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The impact of import competition from China on firm-level productivity growth in the European Union*

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Abstract

We re-examined the impact of rising imports from China on intra-firm productivity growth in the European Union during the period 2005–16. In contrast to previous studies, we found that an increasing share of Chinese imports in total imports has slowed productivity growth over the observation period. This unfolded especially after the 2008/09 financial crisis and was more pronounced for firms with lower productivity growth. On average, the net effect of China's increasing import intensity on productivity growth has been negative for firms in the European Union since 2010. At the beginning of the sample, firms growing at the median rate experienced a modest growth-enhancing effect of 0.02 percentage points, which turned slightly negative at −0.06 percentage points in the last observation year. The effect was muted for high-growth multinational firms, which experienced a productivity growth premium from Chinese import competition at higher growth rates. Compared with the United States, the negative impact of Chinese import competition on the performance of EU firms is visible with a time lag.

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I. Introduction

China's exports to the European Union have increased significantly since its accession to the World Trade Organization in 2001. Over time they have also grown much more sophisticated and are no longer limited to low-tech, low-wage sectors, as was the case in the 1990s (Athukorala 2009; Ding, Sun, and Jiang 2016). In this way, Chinese firms have emerged as direct competitors to firms in advanced economies (Athreye and Kapur 2009).

There is a growing literature assessing the impact of import competition from China on regional labour markets and technology in advanced economies (Autor, Dorn, and Hanson 2013; Dauth, Findeisen, and Suedekum 2014; Balsvik, Jensen, and Salvanes 2015; Autor *et al.* 2016). Differences between the effects in the United States and other economies have emerged, suggesting that the United States has experienced significant negative effects on industrial employment that have not been observed, for example, in Germany or Norway.

Bloom, Draca, and Van Reenen (2016) provided evidence of the productivity-enhancing effects of import competition for firms in the European Union, as suggested by trade integration models (Melitz and Ottaviano 2008). However, the period studied by Bloom *et al.* (2016) ends before the 2008–09 financial crisis. Therefore, it does not capture the rise of Chinese firms as highly cost-competitive exporters in technologically sophisticated industries, which was supported by changes in Chinese economic policy. This suggests that the relationship between imports and performance may also have changed for EU firms.

This paper re-examines the effects of import competition from China on the performance of firms in the European Union. The European Union provides a compelling context to study the effects of trade due to its size as an economic bloc and its centrally negotiated trade agreements, as well as its considerable internal economic diversity. We used a comprehensive dataset of firm-level data combined with highly granular industry-level import data covering the period 2003–16.

We contribute to the existing literature by showing that the positive relationship between imports and productivity growth reported by Bloom *et al.* (2016) has changed over time. We observed a positive effect that turns negative in more recent periods. This implies that Chinese imports hampered the productivity dynamics of EU firms over the period covered by the data. However, we also observed heterogeneity in this effect across firm types: multinational firms are better able to mitigate the negative impact of Chinese imports. Moreover, the negative effect is not uniform across the productivity growth distribution. It is stronger for firms with lower and median productivity growth rates.

II. A brief overview of the literature

The impact of Chinese import competition on industrial employment has been studied first at the regional labour-market level (Dauth *et al.* 2014; Acemoglu *et al.* 2016) and later at the firm level for Europe and Japan (Bloom *et al.* 2016; Yamashita and Yamauchi 2019). Bloom *et al.* (2016) found that surviving firms competing with Chinese imports became more technology-intensive and more productive through an ''escape-entry effect'' (Aghion *et al.* 2009). Firms producing goods and services that are easily substituted by low-cost imports cannot withstand competition and exit. More productive firms in turn escape import competition by innovating and differentiating their products. This leads to higher performance at both the firm and industry levels. At the firm level, resources are reallocated to the most profitable activities, and at the industry level, aggregate performance is enhanced by the exit of less successful firms (Melitz 2003; Melitz and Ottaviano 2008).

In the 1990s and early 2000s, technological imitation was the main strategy pursued by Chinese companies to expand their competence base and enter foreign markets with low-cost products in low-tech industries (Zhang and Zhou 2016). However, Chinese firms have been able to bridge the technology gap in key technology areas (Bergeaud and Verluise 2022). Over the past two decades, they have entered the market with increasingly technologically advanced products in technology-intensive industries. Thus, while Chinese import competition should have a positive effect on the productivity of domestic firms through the ‘‘escape-entry effect’’, it has been observed that the rapid technological progress of Chinese firms has led to a reduction in more ambitious and riskier R&D activities by competing (domestic) firms. As the returns on investment in innovation decline, firms reduce their technological exploration and focus on technological exploitation (Morandi Stagni, Fosfuri, and Santaló 2021). Aghion *et al.* (2009) referred to this phenomenon as the ‘‘discouragement effect’’.

Evidence from Chile suggests that the ‘‘escape-entry’’ effect occurs only in about 10% of the most productive firms, while import competition has a depressing effect on innovation in most other firms (Cusolito, Marin, and Maloney 2023). This, in turn, has a negative impact on productivity growth. Factors such as firm-level technological capabilities or firm size, which help firms cope with the pressure of import competition, mediate the negative effects of the ‘‘China shock’’ (Mion and Zhu 2013; Colatone and Crinò 2014; Hombert and Matray 2018; Fromenteau, Schymik, and Tscheke 2019).

The emergence of Chinese firms as cost-competitive and technologically advanced exporters has often been attributed to a combination of factors. A key element is China’s industrial development strategy, which has been adapted at different stages of its development. In recent years, the five-year plans have sought to promote technological upgrading and improve the economy’s capacity for independent innovation, while earlier stages focused on building an industrial base and establishing a market economy (Jigang 2020).

The Chinese government is actively pursuing industrial leadership and self-sufficiency in strategic industries, focusing on domestic rather than international markets as the foundation of its economy. To capture significant shares of both domestic and international markets, the Chinese government has provided strong support to enterprises in the form of investment funds and subsidies. It is likely that the implementation of the ‘‘Second Displacement Strategy’’ between 2009 and 2016 (Doshi 2021) in particular has changed the nature of competition compared with earlier periods. This initiative was designed to support high-tech industries, such as information technology, robotics, industrial automation, aircraft, new materials, power generation and transmission equipment, pharmaceuticals, and electric vehicles (Naughton, Xiao, and Yaosheng 2023). In addition, the Made in China 2025 strategy targets 10 advanced manufacturing sectors (Li 2018). Public authorities in China have provided direct financial support to Chinese firms to achieve these policy goals through a combination of subsidies, tax breaks, below-market loans and below-market equity. A recent estimate shows that since the introduction of the Government Guidance Funds in 2012, effective public support to government-linked firms has increased from USD 7.9 billion to around USD 418 billion in 2016, reaching USD 850 billion in 2022 (Chimits 2023).

Institutional arrangements in China also disadvantage foreign firms and prevent wages from keeping pace with productivity growth (Barbieri *et al.* 2019; Barwick, Kalouptsidi, and Zahur 2019; Tian 2020). For instance, it has been argued that Chinese subsidies have led to overproduction in the steel industry, providing Chinese producers with an ''unfair'' competitive advantage (Price *et al.* 2016). It has also been argued that the combination of technology transfer, imitation (international firms could only operate in China if they formed joint ventures that were granted access to technology), and subsidy policies (e.g., in the photovoltaic industry) has technologically weakened Chinese firms' competitors (Zhang and Gallagher 2016; Zhang and Zhou 2016).

These developments are reflected in the policy debate. Since it acceded to the World Trade Organization (WTO) in 2001, the Chinese government has faced considerable criticism. As a result, both the European Union and the United States have resisted granting China ''market economy'' status under the WTO, and this debate is still ongoing. Political scientists have also observed a shift in the Chinese government's strategy following the 2008–09 financial crisis, when it adopted a more assertive economic approach to bolster China's geopolitical standing.

If Chinese firms can enter technologically sophisticated markets with cost advantages due to government support, we should expect the ''discouragement'' effect postulated by Aghion *et al.* (2009) to increasingly influence the productivity growth of firms in advanced industrial economies. This effect should be more pronounced for less productive and competitive firms. We re-examined the impact of Chinese import competition on European firms from this perspective, using a comparable sample and econometric approach, over a period that includes the time window of their research and the new phase of Chinese industrial policy starting in 2009.

Our research is related to Bloom *et al.* (2016). While Bloom et al.'s sample covers a period up to 2007, our data take into account the impact of the 2008–09 financial crisis, which changed the dynamics and structure of global trade (Timmer *et al.* 2016). We expect that the empirical relationship between import competition and firm performance will change mainly because Chinese exporters have upgraded their technological capabilities while maintaining cost advantages. In addition, the growth slowdown following the 2008–09 financial crisis may have contributed to the negative impact of import competition. In an economic environment with abundant market opportunities, these effects may have been overshadowed by other dynamics.

III. Conjectures

The literature provides evidence for the growth-enhancing effect of import competition, as implied by the Melitz model and empirically supported by Bloom *et al.* (2016). On the other hand, the unbundling of production from localized knowledge and reduced coordination costs enabled by digitalization have changed competitive dynamics and eroded Ricardian comparative advantages (Baldwin 2011). As returns on investment in innovation decline, firms reduce their exploration of new technologies and markets and increase their exploitation of existing competitive advantages in specific products and markets (Morandi Stagni *et al.* 2021). This dynamic is further accelerated by China's industrial policy, which allows Chinese companies to offer low-cost but technologically sophisticated products. As a result, import competition from China may have had a negative impact on firm-level productivity growth in recent years, as the nature of competition has changed over time.

Conjecture I. The impact of increasing import intensity from China on within-firm productivity growth has changed over time. The growth-enhancing effect has turned into a growth-dampening effect.

Firms differ in their capabilities, behaviour and access to resources, which moderate the effect of import competition. Williamson (1986) was one of the first to point out that multinational firms react differently to import competition than single-country firms because of their international linkages. Multinational firms have better access to resources that allow them to use international trade in their production processes to a greater extent than domestic firms (Navaretti, Venables, and Barry 2004).

Some contributions suggest that this is related to the way these firms organize their value chains. While import competition seems to affect industries with higher levels of routine skills (Lu and Ng 2013), multinational enterprises (MNEs) are also more likely to insource non-routine than routine activities. Costinot, Oldenski, and Rauch (2011) show that industries with low average routineness tend to have higher shares of intra-firm trade. This suggests that MNEs facing import competition can source critical non-routine tasks globally through their network of affiliates. These, in turn, draw on different national capabilities and advantages, allowing MNEs to respond more flexibly to increasing import competition than purely domestic firms. MNEs are also better able to use digital technologies to operate and coordinate large networks of suppliers (Fort 2017). Thus, they may be better positioned to exploit the competitive advantages of the global production system to their advantage through their own subsidiaries and arm's-length suppliers in China and other countries. This leads to our next conjecture:

Conjecture II. Rising import intensity from China has a positive net effect on MNEs' productivity growth.

The literature also discusses the role of firm characteristics in moderating the relationship between international trade and productivity growth. Several authors have found a positive impact of import activity on local productivity growth (Keller 2000; Pavcnik 2002; Blalock and Veloso 2007; Fernandes 2007; Kasahara and Rodrigue 2008; Feenstra, Inklaar, and Timmer 2015), while others emphasize the role of import diversity (Parsons and Nguyen 2009) or foreign direct investment (Keller and Yeaple 2009). At the firm level, import penetration can trigger productivity growth through technology spillovers due to increased competitive pressure or access to high-quality intermediate goods that allow firms to increase their efficiency. At the sectoral level, these aggregate firm-level effects are complemented by competitive elimination, that is, the exit of the least productive domestic firms within a sector due to increased foreign competition, leading to a reallocation of resources and output from less to more productive firms. Overall, the evidence suggests that higher sectoral import levels are associated with higher firm productivity growth.

These effects are heterogeneous across firms, depending on the relative productivity levels of European incumbents and Chinese exporters, as suggested by Aghion *et al.* (2009). According to their theory, more productive incumbents try to escape competition by increasing their efforts to improve their performance relative to the Chinese exporters that they perceive as a threat. Less productive incumbents, on the other hand, would be discouraged by competitive entry as it reduces their expected returns on investment in productivity-increasing activities such as innovation. Which effect ultimately prevails depends on the extent to which European incumbents perceive Chinese exporters as a threat and how the relative competitiveness of European firms and Chinese exporters changes over time.

Deviations from this stylized response pattern could be observed if Chinese exporters first enter the lower rungs of industry-specific quality ladders, and then upgrade their exports as they build up capabilities and move into more technologically advanced segments of the European market, as suggested by Sutton and Trefler (2016). In this case, the response of European firms to escape competition may initially be stronger for lower performing firms operating in less-sophisticated segments of the market, as they may perceive the threat from Chinese exporters more strongly than firms further up the quality ladder. However, as Chinese firms improve their capabilities over time, a discouragement effect should set in. Such an effect should be observed for all types of firms, but would be stronger for low performers. Given the heterogeneity of the population of firms studied here, it was not possible a priori to determine which of these effects dominated in the period we studied, as we did not observe the quality segments in which Chinese exporters are active. However, we expected to observe the heterogeneous effects of increasing import intensity from China across the distribution of productivity growth rates of European firms over time.

Conjecture III. The magnitude of the effect of rising import intensity from China on firms' productivity growth varies with firms' productivity growth rates and over time.

IV. Estimation approach

To estimate the impact of trade on within-firm productivity performance, we exploited differences in exposure to import penetration across countries and industries over time. The estimation strategy broadly follows previous literature (Bloom *et al.* 2016; Ben Yahmed and Dougherty 2017; Yamashita and Yamauchi 2019).

We estimated the specification equation as a log-linear fixed-effects model in first differences. Thus, we regressed productivity growth $\left(\Delta \mathrm{LP}_{j,s,c,t}\right)$ on changes in import intensities $\left(\Delta ImI_{s,c,t}\right)$. The basic productivity growth equation reads:

$$\Delta \mathrm{LP}_{j,s,c,t} = \alpha_{\mathrm{s}} + \alpha_{\mathrm{t}} + \alpha_{\mathrm{c}} + \beta_1 \mathrm{LP}_{j,s,c,2005} + \beta_2 \Delta ImI_{s,c,t} + \beta_3 \Delta \mathrm{CAP}_{j,s,c,t} + e_{j,s,c,t}, \qquad (1)$$

where LP denotes the log of labour productivity of firm j in sector s and country c in period t, $\mathrm{LP}_{j,s,c,2005}$ the firm-specific out-of-sample labour productivity level of 2005,

$(ImI)_{sct}$ is the import share at the sector-country-year level. CAP_{jsct} is the firm-specific capital intensity, defined as the stock of tangible fixed assets in real terms. α_c, α_t and α_s are country, period and sector fixed effects; e denotes the error term.[1] We clustered the standard errors at the treatment (i.e., country–industry) level (see section VII).

We extended this specification to include a time trend over and above the period dummies. This measure is an index variable that takes the value of 1 in 2006, the first year used in our regression analysis, and reaches a maximum of 11 in 2016. This trend is broadly consistent with the technological upgrading of China's export portfolio to the European Union. We considered both the trend and the interaction term of the trend with import intensities.

In addition to ordinary least squares (OLS) regressions, we also implemented a two-stage least squares (2SLS) identification strategy because import dynamics may be endogenous. Unobserved supply and demand shocks could affect trade and performance, implying that the coefficients suffer from reverse causality. We addressed this issue by using an instrumental variable strategy, following approaches used in the previous literature on Chinese import competition (Autor *et al.* 2013; Dauth *et al.* 2014; Bloom *et al.* 2016). The identification idea is that China's rise in the world economy has been a source of supply shocks to all its trading partners. Using information on China's other trading partners identifies the exogenous component of China's rising competitiveness and removes shocks that are specific to the country, region or industry.

We calculated the import intensity for a group of extra-EU economies. We used average import intensities of Australia, New Zealand, the United States, Canada, Israel and Japan. Calculating the mean of the shares avoids bias towards larger countries. The average productivity of the countries is broadly comparable to the average EU productivity and thus captures the size of the shock. Given the differences in competitive positioning, these are countries for which we did not expect significant correlations between demand and supply shocks to firms. Thus, the average import intensities of this group of countries served as an instrument for the Chinese import intensities of EU countries. We tested whether the exclusion restriction is satisfied using a recently proposed procedure that we implemented at the treatment level (D'Haultfœuille, Hoderlein, and Sasaki 2021).[2] We were not able to reject the null hypothesis that the exclusion restriction is satisfied at the 1% significance level. In the specifications that include interaction terms, we also interacted with the extra-EU import intensities and used these linear combinations as additional instrumental variables.

In the context of China shock analysis, recent papers have critically assessed the use of shift-share instruments (Adão, Kolesár, and Morales 2019; Goldsmith-Pinkham, Sorkin, and Swift 2020). Many contributions to this literature rely on shift-share (or Bartik) instruments to identify the effect of import competition on a regional outcome variable. The outcome is regressed on a weighted average of sectoral shocks using regional sectoral shares as weights. These share components of the instrument are assumed to be exogenous to import competition. They are a source of variation that can improve the identification

[1]Singletons which may skew the results are excluded.

[2]The test could not be performed at the firm level because it was too computationally intensive. Therefore, we averaged the productivity at the country year industry level and computed the test statistics.

of the effect. However, this approach is not feasible in the firm-level context due to the different structures of the data with respect to the share components. Following Bloom *et al.* (2016), we relied only on the shift component to identify the effect of changes in import competition on labour productivity growth. The choice of the instrumental variable does not qualitatively affect the within-firm results and ensures a higher degree of comparability of our results with Bloom *et al.* (2016) contribution.

Finally, we used quantile (least absolute value) regressions to allow the effect of increasing import intensity to vary across the distribution of productivity growth. We estimated the quantiles of the conditional distribution as linear functions of the explanatory variables, including country-fixed effects. We ran simultaneous quantile regressions for the 25th, the 50th and the 75th percentiles. We found different coefficients, indicating that the quantiles of the conditional distribution of labour productivity vary with the independent variables in a way that is not captured by regressing the mean (Koenker and Hallock 2001; Angrist and Pischke 2009).

V. Data and variables

The analysis was based on data from multiple sources. This allowed us to track performance and trade relationships over time, overcoming compatibility issues with multiple classifications. We constructed a unique dataset covering the period from 2003 to 2016 (see Online Appendix for a detailed discussion of the data).

The firm-level indicators were based on AMADEUS, a dataset provided by Bureau van Dijk—A Moody's Analytics Company.[3] We used several 10-year waves of AMADEUS to construct a panel. The first step was to make the waves comparable. Each wave contains an identifier for the firm that is unique within each wave but not unique across waves. We used information on identifier changes provided by Bureau van Dijk to construct unique firm identifiers to control for breaks in records. This dataset was then thoroughly cleaned for duplicate entries due to data updates, outliers and missing values.

All nominal values were deflated using Eurostat deflators at the available two-digit level of NACE Revision 2 (reference year 2010). NACE is the statistical classification of economic activities in the European Community. This is important because increased competition should lead to lower prices (Auer and Fischer 2010; Weyl 2019). At the industry level, the inflation rate is negatively and significantly correlated with changes in import intensity (ρ: -0.02).

The sample consists of 102,167 enterprises in 25 EU countries (data are missing for Greece, Cyprus and Lithuania; the United Kingdom is included because it was a member of the European Union during the analysis period). Only active enterprises were considered. Information on insolvent or bankrupt companies was not used.

Firm performance

Labour productivity, defined as firm-specific value added divided by the number of employees, is the key performance indicator. The median real labour productivity is EUR

[3] See https://www.bvdinfo.com/en-gb/our-products/data/international/amadeus (accessed on 28 July, 2023).

41,777 per person employed. The sample broadly reflects the cross-country distribution of GDP per capita as a measure of productivity in the EU economy.[4]

In 2005, the base year of the sample, the average import intensity was 5.7%. This increased to 8.4% in 2016, the last year of observation. Considering the European Union as a bloc, these figures indicate a difference in both levels and dynamics compared to the reference pool of other industrialized countries. The sample mean of the instrumental variable we used in the 2SLS regression was 12.1% in 2005, which increased to 19.5% in 2016.

Labour productivity growth varied across countries, with an annualized pooled average growth rate of 1.6%. Using the full sample, labour productivity growth and import intensity growth were uncorrelated (ρ: 0.00). This labour productivity indicator has been criticized for not accounting for a firm's capital intensity (Syverson 2011). To address this concern, we included firm-specific fixed asset growth in the estimation of labour productivity growth.

Import intensity

We matched firm-level data with trade data from BACI (Gaulier and Zignago 2010), which is a harmonized trade dataset that includes information on imports. Following previous literature (Bernard, Bradford Jensen, and Schott 2006; Bloom *et al.* 2016), we computed a Chinese import intensity indicator based on a value share approach. The measure is based on Chinese imports (IMP_C) and total imports (IMP_{TOT}). Import intensity is then defined as the share of Chinese imports in total imports (IMP_C/IMP_{TOT}) for a given country, year and NACE Revision 2, 4-digit industry.[5]

This allowed us to illustrate the relationship between labour productivity growth and Chinese import intensity. We split the sample into industries that did not import from China, the non-treated group, and industries that reported imports from China, the treated group. In the treatment group, the average import intensity increased from 6.1% in 2004 to 11.7% in 2016. This corresponds to an average annual increase of approximately 0.5 percentage points. There are also differences in productivity growth rates. Firms in the non-treated group grew at an average rate of 2.2%, while firms in the treated group grew at 1.8%.

Beyond the non-treated firms (i), we further differentiated the treated group by the intensity growth of the treatment: (ii) industries with Chinese import intensity growth below the 25th percentile, (iii) industries between the 25th and 75th percentile, and (iv) industries above the 75th percentile. Figure 1 shows the average annual change in productivity between 2004 and 2016. In the later years of the sample, the group of non-treated firms had higher productivity growth. Productivity growth tends to be lower the more intensive the treatment is.

[4] The logarithmic terms of labour productivity and GDP per capita are highly correlated (ρ: 0.95).

[5] We recoded trade data available in the Harmonized System (HS) classification, a standardized numerical method for classifying traded products, to match the industry classification used in AMADEUS (NACE Rev. 2, 4-digit level). The 6-digit hs92 data are converted to hs02, for which a NACE Rev. 1 correspondence table is available, which can be transformed to NACE Rev. 2 at the 4-digit level (see Online Appendix).

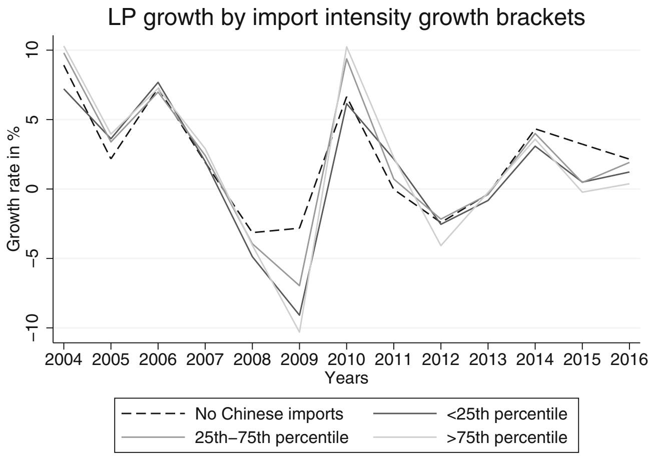

Figure 1. Labour productivity growth by Chinese import intensity growth brackets
Notes: The graph splits the sample into firms in industries (i) without Chinese imports, (ii) with Chinese import intensities below the 25th percentile, (iii) industries between the 25th and 75th percentile, and (iv) industries above the 75th percentile. Productivity growth tends to be lower in the later years of the sample when the treatment intensity is higher

Multinational enterprises

We also used information on the ownership structure of a firm. We define a dummy variable that takes the value of one if a firm belongs to a multinational enterprise group and zero otherwise. Differentiating between MNEs and domestic firms is necessary because they have access to different networks and factors of production (Navaretti *et al.* 2004).

Of the firms in the sample, 23.4% are multinationals, which are different from domestic companies. Their average labour productivity (EUR 55,730) is significantly higher than the average of domestic firms (EUR 38,561; real terms, reference year 2010). Differences in performance can also be observed in growth intensity. The average domestic firm grew in labour productivity by 1.0% per year. The average growth rate of multinationals was 1.4% (P-value: 0.000).

The industries to which multinational enterprises are more likely to be assigned face slightly more import competition from China (7.5% for domestic enterprises and 7.6% for multinational enterprises; the difference is statistically significant, P-value: 0.000). Industries in which multinationals are active also experienced slightly higher growth in Chinese imports (0.32%) than domestic firms (0.28%).

VI. Regression results

We tested the above hypotheses in a series of regressions of labour productivity growth on changes in trade intensity measured at the industry level (Table 1). We implemented 2SLS specifications, supported by post-estimation tests, to account for possible endogeneity. The Kleibergen-Paap rank Lagrange multiplier statistic was highly significant in all specifications, and the Kleibergen-Paap rank Wald F-statistic exceeded the critical values of the 10% maximum instrumental variable size, as proposed by Stock and Yogo (2002).

The equations are identified exactly (see Table 2 and Tables A1–A3 and Figures A1–A3 in the Online Appendix).

In the baseline specification shown in Table 1, columns (1) and (2), we found a positive effect of import intensity growth on labour productivity growth. The OLS coefficient (1) was only weakly significant, and the coefficient of the 2SLS estimation (2) was insignificant.

To test Conjecture I, that there is a time-varying, initially positive, and eventually negative effect of changes in import intensity on productivity growth, we included a time index variable and its interaction with changes in import competition (Δ IMI*Trend) over and above the time fixed effects (see columns (3) and (4)).

We found positive and significant coefficients on changes in import competition. This indicates that there is a positive base effect of increased import competition from China on domestic productivity growth, supporting Bloom *et al.*'s (2016) findings. However, the coefficient of the interaction term of changes in import intensity with the time trend is significantly negative, indicating that the positive baseline effect of increasing import intensity on firms' productivity growth has decreased over the years. When we used the average value of import intensity growth and set the coefficients of regressions (3) and (4), we saw that the net effect becomes negative from 2014 in both the IV estimate and the OLS regression.

In addition, we considered macroeconomic developments and implement specifications based on a dummy variable that takes the value of one for the period following the 2008–09 financial crisis and zero otherwise (columns (5) and (6)). The coefficients on the crisis, and the interaction of the crisis dummy with import intensity growth, are negative and significant. Again, when we included the average annual growth rates of import intensity, we found that the net effect of changes in China's import competition was positive before the financial crisis but became negative thereafter. Thus, the results support Conjecture I.

The second conjecture is that MNEs can offset the negative effects of Chinese import competition. Therefore, we introduced firm characteristics that captured the heterogeneous responses of firms. We included a time-invariant binary variable measuring whether a firm belongs to a multinational group, as well as an interaction term of this dummy with changes in Chinese import intensities (Table 1, columns (7) and (8)). The coefficient measuring whether a firm is part of a multinational enterprise group was positive and statistically significant. The coefficient of import intensity growth became insignificant in both regressions. The interaction terms of being a multinational with import intensity growth showed a positive and significant coefficient in the OLS regression. However, this coefficient became negative and insignificant in the 2SLS regression.

In specifications (9) and (10), we asked whether the time-varying effect of changes in Chinese import competition on productivity growth differed for multinational firms compared with domestic firms. We extended specifications (3) and (4) to include the MNE dummy and a triple interaction term (ΔIMI*Trend*MNE). In both OLS and IV regressions, the estimated coefficients for import intensity growth and its interaction with the time trend were quite stable compared with specifications (3) and (4) of Table 1, indicating a positive base effect that declined over time and became negative in the later years of our sample. In contrast, the coefficient of the triple interaction with the MNE dummy was significantly positive in the OLS regression, indicating the dampening

TABLE 1

Impact of changes in import intensities on labour productivity growth

	(1) *Baseline*	(2)	(3) *Trend*	(4)	(5) *Financial Crisis*	(6)	(7) *MNE*	(8)	(9) *Trend*MNE*	(10)	(11) *25th perc.*	(12) *50th perc.*	(13) *75th perc.*
	OLS	*IV*	*OLS*	*IV*	*OLS*	*IV*	*OLS*	*IV*	*OLS*	*IV*	*QUANT*	*QUANT*	*QUANT*
ΔIMI	0.056*	0.128	0.327***	0.723**	0.275***	0.692***	0.029	0.129	0.332***	0.718**	0.244***	0.141***	0.145***
	(0.029)	(0.134)	(0.082)	(0.331)	(0.062)	(0.201)	(0.030)	(0.138)	(0.082)	(0.331)	(0.028)	(0.020)	(0.028)
Trend			−0.005***	0.005					−0.005***	0.005	−0.003***	−0.005***	−0.007***
			(0.000)	(0.004)					(0.000)	(0.004)	(0.000)	(0.000)	(0.000)
Crisis					−0.009***	−0.007***							
					(0.002)	(0.002)							
MNE							0.018***	0.018***	0.018***	0.019***	0.003***	0.009***	0.018***
							(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ΔIMI*Trend			−0.033***	−0.065*					−0.037***	−0.062*	−0.037***	−0.025***	−0.024***
			(0.009)	(0.034)					(0.009)	(0.034)	(0.005)	(0.003)	(0.005)
ΔIMI*Crisis					−0.185**	−0.628***							
					(0.073)	(0.223)							
ΔIMI*MNE							0.127**	−0.022					
							(0.049)	(0.209)					
ΔIMI*Trend*MNE									0.015***	−0.015	0.007	0.005	0.013**
									(0.006)	(0.023)	(0.005)	(0.004)	(0.005)
Δ Capital	0.031***	0.031***	0.031***	0.031***	0.032***	0.032***	0.032***	0.032***	0.032***	0.031***	0.024***	0.028***	0.029***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)
LP, base	−0.066***	−0.066***	−0.066***	−0.066***	−0.065***	−0.065***	−0.067***	−0.067***	−0.067***	−0.067***	−0.047***	−0.032***	−0.031***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
Fixed effects	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
Observations	889,027	889,027	889,027	889,027	889,027	889,027	888,453	888,453	888,453	888,453	888,453	888,453	888,453
R^2	0.021	0.01	0.021	0.011	0.012	0.01	0.022	0.01	0.022	0.011	0.0231	0.0131	0.0211

Notes: This table reports the regression results of the impact of changes in import intensity on productivity growth. Growth rates in log differences are denoted by Δ. Constants are not reported. All specifications include country, sector and year-fixed effects. In the first stage, the F-statistics of the instruments are above 10 in all specifications. All 2SLS specifications were identified exactly. The Wald test statistics for the joint significance of the interaction effects are highly significant (P-value<0.01). Standard errors are in parentheses in specifications (1)–(10) and clustered at the treatment level. ***P-value<0.01, **P-value <0.05, *P-value <0.1.

TABLE 2

First stage F-statistics of excluded instruments

	Baseline		*ΔIMI * Trend*		*ΔIMI * Crisis*		*ΔIMI * MNE*		*ΔIMI * Trend * MNE*	
	Test value	*P-value*	*Test value*	*P-value*	*Test value*	*P-value*	*Test value*	*P-value*	*Test value*	*P-value*
First stage F-statistic of excl. instruments: ΔImport intensity	$F(1,4013)$: 71.43	0.000	$F(2,4013)$: 37.36	0.000	$F(2,4013)$: 54.55	0.000	$F(2,4013)$: 46.16	0.000	$F(3,4013)$: 32.22	0.000
First stage F-statistic of excl. instruments: ΔImport intensity*Trend			$F(2,4013)$: 37.71	0.000					$F(3,4013)$: 30.47	0.000
First stage F-statistic of excl. instruments: ΔImport intensity*Crisis					$F(2,4013)$: 64.62	0.000				
First stage F-statistic of excl. instruments: ΔImport intensity*MNE							$F(2,4013)$: 64.86	0.000		
First stage F-statistic of excl. instruments: ΔImport intensity*Trend * MNE									$F(3,4013)$: 73.52	0.000

effect of being a multinational firm. Using the average growth of import competition and considering the coefficients of regression (9), we found that the net effect of changes in Chinese import competition on the productivity growth of domestic firms became negative in 2011 but remained positive for multinational firms throughout the observation period. In the 2SLS, the coefficient of the triple interaction of changing import intensity, time and being a multinational was not statistically significant.

Finally, we ran a quantile regression for three separate quantiles to test whether the coefficients of the time trend and its interaction terms with import intensity growth and the MNE dummy varied along the growth distribution. In this way, we tested Conjecture III, which states that the magnitude of the effect of increasing import competition from China varies with the productivity growth rate of domestic and multinational firms over time. Columns (11) to (13) of Table 1 show the positive coefficients of changes in import intensity. The positive base effect of Chinese import growth on productivity growth was more pronounced for low-growth firms than for high-growth firms. The difference between the 25th and the 75th percentile was statistically highly significant (*P*-value: 0.000). However, these positive effects diminished over time. This dampening effect was also more pronounced for domestic firms with lower productivity growth rates than for high-growth firms. Again, the difference between the 25th and the 75th percentile was statistically highly significant. The effects for the 50th and the 75th percentile were mostly identical. Assuming the average growth of import competition for firms in the 25th percentile, the net effect of increasing import intensity from China was negative for low-growth domestic firms starting in 2010. On average, firms growing in the 75th percentile experienced a growth-dampening net effect 1 year later in 2011. Hence, Chinese exporters have become a more credible threat to firms with lower productivity growth. This suggests that, over time, a discouragement effect has set in, reducing labour productivity growth. This effect was less pronounced for European firms with higher productivity growth rates.

How did multinationals compare? The coefficients of MNE affiliation were significantly positive in all three quantile regressions. They increased with higher productivity growth percentiles. Thus, multinationals have a growth premium that is particularly pronounced at higher growth rates. We also interacted the MNE dummy variable with the time trend and the change in import competition from China (ΔIMI*Trend*MNE). The coefficient of the triple interaction effect was significantly different from zero only for firms in the 75th percentile. MNEs in the 75th productivity growth percentile were able to offset the growth-dampening effect experienced by other firms over time. The net effect of increasing Chinese import intensity for high-growth MNEs was positive (though declining) throughout the period. MNEs with lower growth rates (25th or 50th percentile) did not differ from their domestic counterparts in terms of the impact of increasing Chinese import intensity.

Next, we used the average annual increase in Chinese import intensities to quantify the size of the effect. In 2005, the results suggest a growth-enhancing effect of rising Chinese import intensity. At the 25th percentile for domestic firms, the effect was 0.04 percentage points. The effect was slightly lower at 0.02 percentage points at both the median and 75th percentile.

In 2011, the median year of the sample, the growth-reducing effect was −0.03 percentage points at the 25th percentile for domestic firms, and −0.02 percentage points at the 50th and 75th percentiles. Multinationals growing at the 75th percentile offset the negative growth effect by 0.03 percentage points, so that the net effect was slightly positive (0.01 percentage points).

In 2016, we found a small but statistically significant effect of −0.08 percentage points on productivity growth at the 25th percentile for domestic firms. The effect at the 50th and the 75th percentiles was −0.06 percentage points. This effect was partly offset by an increase of 0.05 percentage points for multinationals growing at the 75th percentile. Therefore, the net effect for multinationals in 2016 was −0.01 percentage points.

MNEs experienced a productivity growth premium. While statistically significant, it was small at the 25th percentile (0.3 percentage points), but increased in size at the 50th percentile (0.8 percentage points) and the 75th (2.8 percentage points) percentiles.

The control variables performed as expected. The coefficients on capital stock growth remained significantly positive, and the coefficient on the out-of-sample level of productivity was negative in all regressions. The unreported country, time and industry dummies were mostly significant.

VII. Sensitivity analysis

We conducted several robustness checks that supported our main results (see Appendix). These relate to five dimensions: (i) the functional form, (ii) the performance variable, (iii) outliers, (iv) standard errors and (v) sample selection bias.

First, we validated our results with a ‘‘policy placebo’’ exercise. We ran a regression that included a two-year leading indicator of import intensity growth, the treatment variable. The leading indicator was insignificant, suggesting that the increase in import intensity growth was causing an effect on the outcome. In addition, we included the level of Chinese import intensity growth and its quadratic form. This assumes an interaction between increasing intensity and a higher level as an indirect measure of existing growth opportunities. As our indicator captures market opportunities in a 4-digit industry, these indicators will be zero if there is no market opportunity in that industry (see Online Appendix Table A4).

Second, the main outcome variable is labour productivity, defined as firm-specific value added divided by the number of employees (see Online Appendix Table A5). We included changes in the capital stock as a control variable in the labour productivity estimates. Total factor productivity (TFP) indicators are an alternative approach. We used financial information to implement an Olley–Pakes TFP indicator (Olley and Pakes 1996; Mollisi and Rovigatti 2018), which we used as the target variable. Moreover, import competition may affect investment decisions. Therefore, we also presented results that did not include changes in capital stock as a control variable (see Online Appendix Table A6).

Third, both the target variable, firm-level productivity, and the key explanatory variable, imports from China, may be subject to outliers. Therefore, we re-estimated the regressions using trimmed data. We excluded the top and bottom 1% percentiles of the observed distribution of firm productivity growth (see Online Appendix Table A7). We also winsorised the data set at the same thresholds (see Online Appendix Table A8).

Fourth, in the literature, increasing attention is being paid to the clustering of standard errors (Abadie *et al.* 2023). In the preferred specification, we used standard errors clustered at the treatment (i.e., country–industry level). This is the most conservative but least efficient approach. The serial correlation of the error term is a potential problem in the fixed-effects regressions of productivity growth at the firm level. Following recent literature (Aghion *et al.* 2018), we used heteroscedasticity and autocorrelation corrected (HAC) standard errors with one lag (Newey and West 1986). Newey–West standard errors guard against heteroscedasticity ($Var(u_{it}) = \sigma_t$) and autocorrelation (i.e. serial correlation of the form AR(1) in the time series dimension such as $Cor(u_{it}, u_{i\tau}) = \rho^{|t-\tau|}$), but this assumes that the cross-sectional units (i.e. firms) are uncorrelated. This approach gives more weight to recent reactions than to those further back. Thus, when using Newey–West standard errors, we assumed that the actions of firms are independent of the actions of other firms, and that the actions of firms are less dependent on their actions further back in time (see Online Appendix Table A9).

Previous literature has used firm entry and exit information obtained from AMADEUS data (Bloom *et al.* 2016). They are a viable source for studying intra-firm dynamics. However, firm turnover requires a higher degree of representativeness, which is more likely to be provided by register data, whereas the focus on existing firms may be a source of sample selection bias. We, therefore, implemented a two-step Heckman estimator. In the first stage, we used a dummy variable that takes the value of one if a firm remains fully active and otherwise zero to control for selection into the market. A firm is defined as not active if it is in financial distress, for example, it is in default of its payments, is insolvent or has gone bankrupt. In the first stage, we used as predictors the size of the firm, captured by the number of employees and turnover. The lambda values were significant (see Online Appendix Table A10). In addition, we ran regressions restricting the sample to surviving firms to assess the potential impact of firm exit on productivity growth. We followed Bloom *et al.* (2016) and concentrated exclusively on firms that were active in the final year of our observation period k. We kept the cohort of firms that were classified as active (status not ''bankrupt'', ''liquidated'' or ''dormant'') throughout the whole sample from 2003 to 2016. This allows us to assess whether our results are driven by firm exits. Our main results do not change (see Online Appendix Table A11). All these robustness checks supported the validity of the main results presented in Table 1.

VIII. Discussion and conclusions

The view has long been that imports from China will have a positive impact on specialization and productivity growth of firms and industries. This is empirically supported by European data before the 2008–09 financial crisis (Bloom *et al.* 2016). However, recent evidence shows that after the financial crisis Chinese firms have increasingly entered market segments previously served by firms from industrialized economies (Autor *et al.* 2013). China's industrial policies have enabled Chinese firms to compete on both price and quality.

This led us to the first conjecture: imports from China initially had a positive effect on intra-firm productivity growth, which diminished over time and eventually turned negative. The regression analysis strongly supported this conjecture. We found a growth-enhancing net effect of increasing import intensity from China, especially in the years before the financial crisis. This suggests that in the European Union increased import competition initially induced productivity growth at the firm level. However, there was a reversal of the net effect, which became negative over time. This is in contrast to the United States, where the negative effect of Chinese import competition plateaued after 2010 (Autor, Dorn, and Hansen 2021). EU firms appear to have been able to avoid the negative effects of competition from China for a more extended period. This may be due to differing industrial structures. However, the evidence suggests that Chinese firms have increasingly been able to strengthen their competitive position in markets where EU firms are specialized.

This effect of import intensity growth on productivity growth was not evenly distributed. Firm heterogeneity moderates the effect of import competition from China (Mion and Zhu 2013; Fromenteau *et al.* 2019). Multinational firms may be better able to take advantage of international trade opportunities. We showed that being a multinational is generally associated with higher productivity growth. In addition, our results indicated that multinationals experience a smaller negative effect from rising imports from China. This suggests that the composition of the firm population in terms of multinational and domestic firms shapes the ability to cope with increasing imports from China at the aggregate level. The magnitude of the dampening effects also depends on the performance of the firms in terms of their labour productivity growth rates. This was shown in the quantile regressions. We found a positive net effect of increasing import intensity from China on productivity growth for high-growth MNEs over the entire observation period. Our main finding of a changing and increasingly dampening net effect of increasing Chinese import intensity on firm-level productivity growth over time was confirmed. However, the magnitude of these effects is generally small. This suggests that the actual economic impact of these effects was generally limited.

The results, therefore, support the perspective outlined in the literature review that the impact of import competition with Chinese firms on firm-level performance has changed over the period studied in this paper. Our results contribute to the debate on trade policy and the impact of Chinese industrial policies, such as the competition-distorting use of subsidies, intellectual property rights and market regulations. This is relevant, as the competitive pressure from China is expected to have further increased with ‘‘Made in China 2025’’, China’s industrial strategy (Li 2018), which aims not only to further upgrade the Chinese economy technologically, but also to achieve independence from foreign suppliers in ‘‘core products’’ such as semiconductors, aerospace, information technology or biotechnology. With policy changes in the aftermath of the COVID-19 pandemic both in the United States and the European Union, the results reported in this paper may be subject to changes again. These measures, such as the Inflation Reduction Act that became effective in 2022 or the Green Deal Industrial Plan currently under implementation in the European Union, aim to protect domestic firms from Chinese competitors in certain strategic industries. It is not yet possible to take these developments into account.

From a methodological standpoint, our results come with some limitations. Like other studies on Chinese import competition, we estimated partial equilibrium models. Thus, we were not able to capture the full economic or welfare effects of trade, as suggested, for example, by Caliendo, Dvorkin, and Parro (2019) for the United States. Following a similar general equilibrium approach, Fischer, Herkenhoff, and Sauré (2021) questioned the identification strategy proposed by Autor *et al.* (2013). The authors used a method that isolates the China-specific supply shocks from the sectoral shocks that are common to all exporters, thereby correcting for the identification of supply-induced export growth at the sectoral level. The results were strengthened in the general equilibrium estimations, while the partial equilibrium results were hardly affected. This instrumentation approach requires demand elasticities, which are not available for the currently used data at the NACE Revision 2, 4-digit level.

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Supporting Information

Additional Supporting Information may be found in the online Appendix:

Appendix S1. Supporting Information

Data replication package: the data replication package is available at https://doi.org/10.3886/E188961