South African Manufacturing Industry Structure and its Implications for Competition Policy

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Abstract

This paper surveys the literature on the manufacturing sector in South Africa, focusing on concentration and markup levels, with a view to inform policy. The literature has employed a number of different measures of industrial concentration, namely, the Gini and Rosenbluth indices, the Occupancy Count, the C5% index and, to a lesser extent, Concentration Ratios and the Herfindahl-Hirschman index. Generally, manufacturing industry concentration is found to be high and increasing up to 1996. However, all the measures show decreasing concentration post–1996. In respect of markups, the evidence suggests that markups in South Africa are significantly higher than they are in comparable industries world-wide and they appear to be non-declining. However, there are dissenting voices on this point. We then juxtapose the concentration and price-cost margins findings to industry performance (at the macro level). In particular, we review the literature that examines the relations between concentration and price-cost margins on the one hand and output growth, productivity growth, employment, employment growth, investment and export and import competitiveness on the other. We then draw implications for competition policy in South Africa, pointing out areas that need further research as well as international best practices.

KEYWORDS: manufacturing industry, industry concentration, South Africa, competition policy

JEL classification: L16, L6

1 Introduction

The objective of this paper is to take stock of the literature on the state of South Africa's manufacturing industries with respect to concentration levels, the levels of markups and how these relate to manufacturing industry performance. We take a broader view of industry performance by trying to relate industry structure to output growth, productivity growth, employment and employment growth, investment and export and import competitiveness. We then draw implications for competition policy in South Africa.

Recently, there has been a growing interest in the investigation of the structure of the South African manufacturing sector. Although the literature on the South African manufacturing sector is still limited, there already exist a number of important contributions in this regard. It is therefore necessary to take stock of the research to date and to highlight the areas where knowledge is still scant.

The literature examining concentration and markups in the South African manufacturing sector has employed a number of different measures of industry concentration, namely, the Gini (Fourie and Smit (1989)), the Gini and Rosenbluth indices (Leach (1992); Fedderke and Szalontai (2004);

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Fedderke and Naumann (2005)), the Occupancy Count (Leach (1992)), the C5% index (Fedderke and Szalontai (2004); Fedderke and Naumann (2005)) and to a lesser extent the Concentration Ratios and the Herfindahl-Hirschman Index.[1] Industry concentration is, in general, found to be high and increasing up to 1996. However, all the measures show decreasing concentration post-1996. In respect of markups, the evidence seems to suggest that markups in South Africa are significantly higher than they are in comparable industries world-wide and they are also non-declining (Fedderke *et al* (2005); Aghion *et al* (2007)). Edwards and Van de Winkel (2005) and Du Plessis and Gilbert (2007) however do not share this view. We relate the concentration and price-cost margins findings to industry performance (at the macro level), namely, to output growth, productivity growth, employment and employment growth, investment and export and import competitiveness. We then draw implications for competition policy, pointing out areas that need further research as well as international best practices.

Our general conclusion is that the evidence, at this stage, is not irrefutable. The major problem we noted with the studies surveyed in this paper relates to the use of the Gini and Rosenbluth indices as measures of industry concentration. These indices are used primarily because of data limitations. The problem with these indices is that they are not very good measures of industry concentration (at least in the sense of market power). As such, this brings into question the validity of the conclusions reached based on these measures.

The paper is organised as follows: Section II reviews a number of the measures of industry concentration that are commonly employed in the literature and give an in-depth discussion of the measurement of industry concentration. Section III gives an overview of the data issues in South Africa pertaining to the manufacturing sector. In this section, we point out the data limitations and the comparability issues that are posed by the different data collection methodologies for the pre- and post-1996 periods. We examine the spatial distribution of manufacturing industry in South Africa and its determinants. Section IV examines the South African industry structure, evolution of concentration and the implications for industry performance. We also examine here the relationship between industrial concentration and output growth, productivity growth, employment, employment growth and investment. Section V examines the extent of markups in the South African manufacturing industry and Section VI briefly examines the productive-allocative efficiency debate and relates this debate to the South African evidence. Section VII reviews the literature on trade liberalisation, industry structure and markups in South Africa and Section VIII concludes the paper.

2 Measurement of industry concentration

Industry/market concentration refers to the extent to which a small number of firms or enterprises account for a large proportion of economic activity such as total sales, assets or employment (OECD, 1993). Industry concentration is an important concept in competition policy debates. This is because it is often argued that industry concentration is a proxy for the market power of firms. Following the industrial economics literature, the presumption is that high concentration implies the leading firms have large market shares and thus greater scope for exercising market power. For instance, collusion is easier to sustain with a small number of firms (Tirole, 1988). This reliance on concentration measures in anti-trust policy has been necessitated by the difficulty of directly measuring competition, though recently the New Empirical Industrial Organization (NEIO) has tended to approach this measurement issue more directly (see Bikker and Haaf (2002a, 2002b).

Understanding the structure of an industry is important (especially for policy) since, in general, industry structure has a bearing on the competitiveness of the industry in question. To this end, economists have relied on concentration ratios to unpack the structure of a given industry.[2] There

[1] These measures are defined in Sections II and IV.

[2] We hasten to point out however that there is no obvious relationship between concentration and competitiveness. Indeed, under some conditions, perfectly competitive behaviour is possible even in highly concentrated markets/

are several methods of measuring industry concentration. These methods differ mainly according to their weighting schemes (and thus sensitivity of the index to changes at the tail-end of the firm size distribution) and structure (Bikker and Haaf (2002b: 4); see also Marfels (1971)). Bikker and Haaf (2002b: 3-16) discuss ten such indices. We will not enumerate all of them here – except for the four that are most relevant for our purposes, viz., the Herfindahl-Hirschman index, the k firm concentration ratio, the Rosenbluth index and the Gini index.

The two most commonly used measures of industry concentration in international studies are the k firm concentration ratio (CR_k) and the Herfindahl-Hirschman Index (HHI) (Bikker and Haaf (2002b); Ratnayake (1999)). The CR_k ratio measures the (cumulative) market share of the largest k firms in the industry; that is:

$$CR_k = \sum_{i=1}^{k} s_i; k < n,$$

where s_i is the market share of firm i, n is the total number of firms in the industry and k (arbitrarily chosen by the researcher) is the number of firms included in the computation of the concentration ratio. The advantage of the CR_kover other measures lies in its simplicity and its minimal data requirements. Computation of the CR_kmeasure is straight forward: each of the k largest firms' market shares is assigned equal weight of unity (the top k firms are ranked in descending order with the $i-th$ firm receiving rank i.). Because only $k < n$ firms are considered, the CR_k measure lies between 0 and 1. The obvious weakness of the CR_k measure is that it does not take into consideration all the firms in the industry. In particular, the effect of small firms on market behaviour is totally ignored. For this reason, this measure is called a discrete measure, as it only measures one point on the concentration curve (Leach (1992: 388); Fedderke and Szalontai (2004: 2-3)). Also, CR_k assumes that the size distribution of the largest $k$firms is irrelevant for competition. This obviously is a drawback.

The HHI, on the other hand, takes into account all the firms in the industry (classified as a summary measure). The HHI is the sum of the squared market shares of all the firms in the industry, that is:

$$HHI = \sum_{i=1}^{n} s_i^2,$$

where s_i is the market share of firm i and n is the total number of firms in the industry.[3] The lower bound of the index is 0 (under perfect competition) and the upper bound is 1 (under monopoly). More precisely, $HHI \in \left[\frac{1}{n}, 1\right]$,where the index attains its minimum value of $\frac{1}{n}$when firms are of equal size. The higher the index, the more concentrated the industry is. The U.S. Department of Justice considers a market with an HHI index of less than 0.1 to be a competitive marketplace; an index between 0.1 and 0.18 to be a moderately concentrated marketplace; and an index of 0.18 or greater to be a highly concentrated marketplace (*Investopedia.com*). The advantage of the HHI as a measure of competition is that it recognises the importance of large firms in influencing competitiveness of an industry but it also incorporates the influence of small firms.

Although the HHI is considered superior to the CR_k, these two measures – the CR_k and the HHI – are highly correlated so that the choice of which measure to use is, in general, not always important (Schemalensee (1989: 966); Ratnayake (1999: 1043)).[4,5]

industries. (See for instance Baumol, Panzar and Willig (1982)).

[3] In the United States, the HHI plays an important role in antitrust cases – in particular, in merger cases (Bikker and Haaf (2002b: 7)).

[4] Bikker and Haaf (2002a) find, in a study of concentration indices for 20 countries, a correlation of 0.98 between the the CR_3 and the HHI. In particular, the implied rankings of the countries in terms of banking sector concentrations is virtually identical for the CR_3 and HHI.

[5] A caveat is in order though. As Schemalensee points out (1989: 966), the choice among even highly correlated concentration measures can still *significantly* affect the results obtained (emphasis added).

Other measures that have been used in the literature include the Rosenbluth index, measures of industry inequality such as the Gini (Hart, 1961; Marfels, 1971), the Comprehensive Concentration Index (due to Horvath, 1970) and the Entropy Index.[6]

The Rosenbluth Index, like the HHI, is a summary measure of concentration (it takes all firms into consideration). The firms are ranked according to market share in descending order with the $i-th$ firm receiving rank i. Ranks of firms are used as weights so that the $i-th$ ranked firm is assigned weight i. The Rosenbluth index is computed as follows:

$$R = 1/\left(2\sum_{i} is_i - 1\right)$$

where i is the rank of firm i and s_i denotes firm $i's$ market share. The Rosenbluth index, just like the HHI, takes its minimum value of $1/n$ for equal size firms and a maximum value of 1 in the case of monopoly. The major drawback of the Rosenbluth index, and what distinguishes it from the HHI, is its weighting scheme. Unlike the HHI, the Rosenbluth index assigns less weight to larger firms (firms with high rank) and more weight to smaller firms (firms with lower rank). In other words, the index is overly sensitive to changes in the tail-end of the firm-size distribution.

Marfels (1971: 759) shows that there is an intimate relationship between the Rosenbluth index and the Gini index – which he calls the "inequality counterpart to the Rosenbluth index" (p. 761). This relationship is given by:

$$G = 1 - 1/nR = 1 - \left(2\sum_{i} is_i - 1\right)/n$$

where n is the number of firms in the industry. The Gini index is a measure of inequality in the size distribution of firms. However, the usefulness of inequality measures in trying to understand issues of industrial concentration has largely been tenuous. Early on, Horvath (1972: 841) questioned the importance accorded to the concept of inequality in discussions of industrial concentration. The problem with using measures of inequality to measure industry concentration is that the whole "idea breaks down under the so called 'Lorenz-curve type problems', when an industry with market shares equally distributed among firms would show no concentration whatsoever" (*ibid*). See also Leach (1992: 387).

In order to assess how the different concentration indices perform in trying to capture the structural features of a market/industry, Marfels (1971: 761) calculates the implied concentration indices, given four hypothetical market structures (his Tables 2 and 3). He compares five concentration indices, namely; the HHI; the Rosenbluth index; the Gini index as well as the Entropy index and the Comprehensive Concentration index. We reproduce Marfels' Tables 2 and 3 (see our Tables 1 and 2), focusing only on the first three indices.

As can be seen from Table 2, the HHI and the Rosenbluth indices appear to agree in the way they capture the structural features of "our" hypothetical market. Markets I and II are fundamentally/ structurally similar and so are markets III and IV. Markets I and II are highly concentrated (one dominant firm and a fringe), whereas markets III and IV are moderately concentrated (few but more or less equal size firms). The HHI and the Rosenbluth indices also agree that market I is the most concentrated market while market IV is the least concentrated market. This however, is not what the Gini index reflects. According to the Gini, market II is 'significantly' more concentrated than market I while market III is 'significantly' less concentrated than market IV. Thus, to the extent that concentration ratios are used to explain competitive performance (market power) in an industry, the

[6] We will not consider other indices proposed in the literature over and above those enumerated above. Also, we will not discuss the Comprehensive Concentration and the Entropy indices here for at least two reasons: First, they have not been widely employed in the international literature. Second, and more importantly for this paper, they have not been employed in studies of industry concentration in South Africa. Interested readers should consult Bikker and Haaf (2002b: 3-16) and Marfels (1971) for details.

Gini index performs rather poorly as a measure of industry concentration. Thus Marfels (1971: 761) concludes: "[t]he values of [G], ..., show a *rather erratic course* and prove its *inadequacy* to cope with problems of fewness" (emphasis added).

Although industry concentration proxies for the market power of firms, high concentration per se does not imply firms actually exercise market power.[7] Other market information should be taken into account, e.g., entry barriers, price controls, etc. (Ratnayake, 1999).[8] In fact, it is now generally accepted that there is no obvious *causal* relationship between concentration (structure) and markup (performance).[9]

3 Industry structure: Background issues and preliminaries

In this section we give a brief overview of the data issues and the spatial distribution of manufacturing industry in South Africa and its determinants.

3.1 Data issues in South Africa

The South African manufacturing sector is quite well developed compared to most developing countries. Since 1917, Statistics South Africa (Stats SA) has carried out a census of the 3 digit manufacturing sector largely on a biannual basis. This census was last carried out in 1996. Since then, data on the manufacturing sector has been sporadic. In 2001, a new data set (the Large Sample Survey) of the manufacturing sector was released. However, the form of the new survey data differs from the earlier census data. This raises the question of comparability.

For the 2001 survey, a sample of 10 000 firms was drawn out of a population of approximately 34 000 firms at the 3 digit level (Fedderke and Naumann (2005: 15)). The manufacturing groups were divided into four size groups – size group 1 being the large enterprises and size group 4 the small firms. As Fedderke and Naumann (2005: 16) point out, the response rates to the survey decrease with firm size group – decreasing from about 91% for the size group 1 to about 72% for the size group 4. Also, the large firms are completely enumerated whereas the small firms are not. The use of this data may thus add idiosyncrasies into the calculations of variables (e.g., the Gini index) or into the estimations.

The paucity of data on the manufacturing sector collected by the official statistics agencies post-1996 has meant that most empirical studies on South Africa have had to rely on commercially produced data.[10] Unfortunately, since this data is generated at the 3 digit SIC level, on the basis of the 2 digit SIC based data, various issues of reliability arise in using this data source for both analysis and policy prescription. In addition, this also raises serious issues of comparability with the census of manufacturing data which is collected at the 3 digit level (see also Fedderke and Hill (2006) and Aghion *et al* (2007)). Another major issue with regard to manufacturing data is that there is

[7] For instance, Fedderke and Simbanegavi (2007), in their study of the South African polymer market (a highly concentrated market), find little evidence of the exercise of pricing power by the firms in this market.

[8] For instance, a duopoly market in which firms have equal and constant marginal costs, no capacity constraints and compete with regard to prices will deliver a perfectly competitive outcome.

[9] The structure – conduct – performance (SCP) paradigm, as advanced by Bain in the 1950s, argues that high concentration is a pre-requisite for high markups – implying that concentration drives performance. This was challenged in the 1970s by the *efficiency hypothesis* – a competing explanation that reverses the direction of causality (Demsetz (1973)). The theory runs as follows: Highly efficient firms (low cost firms) can afford to grow their market shares by lowering prices. This (lowering of prices) forces the inefficient firms out of the market leading to higher concentration. Thus, market structure (concentration) is endogenous and is driven by performance. The modern view (New Empirical Industrial Organization (NEIO)) however is that both industry structure and industry performance are endogenous – being driven by some other factors. As Schmalensee (1989: 954) puts it, "..except in textbook competitive markets, derived market structure is clearly affected by market conduct in the long-run". The NEIO does not assume a causal relationship between market structure and performance, but rather, the approach tests competition and the use of market power (Bikker and Haaf (2002b: 21); Bresnahan (1989)).

[10] The main source is Quantec.

no firm level evidence (data) on South Africa. Therefore, data limitations constrain empirical work in South Africa.

Most of the South African studies surveyed in this article utilise data based on the tables published by Stats SA in the census of manufacturing. The (abrupt) end of the census of manufacturing in 1996 therefore makes it very difficult to make meaningful comparisons of the studies using the pre-1996 data and those using the post-1996 data as the data collection methodologies are different.[11]

3.2 Spatial distribution of manufacturing industry in South Africa

In this section, we briefly look at the spatial distribution of manufacturing activity in South Africa. The spatial pattern of agglomeration and specialisation has implications for long term growth. For instance, agglomeration may enhance growth through "cross-pollination of ideas" (Fedderke and Wollnik (2007: 2)). Spatial location of firms is driven by many different factors, for instance, firms may be "pulled" to a particular space by technological advantages (e.g., Silicon Valley) or by the abundance of a factor input (immobile factor, e.g., natural resources) or by the 'big' size of the market.

Fedderke and Wollnik (2007) examine the spatial distribution of manufacturing industry in South Africa for the period 1970 to1996 based on the manufacturing census.[12] As they point out, South Africa's provinces vary in terms of climate, rainfall, maritime habours and natural resource deposits (p. 6). These different factors may thus differentially influence spatial location of industry. Results indicate that manufacturing activity is concentrated in Gauteng. In particular, over the sample period, on average 40+% of manufacturing valued added has been generated in Gauteng in each period. This is followed by the coastal regions (Western Cape (WC), Kwa-Zulu Natal (KZN) and Eastern Cape). In 1970, not much manufacturing activity was taking place in the Northern part of the country (Figure 1). However, by 1996, the pattern appears to be changing, with some significant improvements for the North-West and Limpopo provinces (Fedderke and Wollnik: 8). In KwaZulu-Natal, manufacturing activity increased by 80% over the full sample period (p. 9).

[Figure 1 about here]

In terms of regional specialisation in South Africa, Fedderke and Wollnik (2007: 10) find a weighted average Gini of 0.35 and they conclude that "measured regional specialisation is not very high". The main reason for a "low" weighted average Gini is because Gauteng, the largest province in terms of output (and therefore the province with the greatest weight) is the least specialised and in addition, it shows no trend in specialisation (Fedderke and Wollnik: Figure 2).[13] They also find no consistent trend towards greater regional specialisation over the sample period. Looking at the regions separately, the picture is different. For KZN, evidence points to despecialisation through to the mid 1980s and increased specialisation thereafter. The WC shows increased specialisation in the 1970s, despecialisation in the 1980s and respecialisation thereafter. The other smaller provinces also show evidence of specialisation in the 1990s. Gauteng however shows low and stable specialisation over the full sample period.

Fedderke and Wollnik employ the dynamic Pooled Mean Group (PMG) estimator to investigate the determinants of industry (spatial) concentration. For human capital, they report an elasticity of 0.09. This 'small' elasticity suggests geographic concentration of human capital-intensive industries reflecting the skills shortage in South African manufacturing during the last two decades of apartheid (Fedderke and Wollnik: 17). They further find that both labour intensive and capital-intensive industries tend to be geographically dispersed and hence have not been able to realise agglomeration

[11] Fedderke and Naumann (2005: 16) give some assurance. They argue that although there are issues with the post-1996 data, the 'sampling effect should not be severe as only the smaller firms are effected'. We however advise caution as the comparability of the data remains in question.

[12] They reconstruct today's nine provinces from this data. This is because geographical units have since been rezoned. In addition, repeated revision of the industrial classifications makes industries not strictly comparable across time periods (Fedderke and Wollnik (2007: 7)). The data is on 22 manufacturing sectors.

[13] In terms of the straight average, the regional specialisation is substantially higher with a Gini of 0.50.

benefits. Labour intensive industries are possibly dispersed due to the apartheid pass laws which restricted movement of black workers while capital-intensive industries are possibly dispersed due to first nature reasons (i.e., they are located) close to natural resources) (pp. 19-20). Scale economies, as one would expect, favour industry concentration. In particular, a 1% increase in firm specific internal scale economies will raise concentration (Gini) by about 0.19 percent (p. 20).[14] In contrast, linkages are found to have a large but negative effect on industry location (elasticity of -0.63).[15] Lastly, Fedderke and Wollnik find that regional technology differences positively affect industry concentration, with a Gini of 0.06 (their Figure 6). A summary of their analytical findings is given in Table 3.

[Table 3 about here]

In summary, except for Gauteng, South African manufacturing industry is generally spatially dispersed. This is mainly because of the prevalence of natural resource processing in manufacturing industry. Industry tended to be located close to site to reduce transportation costs. The findings above carry important policy implications. They point to heightened importance of infrastructure. Good and efficient infrastructure, by weakening the effect of distance, can aid the realisation of scale economies through agglomeration. Further, because most manufacturing is located away from harbours and ports (Gauteng province), liberalisation of the economy may not stand to benefit the manufacturing sector unless it is accompanied by investments in infrastructure, in order to lower transport and transactions costs.

4 Industry structure in South Africa: Evolution of concentration levels and implications for industry performance

4.1 Industry concentration in South African manufacturing sector

The general finding of high industry concentration is reported in all the studies of the South African manufacturing sector at least up to the mid 1990s. However, there are some differences in respect of the trend in industry concentration. The measures of industry concentration that have found application in the South African industry studies are the Gini coefficient (Fourie and Smit (1989); Fedderke and Naumann (2005); Fedderke and Szalontai (2004)), the Rosenbluth index (Leach (1992); Fedderke and Naumann (2005); Fedderke and Szalontai (2004)), the Occupants Count (Leach (1992)) and the C5% index (Fourie and Smit (1989); Fedderke and Naumann (2005); Fedderke and Szalontai (2004)). The Occupants Count is defined as the number of firms responsible for a given proportion of total industry output. For instance, the 80% Occupants Count is the number of firms responsible for 80% of total output (Leach (p. 387)). Except for a few exceptions (Fourie (1996)), studies of industry concentration in the South African manufacturing industry have not employed the concentration ratio (CR) or the HHI. The reason being that the way in which the data (on the South African manufacturing sector) is collected does not make it amenable to the calculation of these indices, at least up to the mid 1990s (Fedderke and Szalontai (2004)).[16]

Fourie and Smit (1989) study trends in economic concentration in South Africa, with a view to understanding the implications for the competitiveness of the South African manufacturing industry. They considered the period 1972 to 1982. Due to "scantiness of available statistical information", Fourie and Smit (1989: 242) only managed to compute the Gini coefficient – a relative measure of concentration. They could not, for instance, compute the concentration ratio, HHI or the Rosenbluth index. Their preferred measures are the C5% index and the Gini coefficient. They consider two cases – one where they take into account imports and the other where they do not take imports

[14] In fact scale economies are found to be the most important pro-concentration force (p. 25).

[15] This however contradicts the theoretical priors as well as the findings for the developed economies (of a positive effect). However, a negative elasticity is also found for Spain (Paluzie *et al* (2001)).

[16] Although it is possible to calculate these indices from the recent data sets, one cannot do this for a long enough time (i.e., back to the 1970s) for the data to constitute a meaningful panel study.

into account. They find high and increasing levels of economic concentration in the period under study (pp. 244-247). In their view, this "tendency towards *high* concentration should be cause for anxiety" by the competition board (p. 251, emphasis added)).

Leach (1992) critiqued the approach of Fourie and Smit (1989), in particular their reliance on the Gini coefficient as a measure of industrial concentration. Leach argued that the data employed by Fourie and Smit (1989) does permit the computation of a more appropriate (absolute) measure of industrial concentration – the Rosenbluth index. Leach (1992) thus studies, using the Rosenbluth index and the Occupancy Count, the trends of concentration in the South African manufacturing sector for the period 1972 to 1985. He reports that the Rosenbluth index and the 80% occupancy count agree on the direction of change in concentration in most of the industries (p. 392). However, the conclusions with the Occupants Count and the Rosenbluth index were slightly different. He finds evidence consistent with decreasing industry concentration based on the Rosenbluth index (a decrease in the average Rosenbluth index) but no change in concentration based on the 80% Occupants Count (the average weighted change is zero). Leach finds that the Rosenbluth index decreases for 18 out of 26 industries and the decrease is statistically significant at the 5% level (p. 390). Moreover, both the (unweighted) average and the weighted average changes in the Rosenbluth between 1972 and 1985 are negative (-0.0046 and -0.0009, respectively) – indicative of a decrease in concentration.

Leach argues that the decrease in concentration (as measured by the Rosenbluth index) can be explained by the fact that "the percentage increase in the number of firms was greater than the percentage decline in equality of size" (p. 394). Leach's findings contradict the earlier study by Fourie and Smit (1989) who, using the Gini index as a measure of industry concentration, conclude that concentration increased between 1972 and 1982.[17] Leach strongly criticises Fourie and Smit (1989) for drawing conclusions on manufacturing industry concentration based on a measure of inequality of firm size. As he points out, failure to maintain the distinction between concentration and inequality could lead to erroneous conclusions (p. 395).

Leach (1992) could not close the debate on the trends of manufacturing industry concentration in South Africa for two reasons. First, no clear cut conclusion can be given in respect of the trend of manufacturing industry concentration since his two preferred measures lead to conflicting conclusions. Although the Rosenbluth shows a statistically significant decrease at the 5% level in manufacturing industry concentration between 1972 and 1985, the 80% occupancy count shows a decrease in 16 of 26 industries, but not a statistically significant decrease. Since both measures are plagued with problems, it is not clear what the conclusion ought to be.[18] A more important limitation however pertains to the objectives of the study. Is concentration the real issue of interest here? We think not. Concentration is employed in this literature (including in Leach (1992) we believe) to try and uncover the underlying market structure and hence the competitiveness of the manufacturing sector. But this raises two further issues: (i) there is no obvious relationship between industry concentration and competitive conduct (see for instance Baumol et al, 1982) and (ii), because of the breadth of the manufacturing industry (Leach examines 26 sectors), it is virtually impossible to define with any degree of precision what competitive conduct would entail given the heterogeneity of the sectors. This puts into question the relevance of studies of industrial concentration, especially at a highly aggregated level (3 digit level), in trying to understand competitive behaviour of firms in the manufacturing sector.

To bring a new perspective to the debate, Fourie (1996) examines industry concentration in South Africa using a wide variety of concentration measures but only for a very limited period (1972

[17] Leach did not use the Gini as a measure of industry concentration but rather as a measure of inequality among firms. He finds that inequality among firms increased between 1972 and 1985 (increase in the average Gini index significant at the 1% level (p. 390)). In particular, the Gini coefficient increased for all but three industries (namely, Beverages, furniture and fixtures and transport equipment).

[18] As Leach's Table 2 shows, the numbers of firms involved is substantial (which militates against the Rosenbluth index as it is overly sensitive to changes in the tail-end of the firm size distribution). However, discrete measures of concentration are also known to be inferior to summary measures (which militates against the occupancy count).

to 1988). He compares results of the CR_3, CR_4, CR_{10}, HHI, Gini, Rosenbluth and the Horvath (Comprehensive concentration index). An interesting aspect of Fourie's contribution is that for the first time, we have measures of industry concentration at the 5-digit level. We reproduce his Tables 1 and 4 (see our Tables 4 and 5), reporting only the CR_3,HHI, Gini, Rosenbluth and the Horvath indices.

We report the unweighted averages for the 5-digit levels in Table 5. The weighted averages are lower than the unweighted averages.

[Insert Tables 4 and 5 about here.]

In Table 4 (3-digit level), all the measures except for the Gini show low industry concentration. In particular, in terms of the HHI, the South African manufacturing sector is very competitive (since the HHI index does not exceed 0.1). Also, all the measures, again except for the Gini, appear to show stable to weakly increasing concentration. Table 5 (5-digit level) on the other hand appears to show moderate to high concentration. Going by the HHI, the conclusion based on Table 5 is that the South African manufacturing sector is moderately concentrated (see the discussion in Section II). It is unfortunate that Fourie (1996) interprets this evidence as categorically indicative of high concentration (p. 117).[19]

At both the 3-digit and the 5-digit levels, the HHI and the Rosenbluth yield more or less similar (and low) values indicating low concentration whereas the CR_3 and the Horvath index, both in the 3-digit and the 5-digit levels, show moderate to high concentration. Although Fourie's (1996) analysis does not show 'high' industry concentration in the South African manufacturing sector, this data is slightly outdated (1972 to 1988), especially for policy purposes - hence the need for more studies.

In an attempt to reconcile the earlier conflicting findings of Fourie and Smit (1989) and Leach (1992) and in light of more recent data, Fedderke and Szalontai (2004) and Fedderke and Naumann (2005) examine industry concentration for the manufacturing sector over the 1972 to 1996 and 1972 to 2001 periods respectively. Unlike Leach (1992), they employ the Gini and the Rosenbluth indices as well as the C5% index as measures of industry concentration. The C5% gives the proportion of industry output accounted for by the largest 5% of the firms (Fedderke and Naumann (2005: 2)).[20] They also go a step further by analysing the relationship between concentration and other dimensions of the economy, viz., real output growth, investment, employment, labour productivity, among others. In this respect, they differ with both Fourie and Smit (1989) and Leach (1992).

Both the Gini and the C5% indices point to high levels of concentration. Contrary to Leach (1992), they find that the trend in concentration (based on these two measures) has been upward over the period 1972 to 1996 in a wide range of industries (see Tables 6 and 7).

[Tables 6 and 7 about here]

Based on the Gini, only two sectors (Electrical machinery apparatus, appliances and supplies and Transport equipment) show a decrease in the Gini between 1972 and 1996. The same picture emerges when one considers the C5% index. In terms of the Rosenbluth index, the results are mixed. Just as in Leach (1992), the majority of the sectors (17 sectors) register a decrease in the Rosenbluth index between 1972 and 1996 while only seven sectors show an increase (see the discussion in Fedderke and Szalontai; pp 6-7). This seemingly contradictory evidence calls for parsimony in drawing conclusions and prescribing interventionist competition policies – more so since these three measures are, at best, crude measures of industry concentration in the sense of market power (more on this below).

Whereas Fedderke and Szalontai (2004) focus on the 1972 to 1996 period, Fedderke and Naumann (2005) primarily focus on the post–1996 period. Based on the C5% and the Gini indices, they find high and increasing industry concentration up to 1996 but find evidence of decreasing industry concentration post–1996 (see Tables 8, 9 and 10 below). For the period up to 1996, the Rosenbluth

[19] Bikker and Haaf (2002a) consider concentration to be high if the 3 largest banks control at least two thirds of the market ($CR_3 \geq 0.66$). For instance, Sweden (HHI=0.12, CR_3=0.53); Norway (HHI=0.12, CR_3=0.56) and Canada (HHI=0.14, CR_3=0.54) are considered to be moderately concentrated (pp. 24-25).

[20] However, the exact sense in which the word *"largest"* is used is not explained.

index again yields results that appear to conflict with those of the Gini. There is evidence of increasing concentration in 7 out of 23 sectors while concentration decreases in 16 sectors.[21] For a detailed discussion, see Section 5 in Fedderke and Naumann (2005).

Results for the post–1996 period are consistent across the three measures. In particular, the average and the weighted average changes in all the three indices show a decrease in concentration between 1996 and 2001. The unweighted C5% index rises from 56 percent in 1976 to 68 percent in 1996 and then falls to 54 percent in 2001. In terms of the Gini, only one sector (Paper and paper products) register a positive change in concentration between 1972 and 2001 while all sectors register a negative change (decrease in concentration) between 1996 and 2001. In terms of the Rosenbluth index, all sectors register a decrease in concentration (negative change) both between 1996 and 2001 and between 1972 and 2001. There appears to be a strong decrease in concentration across all sectors post–1996. This is the period associated with trade liberalisation of the South African economy (Edwards, 2005).

[Tables 8, 9 and 10 about here]

In summary, concentration in the South African manufacturing sector is found to be high and increasing up to 1996 and, going by the recent data (Fedderke and Naumann (2005)), the trend in concentration appears to be decreasing. This would seem to suggest that the liberalisation of the South African economy in the 1990s (Edwards and Van De Winkel (2005); Edwards (2006)) is paying off. However, caution is advised as this "apparent" decline in concentration post-1996 is potentially spurious.Two reasons can be advanced to explain such a "spurious"decline in concentration.

First, this apparent decline in concentration post–1996 could well just be an artifact of the data. The 2001 data is not collected in the same manner as the data for the period 1972 to 1996. For the period up to 1996, data is compiled from the census of manufacturing whereas post–1996, the data comes from the Large Sample Survey of the manufacturing sector. This, as pointed out earlier in Section III, raises the question of comparability (see also Fedderke and Naumann (2005)). Second, the high concentration reported above should not be cause for panic. As pointed out earlier, the indices used in the South African studies are in general, "second best" and in many cases,they appear to give conflicting results.Not surprisingly, the international literature has largely shied away from using these indices, preferring instead the concentration ratio (CR) and the HHI, which unfortunately have proved difficult to compute in the South African case.

In our view therefore, any conclusion to the effect that the manufacturing industry in South Africa is highly concentrated needs to be qualified. Although there certainly is evidence *suggestive* of high concentration, there is hardly conclusive evidence to this effect. Our position is informed by the following: First, as pointed out earlier, the Gini coefficient is not a measure of industry concentration (in so far as it relates to market power) but rather, a measure of inequality in the distribution of industry output.[22] Hence, conclusions on concentration based on the Gini coefficient (Fedderke and Szalontai (2004), Fedderke and Naumann (2005), Fourie and Smit (1989)) cannot be taken as "strong"evidence of high concentration in the South African manufacturing industry. All that this evidence (based on the Gini coefficient) tells us is that there is a great deal of inequality in the way output is distributed in the different industries: nothing more.

Second, evidence of "high"concentration based on the C5% index is very problematic. How is this index to be interpreted? To see the problem of interpretation associated with the C5% index, consider the following simple example:

Example 1 *Suppose we have three industries. Industries A, B and D with respectively 1000 firms, 100 firms and 20 firms. Suppose that in each of these industries, the "largest" 5% of the firms account for 50% of industry output. This means that inindustry A, fifty firms account for half the*

[21] Leach (1992) finds that the Rosenbluth index decreases for 18 out of 26 industries.

[22] Leach (1992: 387) argues strongly against the use of the Gini index as a measure of industry concentration. He lists a long list of scholars who have questioned its use as a measure of industry concentration (to which we can add Horvath (1972)). Indeed, the Gini index does not find its way into the leading texts in Industrial Economics, for instance, Tirole's (1988) textbook.

industry output (thus, on average, each firm accounts for only 1% of industry output), in industry B, five firms account for half the industry output (thus, on average, each firm accounts for only 10% of industry output), while in industry D only one firm accounts for half the industry output.

Can we say that these three industries are highly (and equally) concentrated? What, if anything, can we infer about market power in these three industries? Obviously, in general not much can be said in respect of the competitiveness of these industries. However, given the average size of the "large" firms in industries A and B, inference of high concentration and therefore high market power is clearly questionable.[23] However, in industry D, the large firm has a possibility to abuse its dominant position as it virtually controls half of the market and hence a concern about high concentration can be justified. Now, based on Leach (1992), the average number of firms in these industries is large.[24] From Leach (1992: Table 2, p. 393), the average number of firms per sector was 664 firms in 1985.[25]

Third, even if the Rosenbluth index correctly captured industry concentration, evidence of high concentration based on the Rosenbluth index (Leach (1992); Fedderke and Szalontai (2004) and Fedderke and Naumann (2005)) is still tenuous. The above studies all find very low values for the Rosenbluth index. Leach (1992) finds average Rosenbluth indices of 0.033 for 1972 and 0.028 for the year 1985 while Fedderke and Szalontai (2004) and Fedderke and Naumann (2005) find Rosenbluth indices between 0.0051 and 0.03 for the period 1972 to 2001). Going by the US Department of Justice's interpretation/categorisation (seediscussion in Section II),these low values of R are to be interpreted as evidence that the manufacturing industry in South Africa is competitive and thus *not* a major cause for concern. Thus, the increase in inequality of firms (Leach (1992: 390); Fedderke and Szalontai (2004) and Fedderke and Naumann (2005)) and the increase in the C5% index (Fedderke and Szalontai (2004) and Fedderke and Naumann (2005)) have not in any way reduced the competitiveness of the South African manufacturing industry as the Rosenbluth index has remained under 10% since 1972.[26]

In summary, no conclusive evidence has been put forward yet to the effect that the South African manufacturing sector is highly concentrated – at least not in the sense of competitiveness. Thus while the evidence advanced is useful and can thus serve as "stylised facts", pronouncements to the effect that industry concentration is high in South Africa require qualification. Studies surveyed here do not shed much light on the issue of concentration – at least in the sense of competitiveness of the sectors concerned. Thus more focused work is needed before any such pronouncements can be taken as irrefutable.

4.2 Concentration - productivity debate

From a competition policy perspective, industry concentration and the associated market power are issues of concern primarily because inefficiencies and price gouging lower consumer welfare. However, the implications of anticompetitive market structures are much broader than consumer

[23] Yet another problem with this index is that although the average C5% index increased between 1972 and 1996 from 56% to 68% suggesting an increase in average concentration, the number of firms contributing to this output increased from 29 firms in 1976 to 50 firms in 1996 (Table 6 above). It is difficult to conclude based on this information that concentration increased between 1972 and 1996. If anything, this points to decreasing concentration (each of the C5% firms account for a smaller share of output in 1996 than in 1976). But then, this also brings into question the asserted "consistency" (Fedderke and Naumann (2005: 6)) between the Gini and the C5% results

[24] 26 industries in Leach (1992) and 24 industries in Fedderke and Szalontai (2004) and Fedderke and Naumann (2005).

[25] Fabricated metal sector had the largest number of firms in 1985 (2865 firms) while the Glass sector had the smallest number of firms (49 firms). Clearly therefore, the issue of the interpretation of the C5% index is critical.

[26] Fourie (1996: 102) argues that, for a Gini value of about 0.6-0.8 and the smallest 3-digit industry having about 30 firms, one generally gets a maximum value of the Rosenbluth not exceeding 0.20 (as opposed to the theoretical upper bound of unity). Notwithstanding that, in our view, a value of 0.03 is still "low" to make inferences of high concentration even if the maximum is 0.20. Even more, the HHI also gives low values consistent with competitive to moderately concentrated markets.

welfare. There are debates on the concentration-productivity front, concentration-employment front, concentration-investment front, among others. Below we survey some studies (both local and international) dealing with these issues.

There are a number of studies that examine the relationship between concentration and productivity. This is an important subject as the highly productive economies tend to grow faster than countries with lower productivity. This is especially important in the South African context where the government has adopted the ASGI-SA (Accelerated and Shared Growth Initiative of South Africa) programme to try and improve the living standard of the average South African through economic growth. If concentration enhances productivity, then, given the "high" levels of concentration reported above, South Africa is poised for accelerated growth and the objective of policy should be to preserve industry concentration. On the other hand, if concentration has a detrimental effect on productivity, then South Africa has a reason to worry and the objective of policy should be to promote entry of new firms and to foster competition. In this instance, the noted decrease in concentration in the most recent time period (Fedderke and Naumann (2005)) would be welcome (if it is real, rather than an artifact of the data).

International studies of the relationship between concentration and productivity have had mixed findings: some find a small positive effect while others find no effect at all. In their study of the relation between concentration and productivity changes in the short and long-run for the U.S. manufacturing sector, Greer and Rhoades (1976) find that concentration enhances productivity in the long-run. They conclude that "growth in output and the degree of concentration are the primary determinants of long-run productivity change"(p.1033).[27]The effect of concentration however is small. They also find evidence indicating that capital-intensive industries have higher productivity changes than other industries (p. 1034). This is consistent with other studies that find that, over the long-run, productivity rises faster in more concentrated industries so that "unit labour costs rise less rapidly in more concentrated than in less concentrated industries"(see Greer and Rhoades(1976:1031)).On the contrary, Sveikauskas and Sveikauskas (1982) find no evidence of a positive or negative effect of concentration on productivity growth for the U.S. They conclude that "R&D is the only influence which consistently has a positive influence on productivity growth under all circumstances" (p. 773). Ward (1987) differs from the majority of the other studies in that he studies only one industry – the U.S. meatpacking industry. Like Sveikauskas and Sveikauskas (1982), he finds no significant positive or negative relationship and thus he concludes that "..empirical results reported here for a single industry conflict with those of previous interindustry studies" (p. 221).[28]

For South Africa, only a few studies consider the relation between concentration and productivity in the manufacturing sector. Fedderke and Szalontai (2004) examine this relationship for the manufacturing sector in South Africa, using the Gini and the Rosenbluth indices as measures of concentration. They find that increased concentration is detrimental to output growth in the South African manufacturing sector, lowers labour productivity and raises unit labour costs. Fedderke and Naumann (2005) explore this issue further and their findings appear to corroborate the earlier findings of Fedderke and Szalontai (2004).

Aghion *et al* (2007)) directly examine the effect of competition on productivity growth in South Africa. They employ three data sets, namely, the industry level UNIDO panel data for South Africa, firm level Worldscope data for publicly-listed companies and the TIPS (Trade and Industrial Policy Strategies) industry level panel data (see Aghion *et al* (2007: 5-6). The paper starts with a theoretical exposition that explains the channel by which competition is expected to affect productivity growth. They isolate two effects: the *Schumpeterian effect* and the *escape competition effect*. The

[27]The positive effect is explained by the fact that higher industry concentration allows firms to be larger which allows the firms to capitalise on economies of scale. This results in reduced production costs and increased efficiency (Ward (1987: 220)).

[28]Recent literature however generally finds a positive effect of product market competition on productivity growth (Nickell (1996), Blundell *et al* (1999), Aghion *et al* (2005) among others). We hasten to point out however that product market competition and market concentration are not mutually exclusive. Hence these studies do not speak directly to the relationship between concentration and productivity.

Schumpeterian effect occurs where an increase in product market competition reduces the rents from innovation. Because competition reduces the rents from innovation, it reduces the firms' incentives to innovate.Consequently, productivity growth falls (*ibid*: 3). This is the case for firms immediately below the technology frontier. The escape competition effect, on the other hand, occurs when firms are "forced" to innovate so as to maintain the technological gap between themselves and their nearby competitors. Firms at the technology frontier realise that if they do not invest and innovate, firms immediately below them will catch up – causing the former leaders to lose their monopoly rents. Hence, the leaders have an incentive to innovate in order to escape competition. Because firms invest in R&D and innovate, this raises productivity growth.

Using the three data sets, they examine the relationship between a measure of productivity growth and the price-cost margin. Aghion *et al* (2007) estimate the following equation:

$$Pgrowth_{it} = \alpha + \beta PCM_{it} + I_i + I_t + \varepsilon_{it},$$

where $Pgrowth$ is a measure of productivity growth, PCM is a measure of industry competitiveness, I_i and I_t are industry and year fixed effects and ε_{it} is the random error term for industry i.

The results indicate a strong positive effect of product market competition on productivity growth. In particular, the results show a negative impact of the price-cost margin (an inverse measure of product market competition) on productivity growth (*ibid*: 10-15). See also their Tables 13-18 and Figures 2 and 3 below.[29] A similar finding is reported in Zitzewitz (2003). In his study of the US and UK tobacco industries, he finds a positive correlation between product market competition and productivity. In particular, he concludes that the breakup of American Tobacco in 1911 and the resulting competitive environment led to greater technological progress and higher labour productivity in the USA – allowing the US tobacco productivity to overtake the UK productivity in the same sector.

[Figures 2 and 3 about here]

In summary, the evidence on the relationship between concentration and productivity is a mixed bag. Some studies find a negative relationship while other studies find a positive association. The implications of the South African findings, if the results are to be believed, are immediate. Increased concentration does not seem to raise the efficiency of production (Fedderke and Szalontai (2004); Aghion *et al* (2007, 2008)). These findings carry implications for competition policy. First, mergers, to the extent that they increase concentration, should be closely scrutinised. Second, since high markups lower productivity growth, entry by new firms into the concentrated industries and import penetration into such markets ought to be encouraged so as to ensure the market is contestable. That is, entry barriers need to be lowered and import tariffs reduced.

The results for South Africa reported above are important, but we advice caution in interpretation for at least two reasons: First, as discussed above, the totality of the evidence on the relationship between concentration and productivity is mixed and thus inconclusive. For instance, whereas Zitzewitz (2003) finds a positive correlation between product market competition and productivity in the U.S and U.K tobacco industries, Hannah (2004) finds the opposite (at least for the period before the First World War). He finds that if the sample of countries is expanded beyond these two countries (U.S. and U.K.), a positive correlation emerges (p. 13). He hence concludes: there is thus evidence that "monopoly sometimes encourages investment in innovation" (p.14).

Second, it appears the productivity growth equation employed by Aghion *et al* (2007) is somewhat misspecified. There is potential endogeneity between price-cost margins and productivity growth: both could be determined by other factors, e.g., R&D. Observe that R&D can potentially increase both labour productivity and price-cost margins (R&D lowers costs).[30] Alternatively, high price-cost

[29] It is important to point out that all the three data sets are consistent in finding that higher markups are associated with lower productivity growth. They also find that the economic magnitude of the effect is quite large. "In particular, a ten percent reduction in SA markups would increase productivity growth in SA by 2 to 2.5% per year" (Aghion *et al* (2007: 1)).

[30] Time and industry fixed effects cannot adequately capture R&D.

margins, by increasing profitability and hence investment, may lead to higher productivity growth. Such endogeneity/simultaneity, if present, may lead to biased estimates of the parameters and hence wrong inferences.[31]

4.3 Concentration and investment

Many scholars see investment as the engine of economic growth. Generally, the more investment the economy can generate, the more productive that economy will be. In fact, "low investment levels have often been identified as a key factor in explaining suboptimal growth rates for the South African economy" (Fedderke and Naumann (2004: 18)). Given this importance of investment for economic growth, and the objectives of government policy through ASGI-SA, it is imperative that we understand the relationship, if any, between concentration and investment. Does concentration promote or hurt investment in South Africa?

Using both the bivariate and multivariate analyses, Fedderke and Szalontai (2004) find no conclusive evidence of the effect of concentration on investment in the South African manufacturing sector. Both the Gini and the Rosenbluth are significant when controlling for the two indices both individually and jointly. However, the coefficients carry opposite signs (see Table 11). Whereas the Rosenbluth is consistently negative suggesting a negative effect of concentration on investment in the South African manufacturing sector, the Gini is consistently positive suggesting that increased concentration (inequality of firm size distribution) is good for investment (see Fedderke and Szalontai (2004: 21-22)).[32] In light of new data (release of the Large Sample Survey of the manufacturing sector in 2001), Fedderke and Naumann (2005) examine the relationship between concentration and investment for 23 manufacturing sectors. They find evidence pointing to a negative relationship. The coefficient of the Gini is negative but insignificant while the coefficient of the Rosenbluth is negative and significant (Table 12). The implication is thus that concentration is harmful to investment in South Africa (Fedderke and Naumann (2005: 24)).

[Tables 11 and 12 about here]

We have a few comments with regard to this evidence. First, although the evidence points to a harmful effect of concentration on investment in South Africa, we do not think the evidence is conclusive, especially in light of the findings of Fedderke and Szalontai (2004) and also given that some of the coefficients in Fedderke and Naumann (2005) are insignificant.[33] Second, an important argument which calls for parsimony in interpretation of the results is that it is not clear to what extent the "concentration" indices employed in the South African studies reflect the *actual* concentration in the South African manufacturing sector. As pointed out earlier, the Gini and the Rosenbluth are not generally regarded as good measures of industry concentration. Third, as discussed in Section III, the recent data from the 'Large Sample Survey'employed in Fedderke and Naumann (2005) is different in form to the earlier manufacturing sector census data employed in Fedderke and Szalontai (2004). This raises comparability issues and it is thus not clear to what extent this might have affected the results of Fedderke and Naumann (2005). It is our view therefore that the issue of the relationship between concentration and investment in the South African context is still not satisfactorily resolved and hence further research in this regard is needed.

[31] It is somewhat strange that while innovation and hence productivity is driven by investments in R&D in their theoretical model, Aghion *et al* (2007) do not include (omit) R&D in their empirical specification and estimation of the productivity growth equation.

[32] Fedderke and Szalontai (2004) point out that the apparent divergence between the Gini and the Rosenbluth needs to be contextualised. An increase in the inequality of the size distribution of firms raises the Gini while an increase in the number of firms lowers the Rosenbluth index. Since both these effects have been taking place over the sample period, a divergence between the Gini and the Rosenbluth can be expected (pp. 21-22).

[33] Fedderke and Naumann (2005) do not provide intuition or explain why the Gini coefficient should change sign when they add one more data point. Is this an artefact of the data or could this be an economically meaningful result? An explanation is clearly needed given the argument proffered by Fedderke and Szalontai (2004) justifying the different signs for the Gini and the Rosenbluth (see footnote 33 above).

4.4 Concentration – employment nexus

In investigating the causal relationship between concentration and employment, Fedderke and Szalontai (2004) find no conclusive evidence when considering the bivariate associations. However, further examination (using multivariate analyses) shows that increased concentration lowers employment in South African manufacturing industry.[34] The Gini and the Rosenbluth indices both have negative coefficients, "though only the Rosenbluth proves statistically significant" (Fedderke and Szalontai: 20).When controlling for the two concentration measures individually, the coefficients are respectively -0.03 and -0.27 for the Gini and Rosenbluth indices. When jointly controlling for the two indices, the coefficients are respectively -0.07 and -0.10 for the Gini and the Rosenbluth indices.[35] Fedderke and Szalontai (2004) also show that the effect of concentration on employment is non-linear and is also affected by the number of firms. In particular, the higher the level of concentration, the greater the (negative) effect of a further increase in concentration on employment and, for any given level of concentration (Gini), a small increase in concentration will have a greater negative effect on employment the smaller is the number of firms in the industry (p. 20) (see Figure 4 and Table 11).

[Figure 4 about here]

Further support for this negative association is provided by Fedderke and Naumann (2005). They find that higher industry concentration is negatively associated with both employment and employment growth. Based on the Rosenbluth index, the coefficient on employment is negative for all the census years while the coefficient of employment growth is negative in all but two census years (1985 and 1988). In terms of the Gini however, the picture is more blurred. The coefficient for employment is positive for 7 census years and negative for the last three census years (1993, 1996 and 2001). In terms of employment growth, the coefficient is positive for 6 census years and negative for 4 census years. This suggests that the Gini (inequality of firm size) is positively associated with both employment and employment growth.[36] Although the evidence is mixed, the indication is thus that highly concentrated sectors are "more likely to exhibit lower levels of employment"(Fedderke and Naumann(2005: 17)).[37]

In their investigation of labour market flexibility in South African manufacturing, Fedderke and Hill (2006) find that about two thirds of labour employed in South African manufacturing is devoted to fixed costs while only a third of the labour is devoted to variable costs (aggregate labour adjustment coefficient for the manufacturing sector of between 2.84 and 3.43 over the full sample period, see their Table 6). They also find that labour market flexibility increased in the 1970s and early 1980s but decreased in the 1990s (see their Table 7 and Figure 5 below). They find evidence supportive of the increased use of capital in place of labour during periods of increasing labour market inflexibility. That is, labour market inflexibility increases investment in capital – thereby raising the capital to labour ratio in manufacturing (increased mechanisation).[38] This relationship is summarised in Figure 5 below. Figure 5 plots the trend structure in labour flexibility and the true estimated elasticity of substitution between capital and labour over time.

[34] It is conceivable that what is captured here is the fact that large firms are more capital-intensive than small firms. That is, they have higher K/L ratios. However, this is not consistent with falling labour productivity as concentration increases.

[35] Given the magnitudes of the coefficients, the effect of concentration on employment appears to be quite small.

[36] It should also be noted that the coefficients for output and employment for all the census years are too small to be of any economic significance (see Fedderke and Naumann (2005): Table 7).

[37] A caveat is in order though. Fedderke and Szalontai (2004) and Fedderke and Naumann (2005) are largely descriptive in their approach. This is quite limiting. Where results are not as expected or where the different measures disagree, an intuitive explanation/justification of the results to be believed is indispensable – yet this is seldom done in the Fedderke and Szalontai (2004) and Fedderke and Naumann (2005) studies (see for instance Fedderke and Naumann (2005: 16-26)).

[38] An interesting question is whether those firms/industries that respond to increased labour market inflexibility by raising the capital/labour ratio would reverse this during periods of increased labour market flexibility. If not, then the negative employment effect of increased labour market inflexibility (as documented by Fedderke and Hill (2006)) would carry over into the future. This would paint a grim picture for employment growth prospects in South Africa.

The finding that an increase in labour market flexibility raises the capital to labour ratio accords well with intuition: capital and labour are in most cases substitutable, at least to some extent. This has important implications for employment – especially in a developing country context where there is abundance of unskilled and semi-skilled labour. The policy implication is thus that labour market flexibility is good for employment and therefore policies that enhance labour market flexibility (such as ease of hiring and firing) should be encouraged.

[Figure 5 about here]

In summary, studies that examine the relationship between concentration and employment in South Africa have consistently found the relationship to be negative: High concentration lowers employment. This finding is important for policy, especially given the high levels of unemployment in South Africa, namely, to address the unemployment problem in South Africa, it is necessary to first address the structure of industry.

5 Markup pricing in South African Manufacturing industry

The markup is defined as the ratio of price to marginal cost and is denoted by:

$$\mu = \frac{P}{MC},$$

where P is the price and MC is the marginal cost. Like the concentration indices, the markup is a measure of market power. Unlike the concentration indices however, the markup is more precise in that it measures the extent of (exercisable) market power. That is, it measures how much firms can raise prices above marginal costs. The markup is closely related to the Lerner index (price-cost margin). The Lerner index is given by:

$$\frac{P - MC}{P} = 1 - 1\mu,$$

where μ is as defined above. Under perfect competition $\mu = 1$while under monopoly or oligopoly with significant entry barriers the markups can be substantial ($\mu > 1$).

5.1 Extent of markups in South African manufacturing sector

Fedderke *et al* (2005) investigate the extent of markups in the South African manufacturing sector over the period 1970 to 1997. They find high markups for the South African manufacturing industry (see also Fedderke and Hill (2006)). A related study is Aghion *et al* (2007) who examine the relationship between competition and productivity growth in South Africa. They too find that markups in South African manufacturing are significantly higher than in corresponding industries worldwide.[39] Using three alternative data sets, they consistently find evidence of high and non-declining price-cost margins (Table 13). In particular, the average markup for the manufacturing sector over the full sample period is 54% (Aghion *et al* (2007: 9)). They also find that, measured in terms of Net income/Sales, Net income/Assets and Net income/Equity, South African listed firms exhibit around 50% higher profitability compared to their world counterparts (p. 8).

[Table 13 about here]

Fedderke *et al* (2005) find that: (i) Increasing within industry import penetration does not significantly lower markups (coefficient not statistically significant) but (ii) increasing between industry import penetration significantly lowers markups. The same is found for within and between industry export penetration (export penetration lowers markups with the larger effect being reserved for

[39] Fedderke *et al* (2005) find, using various model specifications, the local markups to be about twice those in comparable U.S. industries. Also, the high markups reported in Aghion *et al* (2007) and Fedderke *et al* (2005) have not been eroded by liberalisation of the South African trade regime (Aghion *et al* (2008: 12)). If anything, controlling for trade liberalisation appears to raise the pricing power of the South African manufacturing industries (*ibid*).

between industry export penetration). However, the authors do not give any intuition for the seemingly counterintuitive findings. For instance, it seems counterintuitive that import penetration of close substitutes (increase in within industry penetration) does not seem to lower industry markups while import penetration at the 3 digit manufacturing sector level lowers markups.

Fedderke *et al* (2005) also find that firms that become more cost competitive relative to their industry average face lower markups while firms that face improved cost conditions relative to the manufacturing sector average experience considerably greater markups of price over marginal cost. The first part of this finding appears to support the *efficiency hypothesis* of the structure conduct performance paradigm. According to this view, firms that become more cost competitive relative to their industry average will respond by lowering their prices – an action which may induce the exit of the less efficient firms leading to higher industry concentration (Bikker and Haaf (2002b: 23)). Among other findings, the authors (Fedderke et al, 2005) also note that rising concentration of industries serves to raise the markups, especially rising concentration between industries. However, within industry changes in concentration do not significantly affect markups. This appears to fit well with the general thinking in industrial organisation that there is no obvious causal relationship between industry concentration and markups. Markups are determined mainly by conduct and not market structure. See for instance Schmalensee (1989), Bresnahan (1989) and Ornstein (1975).[40]

The findings of Fedderke *et al* (2005) and Aghion *et al* (2007) reported above contrast sharply with those of Edwards and Van de Winkel (2005).[41] Edwards and Van De Winkel (2005), in their investigation of the effect of trade liberalisation on South African manufacturing sector markups, find low markups for the South African manufacturing industry. In particular, the levels of markups are different whether intermediate inputs are included or not. For instance, when intermediate inputs are excluded, Fedderke *et al* (2005) find the markups average between 72% and 79% while Edwards and Van De Winkel (2005) find the markups average about 42%. There also appears to be disagreement in respect of the comparability of the South African industry markups with other countries. Whereas Fedderke *et al* (2005) and Aghion *et al* (2007) conclude that South African markups are high relative to other countries, Edwards and Van De Winkel (2005) conclude that South African manufacturing industry markups fall at the lower end of the (13-25%) range of the average markups of comparator countries (p. 7).

Edwards and Van de Winkel (2005) ascribe the differences to the use of different estimators, the use of different estimates of the return to capital and to their use of a longer time horizon.[42] In our view however, different time horizons should not affect the results that much unless there are major structural changes in the manufacturing sector between 1998 and 2002. In the absence of such structural breaks, the likely explanation of the differences in the results is the use of different estimators. Unfortunately, Edwards and Van de Winkel (2005) neither explain the differences between their estimator and that of Fedderke *et al* (2005) nor the differences between their return to capital measure and that of Fedderke *et al* and as a result, it is not clear which results are to be believed and why they should be believed. It would have been useful had they justified their estimator, at the least.

The policy implications of these findings are as follows: First, trade liberalisation may serve to reduce markups. Trade liberalisation opens up the domestic market to import competition which, as Fedderke *et al* (2005) and Edwards and Van de Winkel (2005) argue, lowers markups. This is

[40] A simple example illustrates this point: Consider a duopoly market with equal but constant marginal cost in which firms compete a la Bertrand. Such an industry structure is highly concentrated yet also (in the absence of collusion) highly competitive.

[41] Du Plessis and Gilbert (2007) test for the robustness of the Aghion *et al* (2007) findings (that South African firms are more profitable than their world counterparts) wherein they controlled for survivorship bias. Comparing the profitability of the JSE listed South African firms and the Dow Jones listed American firms, Du Plessis and Gilbert find little support for Aghion et al's (2007) claim of greater profitability of South African listed firms. In particular, they report that "the median USA industrial firm has been more profitable than SA industrial firms 56% of the time over [the 1980-2006] period when looking at their operating margins" (p. 8).

[42] Whereas Fedderke *et al* (2005) study the period 1970 to 1997, Edwards and Van de Winkel study the period 1970 to 2002.

important as reduction in markups will have a positive effect on productivity growth in South Africa (Aghion *et al* (2007)). Second, competition policy can be used to increase industry competitiveness and thus reduce price-cost margins. Tough merger policies and the breaking or lowering of entry barriers are some of the policies at the disposal of competition authorities. Where concentration is not dictated to by the desire to enjoy economies of scale, divestiture can be instituted as a way to enhance competition. These policies may be necessary since anticompetitive pricing (high markups) may have negative growth implications by their curtailment of productive capacity (Fedderke *et al* (2005: 29); Aghion *et al* (2008)).

An issue that is, however, not addressed in the South African studies of industry concentration is that of industry (sectoral) concentration versus aggregate (whole manufacturing sector) industry concentration. Fedderke *et al* (several), Leach (1992), Edwards and Van de Winkel (2005), among others study industry concentration at the 3 digit manufacturing sector level. For policy purposes, focusing only on the aggregate concentration may mask other important industry characteristics and dynamics (Fourie (1996: 98)).[43] Indeed, in his study of concentration in the New Zealand manufacturing sector, Ratnayake (1999) finds a declining trend in the levels of concentration in New Zealand manufacturing industries (p. 1046) yet finds that aggregate concentration has actually increased over the same period (p. 1047) – a seemingly contradictory finding. For an explanation, see Ratnayake (1999).

5.2 Markups and the broader implications

In surveying the literature on the South African manufacturing industry structure and performance, we found two main results: (i) the South African manufacturing sector is characterised by "high"concentration and high markups and (ii), an increase in product market competition should have large positive effects on productivity growth in South Africa (Aghion *et al* (2007: 17). A natural question to ask then is: Should we be worried about the above findings?

The findings are to some extent disconcerting especially when it comes to growth and employment. However, the following have to be taken into consideration. First, the implied markups are excessive by international comparisons (Aghion *et al* (2007); Fedderke *et al* (2005)). Clearly therefore, if these high markups also reflect high profits, they are not sustainable in the long-run. There is bound to be entry of new players and increased import penetration – more so in the face of trade liberalisation. Indeed, Du Plessis and Gilbert (2007) do not find evidence pointing to the high profitability of South African listed firms relative to the U.S. listed firms.

Second, it could be that the high markups are justified by other industry or country specific characteristics – so that after controlling for these (*fixed effects*), the markups are internationally comparable. As we know from finance, high risk portfolios on average yield higher returns. However, once we control for the risk, the returns fall in line with those of the market portfolio. The same could be happening with the high markups in the South African manufacturing sector. As a developing economy, South Africa may be amenable to risks which are less pronounced or absent in the developed markets such as the U.S. market. For instance, exchange rate risk may be higher in South Africa mainly due to the volatility of commodity/resource markets.[44] Indeed, firm level (Worldscope) evidence from publicly listed companies appears to support this view. Although listed firms in South Africa appear to be more profitable than "world firms" when measured in terms of net income/sales,net income/assets and net income/equity, their margins, market to book ratios

[43] The 3-digit manufacturing sector is just too broad. There is a lot of heterogeneity in each sector (for instance, each sector can be further broken down into consumer and producer goods subsectors) and as such, factors like entry barriers, scale economies and advertising intensities that affect markups and profitability are difficult to incorporate in the analysis. As Ornstein (1975: 107) points out, "the method of aggregating from firm to industry-wide measures is crucial due to the biases it can introduce". The studies by Fedderke and Naumann (2005), Fedderke *et al* (2005) and Aghion *et al* (2007) fail to take into account the heterogeneity within sectors and thus "implicitly assume that all firms within a [sector] have the same margin which equals the [sector] margin" (*ibid*).

[44] See for instance Fedderke and Pillay (2007).

and price earnings ratios are markedly lower (Aghion *et al* (2007: 8)). In other words, based on fundamentals, South Africa's listed firms perform well below their world counterparts.As pointed out above, in the absence of specific risks, one would expect arbitrage to more or less equalise relative markups.

Third, on the curtailment of productive capacity, it is not obvious that high industry concentration is not amenable to investments and innovations (see for instance Tirole, (1988); Hannah (2004). It should be noted that, in general, there is no obvious relationship between concentration and competition. Even in concentrated industries, threats of entry constantly force market leaders to invest and innovate so as to remain the leader(s) (e.g., Microsoft). This is termed the "escape competition" effect (see Aghion *et al* (2007)).

Lastly, the price-cost margins computed by Aghion *et al* (2007: Table 3) are likely to be biased. The price-cost margins are computed as:

$$PCM1 = \frac{valueadded - totalwages}{sales}$$ [45]

This measure suffers from a number of flaws: First, "the price-cost margin so measured does not account for other expenditures such as advertising, R&D, taxes, depreciation, distribution expenses and components of overhead costs" (Ornstein (1975: 107)). Failure to account for these costs tends to overstate the price-cost margins. Second, labour often does have a fixed component and it appears this fixed component has not been identified.[46] This tends to understate the price-cost margins. It is not clear therefore which bias, if any, is driving the results reported in their Table 3. The markups could be under or overstated. Hence, the high markup findings should be interpreted with caution. Indeed, Du Plessis and Gilbert (2007) find no conclusive evidence that the South African firms are more profitable than their U.S. counterparts.[47] Du Plessis and Gilbert (2007) used firm level data corrected for survivorship bias for the period 1980 to 2006.[48]

6 Productive vs. Allocative efficiency

In the competition policy framework, high industry concentration and high markups are generally considered ills of a market economy which need to be addressed. The competition policy debates have tended to put a lot of weight on allocative efficiency, with the perfectly competitive market outcome regarded as the 'almost' ideal market structure. However, for small and developing economies, productive efficiency is just as important as allocative efficiency, if not more important. This is especially so in open economies, such as South Africa, where domestic producers face competition from imports. The small size of the domestic market means high concentration is necessary if firms are to realise economies of scale in production (Ratnayake (1999)). With fragmented production, average production costs will be higher as each firm's production capacity is far short of the minimum efficient scale (MES). This therefore raises the question: Is high industry concentration necessarily bad for the South African economy?

Concentration and high markups may be important for economic growth in small and developing economies. Whereas productive efficiency favors market concentration (firms have to be large to

[45] Aghion et al (2007) also employ the following measure of price cost margin: $PMC2 = (pY - wL - rK)/pY$,where Y, L and K are respectively the output, labour and capital measured at the sector level. This measure also suffers from the same weaknesses as $PMC1$.

[46] Fedderke and Hill (2006) find that about two thirds of labour employed in South African manufacturing is devoted to fixed costs while only a third of the labour is devoted to variable costs.

[47] Du Plessis and Gilbert also point out that the Aghion et al (2007) findings of high marks-up in the South African manufacturing industry may suffer from survivorship bias as Aghion et al (2007) do not discuss their sample selection procedure.

[48] Du Plessis and Gilbert only compare the South African firms to the U.S. firms while Aghion et al (2007) compare South African listed firms to listed firms in 60 countries.

reap scale economies), allocative efficiency favours market fragmentation (Fedderke and Simbanegavi (2007)).[49] This is because a fragmented industry (especially in a small market) faces high production costs and hence low profits (other things being equal) – which does not augur well for growth (retained profits are an important source of investment funds (Von Ungern-Sternberg (1980)). Also, at a global level (as shown in the survey of the concentration-productivity debates), the evidence on the relationship between concentration and productivity is inconclusive. Some studies find that higher concentration promotes productivity while others (for instance Fedderke and Szalontai (2004)) find evidence of a negative causal relationship.

Insisting on allocative efficiency as the objective of competition policy in the face of small markets also renders local firms less competitive internationally (high production costs). This tends to reduce export competitiveness (export penetration) and increase import penetration. This obviously doesn't augur well for employment retention and creation.

In summary, in addition to investigating the trends in industry concentration and the attendant markups, it is also important to investigate the determinants of industry concentration. Knowing the causes of industry concentration has important implications for competition policy. For instance, in the New Zealand economy, economies of scale have been found to be the major determinant of industry concentration (Ratnayake (1999)). This, as Ratnayake points out, may explain New Zealand's relatively lenient antitrust policies, especially towards mergers. These determinants have, to our knowledge, not been investigated in the South African industry.

7 Trade liberalisation and industry structure

7.1 Debate on the extent of trade liberalisation in South Africa

Fedderke and Vaze (2001) examine the extent to which South Africa's trade regime has opened up since the implementation of trade liberalisation measures (i.e., during the course of the 1990s). They consider 38 sectors of the South African economy. They find that the hype about "significant trade liberalisation" is not borne out by the data. In particular, in terms of the effective rates of protection (ERP), trade liberalisation has had a limited effect on effective protection of South African industries. South African industries are still heavily protected. In some industries, protection appears to have increased (Fedderke and Vaze (2001)).[50] Fedderke and Vaze qualify their findings by pointing out that ERP may not be a good measure of the extent of trade liberalisation in the context of South Africa's trade regime (p. 471).[51]

Rangasamy and Harmse (2003) challenge the findings of Fedderke and Vaze (2001), in particular, their conclusion that protection appears to have increased over the period under study. They point out a number of possible shortcomings with the Fedderke-Vaze approach which could have biased their findings, for instance, the fact that not all sectors were accounted for in the Fedderke-Vaze study. Rangasamy and Harmse reach a different conclusion: "less of South Africa's output enjoyed protection in 2001 (or even in 1998) than in 1988" (p. 718). Put differently, they conclude that, based on ERP analysis, tariff protection has largely decreased. That is, trade liberalisation has successfully taken place but whether it could have occurred at a faster pace remains an open question (ibid: 721). Fedderke and Vaze (2004), in their response to Rangasamy and Harmse, note that their main finding of the original study, that more of South Africa's output is protected in 1998 than in 1988, is in principle actually confirmed by the Rangasamy and Harmse study (Fedderke and Vaze (2004; 411)).

[49] However, note that market concentration and allocative efficiency are not mutually exclusive. The Bertrand case provides an example.

[50] This finding is in line with the findings of Fedderke et al (2005) and Aghion et al (2007) of high markups in South African manufacturing sectors. As Fedderke and Vaze (2001) point out, ERP measures the shelter that a sector has from international prices and is thus a proxy for excess returns a sector can realise due to protective trade (p. 437).

[51] This is because a significant feature of SA's trade liberalisation has been the movement from quantitative restrictions (quotas) to tariff lines. In this case, effective protections rates may understate the extent of trade liberalisation (Fedderke and Vaze (2001: 471)).

Given the seemingly different positions taken by Fedderke and Vaze (2001, 2004) on the one hand, and Rangasamy and Harmse (2003) on the other, Edwards (2005) re-evaluates the extent to which South Africa has liberalised its trade since the late 1980s. He finds that significant progress has been made in terms of reducing tariff protection. In particular, between 1994 and 2004, the "effective protection in manufacturing fell from 48% to 12.7%" (p. 774).[52] Moreover, the pace at which liberalisation has taken place is in line with the pace in other lower-middle income countries. Edwards's findings appear to support the conclusion of Fedderke and Vaze (2001, 2004) that liberalisation has been incomplete. In particular, Edwards notes that further progress (in the simplification of tariff structures and reduction of protection) can be made since effective protection still remain high in some sectors.[53]

7.2 Trade liberalisation and markups

Edwards and Van De Winkel (2005) investigate the effect of trade liberalisation on South African manufacturing sector markups. They employ data for the period 1970-2002. Their findings largely disagree with those of Fedderke et al (2005). More precisely, compared to Fedderke et al (2005) and Aghion et al (2007), Edwards and Van De Winkel (2005) find substantially lower markups for the South African manufacturing sector (see their Table 1). Even more, markups in the South African manufacturing sector are low by international standards (see their Figure 2).

Edwards and Van De Winkel also consider the effects of tariff reduction and increased import penetration on markups. They find that trade liberalisation serves to lower markups. In particular, "a 1% reduction in tariffs during the second period (1995-2002) reduced markups in manufacturing by approximately 2 percentage points" (p. 8). This finding accords well with intuition. This finding is further supported by their examination of the effects of increased import penetration on markups.[54]

By reducing tariffs and other impediments to international trade, trade liberalisation should raise the volume of imports coming into South Africa. As the supply increases, competition should intensify so that the average prices and hence the markups should decline. One potential effect of trade liberalisation is the lowering of industry concentration as domestic firms cede part of their market shares to imports.[55] This effectively lowers the markups. However, even if concentration does not fall, trade liberalisation increases the contestability of the domestic markets to import competition and this works to discipline domestic producers.[56]

As we pointed out earlier, one of the goals of government economic policy in South Africa is to reduce/eradicate poverty. The favoured way to achieve this goal is to grow the economy at a faster pace whilst ensuring that the benefits of growth filter down to the poor. This has been summarised in the acronym: ASGI-SA which stands for Accelerated and Shared Growth Initiative of South Africa. Trade liberalisation may benefit consumers in at least two ways: First, increased import competition forces the domestic firms to reduce margins – thereby benefiting consumers in the form of lower prices (Edwards, 2005: 1). Second, trade liberalisation can provide consumers the benefit of increased product variety. Thurlow (2006) investigates the relation between trade liberalisation and pro-poor growth in South Africa. Using simulations, he finds that trade liberalisation has positively affected economic growth in South Africa. There has been increased investment and it has facilitated

[52] These percentages are unweighted averages. Fedderke and Vaze (2001) use Gross Domestic Product (GDP) weighted ERPs.

[53] Ibid.

[54] Fedderke et al (2005: 21) already noted this.

[55] Edwards and Van De Winkel (2005: 1) point out that imports as a share of domestic expenditure has risen from 17% to 28% between 1990 and 2000. This shows a substantial increase in import penetration. They also note the substantial increase in export penetration.

[56] It is not obvious though that increased import penetration is procompetitive. It is not uncommon that importers and domestic producers collude and thus artificially maintain high prices. Thus, to fully realise the disciplining effect of trade liberalisation, vigilance on the part of the Competition Commission is indispensable.

productivity enhancing technological change in the manufacturing sector (p. 14). Although the poor appear to have disproportionately carried the negative effects of trade liberalisation, they have not been made worse. If anything, trade liberalisation has prevented many households from falling into poverty (ibid).

8 Implications for competition policy in South Africa

What does the totality of evidence in respect of the South African manufacturing sector tell us? The various studies of the South African manufacturing sector can be summarised as follows: The manufacturing sector in South Africa is characterised by "high" industrial concentration (as measured by the Gini and Rosenbluth Indices) and "high" marks-ups relative to comparable industries elsewhere. High markups and high concentration appear to carry negative implications for investment,[57] productivity growth, employment and GDP growth for South Africa.

Although the South African studies surveyed in this paper are useful in formulating broad policy positions, they are of limited use in the formulation of precise competition policy for a number of reasons. First, studies of the manufacturing sector as a whole (3 digit SIC) are not precise enough for policy purposes as they would call for a "one size fits all" remedy. Each industry/sector is likely to exhibit significant intra-industry heterogeneity yet this heterogeneity within an industry may get subsumed in the inter-industry (aggregate) treatments. For instance, the panel studies of the 3 digit manufacturing sector are silent on the definition of the *relevant market* or the *conduct of firms* in a particular market. These are crucial for determining the extent to which firms in a given market are exercising market power and hence to the formulation of the appropriate remedy.

Second, it is important to take cognisance of the limitations of industry concentration as a measure of market power. Concentration is a very crude measure of market power. As such, other market information such as entry barriers, price controls, other trade restrictions, etc., should also be taken into consideration. Such detail is not found in the aggregate manufacturing industry studies surveyed in this paper. This detail is very important. For instance, although the Plastic products sector shows high concentration (see Table 3 above), Fedderke and Simbanegavi (2007), in their study of pricing power in the polymer market (a sub-market of the Plastic products sector) in South Africa, find no evidence of the exercise of market power by the dominant firms (virtually a duopoly) in this market. On the contrary, the evidence in the polymer market points to a highly contested market.[58]

Third, due to data limitations, the literature on industry concentration in South Africa has more or less exclusively relied on the Gini coefficient and the Rosenbluth index as measures of industry concentration. These measures, it should be noted, are not very good measures of industrial concentration (at least in the sense of market power) and as such, they have not found wide application in the international literature (see discussion in Section II). In particular, the Gini coefficient is not a measure of industry concentration but rather a measure of inequality in firm size distribution (Leach (1992); Horvath (1972)). Given these shortcomings of the measures employed to examine industrial concentration in South Africa, we urge caution in the interpretation of the results as well as parsimony when it comes to generalisations.

Fourth, the research on concentration in the South African manufacturing sector has not addressed the question of *the major sources of industry concentration in the South African manufacturing sector.* This question has policy implications. For instance, in a study of industry concentration in New Zealand, Ratnayake (1999), fingers economies of scale as the major source of industry concentration. He argues that this might explain the New Zealand Commerce Commission's lenient policy towards mergers.

[57] Fedderke and Szalontai's (2004) results are mixed while Fedderke and Naumann (2005) find a negative effect of concentration on investment. However, Aghion et al (2007) are supportive of Fedderke and Naumann (2005). They find a strong and negative effect of high markups on productivity growth in South Africa.

[58] This point to the importance of firm level data to complement industry studies.

Fifth, the evidence on manufacturing sector markups in South Africa is mixed. Whereas Fedderke *et al* (2005) and Aghion *et al* (2007) find high markups, Edwards and Van de Winkel (2005) find low markups. Thus, although available evidence appear to favour "high" markups, parsimony is preferred in the interim and more research is required in order to shed more light on this issue (see also Du Plessis and Gilbert (2007, 2008)).

In conclusion, we note that the foundation has been laid by the inter-industry studies of the South African manufacturing sector. The evidence that has been put forward based on these inter-industry studies should be viewed largely as 'stylised facts' as there may be significant unobserved intra-industry heterogeneity. As such, to get more precise evidence in respect of the competitiveness (or otherwise) of the South African manufacturing sector, it is imperative that research should now focus on detailed studies of single industries (intra-industry studies) if policy is to address the specific shortcomings of the particular industries as far as competition and competitiveness are concerned. However, as pointed out earlier, a major obstacle in this regard is the dearth of quality firm level and market level data. Data ought to be availed more frequently if analyses and policy prescriptions are to be reasonably precise.

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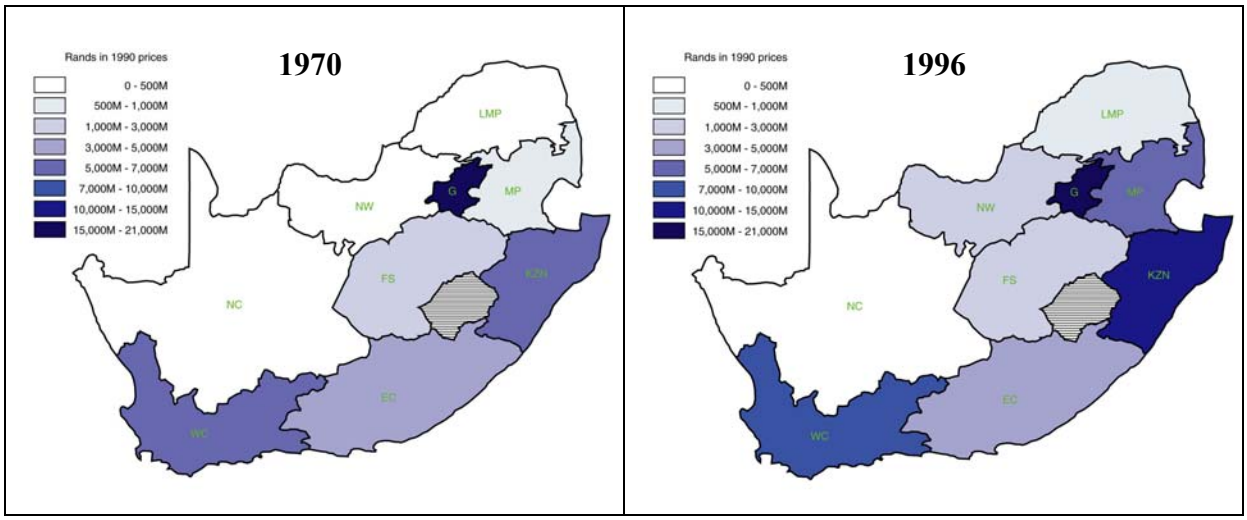
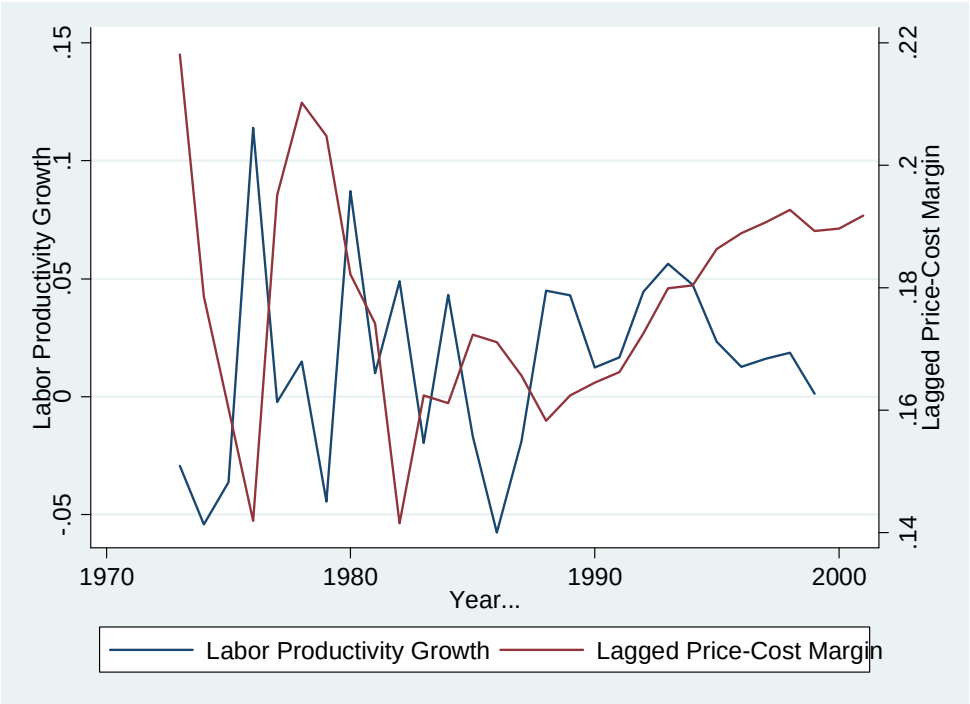
Tables and Figures

Figure 1: Total manufacturing value added by province



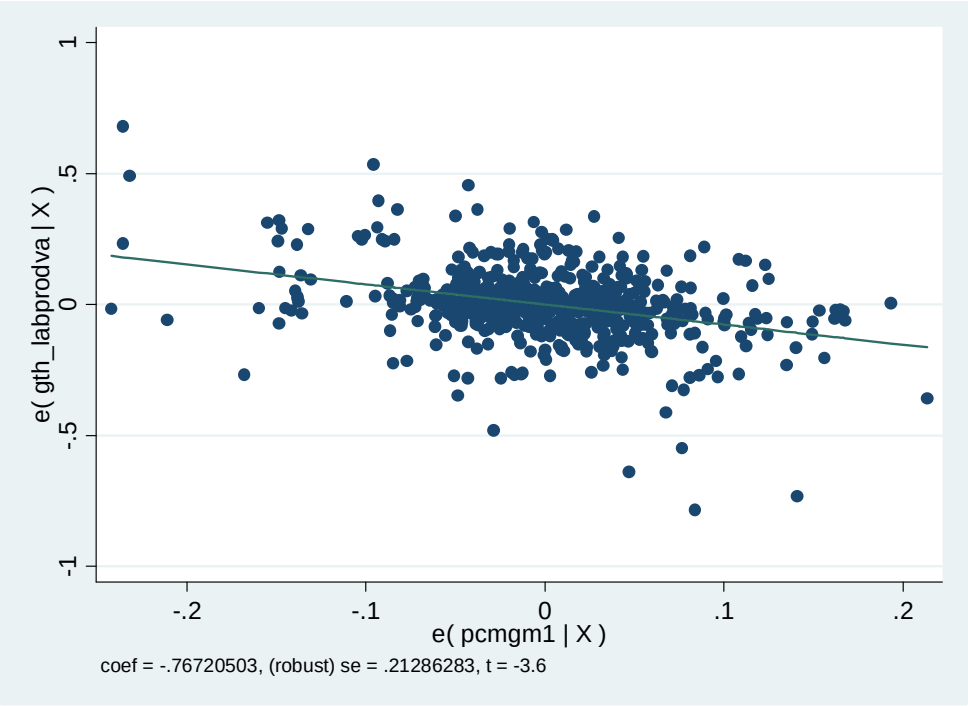
Notes: Our data exclude the former TVBC states. LMP=Limpopo; NW=North-West; G=Gauteng; MP=Mpumalanga; NC=Northern Cape; FS=Free State; KZN=KwaZulu-Natal; WC=Western Cape; EC=Eastern Cape.
Source: Fedderke and Wollnik (2007).

Figure 2: Margins and Growth in South Africa: Aggregate Industry Data



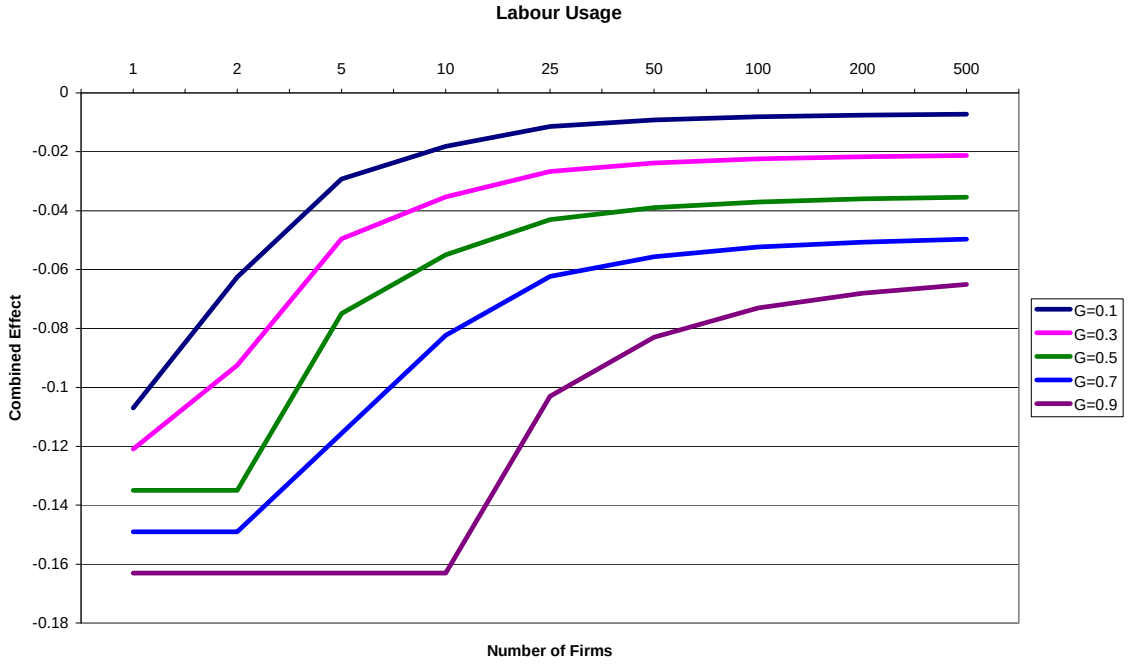
Source: Aghion et al (2007).

Figure 3: Margins and Growth in South Africa: Disaggregated Industry Data



Source: Aghion et al (2007).

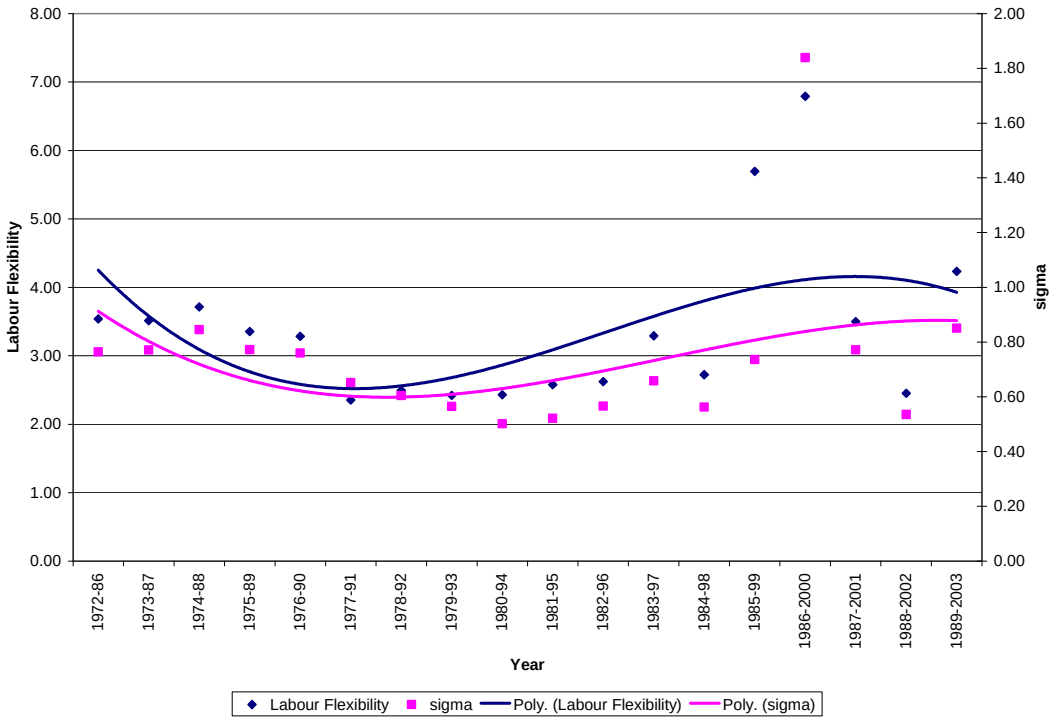
Figure 4: Combined Impact of Concentration on Labour Usage.



Notes: Lines denote the total impact of a 1% increase in the Gini concentration measure at the specified alternate magnitudes (0.1 - 0.9) of the Gini concentration measure. The X-axis specifies alternative numbers of firms present in the market. The Y-axis measures the % change in employment that issues from the 1% change in the Gini concentration measure.[1]
Source: Fedderke and Szalontai (2004).

[1] Note that the truncation to the decrease in the G=0.5, G=0.7 and G=0.9 cases arises due to the fact that the Rosenbluth index is bounded by unity.

Figure 5: Trend Structure in Labour Flexibility and the Elasticity of Substitution between Capital and Labour over Time



Source: Fedderke and Hill (2006).

Table 1: Four Hypothetical Market Structures

I	0.8	0.1	0.1					
II	0.8	0.1	0.05	0.01	0.01	0.01	0.01	0.01
III	0.35	0.35	0.3					
IV	0.35	0.35	0.15	0.15				

Source: Marfels (1971).

Table 2: Concentration in Four Hypothetical Distributions

Measure	*I*	*II*	*III*	*IV*
HHI	0.6600	0.6530	0.3350	0.2900
R	0.6250	0.5263	0.3448	0.3125
G	0.4667	0.7625	0.0333	0.2000

Source: Marfels (1971).

Table 3: Summary of Theoretical Priors and Empirical South African Findings

		HCAP	LAB	TD	SCALE	LINKS
Heckscher-Ohlin	prior actual	>0 +0.09	>0 -0.02			
Ricardian	prior actual			>0 +0.06		
New Trade	prior actual				>0 +0.19	
Economic Geography	prior actual	>0 +0.09			>0 +0.19	>0 -0.63

Note: Figures report elasticities.
Source: Fedderke and Wollnik (2007)

Table 4. Average 3-digit Levels of Concentration 1972-1988

Variable	*1972*	*1982*	*1985*	*1988*
CR_3	**0.3417**	**0.3867**	**0.3517**	**0.3667**
HHI		**0.0966**	**0.0916**	**0.1009**
Horvath	**0.2431**	**0.2597**	**0.2460**	**0.2639**
Rosenbluth	**0.0622**	**0.0591**	**0.0597**	**0.0591**
Gini	**0.7819**	**0.8244**	**0.8209**	**0.8438**

Source: Fourie (1996).

Table 5. Average 5-digit Levels of Concentration 1972-1988

Variable	*1972*	*1982*	*1985*	*1988*
CR_3	**0.5651**	**0.5574**	**0.5711**	**0.5747**
HHI		**0.1883**	**0.2020**	**0.1917**
Horvath	**0.4054**	**0.4048**	**0.4157**	**0.4110**
Rosenbluth		**0.1484**	**0.1613**	**0.1550**
Gini		**0.6952**	**0.6967**	**0.7139**

Source: Fourie (1996).

Table 6. Gini Coefficients: Levels and rankings

Low rank indicates high concentration	**1972**	**1980**	**1990**	**1996**	**Change 1972-96**	**Rank 1972**	**Rank 1980**	**Rank 1990**	**Rank 1996**	**Δ rank 1972-1996**
Food and food products	0.8180	0.8701	0.9028	0.8843	0.0663	7	6	2	5	-2
Beverages	0.8480	0.7834	0.8856	0.8778	0.0298	4	20	5	7	3
Textiles	0.7610	0.8297	0.8555	0.7616	0.0006	18	13	12	24	6
Clothing, except footwear	0.7850	0.8003	0.8109	0.8023	0.0173	13	17	20	18	5
Leather and products from leather	0.6670	0.7562	0.8143	0.8669	0.1999	24	22	18	10	-14
Footwear	0.7040	0.6974	0.7867	0.7713	0.0673	22	24	24	23	1
Wood and wood and cork products	0.7110	0.8030	0.8380	0.8031	0.0921	21	16	14	17	-4
Furniture	0.7570	0.7696	0.7890	0.7905	0.0335	19	21	23	21	2
Paper and paper products	0.7520	0.8031	0.8864	0.8893	0.1373	20	15	4	4	-16
Printing, publishing and allied industries	0.7860	0.7963	0.8288	0.8354	0.0494	11	18	16	15	4
Basic chemicals	0.8150	0.8682	0.8552	0.8786	0.0636	9	7	13	6	-3
Other Chemicals	0.7770	0.8737	0.8363	0.8561	0.0791	14	5	15	14	0
Rubber products	0.8310	0.8603	0.8715	0.8763	0.0453	5	8	8	8	3
Plastic products	0.6910	0.7399	0.8048	0.7800	0.0890	23	23	22	22	-1
Glass and glass products	0.8280	0.8431	0.8814	0.9162	0.0882	6	10	6	2	-4
Other Non-metals	0.7960	0.8744	0.8682	0.8621	0.0661	10	4	9	12	2
Basic iron and steel industries	0.8550	0.8954	0.8907	0.8723	0.0173	3	1	3	9	6
Non-ferrous metal basic industries	0.7760	0.8502	0.8634	0.8615	0.0855	15	9	11	13	-2
Metal products, except machinery and equipment	0.7850	0.8248	0.8117	0.8141	0.0291	12	14	19	16	4
Machinery, except electrical	0.7690	0.7939	0.8073	0.7936	0.0246	17	19	21	20	3
Electrical machinery apparatus, appliances and supplies	0.8150	0.8429	0.8680	0.7973	-0.0177	8	11	10	19	11
Motor vehicles, parts and accessories	0.8860	0.8936	0.9129	0.9181	0.0321	1	2	1	1	0
Transport equipment	0.8730	0.8895	0.8781	0.8637	-0.0093	2	3	7	11	9
Other manufacturing industries	0.7735	0.8326	0.8279	0.8978	0.1243	16	12	17	3	-13
AVERAGE FOR ALL INDUSTRIES	0.7858	0.8247	0.8490	0.8446	0.0588					

Source: Fedderke and Szalontai (2004).

Table 7: Rosenbluth Concentration Index: Level and ranking

Low rank indicates high concentration	1972	1980	1990	1996	Change: 1972-96	Rank 1972	Rank 1980	Rank 1990	Rank 1996	Δ rank 1972-96
Food and food products	0.0046	0.0050	0.0071	0.0051	0.0005	22	19	16	16	-6
Beverages	0.0282	0.0208	0.0528	0.0502	0.0220	8	10	5	4	-4
Textiles	0.0081	0.0094	0.0086	0.0062	-0.0019	17	14	14	15	-2
Clothing, except footwear	0.0039	0.0039	0.0035	0.0031	-0.0008	23	22	21	19	-4
Leather and products from leather	0.0238	0.0233	0.0305	0.0485	0.0247	10	8	8	5	-5
Footwear	0.0281	0.0225	0.0214	0.0171	-0.0110	9	9	10	10	1
Wood and wood and cork products	0.0065	0.0081	0.0087	0.0039	-0.0026	18	16	13	18	0
Furniture	0.0064	0.0046	0.0033	0.0031	-0.0033	19	20	22	20	1
Paper and paper products	0.0294	0.0242	0.0297	0.0242	-0.0052	7	7	9	9	2
Printing, publishing and allied industries	0.0055	0.0040	0.0037	0.0031	-0.0024	20	21	20	22	2
Basic chemicals	0.0440	0.0451	0.0349	0.0448	0.0008	6	6	6	7	1
Other Chemicals	0.0127	0.0161	0.0102	0.0096	-0.0031	15	11	12	12	-3
Rubber products	0.0971	0.0909	0.0548	0.0449	-0.0522	2	2	4	6	4
Plastic products	0.0130	0.0100	0.0073	0.0044	-0.0086	14	13	15	17	3
Glass and glass products	0.1533	0.1798	0.1333	0.1657	0.0124	1	1	1	1	0
Other Non-metals	0.0139	0.0079	0.0070	0.0064	-0.0074	13	17	17	14	1
Basic iron and steel industries	0.0515	0.0529	0.0630	0.0860	0.0345	4	4	3	2	-2
Non-ferrous metal basic industries	0.0507	0.0601	0.0673	0.0811	0.0304	5	3	2	3	-2
Metal products, except machinery and equipment	0.0025	0.0021	0.0014	0.0013	-0.0012	24	24	24	24	0
Machinery, except electrical	0.0049	0.0032	0.0022	0.0017	-0.0032	21	23	23	23	2
Electrical machinery apparatus, appliances and supplies	0.0119	0.0084	0.0069	0.0031	-0.0088	16	15	18	21	5
Motor vehicles, parts and accessories	0.0166	0.0123	0.0128	0.0108	-0.0058	12	12	11	11	-1
Transport equipment	0.0697	0.0474	0.0311	0.0281	-0.0416	3	5	7	8	5
Other manufacturing industries	0.0196	0.0059	0.0045	0.0083	-0.0113	11	18	19	13	2
AVERAGE FOR ALL INDUSTRIES	**0.029**	**0.028**	**0.025**	**0.028**	**-0.002**					

Source: Fedderke and Szalontai (2004).

Table 8: C5% Concentration Index for South African Manufacturing Industry

Sector	1976		1985		1996		2001	
	n	C5%	n	C5%	n	C5%	n	C5%
Food and Food Products	76	65.29	72	70.12	71	75.16	134	65.93
Beverages	12	55.64	9	62.68	8	74.26	21	76.27
Textiles	26	52.29	32	55.92	34	48.11	51	36.00
Clothing, except Footwear	60	46.75	61	50.58	81	58.68	75	34.18
Leather and Leather Products	8	37.17	8	50.25	8	67.86	12	27.69
Footwear	6	36.73	7	46.08	13	56.42	16	39.99
Wood and Wood and Cork Products	32	51.35	30	63.34	65	61.10	67	38.45
Paper and Paper Products	8	53.36	11	75.43	19	62.05	30	78.13
Printing, Publishing and Allied Industries	56	60.99	65	62.45	99	69.25	83	48.90
Basic Chemicals	7	69.55	9	62.88	12	70.79	23	68.55
Rubber Products	22	55.97	26	66.16	36	80.85	64	40.33
Plastic Products	3	36.55	4	46.63	9	56.67	14	30.22
Glass and Glass Products	16	53.46	23	85.40	51	87.31	58	69.74
Other Non-Metals	1	69.60	2	75.83	4	74.96	13	66.07
Basic Iron and Steel Industries	45	73.48	51	76.93	57	69.89	56	76.00
Non-Ferrous Metal Basic Industries	6	47.60	10	63.07	5	64.66	30	70.60
Metal Products, except Machinery and Equipment	4	58.48	5	65.47	4	67.34	45	47.49
Machinery, except Electrical	119	56.14	143	60.24	206	61.79	225	38.41
Electrical Machinery Apparatus	54	60.77	93	66.58	144	58.26	248	51.60
Motor Vehicles, Parts and Accessories	29	79.42	40	83.90	81	85.19	89	78.87
Transport Equipment	33	68.01	40	73.37	56	75.27	120	58.99
Furniture	37	53.39	53	52.12	78	58.38	67	56.68
Other Manufacturing Industries	7	53.15	11	59.90	13	83.38	30	50.66
Average	29	56.31	35	64.14	50	68.16	68	54.34
Average weighted by output		60.81		66.52		69.01		61.09

Notes: n refers to the number of firms making up the group of 5% of largest firms while the C5% value refers to the cummulative percentage of output attributable to that group of firms.

Source: Values for 1972 - 1996 from *Fedderke and Szalontai (2004),* Values for 2001 based on *Stats SA, Large Sample Survey (2004)*

Source: Fedderke and Naumann (2005).

Table 9: Gini Index for South African Manufacturing Industry, 1972 – 2001

Sector	Gini Index					Change	
	1972	1979	1988	1996	2001	1996 - 2001	1972 - 2001
Food and Food Products	0.818	0.872	0.900	0.884	0.752	-0.132	-0.066
Beverages	0.848	0.775	0.878	0.878	0.796	-0.081	-0.052
Textiles	0.761	0.833	0.846	0.762	0.490	-0.271	-0.271
Clothing, except Footwear	0.785	0.807	0.804	0.802	0.532	-0.270	-0.253
Leather and Leather Products	0.667	0.759	0.813	0.867	0.612	-0.255	-0.055
Footwear	0.704	0.687	0.746	0.771	0.534	-0.237	-0.170
Wood and Wood and Cork Products	0.711	0.800	0.840	0.803	0.558	-0.245	-0.153
Paper and Paper Products	0.752	0.794	0.883	0.889	0.784	-0.105	0.032
Printing, Publishing and Allied Industries	0.786	0.796	0.826	0.835	0.651	-0.185	-0.135
Basic Chemicals	0.815	0.860	0.842	0.879	0.765	-0.114	-0.050
Rubber Products	0.831	0.852	0.876	0.876	0.652	-0.224	-0.179
Plastic Products	0.691	0.722	0.797	0.780	0.486	-0.294	-0.205
Glass and Glass Products	0.828	0.870	0.880	0.916	0.813	-0.103	-0.015
Other Non-Metals	0.796	0.875	0.866	0.862	0.737	-0.125	-0.059
Basic Iron and Steel Industries	0.855	0.896	0.898	0.872	0.801	-0.071	-0.054
Non-Ferrous Metal Basic Industries	0.776	0.858	0.874	0.861	0.771	-0.090	-0.005
Metal Products, except Machinery and Equipment	0.785	0.829	0.808	0.814	0.585	-0.229	-0.200
Machinery, except Electrical	0.769	0.788	0.799	0.794	0.547	-0.247	-0.222
Electrical Machinery Apparatus	0.815	0.841	0.868	0.797	0.697	-0.100	-0.118
Motor Vehicles, Parts and Accessories	0.886	0.892	0.906	0.918	0.770	-0.148	-0.116
Transport Equipment	0.873	0.900	0.886	0.864	0.644	-0.220	-0.229
Furniture	0.757	0.773	0.784	0.791	0.676	-0.114	-0.081
Other Manufacturing Industries	0.774	0.842	0.815	0.898	0.719	-0.179	-0.054
Average	0.786	0.823	0.845	0.844	0.668	-0.176	-0.118
Average weighted by output	0.800	0.837	0.854	0.848	0.702	-0.146	-0.098

Source: Values for 1972 - 1996 from *Fedderke and Szalontai (2004),* Calculations for 2001 based on *Stats SA, Large Sample Survey (2004)*

Source: Fedderke and Naumann (2005).

Table 10: Rosenbluth Index for South African Manufacturing Industry, 1972 – 2001

Sector	Rosen Index					Change	
	1972	1979	1988	1996	2001	1996 - 2001	1972 - 2001
Food and Food Products	0.0046	0.0051	0.0070	0.0051	0.0015	-0.0036	-0.0031
Beverages	0.0282	0.0194	0.0483	0.0502	0.0116	-0.0386	-0.0166
Textiles	0.0081	0.0099	0.0087	0.0062	0.0019	-0.0043	-0.0062
Clothing, except Footwear	0.0039	0.0040	0.0037	0.0031	0.0014	-0.0017	-0.0025
Leather and Leather Products	0.0238	0.0242	0.0300	0.0485	0.0104	-0.0381	-0.0134
Footwear	0.0281	0.0219	0.0216	0.0171	0.0067	-0.0104	-0.0214
Wood and Wood and Cork Products	0.0065	0.0082	0.0092	0.0039	0.0017	-0.0022	-0.0048
Paper and Paper Products	0.0294	0.0254	0.0300	0.0242	0.0077	-0.0165	-0.0217
Printing, Publishing and Allied Industries	0.0055	0.0041	0.0037	0.0031	0.0017	-0.0013	-0.0038
Basic Chemicals	0.0440	0.0428	0.0329	0.0448	0.0094	-0.0354	-0.0346
Rubber Products	0.0971	0.0853	0.0670	0.0449	0.0103	-0.0346	-0.0868
Plastic Products	0.0130	0.0100	0.0081	0.0044	0.0017	-0.0027	-0.0113
Glass and Glass Products	0.1533	0.2129	0.1265	0.1657	0.0210	-0.1447	-0.1323
Other Non-Metals	0.0139	0.0080	0.0073	0.0064	0.0034	-0.0030	-0.0104
Basic Iron and Steel Industries	0.0515	0.0579	0.0587	0.0860	0.0083	-0.0778	-0.0432
Non-Ferrous Metal Basic Industries	0.0507	0.0630	0.0713	0.0811	0.0048	-0.0763	-0.0459
Metal Products, except Machinery and Equipment	0.0025	0.0022	0.0015	0.0013	0.0005	-0.0008	-0.0020
Machinery, except Electrical	0.0049	0.0033	0.0023	0.0017	0.0004	-0.0012	-0.0045
Electrical Machinery Apparatus	0.0119	0.0086	0.0075	0.0031	0.0019	-0.0012	-0.0100
Motor Vehicles, Parts and Accessories	0.0166	0.0127	0.0126	0.0108	0.0018	-0.0090	-0.0148
Transport Equipment	0.0697	0.0541	0.0350	0.0281	0.0048	-0.0234	-0.0649
Furniture	0.0064	0.0049	0.0036	0.0031	0.0023	-0.0008	-0.0041
Other Manufacturing Industries	0.0196	0.0065	0.0045	0.0083	0.0020	-0.0063	-0.0176
Average	0.0301	0.0302	0.0261	0.0283	0.0051	-0.0232	-0.0250
Average weighted by output	0.0218	0.0211	0.0217	0.0265	0.0038	-0.0227	-0.0180

Source: Values for 1972 - 1996 from *Fedderke and Szalontai (2004),* Calculations for 2001 based on *Stats SA, Large Sample Survey (2004)*

Source: Fedderke and Naumann (2005).

Table 11: Estimation results for the labour usage equation and the investment function

	lnL	lnL	lnL		Investment Rate	Investment Rate	Investment Rate
lnY	0.57* (0.03)	0.40* (0.03)	0.81* (0.08)	$DlnY^e$	0.13* (0.03)	0.17* (0.03)	0.20* (0.03)
lnRP	0.66* (0.12)	1.28* (0.10)	1.35* (0.14)	Dlnuc	-0.09* (0.02)	-0.10* (0.01)	-0.09* (0.01)
lnSR	-0.24* (0.05)	-0.23* (0.03)	-0.38* (0.16)	σ^2_{sect}	-0.20* (0.05)	-0.21* (0.05)	-0.17* (0.05)
lnOP	0.08* (0.01)	0.01 (0.02)	0.01 (0.03)	σ^2_{sys}	-0.004* (0.001)	-0.004* (0.001)	-0.01* (0.001)
lnGINI	-0.03 (0.20)		-0.07 (0.29)	GINI	0.09* (0.05)		0.76* (0.09)
lnROSEN		-0.27* (0.03)	-0.10* (0.05)	ROSEN		-1.49* (0.29)	-0.62* (0.20)
Φ	-0.19* (0.04)	-0.22* (0.06)	-0.16* (0.04)	Φ	-0.54* (0.06)	-0.46* (0.08)	-0.56* (0.07)
h-test	6.46 [0.26]	8.34 [0.14]	8.35 [0.21]	h-test	11.21 [0.05]	7.41 [0.19]	8,76 [0.19]
ARDL	2,2,0,1,0,1	2,2,2,1,1,1	1,2,0,2,0,2,2	ARDL	1,3,3,3,3,0	1,3,3,3,3,0	3,2,2,2,3,2,0

*Notes: * denotes statistical significance. Figures in round parentheses denote standard errors. Figures in square parentheses denote probability values.*

Source: Fedderke and Szalontai (2004).

Table 12: Investment Function – Estimation Results for Various Specifications, Pooled Mean Group Estimator

Pooled Mean Group Estimator: Dependent Variable: *I*		
ARDL	1,1,1,1,0,2,2	1,1,1,1,2,2
$dlnY^e$	0.030*	0.034*
	(0.016)	(0.013)
dlnuc	-0.005	-0.009
	(0.035)	(0.031)
σ_{sect}	-0.074*	-0.083*
	(0.034)	(0.023)
σ_{sys}	-0.092**	n/a
	(0.051)	
GINI	-0.051	-0.047
	(0.048)	(0.045)
ROSEN	-1.103*	-1.056
	(0.479)	(0.471)
δ	-0.674*	-0.702*
	(0.054)	(0.056)
h-test	9.97	9.75
	[0.13]	[0.08]
RLL	1167.12	1230.77
ULL	1316.65	1373.43
LR: χ^2	299.07*	285.32*

Figures in round parentheses are standard errors, h-test denotes Hausman test, Square parentheses are probability values, * denotes statistical significane at the 5% level, ** at the 10% level of significance

Source: Fedderke and Naumann (2005).

Table 13: Estimated (ARDL) Markup by Individual Three Digit Sector

Manufacturing 3-digit Sectors	1971-2004	(s.e.)	1971-1980	1975-1984	1981-1990	1985-1994	1991-2000	1995-2004
Food	0.86*	(0.10)	0.79	0.87	0.61	0.70	0.68	1.08
Beverages	1.07*	(0.12)	1.45	1.47	0.97	1.30	1.17	2.29
Tobacco	4.05*	(0.58)	4.27	0.73	5.03	3.79	2.16	-7.79
Textiles	0.51*	(0.06)	0.49	0.56	0.30	0.39	0.82	1.26
Wearing apparel	0.29*	(0.07)	0.35	0.29	0.19	0.26	0.24	0.63
Leather & leather products	0.16*	(0.03)	0.17	0.13	0.21	0.26	0.07	-0.25
Footwear	0.14*	(0.04)	0.10	0.14	0.10	0.15	-0.69	0.47
Wood & wood products	0.55*	(0.06)	0.93	0.79	0.59	0.77	-0.24	0.22
Paper & paper products	0.84*	(0.09)	0.17	0.81	0.73	0.81	1.02	1.19
Printing, publishing & recorded media	0.28*	(0.06)	0.35	0.39	0.31	0.45	1.19	0.07
Coke & refined petroleum	3.31*	(0.60)	1.55	2.90	2.93	2.98	4.74	2.12
Basic chemicals	0.83*	(0.11)	0.89	0.79	0.34	0.84	5.05	0.59
Other chemicals & man-made fibers	0.70*	(0.06)	0.40	0.93	0.61	0.76	0.29	0.29
Rubber products	0.52*	(0.06)	0.58	0.60	0.42	0.48	0.03	0.07
Plastic products	0.69*	(0.09)	0.45	0.75	0.50	0.56	1.82	0.85
Glass & glass products	**		0.28	0.40	0.58	0.65	0.84	1.36
Non-metallic minerals	0.96*	(0.25)	0.70	0.79	0.58	0.62	0.29	1.03
Basic iron & steel	0.60*	(0.11)	0.54	0.54	0.24	0.24	0.24	1.52
Basic non-ferrous metals	0.77*	(0.12)	2.75	1.35	0.76	1.16	0.62	1.55
Metal products excluding machinery	0.41*	(0.05)	0.44	0.46	0.32	0.40	0.30	0.79
Machinery & equipment	0.29*	(0.05)	0.14	0.23	0.25	0.39	0.36	0.27
Electrical machinery & apparatus	0.49*	(0.05)	0.93	0.72	0.45	0.62	0.38	-0.01
Television, & communication equipment	0.46*	(0.05)	0.28	0.39	0.44	0.42	0.53	0.52
Professional & scientific equipment	0.52*	(0.06)	0.74	0.61	0.53	0.82	0.98	1.12
Motor vehicles, parts & accessories	0.39*	(0.10)	0.46	0.42	0.19	0.51	0.74	1.41

Other transport equipment	0.36*	(0.08)	0.70	0.49	0.46	0.50	-0.04	0.11
Furniture	0.20*	(0.03)	0.42	0.28	0.18	0.26	0.30	0.42
Other manufacturing	2.16*	(0.19)	3.12	2.00	2.09	3.28	5.73	4.50

*Note: * denotes significance at the 5% level, ** denotes case in which statistically reliable results were not available*

Source: Aghion et al (2007).