Do differences in the exposure to Chinese imports lead to differences in local labour market outcomes? An analysis for Spanish provinces

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Abstract

In the period 1999-2007 Spanish imports from China multiplied by six, making that Asian country the fourth largest supplier to the Spanish economy. In this paper, we analyse whether this massive increase in imports impacted on the labour markets of Spanish provinces to differing degrees, due to differences in their initial productive specialization. Our results show that Spanish provinces with a higher exposure to Chinese imports experienced larger drops in manufacturing employment as a share of the working-age population. However, this reduction was compensated for by increases in non-manufacturing employment.

Resumen

En el periodo 1999-2007 las importaciones españolas de China se multiplicaron por seis, convirtiendo al país asiático en el cuarto mayor proveedor de la economía española. En este trabajo analizamos si el enorme aumento de las importaciones chinas tuvo un impacto diferente sobre el mercado laboral de las provincias españolas debido a su especialización productiva. Nuestros resultados muestran que las provincias españolas con una mayor exposición a las importaciones chinas tuvieron mayores caídas en el empleo manufacturero como porcentaje de la población en edad de trabajar. Sin embargo, esta caída se compensó con un aumento del empleo no manufacturero.

Keywords: imports, China, Spain, employment, manufactures, provinces.

JEL Classification: F16, J23

1. Introduction

The emergence of China as a major trader is one of the most salient features of the current globalization process. In the period 1999-2007, the share of Chinese exports in total world merchandise exports multiplied by a factor of 2.6 (from 3.4% to 8.7%). Export growth was particularly intense for manufactures, where the share increased from 4% to 12%.[1] Spain has not been alien to this process. During the period 1999-2007, China's share in Spanish imports rose from 2.6% to 6.5%, and at the end of the period, China was Spain's fourth most important supplier, behind Germany, France and Italy. In the case of manufactures, the share of Chinese imports grew from 2.9% to 7.7%.

Since the early 1990s, scholars have been pointing out that imports from developing countries in general, and from China in particular, might have disruptive effects on developed countries' labour markets (Wood, 1994). Due to a higher relative endowment in unskilled labour, developing countries have a comparative advantage in unskilled-labour-intensive goods. Moreover, the fragmentation of production processes allows these countries to specialise in certain stages of production, such as assembly tasks, which make intensive use of unskilled-labour (Grossman and Rossi-Hansberg, 2007). Due to their lower costs, imports from developing countries might lead to a drop in the production of unskilled-labour-intensive manufactures, or manufacturing stages, in developed countries, reducing the demand for unskilled labour in those countries.

During the 1990s, with a few exceptions (Wood, 1995), most scholars concluded that the negative impact of developing countries' imports on developed countries' labour markets was tiny, due to the low volume of these imports (Krugman, 1995). However, the subsequent massive increase in imports from developing countries from the mid-1990s onward, mostly explained by the emergence of China as a major trading partner, calls for a re-assessment of the impact of these trade flows on developed countries' labour markets (Krugman, 2008).

This re-assessment should also include a geographical dimension. Previous studies on the impact of competition from developing countries on high-income countries' labour markets were conducted at the country-level and did not analyse whether this impact could vary across regions. As regions differ in their productive specialisation, omission of the geographical dimension might be relevant. In particular, regions specialised in products also imported from China might suffer a larger negative impact on employment than regions specialised in products that do not compete with Chinese imports. Moreover, considering that workers might not move easily across regions, differences in the impact of Chinese imports might lead to differences in regional labour market outcomes that can persist in the medium term.

This paper analyses, using recent data, the impact of Chinese imports on the demand for labour at the regional level, taking Spain as a case study. Following the methodology developed by Autor *et al*. (2013), we assess whether Spanish provinces specialised in goods where the increase in Chinese imports was higher experienced a larger decline in manufacturing employment than Spanish provinces specialised in goods where the increase in Chinese imports was smaller. Applying the methodology developed by Autor *et al*. (2013) to the Spanish case we make two contributions to the literature. First, comparing the results reported by Autor *et al*. (2013) for the US with those obtained in this paper, we can test whether the negative impact of import competition from China on the share of manufacturing labour is larger in rigid markets, such as Spain, where demand shocks are absorbed mainly through quantities, than in more flexible labour markets, such as the US, where demand shocks are also absorbed by factor prices (Jimeno and Bentolila, 2008). Second, Spain is not as endowed with highly skilled labour as the US, leading to a more labour-intensive, and particularly unskilled-labour-intensive, productive specialisation (Minondo, 1999). Hence, the opening to trade with China might have a larger impact on the demand for labour in Spain than in the US.

Our results show that Spanish provinces specialised in industries in which imports from China grew more experienced a larger decline in manufacturing employment. In particular, according to our estimates, an increase in 1,000 US dollars in Chinese imports per worker is associated with a decline of manufacturing employment of approximately two percentage points of the working-age population. Results are robust to omitted variables that might influence changes in imports from China and the demand for labour. Results are also robust to the possibility that firms anticipate the increase in imports from China. Moreover, we find that the negative effect of import exposure on manufacturing employment is compensated for by an increase of employment in other, non-manufacturing sectors. We do not find a significant association between exposure to imports from China, either with unemployment or with participation in the labour market. These results differ from the findings in Autor *et al.* (2013). First, the estimated impact of import exposure on manufacturing employment is larger in Spain, a fact that could be explained by the higher rigidities of the Spanish labour market and a more labour-intensive productive specialisation in Spain. Second, Autor *et al*. (2013) find that import shock to US local labour markets increased the number of unemployed and non-participating individuals, while employment in sectors outside manufacturing remained unaffected. In Spain, we find that the import shock was absorbed by an increase in employment in non-manufacturing sectors. This outcome can be explained by the large expansion of the construction sector during the period of analysis.

This paper is related to previous papers that have analysed the impact of trade with developing countries on developed countries' labour markets. As mentioned above, during the 1990s a large number of studies, using different methodologies, analysed the effects of total trade with developing countries on employment and wages of unskilled and skilled workers in developed countries (Krugman and Lawrence, 1994; Wood, 1995; Leamer, 1998). For the Spanish case, using a factor content of trade methodology, Minondo (1999) showed that trade with developed and developing countries was responsible for a reduction in labour demand, especially for unskilled workers, who represented between 14% and 21% of manufacturing employment.

Later research focused on the effect of a particular type of trade, the offshoring of production stages from developed to developing countries, on the high-wage countries' labour markets. Offshoring of production stages in manufacturing has a sizeable negative effect on the relative demand for unskilled workers in the US (Feenstra and Hanson, 1996 and 1999). Papers on offshoring of services also find that the impacts on labour switching, unemployment, and earnings are not small (Liu and Trefler; 2011). For Spain, Minondo and Rubert (2006) show that offshoring to developing countries is correlated with an increase in demand for skills in manufacturing.[2]

Other papers use firm-level data to analyse the impact of trade with low-wage countries on firm survival and on manufacturing employment in high-wage countries. Bernard *et al*. (2006) find that US manufacturing plant survival and growth are negatively associated with exposure to low-wage countries' imports. Harrison and McMillan (2011) find that, in general, offshoring to low-wage countries substitutes for domestic employment in US manufacturing firms. Papers that match firm and worker data show that offshoring tends to increase high-skilled wages and decrease low-skilled wages. Moreover, low-skilled workers suffer more from the displacement effects of offshoring (Hummels *et al*., 2011). Finally, as explained before, our paper draws heavily on Autor *et al*. (2013), who use a novel methodology to assess the impact of imports from China on US local labour markets. They find that imports have a large impact on unemployment, labour force participation, and government transfers.

The rest of the paper is organised as follows. Section 2 presents some stylised facts on the evolution of Spanish imports from China, and on the evolution of manufacturing employment across Spanish provinces. Section 3 explains how the import-exposure indicator is calculated, presents the database, and describes the results from the regression analyses. Section 4 concludes.

2. Imports from China and the evolution of manufacturing employment in Spain

Figure 1 presents the evolution of Spanish imports from China in both absolute and relative terms. As shown in the figure, during the period 1999-2007, the rise of Chinese imports was impressive. In 1999 imports from China amounted to 3.9 billion US dollars; by 2007, this amount had multiplied by more than six, reaching 25 billion US dollars. We can observe that the increase of Chinese imports accelerated from 2001, the year in which China became a member of the World Trade Organization (WTO). Between 2001 and 2007, growth rates were always at double-digit levels; moreover, in two years, 2004 and 2007, growth rates were higher than 40%. The increase in imports from China is also important in relative terms. As shown in the figure, in 1999 imports from China represented 2.6% of all Spanish imports; by 2007, this share had multiplied almost threefold, rising to 6.5%. The increase in the China's share in Spanish imports is even higher if we focus on manufactures, where it rose from 2.9% to 7.7% during the period 1999-2007. The bulk of import growth from China has been concentrated in three industries: machinery and electrical equipment (35%), metals and other manufactures (26%), and textiles, apparel, and footwear (22%).

[Figure 1 around here]

Figure 2 shows the evolution of manufacturing employment in Spain as a share of total working-age population, and as a share of the occupied population during the period 1999-2007. From 2001 onward we observe a steady decline in the share of manufacturing employment in total occupied population, dropping from 19% in 2001 to 15% in 2007. This decline coincides with the surge of manufacturing imports from China. However, we can also see that manufacturing employment slightly decreased as a share of the working-age population, from 10.5% in 1995 to 10.2% in 2007. These differences are explained by the large increase in the share of the occupied population in the working-age population during the period of analysis.

[Figure 2 around here]

However, the aggregate evolution of manufacturing employment hides substantial differences across Spanish provinces. Figure 3 compares industrial employment as a share of working-age population across Spanish provinces in 1999 and in 2007. We can see first that there are large differences across provinces in the share of manufacturing employment, ranging from Almería, where manufacturing employment is low (5%), to Alava, where the share reached almost 20% in 2007. We also observe that there are large differences in the evolution of manufacturing employment across provinces. There are 27 provinces where manufacturing employment falls as percentage of working-age population; among these, we should highlight Alicante and Palencia, where the drop is more than 6 percentage points. In contrast, there are 23 provinces where the share rises, including Orense and Teruel, where the share of manufacturing employment increases by 5 percentage points.

[Figure 3 around here]

The aim of our empirical investigation is to assess whether the differences in the evolution of the share of manufacturing employment across provinces is associated with the increase in imports from China. In particular, we want to test whether provinces specialised in goods where imports from China increased substantially experienced larger drops in the share of industrial employment. The next section addresses this question.

3. Empirical analysis

3.1 Data and measurement

To analyse the impact of Chinese import competition on a regional labour-market outcomes, Autor *et al.* (2013) develop a model for a small open economy. In this model there is a tradable sector and a non-tradable sector. The tradable sector is composed by various industries; in each industry, firms supply a different variety and compete monopolistically. The model also incorporates differences in industry labour productivity across industries. The model shows that demand for labour in the small open economy declines the larger the increase in China's export supply capacity, and the larger the share of domestic demand served by regional producers. These two variables are captured in an import competition exposure index. Analytically, the import competition exposure index for region i at time t is defined as,

$$\Delta IPW_{it} = \sum_j \frac{E_{ijt}}{E_{cjt}} \frac{\Delta M_{cjt}}{E_{it}} \qquad (1)$$

where (E_{ijt}/E_{cjt}) is the start of period (year t) regions' share of country employment in industry j, E_{it} is start of period total employment in region i, and ΔM_{cjt} is the observed change in country imports from China in industry j between the start and the end of the period. The first component, (E_{ijt}/E_{cjt}), proxies the share of demand that is served by regional producers. The second component, ΔM_{cjt}, proxies the increase of China's export supply capacity in industry j. This measure of local labour market exposure to import competition is the average change in Chinese imports per worker in a region, weighting each industry by its share in the country's total employment.

We have selected provinces as the geographical unit of analysis, because they adequately delimit the boundaries of local labour markets in Spain. Moreover, recent research by the OECD has identified metropolitan areas in Spain as those areas where labour linkages are very high (OECD, 2012). These areas are built clustering urban municipalities with high levels of commuting flows. The majority of the metropolitan areas identified by the OECD correspond to provincial capitals.[3]

We use data on Spanish and UE-14 imports at the 3-digit HS product level from the UN Comtrade Database, for the years 1995, 1999, 2003 and 2007. To concord with employment data, trade data was transformed to the Statistical Classification of Economic Activities in the European Community, rev. 1.1 (NACE rev. 1.1). Data on labour markets for Spanish regions comes from the Survey of the Working Population (*EPA*) published by the Spanish National Institute of Statistics (*INE*), for the second quarter of the years 1995, 1999, 2003 and 2007.

To calculate the import exposure measure, ΔIPW_{it}, the *EPA* provides data on employment by region and by economic activity sector at the 3-digit level from the National Classification Activities - 1993 (*CNAE-93 and CNAE-93 rev. 1*), which is equivalent to the NACE classification. For illustrative purposes, Figure 4 provides a visual impression of the exposure to Chinese import competition in Spain, where provinces are classified into four groups according to the quartiles of the import exposure measure in 1999-2007. Most provinces in the upper quartile are concentrated in the northeastern part of Spain. It must also be noted that the import exposure variable presents a considerable variation across Spanish provinces. While the 25th percentile amounts to an increase of 545 US dollars per worker in Chinese imports, the 75th percentile is almost three times larger, with an increase of 1,492 US dollars per worker during the period 1999-2007.

[Figure 4 around here]

3.2 Import exposure and manufacturing employment

As a first step in our econometric analysis of the impact of Chinese import competition exposure on Spanish manufacturing employment, Figure 5 shows the relationship between changes in manufacturing employment within provinces as a share of working-age population (ages 16 through 64) and import exposure during the period 1999-2007. The plotted regression model controls for the share of manufacturing employment in 1999 and weights provinces according to their start-of-period share in the national population. The prevalence of data points where change in manufacturing employment controlling for its share on total employment is high (low) and import exposure is low (high) supports a negative relationship between import exposure and change in manufacturing employment within provinces. Moreover, the concentration of points near zero indicates that most observations are unlikely to be outliers. The coefficient estimate of import exposure is negative and significant at the 5% level, indicating that for the full sample period (1999-2007) a rise of 1,000 US dollars per worker in a given province's exposure to Chinese imports corresponds to a decline in manufacturing employment of 1.2 percentage points of working-age population.

[Figure 5 around here]

To further analyse the relationship between Chinese import exposure and Spanish manufacturing employment, we fit models of the following form using the full sample of 50 Spanish provinces[4]

$$\Delta E_{mit} = \beta_0 + \beta_1 \Delta IPW_{it} + X'_{it}\beta_2 + u_{it} \quad (2)$$

where ΔE_{mit} is the four-year change in the manufacturing employment share of the working-age population in province *i,* and X_{it} is a vector of control variables for the start of a four-year period labour force and demographic composition which might affect manufacturing employment. All models are estimated using the available data for two four-year periods: 1999-2003 and 2003-2007.

Table 1 presents the detailed estimates of model (2). To control for spatial correlation and/or heterogeneity, standard errors are clustered on Spanish autonomous communities (NUTS-2). In each case we report the parameter estimates and their corresponding robust standard deviation in parentheses, the resulting R^2, and the value of the *F* statistic for the null hypothesis that all estimated coefficients are zero. Columns (1) through (4) show the estimation results for different sets of control variables. When we estimate the model without additional dependent variables (column 1, specification A) the effect on manufacturing employment from import exposure is negative and statistically significant at the 1% level.[5] The point estimate indicates that a rise of 1,000 US dollars per worker in a province's exposure to Chinese imports during a four-year period is associated with a decline in manufacturing employment of approximately 1.3 percentage points of the working-age population.[6] To ensure that this observed negative relation captures the real effect of exposure to increasing import competition from

China, and not just a common trend in the evolution of regional manufacturing employment and Chinese imports, we conduct a falsification exercise regressing past changes in manufacturing employment on future import exposure. Using data for two four-year periods (1995-1999 and 1999-2003) the estimated coefficient for future import exposure is 0.45 with a *t* statistic of 1.57, providing no evidence of reverse causality.

[Table 1 around here]

In the second column we add two controls: the share of manufacturing in a province's start-of-four-year period employment and the growth rate of the working-age population (specification B). The inclusion of the share-of-manufacturing employment variable has a twofold aim. First, it allows us to concentrate on differences on import exposure arising from differential specialization in import-intensive industries within provinces, rather than on differences due to differential concentration of employment in manufacturing versus non-manufacturing activities. Second, we address the possibility that the import-exposure variable may in part reflect the overall trend decline in the manufacturing employment share in Spain, rather than differences across manufacturing industries in their exposure to rising Chinese competition. The growth rate of the working-age population was included as an explanatory variable to control for changes in manufacturing employment as a result of changes in the working-age population size itself. The parameter estimate for this later variable is significant and negative, implying that a 1% higher growth rate in the working-age population is associated to a differential manufacturing decline of 0.06% over a four-year period. The coefficient estimate for the import-exposure variable remains negative and highly significant, and increases in magnitude from 1.3 to 1.7.

Column (3) augments the regression model with six additional controls (specification C); the start-of-four-year period share of working-age population with a college education, the share of working-age population with foreign nationality[7], the share of women in the working-age population, the share of youth in the working-age population[8], and the share of construction employment and the four-year growth rate of house prices.[9] These last two variables are included to account for province differences in the relative importance of the construction sector, and in the impact of the housing bubble, respectively. Apart from these two variables, none of the added controls have a significant effect on manufacturing employment change. The coefficient estimate for construction employment is positive and significant at the 5% level. This result indicates that the increase in manufacturing employment was higher in provinces where the relative importance of construction employment was larger, probably due to a larger demand for both intermediate goods used as inputs in the construction sector and final manufactured goods.[10] On the other hand, the coefficient estimate for the growth of house prices is negative and significant at the 5% level. A possible explanation for this negative relationship between manufacturing employment and the growth rate of house prices would be that in those provinces where the impact of the housing bubble was greater, workers moved toward the construction sector and other construction-related service sectors, probably attracted by higher wage growth.[11] This specification yields a significant and slightly lower coefficient estimate for the import exposure effect than the regression model in column (2).

In column (4) we add several variables to capture technological progress and capital intensity in the Spanish provinces manufacturing sector (specification D). The first variable is the weight of information and communication technologies (ICT) within the sector. The second variable is the share of research and development expenditure

(R&D expenditure) over net operating income. The third variable is the number of patents in force (Patents), and the fourth variable the capital to labour ratio (K-L ratio). Since data for these four variables are available only at the national level and at the 2-digit manufacturing activity level, we follow the same procedure as for the import competition exposure measure to construct the indicators of technological progress and capital intensity.[12] Thus, for each province, the indicator is calculated as the weighted mean of the four-year period change per worker of the corresponding variable, using provincial shares in national industries employment as weights. These added controls leave the main results unaffected. The coefficient on import exposure remains significant at the 1% level and practically identical to that obtained in column (3).

Overall, results show that the effect of exposure to Chinese imports on manufacturing employment remains highly significant for different sets of control variables. However, two important concerns must be pointed out regarding this observed relationship. On the one hand, a simultaneity bias could exist to the degree that, in the import competition measure, anticipated imports from China affect contemporaneous employment. On the other hand, estimation results reported in Table 1 could be biased due to endogeneity of the import exposure variable, since demand shocks can influence industry imports. Both biases would lead us to underestimate the real impact of exposure to import competition from China on manufacturing employment. In order to overcome these two problems, and following Autor *et al.* (2013), we modify the import exposure variable as follows,

$$\Delta IPWO_{it} = \sum_j \frac{E_{ijt}}{E_{cjt}} \frac{\Delta M_{ojt}}{E_{it}} \qquad (3)$$

$$\Delta IPWOL_{it} = \sum_j \frac{E_{ijt-1}}{E_{cjt-1}} \frac{\Delta M_{ojt}}{E_{it-1}} \qquad (4)$$

In equation (3), to control for endogeneity, we substitute Spain's imports from China (ΔM_{cjt}) for other high-income markets imports from China (ΔM_{ojt}). We use countries belonging to the EU-15 (but excluding Spain) as the group of other high-income markets.[13] The empirical literature does not find a significant correlation between EU demand shocks and Spanish demand shocks. (Bayoumi and Eichengreen, 1992; Funke, 1997; Frenkel and Nickel, 2002). Hence, the change in imports from China by EU-14 countries can be considered a good instrument of the change of imports from China by Spain. Additionally, in equation (4) we use employment levels by industry and province from the previous time period (*t-1*) rather than start-of-period employment levels (*t*) to mitigate the potential simultaneity bias.

For illustrative purposes, Figure 6 plots the two-stage estimation procedure which addresses the endogeneity and simultaneity biases, for the full sample period (1999-2007). The regression model controls for the share of manufacturing employment in 1999 and weights provinces according to their start-of-period share in the national population. The first graph in Figure 6 (first-stage regression) shows the large predictive power of the EU-14 imports as instrument for changes in Spanish imports from China. The second graph (second-stage regression) shows the effect of the instrumented import exposure on manufacturing employment. The estimated coefficient for this relationship is -2.30, with a *t* statistic of -6.13.

[Figure 6 around here]

In Table 2 we replicate the estimations from Table 1 with the new two import exposure variables. All models are estimated with instrumental variables (IV) where $\Delta IPWO_{it}$ (columns 1-4) and $\Delta IPWOL_{it}$ (columns 5-8) are used as instruments for the original import exposure variable (ΔIPW_{it}). Parameter estimates and robust standard deviation in parentheses are reported in each case. We also present parameter and robust standard deviation estimates from the first stage regression, as well as the weak identification test (KP) proposed by Kleibergen and Paap (2006). The highly significant coefficient for the instrument and the value of the KP statistic support the instrument validity in all IV regressions.

[Table 2 around here]

For all models in Table 2, the parameter estimate of the exposure to import competition is negative and statistically significant at the 1% level. As expected the estimated coefficients are higher in magnitude than the corresponding estimates from Table 1. However, the parameter estimates for the import exposure variable are rather similar when using either $\Delta IPWO_{it}$ or $\Delta IPWOL_{it}$ as instruments, so that the difference between OLS and IV estimates is largely associated with the correction for endogeneity, whilst the simultaneity bias is quite low. To confirm this result, we run a regression with the full set of controls (specification D), using lagged employment to apportion the change in Spanish imports per worker from China. The estimated coefficient on import exposure is -1.54, similar in magnitude to the OLS estimate (-1.65).

The control variable estimates slightly differ from those obtained with OLS (Column 8). The coefficient on working-age population growth remains significant and negative. However, the coefficients on the share of construction employment and the growth rate of housing prices are of the same sign and similar in magnitude to those from OLS, but only marginally significant.[14] The coefficient on the weight of the information and communication technologies (ICT) is now significant at the 1% level and, opposite to what we expected, its sign is positive. The positive sign implies that a larger increase in the weight of ICT within the manufacturing sector is associated with a higher increase in the share of manufacturing employment over the working-age population. This positive relation could only occur insofar as the new jobs created (due to the need for technical staff to maintain and manage the new technologies) compensates for job loss where new technologies directly replace human workers. Also, it could be argued that those manufacturing sectors where the weight of ICT has increased more are less susceptible to certain adverse shocks (i.e. increasing competition from China or other developing countries). The coefficient on capital intensity is negative and significant at the 10% level, indicating that a larger increase in the capital to labour ratio is associated with a lower increase in manufacturing employment.

Our baseline specification (column 8, Table 2) implies that a rise of 1,000 US dollars per worker in a province's exposure to Chinese imports during a four-year period is associated with a decline in manufacturing employment of 2.05 percentage points of working-age population. The mean increase on weighted Chinese imports per worker in Spain through 1999-2003 and 2003-2007 was about 198 US dollars and 808 US dollars per worker, respectively. Thus, the increase in the exposure to Chinese imports implies a reduction of the share of manufacturing employment of 0.41 percentage points along the 1999-2003 period, and of 1.66 percentage points along the 2003-2007 period. Applying these values to the Spanish EPA data[15] and taking into consideration that only about half of the observed variation in the exposure to Chinese imports can be attributed to the exogenous supply-driven component[16], we calculate that the increasing competition from China caused a differential manufacturing employment of 51,000 workers between 1999 and 2003, and of 281,000 workers between 2003 and 2007. These results are in line with those reported in Minondo (1999). Using a factor content of trade methodology, this author concludes that the increase in Spanish manufacturing trade with low-wage countries up to the year 1995 reduced the demand for manufacturing employment by 404,000 workers. This figure is slightly larger than the 332,000 that we report as the negative demand shock due to the increase in import competition from China in the period 1999-2007.

In comparison to the results obtained by Autor *et al*. (2013), the effect on manufacturing employment of the rising import competition from China is much larger in Spain than in the US. In their benchmark specification, the authors find that a rise of 1,000 US dollars per worker in a US commuting zone's exposure to Chinese imports during a ten-year period is associated with a decline in manufacturing employment of 0.596 percentage points of working-age population. For the period 1990-2000, they calculate that the increasing import competition from China resulted in a reduction of 548,000 workers, and a reduction of 982,000 workers between 2000 and 2007. A plausible explanation for these observed differences would be the fact that Spain is characterized by a more rigid labour market than the US, and thus demand shocks are absorbed mainly through quantities (Jimeno and Bentolila, 1998). In addition to that, productive specialization is more (unskilled) labour intensive in Spain than in the US (Minondo, 1999). Hence, the increase in import competition from China might have a larger negative impact on manufacturing employment than in the US.

3.3. Sensitivity and robustness analyses

A first issue of concern for the estimated negative relationship between import competition from China and manufacturing employment in Spain is whether the relation is robust to different specifications of the model. Following the literature on extreme bound analysis[17], we run several regressions to assess the sensitivity of the estimated coefficient on import exposure to different sets of control variables. Thus, we divide our variables into two groups. The first group contains variables that always appear in the regression (core variables): import exposure, share of manufacturing employment, working-age population growth, and the year dummy. The second, denoted by control group, contains the remaining variables. The change in manufacturing employment is then regressed on the full set of core variables and on all the possible combinations of control variables. For each model *j* we estimate, β_{1j}, and a standard deviation, σ_{1j}, for the import exposure variable. The lower extreme bound is defined as the lowest value of β_{1j} - $2\sigma_{1j}$, and the upper extreme bound is defined to be the largest value of $\beta_{1j} + 2\sigma_{1j}$. The summary statistics from this analysis are presented in Table 3. The import exposure variable is quite robust since its coefficient remains significant and of the same sign at the extreme bounds. At the lower and upper bound, the coefficient is -1.83 and -1.51, respectively, with a *t* statistic of -4.12 and -3.25 for the OLS estimation; -2.51 and -1.89, respectively, with a *t* statistic of -6.04 and -4.24 for the IV (2SLS) estimation, when $\Delta IPWO_{it}$ is used as instrument; and -2.74 and -1.92, respectively, with a *t* statistics of -3.95 and -3.30, when $\Delta IPWOL_{it}$ is used as instrument.

[Table 3 around here]

A second issue of concern is related to the instrument used in the paper to control for endogeneity. We use imports from China to countries belonging to the EU-15 other than Spain as an instrument for imports from China to Spain. As mentioned above, the empirical literature points out that the business cycle in Spain is not correlated with the business cycle in EU-14 countries and, hence, the EU-14 countries' imports from China can be considered a good instrument for Spanish imports from China. In any case, to analyse the robustness of our results to the use of alternative instruments, we replicate the estimation reported in Table 2 using imports from China to high-income OECD countries other than the EU as instrument. The results are reported in Table 4.[18] When we estimate the model with no controls, except for year dummies (columns 1 and 5), imports from China from OECD countries other than EU countries does not appear to be a valid instrument: in the first stage regression the coefficient for import exposure is not statistically significant, and the KP test yields a very low statistic. Nevertheless, when we add more controls the coefficient in the first-stage regression becomes highly significant, and the KP statistic increases. When we use the full set of controls (column 4 and 8) the parameter estimates on import exposure are fairly similar to those obtained when imports from China to the EU-14 is used as instrument.

[Table 4 around here]

Third, the interest of our study is motivated by the large increase of imports from China. However, during the period of analysis, the increase in exposure to other countries' imports might have also played an important role in the decline in the share of manufacturing employment. This may be especially true for countries from Central and Eastern Europe (CEE), since the share of manufacturing imports from CEE countries increased by more than 2.3% between 1999 and 2007 (from 1.4% to 3.7%).[19] Table 5 compares the effect of Chinese import competition to the effect of CEE countries' import competition[20]. For comparative purposes, column (1) presents again the effect of import competition from China on Spanish manufacturing employment. In column (2) we replicate the estimations replacing imports from China by imports from the CEE countries. The coefficient on import exposure is only significant when we instrument imports from the CEECs to Spain with imports from the CEECs to the UE-14 (IV, instrument $\Delta IPWO$). When we further control for simultaneity bias using lagged employment, the coefficient is positive but statistically not significant (IV, $\Delta IPWOL$). In columns (3) and (4) we include both exposure to Chinese imports and exposure to CEE countries' imports. It can be appreciated that the coefficient on the latter is not statistically significant in any case, while the former is negative and highly significant in all cases. Thus, we conclude that increasing imports from the CEECs did not have a significant effect on Spanish manufacturing employment along the period 1999-2007. This result is reasonable, as the increase in imports from China is concentrated in more labour-intensive industries (textiles, apparel, and the assembly of TV, radio and electronic apparatus) than the increase in imports from CEE countries (transport equipment).

[Table 5 around here]

3.4 Alternative measures of trade exposure

Following Autor *et al*. (2013), this section considers three alternatives measures of trade exposure for Spanish provinces to further check the robustness of our previous results. First, import competition from China not only displaces Spanish sales by producers in the national market but also may affect their sales in foreign markets. If this latter effect is large, our initial estimate of the impact of import exposure on manufacturing employment would be biased downward. Therefore, we replace the change in imports per worker from China as defined in equations (1), (3) and (4) with the change in imports per worker incorporating imports in other non-Spanish markets (EU-14). To calculate the total exposure (domestic and international exposure) of Spanish province i to import competition from China, equation (1) is modified as follows,

$$\Delta TIPW_{it} = \sum_j \frac{E_{ijt}}{E_{cjt}} \frac{\left(\Delta M_{cjt} + \sum_{o \neq c} \frac{X_{ojt}}{X_{jt}} \Delta M_{ojt} \right)}{E_{it}} \qquad (5)$$

where ΔM_{ojt} is the change in imports from China to the EU-14 countries in industry j and X_{ojt}/X_{jt} is the initial share of Spanish exports to EU countries over Spanish total exports in industry j.[21] Including international exposure to import competition from China induces an increase in the mean change in imports from China of 37% and of

26% for the periods 1999-2003 and 2003-2007, respectively. Results for total import exposure on manufacturing employment are reported in Table 6, column (2). We present the results from OLS and IV (2SLS) estimations. For the IV (2SLS) estimations, we instrument total import exposure in an identical manner as in equations (3) and (4). The coefficient on domestic plus international import exposure is negative and significant at the 1% level, and contrary to our expectations, lower in magnitude than the reported coefficient on domestic exposure in column (1). Nevertheless, the decrease is rather small with a change of less than one standard deviation (0.2 and 0.3 points for the OLS and IV estimations, respectively).

[Table 6 around here]

Second, the initial import exposure variable includes both final goods and intermediate goods. If higher exposure to Chinese imports increases the variety of inputs that can be used by Spanish firms, their productivity may increase along with their demand for labour. In such a case, the increase of intermediate goods imported from China may partially offset the impact of import competition in final goods on manufacturing employment. To focus on the effect of increasing import competition in final goods, we replace the change in imports per worker by the change in total imports per worker less imports of intermediate inputs per worker. Hence, the variable for a province's import exposure net of intermediate goods is,

$$\Delta FIPW_{it} = \sum_j \frac{E_{ijt}}{E_{cjt}} \frac{\Delta\left(M_{cjt} - M_{Icjt}\right)}{E_{it}} \qquad (6)$$

where M_{Icjt} denotes imports of intermediate goods from China to Spain in industry j. Imported intermediate goods by industry were obtained combining trade data with the Spanish input-output table for years 1999, 2003 and 2007. In this case, the mean change in imports from China falls by 42% and 55% for the periods 1999-2003 and 2003-2007, respectively. As presented in column (3), the coefficient for net of intermediate goods exposure is highly significant and negative, and far larger in magnitude than the reported estimates in column (1). When the import exposure net of intermediate inputs is instrumented to mitigate both the simultaneity and endogeneity biases (IV, instrument *ΔIPWOL*), the magnitude of the estimated coefficient on import exposure rises by more than three standard deviations (from 2.05 to 3.52). Opposite to the US case (Autor *et al.,* 2013, section 7), and although the net impact of import competition from China on Spanish manufacturing employment is negative, it seems that Spanish manufacturing firms have taken benefit from the larger variety of inputs, originating a higher labour demand due to increased productivity. More precisely, the reported differences on the estimated coefficient on import exposure imply that a rise of 1,000 US dollars per worker in a province's exposure to Chinese imports during a four-year period is associated with a differential increase in manufacturing employment of approximately 1.5 percentage points of working-age population.

Finally, to incorporate Spanish exports to China, we construct a new variable, net imports from China, by subtracting the weighted change in Spanish exports per worker (X_{cjt}) to the weighted change in Spanish imports per worker by industry,

$$\Delta NIPW_{it} = \sum_j \frac{E_{ijt}}{E_{cjt}} \frac{\Delta M_{cjt}}{E_{it}} - \sum_j \frac{E_{ijt}}{E_{cjt}} \frac{\Delta X_{cjt}}{E_{it}} \qquad (7)$$

The resulting mean change in net imports per worker is a 28%, and 10% lower than the mean change in imports per worker for the periods 1999-2003 and 2003-2007, respectively. The estimation results for net import exposure are presented in column (4) of Table 6. Again, for the IV (2SLS) estimations we instrument net import exposure as in equations (3) and (4).[22] It can be appreciated that using net imports from China does not practically alter the initial impact of import exposure. This result is not surprising if we account for the fact that exports to China are much smaller than imports from China. In 1999 and 2007, Spanish manufacturing exports to China amounted to 0.4 and 2.3

billion US dollars, respectively, while manufacturing imports from China amounted to 3.8 and 25 billion US dollars, respectively. In relative terms, the increase in exports is much lower than the increase in imports. Between 1999 and 2007, the share of manufacturing exports to China over total manufacturing exports increased by 0.6% (from 0.4% to 1.0%), while the share of manufacturing imports from China increased by almost 5%.

3.5 Import exposure and aggregate labour market outcomes

The last step in our analysis is to determine whether import shocks to manufacturing employment indirectly affected broader labour market outcomes. First, we study whether these trade shocks induced a reallocation of workers across provinces. Should large flows of workers move among provinces as a response to import shocks to the manufacturing sector, the effects on local labour market outcomes, other than manufacturing employment, will be practically negligible.

Table 7 presents the results from several specifications where the dependent variable is the change in log working-age population. As in previous estimations, we include several controls; however, for this analysis we exclude the growth rate of the working-age population. Results are obtained through IV (2SLS) estimations, where we control for both endogeneity and simultaneity biases. The estimated coefficient on import exposure is only significant when the model includes only the share of manufacturing employment in total employment, along with year dummies, as a control (specification B). In the rest of the estimations, the coefficient for import exposure is not statistically significant. So, we conclude that import shocks to local manufacturing did not lead to substantial changes in working-age populations within Spanish provinces. This lack of a significant effect of growing import competition from China on worker flows is consistent with the low inter-regional mobility in Spain.[23]

[Table 7 around here]

As long as workers do not reallocate across provinces as a response to trade shocks, the negative effect on manufacturing employment of Chinese import competition must have some impact on either non-manufacturing employment, unemployment, or population not included in the labour force. The results for the estimated effect of import exposure on these three labour market outcomes are shown in Table 8, for the four different specifications related to the variables included in the set of controls. In all cases, the dependent variable is the change in the log population counts of the corresponding variable. In column (1) we also report the estimation results for the log change in manufacturing employment. We find that a rise of 1,000 US dollars per worker in a province's exposure to Chinese imports during a four-year period is associated with a decline in manufacturing employment of 0.08 log points. Also noteworthy is that we find a significant effect of import competition exposure only on non-manufacturing employment. The positive sign of the estimated coefficient and its magnitude implies that the negative effect of import exposure on manufacturing employment is compensated for by an increase of employment in other, non-manufacturing sectors within provinces. We do not find a significant association between exposure to imports from China and either unemployment or participation in the labour market. This result differs substantially to the findings in Autor *et al*. (2013), where the authors establish that import shock to US local labour markets increased the number of unemployed and non-participating individuals, while employment in sectors outside manufacturing remained unaffected. Plausibly, these differences may be explained by the particular evolution of the Spanish economy during the period of analysis, as compared not only to the US but to the rest of countries in the EU-15 group. Along the period 1999-2007, the mean annual growth rate of real GDP was 3.7%, almost 1% higher than in the US (2.8%) and 1.3% above the EU-15 (2.4%). As a consequence, employment growth was particularly high in Spain[24], primarily due to the large expansion of the construction sector, in which employment increased at an annual rate of about 7.7%. In this context, where labour demand from the construction sector and probably from the construction-related services sector was quite large, the null impact of increasing import competition on unemployment and non-participation in the labour force is reasonably justified.

[Table 8 around here]

Lastly, in Table 9 we analyse the effect of import exposure on province wage levels. Data on average real wages by provinces was obtained by deflating the average nominal wages from the Spanish Tax Agency by the corresponding Consumer Price Index. Since wage data is not available at a sufficiently large disaggregation level by sector, wages for the manufacturing sector were proxied by those from the industry sector.[25] When year dummies are the only control variables, we find a significant negative effect of import exposure on average wages within provinces, in both the manufacturing and non-manufacturing sectors. Nevertheless, the coefficient on import exposure becomes non-significant if we include additional explanatory variables for the change in log average wages. Since the impact of import competition on local prices of non-traded goods may move in the same direction as the impact on nominal wages, preventing us from finding any significant effect of import exposure on real wages[26], we also analysed the effect of increasing import competition from China to the change in log average nominal wages. Again, we did not find any robust significant effect.[27]

[Table 9 around here]

Given the negative impact of increasing exposure to import competition from China on manufacturing employment, the fact that manufacturing wages seem not to be influenced by import competition indicates that manufacturing wages are rigid, at least downwards, coinciding with previous empirical evidence on wage rigidity in Spain.[28] For non-manufacturing sectors, wages may be negatively affected by import exposure owing to a larger supply of workers coming from manufacturing. The fact that non-manufacturing wages are also not influenced by import competition could be explained by wage rigidities as well. However, as mentioned above, the negative effect of the increase of supply on wages may have been compensated for by the increase in demand for labour in construction and construction-related services.

4. Conclusions

During the period 1999-2007, Spanish imports from China increased at an annual growth rate of 26%, making the Asian country Spain's fourth most important supplier. This huge increase in import competition from China should have had large effects on the Spanish labour market. To identify the effect of import competition from China, we analysed differences in the evolution of Spanish local labour markets. Applying the methodology recently developed by Autor *et al*. (2013), we analysed whether local labour markets specialised in industries where the Chinese import surge has been large experienced a concurrent large decline in manufacturing employment. Apart from providing new evidence on the impact of import competition from China in the labour markets of developed countries, this paper contributes to the literature analysing the case of a European country characterised by a more rigid labour market and more labour-intensive productive specialisation than the US.

Our results show that during the period 1999-2007, a higher increase in the exposure to imports from China is associated with larger declines in manufacturing employment. In particular, a 1,000 US dollar increase in imports from China per worker reduces the share of manufacturing employment in the working-age population by 2.05 percentage points. This result is robust to omitted variables and simultaneity. In relative terms, and in comparison to the results in Autor *et al*. (2013), our findings suggest that the impact of increasing import competition from China is larger in Spain than in the US. This result is in line with the fact that Spain is characterised by a more rigid labour market than the US, so that demand shocks are absorbed mainly through quantities, while in more flexible labour markets demand shocks may also be absorbed by factor prices. In fact, although Autor *et al*. (2013) find that import shocks to the US cause a decline in wages that is primarily observed outside the manufacturing sector, we are unable to establish the presence of a robust significant impact of import competition on wages in Spain, either in manufacturing or in non-manufacturing sectors. This result is also in line with the fact that Spain has a more labour-intensive productive specialization than the US.

As Spanish provinces have local labour market characteristics, we analysed how the reduction in manufacturing employment is transmitted to the local labour market. We found that the reduction in manufacturing employment is compensated for by an increase in non-manufacturing employment. Contrary to the results in Autor *et al*. (2013), where import exposure seems to increase both the number of unemployed workers and labour force non-participants, we do not find a significant association between exposure to imports from China and either unemployment or participation in the labour market. Our view on these differences is that the large employment growth experienced by the Spanish economy along the period 1999-2007, owing basically to the expansion of the construction sector, was able to absorb the labour demand shock in manufacturing induced by the high increase in import competition from China.

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Table 1. Import exposure and change in manufacturing employment in Spain, OLS, 1999-2003 and 2003-2007

Dependent variable: change in manufacturing employment as a share of working-age population (%)

Independent variable	OLS, Import exposure: ΔIPW			
	Spec. A	Spec. B	Spec. C	Spec. D
	(1)	(2)	(3)	(4)
Import Exposure	-1.3217^{***}	-1.7158^{***}	-1.6692^{***}	-1.6504^{***}
	(0.2320)	(0.3415)	(0.3570)	(0.4139)
Manufacturing empl.	-	0.0275	0.0323	-0.0005
		(0.0192)	(0.0206)	(0.300)
Working-age population	-	-0.0618^{***}	-0.0473^{*}	-0.0509^{*}
		(0.0190)	(0.0258)	(0.0294)
College-educated	-	-	0.0109	0.0052
			(0.0146)	(0.0184)
Foreign-nationality	-	-	-0.0254	-0.0305
			(0.0385)	(0.0419)
Women	-	-	-0.1201	-0.1292
			(0.0755)	(0.0962)
Young	-	-	-0.0462	-0.0487
			(0.0664)	(0.0649)
Construction empl.	-	-	0.0725^{**}	0.0571^{*}
			(0.0313)	(0.0326)
Housing price	-	-	-0.0110^{**}	-0.0091^{*}
			(0.0049)	(0.0050)
ICT	-	-	-	0.5192
				(0.3435)
R&D expenditure	-	-	-	0.6730
				(2.0870)
K-L ratio	-	-	-	-0.0534
				(0.0464)
Patents	-	-	-	-0.5523
				(1.8995)
R^2	0.40	0.48	0.53	0.55
F statistic	21.86	21.86	25.92	474.65
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: N = 100 (50 provinces x 2 time periods). All regressions include a constant and a dummy for the 2003-2007 period. Standard errors in parentheses. Statistical significance is indicated by *** at 1%, ** at 5% and * at 10%. Models are weighted by period average province share of national population. Standard errors are clustered on Spanish CCAA.

Table 2. Import exposure and change in manufacturing employment in Spain, IV (2SLS), 1999-2003 and 2003-2007

Dependent variable: change in manufacturing employment as a share of working-age population (%)

Independent variable	IV (2SLS), Import exposure: *ΔIPWO*				IV (2SLS), Import exposure: *ΔIPWOL*			
	Spec. A	Spec. B	Spec. C	Spec. D	Spec. A	Spec. B	Spec. C	Spec. D
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Import Exposure	-1.6127***	-2.2711***	-2.0603***	-2.0704***	-1.6905***	-2.3184***	-2.0113***	-2.0545***
	(0.2513)	(0.4136)	(0.3218)	(0.3541)	(0.3511)	(0.5828)	(0.3792)	(0.4407)
Manufacturing empl.	-	0.0504**	0.0462***	0.0108	-	0.0523*	0.0444**	-0.0049
		(0.0242)	(0.0188)	(0.0325)		(0.0308)	(0.0213)	(0.0284)
Working-age pop.	-	-0.0605***	-0.0409*	-0.0454*	-	-0.0604***	-0.0417*	-0.0527**
		(0.0192)	(0.0234)	(0.0263)		(0.0193)	(0.0240)	(0.0262)
College-educated	-	-	0.0066	0.0021	-	-	0.0072	-0.0003
			(0.0131)	(0.0163)			(0.0140)	(0.0162)
Foreign-nationality	-	-	-0.0328	-0.0364	-	-	-0.0319	-0.0400
			(0.0405)	(0.0419)			(0.0402)	(0.0445)
Women	-	-	-0.0887	-0.1024	-	-	-0.0926	-0.0949
			(0.0759)	(0.0937)			(0.0768)	(0.0907)
Young	-	-	-0.0754	-0.0750	-	-	-0.0717	-0.0630
			(0.0644)	(0.0580)			(0.0630)	(0.0584)
Construction empl.	-	-	0.0724***	0.0575*	-	-	0.0724***	0.0474
			(0.0295)	(0.0302)			(0.0293)	(0.0297)
Housing price	-	-	-0.0110**	-0.0095*	-	-	-0.0110**	-0.0081
			(0.0048)	(0.0049)			(0.0048)	(0.0054)
ICT	-	-	-	0.5471	-	-	-	0.6964***
				(0.3481)				(0.1998)
R&D expenditure	-	-	-	0.1054	-	-	-	1.9169
				(1.7372)				(1.7462)
K-L ratio	-	-	-	-0.0540	-	-	-	-0.0558*
				(0.0453)				(0.0335)
Patents	-	-	-	-1.1361	-	-	-	-2.3549
				(1.8545)				(2.6871)
R^2	0.39	0.47	0.53	0.55	0.38	0.46	0.53	0.56
F statistic	32.36	29.28	50.43	322.12	23.88	21.42	42.68	343.43
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
First-stage estimates								
Import Exposure (UE)	0.0992***	0.0944***	0.1046***	0.1056***	0.0782***	0.0639***	0.0738***	0.0704***
	(0.0067)	(0.0129)	(0.0063)	(0.0054)	(0.0106)	(0.0148)	(0.0080)	(0.0079)
R^2	0.91	0.92	0.94	0.94	0.83	0.86	0.90	0.90
KP statistic	4.40	7.93	7.58	7.28	4.43	8.08	7.61	6.46
(p-value)	(0.03)	(0.01)	(0.01)	(0.01)	(0.03)	(0.00)	(0.01)	(0.01)

Notes: N = 100 (50 provinces x 2 time periods). All regressions include a constant and a dummy for the 2003-2007 period. Standard errors in parentheses. Statistical significance is indicated by *** at 1%, ** at 5% and * at 10%. Models are weighted by period average province share of national population. Standard errors are clustered on Spanish CCAA.

Table 3. Summary statistics from extreme bound analysis, OLS and IV (2SLS).

CORE VARIABLES	Mean	Average σ	Average *t-statistic*	Low β_1	High β_1	LEB	UEB
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
OLS: ΔIPW	-1.6457	0.3874	-4.2970	-1.8564	-1.4795	-2.7134	-0.5806
IV (2SLS): $\Delta IPWO$	-2.1415	0.3661	-5.9846	-2.5709	-1.8190	-3.5315	-0.9998
IV (2SLS): $\Delta IPWOL$	-2.1454	0.4815	-4.6127	-2.7364	-1.7294	-4.1226	-0.7539

Notes: LEB = *lower extreme bound*, UEB = *upper extreme bound*. The low β_1 is the estimated coefficient from the regression with the lower extreme bound. The high β_1 is the estimated coefficient from the regression with the upper extreme bound.

Table 4. Import exposure and change in manufacturing employment in Spain, IV (2SLS), 1999-2003 and 2003-2007

Dependent variable: change in manufacturing employment as a share of working-age population (%)
Instrument: imports from China to OECD

Independent variable	IV (2SLS), Import exposure: *ΔIPWO*				IV (2SLS), Import exposure: *ΔIPWOL*			
	Spec. A	Spec. B	Spec. C	Spec. D	Spec. A	Spec. B	Spec. C	Spec. D
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Import Exposure	-2.9182**	-1.9683***	-1.8274***	-1.9897***	-3.9435***	-1.9257***	-2.2896***	-2.4314***
	(1.1621)	(0.5857)	(0.6355)	(0.6140)	(3.7931)	(0.6863)	(0.6522)	(0.7502)
R^2	0.08	0.48	0.54	0.55	0.01	0.48	0.52	0.54
F statistic	14.78	19.81	28.32	322.12	5.99	19.93	56.20	91.07
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
First-stage estimates								
Import Exposure (UE)	-0.1335	-0.2322***	-0.2598***	-0.2706***	-0.0592	-0.1944**	-0.2350***	-0.2356***
	(0.1006)	(0.0129)	(0.0536)	(0.0570)	(0.0927)	(0.0690)	(0.0587)	(0.0634)
R^2	0.45	0.76	0.82	0.85	0.43	0.75	0.83	0.85
KP statistic	1.30	3.82	4.69	4.47	0.40	3.92	4.80	4.42
(p-value)	(0.25)	(0.05)	(0.03)	(0.03)	(0.53)	(0.05)	(0.03)	(0.03)

Notes: N = 100 (50 provinces x 2 time periods). All regressions include a constant and a dummy for the 2003-2007 period. Standard errors in parentheses. Statistical significance is indicated by *** at 1%, ** at 5% and * at 10%. Models are weighted by period average province share of national population. Standard errors are clustered on Spanish CCAA.

Table 5. Import exposure from different exporting countries and change in manufacturing employment in Spain, OLS and IV (2SLS), 1999-2003 and 2003-2007.

Dependent variable: change in manufacturing employment as a share of working-age population (%)

Estimation procedure	China	CEECs	China & CEECs	
			China	CEECs
	(1)	(2)	(3)	(4)
OLS: *ΔIPW*				
Import Exposure	-1.6504***	-1.7236	-1.5305***	-0.5487
	(0.4139)	(1.1057)	(0.4036)	(0.9365)
R^2	0.55	0.47	0.55	0.55
F statistic	474.65	1,146.57	2,897.10	2,897.10
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)
IV (2SLS): *ΔIPWO*				
Import Exposure	-2.0704***	-2.0233**	-2.3556***	0.8352
	(0.3541)	(1.0439)	(0.7215)	(1.5668)
R^2	0.55	0.47	0.52	0.52
F statistic	322.12	927.84	112.93	112.93
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)
First-stage estimates				
Import Exposure	0.1056***	0.0761***	0.0983***	0.0745***
	(0.0054)	(0.0065)	(0.0087)	(0.0081)
R^2	0.94	0.95	0.94	0.95
KP statistic	7.28	5.00	6.15	6.15
(p-value)	(0.01)	(0.02)	(0.00)	(0.00)
IV (2SLS): *ΔIPWOL*				
Import Exposure	-2.0545***	0.2726	-2.8978***	2.7662
	(0.4407)	(1.4725)	(1.1082)	(2.1210)
R^2	0.56	0.45	0.47	0.47
KP statistic	343.43	67.80	76.45	76.45
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)
First-stage estimates				
Import Exposure	0.0704***	0.0443***	0.0707***	0.0375***
	(0.0079)	(0.0120)	(0.0068)	(0.0110)
R^2	0.90	0.85	0.90	0.86
KP statistic	6.46	6.89	5.36	5.36
(p-value)	(0.01)	(0.01)	(0.02)	(0.02)

Notes: N = 100 (50 provinces x 2 time periods). All regressions include a constant and a dummy for the 2003-2007 period. Standard errors in parentheses. Statistical significance is indicated by *** at 1%, ** at 5% and * at 10%. Models are weighted by period average province share of national population. Standard errors are clustered on Spanish CCAA. All regressions include the full set of controls (specification D).

Table 6. Import exposure from different exporting countries and change in manufacturing employment in Spain, OLS and IV (2SLS), 1999-2003 and 2003-2007.

(Dependent variable: change in manufacturing employment as a share of working-age population (%))

Estimation procedure	Domestic exposure (1)	Domestic and international exposure (2)	Net of intermediate goods exposure (3)	Net import exposure (4)
OLS: *ΔIPW*				
Import Exposure	-1.6504***	-1.4321***	-3.0231***	-1.6806***
	(0.4139)	(0.3175)	(0.6855)	(0.4141)
R^2	0.55	0.56	0.55	0.55
F statistic	474.65	1,148.36	89.37	1,632.09
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)
IV (2SLS): *ΔIPWO*				
Import Exposure	-2.0704***	-1.7266***	-3.3037***	-2.2549
	(0.3541)	(0.2912)	(0.5572)	(0.3837)
R^2	0.55	0.55	0.55	0.54
F statistic	322.12	309.14	160.81	276.87
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)
First-stage estimates				
Import Exposure	0.1056***	0.1248***	0.1043***	0.1057***
	(0.0054)	(0.0058)	(0.0052)	(0.0068)
R^2	0.94	0.95	0.96	0.91
KP statistic	7.28	7.36	7.66	7.56
(p-value)	(0.01)	(0.01)	(0.00)	(0.00)
IV (2SLS): *ΔIPWOL*				
Import Exposure	-2.0545***	-1.7259***	-3.5235***	-2.1386***
	(0.4407)	(0.3631)	(0.6112)	(0.4679)
R^2	0.56	0.58	0.57	0.56
KP statistic	343.43	430.22	353.40	494.01
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)
First-stage estimates				
Import Exposure	0.0704***	0.0827***	0.0707***	0.0710***
	(0.0079)	(0.0094)	(0.0069)	(0.0090)
R^2	0.90	0.91	0.88	0.88
KP statistic	6.46	6.41	6.58	6.45
(p-value)	(0.01)	(0.01)	(0.01)	(0.00)

Notes: N = 100 (50 provinces x 2 time periods). All regressions include a constant and a dummy for the 2003-2007 period. Standard errors in parentheses. Statistical significance is indicated by *** at 1%, ** at 5% and * at 10%. Models are weighted by period average province share of national population. Standard errors are clustered on Spanish CCAA. All regressions include the full set of controls (specification D).

Table 7. Import exposure and working-age population growth, IV (2SLS), 1999-2003 and 2003-2007.

Dependent variable: change in log working-age population.

Independent variable	IV (2SLS), Import exposure: *ΔIPWOL*			
	Spec. A	Spec. B	Spec. C	Spec. D
	(1)	(2)	(3)	(4)
Import Exposure	0.0123 (0.0210)	0.0548** (0.0224)	0.0192 (0.0189)	0.0143 (0.0169)
Manufacturing empl.	-	-0.0032*** (0.0012)	-0.0005 (0.0008)	-0.0019** (0.0008)
College-educated	-	-	0.0006 (0.0007)	00004 (0.0007)
Foreign-nationality	-	-	0.0104*** (0.0017)	0.0104*** (0.0020)
Women	-	-	-0.0013 (0.0029)	-0.0013 (0.0030)
Young	-	-	0.0042 (0.0046)	0.0045 (0.0049)
Construction empl.	-	-	0.0042*** (0.0016)	0.0040*** (0.0014)
Housing price	-	-	0.0008*** (0.0003)	0.0008*** (0.003)
ICT	-	-	-	0.0228** (0.0099)
R&D expenditure	-	-	-	-0.0781 (0.0851)
K-L ratio	-	-	-	-0.0036** (0.0014)
Patents	-	-	-	-0.0504 (0.0807)
R^2	0.01	0.01	0.58	0.61
F statistic (p-value)	2.91 (0.08)	3.91 (0.03)	24.69 (0.00)	24.91 (0.00)
First-stage estimates				
Import Exposure (UE)	0.0782*** (0.0106)	0.0610*** (0.0140)	0.0752*** (0.0086)	0.0715*** (0.0080)
R^2	0.83	0.85	0.90	0.90
KP statistic (p-value)	4.43 (0.03)	7.85 (0.00)	7.75 (0.00)	6.44 (0.01)

Notes: N = 100 (50 provinces x 2 time periods). All regressions include a constant and a dummy for the 2003-2007 period. Standard errors in parentheses. Statistical significance is indicated by *** at 1%, ** at 5% and * at 10%. Models are weighted by period average province share of national population. Standard errors are clustered on Spanish CCAA.

Table 8. Import exposure and market labour outcomes, IV (2SLS), 1999-2003 and 2003-2007.

Dependent variable: change in log population counts.

	Manufacturing	Non-manufacturing	Unemployment	Not in the labour force
	(1)	(2)	(3)	(4)
Specification A				
Import exposure	-0.1357***	0.0317	0.0144	-0.0255
	(0.0364)	(0.0294)	(0.0656)	(0.0214)
R^2	0.23	0.01	0.01	0.01
F statistic	6.83	1.63	0.07	0.98
(p-value)	(0.00)	(0.23)	(0.93)	(0.40)
Specification B				
Import exposure	-0.1773**	0.0375*	-0.0780	-0.0296
	(0.0891)	(0.0229)	(0.1070)	(0.0590)
R^2	0.22	0.47	0.13	0.23
F statistic	14.24	27.54	5.63	25.25
(p-value)	(0.00)	(0.00)	(0.01)	(0.00)
Specification C				
Import exposure	-0.1027***	0.0546***	-0.1668	0.0288
	(0.0305)	(0.0204)	(0.1195)	(0.0314)
R^2	0.35	0.64	0.22	0.37
F statistic	58.75	31.71	6.00	52.64
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)
Specification D				
Import exposure	-0.0829**	0.0538**	-0.1377	0.0180
	(0.0361)	(0.0227)	(0.1136)	(0.0271)
R^2	0.39	0.65	0.24	0.37
F statistic	519.59	73.78	78.07	75.28
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: N = 100 (50 provinces x 2 time periods). All regressions include a constant and a dummy for the 2003-2007 period. Standard errors in parentheses. Statistical significance is indicated by *** at 1%, ** at 5% and * at 10%. Models are weighted by period average province share of national population. Standard errors are clustered on Spanish CCAA.

Table 9. Import exposure and wage changes, IV (2SLS), 1999-2003 and 2003-2007

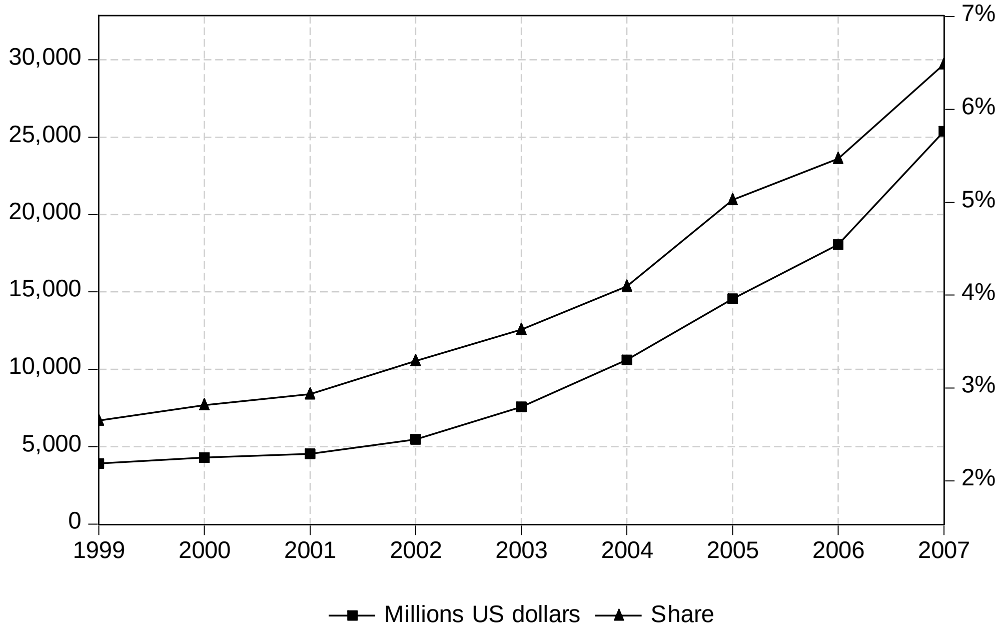
Dependent variable: change in log mean wage.

	Manufacturing	Non-manufacturing	All sectors
	(1)	(2)	(3)
Specification A			
Import exposure	-0.0304**	-0.0357***	-0.0401***
	(0.0140)	(0.0129)	(0.0114)
R^2	0.12	0.35	0.30
F statistic	7.55	23.22	16.62
(p-value)	(0.01)	(0.00)	(0.00)
Specification B			
Import exposure	-0.0409	-0.0362**	-0.0412
	(0.0326)	(0.0183)	(0.0201)
R^2	0.11	0.35	0.29
F statistic	18.57	16.04	9.64
(p-value)	(0.00)	(0.00)	(0.00)
Specification C			
Import exposure	0.0029	-0.0131	-0.0129
	(0.0151)	(0.0103)	(0.0090)
R^2	0.38	0.52	0.53
F statistic	106.18	19.90	16.30
(p-value)	(0.00)	(0.00)	(0.00)
Specification D			
Import exposure	0.0103	-0.0155	-0.0123
	(0.0135)	(0.0098)	(0.0089)
R^2	0.41	0.55	0.55
F statistic	94.37	109.25	269.15
(p-value)	(0.00)	(0.00)	(0.00)

Notes: N = 50. Standard errors in parentheses. Statistical significance is indicated by *** at 1%, ** at 5% and * at 10%. Models are weighted by period average province share of national population. Standard errors are clustered on Spanish CCAA.

Figure 1. Spanish imports from China, 1999-2007

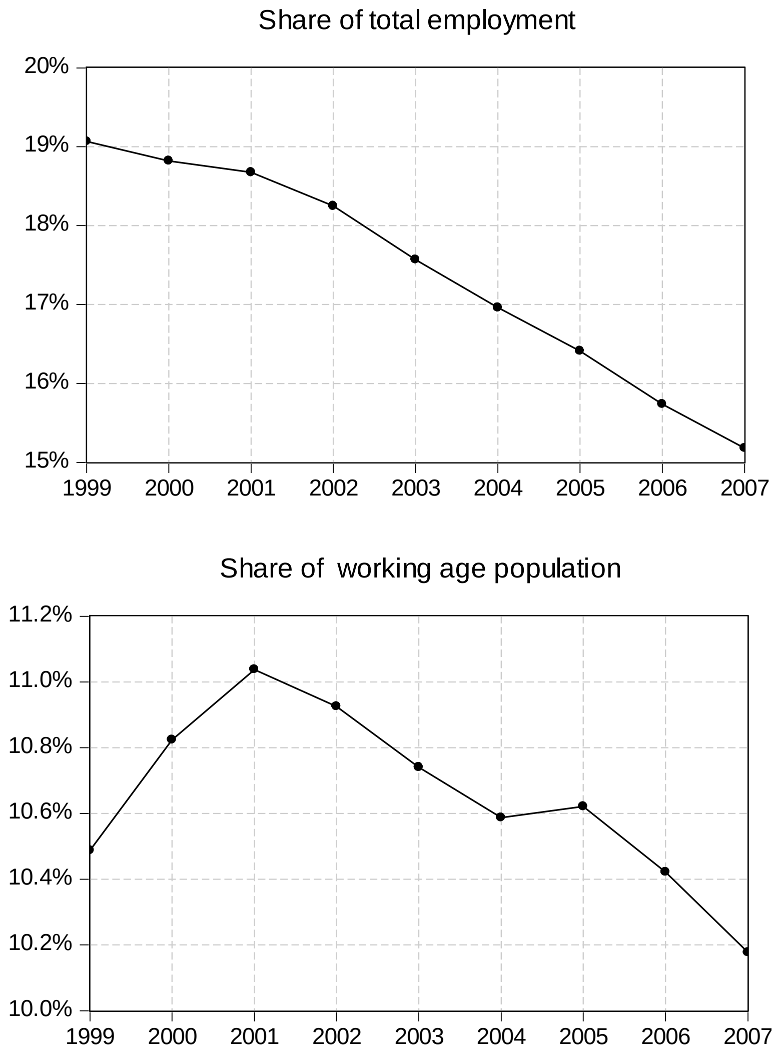
(million US dollars and % of total imports)



Source: UN Comtrade database.

Figure 2. Manufacturing employment in Spain, 1999-2007

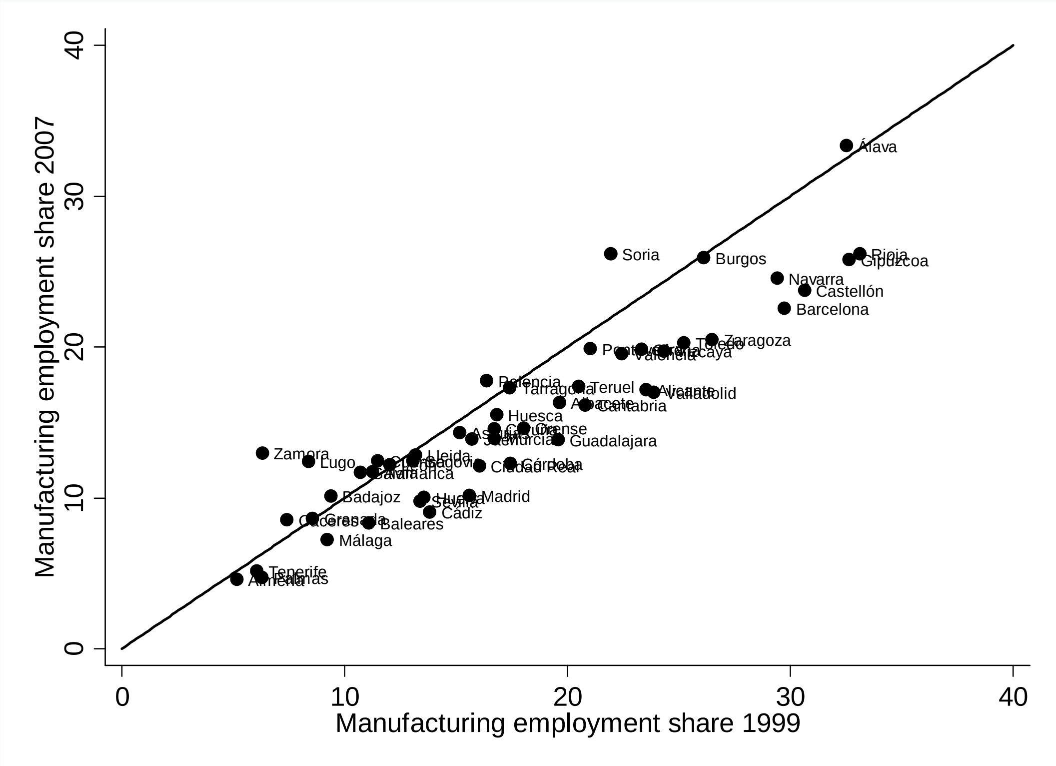
(% of total employment and working-age population)



Source: UN Comtrade database.

Figure 3. Manufacturing employment in Spanish provinces: 1999 vs. 2007

(as % of working-age population)



Source: Spanish Labour Survey (www.ine.es)

Figure 4. Exposure to Chinese import competition in Spain, 1999-2007.

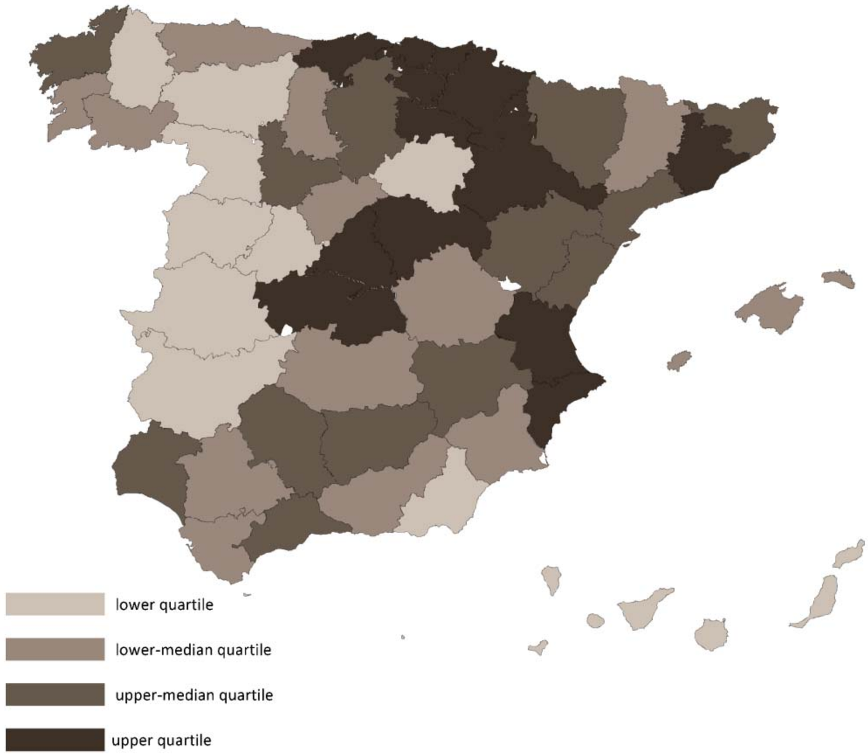


Figure 5. Partial regression plot between import exposure and change in manufacturing employment in Spain, OLS, 1999-2007 (full sample).

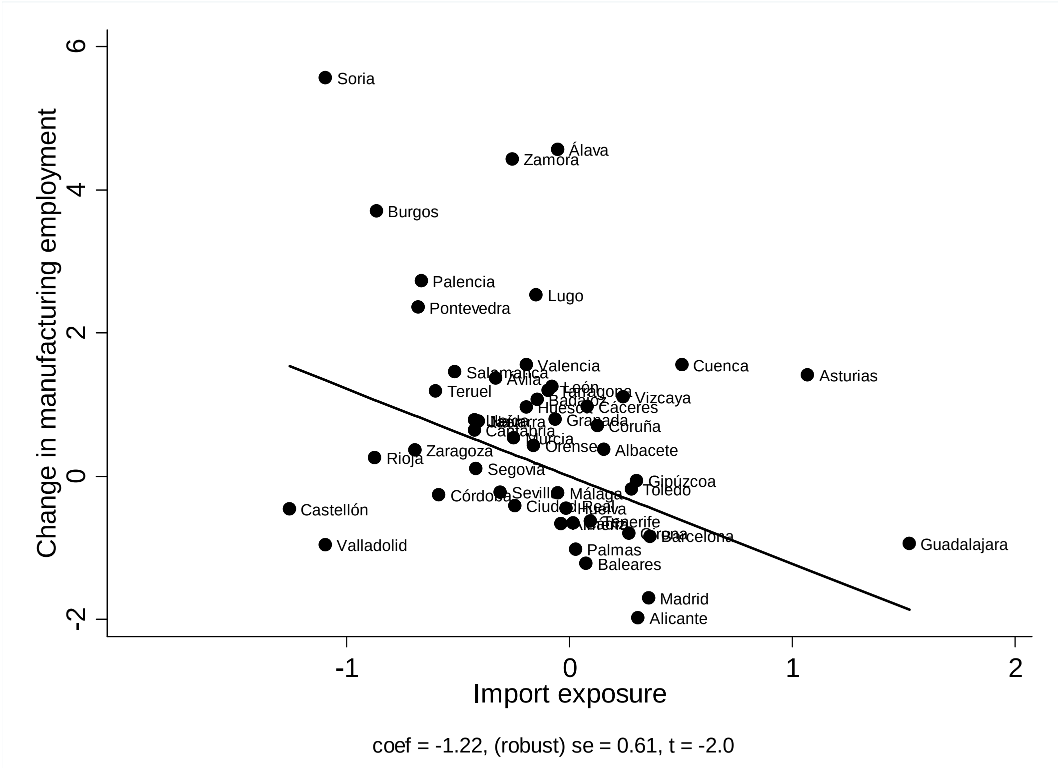
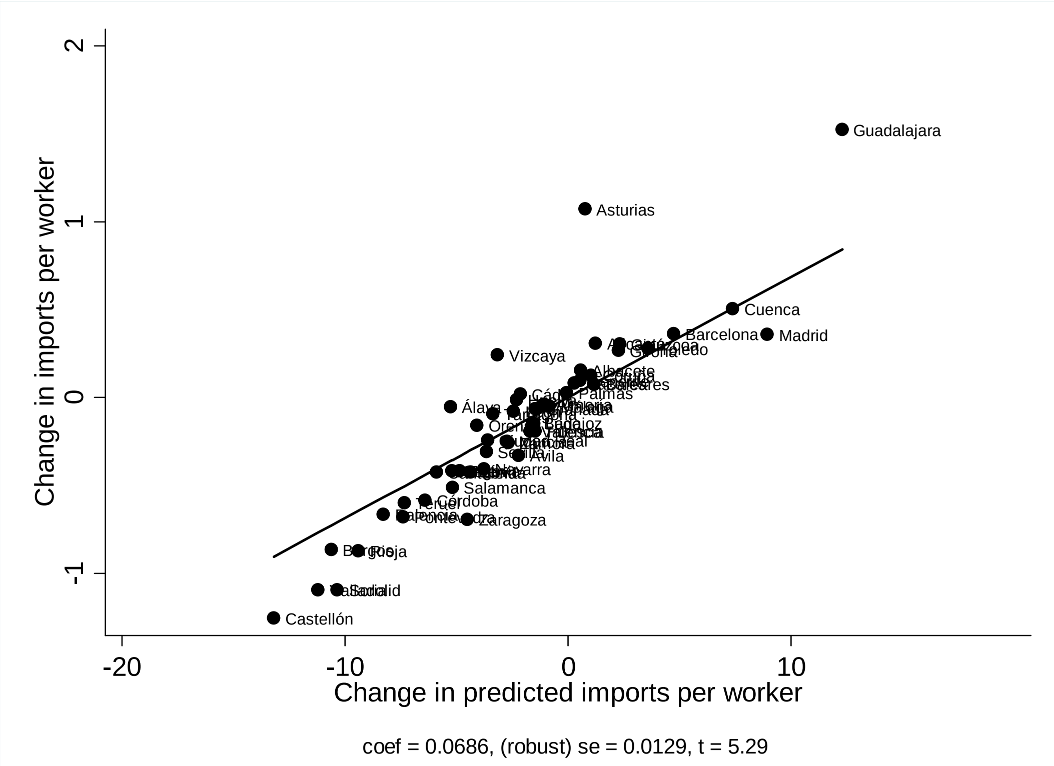
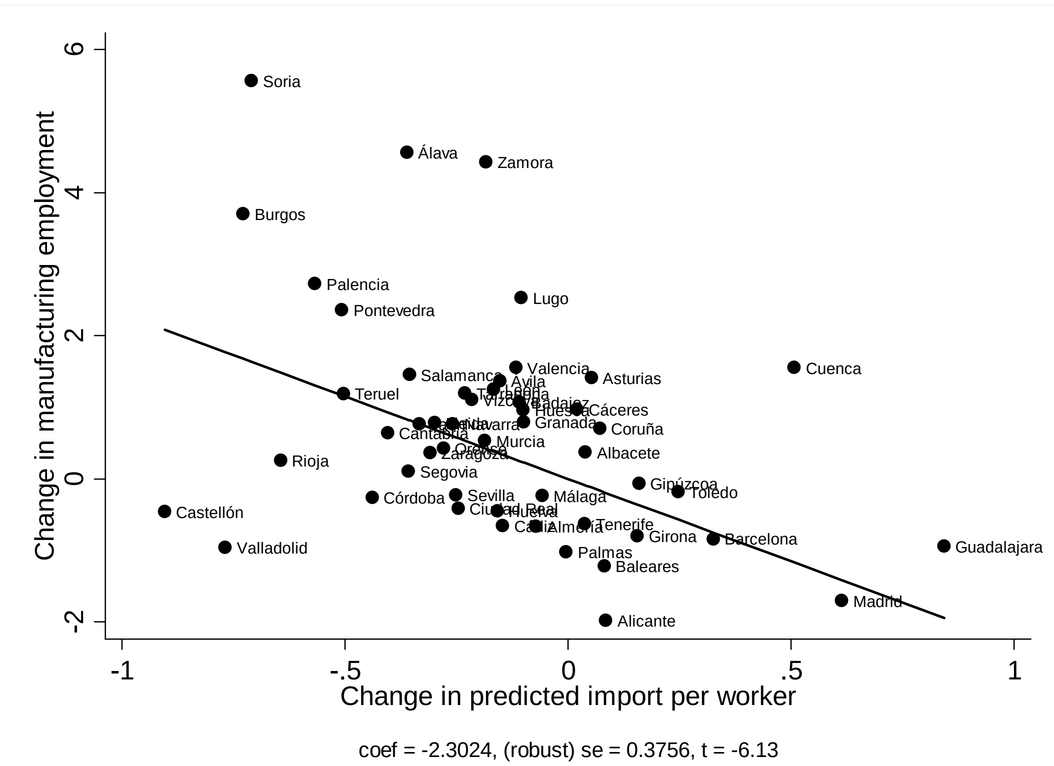


Figure 6. Partial regression plot between import exposure and change in manufacturing employment in Spain, IV (2SLS), 1999-2007 (full sample).

First-stage regression



Second-stage regression



[1] Figures have been calculated from the World Trade Organization and World Bank databases, available at www.wto.org and www.worldbank.org, respectively.

[2] Cadarso *et al.* (2008) find that outsourcing to Eastern and Central European countries reduced employment in Spanish industries characterized by medium-high technology.

[3] See also López-Bazo *et al*. (2005).

[4] Spain is divided into 52 provinces. Due to their special circumstances and the lack of data for several variables, we exclude from the sample the two Spanish provinces located in Africa (Ceuta and Melilla).

[5] As the dependent variable and the independent variable are first differences, the estimation results are equivalent to the estimates of a regression where the dependent variable and the independent variable are measured in levels, and province-level fixed effects are introduced.

[6] The regression coefficient is similar to the one obtained for the full sample period in Figure 5.

[7] All individuals with nationality in high-income countries (World Bank classification) are not included as foreign nationality population.

[8] Working age population between the ages 16 and 24.

[9] The house price data was obtained from the Spanish Ministry of Public Works.

[10] During the period 1999-2007, the construction sector demand for inputs from the manufacturing sector accounted for around one third of the construction sector's total demand for inputs, and 10% of total production in the manufacturing sector (Source: Spanish input-output table 1999-2007).

[11] The mean annual growth rate of the real mean wage along the period 1999-2007 was 2.0% in the construction sector, 1.2% in the manufacturing sector, and 1.3% in the overall economy (Source: Spanish Tax Agency and Spanish National Institute of Statistics).

[12] Data for ICT, R&D expenditure, Patents, and K-L ratio were obtained, respectively, from EU KLEMS, the OECD STAN database, the Spanish Office of Patents and Trademarks (OEPM), and the Spanish National Institute of Statistics.

[13] We refer to these countries as EU-14 throughout the paper.

[14] The probability values for the *t* statistics are now 0.11 and 0.13, respectively.

[15] The share of manufacturing employment over the working-age population was 10.4% in 1999, 10.7% in 2003, and 10.1% in 2007. The number of manufacturing workers was 2,762,000 in 1999, 3,016,000 in 2003, and 3,037,000 in 2007. These data correspond to the second quarter of the corresponding year.

[16] Autor *et al*. (2013, Theory Appendix) perform a decomposition to calculate the share of the variance in imports per worker that stems from the exogenous supply-driven component. They obtain that a 48% of the observed variation in rising Chinese import exposure is due to the supply-driven component, with the remainder attributed to demand factors.

[17] See Levine and Renelt (1992).

[18] To save space, we report only the estimated results for the import exposure variable.

[19] Bulgaria, Czech Republic, Hungary, Estonia, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

[20] Data for CEECs imports to Spain by industry are obtained from the UN Comtrade database.

[21] Data for Spanish exports by industry are obtained from the UN Comtrade database.

[22] Data on EU-14 exports to China are obtained from the UN Comtrade database.

[23] See for example Bentolila (1997).

[24] The mean annual growth rate along the period was 4.2% (1.2% in the US and 1.5% in the EU-15).

[25] Apart from manufacturing, the industry sector includes mining and quarrying, recycling, and electricity, gas, and water supply activities. Plausibly, the bias effect should be negligible since the manufacturing activities represent 94% of employment in the industry sector.

[26] See notes 13 and 39 in Autor *et al.* (2013).

[27] Results are available upon request to the authors.

[28] See for example Arapaia and Pichelman (2007), Holden and Wulfsberg (2008), Bentolila *et al.* (2010)