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ABSTRACT

China's Import Competition, Innovation Strategies, and the Role of Unions*

This paper investigates the relationship between China's import competition and the innovation strategies of domestic firms. Using firm level data from Italy spanning 2005-2010 and employing IV fixed effects estimation techniques, we find that the impact of China's import competition on innovation varies depending on the type of goods imported (intermediate vs. final). Specifically, imports of final goods boost both product and process innovation, while imports of intermediate goods reduce both. Additionally, we extend the analysis to consider the role of unions in moderating these responses. We find that, in unionized firms, imports' impact on innovation is mitigated, specifically to protect workers' employment prospects.

JEL Classification: C33, L25, F14, F60, O30, J50

Keywords: China's import competition, final and intermediate goods, product and process innovation, unions, IV fixed effects estimations

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1. Introduction

In recent years, a prominent topic in economic debate has been the impact of international competition from emerging economies on firms' innovation strategies. China has been especially pivotal in this regard, with its economy experiencing a surge in low-cost exports since the late 1990s, which has significantly impacted advanced economies. Notably, China's share of global manufacturing exports grew from 2% to 5% between 1990 and 2000, then accelerated to 16% by 2011 (Autor et al., 2014).[1]

The empirical literature examining how developed countries respond to China's economic impact on innovation has produced various findings (Bloom et al., 2016, Autor et al., 2020) and recent studies have highlighted the diverse effects of import shocks on innovation, contingent upon factors such as firm productivity, domestic market competition, and specific components of the shock (Aghion et al., 2024, Autor et al., 2020, Cusolito et al., 2023).

Our paper aims to contribute to the literature by investigating the relationship between China's import competition and the innovation strategies of domestic firms, distinguishing import penetration by its components and considering two distinct types of innovation outputs. Specifically, we explore the impact of China's imports—both intermediate and final goods—on firm-level innovation. Given their distinct natures, imports of final goods represent competition in final consumption markets, while imports of intermediate inputs reflect outsourcing strategies that may substitute domestic production abroad. In terms of innovation, we analyze two standard measures of innovation outputs—process and product innovation (Schumpeter, 1934)—which represent different strategic responses with potentially varying labour market implications. Process innovation typically aims to enhance production efficiency and reduce costs, often at the expense of employment, whereas product innovation focuses on improving product quality and diversity, potentially boosting production and employment (Hall et al., 2008; Harrison et al., 2014; Peters, 2004; Pianta, 2001, 2003; Vivarelli, 2014).[2]

[1] In this paper we focus on Italy. The share of China's imports as a percentage of total imports increased from 1% in 1990 to nearly 10% in 2010. Meanwhile, the share of China's imports relative to imports from low and low-middle-income countries (according to the World Bank definition in 2000) rose from 12% in 1990 to 46% in 2010.

[2] Nonetheless, on the one hand, to the extent that process innovation enhances product quality or lowers prices, an increase in demand may lead to more jobs (Pianta 2001, 2003; Hall et al. 2008; Vivarelli 2014). On the other hand, in terms of product innovation, new products might simply replace old ones, resulting in minimal effects on firm employment, or they may be designed to cut costs, producing an impact similar to that of process innovation (Pianta, 2001, 2003; Hall et al. 2008).

We then extend our analysis by considering the importance of institutions, particularly unions, in this relationship. A substantial body of literature has explored how unions can influence firms' innovative activities and strategies, with mixed findings. On the one hand, unions may deter innovation through rent-seeking behaviors and hold-ups; on the other hand, they can also foster innovation by enhancing productivity and boosting job demand, which aligns with union interests (Menezes-Filho and Van Reenen, 2003). Moreover, since innovation is a risky activity, protections against dismissal might be crucial for facilitating effective innovation initiatives (Manso, 2011; Bradley et al., 2016).

Building on this, we investigate how the presence of a union at the firm level moderates the firms' innovative response to China's import competition. This analysis provides novel insights into the influence of unions on firm-level innovation strategies, filling a significant gap in the existing literature. To the best of our knowledge, no studies have comprehensively examined the role of institutions — particularly labour unions — in this context.

We use firm-level panel data from the Italian Survey on Firms and Workers (RIL - "Rilevazione su Imprese e Lavoro") spanning 2005-2010 in the manufacturing sector. This dataset includes comprehensive information on firms' innovation activities and union representation. In our empirical analysis, we regress innovation outcomes (product and process innovation indicators) on import variables, distinguishing between imports of final and intermediate goods. We control for unobserved firm heterogeneity using firm fixed effects and employ instrumental variable strategies to address potential endogeneity issues, such as industry-specific demand shocks or productivity fluctuations. Our instruments are based on industry-level imports from China in other EU countries and the US, selected to capture the supply-driven component of changes in Italian import penetration, while minimizing correlations with domestic demand conditions. To explore how unions moderate the relationship between imports and innovation, we then interact union status with import variables.

Our findings reveal that China's import competition significantly influences firms' innovation activities, with differential impacts depending on the type of import. Imports of final goods stimulate both product and process innovation, indicating firms respond to market competition by expanding product ranges and improving efficiency. Conversely, imports of intermediate goods deter both forms of innovation, with a

greater negative effect on product innovation. This suggests that such imports facilitate cost reductions through outsourcing domestic production processes abroad.

Regarding union effects, their presence at firms substantially moderates these dynamics. While unionized firms show reduced positive responses to final goods competition in terms of process innovation, they mitigate the negative impact of intermediate goods imports on product innovation. These results underscore unions' role in shaping firm strategies, aligning with literature suggesting their focus on protecting employment prospects.

Overall, unionized firms exhibit constrained responses to China's trade shocks, indicating institutions play a crucial role in influencing firm strategies. We argue that our findings for the Italian context may extend to similar European economies characterized by comparable economic structures and union dynamics.

The structure of the paper is organized as follows. In Section 2, we review the literature of reference. Section 3 describes the data and presents descriptive statistics. In section 4, we discuss the empirical specifications, while Section 5 presents the main results. Finally, Section 6 concludes.

2. Related Literature

This paper is related to two strands of literature: the relationship between import competition and innovation, and the impact of unions on innovation. In this section, we review the theoretical and empirical analyses of these topics.

Regarding the literature on firms' innovation responses to import competition, primarily from emerging economies like China, some studies have theoretically formalized this relationship. For example, Bloom et al. (2013) developed a trapped factor model of innovation, in which innovation increases in response to an import competition shock because it encourages a firm to innovate by reducing the opportunity cost of inputs. Relatedly, Aghion et al. (2005) modeled an inverted U-shaped relationship between product market competition and innovation. According to their model, competition may increase the incremental profits from innovating, that is an 'escape-competition effect', but it may also reduce the incentives to innovate for laggard firms, that is a 'Schumpeterian effect'. The balance between the two effects varies between low and high levels of competition, creating the inverted U-relationship.

Empirically, Bloom et al. (2016), focusing on 12 European countries from 2000-2007 and using different measures of innovation (TFP, R&D, patenting), show an increase of

technical change within (surviving) firms, and a reallocation of employment toward more technologically advanced firms in response to China's import competition. Conversely, Autor et al. (2020), focusing on the US from 1991-2007, highlight a negative impact of Chinese imports on firms' patenting, particularly among less profitable and less capital-intensive firms.

Some studies have explored how the impact of import competition on innovation varies depending on the type of imported goods. Notably, Aghion et al. (2024) decompose the "China shock" into two components. Specifically, they identify an output shock affecting firms that compete with goods similar to imported Chinese goods, and an input supply shock affecting firms using inputs similar to those imported from China.[3] Focusing on France from 2000 to 2007, they find that the output shock negatively impacts innovation (new firm patents), with this effect concentrated in low-productivity firms. In contrast, the input supply shock does not have a statistically significant impact on firm innovation. Additionally, they note that the input shock discourages new product introductions, as improved access to cheaper inputs reduces the need to switch to new products. Conversely, the output shock prompts high-productivity firms to export new products.[4] Tajoli and Felice (2018) investigate the relationship between participation in global value chains (GVCs) and countries' innovative performance between 1999 and 2011. They find that, for developing countries, importing inputs from advanced economies is positively associated with a country's innovation outcome, indicating that the international fragmentation of production can act as a channel for technology transfer from developed to developing countries. Conversely, they argue that in advanced countries sourcing inputs from lower-income countries, the incentive to innovate may be reduced if outsourcing is primarily a strategy to control costs in the production process of mature products, thereby extending the product life cycle. Relatedly, Zhong (2023) explores the relationship between the quality of imported intermediate inputs and firms' innovation activities in China, focusing on the period from 2000 to 2009. The study shows that importing high-quality intermediate inputs tends to increase the number of invention patents filed by firms. Colantone and Crinò (2014) show that new imported inputs positively impacted the development of new

[3] In particular, to measure the output shock, they use firms' export data at the product level to assess each firm's exposure to increased Chinese import penetration in its outputs markets. For the input shock, they use firms' import data at the product level to evaluate each firm's exposure to the Chinese import penetration in its inputs markets.

[4] They consider firms' exported product mix, as product-level details for domestic sales are not available.

domestic products across 25 European countries from 1995 to 2007. In a similar vein, Bos and Vannoorenberghe (2019), examining five developing countries from 2009 to 2012, find evidence that the number of newly imported varieties significant impacts on product innovations that depend on new inputs. They also provide suggestive evidence that this effect arises from access to higher-quality imports. Finally, Liu and Qui (2016) investigate the effects of reducing tariffs on intermediate input on the innovation activities of domestic firms in China, using data from 1998 to 2007. Theoretically, they argue that a cut in intermediate input tariffs can create both positive and negative incentives for innovation. On the one hand, lower tariffs allow firms to purchase a larger quantity of input with greater variety and higher quality. This capability may reduce a firm's incentive to innovate, as it can enhance firms' productivity or output quality through a cheaper channel, such as importing intermediate inputs. On the other hand, firms might engage in R&D using these intermediate inputs, benefiting from the technology embedded in the imports. Their findings indicate that tariff reductions lead to less innovative activity among Chinese firms.

Overall, these studies suggest that the impact of intermediate input imports on innovation may depend on various factors, such as a firm's strategy (cost competitiveness vs technological approach), firm characteristics (high- vs low-productivity firms), and the characteristics of the imported inputs (high-quality vs low-quality or new vs existing varieties).

As for the Italian case, to the best of our knowledge, there are no studies specifically analyzing this issue. However, several papers investigate related topics. Bugamelli et al. (2008) examine the restructuring in Italy following the introduction of the euro and show that (particularly low-tech) firms have shifted their business focus from production to upstream and downstream activities, including R&D activities among others.[5] Colantone et al. (2020) analyze the impact of new imported inputs on wages and worker mobility during the period 1995-2007, highlighting that new imported inputs lead to a positive selection of high-skilled workers and displacement of low-skilled workers. Bugamelli et al. (2010) explore how import competition from China affected Italian firms' pricing strategies from 1990-2006, revealing a reduction in price dynamics and markups, particularly in small firms operating in less technologically advanced sectors.

[5] This is because these activities (R&D, product design, marketing and distribution) provide firms with a degree of market power, allowing them to escape pure cost competition.

The second strand of literature we examine focuses on the relationship between unions and innovation, exploring various theoretical perspectives on their impact on firms' innovation activities. On one hand, unions can negatively impact innovation. Evidence suggests that unions make firms less profitable by increasing members' compensation (Menezes-Filho, 1997). This reduced profitability financially constrains firms, affecting their investment decisions and lowering investments in risky R&D activities. Additionally, there can be a "hold-up" problem: since R&D investments entail sunk costs, unions may demand higher wages after an innovation is introduced (Menezes-Filho and Van Reenen, 2003). This mechanism may lead to an ex-ante underinvestment in R&D, which reduces innovation opportunities (Grout, 1984). Finally, unions may have negative attitudes towards innovation, as new technology could lead to job losses and work changes perceived as against union interests (Menezes-Filho and Van Reenen, 2003).[6]

On the other hand, unions might stimulate firm innovative activities. Innovation involves a long, risky process that is often unsuccessful. Providing employees with labor contracts that protect against dismissal in adverse circumstances is necessary to motivate innovation (Bradley et al., 2016; Manso, 2011). Since unions offer protection against workers' contract termination, this might foster a positive relationship between unions and innovation (Bradley et al., 2016). Moreover, unions can increase firm productivity by reducing staff turnover, decreasing protests, and creating moral values (the "collective voice view", Freeman and Medoff, 1984), which may boost innovation (Menezes-Filho and Van Reenen, 2003).[7] Finally, unions' attitudes toward innovation might be more positive when they expect favorable labor market outcomes, such as those derived from product innovation.

The empirical evidence is mixed. Studies focusing on the impacts of unions on direct measures of innovation, such as patents and innovation outputs (product and process innovations)[8], often find negative effects using both firm and industry-level data (Blundell et al., 1999, Bradley et al., 2016, Koeller, 1996, Audretsch and Schulenburg,

[6] For an in-depth survey see Menezes-Filho and Van Reenen (2003) or Bradley et al. (2016).
[7] In particular, Menezes-Filho and Van Reenen (2003) highlight that the pro-productivity stance of unions is particularly valid in Continental European countries, where unions tend to be more cooperative, compared to countries with more conflictual industrial relations, such as the US and the UK.
[8] Studies on R&D generally indicate a negative or statistically insignificant relationship between union and R&D investments. Refer to the review in Menezes-Filho and Van Reenen (2003) for more details.

1990, Acs and Audretsch, 1988, Hirsch and Link, 1987). However, some analyses find positive impacts on product innovation (Schnabel and Wagner, 1994, Walsworth 2010).[9] Additionally, Perone (2024) studies the relationship between labor market institutions (using various proxies) and patents in European regions over 2000-2015, finding that, when significant, union density negatively impacts innovation output, while wage bargaining coverage and centralization show a positive association with patents. As a result, he stresses that a uniform wage higher than the competitive wage can enable the Schumpeterian creative destruction process, forcing firms to invest in innovation to remain competitive.[10]

3. Data description

We use firm level panel data from the RIL database elaborated by the National Institute for the Analysis of Public Policies (INAPP). RIL data are representative of the universe of Italian (capital-owned) firms, and they are collected from three successive surveys (2005, 2007, and 2010). These data provide a wide set of information about Italian firms such as the firm size, composition by occupation and gender, location (NUTS 2 region) and sector (NACE Rev.2, two-digit level), innovation status, and union presence.[11]

Information on the innovative status of the firm is relative to whether a firm has introduced any process or product innovation in the last three years, and information on

[9] Hirsch and Link (1987) measure the relationship between unions and innovation using product innovation as an outcome variable. They find a negative relationship based on US data. However, similar to other cited studies, their analysis is limited to a single year and relies on cross-sectional estimates, which might affect the validity of the results.

[10] Regarding the literature on import competition and unionization, Alquist and Downey (2023) and Charles et al. (2024) document a decline in labor unions in manufacturing sectors due to import competition. Similarly, Matano et al. (2023) examine the relationship between trade exposure and institutions by studying the impacts on national contract minimum wages, finding a negative effect of import competition on minimum wages. Additionally, Chakraborty et al. (2024) explore how labor market regulations influence firms' responses to China's import competition in India. They focus on the outsourcing of manufacturing jobs, proposing a theoretical model that predicts different effects of import competition in pro-worker versus pro-employer states. Their findings show that increased import competition from China leads to a significant rise in domestic outsourcing of manufacturing jobs (to the informal sector), an effect driven by multi-product firms operating in states with pro-worker labor laws. These results align with the model's predictions, which suggest that forward-looking firms are more likely to outsource in response to increased import competition, when future firing costs can be avoided through such outsourcing.

[11] According to INAPP, the sampling strategy involved stratified sampling with variable probability extraction proportional to the size of the firm. The allocation of the sample includes planning the study domains that coincide with the region, size class, legal form and economic activity sector. The estimation phase involved the development of a calibrated estimator based on a series of auxiliary information. The known totals from the calibration procedure were obtained from the ASIA archive (Statistical Archive of Active Enterprises) provided by Istat and correspond to the study domains.

unionization status identifies those firms with any form of workers' representation at the workplace legally entitled to participate in the firm-level bargaining process.

We merge these data with data on China's imports of intermediate and final goods coming from the OECD Stan Bilateral Database in Goods by Industry and End of Use (ISIC Rev.4, two-digit level[12]) and with data on industrial value added from the OECD Stan Database for Structural Analysis.

We focus on the manufacturing sector and clean the data as follows. We exclude firms with fewer than 15 employees, since the incidence of unions in such firms is negligible.[13] Moreover, we drop observations with missing data on our variables of interest (innovation and union) and observations for firms belonging to few sectors for which there are no final goods imports from China.[14] Also, we restrict our analysis to firms with at least two observations in the panel to conduct firm fixed effects estimations. In this way, we end up with a panel of 3,135 observations, which account for 1,333 firms.

As main dependent variables, we use dummy variables indicating whether a firm has introduced a product innovation or a process innovation in the past three years. The key independent variables are the shares of imports of intermediate or final goods over value added, defined at the sector level (NACE Rev.2, two-digit). The import variables are three years lagged to remain consistent with the definition of innovation. Also, we use a union dummy that indicates whether the firm has union representation.[15]

Tables 1 and 2 display the weighted descriptive statistics of the variables of interest in the analysis. For the innovation variables, Table 1 shows that approximately 64% of firms have introduced some form of process innovation in the past three years, while 66% have carried out product innovations. This high incidence is unsurprising considering that our sample excludes small firms with fewer than 15 employees,

[12] The NACE Rev.2 classification and ISIC Rev.4 coincide at the two-digit level. We have information available for 20 sectors.

[13] According to Italian law, workers' representation can only be introduced at the firm level for companies with fewer than 15 employees through the national industrial bargaining system (a rare occurrence). In the RIL data, weighted statistics show that unions are present in less than 2% of firms with fewer than 15 employees.

[14] In particular, we exclude two sectors from the sample (printing and basic metals), which together account for 3.7% of total sample observations, because final imports in these sectors are either null or negligible.

[15] Regarding the institutional framework of unions, Italian law grants workers the right to join a union, participate in union activity, and establish plant-level union representation structures. The primary workplace representation body is the 'unitary workplace union structure' (*Rappresentanze Sindacali Unitarie*, RSU), which can be elected by all employees of the firm. Alternatively, a plant-level union body (*Rappresentanza Sindacale Aziendale*, RSA) can be elected by the members of a particular union.

implying that the average firm size is 58 employees. Moreover, 48% of the firms have union representation, consistent with findings in other papers using similar data (Devicienti et al., 2018). As for the import variables, the 3-year lagged share of imports of final goods over value added is substantially higher than that of intermediate imports. Further, blue collar workers account for 64% of the firms' workforce, and females account for 31%. Table 2 shows the weighted sector distribution of the firms in the sample. The highest incidence is in the 'Metal product' sector (19% of firms), followed by 'Machinery & equipment', 'Food, beverages & tobacco', 'Textile & wearing apparel', and 'Furniture & toys', which each account for around 12%-13% of firms.

As for import penetration, Figures 1 and 2 show the time average of our independent variables across sectors from 2002-2007, the period used in the empirical analysis for the trade variables. From the figures two interesting remarks emerge. First, there is heterogeneity across sectors in the degree of import penetration. Second, this heterogeneity mainly concerns final goods, where the most affected sectors are "Wearing apparel", "Electronics & optical", "Leather", "Furniture & toys", and "Electrical equipment". The other sectors face very low competition from China. Second, in the case of intermediate goods, sectors are more evenly affected by import penetration. In fact, even if there are still sectors highly relying on imports of intermediate inputs (that in some cases coincide with those also facing strong competition in final goods) such as "Textile", "Electronics & optical", "Chemicals", "Coke & fuel", and "Electrical equipment", the remaining sectors still rely to a certain extent on imports of intermediate inputs.

[Table 1 around here]

[Table 2 around here]

[Figure 1 around here]

[Figure 2 around here]

4. Empirical strategy

4.1 Main specification

In this section we present our empirical strategy to investigate the impact of China's import competition on innovation. Using the RIL data for the years 2005, 2007, and 2010, we specify the following linear probability model[16]:

$$Inn_{it} = \beta_1 + \beta_2 * ImpFin_{j(i),t-3} + \beta_3 * ImpInt_{j(i),t-3} + B' * Char_{it} + \delta_i + \gamma_t + u_{it} \qquad (1)$$

where *i* refers to firms, *j(i)* to the sector firm *i* belongs to, and *t* to time. The dependent variable, Inn_{it} is the dummy for either product or process innovation. As main independent variables we use the (log of the) 3-year lagged shares of final imports over valued added, $ImpFin_{j(i),t-3}$, and of intermediate imports over value added, $ImpInt_{j(i),t-3}$. $Char_{it}$ stands for a set of observable firm characteristics: firm workforce composition, including the share of blue-collar workers and the share of female workers in total firm employment, as well as firm size (in log). Finally δ_i is a firm fixed effect to control for unobserved firm heterogeneity, while γ_t represents year dummies. Standard errors are clustered at the industry (NACE Rev.2, two-digit) level. Nonetheless, since the number of industry clusters (18) might be considered limited, we report wild clustered bootstrap standard errors (Roodman et al., 2019) which adjust for weak instruments and a small number of clusters, as highlighted by Cameron et al. (2008).

One issue that we have to take into account is endogeneity. In fact, there may be unobservable factors, such as domestic demand shocks, that simultaneously affect the likelihood that firms import goods from China and their propensity to innovate. We employ an instrumental variable approach, using as instrument the average of the shares of imports over value added for other EU countries[17] and the US (in the vein of Autor et al., 2020). The identifying assumption is that the import share in other high-income countries is not correlated with Italian industrial (demand) shocks, while capturing shocks in the origin countries, specifically those related to the surge in China's exports.

[16] We choose to use a linear probability model instead of a non-linear model, such as a probit model, because our analysis controls for both endogeneity and unobserved heterogeneity, which cannot be adequately addressed within a non-linear framework.

[17] We select the EU15 countries (excluding Italy) for which data on value added are available for all sectors and years. These countries are: Austria, Belgium, Germany, Denmark, Spain, Finland, France, the UK, the Netherlands, and Portugal.

4.2 Heterogenous effects across unionized and non-unionized firms

After assessing the impact of China's import competition on firm innovation performance, we extend our empirical analysis to examine the role of unions in affecting this relationship. We modify eq. (1) by introducing interaction terms between the union dummy and the shares of China's imports over value added, as follows:

$$Inn_{it} = \beta_1 + \beta_2 * ImpFin_{j(i),t-3} + \beta_3 * \left(ImpFin_{j(i),t-3} * Union_{it}\right) + \beta_4 * ImpInt_{j(i),t-3} + \beta_5 * \left(ImpInt_{j(i),t-3} * Union_{it}\right) + \beta_6 * Union_{it} + B' * Char_{it} + \delta_i + \gamma_t + u_{it} \quad (2)$$

Where $Union_{it}$ is the dummy indicating the presence of union at the firm level, and $ImpFin_{j(i),t-3} * Union_{it}$ and $ImpInt_{j(i),t-3} * Union_{it}$ stand respectively for the interaction terms between the firm level union dummy and the (log of the) 3-year lagged shares of final imports and intermediate imports over valued added. All other variables remain the same as in equation (1).[18] [19]

5 Results

5.1 Baseline results

Table 3 presents the IV fixed effects estimates of model (1) where, as emphasized, standard errors are corrected using the wild cluster bootstrap methodology (Roodman et al., 2019). Table A2 in the Appendix displays the estimates with standard errors clustered at the sector (NACE Rev.2, two-digit) level.[20] Columns (1) and (2) report the estimates for process innovation, while columns (3) and (4) present the estimates for product innovation. Furthermore, columns (1) and (3) show the results when only time and firm fixed effects are included in the estimation, whereas columns (2) and (4) incorporate firm-level observable variables. Results show that importing final goods has

[18] In this specification, the interaction terms are instrumented. Therefore, we introduce additional instruments for the analysis, specifically the interactions between the **average of the shares** of imports over value added for **other EU countries and the** US, and the firm union dummy.

[19] We consider firm-level unions to be exogenous. While unions may target more profitable firms with higher rents, identifying an exogenous variation in union presence, particularly in European countries, is challenging without natural experiments (Di Nardo and Lee, 2004; Lee and Mas, 2012; Frandsen, 2012). Breda (2015), in the context of France, highlights that after controlling for detailed firm characteristics, unionization does not target more profitable firms. In France, organizing a union is relatively straightforward, requiring only a willing worker or local union support. Breda (2015) suggests that in such an environment, union assignment can be considered 'quasi-random.' Given the similarity of the Italian institutional framework to that of France, we make the same assumption.

[20] Table A1 in the Appendix presents the first stage estimates.

a positive and significant impact on both process and product innovation. In particular, doubling the share of final goods imports over value added, implies an increase of between 8 and 14 percentage points in the firms' probability of introducing a process or product innovation, respectively. This result points out that firms tend to introduce product innovations to expand the range and quality of supplied goods in response to China's competition in final goods, and they implement process innovations to reduce production costs. This finding is in line with previous empirical literature investigating the impact of China's import competition on innovation (Bloom et al., 2016). Conversely, intermediate imports exhibit a negative impact on both types of innovation, more pronounced for product innovations. Doubling the share of China's intermediate imports over value added implies a reduction of between 6 and 21 percentage points in the likelihood that a firm will introduce a process or product innovation, respectively. This outcome suggests that intermediate imports serve as substitutes for parts of the firm's production processes and associated costs, thereby reducing the incentive to innovate (in line with Tajoli and Felice, 2018, and Aghion et al., 2024).[21]

Overall, these findings indicate that China's imports have a significant impact on the innovative activity of Italian firms, with this impact varying according to the type of goods imported.

[Table 3 around here]

Before moving on to the extension of the empirical analysis, we summarize the results of some robustness checks reported in the Appendix. First, we cluster the standard errors at the firm level rather than at the sector level. The overall results are confirmed, except for the negative impact of intermediate imports on process innovation, which becomes insignificant (Table A3). Second, we consider the possibility of applying sampling weights to our estimates. According to Solon et al. (2015), applying sampling weights is unnecessary for consistency in our specification, as we control for the stratification

[21] Our analysis indicates an overall average effect of intermediate imports on innovation. Nonetheless, intermediate goods are associated with different types of industries (high-tech and low-tech), which may entail diverse impact on firms' innovation activities (Reljic et al., 2021). We have tested this relationship by interacting the intermediate imports variable with a dummy for high-tech industries, as defined by Eurostat. Our findings show that the negative impact of intermediate imports on innovation is mitigated in high-tech sectors, although the effect is not precisely estimated. These estimates are available upon request.

variables in the estimation.[22] Therefore, using weights may only reduce the precision of the estimation. Nonetheless, for the sake of comparison, we report the estimates using sampling weights in Table A4. As expected, the coefficient estimates do not change significantly when applying sampling weights (tests of equality of coefficients never reject the null hypothesis), while their efficiency is somewhat affected. Lastly, we compute an alternative measure for the imports of intermediate goods. Specifically, we recognize that an industry sources inputs not only from its own sector but also from other sectors. Therefore, following Colantone and Crinò (2014), we redefine the imports of intermediates for each sector as the sum of the values of intermediate imports sourced from all sectors (including the sector itself). Data are obtained from the import input-output tables provided by the OECD. The main limitation of using this variable is that the input-output table for Italy is available only for 2010, which prevents us from capturing changes in sector linkages over the years. Additionally, the sector breakdown is more aggregated compared to our original trade variables. Results are shown in Table A5, overall confirming our main findings.

5.2 Heterogeneous Effects Across Unionized and Non-Unionized Firms

In this section, we analyse the role of unions in influencing firms' innovation strategies. Therefore we estimate eq.(2), which modifies eq.(1) by introducing interaction terms between the union dummy and the shares of China's imports over value added. This part of the analysis provides a valuable extension of our findings as, to the best of our knowledge, there are no studies analyzing the role of institutions in affecting firms' innovation responses to import competition. Nonetheless, we suggest taking the results of this subsection with caution due to limitations concerning the union variable.[23]

[22] In particular, we control for firm size, as well as region, sector and legal form, by incorporating firm fixed effects.

[23] More in detail, aside from the assumption of union exogeneity already discussed, our analysis of the role of unions may be limited by our inability to evaluate the impact of the intensive margin of union representation –that is, the share of unionized workers or the influence of unions in decision-making– due to data availability; instead, we can only assess the extensive margin. This is an interesting issue to be explored that we leave for further research. Moreover, while the import variables are lagged by three years, the union dummy relates to the year of the survey. Therefore, we cannot rule out the possibility that a firm may unionize in response to an increase in China's import competition. To address this concern, we conducted a simple test by performing an IV fixed effects regression of the union dummy on the (log of the) 3-year lagged import intensity variables. Findings show a nonsignificant impact of import variables on unions, which reassures us that this issue should not represent a major concern in the empirical analysis. We do not show these estimates for the sake of synthesis. They are available upon request.

Table 4 presents the IV fixed effects estimates for the specification of model (2) with standard errors computed using the wild cluster bootstrap methodology to correct for the presence of few clusters and weak instruments.[24] Columns (1) and (2) show the estimates for process innovation, while columns (3) and (4) show the estimates for product innovation. In columns (1) and (3), only firm and time fixed effects are included in the estimation, while columns (2) and (4) introduce the set of firm observable characteristics as control variables.

First, considering the import variables, results confirm previous findings: imports of final goods positively affect all kinds of innovative activities, while imports of intermediate inputs discourage any kind of innovation.

Second, the interactions of the import components with the union variable provide interesting findings. In general, it is possible to observe that the coefficients of interaction terms, when significant, exhibit effects opposite to those of baseline import impacts. Specifically, the interaction of the union dummy variable with imports of final goods exhibits a negative coefficient for process innovation, while it is not significant for product innovation. Conversely, the interaction between the union dummy variable and imports of intermediate goods shows a positive coefficient for product innovation, while being insignificant for process innovation. Furthermore, the main effect of unions is positive and significant only for product innovation.[25]

These findings suggest that in unionized firms all impacts of imports are dampened, indicating that unions mitigate the effects of import competition. Additionally, there is a general tendency (i.e., the base effect) of unions towards favoring product innovation in line with the idea that product innovation could increase productivity, growth, and employment (Walsworth, 2010, Schnabel and Wagner, 1994).

We argue that this smoothing role of unions serves as a form of protection for workers' employment prospects. In case of adverse shocks for workers, such as the rise

[24] Table A6 in the Appendix shows the estimates with standard errors clustered at the sector (NACE Rev.2, two-digit) level.

[25] As previously emphasized, it is worth noting that firm unionization can be associated with various firms' high-performance characteristics, such as high profitability, productivity, or a high- skilled workforce, which generally improve innovative performance (Pianta and Reljic, 2022). Our findings on unionized firms, which in some cases mitigate firms' innovation responses, do not contradict this evidence. In fact, in our estimates, we control for both observed and unobserved firm heterogeneity, which serve as proxies for firm productivity. Therefore, our analysis examines the role of unions in the relationship between import competition and innovation, after accounting for all firm characteristics except for the presence of unions.

in (labor saving) process innovation driven by competition in final goods, unions mitigate the negative effects on employment by reducing the magnitude of the impact on process innovation. Conversely, in case of favorable shocks, such as an increase in product innovation driven by higher final goods import competition, unions do not significantly react, thereby not constraining the potential positive impact on employment associated with product innovation. Similarly, they minimize the adverse impact of sourcing intermediate inputs on product innovation.

[Table 4 around here]

6. Conclusions

This paper investigates the role of unions in moderating the impact of China's imports on firm innovation outputs (product and process innovation), considering imports distinguished by their end-of use category, final and intermediate.

We use a unique panel data of Italian firms (RIL) for the years 2005, 2007, and 2010 in the manufacturing sector. After controlling for observed and unobserved firm heterogeneity and for endogeneity through of an IV fixed effects approach, we derive the following findings.

First, the impact of imports on innovation strongly depends on the type of imports, distinguishing between final and intermediate goods. Specifically, imports of final goods stimulate all firm innovation activities (both product and process) in response to competition from China, whereas imports of intermediate inputs significantly discourage them. This indicates that firms respond to competition from China's final goods by innovating, whereas the influx of foreign intermediate inputs discourages innovation.

When examining the relevance of unions within this relationship, it emerges that unionized firms react to China's import competition. Our results show that unions tend to attenuate the impacts of imports on innovation, in a way that protects workers' employment prospects.

These findings highlight the importance of considering the role of institutions in analyzing the consequences of globalization, as they significantly impact and influence firm strategies.

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Tables and Figures

Figure 1: Imports of final goods over value added by sector, time-average 2002-2007.

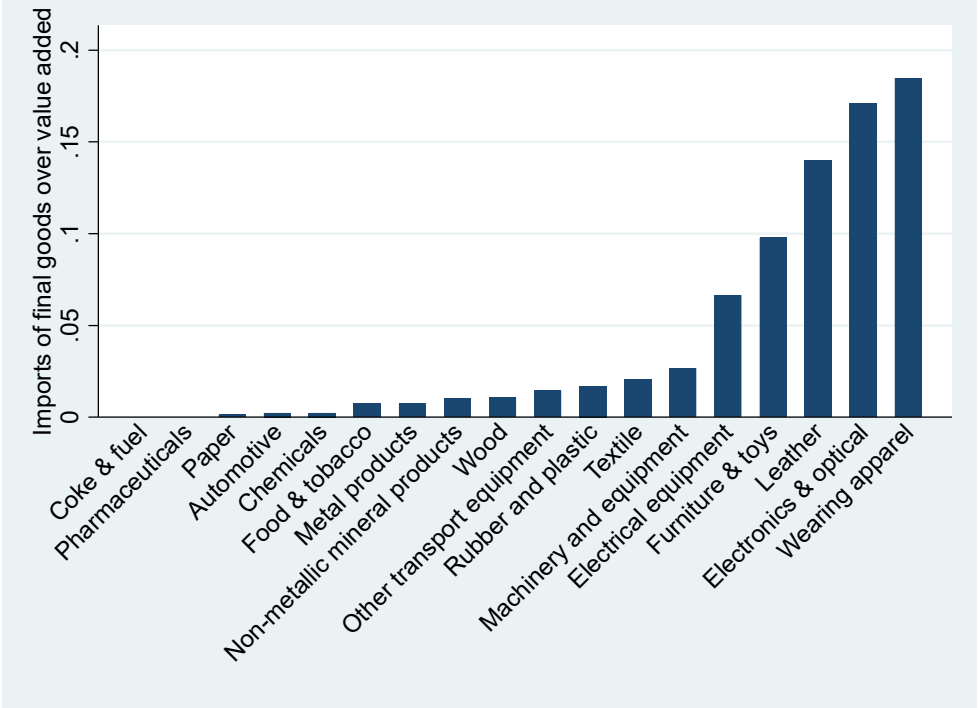

Figure 2: Imports of intermediate goods over value added by sector, time-average 2002-2007.

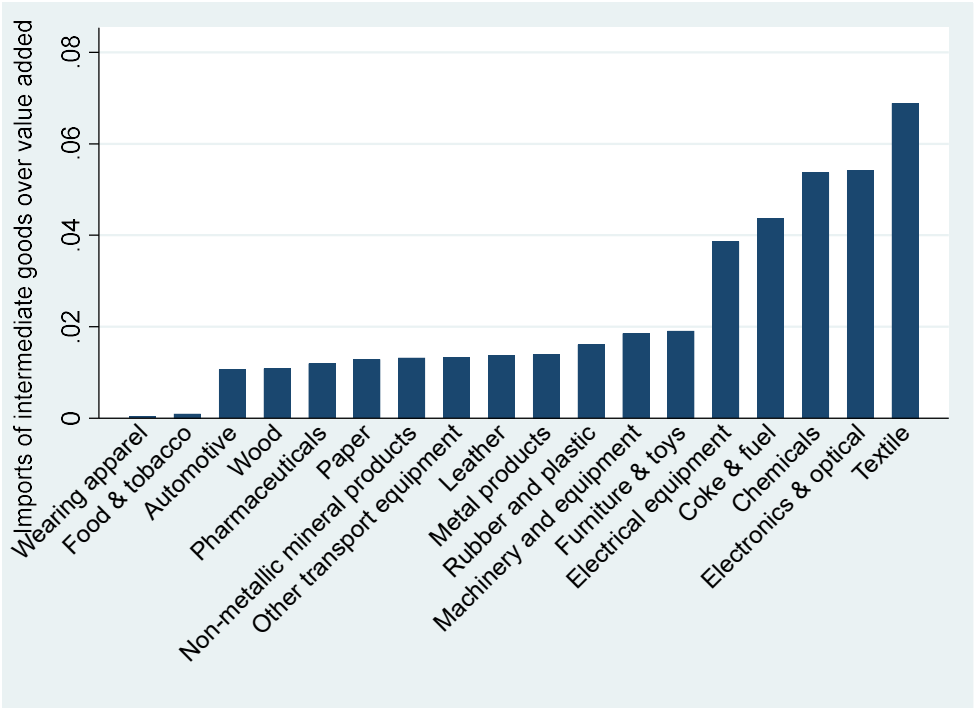

Table 1: Descriptive Statistics of the Variables of the Analysis.

Variable	Mean	Std. Dev.	Min	Max
Process Innovation	0.640	0.480	0	1
Product Innovation	0.660	0.474	0	1
Union	0.483	0.500	0	1
China's share of final imports over value added	0.044	0.058	0	0.278
China's share of intermediate imports over value added	0.019	0.020	0	0.113
Firm Size	58	102	15	6,007
Share of blue collar workers	0.643	0.239	0	1
Share of females workers	0.307	0.231	0	1
Number of Observations	3,135			
Number of Firms	1,333			

Notes: China's share of final/intermediate imports over value added is the 3-year lagged value. Descriptive statistics weighted using sampling weights.
Source: Panel RIL.

Table 2: Distribution of Firms by Sector (NACE Rev.2, Two-Digit Level).

Variable	Freq (%)
Food, beverages & tobacco	12.08
Textile	5.81
Wearing apparel	6.43
Leather	3.50
Wood	2.12
Paper	3.06
Coke & Fuel	0.22
Chemicals	3.30
Pharmaceuticals	0.61
Rubber and plastic	5.10
Non-metallic mineral products	6.08
Metal products	18.69
Electronics & optical	2.55
Electrical equipment	2.92
Machinery & equipment	13.03
Automotive	1.43
Other transport equipment	0.12
Furniture & toys	12.94

Notes: Descriptive statistics weighted using sampling weights.
Source: Panel RIL.

Table 3: IV Fixed Effects Regressions of Innovation Outputs on China's Imports. Wild cluster bootstrap standard errors.

	Process Innovation		Product Innovation	
	(1)	(2)	(3)	(4)
Final imports	0.087**	0.077**	0.126***	0.142***
	[0.020]	[0.037]	[0.007]	[0.002]
Intermediate imports	-0.077**	-0.062*	-0.218**	-0.210**
	[0.047]	[0.085]	[0.020]	[0.027]
Firm control variables	no	yes	no	yes
Time fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Kleinberg-Paap F Stat.	19.40	17.69	19.40	17.69
N. Observations	3,135	3,108	3,135	3,108
N. Firms	1,333	1,323	1,333	1,323
N. Clusters	18	18	18	18

Notes: Wild cluster bootstrap P_values in square brackets. ***,** and * denote significance at 1%, 5% and 10% respectively. Imports are the (log of the) 3-year lagged share of imports over value added. The instruments are the (log of the) average of the 3-year lagged shares of imports over value added for other EU countries and the US.

Table 4: IV Fixed Effects Regressions of Innovation Outputs on Imports from China. Interaction with unions. Wild cluster bootstrap standard errors.

	Process Innovation		Product Innovation	
	(1)	(2)	(3)	(4)
Final imports	0.116***	0.103**	0.125***	0.142***
	[0.002]	[0.014]	[0.006]	[0.003]
Final imports * Firm union	-0.044**	-0.040**	-0.004	-0.007
	[0.028]	[0.033]	[0.821]	[0.687]
Intermediate imports	-0.094**	-0.078*	-0.254**	-0.253***
	[0.026]	[0.052]	[0.019]	[0.019]
Intermediate imports * Firm union	0.018	0.018	0.048	0.057*
	[0.315]	[0.288]	[0.125]	[0.070]
Union dummy	-0.076	-0.073	0.226	0.260*
	[0.476]	[0.511]	[0.117]	[0.071]
Firm control variables	no	yes	no	yes
Time fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Kleinberg-Paap F Stat.	9.72	8.88	9.72	8.88
N. Observations	3,135	3,108	3,135	3,108
N. Firms	1,333	1,323	1,333	1,323
N. Clusters	18	18	18	18

Notes: Wild cluster bootstrap P_values in square brackets. ***,** and * denote significance at 1%, 5% and 10% respectively. Imports are the (log of the) 3-year lagged share of imports over value added. The instruments are the (log of the) average of the 3-year lagged shares of imports over value added for other EU countries and the US.

Appendix

Table A1: IV Fixed Effects Regressions of Innovation Outputs on China's Imports. First stage estimates.

	(1)	(2)
	Final imports	**Final imports**
Final imports instrument	0.854***	0.833***
	[0.266]	[0.262]
Intermediate imports instrument	0.628**	0.626**
	[0.223]	[0.221]
	Intermediate imports	**Intermediate imports**
Final imports instrument	-0.181	-0.181
	[0.138]	[0.138]
Intermediate imports instrument	0.989***	0.990***
	[0.117]	[0.116]

Notes: Standard errors clustered at the sector level in square brackets. ***,** and * denote significance at 1%, 5% and 10% respectively. Column (1) refers to the first stage estimates of columns (1) and (3) of Table 3 and Table A2; column (2) refers to the first stage estimates of columns (2) and (4) of Table 3 and Table A2. Imports are the (log of the) 3-year lagged share of imports over value added. The instruments are the (log of the) average of the 3-year lagged shares of imports over value added for other EU countries and the US.

Table A2: IV Fixed Effects Regressions of Innovation Outputs on China's Imports. Standard Errors Clustered at the Sector Level (NACE Rev.2, Two-Digit).

	Process Innovation		**Product Innovation**	
	(1)	(2)	(3)	(4)
Final imports	0.087***	0.077***	0.126***	0.142***
	[0.023]	[0.025]	[0.033]	[0.033]
Intermediate imports	-0.077**	-0.062*	-0.218***	-0.210***
	[0.034]	[0.032]	[0.069]	[0.067]
Firm control variables	no	yes	no	yes
Time fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Kleinberg-Paap F Stat.	19.40	17.69	19.40	17.69
N. Observations	3,135	3,108	3,135	3,108
N. Firms	1,333	1,323	1,333	1,323
N. Clusters	18	18	18	18

Notes: Standard errors clustered at the sector level in square brackets. ***,** and * denote significance at 1%, 5% and 10% respectively. Imports are the (log of the) 3-year lagged share of imports over value added. The instruments are the (log of the) average of the 3-year lagged shares of imports over value added for other EU countries and the US.

Table A3: IV Fixed Effects Regressions of Innovation Outputs on China's Imports. Standard Errors Clustered at the Firm Level.

	Process Innovation		Product Innovation	
	(1)	(2)	(3)	(4)
Final imports	0.087*	0.077	0.126**	0.142**
	[0.053]	[0.055]	[0.055]	[0.055]
Intermediate imports	-0.077	-0.062	-0.218***	-0.210***
	[0.072]	[0.072]	[0.069]	[0.069]
Firm control variables	no	yes	no	yes
Time fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Kleinberg-Paap F Stat.	319.80	278.40	319.80	278.40
N. Observations	3,135	3,108	3,135	3,108
N. Firms	1,333	1,323	1,333	1,323

Notes: Standard errors clustered at the firm level in square brackets. ***,** and * denote significance at 1%, 5% and 10% respectively. Imports are the (log of the) 3-year lagged share of imports over value added. The instruments are the (log of the) average of the 3-year lagged shares of imports over value added for other EU countries and the US.

Table A4: IV Fixed Effects Regressions of Innovation Outputs on China's Imports. Estimates Weighted Using Sampling Weights.

	Process Innovation	Product Innovation	Process Innovation	Product Innovation
	Standard errors clustered at the sector level		Wild cluster bootstrap standard errors	
	(1)	(2)	(3)	(4)
Final imports	0.141***	0.156***	0.141**	0.156***
	[0.040]	[0.043]	[0.034]	[0.006]
Intermediate imports	-0.068	-0.177*	-0.068	-0.177*
	[0.070]	[0.084]	[0.452]	[0.083]
Firm control variables	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Kleinberg-Paap F Stat.	18.59	18.59	18.59	18.59
N. Observations	3,108	3,108	3,108	3,108
N. Firms	1,323	1,323	1,323	1,323
N. Clusters	18	18	18	18

Notes: Standard errors clustered at the sector level in square brackets in columns (1) and (2). Wild cluster bootstrap P_values in square brackets in columns (3) and (4). ***,** and * denote significance at 1%, 5% and 10% respectively. Imports are the (log of the) 3-year lagged share of imports over value added. The instruments are the (log of the) average of the 3-year lagged shares of imports over value added for other EU countries and the US.

Table A5: IV Fixed Effects Regressions of Innovation Outputs on China's Imports. Alternative Definition of Intermediate Imports.

	Process Innovation	Product Innovation	Process Innovation	Product Innovation
	Standard errors clustered at the sector level		Wild cluster bootstrap standard errors	
	(1)	(2)	(3)	(4)
Final imports	0.058**	0.077**	0.058	0.077*
	[0.024]	[0.032]	[0.104]	[0.098]
Intermediate imports	-0.091**	-0.307***	-0.091*	-0.307**
	[0.046]	[0.098]	[0.083]	[0.016]
Firm control variables	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Kleinberg-Paap F Stat.	18.18	18.18	18.18	18.18
N. Observations	3,108	3,108	3,108	3,108
N. Firms	1,323	1,323	1,323	1,323
N. Clusters	18	18	18	18

Notes: Standard errors clustered at the sector level in square brackets in columns (1) and (2). Wild cluster bootstrap P_values in square brackets in columns (3) and (4). ***,** and * denote significance at 1%, 5% and 10% respectively. Imports are the (log of the) 3-year lagged share of imports over value added. The instruments are the (log of the) average of the 3-year lagged shares of imports over value added for other EU countries and the US.

Table A6: IV Fixed Effects Regressions of Innovation Outputs on Imports from China. Interaction with unions. Standard Errors Clustered at the Sector Level (NACE Rev.2, Two-Digit).

	Process Innovation		Product Innovation	
	(1)	(2)	(3)	(4)
Final imports	0.116***	0.103***	0.125***	0.142***
	[0.022]	[0.025]	[0.034]	[0.033]
Final imports * Firm union	-0.044***	-0.040***	-0.004	-0.007
	[0.014]	[0.014]	[0.016]	[0.017]
Intermediate imports	-0.094***	-0.078**	-0.254***	-0.253***
	[0.035]	[0.035]	[0.068]	[0.067]
Intermediate imports * Firm union	0.018	0.018	0.048**	0.057***
	[0.014]	[0.015]	[0.020]	[0.021]
Union dummy	-0.076	-0.073	0.226**	0.260**
	[0.092]	[0.095]	[0.104]	[0.105]
Firm control variables	no	yes	no	yes
Time fixed effects	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Kleinberg-Paap F Stat.	9.72	8.88	9.72	8.88
N. Observations	3,135	3,108	3,135	3,108
N. Firms	1,333	1,323	1,333	1,323
N. Clusters	18	18	18	18

Notes: Standard errors clustered at the sector level in square brackets. ***,** and * denote significance at 1%, 5% and 10% respectively. Imports are the (log of the) 3-year lagged share of imports over value added. The instruments are the (log of the) average of the 3-year lagged shares of imports over value added for other EU countries and the US.