

The Role of Mining in the South African Economy

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ABSTRACT: This paper examines the contribution of three aggregate mining sectors of the South African economy to output and employment over the 1970-97 period. The finding of a declining importance of mining in output and employment creation must be sectorally differentiated. Gold & Uranium Mining is the chief source of these declines, while evidence for Coal and Diamond & Other Mining is more modulated. We find strong redistribution of output from equity to labour over the course of the 1990's for Gold & Uranium Mining. In mining labour markets, we present developments in employment trends, in real labour cost, and in labour productivity. We examine links between these dimensions in explanation of changing employment trends. We conclude with a VECM estimation of a labour requirements equation to corroborate our findings.

1 Introduction

Conventional wisdom views the mining sector of the South African economy as its quintessence. As contributor to aggregate output, as foreign exchange earner for the economy, as employer, and as a generator of tax revenues mining has often been viewed as the locomotive of South Africa's economic development.¹

Historically such a perception certainly carries much validity. In this paper we examine whether this perception of the role of mining in the South African economy remains justified.

As the evidence that follows will demonstrate, the role of mining in the economy has become a more modulated one. Whereas in some of its traditionally pivotal roles it remains in much the same position, in most areas it is considerably less important than it used to be. Perhaps the best way to characterise the role of mining in the South African economy is that it has been in a process of profound transformation for a period now spanning well over two decades.

Such transformation of the role of the mining sector should be seen as a natural process. Any economy that considers itself on a developmental trajectory would experience diversification of economic activity over time.

The investigation that follows contains two sections. In the first, we examine the contribution of the aggregate mining sector to the total output of the South African economy. In the second, we explore the role of mining in the South African labour market.

Whereas aggregate data on the South mining sector was readily available, more detailed data for certain sub-sectors was more difficult to collect. While providing additional information, the use of a range of different data sources is likely to bring about some loss in consistency. Details about the data used in the different sections of the document and its description are presented in a summary of data sources in the appendix.

¹We focus on output and employment since they have the most immediate and dramatic welfare impact on the South African economy. Historically the investment rate of the mining sector was of significance to the aggregate economy, with output growth in the sector being driven primarily through capital accumulation. The 1980's and 1990's have seen a steady shift in output growth away from capital accumulation to growth that is driven by growth in total factor productivity. Thus investment by the mining sector has assumed less significance in the economy over time.

2 The Contribution of the Mining Sector to Aggregate Output of the South African Economy

The mining sector in South Africa has traditionally occupied a principal role in the generation of output in the economy. Various sources have noted the declining contribution of the mining sector to gross domestic product (GDP) and employment in South Africa.²

This paper sets out to explore the details of this decline. As the evidence on the period 1970-1997 (1998 where available) will confirm, the mining sector has declined in relative and absolute importance in the South African economy in terms of both its contribution to aggregate output, and its contribution to total employment in the economy.

2.1 The Importance of Mining in terms of its Contribution to Value Added in the South African Economy

In this section we examine the contribution of the mining sector to South African output in terms of the real value added contributed by the three aggregate South African mining sectors: Coal, Gold & Uranium and Diamond & Other Mining.³ We examine the net output contributed by the mining sector to aggregate output, purged of the intermediate inputs employed by the mining sectors. As such our concern is with the net contribution of the mining sectors to aggregate output in the South African economy, rather than with the aggregate volume of sales of the sector.⁴

Over the 1970-98 period, the proportional contribution of the mining sector to total value added in the South African economy has more than halved, declining from 21.3% in 1970, to 9.9% of the private sector's GDP in 1998. The strongest decrease in the proportional contribution of mining to total value added of the economy occurred during the 1970-75 period. While

²See Loots (1998), IDC (1998), Jones and Müller (1992).

³Focus on the three aggregate mining sectors is due to data convenience. It is for these three-digit SIC sub-sectors that consistent time series data is available. Where more detailed data was available we note any additional information of relevance.

⁴In the discussion that is to follow, we will henceforth consider the term output to mean value added, rather than gross output or sales. Ignoring intermediate inputs of course gives no indication of the magnitude of derived demand associated with mining. Consideration of derived demand effects lies beyond the scope of this paper.

	1970	1975	1980	1985	1990	1995	1998
Agric, Forest & Fish	5.4	5.4	5.7	5.4	6.1	5.3	6.4
Total Mining	21.3	13.9	13.3	13.0	11.3	10.5	9.9
Total Manufacturing	27.5	30.1	32.8	29.4	29.6	29.3	28.3
Electricity, Gas & Water	2.6	3.1	3.6	4.6	5.1	5.6	5.9
Building & Constr	5.5	6.3	5.0	4.4	4.0	3.4	3.3
Services	37.8	41.1	39.6	43.2	43.9	45.9	46.3

Table 1: Contribution to Private Sector Gross Domestic Product by Economic Sector. Figures are in percentages, and may not add up due to rounding

	1970	1980	1985	1990	1993	1998
Coal	1.1	1.5	2.7	2.0	1.5	1.9
Gold & Uranium	17.2	8.4	7.1	5.7	7.3	4.1
Diamond & Other	3.0	3.3	3.3	3.6	3.0	3.1
Total	21.3	13.3	13.0	11.3	11.8	9.9

Table 2: Contribution of the Three Principal Mining Sectors to Private Sector GDP. Figures are percentages, and may not add up due to rounding.

the decrease continued thereafter, it has been at a far slower rate. Table 1 displays the contribution of the principal sectors in the private sector of the South African economy to GDP in different years. The service sector on the other hand has increased its proportion of GDP to over 45% after 1995, mostly at the expense of the mining sector.

In order to obtain a closer understanding of the declining relative importance of mining in the economy, Table 2 depicts the proportional contributions to GDP of the three principal mining sub-sectors.

What emerges from the evidence is that the declining importance of mining as a proportion of total output in the economy is chiefly attributable to the declining importance of the Gold & Uranium Mining sector. While still contributing 17.2% of the private economy's output in 1970, its proportional contribution to private sector GDP had fallen to 4.1% by 1998. The two other aggregate mining sectors marginally increased their relative share of private sector GDP in the same period to 1998.⁵

⁵The first point to note concerning this evidence is that it proves to be consistent with the evidence that emerges from an examination of the physical volume of output

Of course, a declining relative importance of mining does not have to entail a declining absolute importance. Mining contributing a falling proportion to total value added in the economy is consistent with rising absolute contributions to value added in the economy. It is therefore important to note that the decline in the importance of Gold & Uranium Mining in the South African economy, is not only one of a declining relative importance but also one of falling absolute output levels (See Figure 2). Second, while the decline in Gold & Uranium Mining has been dramatic, it has also been relatively unidirectional, with very few reversals in the decline of absolute output over time. The rise in absolute output by the remaining two aggregate mining sectors, has been subject to some relatively strong cyclical variation (See Figures 1 and 3).⁶

The decline in Gold & Uranium Mining is due to structural factors in the sector, rather than changes in the gold price. Since the gold price has shown both sharp increases, and sharp decreases in US-Dollar terms over the sample period, it is difficult to argue that the declining value added of the gold mining industry is due to changes in the gold price. Figure 4 illustrates. The gold price in Rand terms has - due to the depreciating exchange rate - steadily increased over the period 1970 to 1998, particularly after 1992. Hence, the gold price does not serve as a convincing explanation for declining output in Gold & Uranium Mining. The observed fall in the Rand gold price from 1996 to 1997 by 8.6 % however may have contributed to the recent dramatic output decreases.

The preceding analysis is based on real value added produced by the three aggregate mining sectors of the economy, computed on the basis of the sectoral GDP deflator. While this provides an indication of real output by the economic sector, it does so in terms of a constant price of the output of that particular sector. It does not offer much insight into whether the output of the sector in question has risen in purchasing power relative to other sectors in the economy. In order to establish the sensitivity of our results to the use of sectoral price deflators we also deflate nominal value added by the three principal mining sectors in terms of the aggregate (economy-wide)

of the eight principal mining industries of the South African economy. Gold mining was distinguished from other mining sectors by virtue of its strong and sustained decline in output, while other sectors either increased their volume of output, maintained constant levels of physical output, or where they did report declining output, showed greater cyclical variation.

⁶Again, the analysis of the volume of physical output confirms these two points.

Figure 1: Coal Mining: Comparison of Real Output deflated by Sectoral and Aggregate GDP Deflators

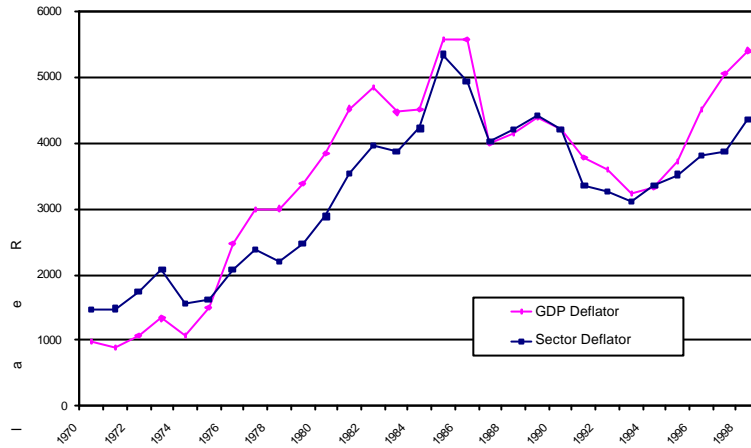


Figure 2: Gold & Uranium Mining: Comparison of Real Output deflated by Sectoral and Aggregate GDP Deflators

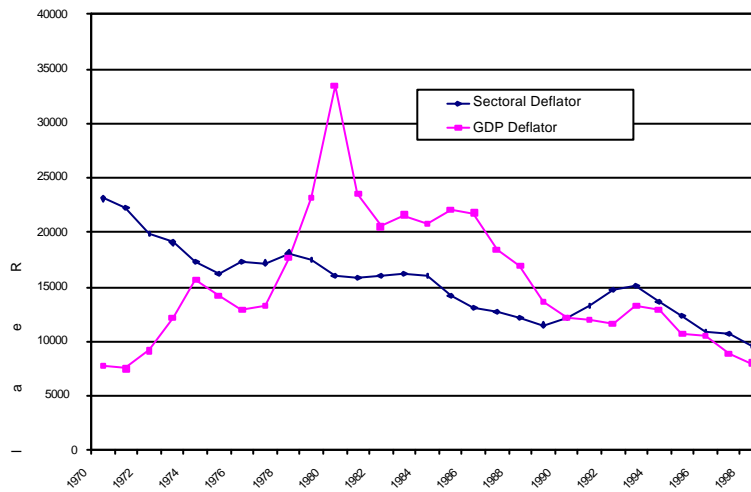


Figure 3: Diamond & Other Mining: Comparison of Real Output deflated by Sectoral and Aggregate GDP Deflators

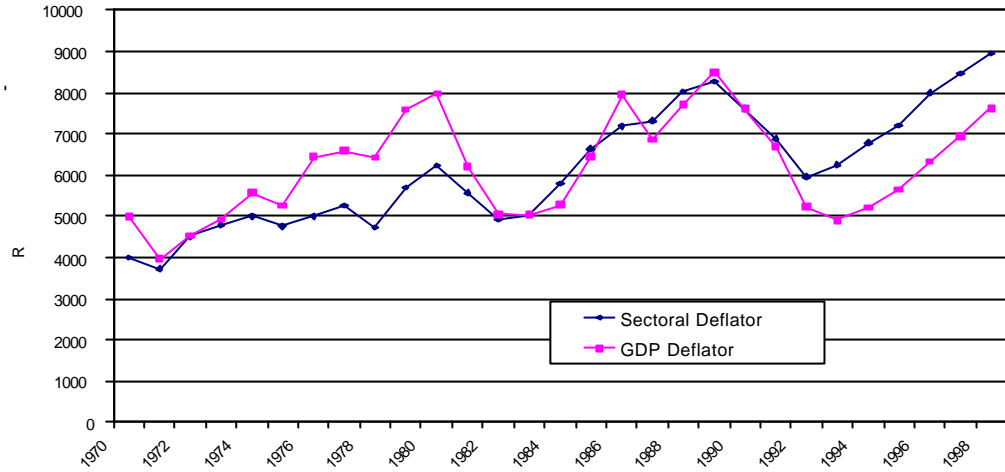
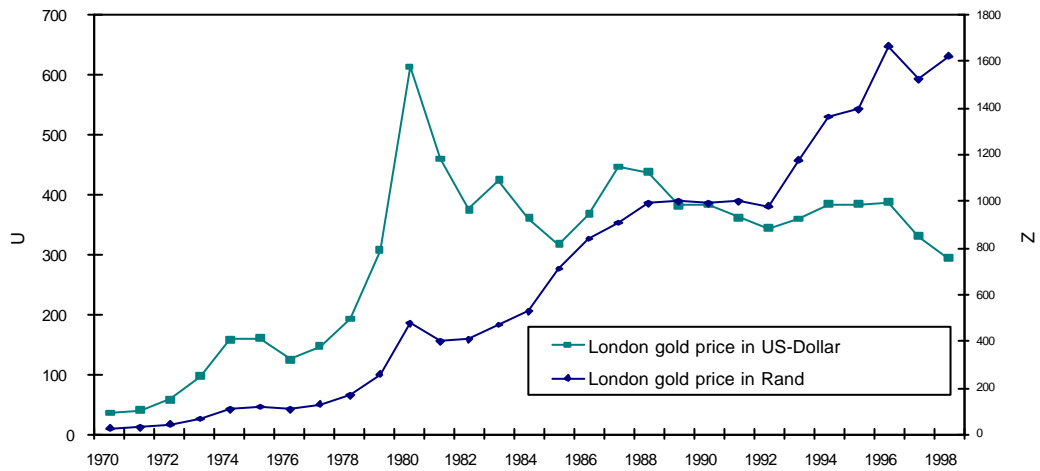


Figure 4: Gold Price in US-Dollar and South African Rand



GDP-deflator. Figures 1, 2 and 3 provide a comparison of the two means of deflating output. As should be evident from the comparison, only for the Gold & Uranium Mining sector does a significant difference emerge between the two means of deflating (for Coal Mining the correlation coefficient between the two real output series is +0.94). In contrast to the real output series that uses the sectoral GDP deflator for Gold & Uranium Mining, which generates a consistent decline in real output of the sector, the aggregate GDP deflator suggests periods of both expansion and contraction for Gold & Uranium Mining. In terms of the GDP deflator, real output of the sector rose through to the early 1980's (and has the sector starting with a much lower level of value added),⁷ but has declined ever since. Despite this difference the suggested pattern of development in real output obtained from the two GDP deflators through the course of the 1980's and 1990's is much the same, with a consistent decline in real output reported in both series, and with both series reporting very similar levels of real output through the course of the 1990's (the correlation coefficient between the two series is +0.71 over this period). The main source of difference between the two output series for Gold & Uranium mining is thus that the negative growth rate in output since 1980 has been more dramatic than the sectoral GDP deflator would imply.

There are also divergences between the output series obtained from the two deflators for Coal and Diamond & Other Mining. For Diamond & Other Mining the sectoral deflator generates lower output figures in the early part of the sample, and higher output figures than the aggregate GDP deflator in the later part of the sample - for Coal Mining the opposite is true. The implication is that Diamond & Other Mining has been losing purchasing power relative to the rest of the economy, Coal Mining has been gaining it. The divergence in percentage terms is large on occasion. However, for both series real output has been on an upward trend over the full sample period.

While there are thus some differences in the real output patterns generated by the two forms of deflation these differences apply principally to the Gold & Uranium Mining sector. Significantly, use of the alternative deflators does not change the principal finding of our analysis thus far: that real output of Gold & Uranium Mining has been falling over the 1980-97 period, while that of Coal and Diamond & Other Mining has been rising over the

⁷The reason for this lies in the gold price bubble of the early 1980's - which raised the purchasing power of the sector relative to the rest of the economy.

same sample period. Given the relative symmetry of results obtained from the two means of deflation, for the purposes of the analysis to follow we will employ real output as computed by the sectoral deflator.

Coal and Diamond & Other Mining have shown growth in both their total output and in terms of their relative contribution to output within the economy, this growth has shown strong cyclical behaviour. Both of the aggregate growth sectors within the mining industry of South Africa have shown periods of very dramatic output expansion, and of equally dramatic output contraction.⁸

The principal finding to emerge from the analysis is that an understanding of the contribution of the mining sector to South Africa's aggregate value added must be sensitive to the differences that arise between the aggregate mining sectors. While the mining sector's contribution to net value added in the economy has declined, this is due to the declining contribution of gold mining, and not due to developments of the mining sector as a whole.⁹

On the other hand, the evidence of a declining contribution of the Gold & Uranium Mining sector to absolute output, and a rising contribution of the Coal and Diamond & Other Mining sectors, should be tempered by the fact that the gold sector still dominates the total mining sector output. The contribution of Gold & Uranium Mining to total mining output stood at 80,9% in 1970 and, while having declined to 46,5% by 1997, it still represents the single largest sector in the South African mining industry.

⁸One reason for this may be due to the years of relative international isolation in which international markets were more difficult to penetrate (see the contraction of Coal Mining over the 1986-93 period). But another reason may also lie with the relative volatility of primary commodity prices. Diamond & Other Mining after all grew most dramatically precisely during the period of international sanctions (1984-89), and showed negative growth during the period of South African reintegration into international markets (1989-92) - suggesting that that more than international sanctions were at play.

⁹Examination of more disaggregated data provided by the Minerals Bureau on the performance of the eight principal mining sectors confirms the point: among these, Coal, Platinum Group Metals, Iron Ore, Manganese Ore and Aggregate & Sands and can be characterised as growing. Apart from Gold, only Chromite and Copper decline in their value of total sales. Care should be taken in interpreting these figures, however. Total sales at this level of disaggregation are reported in nominal terms, and sectoral price deflators were not available. Hence reliable indicators of real output were not available.

	1970's Avg	1980's Avg	1990's Avg
Coal	0.29	0.52	n/a
Gold & Uranium	10.02	12.51	1.13
Diamond & Other	1.45	0.56	0.09

Table 3: Average Proportional Contribution to Total Tax Revenues by Aggregate Mining Sector, by Decade. Figures are percentages.

2.2 Contribution of the Mining Industry to Total Tax Revenue of the South African State

In concert with this decline in net output of the sector, the contribution to total tax revenues of the mining sector has been declining also.

In Table 3 we illustrate the contribution of revenue from the three aggregate mining sectors as a proportion of total tax revenue of government. The vast majority of tax revenue to emerge from the mining sector is due to gold mining. However, after peaking in the early 1980's (principally due to the gold price peak in the early 1980's), tax revenue from gold mining has declined sharply, and it now contributes only approximately 1% of total government tax revenues.

2.3 The Open Economy Context

The preceding discussion revealed a declining importance for the mining sector in the aggregate South African economy. In Table 4 we report average annual export earnings by the principal (SIC two digit sector) economic sectors of the South African economy. The most dramatic growth in export earnings attaches to the manufacturing sector, particularly during the course of the 1990's. The mining sector nevertheless remains the largest single exporter of the South African economy on average, even during the course of the 1990's.¹⁰

Similarly, an examination of the net export earnings¹¹ of the principal

¹⁰Examination of the absolute level of exports by principal economic sector shows that the manufacturing sector has begun to export more than the mining sector since 1995.

¹¹Defined as the difference of the exports and imports of the output generated by a sector. For instance, for the Gold sector, it is exports and imports of gold that are being compared. Thus, the net export measure does not capture the imports of intermediate goods employed by a sector in production. The consequence in the current context will be

	1970's Avg	1980's Avg	1990's Avg
Agric, Forest & Fish.	533	1330	4946
Total Mining	4172	23194	47724
Total Manufacturing	1898	8914	47026
Electricity Gas & Water	6	38	139
Building & Constr	2	10	28
Services	1110	4356	16720

Table 4: Average Annual Export Earnings per Decade by Principal Economic Sectors. Figures are in nominal R Millions, since aggregate deflators for exports are not available.

	1970's Avg	1980's Avg	1990's Avg
Agric, Forest & Fish.	410	693	2697
Total Mining	2971	18546	38585
Total Manufacturing	-2903	-13096	-36857
Electricity Gas & Water	1	35	135
Building & Constr	-8	-15	-71
Services	354	1397	6408

Table 5: Average Annual Net Export Earnings per Decade by Principal Economic Sectors. Figures are in R Millions.

economic sectors of the South African economy further demonstrates that mining has consistently been the largest net earner of foreign exchange of the economy. By contrast, South Africa has been and remains a large net importer of manufactured goods and services. Table 5 illustrates.

The evidence thus points clearly to the importance of the mining sector as a net exporter and hence earner of foreign exchange in the South African economy. Despite its declining contribution to output in relative and absolute terms mining continues to be a vital component of the economy.

to bias upward the net export performance of mining, since South Africa imports little by way of primary commodities, while they may have a relatively strong reliance on capital and manufactured imports, for instance.

2.4 Distribution of Output

The discussion thus far has emphasised the strong changes in the value added contributed by mining in the South African economy. Strong dynamic changes also emerge in terms of the distribution of the value added produced within the three aggregate mining sectors between the two factors of production employed by the sectors: capital and labour.

In order to decompose the value added of the sectors into the earnings of the two factors of production, we graph the real wage bill and net operating surplus (gross operating surplus minus depreciation) as fractions of real GDP over time. Figure 6 reveals a strong upward trend of the wage proportion for the Gold & Uranium Mining sector since the mid-1980's. Also, for Gold & Uranium Mining net operating surplus diminished steadily to a small proportion (4%) of real output in 1997. Factor shares for Coal Mining and Diamond & Other Mining remain relatively constant over time, despite some cyclical fluctuation - see Figures 5 and 7.

The sharp change in the proportion of net value added paid to labour will come to be strongly correlated with changes in the employment trends of the Gold & Uranium Mining sector.

The proportion of value added that can be explained in terms of the real wage bill and net operating surplus, has declined from over 90% to around 80% for Coal and Diamond & Other Mining, and even lower (71%) for Gold & Uranium Mining. The remainder is attributable to depreciation expenses on the capital stock. Since all three mining sectors have become more capital intensive over the 1970-97 period, depreciation costs have grown over time.

The evidence suggests that the South African mining sector has been subject to strong change over time, particularly the Gold & Uranium Mining sector. The strong change in the distribution of net value added between capital and labour observed in the 1970-1997 period pictures mining as a maturing sector in transition.

2.5 Conclusions from the exploratory data analysis

Our descriptive data analysis suggests the following conclusions. *First*, the declining importance of mining in the economy has been led by the fall in output of mining's single largest sector, Gold & Uranium Mining. The two other aggregate mining sectors, Coal and Diamond & Other Mining have not only increased their shares within the output of the mining sectors, but

Figure 5: Coal Mining: Distribution of Output Between Factors of Production

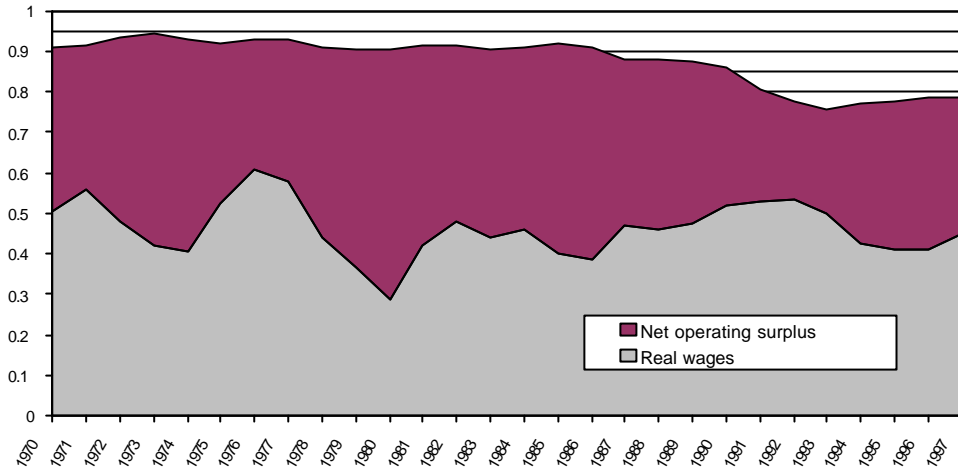


Figure 6: Gold & Uranium Mining: Distribution of Output Between Factors of Production

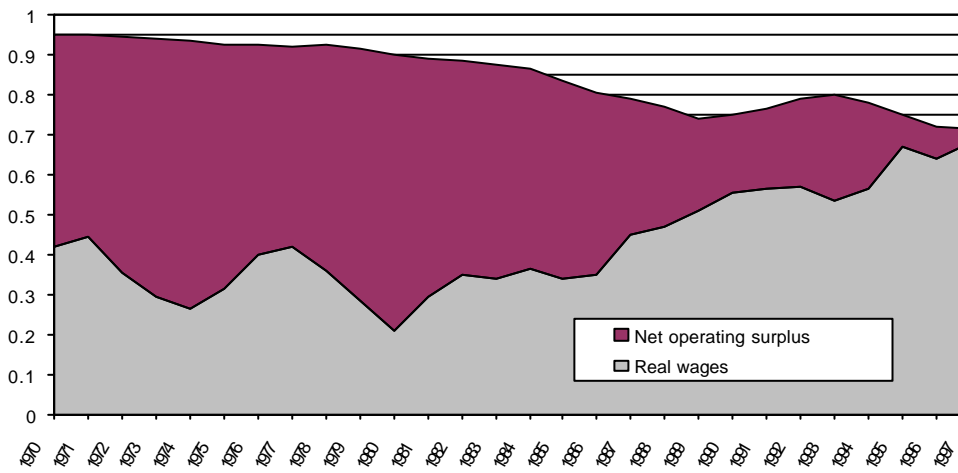
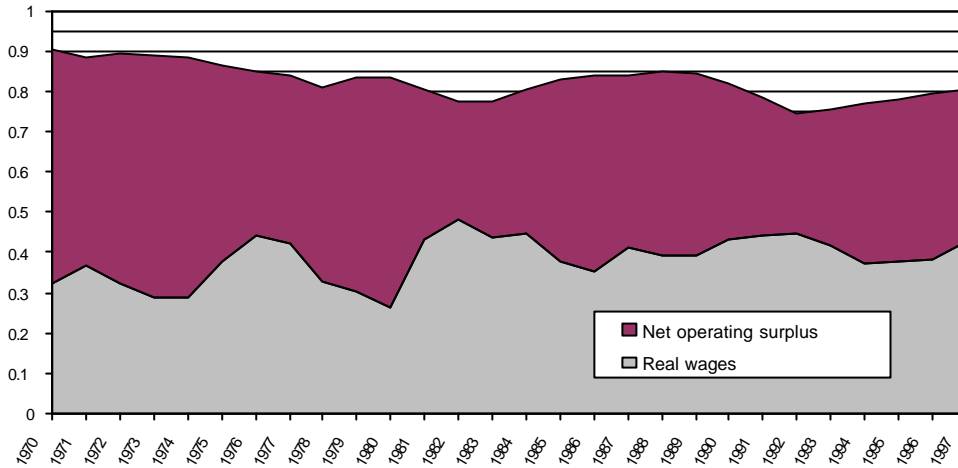


Figure 7: Diamond & Other Mining: Distribution of Output Between Factors of Production



have also marginally expanded their contribution to the aggregate output of the South African economy as a whole. *Second*, the declining importance of gold mining within the economy is allied to maturation of the sector: The distribution of output between the factors of production, capital and labour has been changing quite strongly over the course of the 1970-1997 period. From earning less than half of net value added produced by the sector, labour now obtains approximately 67% of the net value added produced in the Gold & Uranium Mining sector. *Third*, while the contribution of the mining sector in aggregate to the value added produced in the South African economy has been declining due to changes in the gold mining industry, the gold mining sector in particular, and the mining sector in general remains a principal earner of foreign exchange in the economy.

3 Aggregate Labour Market Conditions in the Three Aggregate Mining Sectors of the South African Economy

This section sets out with an examination of trends in labour usage in the three aggregate mining sectors from 1970 to 1997 to provide an initial overview of changes that have occurred in these labour markets of the South African economy. It then turns to some possible explanatory factors that might account for the developments in employment levels and concludes with a brief econometric investigation of the plausibility of such explanations.

Changes in the importance of the mining industry as an employer in the South African economy essentially mirror the predicament of its output in the last three decades. The mining industry has been declining both in terms of its importance as an employer relative to other sectors in the economy, and in terms of the absolute level of employment that it provides. Such job losses have largely affected unskilled workers.

The question here concerns possible reasons for the declining importance of mining as an employer. One immediate candidate is the declining level of value added generated by the mining sector that could translate into a declining demand for labour. Examination of the evidence suggests that at best output levels are a partial explanation of declining employment trends in the mining sectors. The decline in the share of mining in total output of the South African economy has been far more dramatic than the share of mining in total formal sector employment of the economy.

Two further possible explanations for employment trends in South Africa's mining sectors are therefore examined: real labour cost and real labour productivity. Exploratory examination of the evidence suggests that real labour cost for all three mining sectors demonstrates the negative correlation with employment that economic theory would predict. Increases in real labour productivity have not been sufficient to warrant the increases in real labour cost observed for the mining sectors, nor have they been justified by an increasing skills mix of the mining sector's labour force. Finally, prices are unlikely to feature as explanations of employment trends in these sectors.

In the second part of the labour market discussion we examine the three aggregate mining sectors in greater detail. We employ time series (VECM) estimation in order to examine the relative importance of the alternative explanatory variables identified in the initial exploratory data analysis in

accounting for employment trends in the three mining sectors individually.

Our findings suggest that output trends, use of capital stock, and real labour cost all contribute toward an explanation of labour usage patterns in the three aggregate mining sectors. What differs between the three sectors is not the explanatory variables, but the responsiveness of labour usage to change particularly in output, and in real labour costs. Changes in real labour cost have the strongest impact on Diamond & Other Mining, followed by Gold & Uranium and Coal Mining. Diamond & Other Mining also shows the strongest responsiveness to changes in output levels, followed by Coal and Gold & Uranium Mining.

The explanation for the declining importance of mining as an employer in the South African economy therefore is multivariate. It lies with falling levels of real output, and unpropitious increases in real labour costs in these sectors.

3.1 Employment by the Three Aggregate Mining Sectors of the South African Economy

Table 6 shows the contribution of South Africa's principal (2-digit SIC code) economic sectors to private sector employment in the economy over time. Again, the service sector's importance as an employer has increased at the expense of the share of primary sectors.

The decline in the importance of mining as an employer is not only a relative one. As Table 7 illustrates, absolute employment in all three aggregate mining sectors fell dramatically, particularly since the late 1980's. The decline was particularly strong during the latter half of the 1990's, and especially so in Gold & Uranium Mining.

It is crucial to note that the decline in the relative and absolute contribution of mining to the output of the economy in the 1970s, from a share of 21.3% to one of 13.3% of private sector GDP in 1980 did not lead to a proportional decline in mining's relative contribution to employment. While the average growth rate in employment across all sectors was 2.2% per annum for this period, mining employment increased by an average 1.9% per annum. As a consequence the relative importance of mining in South Africa's labour markets persisted. This relative buoyancy of the mining sector as an employer, in times of a declining aggregate output performance relative to other sectors, provides the first indication that output alone cannot serve to

	1970	1975	1980	1985	1990	1995	1998
Agric, Forest & Fish.	19.6	16.8	15.5	13.9	13.3	13.9	14.0
Total Mining	11.9	10.3	12.1	12.2	11.6	9.7	7.4
Total Manufacturing	19.1	20.9	21.5	21.6	22.5	23.1	23.1
Electricity Gas & Water	0.8	1.0	1.2	1.4	1.4	1.2	1.2
Building & Constr	5.8	7.8	5.7	6.2	6.2	5.8	4.8
Services	42.8	43.3	44.0	44.8	45.0	46.3	49.5

Table 6: Contributioun to Private Sector Formal Employment by Economic Sector. Figures are percentages and may not add up due to rounding.

	1970	1975	1980	1985	1990	1995	1997
Coal	73740	76697	93082	101705	89751	63260	55219
Gold & Uranium	425800	378167	473781	526839	491100	382646	241352
Diamond & Other	156763	171057	219800	179899	199572	150732	136543

Table 7: Absolute Employment across the Three Aggregate Mining Sectors

explain the mining sector's labour usage.

Furthermore, relative buoyancy in mining employment persisted through the 1980's and early 1990's. Part of the reason for this is due to the fact that aggregate formal employment in South Africa was declining during the course of the 1990's, moderating the relative decline of mining's contribution to total employment. Ultimately, 1997-98 has seen a particularly dramatic adjustment in mining's relative contribution to employment: in 1998 the employment share of mining has further declined to 7.4%, suggesting that to the extent that falling output levels are responsible for falling employment levels, there may be significant lag effects present in the adjustment of labour usage to equilibrium levels.

Further evidence of the partial link between output and employment emerges from the three aggregate mining sectors of the South African economy. Employment in Gold & Uranium Mining rose through the 1970's and early 1980's, peaking in 1986, despite the fact that real output for this sector had been declining since 1970.¹² Only after 1986 does employment decline

¹²Note that use of the real output series deflated by means of the aggregate GDP deflator would provide a more likely explanation of employment trends here. However, the returns to production in a sector are properly understood in terms of the price obtained for the output of that sector. Once the post-1985 evidence for Gold & Uranium Mining, and the

steadily and jointly with real output of the sector. Once the employment trend in Gold & Uranium Mining turned negative, it has remained consistently negative. Even the increase in Gold & Uranium output levels from 1989 to 1993 was not reflected in a reversal of the decline in employment. Thus by 1997 employment in Gold & Uranium Mining had contracted to 60% of the levels attained at its 1986 high point.¹³

Coal Mining historically has shown a relative strong responsiveness of employment to changes in real output. The high point of employment in the Coal Mining sector corresponded to the peak real output level of 1985. The subsequent decline in real coal output has been accompanied by negative growth in employment. By 1993 output had fallen by 41% from 1985 (at an average growth rate of -6.14% per annum), employment by 34% (at an average growth rate of -4.82% per annum). This linkage has become somewhat weaker during the course of the 1990's. Although output has been rising strongly since 1993 employment numbers have responded only weakly, and in 1997, employment had fallen again by 3.7% relative to 1996.

The experience of Diamond & Other Mining employment is similar to that of Coal Mining. It demonstrates a relatively close link to output levels prior to the 1990's, with a much weaker link between output and employment after 1990. Thus employment and real output for Diamond & Other Mining both peaked around 1980. When employment reached another high in 1991 it had again followed high output levels in the same period. By contrast, the relatively strong growth in output of the Diamond & Other Mining sector since 1992 was not mirrored by positive employment growth. Instead, average employment growth was -1% per annum from 1992-1997.

The following section turns to other possible explanations of employment trends in the mining sector's labour market.

evidence from all other two aggregate mining sectors is considered, it is difficult to persist with the notion that output is a principal driver of labour usage.

¹³The Gold & Uranium Mining sector remains the fifth largest employer in the economy in absolute terms, though it also has the fifth lowest employment growth rate amongst all sectors (and is amongst the sectors with the strongest proportional decrease in employment).

3.2 Links between employment and real labour remuneration

The most immediate additional explanatory variable for employment trends in the mining sector offered by economic theory is the real cost of labour. Figures 8 through 10 depict employment growth and real remuneration per labourer over time.¹⁴

We note that with respect to real labour cost, Gold & Uranium Mining is potentially distinct from the other two aggregate mining sectors. It is noticeable that the real cost of labour for the Gold & Uranium Mining sector fell from 1970 through 1986, and rose sharply subsequently. Since employment in the Gold & Uranium Mining sector rose steadily until 1986, and declined subsequently, real labour cost therefore represents a plausible explanatory variable for employment trends in this sector.

For Coal Mining, real labour cost has been on a steady upward trend over time. Employment over the sample period in Coal Mining has both risen (until 1988), and fallen. Sharp increases in 1980-1982 are followed by a levelling of real remuneration, and employment until 1988. Subsequent rises of real remuneration can be interpreted as having triggered a threshold effect as employment numbers decreased since.

For Diamond & Other Mining again real labour cost has been on a slower but steady upward trend, while employment has remained essentially static with some cyclical variation.¹⁵ Of course, explanations of labour usage patterns are likely to be multivariate in nature, and depend on more than just real labour costs. Nevertheless, an association between real labour cost and employment patterns in the Coal and Diamond & Other Mining sectors appears at best to be somewhat weaker than is plausible for the Gold & Uranium Mining sector.¹⁶

¹⁴We define real remuneration per labourer as: Real Wage Bill/Employment. As the nominal wage bill of each of the sectors was deflated by the sectoral GDP deflator to obtain the real wage bill, it is the real cost of labour relative to the price of output generated by the sector that we are discussing in regard to employment patterns.

¹⁵One should take care in interpreting this evidence. Closer examination of the two series shows that there is at least some countercyclical variation in employment and the real labour cost. Once other explanatory variables are controlled for, we might therefore find that the link between real labour cost and employment for the Diamond & Other Mining sector might increase in strength.

¹⁶Correlation coefficients bear out the plausibility of a stronger association between real labour cost and employment in the Gold & Uranium Mining sector than in the remaining

Figure 8: Coal Mining: Employment and Real Cost of Labour

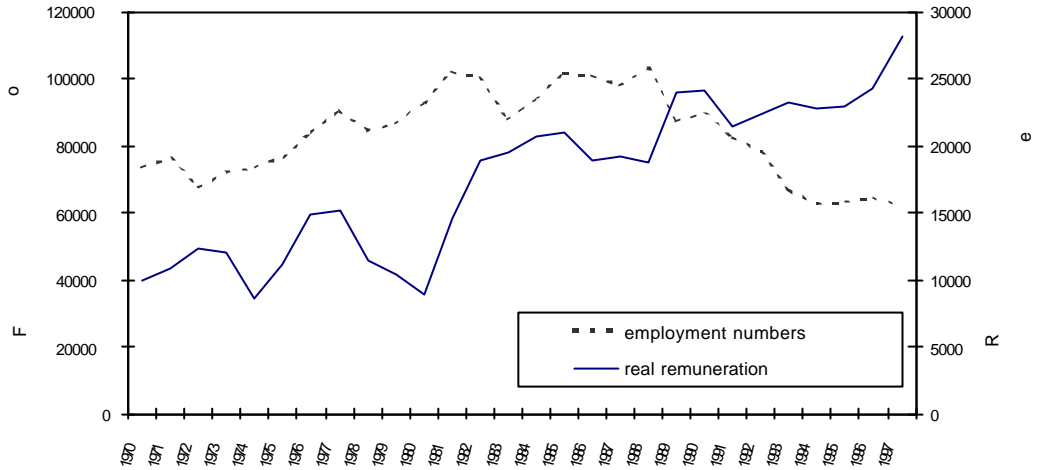


Figure 9: Gold & Uranium Mining: Employment and Real Cost of Labour

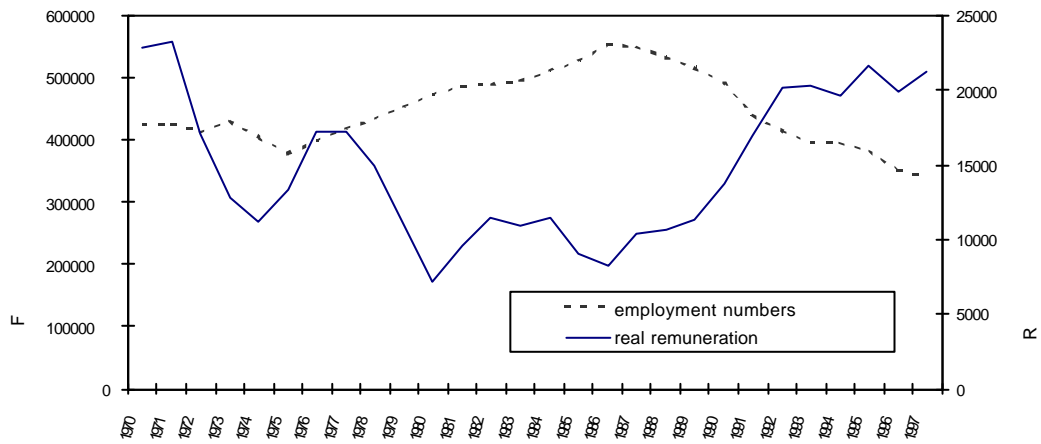
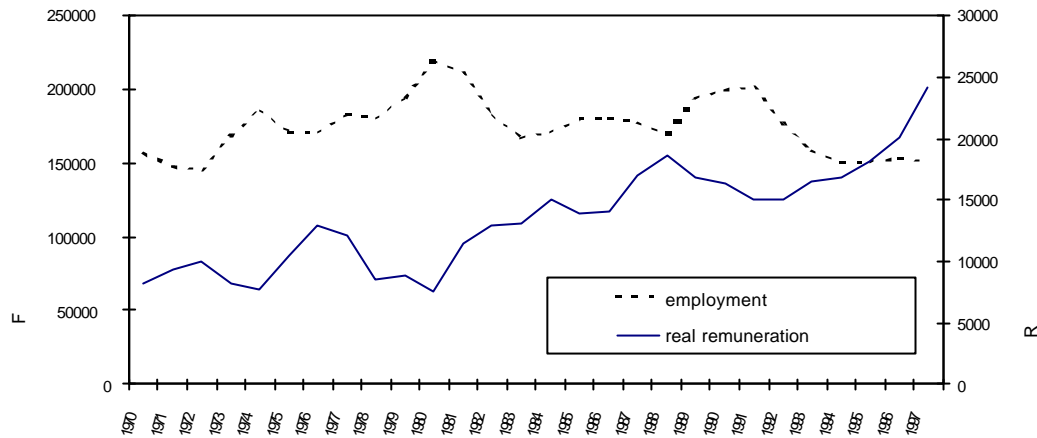


Figure 10: Diamond & Other Mining: Employment and Real Cost of Labour

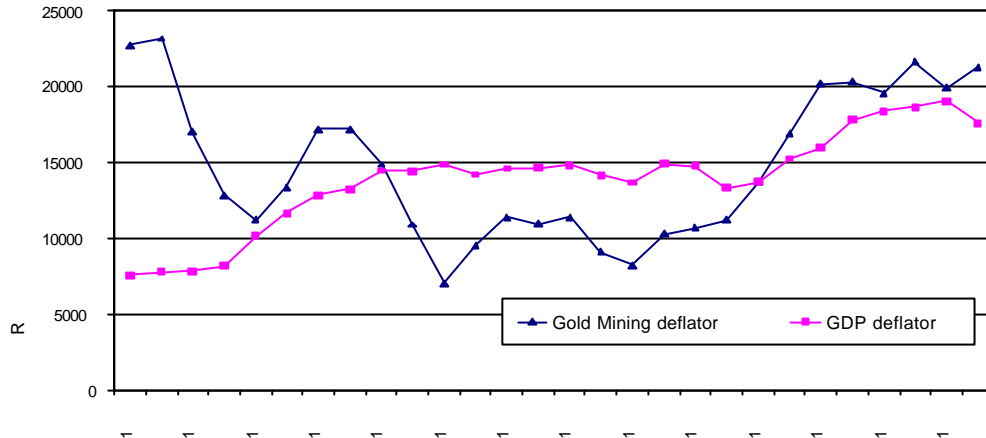


One possible objection to the evidence presented in the present section is that the patterns observed in the real labour cost variable, for instance for Gold & Uranium Mining do not conform to the conventional wisdom that real wages in the sector rose consistently over the course of the 1970's and the first half of the 1980's. The reason for the discrepancy is readily explained. In computing the real labour cost for the purposes of the present analysis, the nominal wage bill of each of the sectors analysed was deflated by the sectoral GDP deflator. This choice of deflator focusses on the real labour cost of the sector. This makes the appropriate comparison the cost of labour relative to the price of output generated by the sector, rather than any other price deflator, such as the aggregate GDP deflator of the economy. While for Coal and Diamond & Other Mining use of the sectoral price deflator or the aggregate GDP deflator makes little substantive difference to the estimated real wage cost,¹⁷ for Gold & Uranium Mining there is an important difference, as is clear from Figure 11. Instead of declining through to the mid-1980's as real labour cost computed on the sectoral price deflator does, real wages computed on the aggregate GDP deflator rose over this period, and stabilised

two aggregate mining sectors. Gold & Uranium Ore Mining exhibits an employment-real labour cost correlation of -0.81, Diamond & Other Mining -0.41 and Coal Mining -0.24.

¹⁷Full results are available from the authors.

Figure 11: Gold & Uranium Mining: Comparative Real Cost of Labour Using Alternative Price Deflators



subsequently (with a slight decline through the 1990's), much as conventional wisdom would predict. The aggregate GDP deflator is the appropriate means of deflation when determining the purchasing power of wages for workers, since their consumption bundle effectively incorporates the output of the economy as a whole. In order to determine the real labour cost to an economic sector, the appropriate price adjustment must be made in terms of the price that attaches to the output of that sector. This is because the cost of labour is relative to the price obtained for the output the labour produces.

While for the analysis that remains in this section it is thus appropriate to employ the real labour cost series obtained from the sectoral price deflator, the evidence obtained for the Gold & Uranium Mining sector in Figure 11 is nevertheless instructive in a number of respects. The strong decline in real labour cost during the course of the 1970's is due to the rise in the gold price over this period. It follows readily that the bargaining power of labour to increase the real purchasing power of their wages was correspondingly enhanced. Hence the rise in the real wage observed over this period is not surprising. After 1987 the ability of organised labour to raise the real wage been considerably more constrained. The rising real labour costs appears to have translated not only into labour shedding in the Gold & Uranium Mining

	1970-75	1975-80	1980-85	1985-90	1990-95	1995-97
Coal	3.98	-2.46	21.02	3.57	-0.94	10.91
Gold & Uranium	-8.55	-9.30	6.81	9.31	10.03	-0.59
Diamond & Other	6.61	-4.88	14.70	3.98	2.17	15.58

Table 8: Average Percentage Changes in Real Labour Cost in the Three Aggregate Mining Sectors.

sector, but it also appears to have limited the ability of organised labour to extract further increases in the real purchasing power of their wages. After 1987 the real wage (as obtained from the aggregate GDP deflator) has been on a steady downward trend.

Finally, one should bear in mind that examination of bivariate graphical evidence (or potentially simple correlations) in the current context may prove misleading. Real labour cost is not the only potential explanatory variable that accounts for labour usage. In the present context a rising real labour cost is consistent with rising employment in the labour market, as long as productivity improvements in labour are such that they justify the increasing real labour remuneration. For this reason, we examine patterns in labour productivity in the following subsection. Nevertheless, the exploratory investigation of the present subsection is suggestive of a plausible hypothesis on the mining labour market: that rising real labour cost may have contributed to declining employment in the mining sector. As such, we have a first additional potential explanation besides the declining output trends in the mining sector to account for falling employment in the sector.

3.3 Links between Labour Productivity and Real Labour Cost

Economic theory would anticipate that perfect labour markets would serve to equalise the marginal product of labour to the marginal cost of labour. It follows that one possible explanation besides changes in the real labour cost for changing employment trends are changes in labour productivity. The theory would predict that at any given real wage rate (marginal cost of labour), a rise in real labour productivity would serve to increase the demand for labour, until the marginal cost - marginal productivity equality is re-established.

	1970-75	1975-80	1980-85	1985-90	1990-95	1995-97
Coal	3.19	7.95	11.27	-1.39	4.02	5.96
Gold & Uranium	-4.47	-4.61	-4.31	-1.22	6.09	-1.28
Diamond & Other	2.40	0.58	5.64	1.19	5.11	8.58

Table 9: Average Percentage Changes in Labour Productivity in the Three Aggregate Mining Sectors.

The implication of the evidence contained in Tables 8 and 9 is that for all sectors the real labour cost variable varies positively with real labour productivity. The correlation between the two variables in fact confirms the association: for Coal Mining +0.75, Gold & Uranium Mining +0.41, Diamond & Other Mining +0.86. However, it is noticeable that the correlation for Gold & Uranium Mining is weaker than in the other two sectors.

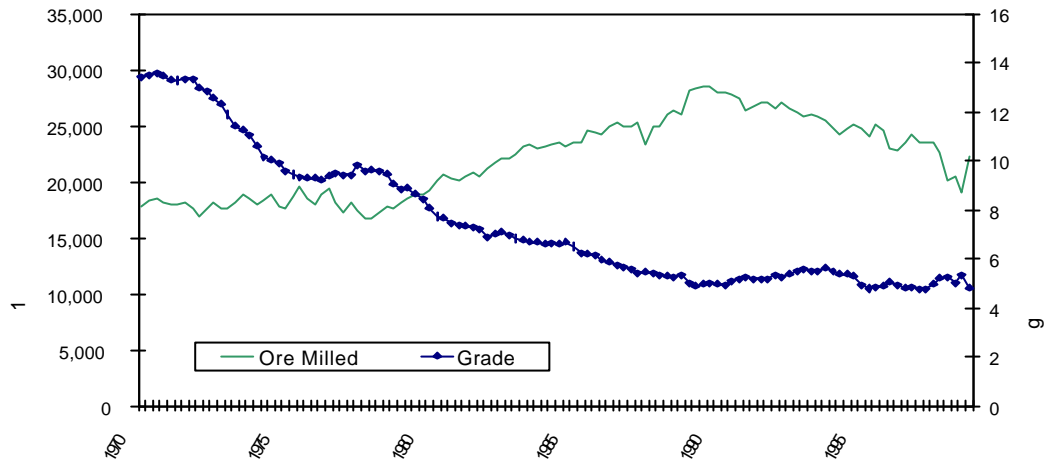
Several explanations are plausible for the apparently weaker correlation found for Gold & Uranium Mining. First, higher union pressure might have hindered real wages from falling in the presence of falling productivity or even raised real wages. A comparison of the total wage bill to value added for the sector serves to shed some light on this. We have already seen that the proportion of value added allocated to wages in the Gold & Uranium Mining sector declined from 42% in 1970 (with lows of 21%) and stabilised at around 35% of the real output value (GDP) until 1986. It increased thereafter to 67% in 1997. By contrast, no corresponding increase in the share of output flowing to labour is evident for the other two aggregate mining sectors. The suggestion might be that for Gold & Uranium Mining real wage pressure was greater than the increases merited by labour productivity improvements.

If correct, the consequence of this finding would be that the declining levels of employment in Gold & Uranium Mining may be due to excessive real wage pressure in the sector, which outstripped real productivity increases.

An alternative explanation refers to the nature of subterranean gold mining itself. The increasing difficulty of gold ore extraction may have led to a falling labour productivity by virtue of the constraints imposed by the mining tasks at hand. Indeed, as Figure 12 illustrates, gold mines increased their ore milled steadily after 1978 but kilograms (fine) produced decreased nevertheless.¹⁸ This loss of efficacy is also reflected in falling grades in terms of grams per ore milled, since a close correlation of ore milled and gold

¹⁸See also Mainardi (1999).

Figure 12: Gold Mining: Ore Milled and Production Volumes (Quarterly).



produced is readily demonstrated.¹⁹

Here the explanation for declining labour usage would lie not in excessive wage pressure, but in the technological requirements of more extreme mining conditions. The concern here is that any increases in labour productivity might have been bought at the expense of employment - and, following from the evidence above, milling activity. Thus labour shedding in favour of increasing capital intensity of production might explain increases in output per worker. However, the correlation between labour productivity and employment numbers while negative is not strong. For Coal Mining the coefficient is -0.10, for Gold & Uranium Mining -0.42, and for Diamond & Other Mining: -0.19. This suggests that labour shedding has played a limited role in the rise of productivity, except perhaps for the Gold & Uranium Mining sector.

There are additional considerations to suggest that excessive wage pressure is associated with falling employment levels in the mining sector. It is possible to identify possible breaks in two of the aggregate mining sectors, that may serve to affect the growth rates of productivity and real wages:

- For Coal Mining it is possible to identify such a break around 1986. Av-

¹⁹The additional data on grades is available from the authors on request.

erage annual growth in productivity was 6.57% for Coal Mining from 1970-1986, just above real labour cost growth of 6.4%. From 1987-1997, average real labour cost growth was 4.12% per annum but productivity growth now was only at 2.91%. The decline in employment in the Coal Mining sector after 1987 is thus not surprising. Real labour productivity ceased to justify the rate of real wage increase of the sector, and demand for labour fell correspondingly.

- For Gold & Uranium Mining real labour cost decreased on average by 4.05% per annum from 1970 to 1986 and increased by 9.55% per annum from 1987-1997. Average productivity growth per annum was negative at -4.93% from 1970-1986 and positive at 3.01% from 1987-1997. The figures manifest an increasing gap between the growth rates of real wages and productivity. If we recall that in this period real output levels were decreasing in the Coal and Gold & Uranium Mining sectors,²⁰ and employment levels at their peak, the subsequent labour shedding seems to have been inevitable. Again, the rift between real wage increases and increases in real labour productivity constituted a strong disincentive to employ labour post 1986. Demand for labour fell correspondingly.

By contrast, for Diamond & Other Mining there is much weaker evidence of a structural break in its labour market. Average real labour cost growth for Diamond & Other Mining stood at 5.21% from 1970 to 1986 and 5.52% from 1987 to 1997. This steady growth rate is mirrored by average annual productivity increases of 3.21% and 3.67% respectively for the two periods. Thus real wage growth consistently outstripped the growth in labour productivity, and changes in employment patterns in these sectors is thus difficult to associate with a change in the relation between real wage growth and real labour productivity.

We provide one final consideration. We have seen that relative changes in real wages and productivity provide a plausible explanation of labour shedding in the South African mining sector. However, one reason for the rising wage bill of the mining sector might be that the labour force of the mining sector has shown dramatically improved skills levels. This would explain rising real wages, while being consistent with either constant or rising

²⁰In the Diamond & Other Mining sector the decrease in output set in only after 1989.

levels of employment. We might also expect a changing skills composition to affect the average productivity of labour.

Data on the skills composition of the labour force is available only for Coal Mining and Gold & Uranium Mining.²¹ The data provides information on the number of employees that fall into the categories denoted “skilled” and “unskilled”. On the basis of this we define the skills ratio as the proportion of the labour force that is considered to be skilled. Figures 13 and 14 display changes in the two aggregate mining sectors’ labour force in terms of skills composition. Both sectors show an improvement in the skills composition of the labour force from the mid-1980’s. However, we note that the rising average skills level in the two mining sectors’ work force is not due to a substantial increase in the number of skilled workers. Instead, it is due to a shedding of unskilled workers.

The evidence of the present section is thus more consistent with an interpretation that suggests that the rising real wage in mining sectors has led to labour shedding, and an effort on the part of mining to increase average labour productivity in order to justify the higher wage structure. It is difficult to suggest that the changing skills composition of the labour force is responsible for the rise in real wages.

3.4 Conclusions from the Exploratory Data Analysis

The descriptive analysis above has presented developments in employment trends, in real labour cost, in labour productivity, and examined potential links between these dimensions of the labour market. The most immediate candidate for declining employment in mining is provided by the evidence of the preceding section: the declining output of mining, and Gold & Ura-

²¹This data is available only for members of the Chamber of Mines. An important note of caution on the compatibility of data at our disposal has to be made at this stage. We derive our conclusions on the skills ratio in the two sectors above, Coal and Gold & Uranium Mining, from data provided by the Chamber of Mines. The remainder of data used in this section has been drawn from WEFA Southern Africa. The Gold Mining data by and large corresponds to the aggregate Gold & Uranium Mining sector in the WEFA dataset in regard to employment numbers and nominal earnings given. For Coal Mining we find a more substantial discrepancy in the number of employees and therefore in total nominal earnings reported. Differences in the nominal earnings are not proportional to the difference in the employment figure. Calculations based on the Chamber of Mines data would lead to a higher average nominal remuneration per employee (skilled and unskilled) for most of the years 1970-1997.

Figure 13: Coal Mining: Skills Composition of Labour Force

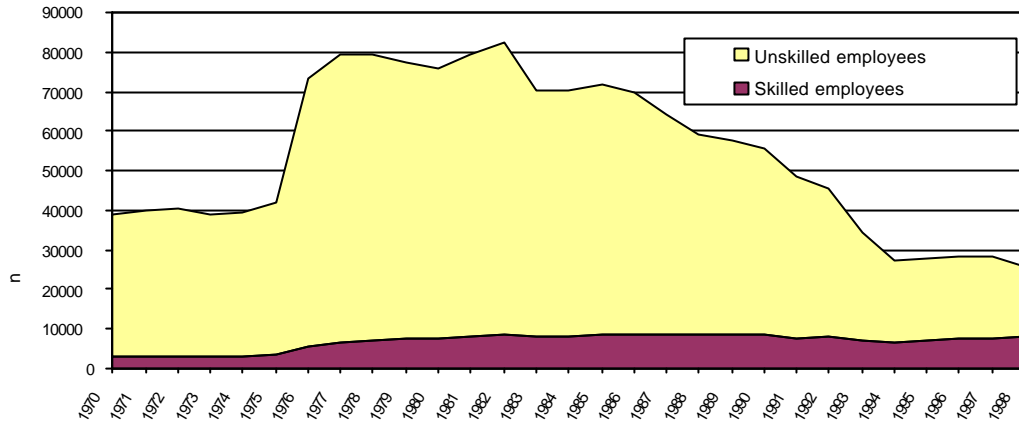
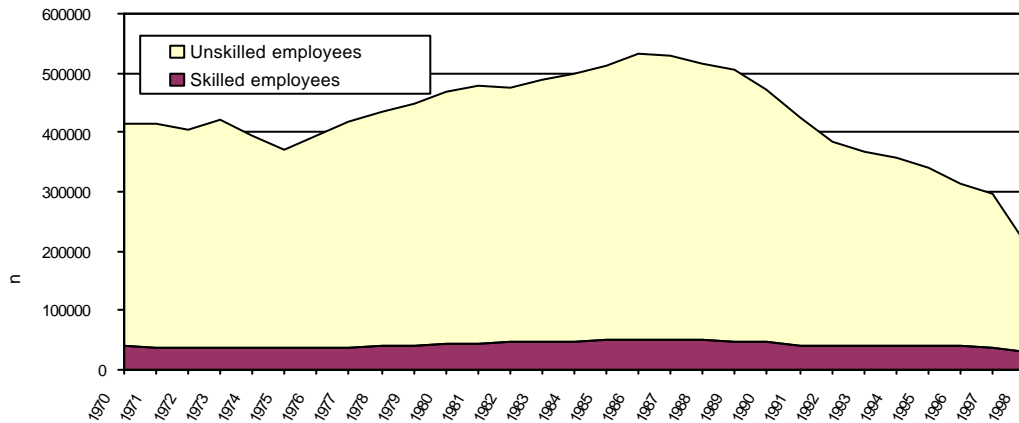


Figure 14: Gold Mining: Skills Composition of Labour Force



mium Mining in particular. However, examination of the evidence suggests that at best output levels of the South African mining sectors are a partial explanation of declining employment trends of the sectors.

Two further possible explanations for employment trends in South Africa's mining sectors were therefore examined: real labour cost and real labour productivity. Exploratory examination of the evidence suggests that real labour cost for all three mining sectors demonstrates the negative correlation with employment that economic theory would predict. Moreover, increases in real labour productivity have not been sufficient to warrant the increases in real labour cost observed for the mining sectors, nor have they been justified by an increasing skills ratio of the mining sector's labour force.

The exploratory data analysis presented above cannot be conclusive on its own. In the final part of the labour market discussion, we therefore employ time series estimation in order to examine the relative importance of the alternative explanatory variables identified in the initial exploratory data analysis in accounting for employment trends in the three mining sectors individually.

3.5 An Econometric Exploration of some Reasons for the Decline in Mining Employment

In what follows we undertake a more detailed econometric exploration of the hypotheses advanced above in explanation of the mining sector's employment patterns.

We begin our discussion with a brief introduction to the econometric methodology employed for the study, before moving on to a discussion of the more detailed results obtained. Johansen²² techniques of estimation employ a vector error-correction (VECM) framework, for which in the case of a set of k variables, we may have cointegrating relationships denoted r , such that $0 \leq r \leq k - 1$. This gives us a k -dimensional vector autoregression (VAR):

$$z_t = A_1 z_{t-1} + \dots + A_m z_{t-m} + \mu + \delta_t \quad (1)$$

where m denotes lag length, and δ a Gaussian error term. While in general z_t may contain $I(0)$ elements, as long as non-stationary variables are

²²See Johansen (1991) and Johansen and Juselius (1990).

present as in the present case, we are exclusively restricted to $I(1)$ elements. Reparametrization provides the VECM specification:

$$\Delta z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \Pi z_{t-k+1} + \mu + \delta_t \quad (2)$$

The existence of r cointegrating relationships amounts to the hypothesis that:

$$H_1(r) : \Pi = \alpha\beta' \quad (3)$$

where Π is $p \times p$, and α, β are $p \times r$ matrices of full rank. $H_1(r)$ is thus the hypothesis of reduced rank of Π . Where $r > 1$, issues of identification arise²³.

The question we confront in our econometric investigation is whether changing employment patterns in South Africa's mining sectors bear any relation to changes in the real wage and changes in the demand for output of the mining sectors. One means of answering this question is to consider a labour requirements equation, derived from the inversion of the production function of each mining sector. Assuming that technology is Cobb-Douglas, log-transforming and inverting a standard production function we obtain:

$$\ln L = \alpha + \beta \ln Y + \delta \ln K + \lambda \ln \left(\frac{W}{P} \right) + \varepsilon_t \quad (4)$$

where Y denotes output, K the capital stock, L the labour input into production, A other factors influencing output such as technological progress and real factor prices, $\frac{W}{P}$ real per labourer remuneration, and ε a standard error term.

Our particular interest lies in two parameters. We wish to know whether changing output levels impact on the demand for labour by the mining sectors in the economy. Specifically, we wish to know whether $\beta > 0$, and hence whether expanding levels of output in the economy increases the demand for labour. Conversely, whether declining output levels in mining explain the labour shedding of these sectors. Second, we wish to know whether changing levels of the real wage influences the demand for labour. Given the preceding discussion on the labour market for the three mining sectors, we are particularly interested to establish whether $\lambda < 0$, and hence whether changing real wage patterns in the mining sectors has been a source of the labour-shedding that we have already reported on.

²³See Wickens (1996), Johansen and Juselius (1990, 1992), Pesaran and Shin (1995a, 1995b), Pesaran, Shin and Smith (1996).

	$\ln Y$	$\ln K$	$\ln\left(\frac{W}{P}\right)$	ECM	SE
Coal Mining	0.90* [37.36]	-0.19* [11.35]	-0.44* [12.17]	-0.55* (2.98)	0.19
Gold & Uranium Mining	0.31 [1.74]	-0.16 [2.10]	-0.69* [13.24]	-1.1* (3.03)	0.36
Diamond & Other Mining	2.26* [9.71]	-0.26 [0.79]	-1.45* [8.25]	-0.63* (2.92)	0.22

Table 10: Long Run Cointegrating Vectors. Figures in round brackets denote t-statistics; figures in square brackets denote chi-square statistics at one degree of freedom on overidentifying restrictions on the cointegrating space for significance.

Lastly, we note that the specification above allows us to establish the impact of changing capital intensity in the mining sector on the demand for labour. The sign of δ allows for a determination of whether the factors of production act as complements or substitutes in the three aggregate mining sectors of the South African economy.

For all three aggregate mining sectors, examination of the inverted production function specified by the labour requirements equation confirms the presence of a single cointegrating vector and hence equilibrium relationship. The resulting coefficients on the explanatory variables in the long run cointegrating relationships are reported in Table 10. Examination of the error correction equation confirms that each of the labour requirement equations estimated for the three mining sectors is an equilibrium model, in the sense that the negative and significant error correction term allows for the elimination of any deviation between actual and equilibrium labour usage.

The error correction (*ECM*) parameters, which can be interpreted as the proportion of any error between actual labour usage and the labour usage implied by the equilibrium relationship that would be eliminated in the succeeding time period, are also reported in Table 10.²⁴

For Coal and Diamond & Other Mining, the output coefficients suggest that growth in output is not jobless once other potential explanatory variables of labour usage are controlled for. On the contrary, growth in Coal Mining output appears to generate an almost proportional increase in the demand for labour, and growth in Diamond & Other Mining appears to generate a

²⁴Detailed results on the trace and maximal eigenvalue statistics specifying the reduced rank of the stochastic matrix, and on the full error correction specification are available from the authors.

strong increase in the demand for labour.

For Gold & Uranium Mining the impact of output on labour demand has been somewhat lower than in the other two aggregate mining sectors in the economy, and it proves statistically insignificant. Hence, for the one sector in which declining output levels could potentially have accounted for declining labour demand, the statistical evidence fails to corroborate a clear link.

On the other hand, it appears as if capital has displaced the use of labour in both the Coal and Diamond & Other Mining sectors, though the elasticity of labour with respect to capital is relatively modest.

By contrast, changing usage of capital seems to have had very little impact on labour usage in the Gold & Uranium Mining sector.

In all three aggregate mining sectors rising real per labourer remuneration is consistently and strongly related to declining labour usage. Each percentage point increase in the real per labourer remuneration of the sector has depressed labour usage by almost half a percent in Coal Mining, almost 0.7% in Gold & Uranium Mining and by 1.45% in Diamond & Other Mining. Again, Diamond & Other Mining is the most responsive of the three aggregate mining sectors to changes in real labour remuneration.

In the labour requirements equation specified and estimated above, the skills composition of the labour force is not explicitly controlled for. One reason for the negative impact of the real wage rate on labour usage may be that the labour force has come to change its skills composition substantially over the estimation period. Thus the negative coefficient on the real wage rate may reflect the fact that the average skills level of the labour force has risen over time, that its wage structure has risen in accordance with the rising skills level, but that a given quantity of output may no longer require as large an input from the now more skilled labour force.

However, a couple of considerations suggest that the above argument is unlikely to apply to Coal and Gold & Uranium Mining.

- From the descriptive section of our report, we have seen that the changing skills composition of the labour force is due to falling unskilled employment, rather than rising skilled employment.
- Where we control for the skills ratio in the labour requirements equation already estimated, we continue to find a unique cointegrating vector, and the real wage elasticity remains negative.

- Where we estimate a labour requirements equation for the skilled and unskilled workforce separately, we again obtain unique cointegrating vectors for the two sections of the workforce for both mining sectors. For Coal Mining, the estimated elasticities are quite distinct. For the skilled workforce there is a positive association between skilled labour usage and skilled real per labourer remuneration. By contrast, for unskilled labour, there exists a powerful negative association between unskilled labour usage and unskilled real per labourer remuneration. For Gold & Uranium Mining the estimated elasticities for both the skilled and the unskilled workforce demonstrate a negative association between labour usage and real per labourer remuneration.

The net implication is thus that while the rising average real wage in Gold & Uranium as well as Coal Mining may have been partially due to the increasing proportion of skilled workers in the labour force, unskilled workers also experienced rising real wages, and the impact of these increases was such as to depress demand for unskilled workers.

Our initial conclusions concerning the negative real wage elasticity is thus confirmed.²⁵

4 Conclusions

The story of the mining sector in South Africa over the last three decades of the twentieth century is one of structural change. We saw strong declines in the sector's contribution to value added in the economy, principally due to the decline in the production of Gold & Uranium Mining. The distribution of output of the Gold & Uranium Mining sector shifted substantially away from equity earnings to labour earnings - through sharp increases in real wages.

The contribution of mining to the net value added produced in the economy has declined sharply since 1970. This decline is attributable primarily to the declining contribution of Gold & Uranium Mining to the total net value added produced in the economy. By contrast, the other two aggregate mining sectors of the economy, Coal and Diamond & Other Mining have

²⁵One concern with the present set of estimations is that the sample size available for the VECM (28 observations) attenuates statistical power. We therefore repeated our estimation using dynamic heterogenous panel estimation on all three panels. All results prove to be consistent with the findings reported here.

contributed a relatively constant proportion to aggregate net value added. A more disaggregated investigation of output by individual mining sectors confirms the view that a number of sectors demonstrate a growing contribution to output, and that it is chiefly the contribution of gold mining to value added in the economy that has been in decline.

The decline in the net value added contributed by mining is mirrored in a declining contribution of mining to total tax revenues of the state. Again, it is gold mining whose contribution has been most clearly in decline since the early 1980's.

The mining sector, and gold mining in particular, remains crucial in terms of the foreign exchange earnings of the economy, however. While the manufacturing sector has come to generate greater export sales than mining during the course of the 1990's, as a net exporter the mining sector remains the single most important earner of foreign exchange for the economy.

Finally, the distribution of the net value added produced by the Gold & Uranium Mining sector of the economy has changed fundamentally over the 1970-97 period. Whereas labour earned less than half of the value added in 1970, by the end of the 1990's labour is now earning approximately 67% of net value added in the sector. As such, the distribution of output within the sector has undergone a fundamental transition, and one that is far more dramatic than in the remaining two aggregate mining sectors of the economy. Certainly it points to a mining sector in transition, assuming a different role to its traditional one in contributing the net output of the South African economy.

In terms of the contribution of the mining sector to employment in the economy, our findings mirror those we obtain for the contribution of mining to net value added in the economy. In particular, mining has contributed a steadily shrinking proportion toward total employment in the economy, and the 1990's have seen a very dramatic absolute fall in employment of particularly unskilled workers. The decline in the importance of mining as an employer is less severe than the decline in its contribution to value added in the economy. And again, the decline is mainly attributable to a massive loss of employment in Gold & Uranium Mining as the largest employer in the mining sector as a whole, although proportionally the employment decrease in Coal Mining has been equally sharp. The weakest proportional decrease has occurred in Diamond & Other Mining. Our analysis explores some of the potential reasons for the decline in employment in the three aggregate mining sectors. Time series (cointegration) data analysis confirms that employment

losses in the mining sector is attributable to rising real wage costs, as well as the declining output of the mining sector. This finding remains robust even where we control for the skills composition of the labour force.

South Africa's economic development has been intimately tied to growth in its mining sector. The evidence presented in the present paper has suggested that this trajectory has been subject to structural change - with a move away from primary commodities production to manufacturing and service industry.

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Section	Source	Variables used
Production Volumes in the Mining Sector	Minerals Bureau	Total Production (Diamonds), Production, Mass of Total Sales where Production not available
The Importance of Mining in terms of its contribution to Value Added in the South African Economy	WEFA WEFA (SARB Quarterly Bulletin)	GDP, by sector Real GDP London Gold Price in US-Dollar London Gold Price in ZAR
Contribution of the Mining Industry to Total Tax Revenue of the South African State	WEFA (CSS)	Mining taxation by aggregate mining sector
Aggregate Labour Market Conditions in the three aggregate mining sectors of the South African Economy	WEFA Chamber of Mines	Formal Employment (number) Nominal Labour remuneration (current prices) GDP (constant prices) GDP deflator (index, 1990=100) Skilled Employees, Average No. in Service Unskilled Employees, Average No. in Service For Coal and Gold Mines, Members of the Chamber of Mines
Links between Labour Productivity and Real Labour Cost	Chamber of Mines	Metric tons ore milled Production total kilograms fine Production grade (grams per metric ton milled)

Table 11: Data Appendix