



Rising to the challenge or perish? Chinese import penetration and its impact on growth dynamics of manufacturing firms in South Africa

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ABSTRACT

Using firm-level tax administrative data from 2010 to 2017, we study the extent to which Chinese import penetration has affected the growth performances of manufacturing firms registered in South Africa. By instrumenting Chinese imports to South Africa with Chinese exports to other developing countries, this paper analyses both the systemic and heterogeneous impact of Chinese import penetration on South Africa-based manufacturing firms. First, we study whether China's import competition has been associated with a downsizing of manufacturing firms in terms of decreasing employment and sales growth, and higher probability of exiting the market, both within the same sector (*direct* import penetration's effect) and across sectors along domestic value chains through input–output linkages (*indirect* import penetration's effect). Second, we test whether firms investing more intensively in their capabilities development—notably in their skills development, production technologies and related process upgrading—are better able to cope with such direct and indirect competitive pressure. Our results indicate that rising exposure to Chinese imports—not only direct one, but also in downstream segments of the domestic value chain—leads to slower sales and employment growth for the entire sample of surviving firms and to a higher probability of shutdown for firms not undertaking significant investments in their capabilities development. However, we also find that, within industries, firms investing relatively more intensively in skills development, production technologies and related process upgrading are more likely to survive and grow despite rising import competition.

1. Introduction

The opportunities and challenges associated with increasing South–South foreign direct investments (FDIs), trade and global value chain (GVCs) integration have taken centre-stage in the academic and policy debate across developing countries (Amighini and Sanfilippo, 2014; UNCTAD, 2015; Amendolagine et al., 2019; Mawdsley, 2019). 'Primarisation' and 'premature deindustrialisation' dynamics experienced by most developing countries since the fast and unregulated trade liberalisation of the 1980s have animated these debates (Paus, 2019; Andreoni and Tregenna, 2020).¹ South–South FDIs and trade have increased significantly over the last two decades and have been seen as

potential new pathways for structural transformation.

South–South FDIs driven by both market-seeking and resource-seeking motives (Gelb, 2005) have been seen as potentially 'more appropriate' because of the higher scope for technology absorption. Fu et al. (2020) provide a framework to disentangle how FDIs may or may not help the host country to unlock its growth potential and overcome binding constraints depending on their 'appropriate compatibilities'. Their comparison between Chinese and US FDIs support the evidence of differential impacts in the host developing countries, with Chinese FDIs having a higher positive impact on employment and productivity growth in low-income countries. Anzolin et al. (2022) find evidence of the importance of domestic capabilities of the hosting country in

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¹ Primarisation of a country's economic structure is represented by a rising share of primary commodities in its export baskets. Over the past three decades, many developing countries have not been able to make significant progresses in terms of their exports' sophistication and, in many instances, they have even reverted to their comparative advantage in natural resources – i.e., re-primarisation (Jenkins, 2014; Paus, 2019). Premature deindustrialisation refers to the case of a country which deindustrialises at a lower level of income per capita than would be typical by international standards. Widespread premature deindustrialisation trends have been documented among many LMICs (Tregenna, 2016a), and it has been linked also to trade liberalisation and the impact of the rise of China (Rodrik, 2016).

increasing the potential of FDI-driven technology transfer.

China looms large in the discussions related to trade and GVCs, given the massive gains in its world shares in manufacturing value added (MVA)² and exports since the mid-1990s (Haraguchi et al., 2017; Lin, 2011). China's upgrade from global assembler to parts provider and system integrator along GVCs, even in some advanced manufacturing technology segments (Fu, 2016; Zhou et al., 2016; Tassej, 2014), has opened important questions regarding its impact on the rest of the world. An increasing amount of contributions have investigated the impact of Chinese import competition on firm performances in advanced economies (Bernard et al., 2006; Bloom et al., 2016; Colantone et al., 2015; Hombert and Matray, 2018; Mion and Zhu, 2013). The literature has concluded that for this group of countries the exogenous productivity driven shock of China's import penetration was over by 2008. However, due to limited availability of longitudinal micro-datasets, only a few studies have been able to produce econometric evidence on the impact of Chinese import competition for LMICs (Alvarez and Claro, 2009; Iacovone et al., 2013; Hou et al., 2021). Even in these limited cases, the heterogeneous and systemic impact of import competition have been only partially addressed.

The recent availability of tax administrative data for South Africa-based companies allows us to contribute to filling this knowledge gap in two ways. First, we study whether China's import competition has been associated with a downsizing of manufacturing firms in terms of decreasing employment and sales growth, and higher probability of exiting the market, both within the same sector (*direct* import penetration's impact) and across sectors, along domestic value chains through input–output linkages (*indirect* import penetration's impact). Second, we analyse whether firms investing relatively more intensively in certain technology and productive capabilities—notably process and product innovation and skills development—are better able to cope with Chinese import competition. To the best of our knowledge, this is the first empirical firm-level study to investigate this issue in South Africa.

Our results indicate that, at the industry level, rising exposure to Chinese imports—not only direct ones but also in downstream segments of the domestic value chain—leads to slower sales and employment growth for the entire sample of surviving firms and to a higher probability of shutdown for firms that do not undertake significant investments in capabilities development. However, we also find that, within industries, firms investing relatively more intensively in skills development, production technologies and related process upgrading are more likely to survive and grow in the wake of import competition. This new evidence contributes to the debate about whether and how recent globalisation, particularly the rise of China, has shifted the goal posts for firms in middle-income countries, intensifying the challenges they face and increasing the urgency to strengthen domestic innovation capabilities.

The remainder of the paper is organised as follows. Section 2 reviews the relevant literature focusing on the specific ways in which a surge in Chinese import penetration can impact relatively less developed industrial systems like South Africa's. In Section 3 we contextualise the issues of interest focusing on the South Africa-China relationship. Section 4 introduces the data and describes the empirical strategy. The main econometric findings are summarised and analysed in Section 5. The final section provides concluding remarks.

2. Literature review

Since China's surge in international trade, a large body of literature has analysed the impact of Chinese import penetration on the domestic production systems of both developed and developing countries,

² MVA is defined as the total estimate of net-output of all resident manufacturing activity units obtained by adding up outputs and subtracting intermediate consumption.

focusing on different dimensions and levels of aggregation. Several studies of industries and local labour markets have documented the contractionary effects on manufacturing employment of the competitive pressure driven by the surge of Chinese imports, both in advanced (Acemoglu et al., 2016; Autor et al., 2013; Balsvik et al., 2015; Donoso et al., 2015; Malgouyres, 2016; Breemers et al., 2019) and emerging countries (Mendez, 2015; Paz, 2018; Sotiriou and Rodríguez-Pose, 2021). Other plant- and firm-level studies have found similar negative effects of increasing Chinese import penetration in terms of employment growth, output growth and survival rates in the manufacturing sector (Bernard et al., 2006; Alvarez and Claro, 2009; Mion and Zhu, 2013; Iacovone et al., 2013; Colantone et al., 2015). However, these studies also pointed to specific features that allow certain firms to better cope with rising import penetration. Bernard et al. (2006) showed that capital- and skill-intensive plants in the United States from 1977 to 1997 were more likely to survive and grow in light of increasing import competition. Hombert and Matray (2018) updated these results for the US and showed that in the 1991–2007 period firms with larger stocks of R&D are more resilient to such trade shocks.

There are only a few systematic studies focusing on developing and middle-income economies. Alvarez and Claro (2009) found that, over the period 1990–2000, Chinese import penetration has driven a decline in employment growth and survival rates for firms in the Chilean manufacturing sector.³ Iacovone et al. (2013) evaluated the effects of increasing Chinese import competition for producers in Mexico and find that sales of smaller plants and more marginal products shrink substantially and are more likely to further decline toward zero, whereas those of larger plants and core products seem relatively more resilient to increased import competition.

To date only two studies have looked at firms in Africa. Darko et al. (2021) find that increasing Chinese competition impacts positively on firm productivity in 24 sub-Saharan Africa countries, mainly through imports of intermediate inputs, and there is significant heterogeneity of these effects in terms of firms' proximity to ports and initial productivity level. Hou et al. (2021) use firm and industry level panel data to investigate the impact of Ghana-China trade on labour productivity and compares it with Ghana-OECD trade. They find that China imports creates greater potentials for Ghanaian manufacturing firms to raise productivity, although more exports to China only enhance productivity in industries in which Ghana has a comparative advantage.

A growing body of literature on firm dynamics have highlighted how the heterogeneity in firm-level characteristics explain differences across firms' performances (Bottazzi et al., 2010; Dosi et al., 2012, 2015; Mathew, 2017; Dosi and Yu, 2019). In principle, investments in skills, production technologies and process upgrading can moderate the effect of trade shocks on firm growth through different channels, such as an increase in productivity (Grossman and Helpman, 1991; Lichtenberg and Siegel, 1991; Aghion and Howitt, 1992), in product differentiation (Sutton, 1991), and market and/or product diversification (Coand and Guenther, 2014).

These hypotheses are strongly supported by evolutionary, resource-based and capability theories of the firm (Penrose, 1959; Amsden, 1997; Dosi et al., 1990, 2001; Lall, 1992, 1999; Lin and Chang, 2009; Andreoni, 2014), which suggest how firms' reactions to competitive pressure and their growth performances critically depend on their different capabilities, specifically how they organise these capabilities in response to changing opportunities, incentives and rising competitive challenges. These authors have emphasised the importance of

³ Alvarez and Claro (2009) found no evidence of any pro-competitive and upgrading effect on capital and skill deepening, productivity catch-up, or increased exporting activities. They associated these negative findings with the low levels of capital and skilled labour, which may have limited the ability of Chilean firms to move towards more sophisticated products in response to import competition.

technology and productive capabilities (such as skills, physical investments, technological and innovation efforts) for firms to manage and advance technological change (Bell and Pavitt, 1993; Lall, 1992; Lee, 2013; Penrose, 1959), to absorb technologies (Cohen and Levinthal 1989), to benefit from participation in trade (Dosi et al., 1990; Lall, 1992) and GVCs (Lee et al., 2018; Milberg and Winkler, 2013; Morrison et al., 2008; Andreoni et al., 2021), and to reconfigure and renew themselves in a changing competitive environment (Teece and Pisano, 1994; Dosi et al., 2001; Winter, 2003).

Engaging in trading activities is one of the key learning channels through which firms can develop these capabilities, starting from exporting products characterised by short-learning cycles up to longer ones (Lee, 2013). Access to cheaper industrial inputs via import can also provide a faster pathway to link up into GVCs and, in some cases, disrupt highly concentrated upstream industries. To make this linking up process effective, firms need also to link back into the local economy, hence developing both vertical linkages along the GVCs and horizontal ones (Andreoni and Tregenna, 2020).

The present work also relates to the literature on the diffusion of shocks (Acemoglu et al., 2012; Contreras and Fagiolo, 2014) and foreign direct investment (FDI) spillovers (Javorcik, 2004; Javorcik and Spatareanu, 2011; Newman et al., 2015) through the input–output network of an economy. Following a methodology similar to the one developed by Acemoglu et al. (2016) and Pierce and Schott (2016), our empirical analysis also takes into account the impact of indirect Chinese import penetration and competitive pressure spreading from directly affected firms to others through input–output linkages in downstream and upstream industries.⁴ The importance of disentangling this form of impact of import penetration is also inspired by multi-sectoral models and industrial development literature emphasising the importance of these intersectoral linkages in countries' economic structures and how a number of different shocks (such as targeted policies, investments, opening to trade, linking to GVCs), acting upon these industrial interdependencies, might force countries towards extremely diverse development paths (Hirschman, 1977; Bahar et al., 2019; Chang and Andreoni, 2020).

In the post-apartheid period, rapid trade liberalisation represented a major shock for South African industries. Since then, the lack of dynamism of the manufacturing sector has been regarded as a key factor in explaining stagnant growth and persistently high unemployment levels (Rodrik, 2008; Tregenna, 2016b). These weak performances and various other signs of premature deindustrialisation have also been associated with the competitive pressure from imports resulting from the multilateral trade reform of the early 1990s (Erten et al., 2019; Rodrik, 2008) and, more recently, from the rapid growth in imports from China following its accession to the WTO in 2001 (Edwards and Jenkins, 2015; Jenkins, 2008).

Detailed sectoral analysis and case studies of the implications of Chinese imports for South Africa generally find adverse effects on domestic production and employment and a crowding out of exports to third countries (Edwards and Jenkins, 2014, 2015; Jenkins, 2008; Morris and Einhorn, 2008). On one hand, Morris and Einhorn (2008) showed how import competition from China in the South African clothing and textile sector enhances consumer welfare, while leading to a negative employment effect in the domestic industry. On the other hand, using Chenery-style decomposition techniques, Edwards and Jenkins (2015) documented that labour-intensive industries exposed to import competition from China suffered large employment declines from 1992 to 2010. Overall, these studies suggest that the competitive pressure exerted by Chinese exports to South Africa has increased rapidly over recent decades, partly at the expense of imports from third

countries, but more importantly crowding out domestic manufacturing production.

Given China's industrial competitiveness and scale capabilities, import penetration to South Africa has the potential to displace and crowd-out exactly those firms who cannot sustain price competitiveness in downstream industries (e.g. garments, manufactured components), but also those in upstream and integrated industries whose efficiency and price competitiveness is dependant on access to large markets (e.g. steel and automotive).⁵ Despite South Africa structural weaknesses and lack of diversification, the country has developed niches of productivity amongst firms operating in medium and advanced manufacturing sectors, prominently mining equipment (Andreoni et al., 2021). We can therefore expect that import penetration can have a disproportional effect due to firm heterogeneity and their different levels of resilience.

3. Context

Since the end of the apartheid era, South Africa's increasing integration into the global economy and the ongoing intensification of import competition from China have gone hand-in-hand with severe unemployment, poor growth performance, and persistent structural transformation challenges (Andreoni et al., 2021).

Following China's accession to the world trade organisation (WTO) in 2001, trade relations between South Africa and China have deepened rapidly with an acceleration following the global financial crisis of 2008. Between 2010 and 2017, China experienced a 65 per cent increase in its MVA, accounting for over 70 per cent of the worldwide increase in MVA that occurred in low- and middle-income economies (LMICs). During the same period, China was responsible for over 53 per cent of the total increase in global manufacturing imports in other LMICs. In 2017, China accounted for over 90 per cent of total manufacturing exports intra LMICs, and from 2010 to 2016 the domestic value-added of its gross manufacturing exports to non-OECD (Organisation for Economic Cooperation and Development) economies increased by 5 percentage points, from around 76 per cent to over 81 per cent.⁶

In 2009, China became South Africa's top export destination, overtaking the United States, and its largest supplier of imports, surpassing Germany. Two main factors were responsible for this acceleration. First, China's increasing thirst for minerals and raw materials to sustain industrial output expansion. Before the global financial crisis of 2008, South Africa accounted for 3.4 percent of total minerals imported by China with a trade value below 2 billion US\$ (2007). By 2009, South Africa accounted for 5.3 percent of total mineral imported by China with a trade value over 6 billion US\$ (2010). Second, while during the mid-1990s China represented a major source of imports in the traditional low-technology and labour-intensive sectors—such as textiles, clothing and footwear—by the 2010s Chinese import penetration had shifted towards medium- and high-technology products such as electronics and machinery (Edwards and Jenkins, 2015).

Using aggregate industry data, Fig. 1 reports on the surge of Chinese manufacturing imports entering South Africa and also provides suggestive evidence of the shrinkage of the domestic manufacturing sector during the period under analysis. From 2010 to 2017, Chinese imports in South Africa's manufacturing sector grew rapidly from 5 per cent of total domestic consumption to over 8 per cent, while the shares of manufacturing in total output and employment have shown a slow but steady declining trend.

Since 2010, the surge in trade structure imbalances and the evolving composition of these bilateral trade flows with China have prompted an

⁴ Acemoglu et al. (2016), however, regressed the change in log employment at the level of the manufacturing industries (rather than firms) on changes in the Chinese import penetration rate (rather than its previous level).

⁵ Edwards and Jenkins (2015) find that the negative impact of China on output and employment in South Africa has been particularly significant in the labour-intensive clothing, footwear and textile sectors.

⁶ Own calculations using data from INDSTAT (2018), UN Comtrade (2018) and OECD-TiVA (2018).

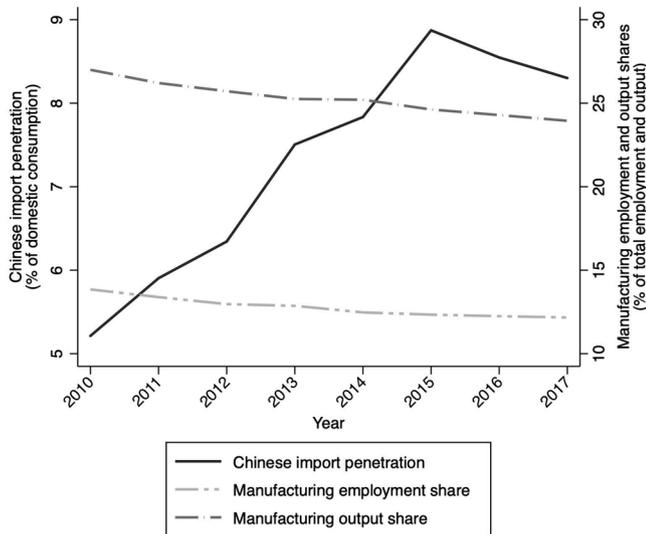


Fig. 1. Trends in manufacturing output, employment, and Chinese import exposure in South Africa, 2010–2017. Note: The import penetration ratio for South African imports from China (left scale), share of South African, manufacturing output (employment) in total output (employment) (right scale). Source: Authors’ calculations using UN Comtrade (2018), Statistics South Africa (2018a,b).

active debate about the deindustrialisation and ‘primarisation’ trajectories of the South African economy, its impact on domestic manufacturing production and employment, as well as the future terms of engagement with China (South African Government, 2018; Andreoni et al., 2021). Despite these concerns, no comprehensive studies have attempted to investigate the impact of Chinese import penetration on the growth dynamics of manufacturing firms in South Africa.

4. Materials and methods

4.1. Data and variables

This study uses information from three different sources. Import penetration variables—direct and indirect—are constructed using trade information provided by the UN Comtrade database, and production and input–output data made available by Statistics South Africa, while firm-level data from company and employee income tax certificates are obtained from SARS.

4.1.1. Measuring direct import penetration

Our main industry-level import penetration variable is computed as the ratio of sectoral imports from China (PEN^{CHN}) to apparent⁷ sector-specific consumption in each year. Analytically:

$$PEN_{s,t}^{CHN} = \frac{M_{s,t}^{CHN}}{M_{s,t} + Y_{s,t} - X_{s,t}} \tag{1}$$

where $M_{s,t}^{CHN}$ is the value of imports from China in sector s in year t ; $M_{s,t}$ is the value of total imports (including China) in sector s in year t ; while $Y_{s,t}$ and $X_{s,t}$ represent the South African sectoral domestic production and exports, respectively.

Industry-level production data are provided by the Manufacturing Sales and Production database of Statistics South Africa for 42 manufacturing sub-sectors (Statistics South Africa, 2018b). Imports and

⁷ Apparent consumption is used here as a proxy measure for consumption of a specific product, defined as production plus imports minus exports of that product.

exports data come from the UN Comtrade database (UN Comtrade, 2018). Using official correspondence tables, we convert trade data at the six-digit commodity level of the World Customs Organisation Harmonised System (HS-2007) into International Standard Industrial Classification of All Economic Activities (ISIC4) manufacturing sectors. These groups are then adjusted slightly to exactly match the industry classification adopted by Statistics South Africa.

Fig. 2 reports the levels (a) and the changes (b) of Chinese import penetration in the South African manufacturing industries for the 2010–2017 period. It shows that, while in 2017 China still represented a major source of imports in the traditional low-technology and labour-intensive sectors such as textiles and clothing, during the 2010–2017 period its dominance shifted to medium- and high-technology sectors such as electronics, non-electrical machinery and professional and scientific instruments.⁸

4.1.2. Measuring indirect import penetration

In addition to the direct import penetration calculated as indicated above, our econometric analysis also takes into account the impact of import penetration on the growth of firms indirectly exposed to Chinese import penetration through input–output relationships along domestic value chains. Specifically, we focus on both import penetration affecting a firm’s downstream clients—*upstream effects*—and a firm’s upstream suppliers—*downstream effects*. Following Acemoglu et al. (2016), to identify the upstream effect, we compute the following variable for each sector s :

$$PEN_{s,t}^{CHN, UP} = \sum_k w_{k,s,2008}^{UP} \times PEN_{k,t}^{CHN} \tag{2}$$

which is equal to the weighted average of import penetration faced in year t by all the industries, indexed by k , that purchase inputs from sector s . These weights ($w_{k,s,2008}^{UP}$) are defined as:

$$w_{k,s,2008}^{UP} = \frac{\mu_{k,s,2008}^{UP}}{\sum_{k'} w_{k',s,2008}^{UP}} \tag{3}$$

where $\mu_{k,s,2008}^{UP}$ represents the value in the 2008 South African input–output table of the output of sector s purchased by industry k , such that the weight reported in Eq. (3) constitutes the proportion of total sales of industry s that industry k uses as inputs within its production process. We decided to use the 2008 input–output table rather than time-varying input–output coefficients since it predates the period covered in our analysis and thus measures sectoral interdependencies that are unlikely to be endogenous to the subsequent import penetration.⁹

Following a similar approach, we estimate the downstream effect ($PEN_{s,t}^{CHN, DOWN}$) and experienced by each sector s as the weighted average of import penetration faced in year t by all the industries, indexed by k , from which industry s buys its inputs. For this purpose, we use the same formula as the one reported in Eq. (2) after reversing the s and k indexes in the numerator of Eq. (3).¹⁰ The formula in Eq. (2) refers to the direct (namely, first-order) effects on a given industry s arising from the import penetration exposure faced by its direct suppliers and buyers. In order to

⁸ Sectors are grouped by technological categories on the basis of the classification proposed by Lall (2000) and reported in Table A1 in the Appendix. We believe that this classification is better suited to a country such as South Africa than the one proposed by Hatzichronoglou (1997) and used by the OECD, which is based on direct R&D intensity and R&D embodied in intermediate and investment goods in a subset of advanced countries.

⁹ Input–output table from 2008 has been preferred to the version of 2009 because the effects of the global financial crisis unfolded in South Africa in 2009.

¹⁰ We restrict the analysis of the impact of indirect import competition on manufacturing firms to all non-services industries.

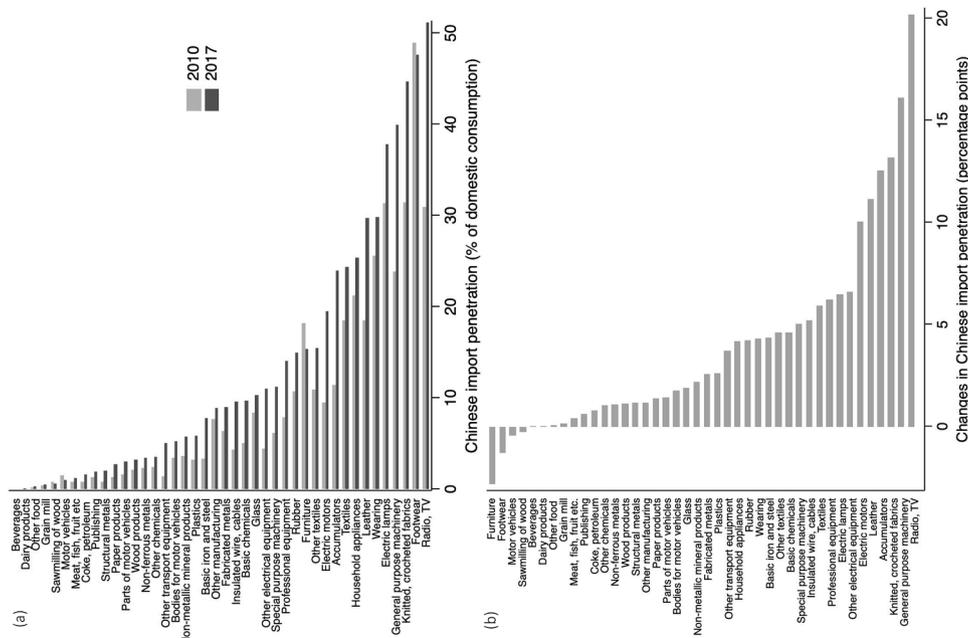


Fig. 2. Levels and changes of Chinese import penetration across South African manufacturing sectors, 2010–2017. Source: authors’ calculations using UN Comtrade (2018), Statistics South Africa (2018b).

account for the full production chain of interdependent downstream and upstream linkages (such as the import penetration exposure faced by all suppliers’ suppliers and buyers’ buyers of sector s), in some additional estimates we also substitute $PEN_{s,t}^{CHN,UP}$ and $PEN_{s,t}^{CHN,DOWN}$ with the entire series of implied responses from the input–output table, given by the Leontief inverse of the matrix of upstream and downstream linkages.

4.2. Main firm-level outcome variables and controls

The primary firm-level data source is the South African Corporate Income Tax (CIT) data, which includes firms’ self-reported items with respect to income, expenditures, equity and liabilities, capital items, and tax credits.¹¹

Starting from this source, we use employee income tax certificates (IRP5 forms) to construct a measure of labour employed by each firm. The data are then restricted to cover the population of manufacturing firms for the 2010–2017 period. In order to systematically identify manufacturing firms, we use the main industry code of the Standard Industrial Classification (SIC7), provided by the CIT database. These codes are then converted to the fourth revision of ISIC (ISIC4) and adjusted slightly¹² to exactly match the industry grouping adopted by Statistics South Africa as described in the subsection ‘Measuring direct import exposure’. Finally, we exclude from the sample those firms with non-positive and missing employment, sales, value-added and capital data. Our final full sample covers over 22,000 firm observations for each

¹¹ For a full description of the dataset and how it is constructed and compiled, see Kreuser and Newman (2018) and Pieterse et al. (2018). The analysis undertaken in our paper is based on the version of the dataset available in March 2019.

¹² In order to ensure consistency with sectoral trade data, we aggregate ‘Publishing’ (324) with ‘Printing and related services’ (325/6) and ‘Electrical motors, generators and transformers’ (361) with ‘Electricity distribution and control apparatus’ (362). Tobacco products are excluded as sales data are not provided by Statistics South Africa.

year between 2010 and 2017, distributed over 42 manufacturing sectors.¹³ To give a sense of the representativeness of our final sample, we have compared the resulting total sales and employment figures at the aggregated level with other official sources of South African firm data as the Quarterly Financial Statistics (QFS) and the Quarterly Employment Statistics (QES). Our final sample captures between 84 and 91 per cent of total sales in the QFS (Statistics South Africa, 2018c), while it overestimates the total employment in the QES (Statistics South Africa, 2018a) by between 7 and 12 per cent.¹⁴ These differences are mainly due to the assignment of different sectoral classifications to the firms by SARS than those used by Statistics South Africa (Pieterse et al., 2018).

Using information from the resulting dataset, we construct a battery of firm-level measures of firm growth, to be used as dependant variables in the subsequent analysis. To address potential endogeneity problems, we follow Bernard and Jensen (2004) and use firm covariates at time t while considering dependant variables at time $t + 1$. The first outcome variable used is firm employment growth— $\Delta \log(\text{Employment})_{i,s}^{t,t+1}$ —which is defined as the log difference between a firm’s full-time equivalent total employment in year $t + 1$ and t . The second variable is output growth— $\Delta \log(\text{Sales})_{i,s}^{t,t+1}$ —which is defined as the log difference between a firm’s total sales in year $t + 1$ and t . Finally, as an additional dependant variable we consider firm exit— $\text{Death}_{i,s}^{t,t+1}$ —which takes a value of 1 for firms operating in t but not operating in $t + 1$, and 0 for firms operating in both periods.¹⁵

For explanatory variables, we consider several covariates. First, the log of total employment ($\log(E)_{i,t}$) and the log of the number of years since registration plus 1 ($\log(\text{Age})_{i,t}$) are used as measures for firm size and age, respectively. Second, we explore the richness of our dataset to identify specific firm-level variables related to investments in certain

¹³ As done in Kreuser and Newman (2018), we cut the top and bottom 1% of firms with respect to the value added to capital ratio in each year to remove outliers.

¹⁴ See also Pieterse et al. (2018) for similar results on a previous version of the panel.

¹⁵ For firms that exit and enter the dataset many times, we consider the shutdown year to be only the one of their final appearance.

technology and productive capabilities development, serving as indicators for the intensity of firms' expenditures in skills development, production technologies and related process upgrading. Unlike innovation surveys, our data source, as an administrative dataset, does not provide any direct and output measure on process and product innovation. Furthermore, the IRP5 forms do not include any information on the skill levels of employees. To overcome these data limitations, we use indirect and input measures of production and technology capabilities as the main covariates of interest in our analysis.¹⁶ The relative levels of investments efforts in production technologies and related process upgrading are proxied by investment intensity in physical capital ($INVST_{i,t}$) which is measured as the yearly additions to the firm's net assets in physical capital (that is gross assets adjusted for depreciation), normalised by sales.¹⁷ The relative levels of spending in product innovation are measured as the ratio of R&D expenses and total sales: $R\&D_{i,t}$. Finally, the relative levels of spending in skills development are operationalised as the ratio of staff training expenses and total sales: $TRAIN_{i,t}$. The focus on these three sets of input measures of production and technology capabilities is also very much in line with recent research looking at the drivers of firm innovation in many African and Latin American countries (Paus et al., 2022). To identify those firms investing intensively in capabilities' development, we build a battery of dummies taking value 1 if the investment intensity of firm i in year t in physical capital, R&D and training programs, respectively, is larger than the sectoral median. These are denoted below as $(d) INVST_{i,t}$, $(d) R\&D_{i,t}$, $(d) TRAIN_{i,t}$.

Tables A2, A3 and A4 in the Appendix reports descriptive statistics (Table A2) and evidence on the main variables used in the regression analysis. More specifically, Table A3 shows that more of the medium and especially large firms spend greater shares of their turnover on innovation- and training-related expenditures when compared to smaller firms. Table A4 reports suggestive evidence of the superior performance of firms investing in one or more activities related to capabilities development when compared to firms not investing in any of these during the 2010–17 period.

4.3. Empirical strategy and expected results

The basic idea of our analysis is to study the impact of both the direct and indirect Chinese import competitive pressure, controlling for firm heterogeneity within industries in terms of investment in process and product innovation and skills development. On one hand, we examine whether Chinese competition has generated a negative impact on manufacturing firms, either affecting their employment decisions, their output dynamics, or their probability of closing down. On the other hand, we explore to what extent, within industries, firms investing relatively more intensively in process and product innovation and skills development are better able to cope with Chinese competition with respect to the outcome variables introduced above. These outcomes between t and $t + 1$ are related to three different sets of variables. The

¹⁶ An underlying assumption here, generally confirmed by the literature, is that the likelihood of being an innovative firm (unobserved in our case) is positively associated with the intensity of its investment efforts in technology and related process upgrading. The logic informing this choice is that firms which are innovating their products need to invest in second order learning efforts, hence in deliberate attempts to improve product via R&D in materials, markets, customers etc.

¹⁷ In order to compute such a variable, we use the assets in property, plant, and equipment, which identify the maximum level of disaggregation with respect to physical capital included in the ITR14 form. As constructed, our investment intensity variable is directly capturing firms' net investment efforts in their production technologies (e.g. machinery, sensorisation, data systems, etc.) and facilities (e.g. new production lines, new laboratories, etc.). These investment efforts often imply some form of upgrading of the technologies used in production and related process and organisational changes.

first set of explanatory variables is made up of a number of year t firm characteristics, $V_{i,t}$, which encompasses log total employment ($\log(E)_{i,t}$), log age ($\log(Age)_{i,t}$), intensity in capital investments ($INVST_{i,t}$), innovation activities ($R\&D_{i,t}$), and skills development ($TRAIN_{i,t}$), as defined in the subsection 'Main firm-level outcome variables and controls'. The second group of variables includes the main regressors of interest, that are the sectoral Chinese import penetration—either direct ($PEN_{s,t}^{CHN}$) or indirect ($PEN_{s,t}^{CHN,UP}$, $PEN_{s,t}^{CHN,DOWN}$)—in year t . Finally, the third set of variables consists of three interaction terms, $X_{i,s,t}$, between the main trade exposure variables in year t and firm-level indicators of investments in process and product innovation and skills development in the preceding year (i.e., $t-1$):¹⁸

$$Outcome_{i,s}^{t,t+1} = f(V_{i,t}, PEN_{s,t}^{CHN}, X_{i,s,t}) \tag{4}$$

To facilitate interpretation, we report and interpret only estimates including interaction terms between our trade exposure variables and a battery of dummies taking value 1 if the investment intensity of firm i in year $t-1$ in physical capital ($(d) INVST_{i,t-1}$), R&D ($(d) R\&D_{i,t-1}$) and training programs ($(d) TRAIN_{i,t-1}$), respectively, is larger than the sectoral median. The introduction of these interactions allows us to analyse the within-industry reallocation effect across firms, taking into account firm-level heterogeneity in terms of certain production and technology capabilities.

More specifically, we consider three different firm outcomes. The first set of results examines the influence of Chinese imports on employment growth of South Africa-based firms:

$$\Delta \log(Employment)_{i,s}^{t,t+1} = c + V'_{i,t} \alpha + PEN'_{s,t} CHN \beta + X'_{i,s,t} \gamma + \delta_t + \delta_i + \varepsilon_{i,t} \tag{5}$$

Second, we explore the extent to which Chinese import penetration impacts sales growth of South Africa-based firms:

$$\Delta \log(Sales)_{i,s}^{t,t+1} = c + V'_{i,t} \alpha + PEN'_{s,t} CHN \beta + X''_{i,s,t} \gamma + \delta_t + \delta_i + \varepsilon_{i,t} \tag{6}$$

We examine the effects of Chinese import penetration on employment and output growth on the subset of surviving firms as well as the full sample of surviving and dying firms. The third adjustment margin analysed is the potential demise of domestic manufacturing firms:

$$Pr(Death)_{i,s}^{t,t+1} = c + V'_{i,t} \alpha + PEN'_{s,t} CHN \beta + X'_{i,s,t} \lambda + \delta_t + \delta_i + \varepsilon_{i,t} \tag{7}$$

where δ_t and δ_i represent time and firm fixed effects, respectively. Both, regressions 6 and 7 employ the same firm characteristics and interaction variables as the employment growth specification in Eq. (5). However, for regression 7, following Alvarez and Claro (2009) and Mion and Zhu (2013), we use a linear probability model as our main specification, and not more conventional discrete choice models as probit or logit. This is done to allow for firm-specific effects that may affect the firm's probability of exiting the market.

In all subsequent estimates, following Cameron et al. (2011), we employ a two-way (firm and industry) clustering approach to correct for unobservable firm- and sector-specific shocks uncorrelated with both $\varepsilon_{i,t}$ and our independent variables.

4.3.1. Instrumenting chinese import penetration

One concern about Eq. (1) as a measure of trade exposure in our subsequent estimations is that observed dynamics in import penetration ratio may partly reflect domestic shocks to South African industries that affect their import demand. In this case, the ordinary least squares (OLS)

¹⁸ We decided to interact the import exposure variable in year t with the dummies at $t-1$ to mitigate potential endogeneity problems. It has been shown that firms might, in fact, respond to Chinese competition by raising their investments or innovation capacities (Bloom et al., 2016).

estimate of how imports from China affect the growth dynamics of manufacturing firms in South Africa lead to biased results of the Chinese import penetration coefficient.

To address this problem and identify the causal effect of rising Chinese import exposure on the growth of manufacturing firms in South Africa, we employ an instrumental variable (IV) approach that accounts for the potential endogeneity of trade exposure. More specifically, we instrument Chinese import penetration with China's share of imports in other LMICs (excluding South Africa).¹⁹ Analogously to our main import penetration measures, upstream and downstream exposure variables are instrumented by replacing the term PEN^{CHN} with our instrumental variable in Eq. (2), while retaining the same weights.

The first-stage regression (Fig. 3, below), with time fixed effects and without detailed controls, confirms the strong predictive power of China's share of imports in LMICs for Chinese import penetration in South Africa.

Our identification strategy is inspired by Autor et al. (2013), who consider the relationship between imports from China and local labour market effects in the United States. We exploit the fact that much of the growth in Chinese exports during the last three decades, including our main period of interest, appears to be strongly related to factors that are specific to China. The historical evidence suggests that the impressive increase in the country's absolute and relative manufacturing capacity

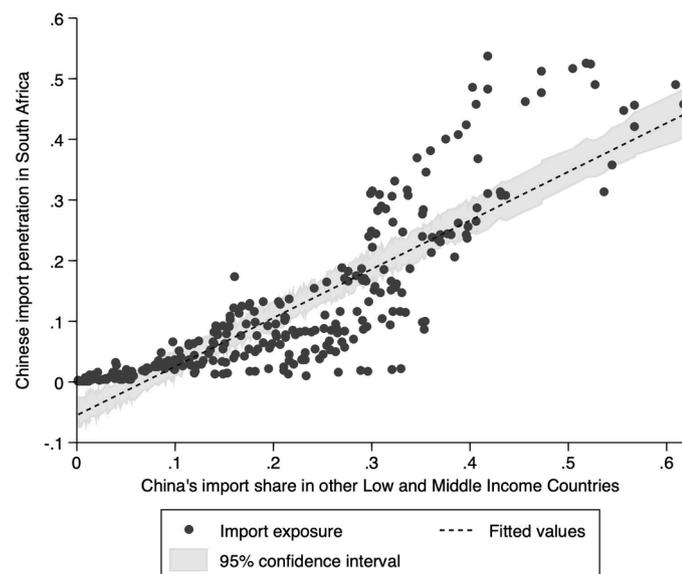


Fig. 3. First-stage regression, 2010–2016. Note: Each point represents a manufacturing industry in a specific year, from 2010 to 2016 ($N = 294$). The South African exposure to Chinese imports is defined as the South African imports from China divided by South African apparent consumption; the comparison countries' exposure to Chinese imports is defined as China's share in other LMICs' imports. Lines are fitted by OLS regression. The 95 per cent confidence interval is based on robust standard errors. The slope coefficient is 0.8 with robust standard error of 0.03; the t -statistic, F -statistic and R -squared are 24.35, 85.8, and 0.73, respectively. Time controls included. Source: Authors' calculations using UN Comtrade (2018), Statistics South Africa (2018b).

¹⁹ Edwards and Jenkins (2015) employed this instrument to analyse the contribution of Chinese import penetration to rising labour productivity at the sectoral level for 44 South African manufacturing industries. Iacovone et al. (2013) used a similar instrumental approach to examine the impact of Chinese competition on Mexican manufacturing firms. We classify countries as LMICs using the World Bank definition for the 2010–2017 period (see Table A5 in the Appendix).

and competitiveness has been driven by massive productivity growth and extensive policy reforms (namely a supply shock from the South African and other developing countries' producer perspective).

Although the instrument has been widely used in the related literature our identification strategy might present a few potential shortcomings.

A first concern is that increasing Chinese imports might be driven by South African—rather than Chinese—changes in productivity and manufacturing capacity. If, for instance, the South Africa-based producers of mining equipment experience a stagnation or a decrease in their productivity and competitiveness, then their sales might decline both in South Africa and in other developing economies, leading each to increase their imports of mining equipment from third countries, including China. While this possibility cannot be ruled out analytically, existing literature and evidence suggest that the dramatic upgrade in productivity and manufacturing capacity in China is likely to be the key driver of Chinese export increases over the last three decades, including the specific period of interest for this study.

Second, our analysis focuses on the 2010–17 period, which follows the timespan considered in previous works (Acemoglu et al., 2016; Alvarez and Claro 2009; Autor et al., 2013; Bernard et al., 2006; Mion and Zhu 2013). However, even if the bulk of China's increase in absolute and relative manufacturing capacity precedes the sample period under examination (from the mid-1990s to 2007), a significant process of expansion and consolidation of the country's global heft can also be observed immediately after the financial crisis. Between 2010 and 2017, for example, China experienced a 65 per cent increase in its MVA, accounting for over 70 per cent of the worldwide increase in MVA that occurred in LMICs. Moreover, China has been responsible for over 40 per cent and 53 per cent of the total increase in global manufacturing imports in the aftermath of the financial crisis in South Africa and other LMICs.

Third, as pointed out by Autor et al. (2013), in some sectors, import demand shocks might correlate across less developed economies. In this case IV estimates of the coefficient of Chinese import penetration would likely be biased. To address this problem, we might re-estimate our regression models excluding those sectors that may give rise to such an issue. This shortcoming of the identification strategy, and the results of the related robustness check are discussed in more details in Section 5.3.

4.3.2. Expected results

Based on the empirical evidence reviewed in Section 3, we first investigate the possibility of a negative impact of Chinese import penetration on the growth dynamics of manufacturing firms whose output directly compete with such imports. Furthermore, accounting for the presence of input-output linkages within the economy, we also check that import penetration might indirectly affect firms' expansionary dynamics. Specifically, following the contribution of Acemoglu et al. (2016) we can expect that import penetration affecting a firm's downstream clients might reduce the demand of these clients for the intermediate or final products produced by the same upstream firm (that is, *upstream effects*). Furthermore, the increase of competition from imports affecting a firm's upstream suppliers might have two different effects (*downstream effects*). On one hand, import competition might exert a downward pressure on input prices, having an expansionary effect on the activities of the procuring firm itself in downstream industries (Goldberg et al., 2010; Hombert and Matray, 2018). On the other hand, import competition might lead to the disruption of existing long-term supply agreements, with downstream firms substituting domestic suppliers with imported inputs. This displacement can have a contractionary effect for the economy.

Finally, irrespective of the specific underlying mechanism (increasing productivity, efficiency or product differentiation, amongst others), we expect that firms that invest more intensively in process and product innovation and in skills development are relatively less affected in terms of growth and survival rates in the wake of Chinese import

competition.

5. Results

In this section, we present baseline estimates of the impact of direct Chinese import competition on three measures of firm growth (employment growth, sales growth, firm exit), taking into account firm heterogeneity. Second, we expand our baseline analysis to account for the impact of indirect Chinese import penetration, propagating through intersectoral linkages along the domestic value chain. Finally, we provide some additional robustness checks and extensions.

5.1. Effects of direct chinese import competition

5.1.1. Employment growth

We first investigate the extent to which employment growth for surviving firms decreases with Chinese import penetration. We also explore whether this impact is smaller, within industries, for firms investing more intensively in skills development, production technologies and related process upgrading. Results are shown in Table 1.

Table 1
Direct import competition analysis: employment growth.

Dep. variable	$\Delta \log(E)_{i,t}^{t+1}$			
Specification	(1)	(2)	(3)	(4)
Estimation method	OLS	OLS	IV	IV
Controls				
$\log(E)_{i,t}$	-0.393*** (0.006)	-0.395*** (0.006)	-0.394*** (0.006)	-0.396*** (0.006)
$\log(\text{Age})_{i,t}$	0.076*** (0.014)	0.075*** (0.014)	0.074*** (0.014)	0.073*** (0.014)
$\text{INVST}_{i,t}$	0.004*** (0.002)	0.004*** (0.002)	0.004*** (0.002)	0.004*** (0.002)
$\text{R\&D}_{i,t}$	0.001*** (0.001)	0.001*** (0.001)	0.001*** (0.001)	0.001*** (0.001)
$\text{TRAIN}_{i,t}$	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Import exposure variables				
$\text{PEN}_{s,t}^{\text{CHN}}$	-0.695*** (0.163)	-0.738*** (0.237)	-1.333*** (0.401)	-1.489*** (0.401)
× (d) $\text{INVST}_{i,t-1}$		0.341*** (0.051)		0.230*** (0.023)
× (d) $\text{R\&D}_{i,t-1}$		0.166** (0.068)		0.150** (0.075)
× (d) $\text{TRAIN}_{i,t-1}$		0.084** (0.026)		0.149** (0.034)
Constant	0.962*** (0.039)	0.958*** (0.039)	1.058*** (0.036)	1.064*** (0.036)
Firm fixed effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
First-stage F-stat.	–	–	666.20	562.69
Observations	90,530	90,530	90,530	90,530
R-squared	0.3206	0.3214	0.3157	0.3162
Number of firms	12,959	12,959	12,959	12,959

Source: Authors' calculations using SARS data.

Notes:

1. dependant variable is log difference of firm employment between year t and $t + 1$.
2. All estimates refer to the subset of surviving firms.
3. China's import share in other LMICs is used as the instrument for $\text{PEN}_{s,t}^{\text{CHN}}$ in columns 3 and 4.
4. The main instrumental variable is interacted with all the dummies in column 4.
5. Standard errors in parentheses are clustered at both the industry and firm level.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

Columns 1 and 2 report the OLS estimates. The former refers to the baseline specification, including our main variable of interest, $\text{PEN}_{s,t}^{\text{CHN}}$. In the latter we add interaction terms between Chinese import penetration and a battery of dummies taking the value 1 for firms intensively investing in physical capital, R&D and personnel training. Columns 3 and 4 report the corresponding IV estimates.

As far as firm-level controls are concerned, all variables apart from firm age and training intensity are significant and exhibit the expected signs. We find that firms with smaller size and relatively high investment intensity in physical capital grow faster in terms of employment. Furthermore, employment growth is higher for firms investing more intensively in R&D.²⁰ Interestingly, and in contrast with most of the literature, we find that, in the South African manufacturing sector, firm age positively influences employment growth.²¹

Estimation results on the impact of import-exposure variables in all specifications reveal that employment growth is significantly and negatively related to import competition from China. The magnitudes of the coefficient of $\text{PEN}_{s,t}^{\text{CHN}}$ are higher in the IV specifications with respect to OLS ones.

Taking the coefficient value corresponding to the entire sample of South Africa-based manufacturing firms, in column 3 we find that a one-standard-deviation increase in Chinese import penetration (equal to 9.7 percentage points) for the mean firm is associated with a decrease in annual firm employment growth of 12.9 percentage points. However, the implied growth magnitudes of our coefficients are quite small in absolute terms, albeit still higher than other similar studies for developed countries (Mion and Zhu, 2013). Indeed, considering that the average across firms of Chinese import penetration has steadily increased from 0.0752 to 0.1073 over the 2010–2017 period across the entire sample, our estimates indicate that the rise in import competition from China accounts for a 4.28 per cent loss in manufacturing-wide firm employment growth.²²

Results in columns 2 and 4 further qualify our baseline OLS and IV findings, respectively. The interactions of $\text{PEN}_{s,t}^{\text{CHN}}$ with the dummy variables on firm-level investments in physical capital, R&D and staff training indicate that Chinese imports are inducing a within-industry reallocation of resources across firms characterised by different intensities in terms of such investments. Specifically, all of the interaction terms in columns 2 and 4 are significant and positive, revealing that, within industries, firms that invest relatively more intensively in capabilities development tend to be hit less hard by Chinese import penetration than other firms.

Using the point estimates in column 4, we find that investing in physical capital, R&D, and personnel training reduces the negative effect of a one-standard-deviation increase in Chinese import competition on firm employment growth by 2.2, 1.3, and 1.4 percentage points, respectively. Thus, moving from below- to above-median investment-intensity in activities related to capability development reduces the effect of import competition by only one-sixth (in the case of investments

²⁰ At the microeconomic level, the empirical literature has generally found a positive employment effect of product innovation. Conversely, the impact on employment of process innovation is more controversial: it might be directly negative due to a job saving effect under fixed output, but also indirectly positive mainly due to a price compensation mechanism boosting output expansion (Calvino and Virgillito, 2017).

²¹ Some exceptions have been found to the widely documented evidence that younger firms grow faster in terms of size than older firms. For example, Shanmugam and Bhaduri (2002) showed that employment growth is faster for older Indian manufacturing firms. Das (1995), again with reference to India, reported a positive effect of firm age on employment growth in the computer hardware industry.

²² The effect of the increase in Chinese import penetration over the period under analysis is given by the following formula: $-1.333 = (0.1073 - 0.0752) = -0.0428$.

in physical capital) and one-tenth (in the case of expenditures in R&D, and of spending in training) of the average effect.

5.1.2. Sales growth

We employ the same specifications structure used in Table 1 to study whether Chinese import penetration has generated a negative impact on output dynamics of surviving firms. We also explore whether this impact is smaller for firms investing intensively in skills development, production technologies and related process upgrading.

As in the case of employment growth, in Table 2 we find that smaller and older firms report higher output growth. Furthermore, sales growth is higher for firms intensively investing in physical capital, while we find no significant relationship between output growth and investments in R&D and in staff training.

Estimation results in all specifications reveal that Chinese import competition negatively and significantly affects output growth of surviving firms. Coefficient estimates in column 3 indicate that a one-standard-deviation increase in Chinese import penetration for the mean firm is associated with a 13.2 per cent decrease in annual firm employment growth. The implied growth magnitude of our coefficient

Table 2
Direct import competition analysis: sales growth.

Dep. variable	$\Delta \log(S)_{i,t}^{t+1}$			
Specification	(1)	(2)	(3)	(4)
Estimation method	OLS	OLS	IV	IV
Controls				
$\log(E)_{i,t}$	-0.364*** (0.010)	-0.364*** (0.010)	-0.365*** (0.010)	-0.364*** (0.010)
$\log(\text{Age})_{i,t}$	0.061** (0.014)	0.060** (0.014)	0.058** (0.014)	0.059** (0.014)
$\text{INVST}_{i,t}$	0.001*** (0.001)	0.001*** (0.001)	0.001*** (0.001)	0.001*** (0.001)
$R\&D_{i,t}$	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)
$\text{TRAIN}_{i,t}$	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Import exposure variables				
$\text{PEN}_{s,t}^{\text{CHN}}$	-0.817*** (0.254)	-0.922*** (0.273)	-1.367*** (0.415)	-1.404*** (0.415)
× (d) $\text{INVST}_{i,t-1}$		0.172** (0.061)	0.232** (0.022)	0.232** (0.022)
× (d) $R\&D_{i,t-1}$		0.102** (0.068)		0.115** (0.054)
× (d) $\text{TRAIN}_{i,t-1}$		-0.099 (0.076)		0.055 (0.038)
Constant	5.749*** (0.155)	5.675*** (0.154)	5.860*** (0.158)	5.879*** (0.160)
Firm fixed effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
First-stage F-stat.	–	–	635.86	547.64
Observations	86,289	86,289	86,289	86,289
R-squared	0.2242	0.2242	0.2196	0.2198
Number of firms	12,919	12,919	12,919	12,919

Source: Authors' calculations using SARS data.

Notes:

1. dependant variable is log difference of firm employment between year t and $t + 1$.
2. All estimates refer to the subset of surviving firms.
3. China's import share in other LMICs is used as the instrument for $\text{PEN}_{s,t}^{\text{CHN}}$ in columns 3 and 4.
4. The main instrumental variable is interacted with all the dummies in column 4.
5. Standard errors in parentheses are clustered at both the industry and firm level.

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

shows that the increase in import competition from China between 2010 and 2017 accounts for a 4.39 per cent loss in manufacturing-wide firm sales growth. The results on the capital investment, innovation, and training interactions with $\text{PEN}_{s,t}^{\text{CHN}}$ indicate that firms investing more intensively in physical capital and R&D are hit slightly less hard by such competitive pressure. Using the point estimates in column 4, we find that firms investing in physical capital and R&D activities reduces the negative effect of a one-standard-deviation increase in Chinese import competition on sales growth by 2.4 and 1.3 percentage points, respectively.

5.1.3. Firm exit

Table 3 reports estimates on the relationship between import competition and the probability of firm death. The structure of the different specifications presented is the same as for employment and sales growth.

The results in Table 3 are fairly consistent with previous empirical evidence for size and age. Firm shutdown is negatively associated with firm size, while the coefficient for firm age is positive and significant.

Table 3
Direct import competition analysis: firm exit.

Dep. variable	$\text{Death}_{i,t}^{t+1}$			
Specification	(1)	(2)	(3)	(4)
Estimation method	OLS	OLS	IV	IV
Controls				
$\log(E)_{i,t}$	-0.056*** (0.002)	-0.054*** (0.002)	-0.056*** (0.002)	-0.052*** (0.002)
$\log(\text{Age})_{i,t}$	0.127*** (0.006)	0.130*** (0.006)	0.127*** (0.006)	0.133*** (0.006)
$\text{INVST}_{i,t}$	-0.002*** (0.001)	-0.002*** (0.001)	-0.002*** (0.001)	-0.002*** (0.001)
$R\&D_{i,t}$	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
$\text{TRAIN}_{i,t}$	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Import exposure variables				
$\text{PEN}_{s,t}^{\text{CHN}}$	0.194 (0.179)	0.275** (0.102)	0.204 (0.178)	0.370** (0.180)
× (d) $\text{INVST}_{i,t-1}$		-0.152*** (0.033)		-0.255*** (0.012)
× (d) $R\&D_{i,t-1}$		-0.025** (0.018)		-0.036** (0.020)
× (d) $\text{TRAIN}_{i,t-1}$		-0.126*** (0.012)		-0.204*** (0.015)
Constant	-0.184*** (0.021)	-0.186*** (0.021)	-0.176*** (0.020)	-0.196*** (0.020)
Firm fixed effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
First-stage F-stat.	–	–	651.10	523.76
Observations	129,695	129,695	129,695	129,695
R-squared	0.0773	0.0773	0.0753	0.0753
Number of firms	22,785	22,785	22,785	22,785

Source: Authors' calculations using SARS data.

Notes:

1. dependant variable is a dummy indicating firm death in year $t + 1$.
2. A linear probability model is used in all specifications.
3. China's import share in other LMICs is used as the instrument for $\text{PEN}_{s,t}^{\text{CHN}}$ in columns 3 and 4.
4. The main instrumental variable is interacted with all the dummies in column 4.
5. Standard errors in parentheses are clustered at both the industry and firm level.

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

This latter finding, in contrast to learning models (Jovanovic, 1982) but consistent with previous evidence on Chilean plants (Alvarez and Claro, 2009), suggests that older firms are more likely to die. Finally, higher investment intensity in physical capital reduces the probability of exit in all the specifications, while the impacts of investment intensity in R&D and in staff training are never significant.

The coefficient value of Chinese import penetration, corresponding to the entire sample of South Africa-based manufacturing firms in columns 1 and 3, reveals that increasing competitive pressure from China does not significantly affect the likelihood of firm shutdown. However, when considering interactions with firm-level investments in capabilities development, in columns 2 and 4, it turns out to be significant and positive. IV results in column 4 indicate that a one-standard-deviation increase in Chinese import penetration for the mean firm not investing intensively in any capabilities development activity is associated with a 3.6 per cent increase in the probability of death. According to our estimates in column 4, the increase in Chinese import penetration between 2010 and 2017 has caused a 1 per cent increase in the shutdown probability for firms not undertaking significant investment in capabilities development. The evidence reported in Table 3 is in line with most of the results of similar studies, which find a positive and significant impact of

import penetration from low-wage countries in general, particularly from China, both in developed (Bernard et al., 2006) and developing countries (Alvarez and Claro, 2009).

The results of the interactions of $PEN_{s,t}^{CHN}$ with our dummies of interests indicate that firms investing more intensively in capabilities have a lower probability of exiting the market in light of increasing Chinese import penetration. All of the interaction terms in columns 2–4 are significant and negative, revealing that investing in capital equipment and innovation activities reduces the negative effect of a one-standard-deviation increase in Chinese import competition on the probability of firm shut-down by 2.5, 0.5 and 2 percentage points, respectively. Thus, moving from below- to above-median investment-intensity in physical capital reduces the effect of import competition by over two-thirds of the average effect, while relatively larger spending in R&D and in staff training is found to diminish such impact by one-seventh and by over half of the average effect, respectively.

5.2. Effects of indirect chinese import competition: accounting for sectoral linkages

Tables 4 and 5 report IV estimates of the impacts of Chinese import

Table 4
Indirect import competition analysis: employment growth.

Dep. variable	$\Delta \log(E)_{i,t}^{t+1}$				
Specification	(1)	(2)	(3)	(4)	(5)
Estimation method	IV	IV	IV	IV	IV
A First-order indirect import exposure variables					
$PEN_{s,t}^{CHN}$	-1.235*** (0.369)	-1.325*** (0.412)	-1.237*** (0.412)		
$PEN_{s,t}^{CHN, UP}$	-2.885*** (0.843)		-3.013*** (0.840)		
$PEN_{s,t}^{CHN, DOWN}$		-0.091 (0.759)	-0.652 (0.746)		
$PEN_{s,t}^{CHN} + PEN_{s,t}^{CHN, UP}$ × (d) $INVEST_{i,t-1}$				-1.245*** (0.373)	-1.369*** (0.358)
× (d) $R\&D_{i,t-1}$					0.208*** (0.020)
× (d) $TRAIN_{i,t-1}$					0.172*** (0.020)
					0.127*** (0.030)
First-stage F-stat.	537.09	515.19	532.89	508.06	447.28
R-squared	0.3305	0.3298	0.3309	0.3311	0.3312
B. Full (higher-order) indirect import exposure variables					
$PEN_{s,t}^{CHN}$	-1.304*** (0.368)	-1.340*** (0.414)	-1.311*** (0.371)		
$PEN_{s,t}^{CHN, UP}$	-2.487*** (0.697)		-2.582*** (0.697)		
$PEN_{s,t}^{CHN, DOWN}$		-0.074 (0.656)	-0.622 (0.640)		
$PEN_{s,t}^{CHN} + PEN_{s,t}^{CHN, UP}$ × (d) $INVEST_{i,t-1}$				-1.322*** (0.362)	-1.440*** (0.351)
× (d) $R\&D_{i,t-1}$					0.202*** (0.019)
× (d) $TRAIN_{i,t-1}$					0.123*** (0.046)
					0.117*** (0.028)
First-stage F-stat.	532.71	510.23	526.11	501.56	432.87
R-squared	0.3304	0.3297	0.3307	0.3312	0.3313
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	90,530	90,530	90,530	90,530	90,530
Number of firms	12,959	12,959	12,959	12,959	12,959

Source: Authors' calculations using SARS data.

Notes:

1. dependant variables are log difference of firm employment between year t and t + 1.
2. All estimates refer to the subset of surviving firms.
3. All specifications report IV estimates and include the constant and all controls used in previous estimates.
4. China's import share in other LMICs is used as the instrument for $PEN_{s,t}^{CHN}$ in all columns.
5. The main instrumental variable is interacted with all the dummies in column 5.

Standard errors in parentheses are clustered at both the industry and firm level.

*p < 0.10.

**p < 0.05.

*** p < 0.01.

Table 5
Indirect import competition analysis: sales growth and firm exit.

Dep. variable	$\Delta \log(S)_{i,t}^{t,t+1}$	$\Delta \log(S)_{i,t}^{t,t+1}$	$Death_{i,t}^{t,t+1}$	$Death_{i,t}^{t,t+1}$
Specification	(1)	(2)	(3)	(4)
Estimation method	IV	IV	IV	IV
A. First-order indirect import exposure variables				
$PEN_{s,t}^{CHN} + PEN_{s,t}^{CHN, UP}$	-1.053*** (0.368)	-1.079*** (0.369)	0.174* (0.160)	0.307** (0.153)
× (d) $INVST_{i,t-1}$		0.045*** (0.022)		-0.222*** (0.010)
× (d) $R\&D_{i,t-1}$		0.108*** (0.051)		-0.029** (0.017)
× (d) $TRAIN_{i,t-1}$		0.042 (0.032)		-0.176*** (0.013)
First-stage F-stat.	545.16	429.45	569.15	413.71
R-squared	0.2086	0.2088	0.0721	0.0722
B. Full (higher-order) indirect import exposure variables				
$PEN_{s,t}^{CHN} + PEN_{s,t}^{CHN, UP}$	-1.023*** (0.383)	-1.047*** (0.383)	0.169* (0.165)	0.296** (0.164)
× (d) $INVST_{i,t-1}$		0.044*** (0.021)		-0.214*** (0.010)
× (d) $R\&D_{i,t-1}$		0.105*** (0.049)		-0.027** (0.017)
× (d) $TRAIN_{i,t-1}$		0.042 (0.031)		-0.169*** (0.012)
First-stage F-stat.	532.09	417.35	540.87	409.12
R-squared	0.2087	0.2090	0.0723	0.0724
Firm fixed effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	86,289	86,289	129,695	129,695
Number of firms	12,919	12,919	22,785	22,785

Source: Authors' calculations using SARS data.

Notes:

1. dependant variables in (1) and (2) is log difference of firm sales between year t and $t + 1$.
 2. dependant variables in (3) and (4) is a dummy indicating firm death in year $t + 1$.
 3. A linear probability model is used in (3) and (4).
 4. Estimates in (1) and (2) refer to the subset of surviving firms.
 5. All specifications include the constant and all controls used in previous estimates.
 6. All specifications report IV estimates.
 - 7.China's import share in other LMICs is used as the instrument for $PEN_{s,t}^{CHN}$ in all columns.
 - 8The main instrumental variable is interacted with all the dummies in column 4.
 - 9Standard errors in parentheses are clustered at both the industry and firm level.
- * $p < 0.10$.
 ** $p < 0.05$.
 *** $p < 0.01$.

exposure on employment and sales growth and the probability of shutdown for South Africa-based firms, analogous to those in Tables 1–3 here, including the indirect import exposure measures. Tables A6 and A7 in the Appendix shows the corresponding OLS estimates. Panel A refers to the effects of the first-order indirect import exposure measures, and panel B employs the full Leontief variants. All specifications include the constant and all the firm-level controls used in the previous estimates in Tables 1-3 (unreported, to facilitate readability).

Columns 1–3 of Table 4 report the results of the impact of direct and indirect Chinese import penetration on employment decisions of firms. On one hand, downstream import effects are negative in sign but never statistically significant (see columns 2 and 3), consistent with the results of Acemoglu et al. (2016) and Hombert and Matray (2018). This might be explained by the fact that in the case of South Africa the increased availability of cheaper foreign imports is offset by a reduction of domestic input supply. On the other hand, in line with our expectations, the upstream import effect has a negative and significant impact on firm

employment growth. Coefficient estimates in column 1 indicate that a one standard deviation increase in upstream Chinese import penetration (equal to 2.6 percentage points) for the mean firm is associated with a decrease in annual firm employment growth of 7.5 percentage points. Given the non-significance of the impact arising through downstream sectoral interdependencies, columns 4 and 5 focus on the upstream effects, regressing firm employment growth on a combined direct-upstream exposure measure, consisting of their sum. As expected, the estimated coefficient on this combined effect lies between the coefficients on the direct and upstream impacts estimated in column 1. Furthermore, the results in column 5 indicate that firms that invest relatively intensively in physical capital, R&D and staff training are also hit less hard by the Chinese import competition pressure affecting their buyers in downstream segments of the domestic value chain. Indeed, investing relatively more intensively in physical capital, in R&D and in staff training activities reduces the negative effect of a one standard deviation increase in the combined direct-upstream Chinese import penetration on employment growth by 2.1, 1.3 and 1.2 percentage points, respectively. Panel B of Table 4 reveals a similar pattern in terms of results. Overall, in this case, the coefficients on the full exposure measures are slightly smaller in magnitude (but also more precisely estimated) than those reported in Panel A on the first-order indirect import exposure.

Table 5 reports the results of the impact of direct and indirect Chinese import penetration on output dynamics and probability of shutdown of South Africa-based manufacturing firms. As for the case of employment growth, we focus on the upstream effects, regressing firm sales growth and the probability of shutdown on the sum of direct and upstream exposure measures as in columns 4 and 5 of Table 4.²³

The results in columns 2 and 4 confirm that firms investing substantial resources in capabilities development grow faster in terms of sales and are less likely to shutdown even in the wake of increasing competitive pressure in downstream segments of the domestic value chain. As in Table 2, we find that staff training expenditures have no significant impact on firm sales growth.

5.3. Robustness checks and additional findings

As a first robustness check, in some additional estimates we also replicate our analysis of firms' employment and sales growth on the full sample, including companies dying during the period under analysis. Table A8 in the Appendix reports the IV results of the direct import competition analysis on firms' employment and sales growth for the full sample. We obtain very similar estimates for the full sample and for the subset of survivors (see specifications 3 and 4 of Tables 1 and 2 above).

Second, following Alvarez and Claro (2009), we also replicate all our estimates including a set of province dummy variables to control for potential shocks to specific locations over time. The results of the direct import competition analysis on firm survival and growth are reported in Table A9 in the Appendix. They remain quantitatively and qualitatively the same.

Third, in some additional estimates we also control for import penetration from other low-wage countries, $PEN_{s,t}^{LOW}$, defined as economies with per-capita income lower than 15 per cent of the US per capita

²³ Unreported estimates (available upon request) show that the effects propagating through downstream sectoral linkages are not statistically significant also in the case of sales growth and probability of exiting the market.

income,²⁴ and from the rest of the world, $PEN_{s,t}^{ROW}$ (mainly upper-middle- and high-income economies). Such variables are computed following the formula in Eq. (1), substituting the numerator with $M_{s,t}^{LOW}$ and $M_{s,t}^{ROW}$, respectively. This counterfactual exercise allows us to better identify the specific effect of Chinese import competition, which constitutes our main variable of interest. Table A11 of the Appendix reports the IV results of the direct import competition analysis on employment growth, sales growth and firm exit, including import penetration from other low-wage countries and from the rest of the world (mainly upper-middle- and high-income economies). Estimates' results indicate that import competition from China has a similar effect, albeit of larger magnitude, to import competition from upper-middle- and high-income economies, while we find no significant impact of imports from other low-wage countries. This finding confirms the evidence that Chinese exports seem to be more sophisticated and show more overlap with OECD countries' products with respect to other low-wage countries (Rodrik, 2006; Schott et al., 2008).

Finally, in an additional robustness exercise, we try to solve a key issue arising from our instrumental variable approach. In fact, as pointed out by Autor et al. (2013), in some sectors import demand shocks might correlate across less developed countries. In this case, IV estimates of the coefficient of Chinese import penetration might likely be biased, appearing smaller than they truly are in the case of firms' growth and death. Following Autor et al. (2013), we address this problem by excluding from our measure of import competition and from the corresponding IV those industries that may give rise to these issues, such as consumer electronics (accumulators and batteries, electric lamps, communication electronic equipment, domestic appliances, etc.).²⁵ Table A12 of the Appendix reports the results of this additional exercise on the direct Chinese import competition effect on growth and survival dynamics of South Africa-based companies. These additional estimates confirm the overall validity of our IV approach and, in fact, the coefficients of our variable of interest remain qualitatively and quantitatively the same: the impact of Chinese import competition becomes only slightly larger when excluding consumer electronics' industries from our measure of imports.

6. Conclusions

In this paper we produce new evidence on the impact of Chinese import competition on the performances of the South Africa-based manufacturing firms from 2010 to 2017. Our results indicate that rising direct Chinese import exposure has negatively affected the

employment and sales growth of surviving firms, and increased the probability of shutdown for the subset of companies not investing intensively in capabilities development. The implied growth magnitude of such effects is relatively high compared to other similar studies for advanced economies (Mion and Zhu, 2013). According to our estimates, the increase in direct Chinese import penetration between 2010 and 2017 accounts for approximately 4.28 per cent and 4.39 per cent of the loss in manufacturing-wide firm employment growth and sales growth in South Africa, respectively, and has caused a 1 per cent increase in the shutdown probability for firms not undertaking significant investments in capital equipment, innovation and training programmes.²⁶

In line with our expectations, upstream import effects—originating in downstream segments of the domestic value chain and propagating upstream to supplying sectors—contribute to reduced firm employment, sales growth and survival rates. Thus, an increase in Chinese import penetration in a given industry has a negative impact on the performance of firms supplying intermediate inputs to the affected sector. Conversely, downstream import effects are never statistically significant. This might be explained by the fact that, in the South African case, the positive effect of increased availability of cheaper foreign imports is offset by the disruption of existing long-term supply relations for specialised domestic inputs. Thus, at least on average, we cannot detect significant effects of firms responding to the supply of cheaper foreign inputs by expanding employment and production.

These negative effects are however smaller for firms investing intensively in capabilities development, specifically in process and product innovation and in skills development programmes. Firms devoting substantial resources to capabilities development are more resilient to such competitive pressure. However, such effects are rather weak and unable to counterbalance the negative impact of Chinese import penetration. Hence, differently from the existing literature on other middle-income countries, we do not find a pro-competitive effect of trade competition from China on South African firms. This is mainly due to the fact that the number of firms showing higher level of resilience is limited, and that their resilience is also compromised by structural factors in upstream and downstream industries which do not allow pro-competitive effects to unleash. For example, the fact that downstream import effects are never statistically significant suggest the fact that upstream industries have managed to remain relatively more insulated from Chinese import competition given high level of concentration and protection. As a result the potential pro-competitive effect of cheaper raw industrial materials in downstream industries has not materialised so far in South Africa. These results are critical in middle-income countries like South Africa where industrialisation has been affected by a high degree of concentration in upstream industries, but also characterised by limited development of downstream sectors and poor firm-level investment performances.

The rise of China has shifted the goal posts for firms in middle-income countries, intensifying the challenges they face. Responding to the rising competitive pressure of Chinese firms, while also capturing the opportunities it offers in terms of restructuring sectors and firms' specialisation, requires increased focus on the heterogeneous responses of firms and their effectiveness, but also industrial policies that can support both firm and system level linkages development and competitiveness in middle-income countries (Andreoni et al., 2021). The shifting terrain of the industrial and tradable sectors also opens new opportunities and spaces for firms in these countries to develop and integrate strategically in domestic, regional and global markets. Beyond the short-term impact, the global pandemic might also lead to a

²⁴ Bernard et al. (2006) and Alvarez and Claro (2009) employed a lower income threshold (5 per cent of the US per-capita income). However, their studies were restricted to the pre-2000 period when China's per-capita GDP was below the threshold of 5 per cent, increasing from 1.4 per cent of the US per-capita GDP in 1990 to 3.6 per cent in 2000. Since our analysis focuses on the 2010–2017 period, we raise the income threshold in order to make a more accurate comparison with other LMICs, taking into account the enormous progress on the economic and living standards side made by China during the last two decades. During our period of interest, China's per-capita GDP was below the threshold of 15 per cent, increasing from 9.4 per cent of the US per-capita GDP in 2010 to 13.8 per cent in 2017. Table A10 in the Appendix provides a list of the countries that are classified as low-wage countries in all years of the sample (excluding China).

²⁵ As pointed out by Autor et al. (2013), in such sectors the increase of Chinese imports both to South Africa and other developing economies might be driven from a combination of rising domestic demand (for mobile phones for example) and growing Chinese productivity and manufacturing capacity (so that parts and components of mobile phones are sourced from Chinese suppliers rather than, say, Japanese or South Korean companies). For these industries, even employing our instrumental approach, we might fail to capture the real effect that rising Chinese imports would have on South Africa-based manufacturing firms.

²⁶ Thus, we find that between 2010 and 2017, the effect of trade with China on output and employment growth in South African manufacturing industries has been significant, but on aggregate still account for a relatively small share of total output and employment growth. Edwards and Jenkins (2015) reach a similar conclusion using industry-level data from 1992 to 2010.

long-term global restructuring of value chains, tradable sectors and competitive dynamics. Ultimately, while rising competitive pressure from Chinese firms matters, what firms and governments in other countries do about it is equally critical in determining the final impact of this complex dance with the dragons.

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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Supplementary materials

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