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# Is Competition from China So Special?*

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**Abstract**

Competition from China is perceived as particularly damaging. We study whether this is true for firm performance. Using the universe of Spanish export transactions, we find that an increase in competition from China does not have a more damaging effect on export revenues, prices, and number of exported products than an equally-sized increase in competition from other countries. We document, though, that Chinese competition raises the probability that a firm ceases to export a good to a destination more than competition from other countries. This effect declines over time. We document an omitted variable bias in studies focusing only on Chinese competition, even when controlling for unobserved heterogeneity of destinations for different products within firms.

**JEL**: F13, F14

**Keywords**: China, competition, exports, Spain, transaction-level data.

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# 1 Introduction

China has rapidly integrated itself into the world economy during the past few decades. At the beginning of its transition to a more market-based economy in 1980, China produced 0.9% of global merchandise exports only. By 2016, however, China was the source of 13% of world merchandise exports and the world's largest exporter.[1]

The rise in China's exports has raised concerns among developed countries not only due to its magnitude, but also because Chinese exports overlap considerably with the products manufactured by developed economies (Rodrik, 2006; Schott, 2008) and sell at lower prices (Fontagné et al., 2008). Due to China's low wages, its allegedly undervalued currency and still ineffective intellectual property rights enforcement, lower environmental standards, and (implicit) export subsidies, there is a broad sentiment that Chinese competition is particularly damaging for developed countries' firms. Alas, firms do not only compete with their Chinese counterparts but with firms from across the globe.

In this paper, we assess whether Chinese competition is more damaging to firms' performance by comparing it to the effect of competition from other countries. Undeniably, the level of Chinese exports has risen, and the increase in Chinese competition, as measured by its market share in export markets, has increased more than for any other competitor. Instead of focusing on its absolute magnitude, we focus on the nature of competition, and evaluate whether an increase in competition from China has a larger negative effect on firms' performance than a similarly-sized increase in competition from other countries. Essentially, we are asking the question whether China's competition is special.

Unlike previous studies that focus on the effect of Chinese competition on the domestic economy (Autor et al., 2013; Mion and Zhu, 2013; Pierce and Schott, 2016), we investigate its impact on the performance of firms in their export markets. Competition affects firm performance in several ways. In a standard heterogeneous firm model with CES demand (Melitz, 2003), an increase in competition, measured by a lower price index, reduces firms' export revenues and drives the least productive firms out of foreign markets. If markups are endogenous, higher competition translates into lower prices (Melitz and Ottaviano, 2008). However, prices may increase if firms upgrade the quality of their products in response to rising import competition (Amiti and Khandelwal, 2013). In addition, tougher competition may lead multi-product exporters to reduce their total number of exported products (Eckel and Neary, 2010; Bernard et al., 2011; Mayer et al., 2014, 2016). If China has a particularly damaging impact on exporters, it should show up in any of these variables in our data.

We use administrative export transactions data for the universe of Spanish exporters

[1] Author's own calculations using World Trade Organization data.

from 1997 to 2016 combined with balance-sheet data to analyze the impact of Chinese and other countries' competition on Spanish firms' export revenues, prices, range of exported products, and the probability that a firm stops to export a good to a given market. In particular, we assess whether stiffer competition from China has been more damaging than a similar increase in competition from other important exporters, such as Germany, Italy, or France. Our data allow us to control for unobserved heterogeneity at the firm-destination-product level, such as differences in product appeal or firm-specific trade costs across export markets.

We make three contributions. First, we document that tougher competition from China reduces Spanish firms' export revenues. However, this effect is similar to the effect of competition from other countries if their competition were to increase by the same amount. In this sense, we do not find that Chinese competition has a particularly damaging effect on Spanish firms' export revenues. We do not find either a stronger impact of tougher Chinese competition on firms' export prices or their number of exported products. However, an increase in Chinese competition raises the probability of a firm ceasing to serve an export market with a particular good more than a similar increase in competition from other countries. Nevertheless, this differential impact diminishes over time and is small relative to a firm's average risk to cease exporting a good to a destination.

Second, we document an omitted variable bias in studies which only focus on Chinese competition. Mechanically, a rise in China's market share implies a reduction in the share of its competitors. Interestingly, the literature studies the impact of Chinese competition in isolation.[2] We show that neglecting other countries' simultaneous changes in their market shares underestimates the impact of Chinese competition on firm performance.

Third, we investigate whether Chinese competition has a larger impact on firms which may be particularly vulnerable as they produce low-tech products or with low productivity. We find that the impact of competition on firms' revenue is lower for high-tech products. However, this is not particular to competition from China. We find that firms with higher productivity are less affected by the impact of Chinese competition on export revenues and product scope; however this effect is economically small.

Our results are robust to instrumenting the competition-intensity measure, estimating specifications with alternative fixed effects, and across different product categories and time intervals. Results also are robust to sample selection, i.e., controlling for endogenous firm exit caused by the competition from China and other countries.

[2] Examples for this type of studies of the "China shock" are Ahearne et al. (2003); Eichengreen et al. (2007); Greenaway et al. (2008); Hanson and Robertson (2010); Autor et al. (2013); Iacovone et al. (2013); Utar and Ruiz (2013); Mion and Zhu (2013); Utar (2014); Autor et al. (2016); Bloom et al. (2016); Pierce and Schott (2016).

We contribute to the literature that analyzes the "China shock" and specifically to studies that investigate the impact of China on other countries' exports. Previous studies use aggregate data (Ahearne et al., 2003; Eichengreen et al., 2007; Greenaway et al., 2008; Hanson and Robertson, 2010) or firm-level data (Iacovone et al., 2013; Utar and Ruiz, 2013; Utar, 2014) which do not allow the authors to distinguish between the effect of Chinese competition in different export markets. Similar to our study, Martin and Mejean (2014) use administrative export transaction data at the destination and product levels to study the impact of Chinese competition and of a summary measure of overall competition from low-wage countries. They focus on French exporters and do not consider the separate impact of competition from individual countries except China. We assess the impact of China's competition on Spanish firms' exports across destinations and products by investigating whether tougher competition from China has a more damaging impact than that from other countries. In addition, for the first time, we explicitly model the attrition bias caused by firms which leave the export market altogether by estimating a system of selection equations.

The remainder of the paper is organized as follows. Section 2 identifies Spanish exporters' main competitors and how competition evolved from 1997 to 2017. Section 3 presents our results regarding Chinese competition on export revenues, prices, the range of products exported, and the likelihood of terminating an export relation. Section 4 tests the robustness of our results, and the final section concludes.

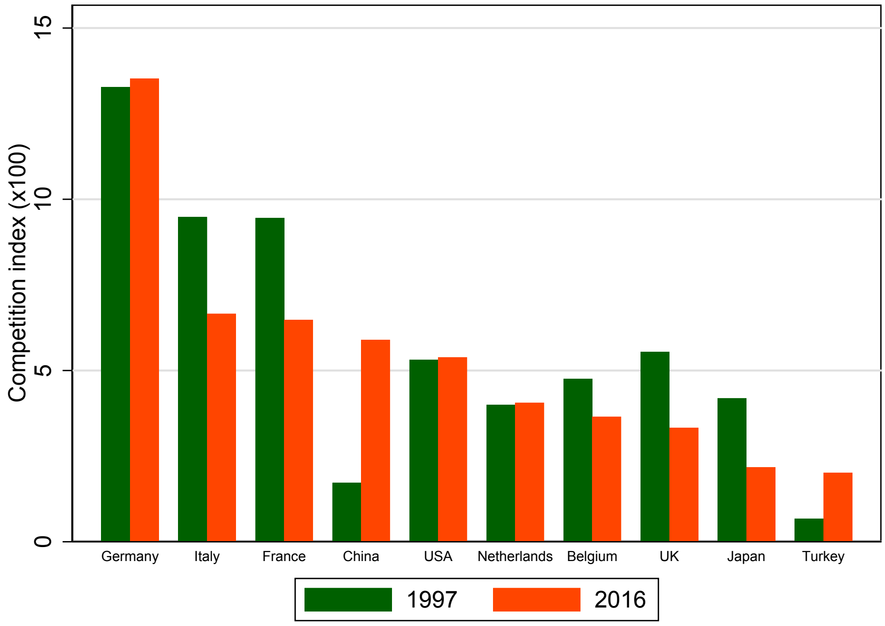
## 2 Who are Spanish exporters' principal competitors?

To determine whether Chinese competition has a particularly damaging effect on Spanish exporters, we need to compare it with the effect of competition from other countries. We identify Spanish exporters' top ten competitors using a competition index by Mattoo et al. (2017). This index is defined as follows:

$$CI_t^i = \sum_J \sum_K \left( \frac{x_{jkt}^{Spain}}{X_t^{Spain}} \frac{m_{jkt}^i}{M_{jkt}} \right) \quad (1)$$

where $CI_t^i$ is the competitive pressure that country $i$ exerts on Spanish exporters in year $t$; $J$ is the set of Spanish export destinations and $K$ is the set of the Harmonized System (HS) 6-digit products exported by Spanish firms; $x_{jkt}^{Spain}$ denotes the value of Spanish exports of product $k$ to destination $j$ in year $t$, $X_t^{Spain}$ denotes the value of total Spanish exports in year $t$; $m_{jkt}^i$ are destination $j$'s total imports of product $k$ from country $i$ in year $t$, and $M_{jkt}$ are total imports of product $k$ by destination $j$ in year $t$. Country $i$ is a tough competitor to Spain if its products have a high market share in export markets that make up a large portion of Spain's total exports.

**Figure 1:** Spain's ten largest export competitors in 1997 and 2016




Source: Authors calculations of $CI_t^i$ from Equation (1), based on United Nations' Comtrade data.

We use data from the United Nations' Comtrade database to identify Spanish exporters' top ten competitors in 2016. As shown in Figure 1, Germany, by a large margin, was the largest competitor for Spanish exporters in 2016, followed by Italy and France. In 2016, China was the fourth-largest competitor in the ranking (compared to ninth in 1997), ahead of the USA, the Netherlands, Belgium, the United Kingdom, Japan, and Turkey. China's competitive presence increased more than that of any other country in Figure 1 between 1997 and 2016. Other increases in competition are seen in Turkey and, more moderately, in Germany, the US, and the Netherlands. Competitive pressure from the other countries in Figure 1 declined between 1997 and 2016, most notably from France, Italy, the UK, and Japan.

In the next section, we test whether the absolute increase in the level of competition from China at the aggregate level also implies that an increase in competition from China has a more damaging effect on the export performance of individual Spanish firms than a similarly-sized increase from these other competitors.

## 3 Competitors' impact on firms' export performance

We begin by analyzing the differential impact of Chinese competition on Spanish firms' export revenues from selling a product in a given market. Using a specification similar to that in Bloom et al. (2016), we define the equation governing firm×destination×product×year export revenues as follows:

$$\ln x_{fjkt} = \alpha China_{jkt} + \sum_{C \in \mathfrak{C}} \beta_C Competitor^C_{jkt} + \gamma_{fjk} + \gamma_t + \epsilon_{fjkt} \tag{2}$$

where $x_{fjkt}$ are the export revenues of firm $f$ from selling product $k$ in destination $j$ in year $t$. $China_{jkt}$ measures the competitive pressure of China in destination $j$, product $k$, and year $t$, and is calculated as follows:

$$China_{jkt} = \frac{m^{China}_{jkt}}{M_{jkt}} \tag{3}$$

where $m^{China}_{jkt}$ are destination $j$'s imports of product $k$ from China, and $M_{jkt}$ are destination $j$'s total imports of product $k$. Note that $China_{jkt}$ is exactly the same competition measure as used in our descriptive analysis in Section 2. Now, though, we do not have to weight across products and markets, because we analyze export revenues for a particular product in a given market. $Competitor^C_{jkt}$ is calculated analogous to $China_{jkt}$, and $C$ refers to one of the remaining countries in the set $\mathfrak{C}$ of Spain's main competitors, identified in Section 2. We calculate the total share of the top ten competitors for all destination×product×year combinations, $\sum_{C \in \mathfrak{C}} Competitor^C_{jkt}$.[3] The median share is 67% of all imports. As a robustness check, we carry out our regressions with the top 20 competitors. The median share rises to 82% of all imports. Still, the main conclusions are not altered. Equation (2) includes firm×destination×product ($\gamma_{fjk}$) and year fixed effects ($\gamma_t$).[4] $\gamma_{fjk}$ controls for the well-documented heterogeneity of market entry costs and demand across firms (Eaton et al., 2011) and products (Bernard et al., 2011).[5]

It is well known that the probability of a firm's exporting status is quite persistent (Roberts and Tybout, 1997). This is also true at the firm-destination-product level (Defever et al., 2015). The first difference estimator is more efficient if there is a high degree of persistence in the data (Wooldridge, 2010). Therefore, as in Bloom et al. (2016), we remove the firm×product×destination fixed effects by taking first differences of Equation (2):

$$\Delta \ln x_{fjkt} = \alpha \Delta China_{jkt} + \sum_{C \in \mathfrak{C}} \beta_C \Delta Competitor^C_{jkt} + \Delta\gamma_t + \Delta\epsilon_{fjkt} \tag{4}$$

[3] In two-thirds of the 1,751,162 year×destination×HS 6-digit product combinations in which Spanish exporters were present in the period 1997 to 2017, at least, seven of the top ten Spanish competitors were present as well.

[4] We also test an alternative specification using firm×product×year fixed effects and destination×year fixed effects instead of firm×destination×product and year fixed effects. Our main conclusions are not altered. We report results in Section E of the Online Appendix, which is available on `https://benediktheid.weebly.com/`.

[5] For this reason, an aggregated product-level gravity model of exports would not allow us to capture precisely the impact of competition on individual exporters.

where $\Delta \ln x_{fjkt} \equiv \ln x_{fjkt} - \ln x_{fjkt-1}$ and similarly for the other variables. We estimate Equation (4) by OLS and cluster standard errors at the product-destination level following the recommendation by Bertrand et al. (2004). First differencing the data requires a firm to export a product in a given export market in two consecutive years. Even though export decisions are persistent, this may lead to a sample selection bias due to attrition. The within estimator for Equation (2) also uses observations of non-consecutive years, i.e., from intermittent exporters which stop to export a good for one or more years. Both the first difference and the within estimator may suffer from attrition bias of firms stopping to serve an export market with a given product for the rest of the sample period. Using a sample selection model in first differences is the natural way to correct for attrition bias, see Wooldridge (2010), chapter 19.9.3. We correct for this bias explicitly in Section 4.3. We therefore stick to the first difference estimator in the main text. We also re-estimate our regressions using the within estimator, see Section H in the Online Appendix. Results remain similar.[6]

Data on Spanish exporters are from the Customs and Excise Department of the Spanish Tax Agency and include the universe of Spanish exporters. The data set contains a firm identifier, export destination, the product's Combined Nomenclature (CN) 8-digit classification, the value of exports, and exported quantities.[7] To calculate $\Delta China_{jkt}$, and competitive pressure from the remaining top ten largest rival countries, we use the United Nations' Comtrade database, which reports export data at the HS 6-digit level. To match it with customs data, we collapse the latter at this disaggregation level and define products at the HS 6-digit classification. The period of analysis is 1997-2017.[8] We provide summary statistics of our data in Table A.1 in the Appendix. Similar to our aggregate measure of competition from Section 2, the average year-to-year increase in China's market share at the product×destination level is the largest among all considered competitors. Our regressions will tell us whether this large increase in the market share has a more damaging impact on firms' performance than an equally-sized increase of competition from other countries.

All our regressions focus on the impact on firm performance measures, i.e., revenues, prices, export market exit, and product scope. We do not study the impact of Chinese

[6]As explained above, to check the robustness of our results, we also estimate Equation (4) using firm×product×time and destination×time fixed effects as an alternative. This set of fixed effects leads to a sizable reduction in the sample. Still, our main conclusions are not altered, see Section E in the Online Appendix.

[7]We consider a firm to be an exporter if it exports at least €1500 of a given product in a given market per year.

[8]To avoid the effect of outliers, we restrict the sample to the top 50 destinations of Spanish exports in 1997, the first year in our dataset. These destinations account for 94% of the value of Spanish exports that year. We also remove Andorra, Gibraltar, and Hong Kong from the list of destinations: Given their location, trade with Andorra and Gibraltar may be more similar to domestic sales than exports; we exclude Hong Kong due to its importance as an entrepôt for trade with China (Fisman et al., 2008).

**Table 1:** The impact of competition on exported products' revenues, prices and survival

| | Revenue | | Price | | Exit | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\Delta China_{jkt}$ | $-0.227^a$ | $-0.429^a$ | 0.004 | 0.002 | $0.078^a$ | $0.089^a$ |
| | (0.011) | (0.012) | (0.007) | (0.007) | (0.006) | (0.006) |
| $\Delta Germany_{jkt}$ | | $-0.483^a$ | | $-0.004$ | | $0.028^a$ |
| | | (0.013) | | (0.008) | | (0.005) |
| $\Delta Italy_{jkt}$ | | $-0.475^a$ | | $-0.010$ | | $0.035^a$ |
| | | (0.014) | | (0.009) | | (0.005) |
| $\Delta France_{jkt}$ | | $-0.498^a$ | | $-0.001$ | | $0.024^a$ |
| | | (0.016) | | (0.010) | | (0.006) |
| $\Delta USA_{jkt}$ | | $-0.453^a$ | | 0.003 | | 0.008 |
| | | (0.014) | | (0.010) | | (0.006) |
| $\Delta Netherlands_{jkt}$ | | $-0.431^a$ | | $-0.012$ | | $0.029^a$ |
| | | (0.019) | | (0.013) | | (0.008) |
| $\Delta Belgium_{jkt}$ | | $-0.449^a$ | | 0.006 | | $0.024^a$ |
| | | (0.019) | | (0.012) | | (0.008) |
| $\Delta UK_{jkt}$ | | $-0.495^a$ | | $-0.016$ | | $0.037^a$ |
| | | (0.018) | | (0.012) | | (0.007) |
| $\Delta Japan_{jkt}$ | | $-0.498^a$ | | $-0.021$ | | 0.006 |
| | | (0.025) | | (0.019) | | (0.011) |
| $\Delta Turkey_{jkt}$ | | $-0.469^a$ | | 0.005 | | $0.075^a$ |
| | | (0.026) | | (0.014) | | (0.011) |
| Observations | 4571004 | 4571004 | 4562420 | 4562420 | 4322634 | 4322634 |
| $R^2$ | 0.002 | 0.004 | 0.000 | 0.000 | 0.002 | 0.002 |

Note: Table reports coefficients of Equation (4) estimated by OLS. Estimations include year fixed effects. Standard errors clustered at the product×destination level are in parentheses. a, b, c statistically significant at 1%, 5%, and 10% respectively.

competition on productivity or innovation. Therefore, our results should be interpreted as the ex post response or revealed performance of Spanish exporters, which may well be a result of these adjustments due to higher competition from China.[9]

Echoing studies that focus only on the effects of Chinese competition, we first estimate Equation (4), including $\Delta China_{jkt}$ as the only independent variable (Column (1) in Table 1). The $\Delta China_{jkt}$ coefficient is negative and precisely estimated, indicating that

[9] See Bloom et al. (2016) for evidence of trade-induced technical change as a result of increasing competition from China.

an increase in Chinese competition correlates with lower export revenues: a ten percentage point increase in Chinese competition leads to a 2.3% reduction in export revenues. In Column (2), we include the competitive pressure from the other top ten competitors. The $\Delta China_{jkt}$ coefficient becomes more negative. This illustrates that omitting competitive pressure from other competitors leads to a downward bias in the $\Delta China_{jkt}$ coefficient.[10] This bias arises due to the mechanical negative correlation between the market share of China and the share of each of the other competitors (Table A.3 in the Appendix).[11] According to the coefficient reported in Column (2), a ten percentage point increase in competition from China leads to a 4.3% reduction in export revenues, doubling the magnitude compared to Column (1). The average year-to-year change in $\Delta China_{jkt}$ in our sample is 0.005, i.e., China's market share increases by 0.5 percentage points from year to year (see Table A.1 in the Appendix). Hence, a doubling of the year-to-year increase in Chinese import competition reduces export revenues by 0.2% (0.005*$\alpha$*100, with $\alpha = -0.429$).[12]

The coefficients for the other competitors are more negative than $\Delta China_{jkt}$. This illustrates that an increase in competition from China does not have a particularly damaging effect on Spanish firms' export revenues compared to a similar increase in competition from other countries. For example, a ten percentage point increase in competition from Germany leads to 4.8% reduction in export revenues, larger than the 4.3% reported for China. If the increase in competition had come from France, Spanish firms' export revenues would have dropped by 5%. Overall, in economic terms, differences across competitors are small. In sum, although competition from China has a negative effect on Spanish firms' export revenues, the impact is similar or even larger for a similar rise in competition from other countries.

Next, we investigate whether competition from China has a particularly damaging effect on the export prices, $p_{fjkt}$, set by Spanish firms. To test this hypothesis, we calculate the export price of Spanish firms as a ratio of value over quantity.[13] We calculate the log difference in export prices between year $t$ and year $t-1$, and estimate Equation (4) with this new dependent variable. Columns (3) and (4) in Table 1 present the results. As done previously, we first estimate Equation (4) with $\Delta China_{jkt}$ as the only independent variable. Then, we estimate it with all rival countries' competitive pressure variables. The $\Delta China_{jkt}$ coefficient is close to zero and statistically not significant, suggesting

[10] Table A.2 in the Appendix shows that the omitted variable bias does not only arise in the $\Delta China_{jkt}$ coefficient but also in the coefficients of the rest of competitors.

[11] The correlation between $\Delta China_{jkt}$ and the change in the sum of the import share of the remaining top ten competitors is -0.26.

[12] Note that $\Delta China_{jkt}$ is a share. Therefore, an increase in $\Delta China_{jkt}$ by 0.01 is equivalent to an increase by one percentage point.

[13] All transactions report the value in euros and the quantity in a weight metric. A third of transactions also provide the number of physical units as an additional measure of quantity. In those cases, we use units instead of kilograms to calculate unit values.

that tougher Chinese competition does not affect Spanish export prices (Column (3)). The coefficients for other competitors are close to zero and not statistically significant either (Column (4)). According to these results, tougher competition does not have any effect on Spanish firms' export prices. In particular, we do not find any differential effect for Chinese competition. These results imply that our negative revenue effects are solely driven by a reduction of the sold quantity. We test this using the change in the log of quantity as the dependent variable in Equation (4). All estimated coefficients are negative and of a similar magnitude as those reported in Columns (1) and (2) of Table 1, confirming our prediction. We report quantity regressions in Section A of the Online Appendix.

Finally, we investigate whether tougher competition increases the probability that a firm ceases to export a good to a given export market. For this analysis, we substitute the dependent variable in (4) by $Exit_{fjkt}$, which takes the value of 1 if the export relation terminates in year $t$, and zero otherwise. We estimate Equation (4) using a linear probability model to ease interpretation of results.[14] For most competitors, tougher competition is associated with a greater probability of ceasing an export relation (Column (6) in Table 1). However, more Chinese competition increases the probability that a firm stops exporting a good to a given export market to a larger extent than a similar increase in competition from other countries. For example, a ten percentage point increase in Chinese competition increases the probability of exit by 0.9 percentage points. If competition from Germany increases, the risk of exit rises by only 0.3 percentage points. These changes are very small relative to the sample's average 25% exit rate (Table A.1). Hence, tougher Chinese competition has a larger negative effect on the probability that a firm ceases to export a good to a given export market. Similarly, tougher Turkish competition also has a large negative impact on the probability of exit.[15]

The exit of a firm from an export market with a particular product may be due to firms concentrating on exporting their core products, dropping products with higher unit costs. This is in line with models of multi-product firms as, e.g., Eckel and Neary (2010), Bernard et al. (2011), Mayer et al. (2014), and Mayer et al. (2016) where tougher competition leads to a reduction of a firm's product scope. In line with our specification in first differences, we use as dependent variable the change in a firm's product scope. We measure product scope as the number of CN 8-digit products that a firm exports to a given market.[16] The independent variables are the shares of Spanish competitors in destination $j$'s total imports.

We present results in Table 2. When Chinese competition is the only independent

[14]Results are similar when estimating a logit model, see Section B in the Online Appendix.
[15]We confirm our results using a Cox proportional hazard model, see Section C in the Online Appendix.
[16]Given the fact that the CN classification changes every year, we use the Van Beveren et al.'s (2012) algorithm to obtain a stable classification for the period under analysis.

**Table 2:** The impact of competition on product scope

| | (1) | (2) |
|---|---|---|
| $\Delta China_{jt}$ | 0.074 | 0.029 |
| | (0.089) | (0.091) |
| $\Delta Germany_{jt}$ | | $-0.004$ |
| | | (0.155) |
| $\Delta Italy_{jt}$ | | $0.381^c$ |
| | | (0.215) |
| $\Delta France_{jt}$ | | 0.128 |
| | | (0.141) |
| $\Delta USA_{jt}$ | | $-0.202$ |
| | | (0.140) |
| $\Delta Netherlands_{jt}$ | | $-0.160$ |
| | | (0.208) |
| $\Delta Belgium_{jt}$ | | $0.361^c$ |
| | | (0.194) |
| $\Delta UK_{jt}$ | | $-0.106$ |
| | | (0.088) |
| $\Delta Japan_{jt}$ | | 0.144 |
| | | (0.131) |
| $\Delta Turkey_{jt}$ | | 0.107 |
| | | (0.301) |
| Observations | 2913041 | 2913041 |
| $R^2$ | 0.001 | 0.001 |

Note: Table reports coefficient of an OLS regression using the change in the number of products exported by firm $f$ to destination $j$ in year $t$ as dependent variable. Estimations include year fixed effects. Standard errors clustered at the destination level are in parentheses. a, b, c statistically significant at 1%, 5%, and 10% respectively.

variable, a raise in competition from China is associated with an increase in the number of exported products (Column(1)). However, the coefficient is not precisely estimated. When we introduce the change in the market share of the rest of competitors, the impact of Chinese competition on product scope declines and remains not significant. Except for Italy and Belgium, the coefficients for the rest of the competitors are not precisely estimated. Hence, Spanish firms do not change their product scope due to Chinese competition. To sum up, except for the risk of terminating the export of a good to a given market, we do not find that an increase in competition from China has a particularly damaging effect on Spanish exporters.

Until now, we assumed that Chinese competition affects all firms and goods in a similar way. We therefore neglected potential differences in the susceptibility of products and firms to foreign competition. Low-tech goods such as apparel may be easier to copy by competitors, whereas producers of high-tech products may be shielded from foreign competition.[17] At the same time, the lack of effective intellectual property rights (IPR) protection in China may make Chinese competition potentially more damaging for Spanish exporters of high-tech products. We expand Equation (4) by introducing interaction terms between each competitor share and a dummy variable, denoted $high-tech_k$, which takes the value of one if product $k$ is high-tech.[18]

Table 3 presents the results. For all competitors except Turkey, the impact of increasing competition on export revenue is significantly lower for high-tech products (Column (2)). Interestingly, the protection offered by specializing on high-tech goods is weakest against competition from China (0.101 is the smallest of the interaction terms). However, this effect is of a similar magnitude as the interaction term of the Netherlands, a country with a high level of IPR protection. There are no significant differences except for the UK in the impact of competition on prices between low-tech and high-tech products (Column (4)). Chinese competition raises the probability that a firm ceases to export to a given market. The coefficient for high-tech products is not precisely estimated (Column (6)). A significant baseline effect but nonsignificant interaction term is also the case for France and Italy. For the rest of countries except for Turkey and the USA, the increase of competition has a lower impact on the probability of leaving the market if the firm exports a high-tech product. We confirm the results from our main analysis that Chinese competition has a larger effect on the probability of exit from an export market. Producing high-tech products can somewhat shield firms' revenues from foreign competition, but it does not lead to a consistent significant reduction of a firm's probability of exit from an export market with a particular good. In any case, the size of this effect is economically small when compared with the average unconditional exit rate of 25%. To sum up, for a similar increase in competition, China does not stand out as particularly damaging even when we distinguish between firms exporting high-tech and low-tech products.

A potential reason for these muted effects of Chinese competition on firms may be that

[17] More generally, consumer goods may be affected differently by Chinese competition than intermediate and capital goods. We present a subsample analysis for these different types of goods in Section D of the Online Appendix.

[18] We follow Eurostat's classification to identify high-tech products. High-tech products are pharmaceuticals, computers, electronic and optical products, as well as air and spacecraft and related machinery. This classification only applies to manufactures and is available at http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-tech_classification_of_manufacturing_industries. In our sample, 5.86% of observations cover high-tech products.

**Table 3:** Impact of competition on high-tech vs. low-tech products

| | Revenue | | Price | | Exit | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\Delta China_{jkt}$ | $-0.228^a$ | $-0.430^a$ | 0.004 | 0.002 | $0.072^a$ | $0.084^a$ |
| | (0.011) | (0.012) | (0.007) | (0.008) | (0.006) | (0.006) |
| $\Delta China_{jkt} \times high-tech_k$ | 0.020 | $0.101^b$ | 0.021 | 0.018 | $0.047^b$ | 0.028 |
| | (0.045) | (0.048) | (0.033) | (0.034) | (0.020) | (0.021) |
| $\Delta Germany_{jkt}$ | | $-0.484^a$ | | $-0.007$ | | $0.029^a$ |
| | | (0.013) | | (0.009) | | (0.005) |
| $\Delta Germany_{jkt} \times high-tech_k$ | | $0.224^a$ | | 0.015 | | $-0.034^b$ |
| | | (0.046) | | (0.037) | | (0.017) |
| $\Delta Italy_{jkt}$ | | $-0.466^a$ | | $-0.009$ | | $0.035^a$ |
| | | (0.014) | | (0.009) | | (0.006) |
| $\Delta Italy_{jkt} \times high-tech_k$ | | $0.216^a$ | | $-0.045$ | | 0.009 |
| | | (0.071) | | (0.058) | | (0.026) |
| $\Delta France_{jkt}$ | | $-0.501^a$ | | 0.006 | | $0.023^a$ |
| | | (0.016) | | (0.010) | | (0.007) |
| $\Delta France_{jkt} \times high-tech_k$ | | $0.176^a$ | | $-0.030$ | | $-0.009$ |
| | | (0.057) | | (0.045) | | (0.021) |
| $\Delta USA_{jkt}$ | | $-0.477^a$ | | $-0.003$ | | 0.008 |
| | | (0.016) | | (0.011) | | (0.006) |
| $\Delta USA_{jkt} \times high-tech_k$ | | $0.294^a$ | | 0.012 | | $-0.022$ |
| | | (0.044) | | (0.035) | | (0.016) |
| $\Delta Netherlands_{jkt}$ | | $-0.419^a$ | | $-0.011$ | | $0.030^a$ |
| | | (0.021) | | (0.013) | | (0.008) |
| $\Delta Netherlands_{jkt} \times high-tech_k$ | | $0.134^b$ | | $-0.058$ | | $-0.070^b$ |
| | | (0.065) | | (0.057) | | (0.028) |
| $\Delta Belgium_{jkt}$ | | $-0.457^a$ | | 0.014 | | $0.028^a$ |
| | | (0.020) | | (0.013) | | (0.008) |
| $\Delta Belgium_{jkt} \times high-tech_k$ | | $0.207^a$ | | $-0.045$ | | $-0.079^a$ |
| | | (0.076) | | (0.060) | | (0.028) |
| $\Delta UK_{jkt}$ | | $-0.496^a$ | | $-0.025^b$ | | $0.047^a$ |
| | | (0.020) | | (0.013) | | (0.008) |
| $\Delta UK_{jkt} \times high-tech_k$ | | $0.172^a$ | | $0.082^c$ | | $-0.075^a$ |
| | | (0.063) | | (0.047) | | (0.024) |
| $\Delta Japan_{jkt}$ | | $-0.503^a$ | | $-0.016$ | | $0.019^c$ |
| | | (0.027) | | (0.020) | | (0.011) |
| $\Delta Japan_{jkt} \times high-tech_k$ | | $0.177^b$ | | $-0.034$ | | $-0.123^a$ |
| | | (0.083) | | (0.067) | | (0.031) |
| $\Delta Turkey_{jkt}$ | | $-0.447^a$ | | 0.000 | | $0.064^a$ |
| | | (0.025) | | (0.015) | | (0.011) |
| $\Delta Turkey_{jkt} \times high-tech_k$ | | 0.248 | | $-0.113$ | | $-0.196$ |
| | | (0.299) | | (0.245) | | (0.124) |
| Observations | 4133322 | 4133322 | 4125394 | 4125394 | 3907546 | 3907546 |
| $R^2$ | 0.003 | 0.004 | 0.000 | 0.000 | 0.002 | 0.002 |

Note: Table reports coefficients of Equation (4) estimated by OLS augmented by interaction terms between the competition measures and $high - tech_k$, a dummy variable indicating high-tech products. Standard errors clustered at the product×destination level are in parentheses. a, b, c statistically significant at 1%, 5%, and 10% respectively.

we assume the same effect of competition on all firms, independent of a firm's productivity level. While our specification in first differences removes the effect of firm productivity on the dependent variable, it assumes that the effect of competition is the same for all firms regardless of their productivity level. In a standard Melitz (2003) model, when trade costs fall, firms with low productivity shrink while firms with high productivity expand. This heterogeneous effect may be masked by our regressions, explaining the null result. We therefore allow the effect of competition to vary with the level of a firm's productivity. We merge the Customs database with the SABI database from Bureau Van Dijk using the correspondence explained in de Lucio et al. (2018). SABI provides financial and accounting records of firms that deposited their accounts in the Spanish Business Register. The merged sample covers around 44% of Spanish manufacturing exports. We calculate Total Factor Productivity (TFP) using Levinsohn and Petrin's (2003) methodology.[19] We create a dummy variable, $high - TFP_{ft}$, that takes the value of one if the TFP of firm $f$ is above the median in its sector in year $t$. We expand Equation (4) by introducing interaction terms between the change in each competitor's share and $high - TFP_{ft}$.

Table 4 presents the results. As expected, the negative impact of Chinese competition on revenues is smaller for firms with high productivity. However, this attenuating effect is small: an increase in Chinese competition by ten percentage points decreases revenue by 5.2% for firms with productivity below the median, and by 4.4% (-0.522+0.080 = -0.442) for firms with productivity above the median. For the rest of competitors the interaction coefficient is either negative, not significant, or both. The impact of Chinese competition on prices is lower for firms with high productivity. This is similar, in both magnitude and significance, to the effect of competition from Germany. We do not find that the probability of ceasing to export a good to a destination is lower for high-TFP firms. Table F.1 in the Online Appendix reports the results for firms' product scope. Competition from China reduces the scope of products in low-TFP firms, and increases it in high-TFP firms. It is noteworthy that firms with high productivity are only shielded from competition from China but not from competition from other countries, except for Belgium.

[19] We estimate a separate production function for each 4-digit NACE rev 2 industry using all firms with complete information about output, materials, tangible assets and employment. Output is deflated using 4-digit NACE rev 2 industrial prices. Materials and tangible assets are deflated using 2-digit NACE rev 2 input and capital prices, respectively. We use the Stata routine `levpet` to estimate the production coefficients using intermediate inputs (materials) to proxy unobservable productivity shocks.

**Table 4:** Impact of competition on high-TFP vs. low-TFP firms

| | Revenue | | Price | | Exit | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\Delta China_{jkt}$ | $-0.314^{a}$ | $-0.522^{a}$ | 0.027 | 0.024 | $0.090^{a}$ | $0.100^{a}$ |
| | (0.027) | (0.029) | (0.017) | (0.018) | (0.012) | (0.012) |
| $\Delta China_{jkt} \times high-TFP_{ft}$ | $0.097^{a}$ | $0.080^{b}$ | $-0.037^{c}$ | $-0.037^{c}$ | −0.006 | −0.005 |
| | (0.034) | (0.036) | (0.022) | (0.023) | (0.013) | (0.014) |
| $\Delta Germany_{jkt}$ | | $-0.532^{a}$ | | 0.021 | | $0.029^{a}$ |
| | | (0.028) | | (0.019) | | (0.010) |
| $\Delta Germany_{jkt} \times high-TFP_{ft}$ | | 0.051 | | $-0.052^{b}$ | | −0.011 |
| | | (0.036) | | (0.024) | | (0.013) |
| $\Delta Italy_{jkt}$ | | $-0.493^{a}$ | | $-0.048^{b}$ | | $0.033^{a}$ |
| | | (0.030) | | (0.021) | | (0.011) |
| $\Delta Italy_{jkt} \times high-TFP_{ft}$ | | −0.022 | | $0.058^{b}$ | | 0.006 |
| | | (0.039) | | (0.026) | | (0.014) |
| $\Delta France_{jkt}$ | | $-0.488^{a}$ | | 0.004 | | $0.023^{c}$ |
| | | (0.034) | | (0.021) | | (0.013) |
| $\Delta France_{jkt} \times high-TFP_{ft}$ | | −0.050 | | −0.001 | | −0.004 |
| | | (0.043) | | (0.027) | | (0.016) |
| $\Delta USA_{jkt}$ | | $-0.440^{a}$ | | −0.015 | | 0.006 |
| | | (0.031) | | (0.021) | | (0.012) |
| $\Delta USA_{jkt} \times high-TFP_{ft}$ | | −0.050 | | 0.025 | | −0.008 |
| | | (0.040) | | (0.028) | | (0.015) |
| $\Delta Netherlands_{jkt}$ | | $-0.367^{a}$ | | 0.035 | | 0.012 |
| | | (0.044) | | (0.031) | | (0.017) |
| $\Delta Netherlands_{jkt} \times high-TFP_{ft}$ | | $-0.095^{c}$ | | −0.041 | | 0.022 |
| | | (0.057) | | (0.038) | | (0.021) |
| $\Delta Belgium_{jkt}$ | | $-0.450^{a}$ | | 0.030 | | 0.002 |
| | | (0.044) | | (0.026) | | (0.016) |
| $\Delta Belgium_{jkt} \times high-TFP_{ft}$ | | −0.052 | | −0.050 | | 0.025 |
| | | (0.056) | | (0.033) | | (0.021) |
| $\Delta UK_{jkt}$ | | $-0.473^{a}$ | | −0.010 | | 0.023 |
| | | (0.043) | | (0.027) | | (0.016) |
| $\Delta UK_{jkt} \times high-TFP_{ft}$ | | $-0.120^{b}$ | | −0.025 | | $0.034^{c}$ |
| | | (0.054) | | (0.035) | | (0.020) |
| $\Delta Japan_{jkt}$ | | $-0.502^{a}$ | | 0.003 | | 0.012 |
| | | (0.061) | | (0.051) | | (0.021) |
| $\Delta Japan_{jkt} \times high-TFP_{ft}$ | | −0.073 | | −0.035 | | 0.013 |
| | | (0.076) | | (0.059) | | (0.026) |
| $\Delta Turkey_{jkt}$ | | $-0.479^{a}$ | | −0.029 | | $0.069^{a}$ |
| | | (0.058) | | (0.034) | | (0.024) |
| $\Delta Turkey_{jkt} \times high-TFP_{ft}$ | | −0.030 | | 0.007 | | −0.029 |
| | | (0.073) | | (0.041) | | (0.028) |
| Observations | 1659302 | 1659302 | 1657626 | 1657626 | 1659302 | 1659302 |
| $R^2$ | 0.004 | 0.005 | 0.000 | 0.000 | 0.002 | 0.002 |

Note: Table reports coefficients of Equation (4) estimated by OLS augmented by interaction terms between the competition measures and $high-TFP_{ft}$, a dummy variable indicating firms with productivity above the median within their industry. Standard errors clustered at the product×destination level are in parentheses. a, b, c statistically significant at 1%, 5%, and 10% respectively.

# 4 Robustness analyses

*4.1 Instrumental variables*

Up to now, we have considered the competitive pressure exerted by Spanish competitors to be exogenous to Spanish firms' sales. However, a concern with our estimates is that an omitted variable may jointly determine the evolution of Spanish firms' exports and rival countries' competitive pressure in a destination.[20] For example, if Colombia reduces tariffs on certain European Union products, Colombia's demand and hence import share from Spain's EU competitors and Spanish exporters' revenues would likely increase at the same time. This would bias the absolute value of our coefficient estimates of competitive pressure from EU countries downwards. Hence, our estimates would present an overly optimistic view of the impact of competition on Spanish exporters. To address this concern, and to make our results comparable to the instrumental variable approach chosen by Autor et al. (2013) and Iacovone et al. (2013), we instrument countries' competitive pressures with their import share in other export markets. Specifically, we construct the instrument as follows:

$$\Delta IVCompetitor^{C}_{jkt} = \frac{\sum_{j'=1}^{5} \Delta Competitor^{C}_{j'kt}}{5} \tag{5}$$

where $j'$ is a destination located in the same geographic zone as destination $j$.[21] The five countries used to calculate the instrument are selected at random.[22] As in Autor et al. (2013) and Iacovone et al. (2013), the instrument captures the exogenous, supply-driven changes in the share of competitors by removing all demand-driven factors that simultaneously affect Spanish exporters and their competitors.

Table 5 reports the results of estimating Equation (4) using 2SLS. At the bottom of the table, we report the Kleibergen-Paap Wald F statistic for weak instruments. Note that this statistic is the same for all odd and even columns, because each column-set uses the same instruments in the first-stage specification. We follow the suggestion in Baum et al. (2007) and compare the statistics with Stock and Yogo's (2005) critical values for independent and identically distributed errors. For Columns (1), (3), and (5) the Stock-Yogo statistic for one endogenous variable ($\Delta China_{jkt}$) for a bias of the IV estimator, relative to the OLS bias, of 10%, and a nominal 5% test is 9.08. For Columns (2), (4), and (6) the Stock-Yogo statistic for three endogenous variables (the maximum reported in the Table) is 9.64. In both cases, the F-statistic is above the threshold, so we can

[20] A similar argument has been made by Hummels et al. (2014) and Mayer et al. (2016).

[21] We consider six geographic zones: Asia, Europe, North Africa, North America, Rest of Africa, Rest of America, and Oceania.

[22] As a robustness check, we randomly selected five destinations from a different zone. The instruments were weaker than those built with Equation (5). Still, the main conclusions of our analysis were not altered when using the alternative instruments.

**Table 5:** Instrumental variables: the impact of competition on exporters

| | Revenue | | Price | | Exit | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\Delta China_{jkt}$ | $-0.383^{a}$ | $-0.714^{a}$ | 0.065 | $-0.015$ | $0.811^{a}$ | $0.585^{a}$ |
| | (0.132) | (0.173) | (0.079) | (0.102) | (0.075) | (0.088) |
| $\Delta Germany_{jkt}$ | | $-1.996^{a}$ | | $-0.244$ | | $-0.258^{b}$ |
| | | (0.306) | | (0.201) | | (0.130) |
| $\Delta Italy_{jkt}$ | | $-0.041$ | | $-0.381$ | | $-0.402^{b}$ |
| | | (0.438) | | (0.292) | | (0.191) |
| $\Delta France_{jkt}$ | | $-0.858^{b}$ | | $-0.389$ | | $-0.729^{a}$ |
| | | (0.402) | | (0.244) | | (0.180) |
| $\Delta USA_{jkt}$ | | $-1.382^{a}$ | | $-0.013$ | | $-1.219^{a}$ |
| | | (0.394) | | (0.261) | | (0.195) |
| $\Delta Netherlands_{jkt}$ | | $-1.141^{c}$ | | 0.510 | | $-0.052$ |
| | | (0.661) | | (0.388) | | (0.287) |
| $\Delta Belgium_{jkt}$ | | $-1.110^{b}$ | | 0.354 | | $-0.500^{b}$ |
| | | (0.523) | | (0.321) | | (0.214) |
| $\Delta UK_{jkt}$ | | $-2.561^{a}$ | | 0.043 | | 0.037 |
| | | (0.787) | | (0.501) | | (0.330) |
| $\Delta Japan_{jkt}$ | | $-1.288^{b}$ | | $-0.410$ | | $-1.794^{a}$ |
| | | (0.638) | | (0.405) | | (0.298) |
| $\Delta Turkey_{jkt}$ | | 0.079 | | $-0.344$ | | $0.915^{a}$ |
| | | (0.694) | | (0.358) | | (0.302) |
| Weak iden. stat. | 1199 | 14 | 1199 | 14 | 1199 | 14 |
| Observations | 4493391 | 4493391 | 4484807 | 4484807 | 4250660 | 4250660 |

Note: Table reports coefficients of estimating Equation (4) by 2SLS using the instruments defined in Equation (5) for the endogenous competition measures. The weak identification statistic corresponds to the Kleibergen-Paap Wald F statistic. Standard errors clustered at the product×destination level are in parentheses. a, b, c statistically significant at 1%, 5%, and 10% respectively.

reject the weak instruments null hypothesis.

Regarding export revenues, as expected, most coefficients have a larger negative value than those reported in Table 1. We do no longer find a statistically significant effect for Italy and Turkey. While Chinese competition has a negative effect on export revenues, its effect is smaller than that of most other competitors. Regarding prices, we find that for all countries the competitive pressure coefficients are not statistically significant. Greater competition from China heightens the risk of terminating an export relation.

However, the impact of more Turkish competition is larger than the impact of more Chinese competition. Contrary to our expectations, we find that tougher competition from Germany, Italy, France, the USA, Belgium, and Japan significantly lowers the risk that a firm ceases to export a good to a destination.

Columns (1) and (2) in Table F.2 in the Online Appendix report IV estimates for the scope of exported products. Now instruments are the average share in five randomly selected destinations' total imports, analogous to the definition of the instruments at the product-level defined in Equation (5) for the endogenous competition measures. The Kleibergen-Paap Wald F statistic is close to zero, indicating that the instruments are weak. Therefore, the reported standard errors cannot be used for inference. Following Andrews et al. (2018), we calculate weak instruments robust confidence intervals.[23] All confidence intervals (not reported) contain the value zero. Therefore, the data suggests that Chinese competition does not have a special effect on firms' product scope in a given export market for a given increase in competition.

In sum, the instrumental variables analysis changes the magnitude of the coefficients and, in some cases, their signs. Qualitatively, however, except for the risk that a firm ceases to export a good to a destination, we still find that tougher competition from China does not have a more damaging effect on Spanish exporters than an equally-sized increase in competition from other countries.

### *4.2 Different time periods and long run changes in competitive pressure*

Next we analyze whether any changes have occurred in the differential impact of Chinese competition over time. We divide our period in two ten-year intervals, 1997-2007 and 2008-2017, and run separate regressions for each performance measure and interval. Table 6 reports the results. Regarding export revenues, all competitive pressure coefficients reduce their negative values in the second period, and the coefficients become more similar in magnitude.[24] Regarding prices, all coefficients are not statistically significant in both periods. The impact of Chinese competition on the probability of terminating an export relation reduces considerably between the first and second interval. Moreover, competition from Turkey has a larger negative impact on the survival of Spanish export relations in the latter period. Regarding the number of exported products, competition from China has a positive impact on the number of products in the early period, but a coefficient close to zero in the latter (Columns (3) and (4) of Table F.2 in the Online Appendix). In sum, the subsample analysis shows that the impact of competition declines and becomes more similar across competitors.

[23] We use the `weakiv` command in Stata by Finlay et al. (2013).

[24] The average value of the coefficient declines, in absolute terms, from -0.53 to -0.41, and the standard deviation drops from 0.04 to 0.02.

**Table 6:** The impact of competition on exporters: before and after 2007

| | Revenue | | Price | | Exit | |
|---|---|---|---|---|---|---|
| | (1) <=2007 | (2) >2007 | (3) <=2007 | (4) >2007 | (5) <=2007 | (6) >2007 |
| $\Delta China_{jkt}$ | $-0.450^a$ | $-0.405^a$ | $-0.009$ | 0.008 | $0.120^a$ | $0.073^a$ |
| | (0.020) | (0.014) | (0.013) | (0.009) | (0.009) | (0.007) |
| $\Delta Germany_{jkt}$ | $-0.567^a$ | $-0.411^a$ | $-0.005$ | $-0.003$ | $0.037^a$ | $0.018^a$ |
| | (0.019) | (0.016) | (0.012) | (0.012) | (0.007) | (0.007) |
| $\Delta Italy_{jkt}$ | $-0.517^a$ | $-0.436^a$ | $-0.018$ | $-0.001$ | $0.031^a$ | $0.039^a$ |
| | (0.020) | (0.019) | (0.013) | (0.013) | (0.007) | (0.008) |
| $\Delta France_{jkt}$ | $-0.577^a$ | $-0.419^a$ | $-0.009$ | 0.007 | $0.031^a$ | 0.015 |
| | (0.023) | (0.021) | (0.013) | (0.013) | (0.008) | (0.009) |
| $\Delta USA_{jkt}$ | $-0.496^a$ | $-0.413^a$ | 0.016 | $-0.011$ | $-0.009$ | $0.028^a$ |
| | (0.020) | (0.019) | (0.014) | (0.014) | (0.008) | (0.008) |
| $\Delta Netherlands_{jkt}$ | $-0.507^a$ | $-0.368^a$ | $-0.030$ | 0.003 | 0.018 | $0.038^a$ |
| | (0.029) | (0.025) | (0.018) | (0.018) | (0.011) | (0.010) |
| $\Delta Belgium_{jkt}$ | $-0.516^a$ | $-0.389^a$ | 0.017 | $-0.005$ | $0.025^b$ | $0.023^b$ |
| | (0.028) | (0.026) | (0.017) | (0.017) | (0.011) | (0.011) |
| $\Delta UK_{jkt}$ | $-0.543^a$ | $-0.448^a$ | $-0.007$ | $-0.027$ | $0.048^a$ | $0.022^b$ |
| | (0.025) | (0.027) | (0.016) | (0.019) | (0.009) | (0.011) |
| $\Delta Japan_{jkt}$ | $-0.558^a$ | $-0.438^a$ | $-0.011$ | $-0.034$ | $-0.001$ | 0.016 |
| | (0.035) | (0.038) | (0.025) | (0.030) | (0.013) | (0.018) |
| $\Delta Turkey_{jkt}$ | $-0.587^a$ | $-0.387^a$ | $-0.012$ | 0.016 | $0.057^a$ | $0.086^a$ |
| | (0.040) | (0.032) | (0.021) | (0.018) | (0.016) | (0.015) |
| Observations | 2042362 | 2528642 | 2034036 | 2528384 | 2042362 | 2280272 |
| $R^2$ | 0.003 | 0.004 | 0.001 | 0.000 | 0.001 | 0.001 |

Note: The estimations include year fixed effects. Standard errors clustered at the product×destination level are in parentheses. a, b, c statistically significant at 1%, 5% and 10% respectively.

It may be that using year-to-year changes is not enough time to identify the impact of Chinese competition on exporters, as firm export behavior at the destination×product level can be quite noisy. We therefore reestimate Equation (4) for longer time intervals of five and ten years. For the five-year lag analysis, we calculate growth rates between 2002-1997, 2007-2002, 2012-2007, and 2017-2012. For the ten-year lag analysis, we calculate growth rates between 2007-1997, and 2017-2007. Results are reported in Table 7. The longer time intervals lead to a very large reduction in the sample and yield on average, as expected, larger coefficients in absolute terms. While a ten percentage point increase in

**Table 7:** Robustness: 5 and 10-year intervals

| | Revenue | | Price | | Exit | |
|---|---|---|---|---|---|---|
| | (1) 5 years | (2) 10 years | (3) 5 years | (4) 10 years | (5) 5 years | (6) 10 years |
| $\Delta China_{jkt}$ | $-0.626^a$ | $-0.892^a$ | 0.014 | 0.042 | $0.169^a$ | $0.198^a$ |
| | (0.036) | (0.053) | (0.017) | (0.027) | (0.014) | (0.026) |
| $\Delta Germany_{jkt}$ | $-0.652^a$ | $-0.712^a$ | 0.029 | 0.039 | $0.042^a$ | 0.013 |
| | (0.033) | (0.063) | (0.020) | (0.033) | (0.012) | (0.025) |
| $\Delta Italy_{jkt}$ | $-0.552^a$ | $-0.643^a$ | $-0.033^c$ | 0.013 | $-0.037^a$ | $-0.102^a$ |
| | (0.037) | (0.066) | (0.019) | (0.031) | (0.013) | (0.028) |
| $\Delta France_{jkt}$ | $-0.521^a$ | $-0.730^a$ | 0.020 | $0.076^c$ | $0.065^a$ | $0.113^a$ |
| | (0.040) | (0.072) | (0.022) | (0.040) | (0.014) | (0.029) |
| $\Delta USA_{jkt}$ | $-0.615^a$ | $-0.786^a$ | 0.031 | $0.078^c$ | 0.001 | 0.057 |
| | (0.042) | (0.074) | (0.023) | (0.040) | (0.019) | (0.049) |
| $\Delta Netherlands_{jkt}$ | $-0.481^a$ | $-0.923^a$ | 0.002 | 0.016 | −0.001 | $0.092^b$ |
| | (0.052) | (0.095) | (0.027) | (0.052) | (0.019) | (0.037) |
| $\Delta Belgium_{jkt}$ | $-0.604^a$ | $-0.634^a$ | 0.024 | −0.009 | 0.016 | −0.014 |
| | (0.052) | (0.101) | (0.029) | (0.047) | (0.018) | (0.036) |
| $\Delta UK_{jkt}$ | $-0.733^a$ | $-1.005^a$ | 0.004 | $0.108^b$ | $0.035^c$ | $0.113^a$ |
| | (0.051) | (0.095) | (0.029) | (0.047) | (0.018) | (0.037) |
| $\Delta Japan_{jkt}$ | $-0.620^a$ | $-0.695^a$ | −0.032 | −0.050 | −0.023 | 0.004 |
| | (0.070) | (0.124) | (0.042) | (0.067) | (0.022) | (0.041) |
| $\Delta Turkey_{jkt}$ | $-0.624^a$ | $-0.941^a$ | −0.001 | −0.037 | $0.132^a$ | $0.267^a$ |
| | (0.076) | (0.130) | (0.030) | (0.055) | (0.027) | (0.052) |
| Observations | 474955 | 134601 | 473162 | 133621 | 356264 | 63711 |
| $R^2$ | 0.006 | 0.007 | 0.000 | 0.001 | 0.005 | 0.004 |

Note: Table reports coefficients of Equation (4) estimated by OLS. Table reports coefficients of Equation (4) estimated by OLS. Standard errors clustered at the product×destination level are in parentheses. a, b, c statistically significant at 1%, 5%, and 10% respectively.

Chinese competition leads to a 4.3% reduction in export revenues for a one-year interval (Column 2 in Table 1), the reduction increases to 6.3% for a five-year interval and to 8.9% for a ten-year interval. The overall conclusion of our baseline analysis is not altered: an increase in competition from China does not have a differential impact on Spanish exporters' revenues, prices, or product scope compared to a similar increase in competition from other countries, but leads to a higher probability that firms stop serving a market with a particular product.

*4.3 Sample selection bias*

Our results on the effect of Chinese competition on revenues, prices, and product scope may be biased because we only observe firms which export a good to a particular destination in both $t$ and $t-1$. In heterogeneous firm models trade liberalization can lead firms to exit a market. In a standard Melitz model, this selection is determined by the time-invariant productivity of the firm. To formalize the selection bias discussion, it is useful to define $s_{fjkt}$, a selection indicator which is 1 if we observe the export relation $fjk$ in year $t$ in our data and zero otherwise. Since our specification in first differences removes the product-specific firm-destination fixed effects, our results are robust to any time-invariant drivers of firm exit from the sample. Firms may also be driven out of the sample by a sufficiently large increase in our competition measures during the sample period. If the change in our observable competition measures was the only determinant of selection into our sample, the probability of observing an export relation would only depend on observables, i.e., $P(s_{fjkt} = 1|\mathbf{\Delta Competitor_{jkt}}, \Delta\epsilon_{fjkt}) = P(s_{fjkt} = 1|\mathbf{\Delta Competitor_{jkt}})$, where we use $\mathbf{\Delta Competitor_{jkt}}$ as a shorthand for our competition measures for all competitors, including China. Under this selection on observables, our regressions presented so far would deliver consistent estimates. However, unobserved time-varying shocks to revenues and prices at the firm level, i.e., $\Delta\epsilon_{fjkt}$ from Equation (4), such as firm-specific liquidity or credit shocks, may also drive firm exit. This selection on unobservables may vary over time, particularly given that our sample includes the financial and public debt crisis.[25] We follow Nijman and Verbeek (1992) and test for the presence of attrition bias by including $s_{fjkt+1}$ as an additional regressor in Equation (4). In these unreported regressions, the estimated coefficient is significantly different from zero, indicating attrition bias in our sample. We therefore must control for the time-varying probability that an export relation existing in year $t-1$ continues to be observed in the next year $t$. We model these probabilities by a system of selection equations, one for every year in our sample, beginning in the second year:

$$P(s_{fjkt} = 1|s_{fjkt-1} = 1) = \Phi(\boldsymbol{\delta}_t'\mathbf{w}_{fjkt}) \quad \text{for } t = 2, \dots, T. \tag{6}$$

As is standard in selection models, Equation (6) implies that selection into our sample is determined by a linear combination of observable variables $\boldsymbol{\delta}_t'\mathbf{w}_{fjkt}$ and an unobservable error term $\nu_{fjkt}$ which is standard-normally distributed. Equivalently, our selection indicator depends on an unobserved latent variable $\boldsymbol{\delta}_t'\mathbf{w}_{fjkt} + \nu_{fjkt}$ such that $s_{fjkt} = \mathbb{1}(\boldsymbol{\delta}_t'\mathbf{w}_{fjkt} + \nu_{fjkt} > 0)$, where $\mathbb{1}(\cdot)$ denotes the indicator function. We assume a linear form for the relation between the errors in the selection and the outcome equation, i.e. $E(\Delta\epsilon_{fjkt}|\nu_{fjkt}, s_{fjkt-1} = 1) = \rho_t\nu_{fjkt}$. A particular feature of the attrition bias

[25] For a lucid discussion of attrition bias as well as potential remedies, see chapter 19.9.3 in Wooldridge (2010).

in our case is that we observe potential drivers of firm exit (our competition measures $\mathbf{\Delta Competitor_{jkt}}$) even for those firms which drop out of the sample.[26] We therefore can include them in $\mathbf{w}_{fjkt}$. We also need an instrument to fulfill the exclusion restriction of our selection model. An instrument must not be correlated with $\Delta\epsilon_{fjkt}$, as any correlation with the error term in the outcome equation ($\rho_t \neq 0$) implies correlation with the error term in the selection equation, $\nu_{fjkt}$. Firms with a history of lower revenues may have liquidity problems as they may not be able to finance expenses via internal financing. These firms may need to seek outside finance, and are hence more exposed to credit shocks. When credit dries up, these firms may not be able to finance an unexpected liquidity shortage and hence have a higher probability of leaving our sample. This implies lagged levels of total firm export revenues as natural instruments. As $\ln x_{fjkt-1}$ (and hence total export revenues $\ln x_{ft-1}$) is correlated with $\Delta\epsilon_{fjkt}$ by construction, we use $\ln x_{ft-2}$, as it is uncorrelated with $\Delta\epsilon_{fjkt}$. We therefore specify the system of selection probabilities as

$$P(s_{fjkt} = 1 | s_{fjkt-1} = 1) = \Phi\left(\sum_{C \in \mathfrak{C}} \zeta_t^C \Delta Competitor_{jkt}^C + \xi_t \ln x_{ft-2}\right) \quad \text{for } t = 2, \ldots, T. \tag{7}$$

After estimating the selection probabilities as separate probit models for each $t$, we can estimate the outcome equation of our selection model by:

$$\Delta \ln x_{fjkt} = \alpha \Delta China_{jkt} + \sum_{C \in \mathfrak{C}} \beta_C \Delta Competitor_{jkt}^C + \sum_{t=2}^{T} \rho_t dT_t \lambda_{fjkt} + \Delta\gamma_t + \Delta\epsilon_{fjkt}, \tag{8}$$

which is our outcome equation augmented by the inverse Mill's ratios $\lambda_{fjkt}$ from the system of selection equations in (6), interacted with their respective period time dummies, $dT_t$.

Table 8 presents the results for revenues and prices. Point estimates are similar to those reported in Table 1. Importantly, we do not find evidence that an increase in Chinese competition has a different effect than an equally-sized increase in competition from other countries. Similar results hold for the impact of foreign competition on firms' product scope within export destinations when comparing Table 2 and Table F.3 in the Online Appendix.

While our selection model takes into account the endogenous firm exit, it assumes that our competition measures are exogenous. As explained in Section 4.1, our coefficients may still suffer from endogeneity bias as there may be unobserved factors which jointly determine demand faced by both Spanish firms and their competitors from other countries

[26] This is different from the textbook example of selection models of endogenous labor supply where wage offers for non-working individuals are not observed.

**Table 8:** Robustness. Selection in revenue and price regressions

| | Revenue | Price |
|---|---|---|
| $\Delta China_{jkt}$ | $-0.430^a$ | 0.002 |
| | (0.014) | (0.009) |
| $\Delta Germany_{jkt}$ | $-0.482^a$ | 0.000 |
| | (0.014) | (0.010) |
| $\Delta Italy_{jkt}$ | $-0.480^a$ | $-0.002$ |
| | (0.016) | (0.011) |
| $\Delta France_{jkt}$ | $-0.498^a$ | $-0.009$ |
| | (0.018) | (0.011) |
| $\Delta USA_{jkt}$ | $-0.461^a$ | 0.000 |
| | (0.017) | (0.011) |
| $\Delta Netherlands_{jkt}$ | $-0.435^a$ | $-0.003$ |
| | (0.022) | (0.014) |
| $\Delta Belgium_{jkt}$ | $-0.456^a$ | 0.006 |
| | (0.022) | (0.014) |
| $\Delta UK_{jkt}$ | $-0.514^a$ | $-0.025^c$ |
| | (0.021) | (0.015) |
| $\Delta Japan_{jkt}$ | $-0.495^a$ | $-0.023$ |
| | (0.030) | (0.022) |
| $\Delta Turkey_{jkt}$ | $-0.451^a$ | 0.005 |
| | (0.029) | (0.016) |
| Observations | 3084857 | 3082042 |
| $R^2$ | 0.004 | 0.000 |

Note: Table presents coefficients of Equation (8) estimated by OLS. Inverse Mills ratio×year dummy interaction variables not reported. Standard errors clustered at the product×destination level are in parentheses. a, b, c statistically significant at 1%, 5%, and 10% respectively.

in a given export destination. We therefore reestimate our selection model but instrument the competition measures as in Section 4.1. We present results in Table G.1 in the Online Appendix. Results remain similar: an increase in Chinese competition does not exert a stronger effect than an equally-sized increase in competition from other countries. Comparing column (2) in Table F.2 with Table F.4, we find, qualitatively, similar results for the product scope.[27]

[27]Again, as in Table F.2, the Kleibergen-Paap Wald F statistic indicates that our instruments are weak, and we cannot reject the null hypothesis that all competition measures have no effect on product

Hence controlling for sample selection and endogeneity of the competition measures does not alter our conclusions: The nature of Chinese competition does not stand out from competition from other countries.

## 5 Conclusion

Chinese exports have increased considerably in the last decades. However, it is unclear whether the nature of Chinese competition is particularly damaging. To answer this question, we assess whether an increase in competition from China has a larger negative effect on exporters than a similar increase in competition from other countries using Spanish customs data. We find that the impact of tougher competition from China on export revenues, prices, and exported products is similar to that from other countries. Heightened competition from China only has a larger negative effect on the probability that a firm ceases to export a good to a destination. Furthermore, this differential effect narrows over time and is small relative to the average risk of a firm ceasing to export a good to a destination. We find that the revenue and product scope of firms with high productivity are less affected by Chinese competition. Because they do not take into account competitive pressures from other countries, studies focusing only on competition from China suffer from an omitted variable bias. Overall, we find that while the absolute level of competition from China has increased, its nature is similar to that from other countries.

In the end, this result is not so surprising. China is only the most recent example of a country coming under scrutiny because of its integration into the world economy. This echoes previous concerns in the 1980s and 1990s regarding the rise of countries such as Japan, South Korea, and Mexico. Today, fears about competition from these countries have subsided, and the focus has shifted toward China. While the rise of Chinese exports is indeed unprecedented, our results indicate that the nature of Chinese competition is similar to competition from other countries.

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## Appendix

This Appendix contains summary statistics, regressions introducing the competitors one-by-one, and correlations. Additional robustness checks mentioned in the main text can be found in the Online Appendix which is available on `https://benediktheid.weebly.com/`.

**Table A.1:** Summary statistics

| Variable | Mean | Std. Dev. | Observations |
|---|---|---|---|
| $\Delta \ln x_{fjkt}$ | 0.015 | 1.140 | 4571004 |
| $\Delta \ln p_{fjkt}$ | 0.013 | 0.734 | 4562420 |
| $Exit_{fjkt} \equiv \Delta NoExport_{fjkt}$ | 0.249 | 0.432 | 4322634 |
| $\Delta \ln n_{fjkt}$ | 0.001 | 0.163 | 4571004 |
| $\Delta China_{jkt}$ | 0.005 | 0.057 | 4571004 |
| $\Delta Germany_{jkt}$ | 0.000 | 0.054 | 4571004 |
| $\Delta Italy_{jkt}$ | −0.001 | 0.052 | 4571004 |
| $\Delta France_{jkt}$ | −0.002 | 0.046 | 4571004 |
| $\Delta USA_{jkt}$ | −0.001 | 0.048 | 4571004 |
| $\Delta Netherlands_{jkt}$ | 0.000 | 0.034 | 4571004 |
| $\Delta Belgium_{jkt}$ | 0.000 | 0.033 | 4571004 |
| $\Delta UK_{jkt}$ | −0.001 | 0.035 | 4571004 |
| $\Delta Japan_{jkt}$ | 0.000 | 0.026 | 4571004 |
| $\Delta Turkey_{jkt}$ | 0.001 | 0.026 | 4571004 |

Note: $No\ Export_{fjkt}$ is a dummy variable that is zero when the firm exports and 1 when it stops to export.

**Table A.2:** Export revenues and competition: one-by-one estimations

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\Delta China_{jkt}$ | -0.227$^a$ | | | | | | | | | | -0.429$^a$ |
| | (0.011) | | | | | | | | | | (0.012) |
| $\Delta Germany_{jkt}$ | | -0.250$^a$ | | | | | | | | | -0.483$^a$ |
| | | (0.012) | | | | | | | | | (0.013) |
| $\Delta Italy_{jkt}$ | | | -0.257$^a$ | | | | | | | | -0.475$^a$ |
| | | | (0.013) | | | | | | | | (0.014) |
| $\Delta France_{jkt}$ | | | | -0.283$^a$ | | | | | | | -0.498$^a$ |
| | | | | (0.016) | | | | | | | (0.016) |
| $\Delta USA_{jkt}$ | | | | | -0.213$^a$ | | | | | | -0.453$^a$ |
| | | | | | (0.013) | | | | | | (0.014) |
| $\Delta Netherlands_{jkt}$ | | | | | | -0.204$^a$ | | | | | -0.431$^a$ |
| | | | | | | (0.019) | | | | | (0.019) |
| $\Delta Belgium_{jkt}$ | | | | | | | -0.207$^a$ | | | | -0.449$^a$ |
| | | | | | | | (0.019) | | | | (0.019) |
| $\Delta UK_{jkt}$ | | | | | | | | -0.257$^a$ | | | -0.495$^a$ |
| | | | | | | | | (0.018) | | | (0.018) |
| $\Delta Japan_{jkt}$ | | | | | | | | | -0.235$^a$ | | -0.498$^a$ |
| | | | | | | | | | (0.025) | | (0.025) |
| $\Delta Turkey_{jkt}$ | | | | | | | | | | -0.246$^a$ | -0.469$^a$ |
| | | | | | | | | | | (0.026) | (0.026) |
| Observations | 4571004 | 4571004 | 4571004 | 4571004 | 4571004 | 4571004 | 4571004 | 4571004 | 4571004 | 4571004 | 4571004 |
| $R^2$ | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.004 |

Note: Table reports OLS coefficients. The dependent variable is the difference in (log) export revenues. Standard errors clustered at the product×destination level are in parentheses. a, b, c statistically significant at 1%, 5% and 10% respectively.

**Table A.3:** Correlation between the changes in Spanish exporters competitors' shares

| | China | Germany | Italy | France | USA | Netherlands | Belgium | UK | Japan | Turkey |
|---|---|---|---|---|---|---|---|---|---|---|
| China | 1.0000 | | | | | | | | | |
| Germany | −0.0854 | 1.0000 | | | | | | | | |
| Italy | −0.0948 | −0.0936 | 1.0000 | | | | | | | |
| France | −0.0668 | −0.0777 | −0.0744 | 1.0000 | | | | | | |
| USA | −0.0939 | −0.0990 | −0.0715 | −0.0601 | 1.0000 | | | | | |
| Netherlands | −0.0524 | −0.0625 | −0.0432 | −0.0440 | −0.0442 | 1.0000 | | | | |
| Belgium | −0.0437 | −0.0677 | −0.0491 | −0.0489 | −0.0428 | −0.0412 | 1.0000 | | | |
| UK | −0.0497 | −0.0645 | −0.0451 | −0.0480 | −0.0658 | −0.0394 | −0.0427 | 1.0000 | | |
| Japan | −0.0362 | −0.0642 | −0.0339 | −0.0304 | −0.0683 | −0.0257 | −0.0222 | −0.0281 | 1.0000 | |
| Turkey | −0.0491 | −0.0348 | −0.0535 | −0.0353 | −0.0181 | −0.0200 | −0.0226 | −0.0202 | −0.0060 | 1.0000 |

Note: All correlations are statistically significant at 1%.