Multidimensional Innovation Responses and Foreign Competition*

Ramiro de Elejalde[†] Carlos J. Ponce[‡] Flavia Roldán[§]

Abstract

The dramatic increase in China's exports after its accession to the World Trade Organization offers a window of opportunity for learning the innovative behavior of firms under competitive distress. Using manufacturing firm-level data, we quantify the effects of foreign competition on innovation in Uruguay. Our estimates show that a higher level of foreign competition reduces innovation inputs (acquisition of new machines, equipment, and software) and outputs (process and product innovations). These adverse effects are larger for firms in business groups and smaller for more productive firms and firms with more skilled labor. (JEL: F14, F10, L11, L60, O19, O31)

Keywords: Foreign competition, Innovation inputs, Innovation outputs, Heterogeneous innovation effects.

1 Introduction

Innovation and the adoption of novel technologies are the key drivers of growth and prosperity. Since the intensity of product market competition affects incentives to invest in these activities, it may have long-lasting economic consequences for firms and the overall economy. The dramatic increase in China's exports after its accession to the WTO offers a window of opportunity for learning the innovative behavior of firms under competitive

*We thank Rodolfo Stucchi and participants of various conferences and seminars for their opinions and comments. The editor and an anonymous referee provided insightful comments that greatly improved the paper. De Elejalde acknowledges support from the National Agency for Research and Development (ANID) under the grant Fondecyt de Iniciación en Investigación/2022 - 11220847.

†Departamento de Economía, Universidad Alberto Hurtado, Erasmo Escala 1835, 8340539 Santiago, Chile; rdeelej[at]uahurtado.cl; +56 (2) 2889 7763.

‡Departamento de Economía, Universidad Alberto Hurtado, Erasmo Escala 1835, 8340539 Santiago, Chile; cponce[at]uahurtado.cl; +56 (2) 2889 7765.

§Universidad ORT Uruguay, Bulevard España 2633, 11300 Montevideo, Uruguay; roldan[at]ort.edu.uy; +598 2707 1806.

distress. This paper studies the effects of import competition from China on innovation in Uruguay, using firm-level data.[1]

Following Autor, Dorn, Hanson, Pisano, and Shu (2020), we instrument import penetration in Uruguayan manufacturing using the contemporaneous industry-level import penetration in Mercosur countries.[2] We begin by showing that rising import penetration from China put competitive pressure on Uruguayan manufacturing firms. Specifically, we find that the increase in import penetration negatively affected sales and both skilled and unskilled employment. These results are consistent with abundant and well-known findings in the literature on the effects of import penetration on high-income economies.[3]

Our main results fall into two categories. First, we study the average effects of rising import penetration on innovation inputs and outputs. We find that an increase of 5 percentage points in import penetration decreases firms' probability of spending on innovation inputs by 3 percentage points.[4] This effect is driven mainly by decreasing expenditures on innovation capital (acquisition of new machines, equipment and software). On the output side, an increase of 5 percentage points in import penetration decreases innovation probability by 4.2 percentage points. Although imprecisely measured, our results indicate that foreign competition decreases the chances of obtaining process, product, and non-technological innovations in similar magnitudes.

Second, we examine whether these average effects hide heterogeneous responses across different firms. More precisely, we explore heterogeneous effects in firm size, whether a firm belongs to a group of firms (business group), productivity, and skilled labor. We find similar effects for import penetration on firms of different sizes. In contrast, we find differential effects for the other characteristics. Firms in business groups responded by decreasing more their innovation expenditures and producing fewer innovations than stand-alone firms. But, innovation expenditures and outputs were less negatively affected for relatively more productive firms and firms with more skilled labor.

The result showing that a firm in a business group curtails innovation expenditures and innovates less than a stand-alone firm can be explained by both the capability theory of firms and trapped factor models.[5]

[1]Information about the country is given in Section 3.

[2]Mercosur is a South American trade bloc whose members are Brazil, Argentina, Uruguay, and Paraguay. Our results are similar for alternative and more demanding identification strategies that use as instruments either imports from China to countries in Latin America and the Caribbean or global exports from China.

[3]This literature studies the impact of import penetration on firms' performance variables such as employment, sales, exports, and total factor productivity. Some representative examples are Bernard, Jensen, and Schott (2006) for the US, Mion and Zhu (2013) for Belgium, Álvarez and Claro (2009) for Chile, and Iacovone, Rauch, and Winters (2013) for Mexico. In contrast to these articles, our work is a detailed study of multidimensional innovation responses.

[4]We use an increase of 5 percentage points in import penetration since that figure is its exact increment from 2004–2006 to 2013–2015.

[5]For the capability theory, firms are problem solvers, and their capabilities come from complementary combinations of routines and heuristics. (See, for instance, Dosi, Faillo, and Marengo (2008).) Ordinary capabilities are idiosyncratic, neither easy to imitate nor to trade. As such, they explain heterogeneity in performance between firms. But they are also sticky and hard to alter in the short run through

The capability theory offers two interesting avenues of interpretation. First, a business group depletes its ordinary capabilities along more dimensions than does a stand-alone firm. A group's strategic assets are internally easily moved either to other firms in the group or to other production lines less affected by foreign competition. Second, because business groups accumulate and develop dynamic capabilities faster than independent firms, they more efficiently re-arrange their competencies to address fast-changing market conditions. (See Helfat and Winter (2011).) These two forces may yield the (at first sight) surprising result that independent firms undergo a decrease in the probability of innovation at a smaller magnitude than firms in business group.

Concerning trapped factor models, if innovation inputs are trapped (see Bloom, Romer, Terry, and Van Reenen (2020)), independent firms face more rigid conditions to reallocate them to more attractive product lines. These two interpretations partially complement each other: while the capability theory rests (partly) on the lower flexibility of ordinary capabilities of independent firms, the latter rests on the idea that innovation inputs (not capabilities) are trapped.

Finally, we discuss the effects of Chinese competition for firms with different levels of productivity and skilled labor. We measure these variables at an initial time-period preceding the ones used in our estimations.[6] Thus they reflect firms' initial-state variables. Results from Costa, Santis, Dosi, Monducci, Sbardella, and Virgillito (2021) suggest that these state variables may indicate firms' underlying complex capabilities. In this sense, our results, somewhat consistent with those of Costa, Santis, Dosi, Monducci, Sbardella, and Virgillito (2021), indicate that the higher a firm's underlying complex capabilities, the lower the negative impact will be on innovation inputs and outputs.

Although there is a growing literature, including works by Autor, Dorn, Hanson, Pisano, and Shu (2020), Bloom, Draca, and Van Reenen (2015) and Yang, Li, and Lorenz (2021), that studies the relationship between foreign competition and innovation for advanced countries (e.g., the US and Europe), empirical evidence for other high-income economies, like Uruguay, is still scant. But beyond that dichotomy, three substantive economic issues tell these two cases apart.

First, the nature of competition between China and Uruguay is different from the rivalry between China and the US or Europe. While low costs are perhaps the main advantage of products from China over those from advanced-rich economies, they play a less crucial role for Uruguay. Ceglowski and Golub (2012) show, for instance, that in the year 2009, China's unit labor cost was roughly between 33% and 50% of the US's unit labor cost, 20% of Belgium's unit labor cost, and 15% of Germany's unit labor cost. Though there is no data about unit labor costs for Uruguay, the hourly manufacturing wage in China

managerial discretion. Consequently, they come at the price of decreased flexibility in the face of competitive shocks. (See Amit and Schoemaker (1993).) Nonetheless, this lack of short-term flexibility may be lessened through the accumulation of dynamic capabilities, that is, through the development of abilities to equilibrate continuity and change. For a first and ambitious attempt to take the theory to data, see Costa, Santis, Dosi, Monducci, Sbardella, and Virgillito (2021).

[6]Details in Section 7.

was (in 2015) around 81% of the corresponding figure for Uruguay.[7] Thus the evidence suggests that the nature of Chinese competition may not be the same for Uruguay as it is for the US or Europe.

Second, the US and Europe are able to curb China's fierce price competition by using innovation capacity either to differentiate their products from Chinese counterparts or to help their products climb the quality ladder (see Hombert and Matray (2018)). In contrast, Uruguay is more likely to find itself relatively far from the technology frontier, and hence local firms are unlikely to try to deter competition by using innovation abilities. This appears to be even more the case over time, given the increasing quality of China's exports (see, for instance, Álvarez and Claro (2007) and Rodrik (2006)), its progressive shifting into high-tech sectors, and its patenting boom in increasingly high-quality manufacturing (see Warner (2015)).

In short, most existing literature focuses on the effects of fierce price competition on innovation in countries with high costs but with an innovative edge. Instead, we study the impact of competition on innovation in a country with somewhat similar costs but with an innovation handicap.

Third, much research, especially for advanced countries, uses patents as a measure for innovation. In contrast, we study the responses of firms along several innovation dimensions. Our data, which come from innovation surveys, afford us the opportunity to design multidimensional indicators of innovation inputs and outputs, such as R&D spending, expenditures on innovation capital (acquisition of new machines, equipment, and software) and product and process innovations.

The rest of the paper is organized as follows. Section 2 places our paper within the relevant literature. In Section 3, we provide background about the economy of Uruguay. We then, in Section 4, proceed to describe our data. Section 5 presents our econometric model and identification strategy. Sections 6 and 7 present our main results. In Section 8, we show that our results are robust to several identification strategies, alternative measures of import penetration, and innovation expenditures. Section 9 concludes.

2 Literature Review

Our work is related to recent literature that studies the effects of import penetration from China on innovation. Autor, Dorn, Hanson, Pisano, and Shu (2020) shows that US manufacturing firms reduced their production of patents, but this negative effect is smaller for initially more profitable and more capital-intensive firms.[8] In contrast, Bloom,

[7] Unit labor costs correct manufacturing wages by labor productivity. To our knowledge, Ceglowski and Golub (2012) are the only authors to present unit labor costs across countries. The data of hourly manufacturing wages come from Trading Economics (https://tradingeconomics.com) and the Household Survey for Uruguay.

[8] Xu and Gong (2017) show for the US that rising import penetration had a positive reallocation effect on R&D expenditures. That is, more productive firms spent more on R&D while less productive firms reduced their spending in that area.

Draca, and Van Reenen (2015) document a positive patenting reaction for firms in Europe. Similarly, Yang, Li, and Lorenz (2021) show that Japanese firms increased their patenting propensity due to higher production of incremental innovations. Yang, Li, and Lorenz (2021) show that, for Canadian firms, incentives to introduce product innovation rose while incentives to implement process innovations decreased when firms were faced with foreign competition.[9]

There are several differences between these works and ours. As previously noted, we aim to understand firms' innovation responses to increasing competition from rivals selling better quality products rather than from rivals having a sizable cost advantage. In terms of results, in contrast to Bloom, Draca, and Van Reenen (2015) and Yamashita and Yamauchi (2020), we find that firms facing Chinese competition decreased the production of innovations. In this respect our results support those of Autor, Dorn, Hanson, Pisano, and Shu (2020). Also, somewhat in line with Autor, Dorn, Hanson, Pisano, and Shu (2020), we report that initially more productive firms and firms with more high-skilled labor are less affected by Chinese competition. Contrary to Yang, Li, and Lorenz (2021), we find that both process and product innovations suffered equally in firms facing higher competitive pressure from China. Unlike these articles, our data allow us to dig into the innovation process itself. In this regard, we show that import competition negatively affected spending on innovation capital, crucial for adopting and adapting novel technologies in high-income countries like Uruguay.

Little literature studies the connection between innovation and China's import penetration for middle and high-income countries. To our knowledge, Álvarez, Benavente, and Crespi (2019) and Iacovone, Keller, and Rauch (2011) are the closest papers to our work. Álvarez, Benavente, and Crespi (2019) (using firm-level data for several Latin American countries) find that a rise in foreign competition affects innovation positively. There are several differences between their work and ours. First, their variable of interest is overall foreign competition. Ours is foreign competition from China. Second, while their identification strategy uses within-sector variation across countries, ours uses within-sector variation across time. Third, their instruments are variables related to regulations, licenses, permits, and corruption reported by firms. Ours is import penetration from China in the same sector but for different countries. These differences make it difficult to compare their results to ours.

Iacovone, Keller, and Rauch (2011) study Mexican firms' responses in organizational structure and operations management. Their main finding is that although foreign competition, on average, does not affect innovation, more productive firms innovate more. Our result is that, although foreign competition on average hurts innovation expenditures and the production of innovations, more productive firms and firms with more skilled labor are less negatively affected. Our work complements that of Iacovone, Keller, and Rauch (2011) by concentrating on different types of innovations. In addition, we study

[9] They also show that depending on the initial innovation strategy (process or product), firms had different performances concerning the probability of exiting the industry and profits.

adjustments in innovation inputs, an aspect only partially covered by Iacovone, Keller, and Rauch (2011).

Finally, Fernandes and Paunov (2013) explore the effects of import competition on product quality upgrades among manufacturing firms in Chile. The main result is that firms reacted to higher competitive pressure by upgrading the quality of their products. Although our data do not allow us to deal with this issue, our results suggest that, if anything, firms facing an increase in competition are likely to decrease product quality.

3 The Uruguayan Economy

Uruguay is a small Latin American country.[10] According to the National Institute of Statistics (INE), in 2019, the share of agriculture in Uruguay's Gross Domestic Product (GDP) was around 8% of GDP, industry contributed to 22%, and the service sector accounted for 61%.[11]

During the period 2004–2015, Uruguay's economic performance was remarkable. The average annual growth rate in real per-capita GDP amounted to about 3.5%. Even during the world financial crisis, in the year 2009, the country's economy managed to grow by around 2.9%. Not surprisingly, GDP per capita tripled from $5,222 in the year 2005 to just over $15,000 in 2015 and poverty rates fell sharply from 32.5% in the year 2006 to 9.6% in 2015.[12]

The heart of Uruguay's trading policies is its participation in Mercosur.[13] Tariffs among members are zero for the majority of goods, but there are some exemptions (e.g., sugar and vehicles) and a few non-tariff barriers like import licenses, quotas, and reference prices. When Mercosur was established in 1991, trade between members boomed, but it has substantially diminished in the last decade. In response to and restricted by the bloc's rules, Uruguay concluded trade agreements with Bolivia, Chile, Mexico, and Peru. Moreover, the country is close to reaching a free-trade agreement with China.[14]

Since its period of trade liberalization during the 1970s, Uruguay has become more integrated into the world. According to the World Bank, Uruguay's degree of openness rose dramatically from a low of 19.9% in 1973 to a current value of 46.4%.[15] Currently, as Figure 1 shows, the value of that indicator for Uruguay is close to the average value of Latin American countries, but well above individual values for Argentina, Brazil, the US, and China.

[10] It covers an area of approximately 176,000 square kilometers, and has a population of around 3.51 million people.

[11] The remaining 9% corresponds to utilities and government activities.

[12] Growth decreased substantially after that period, and annual rates are nowadays approximately 1.6%.

[13] Mercosur is a South American trade bloc whose full members are Brazil, Argentina, Uruguay, and Paraguay.

[14] See, for instance, the September 29, 2021, article 'Uruguay bets on free trade deal with China outside Mercosur' in Diálogo Chino.

[15] The indicator is equal to trade volume (exports plus imports) as a percentage of GDP.

Around 50% of Uruguay's exports are agricultural commodities, but, recently, industries such as information technology have been gaining a fair share of the country's total sales. Although Mercosur has historically been the largest buyer of Uruguay's products (e.g., in 1998, the bloc accounted for 55.3% of Uruguay's total exports), China has gained so much importance that it has become the biggest export destination, currently accounting for almost one-third of Uruguay's exports. On the import side, China has also displaced Argentina, Brazil, and Venezuela. More on this in subsection 4.2.

To offer a flavor of the degree of sophistication of Uruguayan imports, we briefly explore their complexity level as presented in the Economic Complexity Index (ECI) and Product Complexity Index (PCI).[16] The PCI measures knowledge complexity involved in the production of a product, and the ECI measures knowledge accumulated in the population of a country. The average complex product (location) has an index value of zero, and the larger the value of the index, the higher the complexity. Tables 1 and 2 suggest that the sophistication of Uruguay's imports is low, which may be an indication that the country produces and innovates in product spaces with small knowledge content.[17]

4 Data

4.1 Innovation, Sales, and Employment

Our firm-level data come from the Uruguay Innovation Survey, a random stratified sample of the population of Uruguayan firms conducted by the National Agency of Research and Innovation (ANII) across regular time intervals of three years. The survey, which follows guidelines in the Oslo manual, contains self-reported information on sales, employment, and innovation.

We use four consecutive waves in the survey, covering the periods 2004–2006, 2007–2009, 2010–2012, and 2013–2015.[18] The survey is representative of firms with more than 10 employees. All firms with 50 or more employees are included in every wave, and firms with fewer than 50 employees are randomly re-sampled each period. Firms are classified according to the International Standard Industrial Classification (ISIC) revision 3 at the

[16] The indices are calculated by Simoes and Hidalgo (2011) using a dataset of thousands of products and countries. Excellent references are Hidalgo (2021).

[17] Observe that the PCI of Crude Petroleum (the main product imported by Uruguay) is far below average PCI. Reinforcing this point, note that, except for the US, whose products only account for 8% of total imports, the ECI of Uruguay's sellers is just slightly above average.

[18] The wave 2007–2009 covers the 2008 financial crisis and its recovery periods. According to existing empirical evidence (see, for instance, Foster, Grim, and Haltiwanger (2016)), factor reallocation processes are observed in recession periods. Besides, they may improve the productivity of an industry since surviving firms are usually the most efficient ones. Although this may affect our estimates, we believe that Uruguay did not undergo a cleansing effect. First, during the year 2008, Uruguay did not suffer a recession. Although the 2008-2009 crisis got in the way of a vigorous growth path, the growth rate was 2.9% in 2009 and 8% in 2010. Second, and more on the speculative side, a cleansing effect may have happened before 2004 (the first year of our first wave.) The reason is that Uruguay faced a severe economic crisis in 1999–2002, in which real GDP fell by approximately 20%.

4-digit level. This gives us a total sample of 1,297 firms and 3,115 observations. All monetary variables are in Uruguay's constant pesos of 2010.[19]

We describe below the main variables of interest.[20]

Innovation Inputs: The survey collects information on different types of innovation expenditures; that is, on outlays that firms direct to obtain innovations. Firms must report whether they have invested in innovative activities in the *3-year* period.

The data about expenditures include (a) intramural and extramural R&D, (b) acquisition of new machines, equipment and software, (c) engineering, design, and other creative activities, (d) Intellectual Property-related activities, (e) employee training, and (f) innovation management.

Based on the reported information, we construct four binary measures of innovation inputs. Each of these variables takes a value of 1 if a firm reports having invested in a targeted activity. The variable "Positive total expenditure" includes expenditures on any activity, "Positive R&D expenditure" accounts for R&D expenses, "Positive expenditure on innovation capital" includes outlays in machines, equipment and software, and the category "Other positive innovation expenditure" accounts for outlays that belong to any one of the excluded categories in the preceding classification.

Table 3 shows that the fraction of firms that spend (in a period) on some type of innovation input is 47%. Observe also that Uruguayan firms spend most of their budgets on innovation capital (machines, equipment and software) (39%) and other innovative activities (31%) rather than on the typical R&D (19%) category.

Innovation Outputs: Firms must also report whether they have introduced an innovation within the corresponding 3-year period. The survey contains information about (a) product innovations; i.e., selling a new or improved product, (b) process innovations; i.e., adoption of new or improved processes to reduce costs, (c) organizational innovations; i.e., changes in the organizational design of the firm, and (d) marketing innovations; i.e., adoption of new commercialization methods.

Based on the reported information, we construct four binary measures of innovation outputs. Each of these variables takes a value of 1 if a firm reports having introduced a targeted type of innovation. The variable "Any innovation" includes innovation outputs of any type, "Product innovation" considers innovation outputs falling into category (a); "Process innovation" includes innovation outputs falling in category (b), and "Non-technological innovation" groups together outputs that belongs to classes (c) and (d) of the preceding classification.

A few observations are in order. First, these measures may be, for our purposes, better suited than alternative innovation indices, such as patent counts, since, in Uruguay, most innovations originate from adopting new technologies that are usually built-in in innovation capital. Such innovations, although valuable, are not novel enough to deserve

[19] We use producer price indices by industry sector to deflate nominal values.
[20] Table A1 in the Online Appendix provides a detailed description of these variables.

patent protection. Supporting this claim, the available evidence in the Innovation Survey shows that, during the period 2013–2015, only 3.2% of the firms in our sample patented an innovation either in Uruguay or abroad.[21]

Second, we distinguish between product and process innovations since, as Yang, Li, and Lorenz (2021) show, there are reasons to suspect that higher competitive pressure may affect marginal incentives for introducing distinct types of improvements. One must also be cautious and keep in mind, as Jaumandreu and Mairesse (2017) remark, that it can be difficult to disentangle the occurrence of different types of innovation empirically. In many situations, it is not unusual that process innovations imply product changes and that product changes can only be implemented through modifications in the processes of given firms.

Table 3 shows that the percentage of firms that implement (in a period) an innovation of any type is 46%, and that process innovations are much more likely to occur than either of the other two classes of innovation. Quantitatively, the probability of introducing a process innovation is 35%, while for product and non-technological innovations, the probabilities are 25% and 22%, respectively.

Sales and Employment: In the survey, firms also provide information that we use for evaluating their performance. In particular, firms must report their revenues from sales – domestic sales plus exports – and employment during the *last* year of the corresponding 3-year period.[22] Moreover, firms must classify their employees as professionals (employees with a university degree), technicians, administrative workers, production workers, or other workers.

With this information, we construct four performance variables: (a) "Sales", (b) "Total employment" –the number of employees in the firm, (c) "Skilled employment" –the number of professionals and technicians in the firm, (d) "Unskilled employment" –the number of administrative, production and other workers in the firm, and (e) "Labor productivity" –sales per employee at the firm level in thousands of Uruguayan pesos (constant pesos of 2010).

Table 3 shows that average revenues amount to 400 million Uruguayan pesos (20 million US dollars), that an average firm employs 105 employees of whom 95 are unskilled, and that sales per employee are around 3 million pesos (150,000 US dollars). Sales and employment have very skewed distributions: median revenues are equal to 59 million pesos (3 million US dollars), and a median firm employs 45 employees. Only a few large firms obtain more than 5,000 million pesos (250 million US dollars) and employ more than 1,000 employees.

Controls: As controls in our regressions, we include the following variables: (a) "Age" (a firm's age in years), (b) "Business group" (a binary variable that indicates whether a

[21] In the Innovation survey, questions about patenting appear only from the three years 2007–2009 on. For this reason, we cannot use patents as outcomes in our analysis.

[22] From period 2010–2012 on, firms must also report their revenues annually. For comparability purposes, we use the *last* year of each three-year period. Sales are measured in constant Uruguayan pesos of 2010, and we use producer price indices by industrial sector to deflate nominal values.

firm belongs to a business group), (c) “Foreign capital” (a dummy variable that indicates whether a firm has some foreign ownership), and (d) “Large firm” (a binary variable indicating whether a firm has more than 50 employees on average across periods). To construct the latter variable, we chose a threshold of 50 employees because sampling weights differ across firms according to their number of workers. Specifically, firms with more than 50 employees are included in every sample wave, while smaller firms are randomly re-sampled each period. In Section 5, we discuss at length the ‘exogeneity’ of these controls.

Table 3 shows that, on average, firms are 30 years old, 17% of them belong to a business group, 15% have some foreign ownership, and 47% have more than 50 employees.

4.2 Import Penetration from China

We compute import penetration from China (hereafter, import penetration) using the information provided by the UN Comtrade Database and the Survey of Economic Activity. The UN Comtrade is an international dataset that contains information on bilateral imports and exports between countries at the six-digit product level (Harmonized System). The Survey of Economic Activity yearly conducted by the National Bureau of Statistics in Uruguay collects balance sheet information for manufacturing firms.[23]

Our measure of import penetration for industry k (four-digit ISIC codes) at period t is

$$\text{Import Penetration}_{kt} = \frac{M^c_{kt}}{Q_{kt} + M_{kt} - X_{kt}},$$

where, for industry k at time period t, M^c_{kt} denotes imports from China, Q_{kt} measures domestic production, M_{kt} measures total imports, and X_{kt} denotes total exports. We use the UN Comtrade for imports and exports and the Survey of Economic Activity for domestic production.[24]

The variables “Import pen. from China (period)” and “Import pen. from China (year)” in Table 3 measure, respectively, import penetration for each three-year period and for the last year of the corresponding three-year period.[25] We measure import penetration at the last year of a period for matching the reference year of sales and employment in the survey.

Table 3 shows that import penetration has been steadily increasing over time, starting at 4% for the period 2004–2006 and reaching 9% for the period 2013–2015. Though on

[23] The survey is a representative sample of all manufacturing firms that employ 10 employees or more. It contains firms with 50 or more employees in every sample wave, and firms that employ more than 10 but less than 50 employees are randomly re-sampled each year.

[24] We match and aggregate the trade data in UN Comtrade to the four-digit ISIC codes using a product concordance provided by the World Integrated Trade Solution (WITS). All variables are in constant pesos of 2010.

[25] “Import pen. from China (period)” is the average of import penetration across the three years of the period.

average across time, import penetration amounts to 7%, there exists a wide dispersion across different industrial sectors. Figure 2 plots the change in import penetration from the period 2004–2006 to the period 2013–2015 at the industry level. To ease exposition, we aggregated industrial sectors at the 2-digit level. The figure shows that some sectors such as Textiles (17), Wearing apparel, dressing, and dyeing of fur (18), Office, accounting and computing (30), Radio, television, and communication equipment (32), have been dramatically affected by Chinese imports. Others such as Food products and beverages (15), Coke, refined petroleum and nuclear fuel (23), and Paper (21) have undergone almost no significant change.

Let us shed further light on these trends by briefly examining the driving forces behind the rise of import penetration. As the equation below shows, we decompose (at the aggregate level) the variable "Import penetration from China (year)" as the product of total import penetration at year t (first term in the formula below) and the share of imports from China at year t (second term in the formula below); that is, as

$$\text{Import Penetration}_t = \frac{M_t}{Q_t + M_t - X_t} \times \frac{M_t^c}{M_t},$$

where M_t, Q_t, and X_t are aggregate imports, aggregate domestic production, and aggregate exports, respectively. Figure 3 shows that the rise in import penetration comes mainly from the growth of the participation of imports from China in total imports. In other words, while import penetration remains stable over time, China has gained participation in total imports. These trends raise the question: What trading partners has China replaced in its sales to Uruguay? Figure 4 provides the answer: increasing imports from China have come at the expense of exports to Uruguay from Latin American countries.

5 Econometric Model and Empirical Strategy

To study the causal effect of import penetration on innovation activities at the firm level, we estimate the following specification:

$$y_{ikt} = \beta_0 + \beta_1 \,\text{Import Penetration}_{kt} + \gamma' x_{ikt} + \eta_k + \eta_t + \epsilon_{ikt},$$

where y_{ikt} is the outcome of interest for firm i in industry k at time period t, $\text{Import Penetration}_{kt}$ is import penetration in industry k at time period t, x_{ikt} is a vector of controls at the firm level, η_k is an industry fixed effect, η_t is a time fixed effect, and ϵ_{ikt} is a time-varying unobservable that affects the outcome of firm i at time period t.

For controls, as indicated previously, we include in our regressions the variables "age", "business group", "foreign capital", and "large firm." These variables are, in the terminology of Angrist and Pischke (2009), good controls insofar as they are not affected by foreign competition.

The age of a firm evolves mechanically over time, so foreign competition is unlikely to have an effect on this variable. On the other hand, changes in import penetration may affect the variables "business group" and "foreign capital." For instance, the variable "foreign capital" may be affected by changes in import penetration because these changes may alter the expectations of foreign investors and, as a consequence, their investment strategies. Similarly, an increase in import penetration may foster the acquisition of smaller firms by larger ones, and this process may affect whether a firm belongs to a business group.[26] To relax endogeneity concerns about the variables "business group" and "foreign capital", we show in Tables A22 to A24 in the Online Appendix that our results barely change if we drop these variables from our list of controls.

Firm size ("large firm") may also be affected by changes in import penetration. To deal with this, we take two steps. First, we compute a time-invariant measure defined as the average (across periods) number of employees a firm employs. Second, we use the latter to construct a dummy variable ("Large firm") that takes a value equal to 1 if the average (across periods) number of employees a firm employs is higher than 50. This procedure should ease concerns about 'bad' control problems since even if changes in import penetration affected employment, a firm would be unlikely to change its size from "small" to "large" or vice-versa. Finally, we perform a robustness check in which we drop firm size as a control and estimate the model using fixed effects for firms. Our findings are similar to the ones presented later.

Estimating the causal effect of import penetration on innovation activities must deal with several identification threats. First, unobserved characteristics could correlate with both innovation and import penetration. For example, sectors in which Uruguay has comparative advantages, such as food products, may be less affected by imports coming from China, and also be, at the same time, more innovative. To deal with this issue, we include industry fixed effects to control for any sector time-invariant unobservable.

Second, both innovation activities and import penetration could be correlated with phases of the business cycle. In expansionary cycles, firms may have more incentives to implement innovations due to larger market size. But at the same time, larger market size may attract more imports from abroad. To deal with this problem, we include time fixed effects in our regressions. By doing this, we control for common trends that may simultaneously affect import penetration and innovation across industries.

The third and greatest challenge to correct identification of the impact of Chinese competition is the possibility of reverse causality running from innovation in Uruguayan firms to import penetration. For example, a firm may successfully adopt a process innovation, decrease its costs, and, as a result, displace China's products from the market. To address this issue, we follow Bloom, Draca, and Van Reenen (2015), and Autor, Dorn, Hanson, Pisano, and Shu (2020), who use the rise of exports from China to the rest of the world as the basis of a natural experiment. We instrument import penetration in Uruguayan manufacturing using contemporaneous industry-level import penetration in Mercosur

[26] We thank an anonymous referee for raising this point.

countries.[27] Our instrument for import penetration in industry k at time period t is:

$$\text{Import Penetration IV}_{kt} = \text{Import Penetration}_{k0} \times \frac{M^O_{kt}}{M^O_{k0}},$$

where Import Penetration_{k0} is import penetration at year 2002 and M^O_{k0} (M^O_{kt}) are total imports from China to Mercosur countries at year 2002 (at time period t). So, we instrument import penetration in a given industrial sector by exploiting the evolution of imports from China to other Mercosur countries in the corresponding industrial sector.

A credible identification strategy requires an instrument to satisfy 'relevance' and 'endogeneity' assumptions. Concerning relevance, the idea behind our instrument is that the growth of China's sales occurred not only in Uruguay's industrial sectors but also in the same industries in other Mercosur countries. Concerning exogenenity, the idea is that the growth of imports from China was exogenous and driven by supply shocks in that country, such as diminishing trade costs, increasing productivity, and its access to WTO, rather than by commonly unobserved demand shocks in Mercosur countries.

To test the relevance of our instrument, we use the first stage of the structural model reported in Table 4. The table shows estimates of the first stage for import penetration in the 3-year period (column 1) and in the last year of the corresponding period (column 2). The results show that import penetration in Uruguay and import penetration in Mercosur countries are highly correlated. The robust first-stage F-statistic is 33.4 for the 3-year period and 29.7 for the last year of the period, making clear that the instrument satisfies the relevance assumption.

To make the exogeneity assumption more credible, in Section 8 we estimate our model using two alternative instruments. The first instrument includes exports from China not only to Mercosur countries but also to other Latin American and Caribbean countries. The second instrument uses exports from China to the rest of the world. These alternative instruments make the exogeneity assumption more plausible since common demand shocks affecting all countries are unlikely to occur. Using any of these instruments, we obtain similar results.

6 Results

6.1 Sales and Employment

Has rising import penetration from China put pressure on Uruguayan firms? How has this pressure affected the performance of manufacturing firms? We briefly answer these questions by estimating the effects that foreign competition has had on sales and employment.

[27] We do not consider Venezuela in our list of countries since its trade data has not been available in the Comtrade dataset since the year 2014.

Our data for sales and employment correspond to the last year of a given period. Thus we also use import penetration for the last year of the period. As shown in Table 3, import penetration rose by 3 percentage points from 2006 to 2015. Table 5 reports results. The first column indicates that firms facing an increase in import penetration reduced their sales substantially: an increase of 3 percentage points in import penetration reduces sales by 8%. The last three columns show a decline in the utilization of labor. Similar to the impact on sales, an increase of 3 percentage points in import penetration decreases employment by around 6.4%. The magnitudes of these effects are similar to those reported in other studies including Autor, Dorn, Hanson, Pisano, and Shu (2020). Observe also that the negative effect on employment is similar for both skilled and unskilled workers.[28] Taken together, these results suggest that firms facing higher competitive pressure from China reduced their scales of operation without changing the labor mix between skilled and unskilled workers.

6.2 Innovation Inputs

Since for innovation expenditures (and also for innovation outputs) we use data for three-year periods, we do the same for import penetration. As shown in Table 3, the rise in import penetration from period 2004–2006 to period 2013–2015 was equal to 5 percentage points.

Table 6 reports the estimated effects of the rise in import penetration on the probability of spending for innovation. Column 1 shows that an increase in import penetration decreases that probability, but the effect is only significant at the 10% level. Columns 2 to 4 report the effects that import penetration had on different types of innovation expenditures. They show that the rise in import penetration had a negative and statistically significant impact on the probability of spending on innovation capital (machines, equipment and software.) Moreover, the magnitude of the effect is substantive: an increase of 5 percentage points in import penetration decreases the probability of spending on innovation capital by 3.5 percentage points. That is, in terms of the mean of the dependent variable, a 9% decrease.

6.3 Innovation Outputs

Table 7 reports the impact of import penetration on innovation outputs. Our IV result, in column 1, shows that higher competitive pressure from China strongly decreased the probability of a firm's introducing an innovation. This effect is significant at 5% and economically relevant: an increase of 5 percentage points in import penetration decreases innovation probability by around 4.2 percentage points. That is, in terms of the mean of the dependent variable, a 9.1% decrease.

[28] Table A12, in the Online Appendix, reports the estimated effect of import penetration on the share of skilled labor. We find no evidence to reject the hypothesis that imports do not affect the skilled labor share.

In columns 2 to 4, we report the effects of the rise in import competition on different types of innovation outputs. Although imprecisely measured, our estimates indicate that a higher competitive pressure decreased the probability of introducing a process, product, or non-technological innovation. This lack of precision (as discussed in Section 4) most likely stems from the fact that different types of innovations are usually simultaneously introduced.

Let us sum up and interpret our findings thus far. As the rise in import penetration negatively affected revenues (and potentially profits), it ultimately decreased the marginal incentives of Uruguayan firms to produce innovations. As a result, firms simultaneously decreased their use of skilled labor and cut their budgets to acquire innovation capital. The results are consistent with a model in which innovations come from learning novel technologies in order to adapt them to local conditions. Are they homogeneous across firms? We address this issue below.[29]

7 Heterogeneous Effects

To study heterogeneous effects of import penetration, we classify firms according to four different metrics: (a) size, (b) business group property, (c) productivity, and (d) skilled labor.

The Innovation Survey is especially suitable to study size effects since it is a representative sample of small and large firms. To examine size effects, we interact import penetration with the binary variable "large firm", which is a time-invariant variable that takes a value of 1 if the firm employs, on average, 50 or more employees (see Section 4 for more details in the construction of this variable). Tables 8 to 9 report results. The finding is that size neither ameliorates nor amplifies the effects of rising import penetration on innovation input-output.

In the Survey, firms are also asked to report whether or not they belong to a business group. Based on the reported information, we interact import penetration with the binary variable "business group", which takes a value of 1 if the firm belongs to a group. Tables 10 to 11 show results.

Surprisingly, firms in business groups were more severely affected by rising competitive pressure from China than were stand-alone firms. The fall in innovation capital and innovation output was higher for firms in business groups than for stand-alone firms.[30]

[29] For both sales and employment, all the controls are statistically significant and have the expected sign. The variables "firm size", "age", "business group", and "foreign capital" are correlated positively with sales and (skilled, unskilled, and total) employment. For innovation activities, the variable "firm size" is positively correlated with innovation inputs and outputs, while being in a business group is positively correlated with innovation input. In our data, once differences in firm size are taken into account, neither the age of a firm nor having foreign capital is helpful in explaining whether a firm innovates or invests in innovation activities.

[30] A possible concern is that the variable "business group" is correlated with "foreign capital" and that the interaction with "business group" may be capturing some of the effects of the variable "foreign

How could this result be interpreted? The first explanation is that firms in business groups sell closer substitutes to China's products than independent firms. We do not disregard the possibility that this explanation has validity, but other interpretations rely on more subtle arguments: one based on the capability theory of the firm and the other on the 'trapped factor' model of Bloom, Romer, Terry, and Van Reenen (2020).

Concerning the first interpretation, business groups (in contrast to independent firms) employ their technological and R&D capabilities across a wide range of diverse and complex activities. Thus, groups can reallocate their strategic assets to relatively more profitable market segments faster than stand-alone firms. Moreover, business groups (in contrast to independent firms) may have dynamic capabilities for re-arranging competencies to address fast-changing market conditions. These two forces lead to the surprising result that business groups decreased innovation inputs and outputs in a larger magnitude than stand-alone firms.

Let us now make clear our argument based on trapped factor models. Assume that an (unanticipated) trade shock negatively affects the marginal return of innovating product (or process) i. We compare the optimal response of a firm that only innovates in product-line i –a stand-alone firm– with that of a business-group member that innovates along two product lines i and j. We assume, as it is usually the case in developing countries, that in the short run, there exist adjustment costs that prevent a fast re-allocation of innovation inputs among different firms.[31] Then, a group can re-allocate its innovation inputs from product line i to product line j, yielding a substantial decrease in the probability of introducing innovations in product line i. On the other hand, a stand-alone firm still has to use a fraction of its 'trapped' factors on product line i, which leads to a *smaller* decrease in the probability of innovating.

We now move to test the role played by firms' initial conditions in their responses to increasing import penetration. To explore this issue, we classify firms according to two different metrics: (a) skilled labor and (b) productivity.

To study heterogeneous effects by skill composition, we use the Innovation Survey for periods 1998–2000 and 2001–2003. As these 'initial' periods precede the periods used in our sample, this variable is more likely to be exogenous. We compute our measure of skills only for large firms (firms with 50 or more employees) since smaller ones are re-sampled in every survey wave. Our final sample has 325 firms and 1,109 observations.[32]

We follow two steps to obtain results. First, we compute the share of skilled labor for

ownership." To relax this concern, we estimate a specification with interactions between "business group" and "foreign capital." The results, reported in Tables A30 and A31 in the Online Appendix, show that these effects are mainly driven by the variable "business group" rather than "foreign capital."

[31] These adjustment costs usually are the result of frictions in labor markets.

[32] The results for the baseline specifications using this sample are similar to those obtained using the full sample –see Tables A13 to A14 in the Appendix.

firm i in sector k as

$$\text{share of skilled labor}_{ik} = \frac{\text{skilled employment}_{ik}}{\text{total employment}_{ik}},$$

where "skilled employment$_{ik}$" is the number of employees with either technical or university degree and "total employment$_{ik}$" is the total number of employees. Second, we compute the binary variable "high share skilled$_{ij}$", which takes a value of 1 if the share of skilled labor for a firm is larger than the median share in the corresponding sector.

Tables 12 to 13 report results. The effect of import penetration on firm innovation (both inputs and outputs) is less negative for firms with more skilled labor. The overall picture is that firms with initially higher skills were less affected and became more innovation-oriented as they reduced their innovation capital and production of innovations in a smaller magnitude.

To measure firm productivity, we proceed as follows. First, by using data from the Survey of Economic Activity, we calculate labor productivity as the ratio between sales in constant 2010 pesos and the number of employees between 1998 and 2003. We choose to measure employment in that period to ease concerns about endogeneity in our productivity measure. Similar to the case of skilled labor, we use a sample of large firms (firms with 50 or more employees.) Our final sample has 339 firms and 1,148 observations.[33]

Second, following Aghion, Bloom, Blundell, Griffith, and Howitt (2005), we compute the productivity distance to the frontier of firm i in sector k as

$$\text{distance to the frontier}_{ik} = \frac{\text{max productivity}_k - \text{productivity}_{ik}}{\text{max productivity}_k},$$

where "productivity$_{ik}$" is labor productivity for firm i in sector k and "max productivity$_k$" is labor productivity for the most productive firm in the sector. Observe that the higher the productivity of a firm, the smaller the value taken by this non-negative function will be. Thus, firms with the highest productivity have a distance to the frontier equal to zero. Finally, we construct, for each firm, a binary variable "close to the frontier", which takes a value of 1 if the "distance to the frontier$_{ik}$" is less than or equal to .75, which is approximately the median value of the distance to the frontier in our sample.

Tables 14 to 15 report findings. We find that more productive firms decreased their innovation expenditures in a smaller degree than less productive firms and so became relatively more innovation-oriented (see Table 14). As a result, their innovation outputs fell less than those of less productive firms (see Table 15).[34]

[33] To ensure that our results do not depend on the selected sample, we estimated our baseline model using this new sample. The results, reported in Tables A15 to A16 in the Online Appendix, are similar to those obtained using the full sample.

[34] In Tables A17 and A18 in the Online Appendix, we study whether the effect of import penetration is non-linear in firm productivity. We create three dummies for different distances to the productivity frontier: $.75 \leq \textit{Distance} \leq .85$, $.50 \leq \textit{Distance} \leq .75$ and $\textit{Distance} \leq .50$. Then we interact these dummy variables with import penetration and our instrument. The results suggest that firms at a distance smaller than .75 are less affected by import penetration than firms further away from the

Both the former and latter results, as discussed in the Introduction, are in line with the idea that firms with initially more underlying complex capabilities and 'superior' state variables perform better (See Costa, Santis, Dosi, Monducci, Sbardella, and Virgillito (2021)).[35]

8 Robustness

Alternative Identification Strategies: Our identification strategy relies on the idea that supply shocks in China drove rising import penetration elsewhere, including in Uruguay, identified by the correlation between import penetration in Uruguay and other Mercosur countries. One could question whether demand shocks across these countries (instead of supply shocks in China) were the driving forces behind the evolution of import penetration. To rule this out, we construct an alternative instrument based on the growth of China's exports to other Latin American and Caribbean countries. Because there are substantial differences between these countries and Uruguay (wealth, geography, trade exposure, etc.), we believe that the correlation between import penetration in Uruguay and in these other countries is not likely to be explained by common demand shocks. Tables 16 to 18 report results. Using this new instrument, the coefficients of interest in our baseline specification keep their sign and statistical significance.

We also perform a more demanding exercise by constructing an instrument based on the evolution of exports from China to the rest of the world excluding Uruguay. This new instrument satisfies exogeneity under weaker assumptions, but it is less likely to be relevant for import penetration in Uruguay. Indeed, Table 19 shows that the instrument passes the relevance test when it is computed for three-years periods but not when it is calculated for the last year of a given period. For this reason, in Tables 20 and 21, we only report the results for innovation inputs and outputs. We find that the main results of our baseline specification still hold.

Alternative Measure of Import Penetration: Following Bloom, Draca, and Van Reenen (2015), we compute import penetration as the ratio of imports from China over total imports instead of apparent consumption. Tables A2 to A4 in the Online Appendix show that we obtain similar results.

Alternative Measure of Innovation Expenditure: In the Innovation Survey, firms also report their innovation expenditure in the last year of the three-year period. We use this information to construct the logarithm of innovation expenditure (measured in constant 2010 Uruguayan pesos). Table A5 in the Online Appendix reports results. As can be seen, the results are similar and confirm the reduction in innovation capital in response to the rise in import penetration.

frontier.

[35] We recognize, as Costa, Santis, Dosi, Monducci, Sbardella, and Virgillito (2021) do, that it may be fruitless to search for best practices.

Panel Data Structure: The Innovation Survey became a panel of firms since the three-year period 2007–2009. The problem in using this data is that the sample size drops by 500 observations since small firms included in the sample for the period 2004–2006 were randomly re-sampled in the next wave covering the period 2007–2009. Despite these qualifications, we use the data to estimate a model with firm fixed effects. Tables A6 to A8 in the Online Appendix show that our results are similar.

Sectors without Domestic Production: A plausible objection to our results might be that they are driven by sectors in which Uruguay has no domestic production. We drop those sectors where domestic production is less than 10% of apparent consumption. Tables A9 to A11 in the Online Appendix show that similar results obtain.

Import Penetration of Intermediate Goods: An increase in foreign competition can generate gains from importing better quality intermediate goods.

Recent articles suggest that this channel could be relevant for Uruguay. Zaclicever and Pellandra (2018) show that foreign inputs have a positive effect on firms' productivity. Precisely, they find that (a) Mercosur's imports enhance productivity by enlarging the set of varieties, (b) inputs from advanced economics are productivity-enhancing due to their technological content, and (c) inputs from other destinations have no effect on firms' TFP. Similarly, Blanchard, Peluffo, and Zaclicever (2019) find a positive effect for imported inputs on firms' TFP. They also show that its magnitude is positively related to firms' absorptive capacity (measured by the employment of skilled labor).

To address this issue, we follow the approach in Bloom, Draca, and Van Reenen (2015) and compute import penetration from China in intermediate goods for each sector.[36] Tables A19 to A21 in the Online Appendix report the estimated effects on sales, employment, innovation inputs and outputs. Our findings show that while an increase in import penetration of final products yields a negative effect, the impact of import penetration of intermediate goods is not estimated very precisely. Thus the evidence about these latter effects is not clear.

Exporting Status: To determine whether being an exporter increases the resilience of firms to import penetration from China, we create the new variable "firm exporting status", i.e., a time-invariant dummy that indicates whether the firm has exported in at least one period in the sample.[37] We run two exercises. First, we show that the results barely change if we control for "firm exporting status" (see Tables A32 to A34 in the Online Appendix). Second, we include in our regressions an interaction between import penetration and firm exporting status.[38] Tables A38 and A39 in the Online Appendix report the results. We find that although the estimates for the interaction positively affect innovation inputs and outputs, they are not significant. Thus the evidence does not allow us to conclude that exporters are more resilient to foreign competition than non-exporters.

[36] See the Online Appendix for more details.

[37] We choose to use a time-invariant variable to avoid concerns about whether an increase in foreign competition in a certain period could affect firm exports in that period.

[38] We thank an anonymous referee for raising this issue.

9 Discussion and Conclusions

This paper studies how the rising import penetration from China affected innovation activities in Uruguayan firms. We find that the rise in import penetration negatively affected firms' sales and employment. Moreover, firms reacted by decreasing their expenditures for innovation capital substantially. As a consequence, innovation outputs suffered significantly. Interestingly, we find striking heterogeneous responses across firms with different characteristics.

Specifically, we show that firms with higher productivity and more skilled labor before the increase in imports from China cut innovation inputs and outputs at a smaller magnitude. In other words, firms with initially more underlying complex capabilities were more resilient to competition. We also find an unexpected result: firms belonging to a business group curtailed more innovation expenditures than stand-alone firms. Our preferred explanation for this result is that as firms (in business groups) have more flexible capabilities than stand-alone firms, they re-allocate faster their resources to production lines less affected by foreign competition.

The result that the negative impact of rising import penetration is heterogeneous across firms provides guidelines on policy interventions. Specifically, the design of efficient learning processes for accumulating technological capabilities should be at the heart of public policy. Since firms with more developed capabilities and complex behaviors were more resistant to competition, public policy should assist low productivity firms to detect and absorb different mixtures and combinatorics of practices and heuristics. The task is unavoidably challenging since capabilities are home-grown and hard to transfer between entities. Thus, private-public efforts to create effective communication channels between firms of different degrees of productivity should be a first and crucial step.

Although we are very cautious about generalizing our results, we believe that they could be informative for designing public policies in countries similar to Uruguay. That said, more research is needed for countries and regions (beyond the US and Europe) to understand the implications of foreign competition on innovation activities. Finally, a fruitful avenue for further research is to study how the different dimensions along which firms compete affect their innovation responses. Disentangling these effects is far from a trivial exercise, but it surely will add much to our knowledge.

References

Aghion, P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt (2005): "Competition and Innovation: an Inverted-U Relationship," *The Quarterly Journal of Economics*, 120(2), 701.

Álvarez, R., J. M. Benavente, and G. Crespi (2019): "Foreign Competition and

Innovation in Latin America," Discussion paper IDB -DP -00 728, Inter - American Development Bank.

Álvarez, R., and S. Claro (2007): "On the Sources of China's Export Growth," Working Papers Central Bank of Chile 426, Central Bank of Chile.

——— (2009): "David Versus Goliath: The Impact of Chinese Competition on Developing Countries," *World Development*, 37(3), 560–571.

Amit, R., and P. J. H. Schoemaker (1993): "Strategic assets and organizational rent," *Strategic Management Journal*, 14(1), 33–46.

Angrist, J. D., and J.-S. Pischke (2009): *Mostly Harmless Econometrics: An Empiricist's Companion*, no. 8769 in Economics Books. Princeton University Press.

Autor, D., D. Dorn, G. H. Hanson, G. Pisano, and P. Shu (2020): "Foreign Competition and Domestic Innovation: Evidence from US Patents," *American Economic Review: Insights*, 2(3), 357–74.

Bernard, A. B., J. B. Jensen, and P. K. Schott (2006): "Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of US manufacturing plants," *Journal of international Economics*, 68(1), 219–237.

Blanchard, P., A. Peluffo, and D. Zaclicever (2019): "Revisiting the role of Imported intermediates on Productivity: A firm-level analysis for Uruguay," Serie Documentos de Trabajo 03/19, UR. FCEA. IECON.

Bloom, N., M. Draca, and J. Van Reenen (2015): "Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity," *The Review of Economic Studies*, 83(1), 87–117.

Bloom, N., P. Romer, S. J. Terry, and J. Van Reenen (2020): "Trapped Factors and China's Impact on Global Growth," *The Economic Journal*, 131(633), 156–191.

Ceglowski, J., and S. S. Golub (2012): "Does China still have a labor cost advantage?," *Global Economy Journal*, 12(3), 1850270.

Costa, S., S. D. Santis, G. Dosi, R. Monducci, A. Sbardella, and M. E. Virgillito (2021): "From organizational capabilities to corporate performances: At the roots of productivity slowdown," LEM Working Paper Series 2021/21, Pisa.

Dosi, G., M. Faillo, and L. Marengo (2008): "Organizational Capabilities, Patterns of Knowledge Accumulation and Governance Structures in Business Firms: An Introduction," *Organization Studies*, 29(8-9), 1165–1185.

Fernandes, A. M., and C. Paunov (2013): "Does trade stimulate product quality upgrading?," *Canadian Journal of Economics*, 46(4), 1232–1264.

Foster, L., C. Grim, and J. Haltiwanger (2016): "Reallocation in the great recession: cleansing or not?," *Journal of Labor Economics*, 34(S1), S293–S331.

Helfat, C. E., and S. G. Winter (2011): "Untangling dynamic and operational capabilities: Strategy for the (N) ever-changing world," *Strategic management journal*, 32(11), 1243–1250.

Hidalgo, C. A. (2021): "Economic complexity theory and applications," *Nature Reviews Physics*, 3(2), 92–113.

Hombert, J., and A. Matray (2018): "Can Innovation Help U.S. Manufacturing Firms Escape Import Competition from China?," *The Journal of Finance*, 73(5), 2003–2039.

Iacovone, L., W. Keller, and F. Rauch (2011): "Innovation responses to import competition," Working paper.

Iacovone, L., F. Rauch, and L. A. Winters (2013): "Trade as an engine of creative destruction: Mexican experience with Chinese competition," *Journal of International Economics*, 89(2), 379–392.

Jaumandreu, J., and J. Mairesse (2017): "Disentangling the effects of process and product innovation on cost and demand," *Economics of Innovation and New Technology*, 26(1-2), 150–167.

Mion, G., and L. Zhu (2013): "Import competition from and offshoring to China: A curse or blessing for firms?," *Journal of International Economics*, 89(1), 202–215.

Rodrik, D. (2006): "What's So Special about China's Exports?," *China & World Economy*, 14(5), 1–19.

Simoes, A. J. G., and C. A. Hidalgo (2011): "The economic complexity observatory: An analytical tool for understanding the dynamics of economic development," in *Workshops at the twenty-fifth AAAI conference on artificial intelligence*.

Warner, E. (2015): "Patenting and Innovation in China: Incentives, Policy, and Outcomes," Discussion paper, Rand Graduate School Santa Monica CA.

Xu, R., and K. Gong (2017): "Does Import Competition Induce R&D Reallocation? Evidence from the U.S.," Working Paper 17/253, International Monetary Fund, USA.

Yamashita, N., and I. Yamauchi (2020): "Innovation responses of Japanese firms to Chinese import competition," *The World Economy*, 43(1), 60–80.

Yang, M.-J., N. Li, and K. Lorenz (2021): "The impact of emerging market competition on innovation and business strategy: Evidence from Canada," *Journal of Economic Behavior & Organization*, 181, 117 – 134.

Zaclicever, D., and A. Pellandra (2018): "Imported inputs, technology spillovers and productivity: firm-level evidence from Uruguay," *Review of World Economics (Weltwirtschaftliches Archiv)*, 154(4), 725–743.

Appendix A: Tables

Table 1: Complexity index for the top products imported by Uruguay in 2015

Product	Share of Uruguayan imports		Product Complexity Index
	%	Cumulative %	
Crude Petroleum	15%	15%	−2.94
Electric Generating Sets	4%	19%	0.74
Cars	3%	23%	0.59
Packaged Medicaments	3%	25%	0.61
Refined Petroleum	2%	27%	−1.12
Delivery Trucks	2%	29%	0.26
Broadcasting Equipment	2%	30%	0.74
Pesticides	2%	32%	0.17

Source: Simoes and Hidalgo (2011).
Notes: This table reports the Product Complexity Index for the top products imported by Uruguay in 2015.

Table 2: Complexity index for the top suppliers of Uruguay goods imports in 2015

Country	Share of Uruguayan imports		Economic Complexity Index
	%	Cumulative %	
China	20%	20%	0.91
Brazil	17%	37%	0.74
Argentina	15%	52%	0.45
United States	8%	60%	1.64

Source: Simoes and Hidalgo (2011).
Notes: This table reports the Economic Complexity Index for the top suppliers of Uruguay goods imports in 2015.

Table 3: Descriptive statistics: Means by period

	2004–2006	2007–2009	2010–2012	2013–2015	Total
Import pen. from China (period)	0.04	0.06	0.08	0.09	0.07
Import pen. from China (year)	0.06	0.07	0.09	0.09	0.08
Import pen. from China IV (period)	0.08	0.20	0.28	0.31	0.22
Import pen. from China IV (year)	0.11	0.21	0.31	0.31	0.24
Sales and employment					
Sales	268,388	321,899	530,797	575,318	426,292
Total employment	97	100	115	107	105
Unskilled employment	89	90	104	97	95
Skilled employment	8	10	10	10	10
Labor productivity	2,123	2,387	3,605	3,788	2,986
Innovation inputs					
Positive total innovation exp.	0.47	0.50	0.43	0.48	0.47
Positive R&D exp.	0.20	0.19	0.17	0.20	0.19
Positive exp. on innovation capital	0.38	0.41	0.37	0.39	0.39
Positive other innovation exp.	0.36	0.37	0.24	0.27	0.31
Innovation outputs					
Any innovation	0.46	0.50	0.41	0.48	0.46
Product innovation	0.25	0.26	0.21	0.28	0.25
Process innovation	0.33	0.41	0.31	0.36	0.35
Non-technological innovation	0.25	0.21	0.17	0.23	0.22
Age	32.27	28.05	31.11	32.02	30.87
Business group	0.18	0.15	0.18	0.20	0.17
Foreign capital	0.14	0.14	0.16	0.15	0.15
Large firm	0.49	0.46	0.47	0.45	0.47
Observations	757	790	708	860	3,115

Source: Innovation Survey 2004–2006, 2007–2009, 2010–2012 and 2013–2015 for innovation variables, employment, sales and firm's characteristics, Survey of Economic Activity 2004–2015 and UN Comtrade for import penetration from China.
Notes: "Sales" are firm sales in thousands of Uruguayan pesos (constant pesos of 2010), "Total employment" are the number of employees in the firm, and "Labor productivity" are sales per employee at the firm level in thousands of Uruguayan pesos (constant pesos of 2010).

Table 4: First stage estimation

Dependent Variable: Import penetration from China	(1)	(2)
Import penetration from China IV (year)	0.097***	
	(0.018)	
Import penetration from China IV (period)		0.120***
		(0.021)
First stage F-stat	29.7	33.4
Mean DV	0.077	0.077
R-squared	0.951	0.959
Observations	3,115	3,115

Note: This table reports the first stage estimates for the IV regressions. The dependent variable is import penetration from China in Uruguay and the instrument uses imports from China to Argentina, Brazil, and Paraguay (see text for details).
All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.
The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 5: Effect of Import Competition from China on Sales and Employment

	Log sales	Log total employment	Log unskilled employment	Log skilled employment
Panel A. OLS				
Import penetration from China (year)	−0.901	−0.900*	−0.758	−0.778
	(0.887)	(0.512)	(0.546)	(0.567)
Panel B. IV				
Import penetration from China (year)	−2.686***	−2.123***	−1.980***	−2.251***
	(0.599)	(0.511)	(0.529)	(0.441)
First stage F-stat	29.7	29.7	29.7	29.7
Mean DV	11.085	3.942	3.809	1.499
Observations	3,115	3,115	3,115	3,115

Note: This table presents the OLS and IV estimates for the effect of import competition from China on sales and employment. Each column estimates the effect of competition on a different variable. Panel A reports OLS estimates, and Panel B reports IV estimates where import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details).
All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.
The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses..
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 6: Effect of Import Competition from China on Innovation Inputs

	Positive total innovation exp.	Positive R&D exp.	Positive exp. on innovation capital	Positive other innovation exp.
Panel A. OLS				
Import penetration from China (period)	−0.466*	−0.258**	−0.500***	0.096
	(0.248)	(0.112)	(0.154)	(0.196)
Panel B. IV				
Import penetration from China (period)	−0.587*	−0.240*	−0.696***	0.103
	(0.341)	(0.125)	(0.206)	(0.248)
First stage F-stat	33.4	33.4	33.4	33.4
Mean DV	0.472	0.192	0.388	0.309
Observations	3,115	3,115	3,115	3,115

Note: This table presents the OLS and IV estimates for the effect of import competition from China on innovation inputs. Each column estimates the effect of competition on a different variable. Panel A reports OLS estimates, and Panel B reports IV estimates where import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details).

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 7: Effect of Import Competition from China on Innovation Outputs

	Any innovation	Product innovation	Process innovation	Non-technological innovation
Panel A. OLS				
Import penetration from China (period)	-0.618^{***}	-0.319^{*}	-0.233	-0.181
	(0.223)	(0.161)	(0.174)	(0.115)
Panel B. IV				
Import penetration from China (period)	-0.706^{**}	-0.303^{*}	-0.225	-0.273^{*}
	(0.287)	(0.178)	(0.170)	(0.153)
First stage F-stat	33.4	33.4	33.4	33.4
Mean DV	0.465	0.251	0.352	0.217
Observations	3,115	3,115	3,115	3,115

Note: This table presents the OLS and IV estimates for the effect of import competition from China on innovation outputs. Each column estimates the effect of competition on a different variable. Panel A reports OLS estimates, and Panel B reports IV estimates where import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details).

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 8: Effect of Import Competition from China on Innovation Inputs: Heterogeneous effects by firm size

	Positive total innovation exp.	Positive R&D exp.	Positive exp. on innovation capital	Positive other innovation exp.
Import penetration from China (period)	-0.616^{**}	-0.248	-0.713^{***}	0.254
	(0.304)	(0.190)	(0.237)	(0.310)
Import pen from China × large firm	0.048	0.013	0.028	-0.248
	(0.192)	(0.166)	(0.236)	(0.169)
First stage F-stat	41.2	41.2	41.2	41.2
First stage F-stat (interaction)	40.3	40.3	40.3	40.3
Mean DV	0.472	0.192	0.388	0.309
Observations	3,115	3,115	3,115	3,115

Note: This table presents the OLS and IV estimates for the effect of import competition from China on innovation inputs by firm size. Each column estimates the effect of competition on a different variable. Import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details). "Large firm" is a dummy variable that indicates if the firm has, on average, 50 or more employees.

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 9: Effect of Import Competition from China on Innovation Outputs: Heterogeneous effects by firm size

	Any innovation	Product innovation	Process innovation	Non-technological innovation
Import penetration from China (period)	-0.710^{**}	-0.264	-0.246	-0.220
	(0.280)	(0.185)	(0.194)	(0.200)
Import pen from China × large firm	0.007	-0.064	0.035	-0.087
	(0.183)	(0.185)	(0.188)	(0.124)
First stage F-stat	41.2	41.2	41.2	41.2
First stage F-stat (interaction)	40.3	40.3	40.3	40.3
Mean DV	0.465	0.251	0.352	0.217
Observations	3,115	3,115	3,115	3,115

Note: This table presents the IV estimates for the effect of import competition from China on innovation outputs by firm size. Each column estimates the effect of competition on a different variable. Import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details). "Large firm" is a dummy variable that indicates if the firm has, on average, 50 or more employees.

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 10: Effect of Import Competition from China on Innovation Inputs: Heterogeneous effects by business group status

	Positive total innovation exp.	Positive R&D exp.	Positive exp. on innovation capital	Positive other innovation exp.
Import penetration from China (period)	-0.516	-0.207	-0.611^{***}	0.188
	(0.325)	(0.133)	(0.204)	(0.245)
Import pen from China × business group	-0.462^{*}	-0.219	-0.554^{***}	-0.549^{**}
	(0.238)	(0.221)	(0.187)	(0.216)
First stage F-stat	17.3	17.3	17.3	17.3
First stage F-stat (interaction)	39.7	39.7	39.7	39.7
Mean DV	0.472	0.192	0.388	0.309
Observations	3,115	3,115	3,115	3,115

Note: This table presents IV estimates for the effect of import competition from China on innovation inputs by business group status. Each column estimates the effect of competition on a different variable. Import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details). "Business group" is a dummy variable that indicates if the firm belongs to a group of firms.
All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.
The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at industry level (4-digit ISIC codes) are in parentheses.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 11: Effect of Import Competition from China on Innovation Outputs: Heterogeneous effects by business group status

	Any innovation	Product innovation	Process innovation	Non-technological innovation
Import penetration from China (period)	-0.612^{**}	-0.234	-0.142	-0.208
	(0.288)	(0.182)	(0.168)	(0.147)
Import pen from China × business group	-0.612^{***}	-0.453^{***}	-0.545^{***}	-0.422^{**}
	(0.227)	(0.167)	(0.201)	(0.169)
First stage F-stat	17.3	17.3	17.3	17.3
First stage F-stat (interaction)	39.7	39.7	39.7	39.7
Mean DV	0.465	0.251	0.352	0.217
Observations	3,115	3,115	3,115	3,115

Note: This table presents IV estimates for the effect of import competition from China on innovation outputs by business group status. Each column estimates the effect of competition on a different variable. Import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details). "Business group" is a dummy variable that indicates if the firm belongs to a group of firms.
All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.
The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 12: Effect of Import Competition from China on Innovation Inputs: Heterogeneous effects by skilled labor ratio

	Positive total innovation exp.	Positive R&D exp.	Positive exp. on innovation capital	Positive other innovation exp.
Import penetration from China (period)	-1.223^{**}	-0.417	-1.314^{***}	-0.377^{*}
	(0.471)	(0.421)	(0.400)	(0.216)
Import pen from China × high share skilled	0.482^{*}	0.524^{*}	0.649^{**}	0.298
	(0.258)	(0.275)	(0.273)	(0.299)
First stage F-stat	15.2	15.2	15.2	15.2
First stage F-stat (interaction)	100.7	100.7	100.7	100.7
Mean DV	0.630	0.297	0.536	0.459
Observations	1,108	1,108	1,108	1,108

Note: This table presents IV estimates for the effect of import competition from China on innovation inputs by skilled labor ratio. Each column estimates the effect of competition on a different variable. Import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details). "High share skilled" is a dummy variable that indicates if the share of skilled labor for a firm is larger than the median share in the corresponding sector for the period 1998–2003.

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 13: Effect of Import Competition from China on Innovation Outputs: Heterogeneous effects by skilled labor ratio

	Any innovation	Product innovation	Process innovation	Non-technological innovation
Import penetration from China (period)	-1.219^{**}	-0.539^{**}	-0.162	-0.607^{***}
	(0.469)	(0.244)	(0.298)	(0.190)
Import pen from China × high share skilled	0.478^{*}	0.245	0.002	0.305^{*}
	(0.267)	(0.209)	(0.394)	(0.155)
First stage F-stat	15.2	15.2	15.2	15.2
First stage F-stat (interaction)	100.7	100.7	100.7	100.7
Mean DV	0.625	0.353	0.486	0.292
Observations	1,108	1,108	1,108	1,108

Note: This table presents IV estimates for the effect of import competition from China on innovation outputs by skilled labor ratio. Each column estimates the effect of competition on a different variable. Import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details). "High share skilled" is a dummy variable that indicates if the share of skilled labor for a firm is larger than the median share in the corresponding sector for the period 1998–2003.

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 14: Effect of Import Competition from China on Innovation Inputs: Heterogeneous effects by firm productivity

	Positive total innovation exp.	Positive R&D exp.	Positive exp. on innovation capital	Positive other innovation exp.
Import penetration from China (period)	-1.543^{***}	-0.354	-1.408^{***}	-0.327
	(0.385)	(0.407)	(0.268)	(0.249)
Import pen from China × close to the frontier	0.797^{***}	0.216	0.495^{**}	0.131
	(0.243)	(0.180)	(0.196)	(0.196)
First stage F-stat	61.6	61.6	61.6	61.6
First stage F-stat (interaction)	43.4	43.4	43.4	43.4
Mean DV	0.628	0.301	0.534	0.456
Observations	1,147	1,147	1,147	1,147

Note: This table presents IV estimates for the effect of import competition from China on innovation inputs by firm productivity. Each column estimates the effect of competition on a different variable. Import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details). "Close to the frontier" is a dummy variable that indicates if the distance of the firm productivity to the most productive firm in the sector is smaller than .75 for the period 1998–2003 .

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 15: Effect of Import Competition from China on Innovation Outputs: Heterogeneous effects by firm productivity

	Any innovation	Product innovation	Process innovation	Non-technological innovation
Import penetration from China (period)	−1.517***	−0.721***	−0.504**	−0.594***
	(0.365)	(0.223)	(0.237)	(0.186)
Import pen from China × close to the frontier	0.799***	0.501**	0.518**	0.310**
	(0.239)	(0.199)	(0.241)	(0.148)
First stage F-stat	61.6	61.6	61.6	61.6
First stage F-stat (interaction)	43.4	43.4	43.4	43.4
Mean DV	0.622	0.356	0.483	0.289
Observations	1,147	1,147	1,147	1,147

Note: This table presents IV estimates for the effect of import competition from China on innovation outputs by firm productivity. Each column estimates the effect of competition on a different variable. Import penetration from China in Uruguay is instrumented using imports from China to Argentina, Brazil, and Paraguay (see text for details). "Close to the frontier" is a dummy variable that indicates if the distance of the firm productivity to the most productive firm in the sector is smaller than .75 for the period 1998–2003 .

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 16: Effect of Import Competition from China on Sales and Employment: Robustness using IV with imports from China to other countries in Latin America and the Caribbean

	Log sales	Log total employment	Log unskilled employment	Log skilled employment
Panel A. OLS				
Import penetration from China (year)	−0.901	−0.900*	−0.758	−0.778
	(0.887)	(0.512)	(0.546)	(0.567)
Panel B. IV				
Import penetration from China (year)	−2.260**	−2.310***	−2.229***	−1.912***
	(0.928)	(0.511)	(0.532)	(0.514)
First stage F-stat	27.4	27.4	27.4	27.4
Mean DV	11.085	3.942	3.809	1.499
Observations	3,115	3,115	3,115	3,115

Note: This table presents the OLS and IV estimates for the effect of import competition from China on sales and employment. Each column estimates the effect of competition on a different employment variables. Panel A reports OLS estimates, and Panel B reports IV estimates where import penetration from China in Uruguay is instrumented using imports from China to other countries in Latin America and the Caribbean (see text for details).
All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.
The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses..
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 17: Effect of Import Competition from China on Innovation Inputs: Robustness using IV with imports from China to other countries in Latin America and the Caribbean

	Positive total innovation exp.	Positive R&D exp.	Positive exp. on innovation capital	Positive other innovation exp.
Panel A. OLS				
Import penetration from China (period)	-0.466^{*}	-0.258^{**}	-0.500^{***}	0.096
	(0.248)	(0.112)	(0.154)	(0.196)
Panel B. IV				
Import penetration from China (period)	-0.834^{**}	-0.221	-0.866^{***}	0.081
	(0.314)	(0.159)	(0.290)	(0.327)
First stage F-stat	26.5	26.5	26.5	26.5
Mean DV	0.472	0.192	0.388	0.309
Observations	3,115	3,115	3,115	3,115

Note: This table presents the OLS and IV estimates for the effect of import competition from China on innovation inputs. Each column estimates the effect of competition on a different variable. Panel A reports OLS estimates, and Panel B reports IV estimates where import penetration from China in Uruguay is instrumented using imports from China to other countries in Latin America and the Caribbean (see text for details).

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 18: Effect of Import Competition from China on Innovation Outputs: Robustness using IV with imports from China to other countries in Latin America and the Caribbean

	Any innovation	Product innovation	Process innovation	Non-technological innovation
Panel A. OLS				
Import penetration from China (period)	-0.618^{***}	-0.319^{*}	-0.233	-0.181
	(0.223)	(0.161)	(0.174)	(0.115)
Panel B. IV				
Import penetration from China (period)	-0.879^{***}	-0.402^{*}	-0.237	-0.446
	(0.309)	(0.226)	(0.232)	(0.339)
First stage F-stat	26.5	26.5	26.5	26.5
Mean DV	0.465	0.251	0.352	0.217
Observations	3,115	3,115	3,115	3,115

Note: This table presents the OLS and IV estimates for the effect of import competition from China on innovation outputs. Each column estimates the effect of competition on a different variable. Panel A reports OLS estimates, and Panel B reports IV estimates where import penetration from China in Uruguay is instrumented using imports from China to other countries in Latin America and the Caribbean (see text for details).

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 19: First stage estimation: Robustness using IV with exports from China

Dependent Variable: Import penetration from China	(1)	(2)
Import penetration from China IV (year)	0.525**	
	(0.234)	
Import penetration from China IV (period)		0.894***
		(0.273)
First stage F-stat	5.0	10.7
Mean DV	0.077	0.077
R-squared	0.924	0.920
Observations	3,115	3,115

Note: This table reports the first stage estimates for the IV regressions. The dependent variable is import penetration from China in Uruguay and the instrument uses the evolution of total exports from China except those exports to Uruguay (see text for details).
All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.
The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 20: Effect of Import Competition from China on Innovation Inputs: Robustness using IV with exports from China

	Positive total innovation exp.	Positive R&D exp.	Positive exp. on innovation capital	Positive other innovation exp.
Panel A. OLS				
Import penetration from China (period)	−0.466*	−0.258**	−0.500***	0.096
	(0.248)	(0.112)	(0.154)	(0.196)
Panel B. IV				
Import penetration from China (period)	−1.346***	−0.362	−1.298**	−0.095
	(0.424)	(0.257)	(0.517)	(0.392)
First stage F-stat	10.7	10.7	10.7	10.7
Mean DV	0.472	0.192	0.388	0.309
Observations	3,115	3,115	3,115	3,115

Note: This table presents the OLS and IV estimates for the effect of import competition from China on innovation inputs. Each column estimates the effect of competition on a different variable. Panel A reports OLS estimates, and Panel B reports IV estimates where import penetration from China in Uruguay is instrumented using total exports from China except those exports to Uruguay (see text for details).

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 21: Effect of Import Competition from China on Innovation Outputs: Robustness using IV with exports from China

	Any innovation	Product innovation	Process innovation	Non-technological innovation
Panel A. OLS				
Import penetration from China (period)	-0.618^{***}	-0.319^{*}	-0.233	-0.181
	(0.223)	(0.161)	(0.174)	(0.115)
Panel B. IV				
Import penetration from China (period)	-1.410^{***}	-0.661^{*}	-0.307	-0.861^{*}
	(0.444)	(0.344)	(0.325)	(0.476)
First stage F-stat	10.7	10.7	10.7	10.7
Mean DV	0.465	0.251	0.352	0.217
Observations	3,115	3,115	3,115	3,115

Note: This table presents the OLS and IV estimates for the effect of import competition from China on innovation outputs. Each column estimates the effect of competition on a different variable. Panel A reports OLS estimates, and Panel B reports IV estimates where import penetration from China in Uruguay is instrumented using total exports from China except those exports to Uruguay (see text for details).

All models include industry fixed effects (4-digit ISIC codes), time fixed effects, and the following controls: firm's age and its square, a dummy variable that indicates if the firm belongs to a group of firms, a dummy variable that indicates if the firm has foreign capital, and a dummy variable that indicates if the firm has, on average, 50 or more employees.

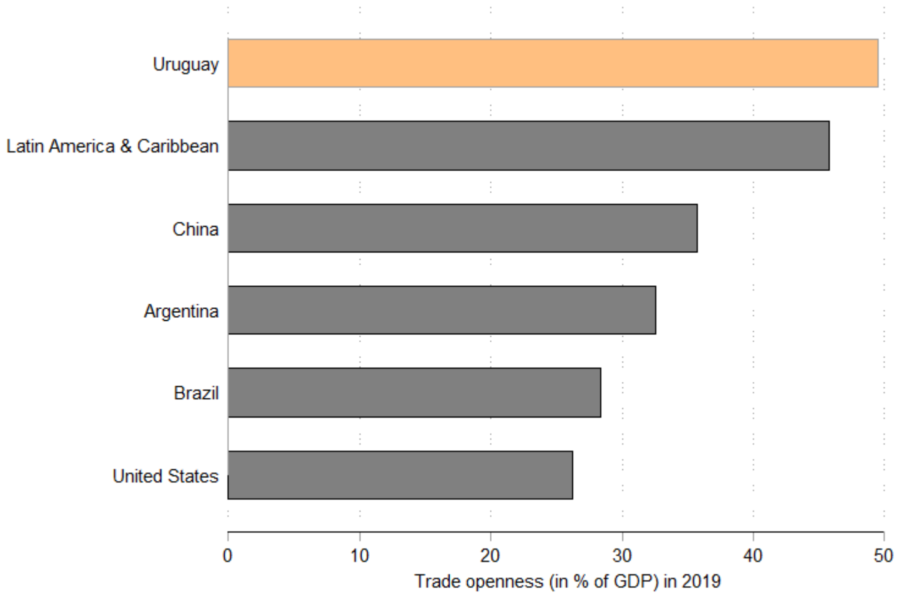
The first stage F-statistic is the cluster-robust F-statistic. Asymptotic standard errors clustered at the industry level (4-digit ISIC codes) are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

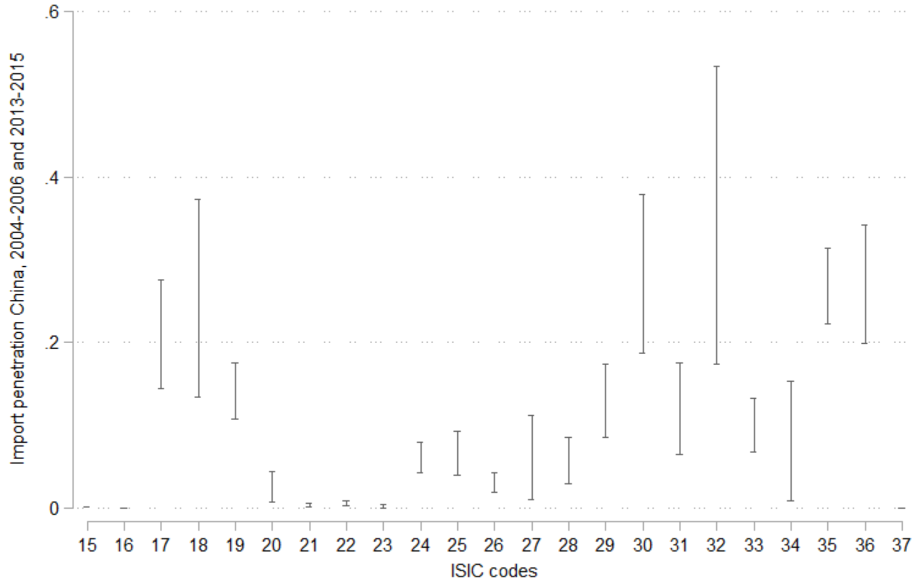
Appendix B: Figures



Notes: Trade openness is the sum of exports and imports of goods and services measured as a share of gross domestic product.

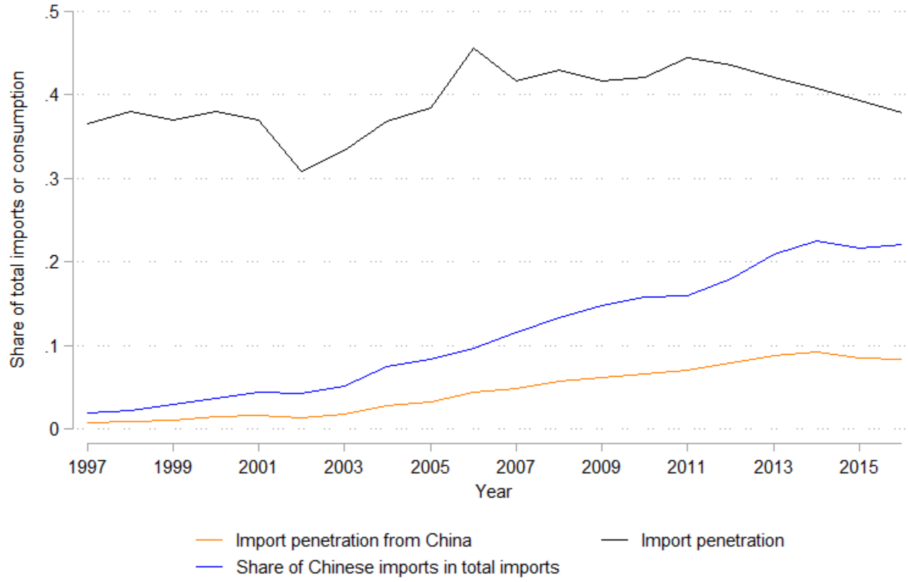
Source: World Bank national accounts data, and OECD National Accounts data files.

Figure 1: Trade openness for selected countries, 2019.



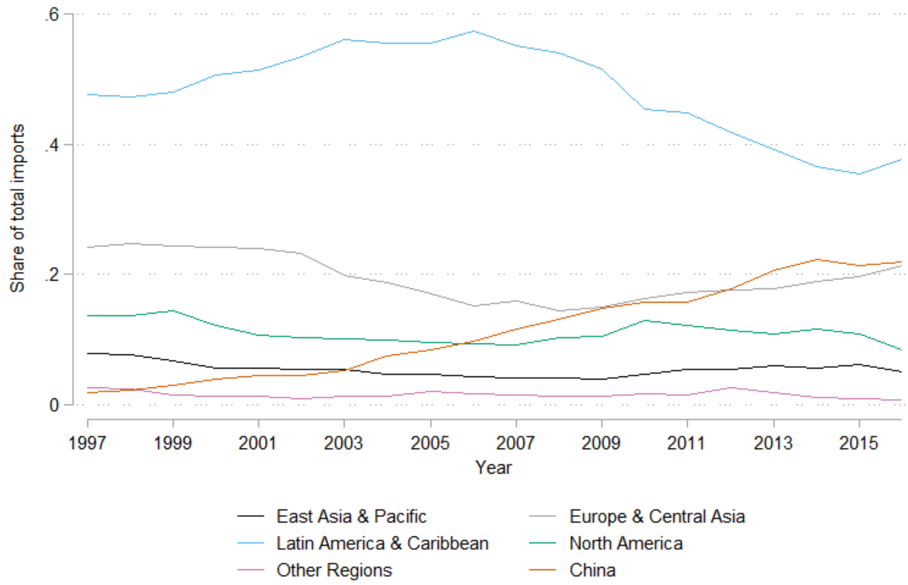
Notes: This figure shows the change in import penetration from China from 2004–2006 to 2013–2015. For each sector, the bottom of the bar corresponds to import penetration in 2004–2006, the top of the bar corresponds to import penetration in 2013–2015, and the length of each vertical bar illustrates the change between those two periods.
The different sectors are: Food products and beverages (15), Tobacco (16), Textiles (17), Wearing apparel, dressing and dyeing of fur (18), Leather and footwear (19), Wood except furniture (20), Paper (21), Publishing (22), Coke, refined petroleum and nuclear fuel (23), Chemicals (24), Rubber and plastics (25), Other non-metallic mineral products (26), Basic metals (27), Metal products except machinery and equipment (28), Machinery and equipment (29), Office, accounting and computing (30), Electrical machinery (31), Radio, television and communication equipment (32), Medical, precision and optical instruments, watches and clocks (33), Motor vehicles, trailers and semi-trailers (34), Other transport equipment (35), Furniture (36), and Recycling (37).

Figure 2: Change in import penetration from China, 2004-2006 and 2013-2015.



Notes: This figure shows the evolution of total import penetration (black line), the share of imports from China of total imports (blue line), and import penetration from China (orange line) for Uruguay in 1997–2016.

Figure 3: Decomposition of import penetration from China



Notes: This figure shows the evolution of the shares of different regions in total imports for Uruguay in 1997–2016.

Figure 4: Evolution of Uruguayan imports from different regions