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Product Market Competition, Productivity, and Jobs

The Case of South Africa

Seidu Dauda
Sara Nyman
Aalia Cassim

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Abstract

The degree of concentration and market power in South African markets has been the topic of much policy discussion. However, there has been little evidence on what drives market power and the impact of the degree of competition in South African markets on economic outcomes. This paper improves on previous markup estimates for South Africa using a methodology developed by De Loecker and Warzynski (2012) applied to tax administrative data for 2010–14. The paper then explores the firm-level determinants of the estimated markups and assesses the link between competition and firm-level outcomes, including productivity, employment, and wages. The analysis finds that average markups across the economy appear to have risen between 2010 and 2014. Larger firms, higher-intensity exporters, and firms with greater sales shares charge higher markups than comparator firms in South Africa, even after controlling for efficiency. Moreover, lower product market competition has a significant, negative effect on productivity growth, employment growth, and wage growth in South African manufacturing industries. Higher sales-weighted and value-added-weighted average industry-level markups are associated with lower industry-level entry rates. The findings highlight the importance of implementing sound pro-competition government interventions and the significant economic benefits associated with such policies.

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Product Market Competition, Productivity, and Jobs: The Case of South Africa[1]

Seidu Dauda

Sara Nyman

Aalia Cassim

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1. Background

Product market competition is often cited as a key driver of productivity and economic growth – and thus is an important piece in the puzzle of boosting South Africa's economic performance. At present, there is significant discussion on the level of competition faced by firms across South African industries. This in part stems from concerns that product markets have remained relatively concentrated since the end of apartheid, with newer and smaller firms unable to successfully compete against larger incumbents that benefit from scale and other advantages. This has implications for the degree of rivalry in markets. Historically, there have been four main conglomerate groupings which have controlled the majority of economic activity (Roberts, 2004) - Anglo American Corporation, Sanlam, Liberty Life and Rembrandt/Remgro. Together, they held 80.2 percent of JSE market capitalization in 1985 and 59.8 percent in 2002. In addition, Roberts pointed out that the 1996 manufacturing survey suggested the largest four firms account for more than half of output in 47 percent of the 57 main product groupings. Fedderke et al. (2018) find that concentration ratios for the top 5 percent of firms across industries have increased across most industrial categories from before 2001 to 2010 and 2012.[2]

In part, currently observed market structures result from South Africa's legacy of exclusion (World Bank Group, 2018). However, they can also be reinforced by a lack of pro-competition principles in current government interventions in some markets, making it difficult for South Africa to overcome its historical legacy. South Africa's overarching economic development plans have in fact advocated for competition policies in the past. The New Growth Path adopted in 2011suggests that competition is key to generating employment and investment opportunities, as well as lower prices for businesses and consumers. In a similar vein, the National Development Plan (National Planning Commission, 2012) suggests that bolstering competition in high value-added sectors and diversifying industry are key to bringing more individuals into the labor market and improving the skill base of the economy. While South Africa has made important strides in implementing its

[2] When discussing product markets in South Africa, there are two distinct types of "concentration" which have typically been part of policy dialogue: i) concentration of economic ownership across the economy; and ii) concentration within specific markets. While the two are linked, it is crucial to distinguish between them since they have different implications. The former encompasses the concentration of economic ownership in a few parent firms across markets, while the latter refers to concentration within a specific market (or set of substitutable products). It is the latter type of concentration that is spoken of in the context of competition outcomes.

competition law over the last two decades, there is still room to enhance a broader set of public policies – such as regulation of network industries, trade policy and industrial policy - in a way that can foster competition and thereby address national social and economic objectives.

An assessment of the current level of competition in a market is important to inform policy recommendations. Market structure is only one potential reflection of competition and a more thorough assessment requires going beyond structure to understand firm interaction and conduct. In particular, this calls for an understanding of firms' exercise of market power. Typically, market power refers to the degree to which a firm is able to maintain its prices above marginal cost for a sustained period of time.[3] This conduct shapes incentives for improvements in productivity and innovation and drives economic outcomes. Obtaining a measure of a firm's markup (price charged relative to marginal cost) can be a better way of understanding market power than the existing proxies of competition. Concentration is problematic if it reflects a high degree of undue market power. However, it can also be an efficient market structure when markets are characterized by scale economies and network effects. Moreover, a key factor for a firm's market power is the threat of entry as well as the existence of actual competitors in the market. Thus, concentration is most problematic when it is the result of protections that shield incumbents from competition and when large firms are not adequately incentivized to compete through effective ex post competition enforcement. Ensuring effective ex post enforcement is particularly important in the context of markets where demand is relatively small compared to the efficient scale of production, while pro-competition ex ante government interventions are crucial for setting the stage for effective rivalry across markets.

While the body of empirical evidence on the extent of competitive pressure within the context of South African manufacturing industries is growing, it is still relatively scanty. In addition, the lack of firm-level data (up until 2015) has been prohibitive, particularly in terms of the statistical methods that can be used, to examine competition. The objective of this paper is two-fold: (1) We estimate indicators of product market competition using a new and more robust methodology than previous studies. By doing so, the paper contributes and enhances the ongoing debate on the extent of competitive pressure within South African manufacturing industries. (2) We explore the

[3] Although it is worth noting in less traditional markets that are multi-sided this definition is less useful.

determinants of firm-level markups in formal manufacturing industries and then, using these markups as a proxy of product market competition, we examine the link between competition and firm-level outcomes such as productivity growth, employment and wages. This paper provides a novel contribution to the analysis of competitive conditions in South African markets in three ways: by generating additional evidence using a more comprehensive firm-level data set than most previous studies and by providing improved estimations of markups as well as new results on the link between competition and key economic outcomes. For example, we are not aware of any literature in the South African context that has linked behavioral proxies of competition, such as markup, to employment and wages.

1.1. Review of the literature

Measuring competition in South Africa

In respect of markups, some evidence seems to suggest that manufacturing markups in South Africa have been significantly higher than they are in comparable industries world-wide (in particular in the United States) and they are also non-declining (Fedderke et al., 2007) manufacturing markups in the period 1990 to 1997; Aghion et al (2008) up to 2004). Fedderke et al. (2018) were the first to calculate firm-level markups for the South African manufacturing sectors using administrative tax data (SARS-NT panel). They find sector-specific relationships between markups, levels of market concentration and barriers to entry which might be one channel through which firms are able to maintain dominant positions in certain sectors. Additional empirical evidence by Klein (2011) and Fedderke (2013) also supports the conclusion that markups are relatively high. However, recent empirical work by Zalk (2014) and Du Plessis et al. (2015) points to conflicting findings suggesting that firms in South African manufacturing industries do not enjoy significantly higher markups than firms in comparator countries. While Zalk (2014) used similar data sets and price-cost margin (PCM) measures as Aghion et al (2008) but treated the data sets differently, Du Plessis et al. (2015) used different data sets. In addition, Edwards and Van de Winkel (2005) find average markups are below those in the United States and are close to the median of other countries. They ascribe the divergence from previous papers' findings to the use of a different methodology as well as a different time horizon. More recently, De Loecker and Eeckhout (2018) have found a modest increase of markups in South Africa over the period from 1980 to 2016 using data primarily on publicly listed companies.

Impact of competition on economic outcomes

While several studies have attempted to measure trends in industrial competition in South Africa, there is a dearth of literature that examines the impact of South Africa's market structure on economic outcomes. Fedderke and Naumann (2011) find that concentration, as measured by the Gini and Rosenbluth coefficients, lowers investment rates. Fedderke and Szalontai (2009) find that higher concentration is detrimental to output growth, lowers labor productivity and raises labor unit costs. In addition, Aghion et al. (2008) find a strong positive effect of product market competition, as measured by price-cost margins, on productivity growth. This paper builds on and complements these previous studies to further understand the impact of competition on productivity growth as well as on labor market outcomes.

2. Measuring competition and treatment of data

2.1. Estimated markups and other commonly used proxies of competition

While previous literature for South Africa has estimated structural and behavioral measures of competition such as Hirschman Herfindahl Index (HHI) and PCM, these measures have several important limitations (refer to the Annex for details on some of these issues). Noting the caveats associated with these measures, the indicator of competition used in this paper's analysis is estimated firm-specific markups derived following the methodology developed by De Loecker and Warzynski (DLW, 2012) and pioneered by Hall (1986). This methodology has several advantages over indicators that have typically been used in South Africa to date. In this regard, our analysis is novel within the context of South Africa.

The DLW method is a structural estimation of firm-level markup, while accounting for productivity shocks. It relies on the idea that, for a cost-minimizing firm, the output elasticity of a variable production input that is free of adjustment costs equals its expenditure share in total revenue when price equals marginal cost of production. Therefore, any divergence between the output elasticity and the share of that variable input in total revenue represents a firm's markup if competition is imperfect. The choice of the variable input that is free of adjustment costs is important. We use intermediate inputs as the variable input free of adjustment costs. The methodology does not require data on firm-level prices or require accurate marginal cost estimates, and it leads to more reliable estimates of markup than PCM, as it accounts for potential endogeneity issues by accounting for productivity shocks. Since a firm's unobserved productivity is potentially correlated with its input choices, not accounting for productivity shocks would otherwise lead to biased markup estimates.[4] See section E of the Annex for a brief discussion on the empirical framework for obtaining the firm-level markups and the output elasticities. For a more detailed exposition, refer to De Loecker and Warzynski (2012).

Since the application of the DLW method involves estimating a production function, we recover the Solow residual or total factor productivity (herein referred to as TFP or productivity) under the method. Given that we do not observe firm-level prices, we are unable to estimate a quantity-based productivity (TFPQ). Instead, we recover a measured revenue-based productivity (TFPR) after deflating all nominal variables by the appropriate deflators reported in the data set. While we do not have physical quantities or detailed price indices to convert revenues into physical output, De Loecker and Warzynski (2012) show that using revenue data to recover markup does not affect the temporal changes in the level of the markup or the estimated association between markups and firm-level variables, which we examine in this paper. It might, however, have an effect on the level of the estimated markup. We estimate the production function using the Ackerberg, Caves, and Frazer (ACF, 2015) two-step estimator, which corrects for potential endogeneity and collinearity issues.[5] A key caveat of this is that recent work has noted problems in applying the ACF estimator to the gross output production function (Gandhi, Navarro, and Rivers, 2018). We estimate the production function at the two-digit ISIC industry level, which allows for technology to vary across industries to some extent, although it should be noted that there is likely to be significant firm heterogeneity even within narrowly-defined industries.[6] However, our use of the more flexible

[4] The bias may be due to simultaneity between output and variable inputs. Simultaneity arises because productivity is known to profit-maximizing firms (but unobservable to the econometrician) when they choose their input level. Firms will expand their output (by using more inputs) due to positive productivity shocks. Thus, the positive correlation between the unobserved productivity shock and input levels biases the estimates of the output elasticities.

[5] We use the Stata routine "prodest" – developed by Rovigatti and Mollisi (2016) – to estimate the production function and recover the output elasticity of intermediate inputs and labor, and the total factor productivity measure, as well as the first-stage residual to be used to correct for measurement error in output or sales.

[6] Estimating the production function at the 4-digit level may be possible but given the data at hand this would greatly restrict the number of observations available.

translog gross output production function specification allows for firm-time variation in the estimated output elasticities through differences in input use.

Due to restrictions in the data set, we restrict the markup and productivity analysis to firms in the manufacturing industries. because the proxy variable for materials (cost of sales) is missing for a sizable number of non-manufacturing firms in the sample, particularly those in the services sectors such as financial and insurance activities, real estate activities, and professional activities like legal and accounting services.[7]

2.2. Data

We use the SARS-NT firm-panel data set based on tax administrative data. This firm-level panel data are created using the South African Corporate Income Tax (CIT) information sourced from SARS. Although data are available for the years 2008-2017, we start our sample from 2010 given that there is a considerable proportion of firms with missing sales revenue information in 2008 and 2009 relative to the other years - a key variable underpinning this analysis. We have therefore conducted our analysis using data for the years 2010-2017. However, due to observed issues with some variables (including sales and employment) for 2015, we have chosen to present analysis for 2010-2014 as our primary set of results. Nevertheless, it is worth noting that estimated effects using data for 2010-2017 are in line with those using a sample up to 2014, albeit of different magnitude. Finally, since the data are derived from tax administrative data, only formal firms are included in the data set and the results that follow must be read in this context.

In order to improve our estimated competition indicators, in treating the data, we carefully considered a number of issues, considering principles of Industrial Organization. As an example, we made important decisions with respect to missing values of the core variables of interest and unreliable wage data in some years for some firms. In addition, we selected variables for the analysis based on how well they capture the underlying microeconomic concepts required to gain an accurate estimation of competition dynamics. For instance, we selected a wage measure that

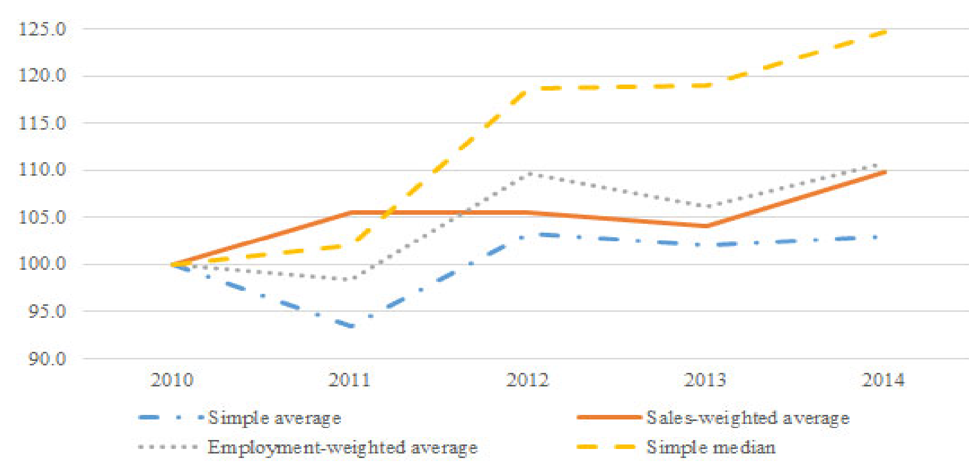
[7] In addition, there are various conceptual and empirical problems relating to the measurement of output, prices, and productivity in the non-manufacturing sectors (see https://www.brookings.edu/research/productivity-in-the-services-sector/).

varies as closely as possible with output and therefore that would be as relevant as possible for a firm's pricing decisions. For further details on the treatment of the data, refer to the Annex.

3. Empirical analysis and results

This section will discuss the findings of the empirical analysis that linked competition (proxied by markups) to economic indicators crucial for South African policy makers, such as productivity growth, employment and wage outcomes, and industry-level entry rates. First, however, , we provide some observations on the evolution of markups across manufacturing industries between 2010 and 2014 to illustrate the background of the analysis: Mean and median industry markups in the manufacturing sector[8] appear to have risen between 2010 and 2014 (Figure 1). For the mean industry markup, this pattern is more noticeable when firm markups are weighted by either sales or employment, suggesting that the rise is disproportionately driven by larger firms. Median markups within an industry have risen more rapidly than mean industry markups, potentially suggesting that the overall rise in markups has come disproportionately from firms within the middle of the industry distribution of markups rather than very high or very low markup firms.

Figure 1. Evolution of average markups across South African manufacturing industries (2010 = 100)



Note: Markups estimated using methodology developed by De Loecker and Warzynski (2012)

[8] Average industry markups here are given as the simple average of the within-industry average markups, where the within-industry markup is either weighted or unweighted. Median industry markup is the simple average of the within-industry median.

Underlying this are differences in the dynamics within specific industries. For example, between 2010 and 2014, 67 percent of industries experienced a rise in unweighted mean industry markups (with the average rise being 13 percent over that period) while the remaining 33 percent experienced a decline in markups (average decline of 10 percent).

Table 1. Change in industry markups across the manufacturing sector between 2010-2014

Measure of overall industry markups	The proportion of manufacturing industries with a positive/negative change in overall markups		The average change in industry markup for industries with a positive/negative change	
	Positive	Negative	Positive	Negative
Unweighted mean	67%	33%	13%	-10%
Sales weighted mean	63%	37%	33%	-10%
Employment weighted mean	67%	33%	36%	-14%
Valued added weighted mean	70%	30%	66%	-11%
Average industry median	72%	28%	4%	-3%

Note: Markups estimated using methodology developed by De Loecker and Warzynski (2012)

Industries that have seen the greatest increases in mean markups as observed in the data include: manufacture of chemicals, pharmaceuticals, textiles and machinery. It is worth noting that these industries may be those that are becoming more intensive in capital usage and R&D over time (particularly industries like pharmaceuticals) and that this increase reflects those dynamics. These markups do not account for differences in efficiency and therefore their increases may reflect efficiency gains rather than increases in pricing power. Of policy interest for South Africa is also that, while several food and beverages industries have seen modest increases in markups, others show a similar magnitude of decreases in markups.

The rest of this analysis will shed light on some potential determinants of markups and discuss key findings of the empirical analysis of related economic outcomes. The markups used are estimated following the methodology laid out in De Loecker and Wazynski (2012). We recover these markups while controlling for variables which could affect the optimal choice of input demand for the firm. These include export status and age, which are used as controls.

3.1. Determinants of firm markups and prices

As a first step in this analysis, we look to relate a firm's markups and pricing behavior to various firm-specific characteristics in a fixed effects regression framework. We cluster standard errors at the firm level. Key firm-specific characteristics of interest here are the relationship between a firm's share in total sales of the 3-digit subsector (hereafter referred to as sales share and used as a proxy for market share since the definition of a true relevant market from an antitrust perspective is not available in the data), whether it is a new entrant, its export status, size and age.[9]

The specification we take to the data is given by

$$\ln \mu_{it} = \alpha + X_{it}'\beta + \delta_t + \gamma_i + \varepsilon_{it} \qquad [1]$$

where a firm's logged markup (μ_{it}) is modeled as a function of its contemporaneous characteristics $X_{it}$with unknown weights β, α is a constant, δ_t are time-specific effects (to account for economic shocks or economy-wide changes in policy), and ε_{it} is the error. X_{it}contains firm-specific variables of specific interest in the context of South Africa including the firm's sales share,[10] the export status of the firm (the share of export sales in overall sales of the firm[11]), whether or not the firm is a new entrant,[12] as well as various control variables including: firm age,[13] number of employees[14] and total capital stock (proxied by the book value of tangible assets) in order to capture differences in size and factor intensity. The firm's level of current productivity, lagged productivity or its level

[9] Throughout this paper, we include categorical variables of export status, size and age in order to assess the differential effects between different cohorts. This is consistent with previous literature on South Africa including, for example, Aterido et al, 2019.
[10] Note that in calculating sales shares, we use only domestic sales given that domestic market concentration is most relevant for competition dynamics within South Africa. Not excluding export revenues can provide a misleading picture on domestic market concentration.
[11] Classified into three categories: Exporters with a share of exports in sales of: less than 11 percent (low-intensity exporters); greater than or equal to 11 percent and less than 25 percent (medium-intensity exporters); and greater than or equal to 25 to 100 percent (high-intensity exporters), with the base category being non-exporting firms. While dummies based on export share in sales are a common determinant in the empirical literature, there does not appear to be a commonly agreed upon cut-off threshold. As a result, the thresholds used in this analysis are informed by thresholds that could be found elsewhere in the literature, as well as the distribution of the available data.
[12] A new entrant would be a firm in a specific year that has a reported birth year equal to the current year and reported positive sales.
[13] The firm's age (in five categories: 6 to 10 years, 11 to 20 years, 21 to 20 years, 31 to 40 years and above 40 years). The base category to which the coefficients on the age dummies compare is the group of firms aged 1 to 5 years.
[14] The firm's size based on the number of employees (6 to 10 employees, 11 to 20 employees, 21 to 50, 51 to 100, 101 to 250, 251 to 100 and over 1000 employees). The base category to which the coefficients on the size dummies compare is the group of firms with 1 to 5 employees.

of productivity growth was included in various specifications to control for other technological and cost factors.[15]

It should be noted that the introduction of productivity into the model changes the interpretation of the dependent markup variable. In general, high markups could be the result of either high prices or low marginal cost, i.e. high productivity. Introducing productivity into the model allows us to control for differences in marginal cost between firms. Thus, specifications that include productivity control for differences in marginal cost, which lets the other elements of β pick up the variation in average prices related to the market power and demand conditions faced by firms with different characteristics. The coefficient on the productivity variable will pick up the passthrough effect of marginal cost changes on overall markups.

Firm characteristics that are likely to impact future productivity have been included as controls in the first-stage regression to recover markups – here, these characteristics include export status and sales share. However, we are not interpreting the elements of β as causal parameters but instead are testing whether, on average, new entrants, exporters, and firms with higher sales shares have different markups. These results have not been documented for South Africa before as far as we are aware. It is relevant to note that the markup is being calculated on the entirety of a firm's production including production that is sold in international markets and across a variety of products.

The first specification examines the determinants of markup. In the second specification we control for current levels of revenue-based productivity. Since markups are determined by a combination of price levels and marginal costs (a measure of efficiency), controlling for the latter allows us to interpret the coefficients of these models as determinants of pricing levels. Findings are generally robust across regression specifications. Table 2 shows the empirical determinants for firm-level markups. Results are discussed below.

[15] Persistence in behavior may make the markup process dynamic, however, like De Loecker and Wazynski (2012) and many others in the literature, we are primarily interested in how firms' markups relate to contemporaneous characteristics. Nevertheless, as an additional check we have tried a dynamic specification of this model (not shown here) and the results on exports, sales share and firm size remain comparable.

Table 2: Determinants of markup and market power in South African manufacturing industries

	Model 1	Model 2	Model 3
Low-intensity exporters	-0.010***	0.002	-0.009***
	(0.002)	(0.001)	(0.002)
Medium-intensity exporters	-0.018***	-0.002	-0.014***
	(0.003)	(0.002)	(0.004)
High-intensity exporters	-0.016***	0.010***	-0.009*
	(0.005)	(0.004)	(0.005)
Sales share	0.741***	2.048***	0.724
	(0.260)	(0.328)	(0.454)
Age: 6-10 years	-0.004**	0.004**	-0.006**
	(0.002)	(0.002)	(0.002)
Age: 11-20 years	-0.003	0.005**	-0.007*
	(0.003)	(0.002)	(0.004)
Age: 21-30 years	0.003	0.001	-0.008
	(0.004)	(0.004)	(0.005)
Age: 31-40 years	0.006	-0.005	-0.001
	(0.008)	(0.006)	(0.009)
Age: 41 years or more	0.015	-0.009	0.005
	(0.011)	(0.009)	(0.011)
Firm size: 6-10 employees	0.016***	0.107***	0.023***
	(0.002)	(0.003)	(0.003)
Firm size: 11-20 employees	0.035***	0.202***	0.042***
	(0.003)	(0.004)	(0.004)
Firm size: 21-50 employees	0.053***	0.307***	0.062***
	(0.003)	(0.006)	(0.005)
Firm size: 51-100 employees	0.059***	0.410***	0.065***
	(0.005)	(0.008)	(0.007)
Firm size: 101-250 employees	0.060***	0.518***	0.067***
	(0.007)	(0.011)	(0.009)
Firm size: 251-1000 employees	0.042***	0.619***	0.055***
	(0.014)	(0.017)	(0.014)
Firm size: over 1000 employees	0.018	0.714***	0.035**
	(0.014)	(0.019)	(0.014)
Log of capital stock	-0.000	-0.002**	-0.000
	(0.001)	(0.001)	(0.001)
Entrants	0.022	-0.013	-0.003

	(0.017)	(0.012)	(0.021)
Log of TFP		0.388***	
		(0.008)	
Log of lagged TFP			-0.010**
			(0.005)
Firm effects	Yes	Yes	Yes
Year effects	134986	134986	93465
No. of observations	0.017	0.344	0.016
Within R-squared	-0.010***	0.002	-0.009***
	(0.002)	(0.001)	(0.002)

Notes: All models include firm and year fixed effects. Standard errors clustered at the firm level are parentheses. ***, **, and * indicate significance at 1 percent, 5 percent, and 10 percent. The reference categories for the exporter, age, and firm size groups are "Non-exporters", "Age: 2-5 years", and "Firm size: 1-5 employees", respectively.

Sales share

A simple model of oligopoly competition between firms in prices or quantities would imply a positive relationship between sales share and markup, since the elasticity of demand faced by a firm is decreasing in its market share. Indeed, this relationship is often postulated in South Africa and the results obtained confirm a significant positive relationship between the two variables, i.e. firms with higher sales share being able to charge higher markups. The average change in markup and prices per 1 percentage point change in sales share is around 1 percent and 7 percent respectively.

Export status

A number of theoretical international trade models have predictions regarding markups and firm-level export status. Most models suggest that exporting firms would be more productive (either through self-selection of more productive firms into export or through "learning by exporting") and therefore would have higher markups due to lower costs per unit of production.[16] Another theory could be that firms lower their markups when exporting to more competitive foreign markets. As a result, markups for exporting firms would be lower on average and there would be a clear pattern of markups falling as the share of exports in the firm's sales increases.[17] In understanding the association between export status and markups, the method we have used here

[16] See for example Bernard et al. (2003) and Melitz and Ottaviano (2008).
[17] See for example Hornok and Muraközy (2018).

has the advantage that we can control for productivity improvements that are endogenous to past export status (as hypothesized in the first theory outlined above) and thus focus on whether there are other factors that affect the pricing power of exporters, such as the competitive pressure faced in foreign markets (as per the second theory).

Our results suggest that neither of these predicted correlations between a firms' markups and its export status hold in the case of South Africa. Table 2 shows that markups charged by exporters are on average significantly lower than those charged by non-exporters. However, after controlling for efficiency, this effect disappears and high-intensity exporters (firms with above 25 percent of sales from export) appear to in fact have higher pricing power than other firms. This might indicate that high-intensity exporters tend to participate in less competitive markets, either at home or abroad.

Firm size (in terms of employment)

When various firm sizes are compared (using the number of employees as the measure of firm size) relative to the control group (of firms with 1-5 employees), larger firms have higher markups and charge higher prices. When controlling for efficiency, firms' prices monotonically increase with firm size, with the estimated magnitudes being significantly different from each other.[18] While firms with between 6 and 10 employees have prices that are around 11.3 percent higher than those of the smallest firms, firms with more than 1,000 employees charge prices that are 104.2 percent higher than those of the comparator group.[19] Given that the results remain robust with the inclusion of productivity and lagged productivity in the regression, it appears that the effect is at least partially due to larger firms charging higher prices and not solely driven by differences in efficiency.[20]

[18] The existence of a positive correlation between sales share and firm size across the sample may mean that the estimated effect of these variables is dampened.
[19] The estimation of the magnitudes of the dummy variables in semilogarithmic equations follows Kennedy (1981).
[20] Note that the dynamic version of the markup regression suggests that firm size is positively associated with the degree to which their markup changes from period to period.

3.2. Competition and economic outcomes

Having identified some of the determinants of firm markups in the South African context, the analysis now turns to identifying the impact of markups (as a measure of the market power held by firms) on economic outcomes that are relevant for South African policy makers. The results shed light on the relationship between competition and productivity, employment, wages, as well as firm entry.

Productivity growth

The following sections model these outcomes using the below set up and controlling for firm fixed effects:

$$\Delta lnTFP_{it} = \alpha_0 + \alpha_1 \ln \mu_{it-1} + X_{it}\beta + \delta_t + \gamma_i + \varepsilon_{it} \qquad [2]$$

where TFP_{it} is total factor productivity and μ_{it-1} is the lagged markup. Since the estimates of productivity and markup are both affected by output prices, there may be some correlation between contemporaneous productivity and markups. Although regressing contemporaneous productivity on lagged values of markup should partly mitigate this concern, it is worth keeping this caveat in mind. X_{it} is a vector of control variables, which include export status (using the same categorizations explained in the section above), variables to capture labor and capital use, firm age, whether the firm is a new entrant, sales share, and lagged TFP growth. Table 3 shows the determinants of productivity growth of South African firms. Both model specifications presented below capture similar information regarding the relationship between labor and capital and can be seen as robustness checks.

Table 3: Effects of weaker competition on productivity growth in South African manufacturing industries

	Model 1	Model 2
Log of lagged markup	-0.631***	-0.630***
	(0.033)	(0.034)
Low-intensity exporters	-0.007	-0.013**
	(0.006)	(0.006)
Medium-intensity exporters	-0.012	-0.019**
	(0.009)	(0.009)
High-intensity exporters	-0.042***	-0.047***

	(0.015)	(0.016)
Sales share	-3.127***	-3.593***
	(0.764)	(0.879)
Age: 6-10 years	0.030***	0.024***
	(0.006)	(0.007)
Age: 11-20 years	0.030***	0.021**
	(0.009)	(0.009)
Age: 21-30 years	0.018	0.012
	(0.012)	(0.012)
Age: 31-40 years	-0.008	-0.004
	(0.024)	(0.025)
Age: 41 years or more	0.008	0.015
	(0.038)	(0.039)
Firm size: 6-10 employees	-0.165***	
	(0.007)	
Firm size: 11-20 employees	-0.316***	
	(0.010)	
Firm size: 21-50 employees	-0.463***	
	(0.014)	
Firm size: 51-100 employees	-0.612***	
	(0.019)	
Firm size: 101-250 employees	-0.760***	
	(0.027)	
Firm size: 251-1000 employees	-0.938***	
	(0.044)	
Firm size: over 1000 employees	-1.288***	
	(0.044)	
Log of capital stock	0.021***	
	(0.003)	
Log of capital intensity		0.045***
		(0.003)
Lagged TFP growth	-0.305***	-0.293***
	(0.010)	(0.010)
Firm effects	Yes	Yes
Year effects	Yes	Yes
No. of observations	60913	60913
Within R-squared	0.310	0.265

Notes: All models include firm and year fixed effects. Standard errors clustered at the firm level are parentheses. ***, **, and * indicate significance at 1 percent, 5 percent, and 10 percent. The reference categories for the exporter, age, and firm size groups are "Non-exporters", "Age: 1-5 years", and "Firm size: 1-5 employees", respectively.

Previous empirical literature – both theoretical and empirical –indicates that competition can drive greater productivity growth. It does this through: i) within-firm effects (where competition acts as a disciplining device, encouraging firms to become more efficient and to innovate), and ii) across-firm effects whereby competition ensures that more productive firms increase their market share at the expense of the less productive. Aghion et al (2008) provided the baseline study of the relationship between markups and productivity growth in South Africa through a study of publicly-listed companies. They find that higher markups have a large negative impact on productivity growth for publicly-listed firms in South African manufacturing industries.

Our results confirm that competition is positively related to productivity growth in South Africa. The results indicate that higher markups – and by extension lower competition – negatively impact productivity growth. The results are highly significant across model specifications, as presented in Table 3. Our results suggest that a 10 percent reduction in average markups in manufacturing industries is associated with a 0.1 percent increase in productivity growth. To put this in context, this productivity gain would have taken South Africa's negative productivity growth for manufacturing industries into positive territory over the period between 2010 and 2014.

The results also suggest that South African exporters have lower productivity growth than non-exporters, particularly in the case of firms with over 25 percent of their sales coming from export. While this may appear contrary to the theoretical prediction of learning-by-exporting, it could be in line with the theory that more productive firms self-select into export – assuming that more productive firms have less room for productivity growth. It could also be the case that exporting firms have been able to compete despite their low productivity growth due to support from the South African government directed at export sectors.[21] Future work could explore these potential explanations further.

[21] Between the years 2006 and 2012, foregone tax revenue from tax incentives amounted to around 1.3 percent of GDP on average (World Bank, 2016). And figures appear similar from 2013 to 2016 according to the 2018 Budget Review. The majority of these tax expenditures are directed towards the Automotive Production and Development Program (APDP) which is aimed at exporters, and towards the diesel refund scheme available for primary producers

There is a negative relationship between firm size, as measured by employment, and productivity growth and the negative effect becomes larger with increasing firm size. Firms with 6 to 10 employees have 15.2 percent lower productivity growth than the comparator category (firms with 5 employees or less), while firms with more than 1,000 employees have 60.9 percent lower productivity growth than the smallest firms. A test on the equality of the coefficients on firm size confirms that the estimated size effects are statistically different from each other, thus confirming the productivity differential between different firm size categories. This is in line with recent results from Aterido et al. (2019), who found that larger firms were less productive, but it is opposed to Kreuser and Newman (2018) who find larger firms to be more productive than smaller firms. Unlike these previous papers, our results have the advantage of overcoming a common criticism of productivity studies whereby revenue-based productivity measures can be confounded by differences in markups across firms. Our findings confirm that larger firms are less productive even after controlling for markups. While further research would be needed to uncover the reasons for this, a possible explanation could be found in industrial policy support and protections for larger but relatively less efficient firms.

Employment and wages

South Africa's unemployment rate in 2018 stood at roughly 27 percent.[22] Young people are particularly affected, with national estimates suggesting that youth unemployment stood at 53.4 percent in 2018.[23] As a result, employment creation is a key priority for South African policy makers.

Both theoretical models and empirical work tend to suggest that a lack of competition in product markets stifles employment in the long term and/or on aggregate. The basic intuition is that less

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on land and offshore (e.g. agriculture, mining and fishing). Furthermore, there are smaller incentive schemes targeted explicitly at exporting enterprises, e.g. Sector Specific Assistance Scheme (SSAS) Project Funding for Emerging Exporters or the Export Marketing and Investment Assistance (EMIA) scheme. In addition, there are numerous additional financial incentives available through various agencies that do not appear as tax expenditures (e.g. grants or subsidized loads).

[22] National estimates suggest that unemployment stood at 26.92 percent in 2018, while the ILO estimates unemployment for 2018 to be at 26.96 percent. Source: World Development Indicators (WDI) Database (2019).

[23] WDI Database (2018).

intense competition raises prices above marginal cost, reducing output demanded by consumers and, therefore, reduces labor demanded by producers.[24] An increase in prices also reduces real wages, which could theoretically reduce the supply of labor if the substitution effect outweighs the income effect or boost labor supply if the income effect outweighs the substitution effect. The impact of competition on wages has been relatively less examined than the impact on employment and productivity. Existing studies have focused on the effect on wage inequality rather than on wage levels or growth – and these have been mixed in the findings.[25] We are not aware of any literature in the South African context that has linked competition, as proxied by a behavioral indicator such as markup, to employment and wages.

Employment growth

To test the relationship between competition and employment growth in South Africa we use the following specification:

$$\Delta\ln l_{it} = \alpha_0 + \alpha_1 \ln \mu_{it-1} + Z_{it}\beta + \alpha_2 \Delta\ln w_{it} + \alpha_3 \ln TFP_{it-1} + \alpha_4 \Delta\ln l_{it-1} + \delta_t + \gamma_i + \varepsilon_{it} \quad [3]$$

Where l_{it} is employment in firm i at time t. Z_{it} is a vector of control variables that includes export status (using the same categorizations explained in the section above), firm age, whether the firm is a new entrant, sales share, and log of lagged capital stock.[26] We also control for real wage growth. Since we do not observe true firm level wage rates, we impute the level of firm wages (w_{it}) using data on the total wage bill divided by firm-level employment.

The findings reported in Table 4 suggest that firms that face lower competition (i.e. those that have higher pricing power) have lower employment growth – and this holds whether we control for productivity growth or not. A 10 percent reduction in average observed markups leads to a 0.12 percent increase in employment growth. While the impact on employment growth may seem small,

[24] See for example Spector (2004) and Blanchard and Giavazzi (2003) for examples of theoretical work; and Griffith, Harrison, and Macartney (2007); Fiori et al. (2012); and Nicoletti and Scarpetta (2005) for examples of empirical work. World Bank – OECD (2017) also contains a review of the links between competition and employment outcomes.
[25] See World Bank – OECD (2017) for a review on the links between competition and wages.
[26] Alternative specifications replacing lagged productivity with contemporaneous productivity growth were also tested as robustness checks (not shown). Results were consistent with those shown here.

it represents more than a doubling of mean employment growth in manufacturing industries (of 0.07 percent) between 2010 and 2014.

As discussed above, measured markups have two dimensions: pricing power and efficiency. Either of these could be linked to employment outcomes. However, since we control for efficiency levels through the inclusion of lagged productivity in the regression, our results can be interpreted as reflecting the impact of firms' pricing power.

Table 4: Effects of weaker competition on employment growth in South Africa manufacturing industries

	Model 1	Model 2
Log of lagged markup	-1.014***	-1.124***
	(0.043)	(0.044)
Low-intensity exporters	0.016	-0.006
	(0.010)	(0.009)
Medium-intensity exporters	0.030*	0.001
	(0.016)	(0.014)
High-intensity exporters	0.051**	0.005
	(0.025)	(0.021)
Sales share	3.312***	-0.561
	(0.991)	(0.492)
Age: 6-10 years	-0.017	-0.029***
	(0.011)	(0.009)
Age: 11-20 years	-0.013	-0.032**
	(0.015)	(0.013)
Age: 21-30 years	-0.000	-0.014
	(0.020)	(0.017)
Age: 31-40 years	-0.000	-0.016
	(0.029)	(0.029)
Age: 41 years or more	0.024	0.037
	(0.042)	(0.047)
Real wage growth	-0.170***	-0.137***
	(0.009)	(0.007)
Log of lagged TFP	0.874***	
	(0.029)	
Lagged employment growth	-0.147***	-0.165***

	(0.007)	(0.006)
Log of lagged capital stock	-0.007**	-0.017***
	(0.003)	(0.003)
TFP growth		-0.920***
		(0.026)
Firm effects	Yes	Yes
Year effects	Yes	Yes
No. of observations	60293	60293
Within R-squared	0.337	0.473

Notes: All models include firm and year fixed effects. Standard errors clustered at the firm level are parentheses. ***, **, and * indicate significance at 1 percent, 5 percent, and 10 percent. The reference categories for the exporter and age groups are "Non-exporters" and "Age: 1-5 years", respectively.

Wage growth

To test the relationship between competition and wage growth we use the following specification:

$$\Delta w_{it} = \alpha_0 + \alpha_1 \ln \mu_{it-1} + Z_{it}\beta + \alpha_2 \ln TFP_{it-1} + \alpha_3 \Delta TFP_{it-1} + \alpha_4 \Delta \ln w_{it-1} + \alpha_5 \Delta l_{it} + \delta_t + \gamma_i + \varepsilon_{it} \quad [4]$$

where w_{it} is the average wage at firm i at time t. Z_{it} is the vector of control variables for the growth regression that includes export status (using the same categorizations explained in the section above), firm age, as well as measures of factor usage by the firm.

Several factors can shape the relationship between competition and wages, including the stance of labor market regulations and the bargaining position of workers (which affects the distribution of rents) as well as the level of productivity. For example, firms that face lower competition may be less productive and therefore may pay lower wages. However, since we control for productivity in our model, we would not expect to pick up the effect of this channel. On the other hand, firms that face lower competition may earn higher margins which can then be shared with workers (depending on wage bargaining structures).

Our results suggest that firms that face lower competition (higher pricing power) have lower wage growth (Table 5). A 10 percent reduction in average observed markups leads to a 0.04 percent increase in wage growth. This would have almost negated the decline in mean wage growth observed in South African manufacturing industries 2010 and 2014 (-0.05 percent).

At the same time, sales share is positively associated with wage growth. By contrast, greater firm size (as measured by employment levels) appears to be highly negatively related to wage growth. The larger is the current number of employees, the lower is the wage growth. This might indicate that larger firms are able to rely more on reputation, job security or other non-wage factors to attract workers.

Table 5: Effects of weaker competition on wage growth in South Africa manufacturing industries

	Model 1	Model 2
Log of lagged markup	-0.407***	-0.463***
	(0.048)	(0.047)
Lagged TFP growth	0.418***	0.412***
	(0.031)	(0.031)
Log of lagged TFP	-0.200***	-0.132***
	(0.041)	(0.038)
Low-intensity exporters	0.023	0.021
	(0.015)	(0.015)
Medium-intensity exporters	0.010	0.008
	(0.027)	(0.027)
High-intensity exporters	0.053	0.053
	(0.034)	(0.034)
Sales share	2.920***	2.881***
	(0.854)	(0.849)
Age: 6-10 years	-0.016	-0.019
	(0.019)	(0.019)
Age: 11-20 years	-0.009	-0.012
	(0.025)	(0.025)
Age: 21-30 years	0.047	0.044
	(0.036)	(0.036)
Age: 31-40 years	0.030	0.034
	(0.057)	(0.057)
Age: 41 years or more	0.122	0.128
	(0.090)	(0.089)

Firm size: 6-10 employees	-0.112***	
	(0.020)	
Firm size: 11-20 employees	-0.192***	
	(0.027)	
Firm size: 21-50 employees	-0.254***	
	(0.035)	
Firm size: 51-100 employees	-0.318***	
	(0.051)	
Firm size: 101-250 employees	-0.365***	
	(0.066)	
Firm size: 251-1000 employees	-0.471***	
	(0.103)	
Firm size: over 1000 employees	-1.103***	
	(0.107)	
Log of capital stock	0.017***	
	(0.004)	
Employment growth	-0.555***	-0.592***
	(0.017)	(0.015)
Log of capital intensity		0.028***
		(0.004)
Lagged real wage growth	-0.438***	-0.436***
	(0.015)	(0.015)
Firm effects	Yes	Yes
Year effects	Yes	Yes
No. of observations	60293	60293
Within R-squared	0.343	0.342

Notes: All models include firm and year fixed effects. Standard errors clustered at the firm level are parentheses. ***, **, and * indicate significance at 1 percent, 5 percent, and 10 percent. The reference categories for the exporter, age, and firm size groups are "Non-exporters", "Age: 1-5 years", and "Firm size: 1-5 employees", respectively.

3.3. Industry-level entry rates

The last set of regressions presented in this section (Table 6) provides insights into the relationship between the level of competition in an industry and industry-level entry, i.e. the number of new firms entering specific industries.[27]

[27] The entry variable definition is based on a firm's first year of sales.

The results indicate that if industry-level competition is measured using average markups across all firms in an industry, there no evidence of a significant effect of average markups on entry in that industry. However, when weighting the average markup by sales or by value-added in order to better understand how the market power of firms with a more prominent market position affects industry-level entry, we find a significant negative relationship between markup and entry rate. The difference in the magnitude of effect between the unweighted and sales- or value-added-weighted averages suggests that entry might be dampened in the presence of firms with a larger market presence that also hold greater market power – perhaps because these firms have some ability to foreclose entry into their industries or that they benefit from policy- or natural barriers that hinder entry and protect their positions. It is worth noting that the relationship does not hold when weighting by employment, suggesting that it may be a firms' market position in terms of sales that may be more relevant for entry dynamics than its position in terms of employment.

Table 6: Relationship between competition and industry-level entry rates

	Model 1	Model 2	Model 3	Model 4
Lagged average markup	-0.004			
	(0.009)			
Lagged sales-weighted markup		-0.054**		
		(0.023)		
Lagged VA-weighted markup			-0.022***	
			(0.004)	
Lagged employment-weighted markup				-0.009
				(0.021)
Average age of firms	-0.006	-0.006	-0.007	-0.006
	(0.012)	(0.011)	(0.011)	(0.012)
Log of market-level total employment	0.063	0.080	0.079	0.063
	(0.104)	(0.102)	(0.102)	(0.102)
Average capital intensity	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Log of average R&D expenditure	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Sector effects	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes
No. of observations	240	240	240	240

Within R-squared	0.022	0.030	0.034	0.022

Notes: The dependent variable is the productivity dispersion of the sample (as measured by the standard deviation of log TFP). All models include industry and year fixed effects. Standard errors clustered at the industry level are in parentheses. ***, **, and * indicate significance at 1 percent, 5 percent, and 10 percent.

4. Conclusion

The degree of concentration and competition in South African markets and the extent to which firms enjoy relatively high markups have been topics of much policy discussion. However, there has been little evidence to date on what drives markups and market power, and the impact that the degree of competition in South African markets may have on economic outcomes. In this paper we estimate markups for South Africa's manufacturing sector using a methodology developed by De Loeker and Warzynski (2012). We use these estimated markups first to examine the determinants of markups and market power, and second to identify the impact of product market competition (using markups and controlling for efficiency levels) on economic outcomes.

Overall, average industry markups appear to have risen between 2010 and 2014 (Figure 1). For the mean industry markup, this pattern is more noticeable when firm markups are weighted either by sales or employment, suggesting that the rise is driven disproportionately by larger firms. Median markups within an industry have risen more rapidly than mean industry markups, which could suggest that the overall rise in markups has come disproportionately from firms within the middle of the industry distribution of markups (rather than very high or very low markup firms).

We find that firms with a higher share of sales in their industry and larger firms (in terms of employees) charge higher markups and appear to have higher pricing power as one might expect. Meanwhile, firms with relatively high export intensity (over 25 percent of sales) charge lower markups but have higher pricing power.

In terms of the second objective and in the context of South Africa's poor economic performance over the past decade, this paper provides evidence of the impact that low levels of competition have had on firm performance. Our key findings suggest that firms that face lower competition (i.e. have greater pricing power) have lower productivity growth. After controlling for markups, we also find that small firms tend to show higher productivity growth than large firms. One hypothesis for this could be that industrial policies may have frequently targeted larger firms, thus leading to protections or market distortions that have dampened incentives for productivity gains among these firms and hindered their exit from the market.

Another important finding, which specifically addresses South Africa's persistently high unemployment rate, is that firms that face lower levels of competition have lower employment growth. This points to the output expansion effect of greater competition, which would imply the expansion of employment opportunities as competition is boosted. We also find that firms that face greater competition display greater wage growth, even when controlling for productivity - potentially because such firms need to increase their wages to attract more employees.

The industry-level analysis suggests that industries that have higher sales-weighted or value-added-weighted average markups have lower rates of entry, indicating that the presence of larger firms with market power may dampen entry.

The findings of this paper highlight the importance of implementing sound pro-competition regulations and government interventions for productivity growth and employment. In addition to continuing to enforce the competition law, ensuring that sector policies and industrial policies are designed to promote contestability and a level playing field within manufacturing markets will be key. In particular, the results suggest that the economic benefits from such policies are significant and that outcomes such as promoting employment growth and wage growth can be boosted through pro-competition reforms.

This study lends itself to further research. A key question for additional work would be to understand the policy drivers of the degree of competition, including the effects of industrial policy design on market power and market dynamics or those of past sectoral reforms or competition law enforcement on the degree of competition in markets.[28] For example, for some of the patterns we observe with respect to the productivity of exporters and larger firms, further research would be beneficial to understand their drivers. It would also be interesting to further understand the effects of participation in Global Value Chains and exporting intensity on the degree of competition faced by firms and the extent to which that affects pricing behavior.

[28] For an overview of competition enforcement in South Africa, see Purfield et al, 2016.

Annex

Treatment of the data

(A) **Market or industry definition**: An appropriate definition of the relevant market for competition considers both the product and geographic dimensions of the market. However, as often occurs in such analyses, International Standard Industrial Classification (ISIC) codes are the best available categorization for the "relevant" market or industry where firms compete. In South Africa, information is only at the 3-digit ISIC Fourth Revision level. There are multiple industry codes reported in the data set. To get a finer view of the "relevant" market, we use the most disaggregated industry code possible. While we use the industry classification codes reported by firms in the CIT data, Kreuser and Newman (2018) note that the code that comes with the CIT data is inconsistent with other measures of firms' industry codes emanating from other sources. We mitigate this inconsistency by assigning firms to their most frequently observed industry of economic activity in the CIT data, and where no unique mode exists, to their last observed industry of economic activity.[29] In calculating sales shares, we use only domestic sales given that domestic market concentration is most relevant for competition dynamics within South Africa. Excluding export revenues can provide a more reliable picture of domestic market concentration.

(B) **Core variables used in the analysis**: The core variables required for the estimation of the competition indicators and for the subsequent analysis relating competition proxies to firm-level outcomes are sales revenue, intermediate input costs, number of employees, capital, and total employee compensation. Total cost of sales is used as a measure of intermediate inputs costs. The total number of employees is used as labor input in the estimation of the production function and the analysis of job growth. There are many different employment variables reported in the data set. They are based on the different sources of the data (i.e., the IT14 and ITR14 forms), and there are weighted and unweighted versions of each source.[30] We use the period-weighted employment variable from the IRP5 form. A considerable number of employees worked only for some periods during the year - while the unweighted employment variables for a firm count the number of jobs,

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[29] The alternative will be to use the firms' industry classification codes reported on the employee's IRP5 forms, as used by Kreuser and Newman (2018). However, this code is at the more aggregated 2-digit ISIC Fourth Revision level, and hence will considerably depart from the "relevant" market or sector where firms compete. In addition, we believe that using this alternative code will not alter our findings as found by Kreuser and Newman (2018).

[30] The choice of any of these variables is guided by research needs such as the period under study. For further details on how these variables were created, see Pieterse et al. (2018).

not of individuals. Thus, the unweighted employment measures would not distinguish between a full-time employee who worked the whole financial year and a part-time employee who worked for just a few periods of the financial year. Hence, the period-weighted employment variable is closer to the concept of full-time equivalent workers. The period-weighted employment variable in the data set was derived by weighting each employee by the number of periods he/she worked. The total number of employees of each firm is then the sum of the period-weighted employment variable. For capital, we use the value of total fixed assets at the beginning of the year (i.e., the value of property, plant and equipment, other fixed assets and reported depreciation). For wages, although there are three employee expense variables in the data set, we use total employee expenses (including medical, provident and pension fund contributions, but excluding directors' remuneration) as a measure of total employee compensation.[31] We impute for missing values of this variable based on the procedure below. We also make use of value added, defined as sales revenue minus cost, in the analysis.

(C) **Sample restrictions and the creation of the total employee expense variables**:

(a) We drop observations with missing sales data in all the analysis. Other sample restrictions relating to the creation of the competition indicators and any further analysis depend on the core variables needed for the estimation and the subsequent analysis. Except for total employee expenses where some missing values were imputed, details of which are provided below, firm-year observations that are missing the core variables used in the estimation and the subsequent analysis are dropped.

(b) **Assumptions on dormancy**: There are a sizable number of firms with missing or zero sales. We consider such firms as being economically inactive or dormant in those years and as such drop observations for those years. In addition, if a firm is missing cost of sales and all available employee expense data, we drop the observations for those years.

(c) **Creation of the total employee expense variables**: We use two wage variables: (i) total employee expenses including medical, provident and pension fund contributions, but excluding

[31] The other two employee expense variables available in the data set are total employee expenses only (i.e., excluding medical, provident and pension fund contributions) and total employee expenses (including medical, provident, pension fund contributions, and directors' remuneration). Using the former would potentially underestimate the true cost of labor for firms and using the latter, which includes directors' remuneration, would make labor cost less freely adjustable. Besides, directors are generally not considered to be employees of a firm.

directors' remuneration; and (ii) total employee expenses including medical, provident and pension fund contributions and directors' remuneration. We then create two new variables based on these two wage variables and take the following steps to impute values for missing years of the respective two new variables:

Step 1 – **Creating new wage variables**: We start by creating new variables named wagebill1 and wagebill2: wagebill1 to be equal to total employee expenses including medical, provident and pension fund contributions, but excluding directors' remuneration, and wagebill2 to be equal to total employee expenses including medical, provident and pension fund contributions and directors' remuneration.

Step 2 – **Dropping unusable observations**: Some firms have missing or zero cost of sales and missing or zero wagebill1 and wagebill2 data for some years. We considered such firms to be dormant and hence dropped the data for *all years* that they are present in the remaining sample. Similarly, observations of firms with missing or zero cost of sales and – for that year - with missing or zero wagebill1 and wagebill2 data are dropped. In addition, we drop any firm observation for which wagebill1 is greater than wagebill2. Only one observation was dropped by this rule.

Step 3 – **Imputations for missing or zero wagebill1 and wagebill2 variables**: Since positive and non-missing values for wagebill2 are present in all cases where such values exist for wagebill1, but the reverse is not always the case, we first impute for cases where wagebill1 is missing. For each firm, we use the average of the ratio of wagebill2 to wagebill1 to impute for cases where wagebill1 is missing for the firm. Then for the wagebill1, we use the average across all years for each firm to impute for the years for which its values are missing. We do the same for the variable wagebill2.

Step 4: Dropping of remaining firms: Any remaining firms with positive and non-missing cost of sales but missing values for wagebill1 and wagebill2 for all years for which they are in the sample are dropped. After this imputation, we are left with only firms with wagebill1 and wagebill2 data for all years for which they are in the sample.

(D) **Aggregation of firm-level PCM and markup estimates to the market leve**l: We trim the firm-level markup estimates by the top and bottom 1 percent of the 2-digit industry and year distribution before relating them to firm-level characteristics or aggregating to the market level.

We aggregate them to the market level using both simple averages and weighted averages. We use the following three alternative weighting variables: sales, value added and employment.

Commonly-used measures of competition

Measures of competition based on the structural approach from traditional Industrial Organization literature, such as concentration ratios and the Hirschman Herfindahl Index (HHI), infer the level of competition from the structure of a market. However, these measures have been faulted for their inability to reflect certain market dynamics and to capture the true intensity of competition (see the example provided in the paragraph below). Non-structural measures of competition based on the New Empirical Industrial Organization, such as the Lerner Index (the price-cost margin[32]) and the Boone (2000, 2008) indicator, infer the level of competition directly from firms' conduct.

While these indicators are intuitive and relatively simple to derive from balance-sheet data, changes in indicators of concentration indices and market-level PCM could provide a misleading picture of the dynamics of competitive conditions because their measurement often fails to account for important features of certain market dynamics. For instance, market-level PCM and concentration indices like HHI are not strictly monotonic to changes in competition intensity. While an increase in the magnitude of these indicators is often taken as being indicative of a reduction in competition, an increase may also be consistent with higher competition intensity due to reallocation and selection effects. For example, if the dissolution of a price-fixing or quantity-fixing cartel intensifies competition between incumbents, then market shares of more efficient firms could increase at the expense of less efficient firms (i.e., a reallocation effect) and some inefficient firms may even exit the market (i.e., a selection effect). This would lead to a rise in concentration indices and market-level PCM, which could be wrongly interpreted as a decrease in competition intensity.[33]

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[32] The price-cost margin (PCM) is a measure of a firm's profit margins. As an approximation of a firm's markup, it is, to some extent, a measure of the market pricing power of firms. PCM is calculated as the difference between output price and marginal cost of production as a proportion of output price, while markup is calculated as the ratio of output price to marginal costs.

[33] In addition, these indicators fail to account for the realities of certain markets and hence do not properly proxy for the degree of market power. This is often the case in technology-driven markets. For example, in telecommunications, the cost structure of firms is such that marginal cost pricing is unrealistic. In digital markets where multi-sided digital platforms are prevalent, firms will often charge zero prices to one side of the market in order to attract players on another side of the market. Other situations where such indicators may fail to account for the realities include

A more recent indicator that is gaining ground as a measure of competition due to its ability to capture these market dynamics is the Boone indicator. This indicator is centered on the notion that competition rewards efficiency and punishes inefficiency by reallocating market shares from inefficient firms to the more efficient ones.[34] Therefore, firms that are more efficient (and hence have lower marginal cost of production) benefit more from competition. A common form of the Boone indicator is based on profit elasticity within a market, which measures the percentage increase in profits due to a percentage fall in efficiency (often proxied by marginal costs). The Boone Indicator is therefore specified at the market level and as such does not lend itself to further firm-level analysis that relates competition to firm-level outcomes.

Empirical framework for obtaining firm-level markups and output elasticities

The derivation of our firm-level markups using production data follows the methodology of De Loecker and Wazynski (DLW, 2012), which relies on the insight pioneered by Hall (1986, 1988). The DLW method is a structural estimation of markup at the firm level, while controlling for productivity shocks. In this section, we describe the DLW methodology. We refer the reader to DLW (2012) for a more detailed discussion.

The key assumption of the method is that firms act as cost minimizers. The method then relies on cost-minimizing firms and the existence of at least one variable input of production that is free of adjustment costs. The central idea of the method, which is based on standard first-order conditions on cost minimization, is that for a cost minimizing firm, the output elasticity of a variable production input (that is free of adjustment costs) should equal its expenditure share in total revenue when competition is perfect (i.e. price equals marginal cost). When competition is imperfect, any wedge between an input's output elasticity and its revenue share should capture markup.

A firm *i* at time *t* produces output using the following production technology:

$$Q_{it} = Q_{it}(X_{it}, K_{it}, \Omega_{it}) \qquad (1)$$

contestable markets and potential entrants, collusion, Bertrand-style competition, and cases where production levels are not easily adjustable.

[34] With the assumptions that firm-level efficiency levels are observable, that firms differ in their efficiency levels and that firms of the same level of efficiency (when competing on a level playing field) earn similar profits.

where X_{it} is a vector of variable inputs such as labor, intermediate inputs, and electricity, K_{it} is a dynamic input in production such as capital stock, Ω_{it} is firm-specific productivity term, and $Q_{it}(.)$ is continuous and twice differentiable with respect to its arguments. The Lagrangian function for cost minimization is then

$$L(X_{it}, K_{it}, \lambda_{it}) = \sum_{v=1}^{V} p_{it}^{X} X_{it} + r_{it} K_{it} + \lambda_{it}(Q_{it} - \bar{Q}_{it}(.)) \qquad (2)$$

where p_{it}^{X} and r_{it} are the firm's input price for a variable input V and capital, respectively. The first-order cost-minimizing condition for any variable input that is free of any adjustment costs is

$$\frac{\partial L}{\partial X_{it}} = p_{it}^{X} - \lambda_{it} \frac{\partial Q_{it}(.)}{\partial X_{it}} = 0 \qquad (3)$$

where $\lambda_{it} = \frac{\partial L}{\partial Q_{it}}$ is the marginal cost of production at a given output level. Rearranging equation (3) and multiplying both sides by $\frac{X_{it}}{Q_{it}}$ gives

$$\theta_{it}^{X} = \underbrace{\frac{\partial Q_{it}(.)}{\partial X_{it}} \frac{X_{it}}{Q_{it}}}_{\text{Output elasticity}} = \frac{1}{\lambda_{it}} \frac{p_{it}^{X} X_{it}}{Q_{it}} \qquad (4)$$

Note that equation (4) conditions on the use of dynamic inputs of production such as capital, and potentially other production inputs facing adjustment costs.

(Static) price setting implies that markup (defined as the ratio of output price over marginal cost) is $\mu_{it} = \frac{P_{it}}{\lambda_{it}}$, which then implies

$$\frac{1}{\lambda_{it}} = \frac{\mu_{it}}{P_{it}} \qquad (5)$$

Substituting equation (5) into (4) and rearranging gives the formula for recovering firm-level markups as

$$\mu_{it} = \frac{\theta_{it}^{X}}{\left(\frac{p_{it}^{X} X}{P_{it} Q_{it}}\right)} \qquad (6)$$

where $p_{it}^X X_{it}$ is expenditure on input X_{it} and $P_{it}Q_{it}$ is total revenue. Thus $\frac{p_{it}^X X_{it}}{P_{it}Q_{it}}$ is the expenditure input share of X in total revenue. Under perfect competition, price equals marginal cost, and so markup $\mu_{it} = \frac{P_{it}}{\lambda_{it}} = 1$ and therefore equation (6) becomes $\theta_{it}^X = \frac{p_{it}^X X_{it}}{P_{it}Q_{it}}$.

While the revenue share of the variable production inputs (that is free of any adjustment costs), $\frac{p_{it}^X X_{it}}{P_{it}Q_{it}}$, is directly observed in the data, the output elasticity, θ_{it}^X, must be estimated from a production function.

Thus, the approach requires an estimation of the production function to recover the output elasticities. We assume a translog production function[35] with Hicks-neutral productivity and estimate the following production function on gross output (revenue):

$$y_{it} = \alpha_{it} + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{lk} l_{it} k_{it} + \beta_{lm} l_{it} m_{it} + \beta_{km} k_{it} m_{it} + \omega_{it} + \epsilon_{it} \qquad (7)$$

where y is gross output (or sales revenue), l is labor (the number of employees), k is capital stock (the book value of tangible assets), m is materials (the value of material inputs used directly for production), ω is total factor productivity, and ϵ error term, respectively. All the variables are in log form. The β's are the parameters to be estimated.

In the absence of physical quantities or firm-level prices, we deflate all variables with industry-specific price indices; value added or sales revenue by subindustry-level deflators from the Producer Price Index, material costs by deflators based on input-output tables and capital by deflators constructed from the Gross Fixed Capital Formation. As noted by DLW (2012), the use of deflation only affects the level of the markup estimates, and not the correlation between markups and firm-level characteristics.

[35] The alternative would have been to use a Cobb-Douglass specification. However, doing so would result in all firms in a sector having the same output elasticities. This will make the elasticity independent of input use intensity, which could lead to variations in technology being attributed to variation in markups. This will potentially bias the results when analyzing markup differences across firms.

We estimate the production function using the Ackerberg, Caves, and Frazer (ACF, 2015) two-step estimator,[36] which corrects for the standard simultaneity problem. This requires using 1-year lagged values of the instrument(s) which means remaining firms must have at least two consecutive years of information on the core variables needed for the estimation of the output elasticities and the recovery of markups. We estimate the production functions at the 2-digit industry level to allow for industry differences in the production technology. Under a translog gross output production function, the output elasticity for materials (m) is given by

$$\hat{\theta}_{it}^{m} = \hat{\beta}_m + 2\hat{\beta}_{mm}m_{it} + \hat{\beta}_{lm}l_{it} + \hat{\beta}_{km}k_{it} \qquad (8)$$

We compute markups using the estimates of output elasticity $\hat{\theta}_{it}^{m}$ and data on firm-level materials expenditures and total revenues. From (6) above, we use

$$\hat{\boldsymbol{\mu}}_{it} = \frac{\hat{\theta}_{it}^{m}}{\left(\left(\frac{materials\ costs}{\text{total revenue}}\right)\Big/_{\exp(\hat{\epsilon}_{it})}\right)}$$

where the additional term $\exp(\hat{\epsilon}_{it})$ in the empirical specification is to allow for measurement error in output observed in the data and for unanticipated shocks to production, which are combined into ϵ such that observed output is $\check{Q}_{it} = Q_{it}\exp(\epsilon_{it})$ or $y_{it} = \ln Q_{it} + \epsilon_{it}$ in log terms. Thus, $\hat{\epsilon}_{it}$ is the residual from the first-stage regression**.** This correction in the empirical specification is important as it removes any expenditure shares variation emanating from output variation that are unrelated to variables affecting input demand including input prices, productivity, technology parameters, and market characteristics, such as the elasticity of demand and income levels.

[36] The ACF approach, unlike the Olley and Pakes (1996) and Levinsohn and Petrin (2003) approaches, does not identify any coefficients of interest in the first stage estimation routine. Instead, all input coefficients are estimated in the second stage.

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