impact on employment through an 'output effect', which shifts the demand for labour curve outwards. Capital stock could have a positive or negative relationship with employment, depending on whether these factors of production are complements or substitutes in production, respectively. Finally, technological progress is hypothesised to have a negative effect on employment levels as it is generally labour-saving. Equation 3 summarises these relationships.

$$L = f(\underset{-}{RW}, \underset{+/-}{PROD}, \underset{+/-}{K}, \underset{-}{TP}) \qquad (3)$$

2.3.4 Determinants of capital stock

Similar to the demand for labour, the demand for capital depends on factor prices – negatively on the real user cost of capital (not included here) and positively on real wages. If labour and capital are complements in production, we expect a positive relationship between these variables; if they are substitutes, we expect a negative relationship. An increase in labour productivity, say due to improved skills, would likely encourage firms to use more fixed capital. Technological progress could reduce the use of fixed capital if it raises efficiency, but it could also be associated with an increase in capital stock to the extent that technology is embodied in capital equipment. The sign is therefore ambiguous.

$$K = f(\underset{+}{RW}, \underset{+}{PROD}, \underset{+/-}{L}, \underset{+/-}{TP}) \qquad (4)$$

2.3.5 Determinants of technological progress

Technological progress is often considered as exogenous with respect to other macroeconomic variables (for example in production functions). In the present case, it would be hard to argue that changes in employment, real wages, average labour productivity or the capital stock have a direct causal impact on the *creation* of new technologies.[2] However, changes in these variables may contribute to the *adoption* of new technologies. For example, if real wage rates are substantially higher than our international competitors, this may force

2 Except, perhaps, if one accepts the adage, 'necessity is the mother of invention', the necessity being caused by a shortage of adequate factor inputs.

firms to adopt best practice technology. If labour productivity rises due to improved education and training, this may facilitate the acquisition and use of new technologies by firms. Conversely, an increase in employment (e.g. because it is an abundant factor) may reduce the incentive to adopt expensive new technologies. As mentioned above, some capital equipment embodies technology, and so we may expect a positive relationship between these variables, although it is not causal in the usual sense.

$$TP = f\,(\underset{+}{RW},\ \underset{+}{PROD},\ \underset{-}{L},\ \underset{+}{K}) \qquad (5)$$

Viewing equations 1 to 5 as a system, it is clear that the relationships among the five variables are complex, with feedback effects and in some cases ambiguous or multiple signs and/or causal directions. This paper attempts to shed some light on which of these effects are strongest, on the basis of empirical testing. The cointegrating VAR and VECM approach (described in more detail in Section 3.2) is sufficiently flexible to accommodate a complex set of interdependencies among the variables. It also has the advantage of distinguishing between long-run and short-run relationships.

3. Data and Methodology

This section considers the sources and reliability of the data series, and outlines the empirical methodology to be applied.

3.1 Data sources and reliability

The study makes use of quarterly data for the period 1970/Q1 to 2002/Q4. The wage bill and total employment series were taken from StatsSA's (2003) *Survey of Employment and Earnings (SEE)*.[3] The SEE was in fact introduced in the first quarter of 1998, and according to the SARB (2004: s-136), figures after 1998/Q1 'are not strictly comparable with earlier data'. A close examination of the series reveals that nominal total wages and salaries (the wage bill) rose discontinuously between 1997/Q4 and 1998/Q1. In the new survey, one might have expected both the wage bill and total employment to have changed in line with one another, leaving average wages more or less constant, but this was not the case (i.e. recorded employment did not rise suddenly). This results in the average wage series jumping to a higher level at that time, while employment and productivity did not experience such a discontinuity (gross value added does not exhibit a break). Consequently, the econometric tests were performed for the period 1970/Q1 to 1997/Q4 in addition to the full period in order to check for sensitivity to this data anomaly.

More generally, there has been considerable controversy over the accuracy of StatsSA's employment figures in recent years. For example, while the SEE has shown declining non-agricultural formal sector employment since 1990, evidence from the October Household Surveys and Labour Force Surveys suggests that total employment has in fact been rising in recent years. From the third quarter of 2003 StatsSA expanded the coverage of

3 Since the wage bill exhibited a marked seasonal pattern, this series was seasonally adjusted using the U.S. Commerce Department's so-called 'X12' method (see EViews, 2004).

its SEE, including approximately 1700 additional firms (representing an increase of some 20 per cent), mainly in the construction, trade and financial services sectors (SARB, 2004: 13). The employment and wage bill estimates based on the new SEE were dramatically higher in these sectors, which casts serious doubt on the reliability of the historical data. However, estimates for the mining and manufacturing sectors remained relatively consistent betwen the old and new SEE, and therefore the employment time series used in this paper are arguably reasonably reliable. This is one of the reasons this study limits its scope to the manufacturing sector.

The manufacturing gross value added and real fixed capital stock series were sourced from the South African Reserve Bank's *Quarterly Bulletin* (SARB, 2004). Indications are that the SARB will substantially revise its national accounts data towards the end of 2004, so the results presented here should be regarded as provisional. As the fixed capital stock series is available in annual frequency only, it was converted to quarterly figures by a quadratic-match-average interpolation procedure (see EViews, 2004). While this conversion is certainly not ideal, it does at least preserve the overall trend and shape of the original series. Caution should however be exercised when interpreting short-run coefficients in the error correction modelling.

A multifactor productivity index for the manufacturing sector, sourced from the National Productivity Institute (and supplied by Global Insight), is used as a proxy for technological progress. This series was converted from annual to quarterly frequency using the same procedure as for capital stock; the same caveat therefore applies.

All five data series (employment, real wages, productivity, capital stock and technical progress) were converted into indices with base date 1995/Q2. This transformation was performed mainly to facilitate graphical comparisons, and makes no difference to the empirical results, as it merely strips them of their original units of measurement. Finally, in keeping with common practice in macroeconomics, a natural logarithm transformation was applied to the indices for the econometric modelling. This serves to linearise any exponential trends which may be present in the series, and also permits the linear regression coefficients to be interpreted directly as elasticities.[4]

3.2 Empirical methodology

The productivity-wage-employment relationship is investigated empirically as follows. First, preliminary data analysis is conducted. Graphs of the time series are examined to check for the existence of trends and/or structural breaks. Next, correlation coefficients and growth rates are presented to give a preliminary indication of the main patterns and statistical associations. Augmented Dickey-Fuller tests are then applied to the three series to determine their stationarity properties.

If the variables are found to be integrated of order one, I(1), we may proceed to apply Johansen's (1988) multivariate test for a long-run relationship (cointegration). The Johansen

4 The following notation is used for the variables: LRW = log (real wage); LPROD = log (productivity); LE = log (employment); LK = log (capital stock); LMFP = log (multifactor productivity).

procedure begins by selecting an appropriate lag order for the VAR. This is done using the Akaike Information Criterion (AIC), the Schwarz Bayesian Criterion (SBC), a Likelihood Ratio (LR) test and an 'adjusted' LR test, the latter being considered more reliable in small samples (Pesaran & Pesaran, 1997). A further check on the selected lag order is performed by testing for residual autocorrelation in the individual VAR equations using a Lagrange Multiplier (LM) test. Unfortunately, the 'appropriate' lag order is not always clear, and one generally faces a trade-off between parsimony and explanatory power. Once the lag order has been selected, the next step is to apply Johansen's (1988) maximal eigenvalue and trace tests to establish the number of cointegrating vectors in the system. However, these tests depend on assumptions one has to make about the way in which deterministic terms (a constant and a time trend) are included in the cointegrating VAR specification. Specifically, one may assume that a linear trend exists in the data series, and/or that there is a constant or linear trend in the cointegrating relation. Should one or more cointegrating relations be found, the long-run elasticities can be estimated. Furthermore, an error correction model (ECM) can then be estimated to account for the short-run dynamics in the system as well as the long-run equilibrating mechanism.

In the testing procedure, attention will be paid to the sensitivity of the results to the following factors: the choice of price deflator for wages; the sample period; the number of variables included in the VAR; and the cointegrating VAR specification (i.e. the number of lags and the way they intercept and trend are included). The intention is to be as transparent as possible in the modelling process. The most notable results will be reported in detail, and the others merely summarised.

Finally, Granger causality tests are performed in an attempt to establish statistically the causal directions among the variables. 'Granger causality' is interpreted thus: 'If X and Y are two jointly covariance stationary processes, then X is said to "Granger-cause" Y if past Y and past X better predicts current Y than past Y alone' (Alexander, 1993:87). Hence, the issue is technically one of 'predictability' involving lead-lag relationships rather than 'causality' in the strict sense of an endogenous/exogenous relationship. The causality tests are applied within the error correction specification as this ensures stationarity of the variables. Wakeford (2004) provides a rationale for the applicability of the VAR and Granger methodology for productivity and wages. Estimations and tests are performed using the *Microfit 4.0*® and *EViews 5.0*® econometric packages.

The cointegrating VAR methodology adopted here has certain advantages and disadvantages relative to other approaches. Its main limitation is the relatively small number of variables which can feasibly be included, compared with a simultaneous equation or 'structural' model. Other variables which could have an impact on the productivity–wage–employment relationship include union activity (e.g. proxied by strikes), the real user cost of capital, and unanticipated inflation, for example. On the other hand, Havemann (2004) makes the case that Pagan's (2002) proposed trade-off between theoretical and empirical coherence applies to the South African labour market. A big advantage of the VAR approach is that it does not impose any *a priori* theoretical restrictions on the variables entering the various equations, but rather 'lets the data speak for themselves'. The intention of this paper is to be empirically rather than theoretically driven, and therefore the VAR framework has merits. A second point worth noting is that the Johansen approach is superior to the single-equation approach of Engle & Granger (1987), for at least two reasons: we have a system of five variables which may all be endogenously determined; and there may be more than one cointegrating vector.

4. Empirical Results

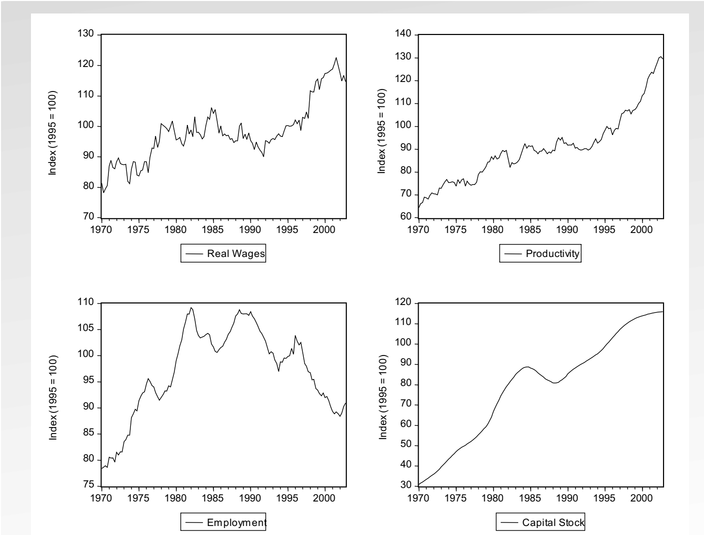
4.1 Preliminary data analysis

A visual examination of time plots of the variables provides a useful initial orientation to the data (see Figure 2). Real wages have shown an upward trend over the past three decades, although this was interrupted in the late 1980s by a period of decline. The graph also reveals a fairly high degree of volatility in the 1970s and 1980s; much of this can be traced to underlying fluctuations in the GDP deflator. Since about 1992, the real wage index has risen particularly rapidly, with generally more muted variations around the trend. The sharp increase in 1998 reflects, at least in part, the introduction by StatsSA of the *Survey of Employment and Earnings* mentioned in the previous section. The pronounced dip in real wages in 2002 is mainly due to a rapid rise in inflation following the rand's precipitous depreciation in 2001.

The productivity series displays a broadly similar pattern, although it is somewhat smoother. Over the 1970s and 1980s there is a definite positive trend, interrupted by a number of shocks which correspond to business cycle recessions. From about 1992 the upward trend in labour productivity becomes much steeper.

The most striking feature of the employment graph is the changing direction of the trend. From 1970 to 1982 employment rose rapidly, except for a drop in 1976-1977, possibly following the Soweto riots. In the 1980s the series displays the effect of the business cycle, with declines in 1982-1985 followed by a recovery. The picture from 1990 has been rather dismal, with a steep decline apart from a spike after the first democratic election in 1994. There was a slight upturn in employment levels in 2002, probably reflecting more favourable export conditions as a result of currency weakness.

Figure 2: Real wages, productivity, employment and capital stock, 1970–2002

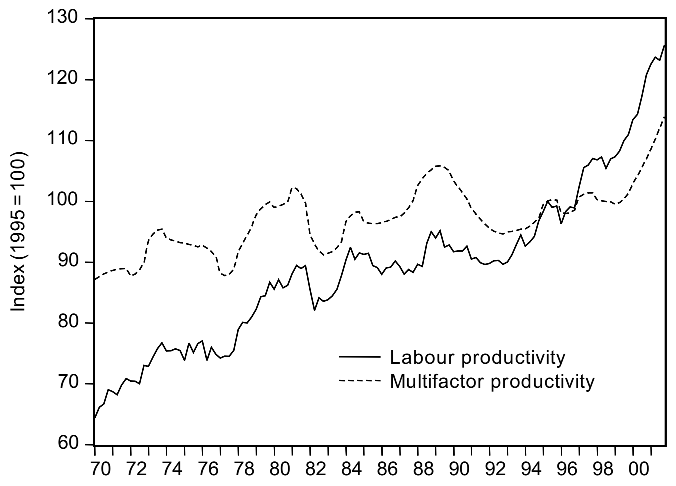


Sources: SARB (2004); StatsSA (2003) and own calculations

The capital stock index rises monotonically except for the period 1985 to 1989, which coincided with the imposition of economic sanctions on South Africa, which severely curtailed imports of capital equipment. The capital stock was augmented at a fairly high rate until the late 1990s, when the rate of increase declined.

Figure 3 plots the labour productivity and multifactor productivity (MFP) indices. Two important questions are: (a) is MFP an adequate proxy for technological progress; and (b) is MFP sufficiently independent of labour productivity? Judging from the graph, the two series are clearly very closely related, exhibiting similar trends as well as cyclical behaviour. The main difference is that labour productivity rises more rapidly over the period. This is to be expected, as MFP is the residual growth in output once labour and capital inputs have been taken into account, and capital stock as we saw has grown considerably (and relatively smoothly) over the period. In other words, since we have capital stock as well as labour productivity in our group of variables, MFP is probably superfluous. Furthermore, the marked cyclical pattern in MFP can hardly be taken to imply that technological progress has undergone large upswings and downswings; rather, it probably reflects varying rates of capacity utilisation over the business cycle. It is also highly likely that a substantial portion of technology in the manufacturing sector is embodied in capital equipment, and will thus not be reflected in MFP. All in all, therefore, MFP seems a poor proxy for technological progress and insufficiently independent of labour productivity. Unfortunately, no better proxy is available.

Figure 3: Labour productivity and multifactor productivity, 1970–2002



Source: Own calculations based on SARB (2004), StatsSA (2003) and NPI (2004)

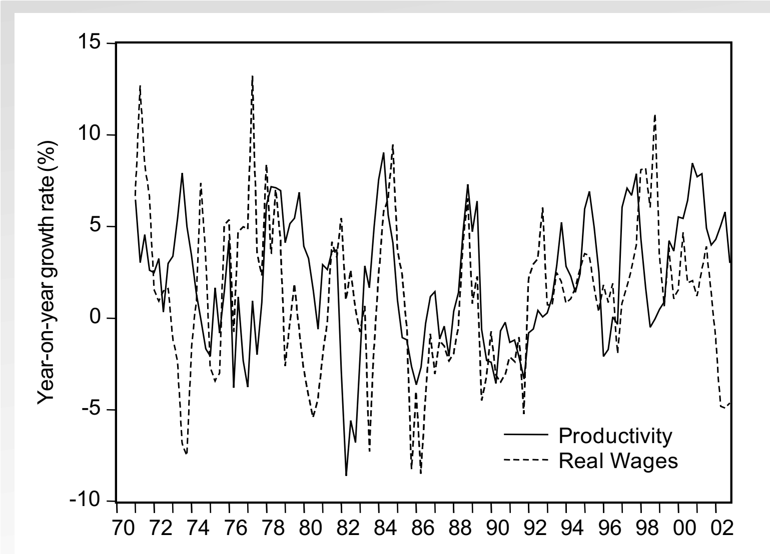
4.1.1 Evidence of a structural break in 1990

The employment graph indicates that a structural change may have occurred in the labour market around 1990. When a Hodrick-Prescott filter is applied to the employment series, the resulting trend element has a single peak in 1990/Q1. Fedderke & Mariotti (2002) also find clear evidence of a structural break in 1990 in their sectoral analysis of manufacturing. This break manifested in changing employment growth rates and an increasing skills intensity of production. Both average real wages and labour productivity rise more sharply in the 1990s, although the turning point seems to be a couple of years later than in the case of employment. This may suggest that rising average real wages were not in fact a primary cause of job losses, but rather followed such losses. Wakeford (2004) discusses various factors which may explain the occurrence of a structural break in or around 1990. These factors include a deep recession, tight monetary policy, increased international competition leading to a substitution of capital for labour, and labour market policies which raised the cost of labour. On the basis of this reasoning and the above evidence, the possible existence of a structural break will be tested in the econometric modelling in Section 4.2.

4.1.2 Growth rates

The dynamic relationship between real wages and productivity is illustrated in Figure 4, which plots the year-on-year growth rates of these variables. Both series have been volatile throughout the period, although real wages have been slightly more so. The short-run association between the variables seems to have been slightly stronger during the 1980s and 1990s, with a marked divergence in the growth rates since 2000.

Figure 4: Growth in productivity and real wages, 1970–2002



Source: Own calculations based on SARB (2004) and StatsSA (2003)

Table 1 displays the average, year-on-year growth rates of the five variables for each of the last three decades. In the 1970s, all five variables grew appreciably, with capital stock growing most rapidly. In the 1980s, real wages actually showed a negative average growth rate, while the other variables grew positively but less rapidly than before. The figures from 1990 show that employment has been declining substantially, while capital stock has continued to grow more rapidly than the other variables. Labour productivity has been growing more rapidly than real wages throughout the period, but particularly since 1980. This is clear evidence that labour has been receiving a diminishing share of output in recent years. Multifactor productivity growth has declined in each decade, which probably says more about the unreliability of this measure as a proxy for technological progress than anything else.

Table 1: Average year-on-year growth rates of productivity, real wages, employment, fixed capital stock and multifactor productivity (%)

Variable	1971–1979	1980–1989	1990–2002
Productivity	2,6	1,0	2,5
Real wages	2,5	–0,3	1,4
Employment	2,1	1,3	–1,4
Capital stock	7,3	3,0	2,6
Multifactor productivity	1,3	0,6	0,4*

Source: Own calculations based on StatsSA (2003), SARB (2004) and NPI (2004). *1990-2001

4.1.3 Correlations

The correlation coefficients presented in Table 2 provide an initial indication of the relationships among the five variables. In the 1970s all five variables exhibited upward trends and so their correlations are all positive. In the 1980s most of the pairwise coefficients are relatively small, which is probably due to the volatility of that decade as a result of political factors and marked business cycle movements. The relatively strong correlations for 1990–2002 reflect the dominant trends in the series during this period. Perhaps the most striking feature of these statistics is the way the correlations involving employment changed from positive to negative between the 1970s and (especially) 1990s. In the entire period, 1970–2002, the pairwise correlations are all positive, although those involving employment (L) are relatively small, which is a result of the trend in this series shifting from positive to negative around 1990. This suggests that employment may be found to be insignificant in the econometric models.

Table 2: Pairwise correlation coefficients

Variables	1971–1979	1980–1989	1990–2002*	1970–2002*
RW–PROD	0,75	0,29	0,92	0,90
RW–L	0,65	–0,18	–0,92	0,16
RW–K	0,82	0,55	0,94	0,84
RW–MFP	0,43	–0,22	0,75	0,69
L–PROD	0,82	0,21	–0,89	0,21
L–K	0,94	–0,02	–0,88	0,48
L–MFP	0,58	0,43	–0,59	0,44
K–PROD	0,92	0,26	0,90	0,92
K–MFP	0,66	–0,34	0,62	0,72
PROD–MFP	0,86	0,74	0,86	0,84

Source: Own calculations based on SARB (2004), StatsSA (2003) and NPI (2004). *Sample ends in 2001 in the case of MFP

4.1.4. Orders of integration

We now turn to an analysis of the stationarity properties of the series (in logged form). The visible evidence of upward trends (see Figure 1) suggests, *a priori,* that all the series are non-stationary. This is tested formally by way of Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) tests. The ADF test allows one to distinguish between difference stationary and trend stationary time series processes; the former contain unit roots, while the latter are stationary once a linear trend has been removed. Unfortunately, DF and ADF tests have low power in small samples and are not effective in distinguishing borderline cases. The results, shown in Table 3, indicate that LPROD, LRW, LL and LMFP are all I(1) variables, i.e. integrated of order one (non-stationary in levels but stationary in first differences). On the other hand, LK is found to be I(2). These results are robust to the inclusion of a deterministic trend in the test regressions (column 4), and in all but one case is also robust to the inclusion of one or four lagged difference terms, which account for possible residual autocorrelation. The one exception is the DF test statistic for LK of –9.17 in column 3, which is spurious since there is clear evidence of an upward trend in the series, and LK has substantial autocorrelation (the ADF(1) specification is selected by the three model selection criteria in this instance). When the Johansen procedure is applied, capital stock will have to be entered in first differences to ensure that it is I(1) like the other variables.

Table 3: Augmented Dickey-Fuller tests for order of integration, 1970–2002

Variable	Test	**I(1) vs I(0)**	**I(1) vs I(0) + trend**	**I(2) vs I(1)**
LRW	DF	-1.42	**-2.60**	**-13.58***
justright	ADF(1)	**-1.18**	-2.22	-10.08*
	ADF(4)	-1.02	-1.91	-5.15*
LPROD	DF	**0.41**	**-1.19**	**-11.42***
	ADF(1)	0.46	-1.14	-6.94*
	ADF(4)	0.34	-1.40	-5.12*
LL	DF	-2.37	-1.31	-8.35*
	ADF(1)	-2.11	-1.33	**-4.37***
	ADF(4)	**-2.30**	-1.98	-3.34*
LK	DF	-9.17*	-3.07	**-1.69**
	ADF(1)	**-2.25**	**-2.56**	-1.44
	ADF(4)	-2.33	-2.33	-1.92
LMFP	DF	-0.05	-0.92	-5.45*
	ADF(1)	**-1.70**	-3.04	-4.38*
	ADF(4)	-0.86	**-2.04**	**-3.81***
5% critical value		*-2.88*	-3.45	-2.88

Notes: *Statistically significant at the 5 per cent level. Bold print test statistics correspond to the 'best' lag specification chosen by the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) and Hannan-Quinn Criterion (HQC). The sample for LMFP ends in 2001Q4.

4.2 Cointegration tests

4.2.1 Testing for multivariate cointegration, 1970–2002

In the previous section it was argued that multifactor productivity is not a reliable proxy for technological progress (and is not sufficiently independent of labour productivity and capital stock). It therefore seems prudent to exclude the MFP variable from the cointegration analysis.[5] Hence we begin with four variables, namely log real wages (LRW), log productivity (LPROD), log employment (LL) and the first difference of log capital stock (DLK), all of which are I(1). Estimation begins with the longest sample period available, namely 1970/Q1 to 2002/Q4. Following the graphical indications that a structural break may have occurred in 1990, and the supporting discussion, a dummy variable (D90) is included which takes on values of 0 up till 1989/Q4 and 1 thereafter. Furthermore, another dummy variable (D98) is included to test whether the change in StatsSA's survey instrument from 1998/Q1 significantly affects the results (see discussion in Section 3.1).

The first step is to test for the appropriate lag order *(p)* in the VAR. A starting point of five lags is chosen, which is most likely sufficiently general for quarterly data. The results, displayed in Table 4, are ambiguous: the AIC selects $p = 2$, the SBC selects $p = 1$, while the Likelihood Ratio (LR) test and adjusted LR test both select $p = 4$.[6] It is usually better to include too many lags rather than too few, and therefore a VAR(4) is arguably most appropriate. Further support for this is provided by Lagrange Multiplier (LM) tests for autocorrelation applied to the residuals of individual equations in a lower order VAR; these yield evidence of significant serial correlation in the employment (LL) equation.

5 To cover all the bases, the modelling was conducted with MFP included, but it was found to be statistically insignificant in the long-run equations.

6 The adjusted LR test is considered more reliable in small samples (Pesaran & Pesaran, 1997).

Table 4: Testing for lag order in the VAR

Test statistics and choice criteria for selecting the order of the VAR model					
Order	**LL**	**AIC**	**SBC**	**LR test**	**Adjusted LR test**
5	1691.2	1599.2	1468.7	—	—
4	1678.3	1602.3	1494.5	CHSQ(16)= 25.7174 [.058]	21.0230 [.178]
3	1659.7	1599.7	1514.6	CHSQ(32)= 62.9087 [.001]	51.4253 [.016]
2	1647.6	1603.6	1541.2	CHSQ(48)= 87.1806 [.000]	71.2667 [.016]
1	1629.5	1601.5	1561.8	CHSQ(64)= 123.2837 [.000]	100.7796 [.002]
0	1006.1	994.10	977.08	CHSQ(80)= 1370.1 [.000]	1120.0 [.000]

Notes: AIC = Akaike Information Criterion, SBC = Schwarz Bayesian Criterion. Based on 126 observations from 1971Q3 to 2002Q4. Order of VAR = 5. List of variables included in the unrestricted VAR: LRW, LPROD, LL, DLK. List of deterministic and/or exogenous variables: C (constant), D90, D98.

Next, an LR test of restrictions was applied to test the significance of the dummy variables D90 and D98. The chi-square statistic for D90 is 6,63, which is not significant at even the 10 per cent level. In contrast, the chi-square statistic for D98 is 15,78, which is significant at the 1 per cent level, implying that the data revision in 1998 has a significant effect on the estimation. Repeating these tests within a VAR(4), the same conclusion is found for D98, but D90 has a chi-square statistic of 9,59, which is significant at the 5 per cent level. There is thus only weak statistical evidence of a possible structural break in 1990.

Now that the VAR order has been established, Johansen's (1988) maximum likelihood test for cointegration can be applied. However, one first has to make an assumption regarding the way in which intercept and/or trend terms are included in the VAR model. For the sake of completeness and transparency, the test results are shown in Table 5 for three combinations of intercept/trend specification (the other two theoretically possible cases are rarely appropriate in practice). The most general case, 'unrestricted intercepts, restricted trends', means that there is a deterministic trend in the cointegrating relation and a general constant in the VAR, which allows for linear time trends in the underlying variables. 'Unrestricted intercepts, no trends' has only a general constant in the VAR. "Restricted intercepts, no trends' means there is an intercept in the cointegrating relation only, and is applicable when the variables have non-zero means but no trends (EViews, 2004). In all three cases the trace test indicates the presence of one cointegrating vector (CV). However, the maximum eigenvalue test suggests no cointegration when no trend is included (r = 1 at the 10 per cent level), but two cointegrating relations when a trend is included. The results show that the number of cointegration relations found is sensitive both to the way in which intercept and trend terms are included and the specific test used.

Table 5: Summary of cointegration tests for LRW, LPROD, LL and DLK, 1970–2002

Specification of the cointegrating VAR	Maximal eigenvalue	Trace
Restricted intercepts, no trends	0	1
Unrestricted intercepts, no trends	0	1
Unrestricted intercepts, restricted trends	2	1

Note: Figures refer to the number of cointegrating vectors (*r*) indicated by each test at the 5 per cent significance level.

Since all of the variables were found to contain stochastic trends (as opposed to being trend stationary), the 'unrestricted intercepts, no trends' option is arguably most appropriate. The detailed results of this cointegration test are reported in Table 6. The maximal eigenvalue test suggests that the number of cointegrating vectors (*r*) is zero; the trace test indicates $r = 1$. Supported by theory, it seems justifiable to assume that there is one cointegrating vector. This permits estimation of the long-run relationship, which when normalised on LRW is given by:

$$Z = LRW - \underset{(0.28)}{0.20}*LPROD - \underset{(0.25)}{0.46}*LL - \underset{(1.19)}{0.76}*DLK \qquad (6)$$

This result is somewhat surprising in that none of the three long-run coefficients is statistically significant, based on the estimated standard errors shown in parentheses.[7] This result could be due to the loss of degrees of freedom from including a large number of coefficients in the cointegrating VAR (four variables with four lags each). Indeed, this is one of the limitations of the VAR approach, as mentioned in Section 3.2. It is therefore not possible to conclude that a long-term relationship exists between these four series for this sample period.

7 Inspection of the individual error correction equations (not shown) reveals that the F statistics for the LPROD and DLK equations are not significant. Moreover, most of the lagged difference terms in all of the equations are insignificant. Overall, the models perform quite poorly in terms of statistical robustness.

Table 6: Cointegration test using 'unrestricted intercepts, no trends', 1970–2002

Eigenvalue test:			*Critical values*	
Null	*Alternative*	*Eigenvalue*	*5%*	*10%*
r = 0	r = 1	27.35	27.42	24.99
r <=1	r = 2	13.77	21.12	19.02
r <=2	r = 3	8.95	14.88	12.98
r <=3	r = 4	4.15	8.07	6.50
Trace test:			*Critical values*	
Null	*Alternative*	*Trace*	*5%*	*10%*
r = 0	r ≥ 1	54.23	48.88	45.70
r <=1	r ≥ 2	26.87	31.54	28.78
r <=2	r ≥ 3	13.10	17.86	15.75
r <=3	r = 4	4.14	8.07	6.50

4.2.2 Testing for multivariate cointegration, 1970–1997

As mentioned above, the D98 dummy variable was highly significant, indicating that the data revision (causing real wages to rise discontinuously) in 1998 affects the results. Therefore, the analysis was repeated for the period 1970 to 1997, which allows us to check whether the results obtained above are robust to the chosen sample period. The D90 variable was initially included, but was found to be statistically insignificant on the basis of an LR test (the chi-square statistic with four degrees of freedom is 5,04; probability = 0.283), and was thus omitted. The tests for lag order in the VAR were highly ambiguous: the AIC and SBC chose 3 and 1 lag, respectively, while the LR test suggested $p = 5$ and the adjusted LR test selected $p = 4$. On balance, either a VAR(3) or a VAR(4) may be optimal. The maximal eigenvalue and trace tests consistently found no evidence of cointegration, irrespective of the trend/intercept specification. This holds for both a VAR(4) and a VAR(3). It therefore seems safe to conclude that these four variables are not cointegrated for the period 1970 to 1997. This highlights the fact that cointegration is a sample-dependent phenomenon, not a time-invariant property of the variables.

Since DLK was found to be highly insignificant in the 1970–2002 long-run equation, the tests were applied again with this variable omitted. In the trivariate case of LRW, LPROD and LL, however, LL is consistently insignificant (for both sample periods as well as various cointegrating VAR specifications). This did not appear to be as a result of a structural break in the employment series in 1990, as the dummy variable D90 was consistently insignificant. The log employment (LL) series creates problems for the VAR modelling, since it is highly autocorrelated (up to four lags). In both the three- and four-variable tests, this autocorrelation led to a bias towards a higher order VAR, which in turn resulted in less robust statistical results due to the loss of degrees of freedom. In case the LL variable skewed the results, the tests were applied to the three variables LRW, LPROD and DLK for the period 1970–97. In this instance, no evidence of cointegration is found, irrespective of the test (maximal eigenvalue or trace) or the trend/intercept specification of the VAR. For the period 1970–2002 (including the dummy D98 for the real wage discontinuity), in the one case in which cointegration was found (restricted intercepts, no trends), DLK was again insignificant.

4.2.3 Testing for bivariate cointegration between real wages and productivity, 1970–2002

Since employment and capital stock were not found to be significant in the multivariate cointegration tests, the tests were applied to the bivariate relationship between LRW and LPROD, starting with the period 1970/Q1 to 2002/Q4. A VAR(1) was unanimously selected by the AIC, SBC and LR tests. Further, no residual serial correlation was found in either of the two VAR equations, confirming the appropriateness of the first order VAR. The dummy variable D98 was found to be significant (chi-square = 7,08, probability = 0,029), indicating that the data revision from 1998/Q1 makes a statistically significant impact on the results. The subsequent cointegration tests (see Table 7), using the 'unrestricted intercepts, no trends' specification, both found one cointegrating vector, which was estimated as:

$$Z = LRW - \underset{(0.10)}{0.38}*LPROD \quad (7)$$

This implies that a one per cent increase in manufacturing productivity is associated with a 0.38 per cent rise in real wages in the long run (a statistically significant result). From an economic perspective, this coefficient seems on the low side (although cf. Figure 5 and the related discussion in Section 5).

Table 7: Cointegration test for LRW and LPROD, 1970–2002

Eigenvalue test:			*Critical values*	
Null	*Alternative*	*Eigenvalue*	*5%*	*10%*
r = 0	r = 1	16.47	14.88	12.98
r <=1	r = 2	2.34	8.07	6.50
Trace test:			*Critical values*	
Null	*Alternative*	*Trace*	*5%*	*10%*
r = 0	r ≥ 1	18.81	17.86	15.75
r <=1	r = 2	2.34	8.07	6.50

As a further check on the robustness of the above result, the sample period was restricted to end in 1997/Q4. Once again, a VAR(1) was selected. However, in this case the maximal eigenvalue test suggests $r = 0$ at the 5 per cent level, while the trace test indicates $r = 2$ (see Table 8). The latter result should obtain only if the variables are I(0), but this is clearly not the case, and therefore this result is regarded as spurious. Therefore, we conclude that there is no cointegration between LRW and LPROD between 1970 and 1997. This result is robust to how the intercept and trend are included in the cointegrating VAR. Hence, as before, the sample period affects the outcome of the cointegration tests.

Table 8: Cointegration test for LRW and LPROD, 1970–1997

Eigenvalue test:			*Critical values*	
Null	*Alternative*	*Eigenvalue*	*5%*	*10%*
r = 0	r = 1	11.41	14.88	12.98
r <=1	r = 2	2.18	8.07	6.50
Trace test:				
Null	*Alternative*	*Trace*	*5%*	*10%*
r = 0	r ≥ 1	13.59	17.86	15.75
r <=1	r = 2	2.18	8.07	6.50

The final step was to test for the sensitivity of the choice of price deflator for real wages. The same testing procedure was applied to LRPW (where the deflator is the manufacturing PPI) and LPROD. In this case, the D98 variable was found to be insignificant, which is puzzling. In the ‘restricted intercepts, no trends’ case, the maximal eigenvalue test found one cointegrating vector at the 5 per cent level while the trace test found one CV at 10 per cent only. Assuming one CV is appropriate, the long-run relationship is estimated as follows:

$$\underset{}{Z = LRPW - \underset{(0.25)}{0.91}*LPROD - \underset{(1.16)}{0.23}} \qquad (8)$$

The long-run ‘productivity elasticity of wages’ is insignificantly different from unity, meaning that a one per cent rise in productivity is associated with a one per cent rise in real wages in the long term. However, allowing for possible deterministic trends in the data results in no cointegration. For the period 1970 to 1997, no evidence of cointegration was found, irrespective of intercept/trend specification, and so the above result is highly sensitive to the sample period.

Finally, the analysis is repeated using LRCW (where the deflator is the economy-wide CPI) and LPROD. D98 is found to be significant. The only case in which a cointegrating vector is found is when an intercept but no trend is included in the cointegrating relation. The estimated long-run relation is:

$$\underset{}{Z = LRCW - \underset{(0.26)}{0.47}*LPROD - \underset{(1.71)}{2.46}} \qquad (9)$$

The coefficient on productivity is not significantly different from zero at the 5 per cent level and so this result may not be meaningful. Truncating the sample period to end in 1997 did not result in any substantive change to this result.

All this goes to show that the outcome of bivariate cointegration tests depends on the choice of price deflator for real wages, as well as on the sample period and the specification of the cointegrating VAR. Hence, the results presented above cannot be considered statistically robust.

4.3 Error correction models and Granger causality

Nevertheless, as a cointegrating relation was found between LRW and LPROD for the period 1970 to 2002, an ECM may be estimated and used to test for a long-run causal relationship between the variables. However, because the lag order of the VAR is one, no lagged difference terms appear as regressors (only the error correction term appears), and therefore we cannot test for short-run Granger causality within the ECM. The ECM estimation results are reported in Table 9. The DLRW model has low explanatory power, but the F-statistic is significant at 1 per cent and the model passes the conventional tests for serial correlation, functional form and residual normality at the 5 per cent level, although there is some evidence of heteroscedasticity. All three regressors (constant, error correction term and the dummy variable for the 1998 data revision) are statistically significant at the 1 per cent level. The ECM term is negative as expected, indicating that real wages adjust back towards long-run equilibrium (with productivity) following a shock in the previous period. The magnitude of this coefficient suggests that approximately one fifth of the disequilibrium is corrected within the first quarter. Long-run Granger causality running from productivity to real wages may be inferred from the significance of the ECM term. In contrast, the productivity equation is very poorly specified. The F statistic is highly insignificant, as are each of the individual regressors including the ECM term. We therefore cannot conclude that real wages Granger cause productivity in the long run.

Table 9: Error correction models for LRW and LPROD, 1970–2002

1970/Q1 – 2002/Q4; n = 131	*Dependent variable*	
Regressor	DLRW	DLPROD
CONSTANT	0.60*	-0.049
	(0.15)	(0.10)
ECM(-1)	-0.21*	0.02
	(0.05)	(0.04)
D98	0.02*	0.003
	(0.01)	(0.005)
R-squared	0.11	0.01
Adjusted R-squared	0.09	-0.002
F(2,128)	7.59	0.86
prob(F)	0.001	0.43
Standard error	0.025	0.017

Note: *Significant at 1 per cent; standard errors in parentheses

5. Discussion

5.1 Distributional implications of the productivity–wage relationship

As argued in Wakeford (2004), the relationship between labour productivity and real wages carries important policy implications relating to the distribution of income. Specifically, the consequences of increased productivity depend on how the extra value added per worker is distributed between firms and workers. Either workers can be paid more without reducing corporate profits or fuelling inflation, or businesses can increase profits without increasing employment (meaning unemployment is not reduced). Usually one might expect some

$$RULC = \frac{rw.L}{Q} = \frac{rw}{prod} = \frac{RW/L}{Q/L} = \frac{RW}{Q} \text{ = wage share of output}$$

combination of the two, the shares of the pie depending on, for example, the relative strengths of union and firm bargaining power. If an increase in productivity is not matched by a commensurate (proportional) increase in real wages, then unit labour costs will decrease, which sounds good for economic efficiency. However, real unit labour costs are in fact identical to labour's share of value added (see below), and so from workers' vantage point, such a decline is bad news. In other words, we are faced with the familiar trade-off between efficiency (read: greater profits) and distributional equity. In a socio-economic climate of extreme inequality and endemic poverty, the distributional aspect cannot be ignored, particularly as growth (through efficiency) is demonstrably not 'trickling down' to the poor to any meaningful extent.

One of the main findings of the empirical analysis in the previous section is that labour productivity has indeed grown more rapidly than real wages in the period 1970-2002. This result emanated from the growth rate figures as well as the econometric estimation, which found that wages rose by approximately 0,4 per cent for each 1 per cent rise in productivity. This implies that labour's share of value added has declined over time. Emphasizing the components of the two series clarifies this: the average real wage is the wage bill divided by total employment, while productivity is value added (output) divided by total employment. Hence, a simplified way of looking at this issue is to examine the ratio of the wage bill to value added directly, so that the employment denominators cancel out. This is shown in the equation below, which also highlights the fact that real unit labour cost equals the ratio of per worker wages to per worker output (productivity).[8]

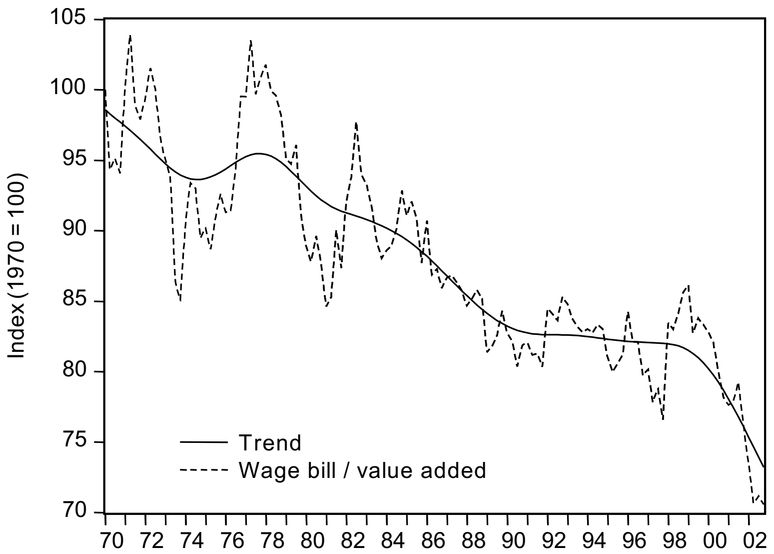
where: RULC = real unit labour costs

rw = real wage per worker
L = employment
Q = real output
prod = labour productivity
RW = real wage bill

Figure 5 plots the share of value added accruing to labour in manufacturing between 1970 and 2002. The trend (obtained using the Hodrick-Prescott filter) is steeply downward, losing more than 25 per cent of its value over the period.

8 Note that the same price deflator (the manufacturing GDP deflator) was used to convert both wages and output from nominal to real figures; hence prices can be suppressed.

Figure 5: Wage share of output in manufacturing, 1970-2002



Source: Own calculations based on SARB (2004) and StatsSA (2003)

5.2 Changing labour market dynamics

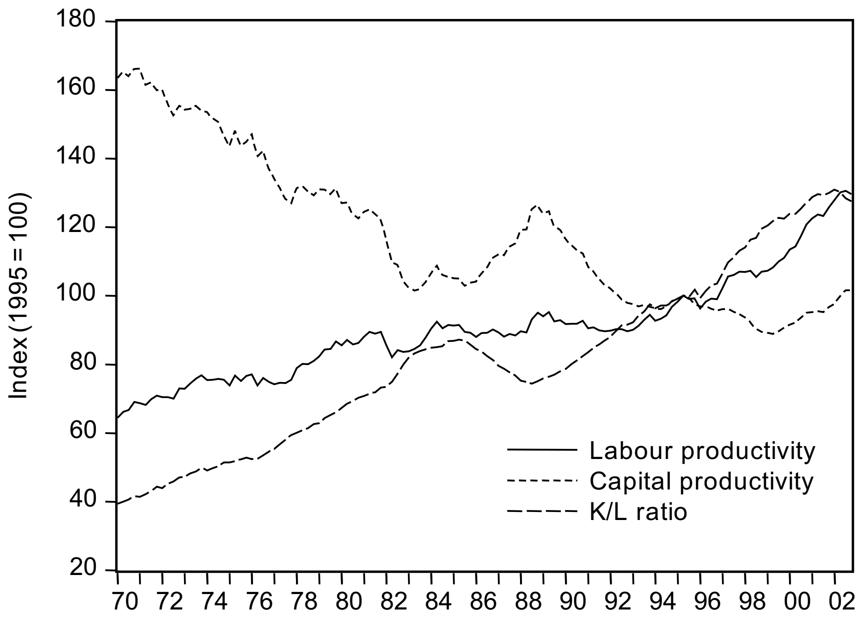
The question arises as to what has been driving the changing division of the economic pie between workers and owners. Unfortunately, the econometric estimations did not shed much light on this issue, as the results were sensitive to specification and some of the key variables (employment and capital stock) were found to be statistically insignificant related to the others. Nevertheless, it is possible to construct various scenarios based on the observable trends in the data series.

It is clear that major restructuring has taken place in the South African manufacturing sector over the past few decades. In particular, there has been a substitution of capital for labour in the production function. This has been evidenced by the rapid decline in employment levels but growth (albeit relatively slow) in both capital stock and output during the 1990s. Figure 6 shows the steady rise in the capital–labour ratio since 1970 (apart from a dip in the mid-1980s when sanctions were imposed and South Africa's access to foreign fixed capital was suddenly curtailed). It is therefore not surprising that labour productivity has risen fairly rapidly. What few people seem to acknowledge, however, is the persistent *decline in capital productivity* (i.e. total output divided by fixed capital stock). This situation is perverse given South Africa's abundance of labour (albeit unskilled).

The cause of this restructuring is by no means certain, but one possible scenario is that rising real wage demands induced firms to substitute other factors of production for labour. This is consistent with the findings of a negative wage-employment elasticity in South Africa (see, for example, Bhorat & Leibbrandt (1998), Fallon (1992), Fallon & Lucas (1998) and Havemann (2004)). However, an unambiguous causality between wages and employment has not been established either empirically or theoretically. Nevertheless, wage increases seem likely to be at least part of the story.

An alternative scenario can also be hypothesised. Instead of rising average real wages driving the restructuring, the underlying cause could have been other incentives facing producers, such as labour market inflexibility or technological advances embodied in capital. The immediate result was the same, i.e. slow growth in value added in the face of falling employment, resulting in growth in measured average productivity. This may have served as a basis for labour unions bargaining for higher real wages, although from the results in the previous section it appears that this bargaining power was rather weak, so that labour enjoyed a relatively meagre portion of the productivity gains. Thus it seems somewhat inconsistent for trade unions to be strong enough to raise average wages, but too weak to avert a declining wage share. One possible explanation is that skilled workers are in collusion with employers to raise their wages, at the expense of unskilled workers' jobs.[9]

Figure 6: Labour productivity, capital productivity and the capital/labour ratio



Source: Own calculations based on SARB (2004) and StatsSA (2003)

9 I am grateful to Nicoli Nattrass for making this point.

6. Conclusions

The aim of this paper was to contribute to the debate on labour market dynamics in South Africa. More specifically, it sought to investigate the empirical relationship between productivity, real wages and employment in South Africa’s manufacturing sector, using appropriate time series econometric techniques. The main value of this approach is that it imposes few *a priori* theoretical assumptions regarding the relations between the variables, but rather allows the data to ‘speak for themselves’. This is all well and good so long as the data are accurate reflections of reality (and that appropriate variables are chosen). This study focused on the manufacturing sector precisely because these data are considered fairly reliable over the long run (at least compared with other sectors). Hence, the empirical results can be used to test various hypotheses concerning structural relationships among key labour market variables.

Unfortunately, the econometric results were not particularly helpful in contributing to our understanding of the relationship between wages, productivity, employment and capital stock, since the latter two variables were not found to be statistically related to the others in the long run. The modelling suggests that a cointegrating relationship may exist between real wages and productivity for the period 1970–2002. According to the model, a 1 per cent rise in productivity is associated with an increase of approximately 0,38 per cent in real wages in the long run. This coefficient may be implausibly small, although the fact that it is less than one is congruent with the preliminary data analysis in that real wage growth has not kept pace with productivity gains in the long run. The error correction model suggests that the long-run causality runs from productivity to real wages, which is consistent with wage-bargaining theory. However, an important finding is that the econometric results are sensitive to several factors: the sample period; the change in data collection by StatsSA in 1998; the specification of the cointegrating VAR (in terms of the lag order and the inclusion of intercept and trend terms); and the choice of price deflator for real wages. Hence we cannot place much reliance on the econometric results, and those which do appear individually robust are suggestive only.

Two further points relating to data and empirical modelling are worth making. First, an issue to emerge from the literature review, as well as the section describing the data, is the critical issue of data reliability. While it has been common knowledge that consistent and accurate time series data on employment and wages (in particular) are very scarce in this country, many researchers – despite having noted this deficiency – seem, in their enthusiasm for econometric modelling, to forget this when drawing policy inferences from their empirical results. Therefore, it is imperative that researchers be as transparent as possible in disclosing the sources of their data and any manipulations of them.[10] Second, this paper has demonstrated that in some cases, simple empirical techniques such as graphs and summary statistics of key variables can provide as much (if not more) useful information as complicated econometric procedures. Indeed, given the many pitfalls of applied econometrics, such as sensitivity to theory, variable definitions and data quality, policy makers should be wary of being too easily convinced by apparent technical sophistication. Most importantly, it is vital

10 The data used in this study are available from the author on request.

that empirical modelling exercises be evaluated on the basis of sound economic logic and intuition. Basing policy prescriptions on dubious empirical results, with a blind faith in quantitative evidence, is a dangerous practice. On the other hand, ignoring empirical evidence altogether leaves the policy process vulnerable to the vagaries of political expediency. Therefore, a sensible blend of careful quantitative analysis and well-informed, intuitive understanding of economic processes is likely to inform the best policies.

Having said all this, a clear finding emerging from this paper is that the manufacturing sector has been growing increasingly capital intensive over time, as capital stock has grown more rapidly than employment. In fact, since about 1990, employment levels (particularly of unskilled workers) have declined in absolute terms, while output has continued to rise. This has led to a fairly rapid rise in labour productivity, as well as growth in average real wages. However, since productivity gains have not been fully matched by wage increases, labour’s share of output has declined. Since a substantial portion of technology is embodied in capital equipment, the rising capital–labour ratio and labour productivity probably reflect technological progress at least to some extent. Other reasons for these trends may be a lack of international competitiveness due to unskilled wage rates being in excess of those in labour abundant countries in Asia, and possibly also labour market inflexibility. The upshot of all this is that calls for South African manufacturing to improve its competitiveness (and move into dynamic, high-technology products) imply further job shedding. In the face of very high existing levels of unemployment and inequality, together with a dire skills shortage, the question is whether South Africa can really afford (from a socio-economic perspective) to continue its current trajectory.

Many commentators argue that increasing the rate of economic growth (to about 5 or 6 per cent per annum) is the only effective way to generate enough new jobs to reduce the unemployment rate. However, it seems clear from South Africa’s economic performance in recent years that shifting to a higher growth trajectory would require something of a miracle. External conditions are likely to become even more unfavourable for our manufacturing industries, for example because of the precarious state of the US economy (massive twin deficits combined with excessive household indebtedness) and its effect on global commerce. Furthermore, international competition is becoming fiercer all the time, and thus it seems likely that South Africa will continue to lose manufacturing jobs, especially in labour-intensive sectors. The same can probably be said for mining and possibly the construction sector. Pinning hopes for reducing the unemployment rate on growth within the current economic system and policy framework therefore seems unrealistic. Rather, creative initiatives aimed at boosting local economy and protecting labour-intensive industries, as well as continued efforts to upgrade the skills base of the labour force, are vital in order to ensure meaningful work opportunities and livelihoods for the vast majority of South Africans.

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