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ABSTRACT

Collateral Damage? Labour Market Effects of Competing with China – at Home and Abroad*

The increased range and quality of China's exports is a major ongoing development in the international economy with potentially far-reaching effects. In this paper, on top of the direct effects of increased imports from China studied in previous research, we also measure the indirect labour market effects stemming from increased export competition in third markets. Our findings, based on matched employer-employee data of Portugal covering the 1991-2008 period, indicate that workers' earnings and employment are significantly negatively affected by China's competition, but only through the indirect 'market-stealing' channel. In contrast to evidence for other countries, the direct effects of Chinese import competition are mostly non-significant. The results are robust to a number of checks and also highlight particular groups more affected by indirect competition, including women, older and less educated workers, and workers in domestic firms.

JEL Classification: F14, F16, F66, J31

Keywords: international trade, labour market, matched employer-employee data, China, import competition

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1 Introduction

The impact of international trade on labour markets is a classical question (Stolper and Samuelson, 1941) which is currently subject to greater interest. Over recent decades, not only has international trade grown strongly but its pattern has also evolved significantly: global value chains emerged as a new paradigm for the international organisation of production while new, labour-intensive countries have become key players in the world market (Krugman, 2008; Hanson, 2012).

In this context, a number of recent studies have examined the micro-level effects of rising imports on different groups of workers (e.g. Autor et al., 2014 and Dauth et al., 2018), generally focusing on the cases of large developed economies or countries with specialisation patterns different from those of emerging economies. This research has documented substantial adjustment costs in the domestic industries most exposed to imports from developing countries, in particular China. These distributional consequences have also led to qualifications regarding the, until recently, very positive views regarding the welfare gains from international trade.

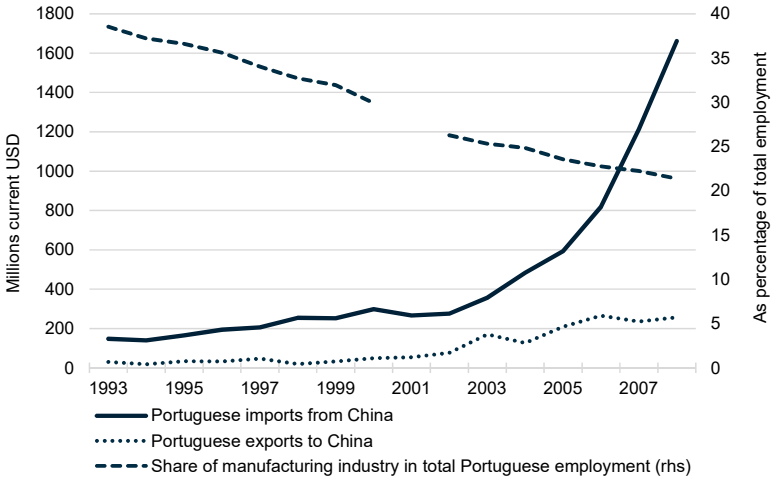
In this paper, we focus on the *indirect effects* stemming from the increased competition that one country can generate in the export markets of other economies, focusing explicitly on the case of China. In other words, China can affect the labour market of country A not only because of its exports to that country but also by reducing the exports of country A to country B as China increases its exports to country B. Specifically, we propose different measures of this indirect effect and analyse their labour market effects.

This indirect, 'market-stealing' effect can become increasingly important for high-income countries, including the US or Germany, as China's exports are increasingly more diversified and sophisticated, while also less reliant on low-wage labour. For less developed countries, the additional competitive pressures in international markets posed by developing economies in East Asia, in particular China, have already been in play for several years. In fact, the large export market share gains of China in low-tech, low-skill products, like textiles, clothing, footwear, electric appliances, and toys, were accompanied by losses in the export shares of those industries of several other countries.

Our empirical evidence on both the direct and indirect labour market effects of China's emergence in international trade is based on the case of Portugal. As a (small) open economy with a comparative advantage profile more comparable to that of China than most other developed economies (Cabral and Esteves, 2006), Portugal is an interesting country not only to revisit the direct relationships examined in the literature but also to illustrate the largely undocumented indirect effects that we propose here. Indeed, China's share in goods imports from Portugal more than tripled, reaching a level in 2008 more than eleven times higher than the

one of 1993 (Figure 1). At the same time, the share of total employment in manufacturing in the country nearly halved over the period we consider (1993-2008) and economic growth during this period was always low (except for 1996-2000).

Figure 1: Portuguese international trade with China and manufacturing employment in Portugal



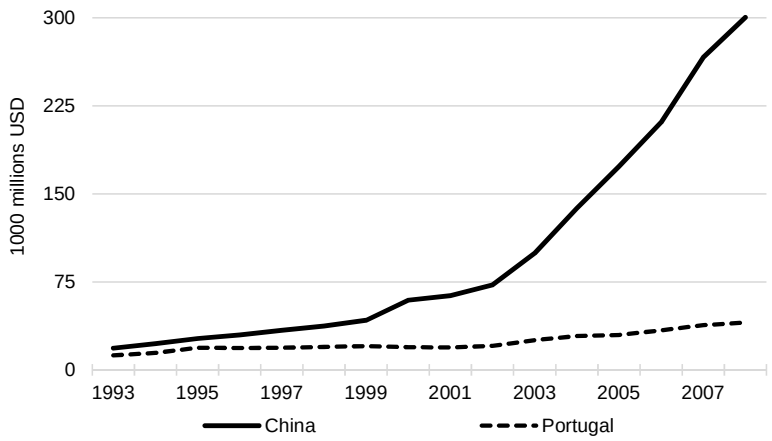
Sources: CEPII - CHELEM database and Quadros de Pessoal (QP)
Notes: Portuguese goods imports from (exports to) China in millions of current US dollars on the left scale and share of full-time employees working in the Portuguese manufacturing industry, as a percentage of total full-time private employment on the right scale.

On top of the direct effects, stemming from much larger increases in exports from China to Portugal than the other way around, Figure 2 highlights the potentially intensified competition from China faced by firms in Portugal in terms of exports to the European Union (EU) markets.[1] Between the early 1990s and 2008, the large increase of Chinese exports to these markets was contemporaneous to a relatively subdued growth of Portuguese exports. Zooming in, Figure 3 depicts a form of the indirect effects that we also consider in this paper, the changes in industry market shares of China and Portugal in the EU market between 1993 and 2008, finding suggestive evidence of a negative relationship between the two variables. Greater increases in the market shares of China's exports tend to be associated with larger losses in the market shares of Portuguese exports. This is particularly the case in industries that accounted for a substantial proportion of Portuguese exports in 1993. This pattern is also consistent with the evidence in Dauth et al. (2014) that rising Chinese exports lead to a strong diversion of German imports from other (mostly European) countries.

Our empirical analysis of the labour market impacts accrued from the direct and indirect effects of China's emergence is based on a matched panel database covering all firms with at least one employee in Portugal over the period 1991 to 2008. More precisely, our main sample comprises individuals that were full-time employed both in 1991 and in 1993, who are

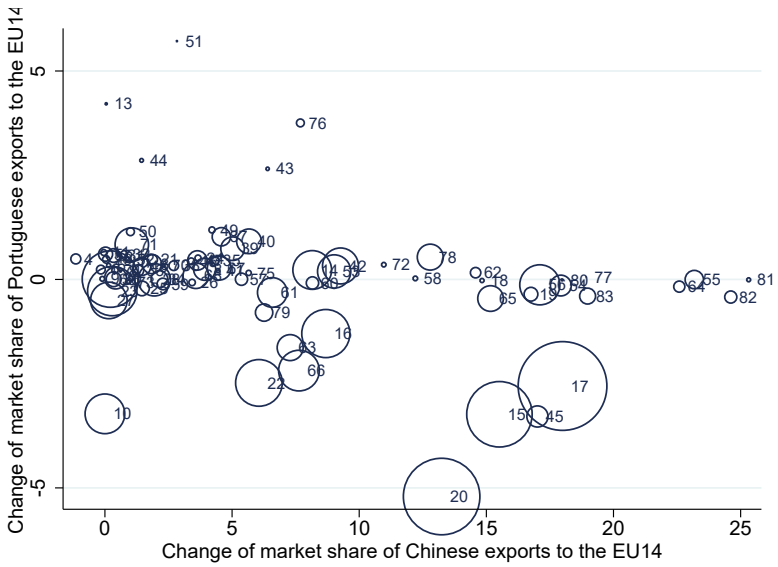
[1] A different direct impact, which we also examine, is the enhanced export opportunities for Portuguese firms to China, which also increased significantly but 'only' by a factor of six.

Figure 2: Nominal exports of China and Portugal to the European Union



Source: CEPII - CHELEM database.
Notes: Chinese and Portuguese exports to the 15 original Member States of the European Union excluding Portugal (EU14). Data in 1,000 millions current US dollars.

Figure 3: Changes in export market shares of China and Portugal in the European Union (1993-2008)



Source: Authors' calculations based on the CEPII - CHELEM database.
Notes: EU14 refers to the 15 original Member States of the European Union excluding Portugal. Export market shares computed as Chinese (Portuguese) exports to the EU14 divided by total imports of the EU14, by industry. Changes in percentage points from 1993 to 2008. The size of each circle is proportional to the value of Portuguese exports of that industry to the EU14 in 1993. The description of the 83 manufacturing industries considered is included in Appendix A.

then followed until 2008 so that we can examine their cumulative wage earnings and years of employment over the 1994-2008 period. We exploit the comprehensiveness and richness of the data to examine how these workers were affected by China's exports not only to Portugal but also to other markets that Portuguese firms traded with. Our identification strategy is inspired by a number of influential articles by David Autor, David Dorn, Gordon Hanson, and several co-authors which combine nationwide changes in sector-specific import exposures with the national industry affiliation of workers (Autor et al., 2014; Autor et al., 2015; Acemoglu et al., 2016).[2] As before, we exploit the fact that the significant rise of China from a closed to a market-oriented economy and the world's largest exporter was sudden, largely unexpected, and motivated by exogenous factors such as changes in domestic policies and in trade agreements.[3] To account for possible endogeneity issues due to unobserved domestic (demand-side) conditions, rather than by rising Chinese productivity and market accessibility (supply-side) factors, these papers propose an instrumental variable (IV) approach, which we also follow.

Consistent with previous research, we find evidence of negative effects from China's emergence in international trade in the labour market of a developed economy, in this case Portugal. However, in striking contrast to evidence for other countries, the direct effects of China import competition on the domestic labour market of Portugal are mostly non-significant. Here, the negative labour market effects associated with China's emergence result mainly from the resulting losses in Portugal's export market shares, not from the growth in Portugal's imports from China. Moreover, the impacts of competition from China exhibit some heterogeneity across individuals, with older, less educated, female and domestic-firm workers suffering higher employment and earning losses. Overall, our methodology and findings contribute to a better understanding of the full range of existing and potential labour market effects around the world of emergence and ongoing growth of China - as of other countries.

The remaining of the paper is organised as follows. Section 2 discusses some of the related research that frames this study. Section 3 details our data sources and identifying assumption whereas Section 4 outlines our econometric framework. Section 5 presents our estimation results. Finally, Section 6 concludes.

2 Related Literature

A number of recent papers have analysed how domestic labour markets adjust to the changes in international trade associated with the integration of low- and middle-income countries into the global economy. In this section, we present a non-exhaustive review of studies that

[2] The same empirical strategy has been used to study whether import competition increased voters' support for extreme populist parties in the US (Autor, Dorn, Hanson and Majlesi, 2016) and in Germany (Dippel et al., 2017).

[3] See Hsieh and Klenow (2009); Hsieh and Ossa (2016); and Brandt et al. (2017).

are closely related to our study and provide a framework for our analysis (see Autor, Dorn and Hanson (2016) and Muendler (2017) for comprehensive surveys of this research). This literature has focused on three main levels of analysis: the local labour market, the firm, and the worker.[4]

In the first level of analysis, an important contribution by Autor et al. (2013) examines the effect of rising Chinese competition on US local labour markets, exploiting cross-market variation in exposure stemming from differences in industry specialisation. Instrumenting US imports with changes in Chinese imports by other high-income countries, Autor et al. (2013) conclude that rising imports from China caused higher unemployment and reduced wages in US local labour markets that host import competing manufacturing industries. The same methodology is followed by Dauth et al. (2014) for Germany, Balsvik et al. (2015) for Norway, Donoso et al. (2015) for Spain, Mendez (2015) for Mexico, Costa et al. (2016) for Brazil, Pereira (2016) for Portugal, and Malgouyres (2017) for France. Recently, Feenstra et al. (2017) also find a negative effect of Chinese import competition on US employment, but argue that this effect was largely offset by the global expansion of US exports.

Other papers study additional dimensions of firms' reactions in response to the same type of international trade shocks. In a seminal paper, Bernard et al. (2006) show that plant survival and growth are lower in US manufacturing industries facing higher exposure to imports from low-wage countries. Evidence that greater Chinese import competition tends to increase plant exit and reduce firms' sales and/or employment growth is available for Chile (Álvarez and Claro, 2009), Mexico (Iacovone et al., 2013), Belgium (Mion and Zhu, 2013), Denmark (Utar, 2014), and for a panel of firms from twelve European countries (Bloom et al., 2016).

Empirical evidence at the worker-level, the level of analysis that we also follow in this paper, is scarcer. Autor et al. (2014) study labour adjustment costs analysing the effects of Chinese trade exposure on earnings and employment of US workers from 1992 through 2007. Their findings suggest that workers who experienced higher subsequent import growth in their original industries of employment gained lower cumulative earnings. These workers also faced an elevated risk of receiving public disability benefits vis-à-vis other individuals working in less exposed manufacturing industries. Moreover, affected workers spent less time working for their initial employers and in their initial 2-digit manufacturing industries.

Following the same econometric strategy, Ashournia et al. (2014) exploit data from Danish workers and find that Chinese import penetration decreases wages for low-skilled employees while Hakkala and Huttunen (2016), using Finnish worker-firm data merged with product-level trade data, distinguish between import competition in final products and offshoring. Their results indicate that both types of competition increase the job loss risk for all workers,

[4] In a different vein, Amiti et al. (2017) provide evidence on the consumer benefits from international competition. They show that the lowering of Chinese import tariffs enhanced China's competitiveness and translated into a decline of the US price index for manufactured goods.

in particular for those in production occupations. Majlesi and Narciso (2018) find that individuals living in a municipality more exposed to Chinese import competition are more likely to migrate to other municipalities within Mexico. In contrast, this trade shock reduces the likelihood of migrating to the US. Finally, Pessoa (2018) concludes that import competition from China significantly decreases UK workers' years of employment and earnings, with high skilled workers suffering lower losses.

Dauth et al. (2018) examine the impact of rising international trade exposure on individual earning profiles of German manufacturing workers. They complement Autor et al. (2014) by focusing on both imports and export shocks, not only from China but also from Eastern European countries, and by studying the effects among heterogeneous employer-employee matches as well as the reallocation process in response to trade shocks. Their results contrast significantly with those found in the US context. For Germany, this particular globalisation episode was mainly positive, but there were winners and losers. High-skilled workers benefited the most from the increased export opportunities, while the incidence of import shocks fell mostly on low-skilled workers. In a related paper, Dauth et al. (2017) estimate the aggregate effects of rising trade with China and Eastern Europe on the German labour market and, in particular, on the composition of service versus manufacturing jobs. They find that, in contrast to the US, these trade shocks did not accelerate the secular decline of manufacturing (rise of service) employment in Germany.

Most studies on the impact of China's emergence in international trade on the labour markets of developed countries are focused on what we refer to as the direct effects of China's imports. As explained above, we argue that the impact of indirect effects stemming from greater export competition from China may be as important. In this regard, Flückiger and Ludwig (2015) use product-country level data and show that increased Chinese competition in the export markets induces a contraction in the European countries' manufacturing sectors, with significant negative effects on output and employment. In a different vein, Mattoo et al. (2017) estimate the effect of movements in China's exchange rate on the exports of other developing countries in third country markets. They find that exports to third markets of countries facing greater import competition from China tend to rise (fall) more as the renminbi appreciates (depreciates). At the firm-level, Utar and Ruiz (2013), using data for Mexican exporters, show that intensified Chinese competition in the US had a negative effect on employment, especially on the most unskilled labour sectors. However, they also present evidence of industrial upgrading in response to the shock. Additionally, Martin and Mejean (2014) reveal how foreign competition from low-wage countries impacted the quality content of French exporters. They show that the improvement is more pronounced in markets that faced higher competition.

Our paper contributes to this research by focusing on worker-level effects and offering a template for analysis that can be followed by other researchers also interested in quantifying

the magnitude of indirect effects of international trade competition in export markets.

3 Data and Identification

3.1 Industry Trade Shocks

One of the main structural changes of the world economy in recent decades has been the integration of China in international trade. Since the early 1990s and, in particular, after its accession to the World Trade Organisation (WTO) in 2001, Chinese trade flows have exhibited strong growth, gaining market shares and creating significant competitive challenges to most developed countries. The period we consider for the shock is between 1993 to 2008, comprising much of China's export boom. The decision to end the analysis in 2008 was dictated by the great recession of that year which was followed by a significant decline in international trade worldwide.

In this section, we describe the measures of workers' exposure to trade with China that we use. First, we consider a standard measure of direct import competition from China in the Portuguese domestic market. Second, we assess the indirect effect of competition from China in foreign markets to which Portuguese producers export. Third, we describe the instrumental variable approach used.

Following Autor et al. (2014), the direct import exposure to China of a specific Portuguese industry j over the τ period 1993-2008 can be measured as the change of its import penetration ratio:

$$\triangle IPdir_{j,\tau} = \frac{\triangle M_{j,\tau}^{chn \to prt}}{WB_{j,93}}, \tag{1}$$

where $M_j^{chn \to prt}$ represents Portuguese imports from China for a specific industry j and $\triangle M_{j,\tau}^{chn \to prt}$ is the change of the latter over the period τ, 1993-2008. $WB_{j,93}$ is the total wage bill of industry j in 1993, which is used as a proxy of the initial industry size. Due to data restrictions, it is not possible to use the initial domestic absorption to normalise each industry's imports, as in Autor et al. (2014), thus we follow Dauth et al. (2018) and use the total wage bill to normalise the change in trade flows at the industry-level.

As we discussed before, the level of bilateral trade between two countries does not necessarily reflect the degree to which the two countries compete in international markets. In fact, the strong growth of Chinese exports can impact the Portuguese manufacturing sector not only through intensifying competition in the domestic market, but also in foreign markets where Portuguese firms compete with China. In the case of Portugal, as in many other countries, we expect this effect to be particularly relevant given that the product specialisation

of the Portuguese exports is relatively similar to the one of China in this period (Cabral and Esteves, 2006). The other 14 original member-states of the European Union (EU14) as a whole constitute the most important destination of Portuguese exports, representing around 80 percent of total exports of goods in 1993-2008. Hence, we select these EU14 countries as the third markets where the competition from Chinese products will be assessed.

The main measure of indirect import competition from China in each industry j from 1993 to 2008 that we propose in this paper is:

$$\triangle IPind_{j,\tau} = \frac{\sum_{C=1}^{14} \omega_{j,93}^{prtC} \triangle M_{j,\tau}^{chn \to C}}{WB_{j,93}}, \qquad \text{with} \qquad \omega_{j,93}^{prtC} = \frac{M_{j,93}^{prt \to C}}{M_{j,93}^{\to C}} \tag{2}$$

where $\omega_{j,93}^{prtC}$ is the share of Portugal on total imports of each EU14 country C in each industry j in 1993, $M_{j,93}^{prt \to C}$ are imports from Portugal by country C and industry j (i.e., industry j Portuguese exports to country C) and $M_{j,93}^{\to C}$ are the total imports of country C of industry j. This weight is then multiplied by the change in the absolute value of imports of country C from China from 1993 to 2008 by industry j, $\triangle M_{j,\tau}^{chn \to C}$. The measure is normalised by the wage bill of industry j in Portugal in 1993, similarly to Equation (1).

Equation (2) is a measure of competition of Chinese products in the EU14 market, computed as a weighted average of the change in Chinese exports to each EU14 country by industry, where the weights are the initial shares of Portuguese exports in the imports of each individual destination market. The notion of individual market used herein refers to each j,C market, measured as imports of industry j by EU14 destination country C corresponding to a total of 1,162 individual markets (83 industries $*$ 14 countries). Intuitively, this means that, in each industry and destination country, Portuguese exports will be affected by the increased competition from China in a way that is proportional to its initial export share in that individual industry-country market. For instance, a Portuguese industry with a large market share in Spain in 1993 can be expected to be more exposed to competition from China if Spain subsequently increases its imports from China of these products compared to a Portuguese industry that only has a minor export market share in Spain. We also consider a complementary measure in our robustness checks.

The direct and indirect measures above, when taken together, reflect the competition from China faced by Portuguese firms both in the domestic market, Equation (1), and in its main destination markets, Equation (2). As discussed in the literature, a problem with Equation (1) as a metric of trade exposure is that the observed changes in Portuguese bilateral trade flows with China can reflect also Portuguese supply and demand shocks rather than just China's growing productivity and falling trade costs. To capture the China-driven effect on Portuguese trade with China, we follow the cited literature and instrument this direct import competition variable using Chinese exports to other countries with comparable income lev-

els. The countries were selected based on their income similarity to Portugal using data on GDP per capita on purchasing power parities (PPP) in constant 2011 international dollars over the 1993-2008 period from the World Development Indicators of the World Bank, excluding all members of the EU. Our final instrument group consists of 7 non-EU high and upper middle-income countries: Argentina, Chile , Uruguay , Mexico, Turkey, Israel and New Zealand. We expect correlations in industry-level demand and supply shocks between Portugal and these countries, and potential exogenous effects of shocks in these countries on the Portuguese labour market, to be minor. Nonetheless, we execute a robustness check where we modify the countries in the instrument group. The instrument is defined as follows:

$$\triangle IPO_{j,\tau} = \frac{\triangle M_{j,\tau}^{chn \to O}}{WB_{j,91}}, \tag{3}$$

where $M_j^{chn \to O}$ are imports of the 7 selected countries from China in industry j. The measures are normalised by the wage bill of the respective industry j in Portugal in 1991.

Given the small relative size of the Portuguese economy, the measure of exposure to competition from China in export markets defined in Equation (2) is arguably determined independently of Portuguese trade and labour market shocks (see Balsvik et al. (2015) for a similar argument for Norway). Moreover, since the seminal paper of Bayoumi and Eichengreen (1992), the picture that emerged from the large body of literature on business cycle synchronisation in the euro area is that the Portuguese cycle is among those with the lowest correlation with the euro area cycle and, in particular, the correlation of demand shocks in Portugal is very low (see for Haan et al. (2008) for a review of this literature and Belke et al. (2017) for a recent application). Hence, we argue that the growth in imports from China of a given industry by each EU14 country is exogenous to the domestic conditions in that industry in Portugal and do not instrument the measure of indirect competition of Equation (2).[5]

The international trade data we use is from the CEPII - CHELEM database, which reports bilateral trade flows of goods, expressed in millions of current dollars, since 1967. The database comprises 84 countries, a World aggregate, and 121 different manufacturing products, with a breakdown at the 4-digit level of the International Standard Industrial Classification of All Economic Activities (ISIC), rev.3.[6] After several reconciliation procedures, these 121 products were grouped into 83 manufacturing industries based on the most disaggregated level of ISIC rev.4. The description of the main steps that we took to reconcile international trade and labour market data, as well as of the 83 trade-exposed industries, is included in Appendix A.

All nominal trade flows were converted to 2008 euros using the Consumer Price Index (main-

[5] Donoso et al. (2015) follow a similar strategy in their assessment of the effects of exposure to China in Spanish local labour markets.
[6] See De Saint-Vaulry (2008) for a detailed description of this database.

land Portugal, excluding housing) and the following official exchange rates: escudo/ECU and ECU/dollar until 1998 and euro/dollar from then onwards.

3.2 Worker-level Outcomes

Our labour market database is *Quadros de Pessoal* (QP), an administrative dataset covering virtually all employees and firms based in Portugal, including their unique and time-invariant identifiers and the firm-worker match. All firms, excluding public administration organisations, with at least one employee are obliged by law to provide this information to the Ministry of Labour and also to exhibit it in the firm to facilitate monitoring and compliance with labour law. The reference month regarding the employee data is October of each year (March until 1993).

The data also provides, for each year, a large number of firm variables (e.g. location, industry, sales, total employment) and worker characteristics (e.g. schooling, gender, different types of earnings, occupation). The earnings measure we adopted includes the base wage (monthly gross pay for normal hours of work) and the regular subsidies and premiums paid on a monthly basis. Our analysis focused on full-time workers (in any case a large majority of workers) and workers paid at least 80 per cent of the minimum wage.[7]

We analyse the years between 1991 and 2008 (except 2001 for which worker-level data is not available). Our sample includes workers aged 15 to 65 throughout the whole period of 1991-2008 (i.e., 15-48 in 1991 and 32-65 in 2008). We consider only individuals employed both in 1991 and in 1993 (but not necessarily in 1992), to guarantee a minimum degree of labour force attachment in the years prior to the outcome period (and to establish a more representative measurement of the workers' reference wages, as explained below). Our main sample consists of $602,073$ different workers employed in 1991 and 1993 in either manufacturing or non-manufacturing sectors, who we then follow annually every year until 2008, of which $283,272$ individuals are employed in the manufacturing industry in 1991 and 1993.

We use two main worker-level outcomes: (real) wage earnings and years of full-time employment, both computed over the 1994-2008 period.[8] We follow Autor et al. (2014) and define the wage outcome variable as the cumulative (real) earnings of a worker from 1994 to 2008, divided by the average earnings of 1991 and 1993 (base wage). Periods of non-employment in the sample are considered as zero earnings. As to the second main outcome variable, on employment over the period, we use the number of times (in the October census month) that an individual is present in the data set (implying that the individual has a private sector labour contract in each year).[9]

[7] By law, workers formally classified as apprentices can receive a minimum wage that is, at least, 80 per cent of the full rate. We also dropped a small number of individuals with missing information in key variables such as gender, age, and industry.

[8] Nominal wages were inflated to 2008 euros using the Consumer Price Index (Portugal mainland, excluding housing).

[9] Given the nature of the data set, non-employment could represent unemployment, inactivity, emigration or death but also self-

3.3 Descriptive Statistics

Table 1 provides descriptive statistics for our main variables. The key dependent variable, relative cumulative earnings, was multiplied by 100 and presents an average value of 1,040. This means that, on average, cumulative (real) earnings from 1994 to 2008 (a 14-year period, as data for 2001 is not available) were more than 10 times higher than the average (real) earnings experienced in 1991 and 1993. Manufacturing workers cumulatively earned, on average, 9.5 times their initial average monthly earnings, while non-manufacturing workers, who were not directly exposed to the shocks (defined in terms of imports and exports of goods), cumulatively earned 11.1 times their initial average monthly earnings.

Our second depend variable is defined as cumulative years of full-time employment in the private sector over the same 14-year period. We find that, on average, a worker has almost 8 years with positive earnings, which represents approximately 57 percent (8/14) of the outcome period. Considering the 25th and 75th percentiles, this variable ranges between 5 and 12 years of employment (main sample) and 5 and 11 years (manufacturing only).

Among workers initially employed in a manufacturing industry, the average increase in the direct import penetration ratio faced by workers was 1.9 percentage points. However, the average increase in China's import competition is almost four times bigger (7.0 percentage points) in the case of the indirect import penetration ratio, again for workers (originally) in manufacturing industries.

There is a considerable heterogeneity of the individual trade exposure measures among workers. The 25th/75th percentile dispersions are much higher in the case of the indirect import competition indicator (over 15 percentage points) than in the case of the direct import penetration (1 percentage point). In other words, from 1994 to 2008, the worker at the 75th percentile experienced a 35 times stronger increase in indirect import competition than the worker at the 25th percentile (almost 4 times stronger for the direct import penetration measure). The instrument displays values that are similar to the ones of the indicator of direct import penetration. All these figures are significantly smaller when all (manufacturing and non-manufacturing) workers are considered: 53 percent of the full-sample workers were employed in non-manufacturing industries in 1993 and their import penetration ratios are zero by definition.

employment, part-time activity, measurement error, or employment as a civil servant. Given the nature of the labour market and the definition of the sample as of 1993, the first two outcomes (unemployment and inactivity) are by far the most important cases.

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	P25	P75
All workers				
Base Wage (average 1991 and 1993)	844.233	577.713	490.380	994.886
Dependent variables (1994-2008)				
Cumulative Earnings	1040.914	710.148	513.844	1485.4
Cumulative Employment	7.982	4.295	5	12
China Shock variables (1993-2008)				
$\triangle IPdir_j$	0.901	5.346	0	0.695
$\triangle IPind_j$	3.303	7.577	0	2.448
$\triangle IPO_j$	0.044	0.483	0	0.031
Manufacturing workers				
Base Wage (average 1991 and 1993)	718.913	474.587	452.232	799.618
Dependent variables (1994-2008)				
Cumulative Earnings	953.145	624.877	503.127	1343.705
Cumulative Employment	7.681	4.058	5	11
China Shock variables (1993-2008)				
$\triangle IPdir_j$	1.914	7.668	0.358	1.367
$\triangle IPind_j$	7.020	9.794	0.444	15.598
$\triangle IPO_j$	0.094	0.701	0.017	0.069

Notes: The main sample includes 602,073 workers employed in 1991 and 1993 in both the manufacturing and non-manufacturing sectors. The sample of workers employed only in manufacturing in 1991 and 1993 includes 283,272 workers. By definition, non-manufacturing workers have zero trade exposure with China. Base wages in 2008 euros. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993 (base wage); Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1), the variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, which is defined in Equation (3) and uses imports from China of seven selected countries. Given the large scale of the flows, the instrument variable is divided by 1000.

4 Econometric strategy

Our empirical analysis takes a medium-run perspective regarding the international trade impact of China on workers' cumulative wages and employment. The equation of the direct effects of import competition is specified as follows:

$$Y_{i,\tau} = \beta_0 + \beta_1 \triangle IPdir_{j,\tau} + \beta_3 X_{i,93} + \beta_4 X_{f,93} + \beta_5 X_{j,93} + \varepsilon_{i,\tau}, \quad (4)$$

where $Y_{i,\tau}$ is the dependent variable of interest for worker i employed in firm f in industry j in 1993, namely the cumulative earnings over 1994 to 2008 normalised by the average earnings in 1991 and 1993; or the number of years when that individual was employed in the private sector over the same 1994-2008 period. The coefficient of interest is β_1, which measures the impact of the change in direct import exposure to China from 1993 to 2008, with $\triangle IPdir_{j,\tau}$ defined in Equation (1), based on the industry in which the worker was employed in 1993.

The econometric estimations of the next section will also assess the impact of changes in indirect competition from China in export markets. The extended version of the previous equation considering the roles of the direct and indirect variables together is specified as

follows:

$$Y_{i,\tau} = \beta_0 + \beta_1 \triangle IPdir_{j,\tau} + \beta_2 \triangle IPind_{j,\tau} + \beta_3 X_{i,93} + \beta_4 X_{f,93} + \beta_5 X_{j,93} + \varepsilon_{i,\tau}. \quad (5)$$

where the indirect dimension $\triangle IPind_j$ is defined in Equation (2). As in Autor et al. (2014), all regressions include individuals working in the 83 manufacturing industries that were trade-exposed to China, as well as workers employed in non-manufacturing sectors, which, by definition, have zero (goods) trade exposure. In the robustness section, we also estimate the regressions using only the smaller sample of workers employed in the manufacturing industry in 1991 and 1993.

A number of workers' characteristics that potentially affect wages (and may be correlated with different import exposures) are included in the vector $X_{i,93}$, depending on the specification, namely a female dummy variable, eight formal schooling categories, and eight formal categories of worker's qualifications.[10] We also included quadratic polynomials in age and in tenure to account for the fact that wages tend to increase at a decreasing rate with years in the labour market and with years of experience in the same firm.

$X_{f,93}$ is a vector of firm-level controls in 1993 that includes two variables capturing the size of the firm - the number of employees and the logarithm of turnover (annual sales) -, the share of equity owned by the government, and twenty eight regional dummies (NUTS 3 level). In addition, the share of foreign equity (a measure of foreign ownership) is also included, following recent evidence of differentiated wage and hiring policies of foreign-owned firms (Hijzen et al., 2013).

Despite the large set of controls already included, we may still miss some potentially relevant controls at the sector level, such as technology-related variables. To minimise this potential issue and absorb additional heterogeneity across individuals, we also include dummy variables for 9 broad aggregate sectors computed based on the 83 trade-exposed manufacturing industry (the omitted category is the non-manufacturing sector).[11] This means that the regressions estimate the impact of the trade shock from differences across sub-industries of each given broad sector. Moreover, we add a measure of overall import penetration of the industry in 1993, to control for other shocks associated with a greater level of imports of an industry that can be confounded with trade with China.

Furthermore, robust standard errors are clustered at the start-of-the-period industry level. More precisely, within the manufacturing industry standard errors are clustered at the level of the 83 industries of the trade shock. For non-manufacturing sectors, the standard errors are clustered at the 2-digit level of ISIC rev.4. Overall, standard errors are adjusted for 235

[10] Blanchard and Willmann (2016) find that individual gains from trade may be non-monotonic in workers' ability.

[11] The 9 aggregates are food, drinks and tobacco; textiles, clothing and footwear; wood and paper; chemicals; plastics, glass and rubber; metals; machinery, equipment and electronics; transport equipment; others. Appendix A includes the description of the manufacturing industries included in each aggregate.

clusters.

As discussed in the previous section, the regressions estimated by two-stage least squares (IV) use the variable described in Equation (3) as instrument of the direct effects of import competition. Appendix B presents the main descriptive statistics of the control variables used in the analysis.

5 Empirical results

In all regression tables, OLS results are contrasted with IV regressions. Panel A presents the results in which the dependent variable is cumulative earnings, computed by adding up individual labour wages from 1994 to 2008 and then normalising that sum by the average earnings of the same individual in 1991 and 1993. Panel B reports results for one further labour market outcome as the dependent variable: the number of years that an individual spent working in the private sector, as a full-time employee. To rule out other possible confounding mechanisms, vectors of controls are added at the individual, firm, and sectoral levels. In Columns (2) we use the same set of controls as in Columns (6) – individual, firm and sector controls.

5.1 Baseline Results

In this subsection we present the baseline results for the full sample. The results considering only the direct impact are presented in Table 2, in which the key regressor of interest is $\triangle IPdir_j$ as in Equation (1), instrumented with imports from China of seven other countries as in Equation (3). As can be seen, the instruments appear to be strongly partially correlated. Regardless of the specification and estimation method, we always find a non-statistically significant association between the Chinese direct import penetration measure and both cumulative earnings (Panel A) and cumulative years of employment (Panel B).[12] These results indicate that, in contrast to the countries considered so far in the literature, imports from China did not have a significant negative effect upon the Portuguese labour market outcomes up to 2008.

These findings may be driven by the magnitude of the shock itself, with potentially greater penetration of Chinese imports in the US than in Portugal. Another possible reason for the lack of evidence of negative direct effects in Portugal may reside on product quality upgrading by firms in sectors that experience a rise in their domestic trade competition from Chinese imports. These results and interpretation would be consistent with evidence for other countries: Bloom et al. (2016) find that Chinese import penetration correlates positively with

[12] In all specifications, standard errors are clustered at the start-of-period sector-level. All controls have the expected signs. Results reporting the complete set of estimates are available from the authors upon request.

Table 2: Baseline Results: Direct Effects

	OLS		IV			
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A. Cumulative Earnings			
$\triangle IPdir_j$	-1.469	-0.116	-0.386	-0.363	-0.205	0.251
	(1.440)	(0.608)	(0.959)	(0.537)	(0.388)	(0.662)
			Panel B. Cumulative Employment			
$\triangle IPdir_j$	-0.676	-0.250	-0.299	-0.196	-0.251	-0.019
	(0.637)	(0.543)	(0.426)	(0.274)	(0.286)	(0.544)
First stage $\triangle IPO_j$			9.093***	9.086***	9.026***	8.366***
			(0.635)	(0.630)	(0.585)	(0.693)
First stage F test			204.884	208.108	237.734	145.841
Individual controls	No	Yes	No	Yes	Yes	Yes
Firm controls	No	Yes	No	No	Yes	Yes
Sector controls	No	Yes	No	No	No	Yes

Notes: N = 602,073. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, which is defined in Equation (3) and uses imports of seven selected countries from China. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant. All controls are considered at the start-of-period level (1993). Workers' controls include a female dummy variable, eight formal education categories, eight formal categories of worker's qualifications, age and age squared, and tenure and tenure squared. The vector of firm-level controls includes the number of employees, the natural logarithm of turnover, the share of public equity, the share of foreign equity, and twenty eight regional location dummies at the NUTS3 level. The vector of sector-level controls include a set of dummy variables for 9 broad aggregate categories computed based on the 83 trade-exposed manufacturing industry and a measure of overall import penetration of the industry. Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

within-plant innovation in the UK, using data on the number of computers, patents, and R&D expenditure; while Mion and Zhu (2013) find that import competition from China induces skill upgrading in low-tech manufacturing industries in Belgium.

Other potential explanations concern differences in labour market institutions between Portugal and other countries (in particular the US), including widespread sectoral collective bargaining agreements, which set minimum wages for virtually all workers, especially in manufacturing. More restrictive employment protection law in Portugal may potentially reduce the impact of China in terms of job loss and consequent earnings losses. Higher inflation rates in other countries may have also facilitated the adjustment of real wages following the import shock.

As we discussed above, the emergence of China in the global arena can affect firms in developed countries not only through the direct impact of increased Chinese imports in the domestic market but also through increased export competition in third markets. Table 3 presents the estimation results of Equation (5) that adds the indirect effect of Chinese competition in EU14 markets, defined in Equation (2).

Looking first at the direct impact, in a context in which we also control for the indirect effect, we find that the coefficient remains non significant both in Panel A and Panel B in the OLS specifications. However, when moving to the IV analysis, the coefficients are positive in the first three specifications, even if again not significant in the most detailed specification that includes the sector-level controls. This suggests that the positive coefficients obtained in

the first IV specifications reflect other sectoral upward trends that are confounded with the trade shock and have a positive impact in workers' wage and employment outcomes. When we control for confounding sectoral shocks through the inclusion of nine broad industry dummies and, hence, examine the impact of trade exposure within the same broad industry rather than comparing workers across very different fields of economic activity, the estimated parameters for the direct effect in Column (6), for both cumulative earnings and years of employment, become statistically non-significant.

When turning to our measure of indirect import penetration defined in Equation (2), we find evidence of strongly negative effects in all six specifications. In Panel A, the coefficients range from -8.3 in Column (1) to -1.5 in (2) for the OLS regressions and from -8.8 in Column (3) and -1.65 in (6) for the IV regressions and are always statistically significant, at least at the 5% level. These results indicate that the indirect effects from increased competition from China in third-country export markets have a sizeable negative effect on the wages and employment of workers in affected industries. We also find that, in some specifications, the direct effects become positive when considering the indirect effects as well and even significantly so in some cases, perhaps because of countervailing positive effects from product quality upgrading in Portuguese firms.

Table 3: Baseline Results: Direct and Indirect Effects

	OLS		IV			
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A. Cumulative Earnings			
$\triangle IPdir_j$	2.733	0.413	4.656**	2.730*	2.696**	1.012
	(1.777)	(0.624)	(2.157)	(1.449)	(1.343)	(0.903)
$\triangle IPind_j$	–8.268***	-1.534**	-8.754***	-5.462***	-5.419***	-1.652**
	(2.767)	(0.686)	(2.772)	(1.683)	(1.646)	(0.729)
			Panel B. Cumulative Employment			
$\triangle IPdir_j$	1.060	0.120	1.772**	1.091*	1.231**	0.511
	(0.731)	(0.496)	(0.903)	(0.609)	(0.609)	(0.595)
$\triangle IPind_j$	-3.417***	-1.073***	-3.597***	-2.273***	-2.769***	-1.150**
	(1.179)	(0.411)	(1.197)	(0.763)	(0.865)	(0.447)
First stage $\triangle IPO_j$			8.743***	8.702***	8.681***	8.094***
			(0.355)	(0.321)	(0.302)	(0.614)
First stage F test			608.161	736.980	828.587	173.853
Individual controls	No	Yes	No	Yes	Yes	Yes
Firm controls	No	Yes	No	No	Yes	Yes
Sector controls	No	Yes	No	No	No	Yes

Notes: N = 602,073. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1) and the variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, which is defined in Equation (3) and uses imports of seven selected countries from China. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant. All controls are considered at the start-of-period level (1993). Workers' controls include a female dummy variable, eight formal education categories, eight formal categories of worker's qualifications, age and age squared, and tenure and tenure squared. The vector of firm-level controls includes the number of employees, the natural logarithm of turnover, the share of public equity, the share of foreign equity, and twenty eight regional location dummies at the NUTS3 level. The vector of sector-level controls include a set of dummy variables for 9 broad aggregate categories computed based on the 83 trade-exposed manufacturing industry and a measure of overall import penetration of the industry. Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

Finally, we add up the direct and indirect effects to measure the overall economic impact of China's import penetration. More specifically, we compare a 1993 manufacturing worker

at the 3rd quartile of each import penetration distribution (1.367 percentage points for the direct impact and 15.598 for the indirect impact) and a similar manufacturing worker at the 1st quartile of import exposure (0.358 for the direct impact and 0.444 for the indirect) as depicted in Table 1. The resulting relative reduction in earnings in the outcome period using the estimates of the more comprehensive specification of Column (6) of Table 3 is 24.0% $(1.012*(1.367-0.358)-1.652*(15.598-0.444))$. Given the non-statistically significance of the direct effect, considering only the indirect effect and comparing again all-similar manufacturing workers located in the 25th and 75th percentiles of the distribution of the indirect import exposure, the implied differential reduction in cumulative wages is 25.0% of the base wage. In other words, the overall negative effect is virtually exclusively driven by the indirect effect.

For cumulative employment years, considered in Panel B, the results are similar, with increased competition from China in export markets decreasing the number of years spent on employment between 1994 and 2008. The reduction in years of employment for a manufacturing worker initially employed in an industry at the 75th percentile of Chinese indirect import exposure relative to a worker at the 25th percentile is 17.4% $(-1.150*(15.598-0.444))$.[13]

We interpret these results as evidence that, when considering the two channels above, China's expanding role in global trade represented a major negative shock for the labour market of Portugal, in line with evidence for other countries. However, a major difference relative to earlier research on other countries is that, in the case of Portugal, we find that the overall impact is exclusively driven by the indirect effects.[14]

Overall, we conclude that, unlike previous research, China can affect negatively the labour markets of developed economies not only or not at all through its increase in exports to the country. In fact, for Portugal, this direct effect is very small and even positive in some cases, perhaps because of product quality upgrading effects. More importantly, China's emergence in international trade can drive an intensified competition in third-country markets, leading to trade diversion, which can then generate significant negative labour market effects, as in the case of Portugal studied here.

5.2 Heterogeneity in the Impact of the Increased Trade Exposure

There is now a large consensus in the economic literature on the positive effect of international trade on aggregate welfare but also on its distributional consequences and impacts on

[13] We also estimated the impact of Chinese indirect competition without controlling for direct import penetration and our results are robust to this change. In a specification with only the indirect effect, the differential impacts on cumulative wages and years of employment for a worker in the 75th percentile relative to a worker in the 25th percentile of the distribution of the indirect measure of trade exposure are -22.0% and -15.9%, respectively.

[14] Autor et al. (2014) also compute a measure of the indirect effects which they then add to their direct effects measure to show that their main result is robust to this alternative measure. They therefore do not allow these two variables to have separate and distinct effects.

income inequality within a country (see Autor (2018) and Crozet and Orefice (2017) for two recent policy-oriented discussions of the impact of international trade in the labour market). The adverse impacts of trade tend to be very concentrated among specific groups of workers, industries and locations more vulnerable to trade competition. The implementation of appropriate public policies aimed at protecting trade-exposed workers and mitigating or even reversing the costs of trade adjustment (including, for instance, hiring incentives, in-work subsidies, and training) requires the identification of the individuals that tend to be more negatively exposed to globalisation.

In this subsection, we investigate which specific groups of workers were more affected by the increased international trade exposure to China, taking into account both the direct and indirect channels. More specifically, we extend the main analysis above to explore potential heterogeneity in the impact of the increased direct and indirect competition from China according to important workers' dimensions available in our data set such as age, gender and schooling. We also examine whether the effects are distinct for individuals working in domestic- and foreign-owed firms in the pre-shock period.

Table 4 divides the sample of workers considering those with above and below the median age in 1993 (35 years old). We find that the indirect effects on earnings fall exclusively on older workers. These workers tend to be paid higher wages, above market-level values, because they are better positioned to benefit from rent sharing (Martins, 2009) and better matching with their employers (Snell et al., 2018). Therefore they tend to lose the most if they become unemployed or have to move to a new firm with a lower level of seniority or where they are not as well matched. These results are in line with the findings from the displacement literature (see Raposo et al. (2015) for a study of job displacement in Portugal). The negative indirect effects on employment can now be observed for the two groups but are still stronger for older workers who, when leaving the firm, may take longer to find suitable matches. Unemployment benefits are also more generous in their duration (up to three years) for older workers, potentially prompting them to remain unemployed for a longer period and exacerbating the public cost of their non-employment, while reducing the income effects of the drop in ernings above. In all cases, we do not find significant direct effects.

We also investigate if women tend to suffer more or less than men from exogenous trade shocks. Despite the convergence of male and females observable attributes, Cardoso et al. (2016) show that the wage gender gap in Portugal, conditional on those workers' characteristics, amounts to 23 log points on average in the 1986-2008 period. In Table 5, which divides the workers' sample between males and females, we find that the indirect effects on women are more negative than those on men, both for earnings and employment. This gender heterogeneity in the effects may result from the higher proportion of women employed in sectors that are more exposed to the competition from China, in particular competition in export markets. For instance, in the more labour-intensive manufacturing sectors of textiles,

Table 4: Heterogeneity: Sample Median Age

	Less 35 years old		More 35 years old	
	OLS	IV	OLS	IV
	Panel A. Cumulative Earnings			
$\triangle IPdir_j$	0.113	0.247	0.700	2.451
	(0.648)	(0.892)	(1.022)	(1.760)
$\triangle IPind_j$	-0.869	-0.892	-1.668**	-2.005**
	(0.644)	(0.640)	(0.670)	(0.808)
	Panel B. Cumulative Employment			
$\triangle IPdir_j$	0.125	0.098	0.015	1.463
	(0.487)	(0.668)	(0.921)	(1.367)
$\triangle IPind_j$	-0.870**	-0.865**	-1.521**	-1.799**
	(0.416)	(0.418)	(0.630)	(0.748)
First stage $\triangle IPO_j$		8.109***		7.856***
		(0.637)		(1.362)
First stage F test		161.943		33.277
Controls	Yes	Yes	Yes	Yes
Number of Observations	301 328	301 328	300 745	300 745

Notes: Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1) and the variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, which is defined in Equation (3) and uses imports of selected countries from China. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

clothing and footwear, the proportion of female employees was around 68% in 1993.

Table 5: Heterogeneity: Gender

	Male		Female	
	OLS	IV	OLS	IV
	Panel A. Cumulative Earnings			
$\triangle IPdir_j$	-0.126	0.627	0.805	1.561
	(0.792)	(0.848)	(0.854)	(1.821)
$\triangle IPind_j$	-0.543	-0.748	-1.406**	-1.479***
	(0.651)	(0.691)	(0.556)	(0.552)
	Panel B. Cumulative Employment			
$\triangle IPdir_j$	-0.159	0.427	0.380	0.774
	(0.626)	(0.625)	(0.690)	(1.136)
$\triangle IPind_j$	-0.537	-0.697	-1.015**	-1.054**
	(0.523)	(0.568)	(0.423)	(0.421)
First stage $\triangle IPO_j$		8.306***		7.428***
		(0.456)		(0.955)
First stage F test		332.270		60.460
Controls	Yes	Yes	Yes	Yes
Number of Observations	371 664	371 664	230 409	230 409

Notes: Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1) and the variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, which is defined in Equation (3) and uses imports of selected countries from China. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

The direct and indirect effects of increased competition from China are not statistically sig-

nificant for university graduates, as can be inferred from Table 6, which splits the workers' sample between those with and without tertiary education in 1993. Workers with higher schooling levels are likely to be able to move to different occupations, and therefore, to be less affected by negative international trade shocks. Moreover, they may also be better placed to take advantage from employment opportunities that follow from product upgrading, as schooling facilitates access to better paying firms and jobs (see Cardoso et al. (2018) for a detailed study of the sources of the returns to education in Portugal).

Table 6: Heterogeneity: University Education

	Non Tertiary		Tertiary	
	OLS	IV	OLS	IV
	Panel A. Cumulative Earnings			
$\triangle IPdir_j$	0.425	1.091	-0.345	0.260
	(0.607)	(0.943)	(1.651)	(1.465)
$\triangle IPind_j$	-1.469**	-1.595**	-0.224	-0.577
	(0.690)	(0.739)	(2.541)	(2.407)
	Panel B. Cumulative Employment			
$\triangle IPdir_j$	0.124	0.549	-0.203	0.018
	(0.503)	(0.629)	(0.844)	(0.656)
$\triangle IPind_j$	-1.032**	-1.112**	-0.954	-1.083
	(0.420)	(0.458)	(1.415)	(1.368)
First stage $\triangle IPO_j$		8.016***		8.236***
		(0.681)		(0.196)
First stage F test		138.736		1 769.592
Controls	Yes	Yes	Yes	Yes
Number of Observations	574 286	574 286	27 787	27 787

Notes: Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1) and the variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, which is defined in Equation (3) and uses imports of selected countries from China. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

Finally, Table 7 divides the sample between workers employed in domestic and foreign firms, defined as firms with at least 10% of foreign capital equity ownership in 1993. We find that individuals employed in foreign-owned firms do not appear to be affected by China's direct and indirect competition. Foreign-owned firms, which are typically affiliates of foreign multinationals, may be more resilient to international trade shocks as they are likely to be part of global value chains. For instance, Martins and Yang (2015) present evidence that the wages of workers in affiliates of multinational firms around the world are influenced not only by the profitability of the affiliate itself but also by the profitability of the parent company.

Table 7: Heterogeneity: Origin of Firms Equity

	Domestic		Foreign	
	OLS	IV	OLS	IV
	Panel A. Cumulative Earnings			
$\triangle IPdir_j$	-0.314	0.665	2.022	1.410
	(0.822)	(1.043)	(2.327)	(3.571)
$\triangle IPind_j$	-1.609**	-1.739**	-1.963	-1.782
	(0.693)	(0.744)	(1.989)	(2.222)
	Panel B. Cumulative Employment			
$\triangle IPdir_j$	0.043	0.823	0.843	0.317
	(0.598)	(0.693)	(1.751)	(2.529)
$\triangle IPind_j$	-0.899**	-1.003**	-1.890	-1.734
	(0.410)	(0.446)	(1.532)	(1.693)
First stage $\triangle IPO_j$		7.910***		7.387***
		(0.701)		(0.745)
First stage F test		127.303		98.265
Controls	Yes	Yes	Yes	Yes
Number of Observations	531 890	531 890	70 183	70 183

Notes: Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1) and the variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, which is defined in Equation (3) and uses imports of selected countries from China. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

5.3 Robustness Results

In this subsection, we present several robustness checks of our baseline results. We start by measuring the change in direct and indirect trade exposure to China using a gravity-based approach, which captures the differential changes in China's sectoral productivity and trade costs relative to Portugal. We proceed by including a measure of the increase in export opportunities for Portuguese exporters arising from the integration of China in world markets; then we revise our measure of trade diversion and express it in percentage changes. We also instrument our direct import penetration measure with a different set of countries, work through our analysis using a smaller sample of manufacturing workers, and use a distinct variable as a proxy of the initial size of an industry. Finally, we split the sample period in two.

First, we adopt an alternative identification strategy that imposes weaker assumptions in measuring the direct and indirect import competition from China, based on a gravity model of trade. Appendix C describes in detail the procedures used to construct these measures of trade exposure. Intuitively, instead of using actual changes in Chinese exports as in Equations (1) and (2), we use gravity residuals to capture the rising productivity and increasing market accessibility of China relative to Portugal and the implied differential change of Portugal's attractiveness relative to China from the perspective of third countries. The gravity approach neutralises import demand shocks in the destination markets, thereby isolating supply and trade-cost driven changes in Chinese export performance, which are precisely

the components of China's export growth that we want to capture.

Table 8 shows the results of this alternative specification, which is estimated by OLS, as the gravity approach sterilises the confounding effects of possible unobservable shocks. As in our baseline regression, the impact of increased Chinese import penetration on the Portuguese domestic market is statistically non-significant, while the effect of higher competition of Chinese products in the main destination markets of Portuguese exports is negative and significant. To compare the economic magnitudes of these estimates with those of our baseline regression, we consider a manufacturing worker at the 75th percentile of the distribution of the gravity-based measure of indirect import competition (39.724) and a similar worker at the 25th percentile of the same distribution (0.530). Using the estimates of Column (2), the worker who experiences a stronger rise in indirect trade exposure has a relative reduction in cumulative wages of 17.6% $(-0.448 * (39.724 - 0.530))$ of the base wage over the outcome period (9.4% differential decline in years of employment). These magnitudes are consistent but more conservative than those obtained with our baseline results, because the rise in gravity residuals captures only the exogenous differential increase in competitiveness and accessibility of China, and should be interpreted as a conservative estimate of the impact of Chinese competition on the Portuguese labour market. Nevertheless, the fact that our gravity and baseline estimates lead to consistently negative economic effects of China's indirect competition in third markets suggests that correlated import demand shocks across countries are not driving our main results and, hence, adds further confidence to their causal interpretation.

Table 8: Robustness: Gravity-based Measures

	OLS	OLS
	(1)	(2)
Panel A. Cumulative Earnings		
$\triangle IPGdir_j$	-0.040	0.249
	(0.099)	(0.196)
$\triangle IPGind_j$		-0.448**
		(0.204)
Panel B. Cumulative Employment		
$\triangle IPGdir_j$	-0.070	0.084
	(0.079)	(0.124)
$\triangle IPGind_j$		-0.239**
		(0.107)
Controls	Yes	Yes

Notes: N= 602,073. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $IPGdir_j$ is the gravity-based measure of direct import competition defined in Equation (C.6), computed using the average change of the residuals for each industry j across 82 destination countries between 1993 and 2008, based on the estimation of a gravity model of trade for China and Portugal. The variable $IPGind_j$ is the gravity-based measure of indirect import competition defined in Equation (C.7), computed using the change of the residuals for each industry j and country C of the EU14 between 1993 and 2008, based on the estimation of a gravity model of trade for China and Portugal. See Appendix C for a detailed description of these variables. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

Second, we test a different impact channel of the integration of China in international trade: the increased export opportunities for Portuguese firms that may follow from the higher demand for imports from China. The measure of the direct export opportunities in each Portuguese industry j that we propose is defined as:

$$\triangle EO_{j,\tau} = \frac{\triangle X_{j,\tau}^{prt \to chn}}{WB_{j,93}}, \tag{6}$$

where $\triangle X_{j,\tau}^{prt \to chn}$ is the change in Portuguese exports of industry j to China over the period 1993-2008.

In the following regression table, we use a measure of net direct import penetration, including both Portuguese imports from China and Chinese imports from Portugal. This measure allows us to take into account some of the potentially positive labour market effects of China's emergence in terms of increased Portuguese exports to China, possibly offsetting some of the effect of China's higher import penetration. This new measure is:

$$\triangle NIPdir_{j,\tau} = \triangle IPdir_{j,\tau} - \triangle EO_{j,\tau}, \tag{7}$$

We instrument it as follows:

$$\triangle EOO_{j,\tau} = \frac{\triangle X_{j,\tau}^{O \to chn}}{WB_{j,91}}, \tag{8}$$

$$\triangle NIPO_{j,\tau} = \triangle IPO_{j,\tau} - \triangle EOO_{j,\tau}, \tag{9}$$

where $\triangle IPO_{j,\tau}$ is defined in Equation (3) and $X_j^{O \to chn}$ are the exports of the same seven selected countries to China in industry j.

We consider also the indirect effect of competition in third markets in the regression and include the measure of net import penetration of Equation (7), which adjusts the direct effect of import competition with the impact of exports to China. Table 9 shows that our results are robust to this new specification. We find that, while the direct effects, even in this broader definition, are still statistically non-significant, the indirect effects remain significantly negative with a coefficient very similar to that of our baseline results.

Table 9: Robustness: Net Direct Effects and Indirect Effects

	OLS	IV
	(1)	(2)
Panel A. Cumulative Earnings		
$\triangle NIP_j$	0.319	0.841
	(0.580)	(0.864)
$\triangle IPind_j$	-1.510**	-1.602**
	(0.687)	(0.725)
Panel B. Cumulative Employment		
$\triangle NIP_j$	0.105	0.464
	(0.451)	(0.572)
$\triangle IPind_j$	-1.068**	-1.132**
	(0.412)	(0.443)
First Stage $\triangle NIPO_j$		8.026***
		(0.675)
F test		141.598
Controls	Yes	Yes

Notes: N= 602,073. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle NIP_j$ is the direct net import penetration of Equation (7) which considers both direct import penetration from China and export opportunities to China. The variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle NIPO_j$ is the instrument of the variable $\triangle NIP_j$, which is defined in Equation (9) and uses both imports from China and exports to China of selected countries. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

Third, we examine a distinct measure of workers' indirect exposure to trade with China. Basically, instead of using absolute changes in the levels of imports from China as in Equation (2), we examine percentual changes of the market shares of Chinese exports in each industry and destination country from 1993 to 2008. This alternative measure of indirect competition from China is computed as the changes in export market shares of China in each of the EU14 countries by industry j, as a percentage of total imports of each individual market in 1993, weighted by the share of each EU14 country in total Portuguese exports of each industry in 1993:

$$\triangle IPind2_{j,\tau} = \sum_{C=1}^{14} \upsilon_{j,93}^{prtC} \triangle_{\tau}\left(\frac{M_j^{chn\to C}}{M_{j,93}^{\to C}} * 100\right), \qquad \text{with} \qquad \upsilon_{j,93}^{prtC} = \frac{X_{j,93}^{prt\to C}}{X_{j,93}^{prt\to}} \tag{10}$$

where $\upsilon_{j,93}^{prtC}$ is the share of each EU14 country C in total Portuguese exports of each industry j in 1993. $X_{j,93}^{prt\to C} = M_{j,93}^{prt\to C}$ of Equation (2) are Portuguese exports of each industry j to each country C of the EU14 and $X_{j,93}^{prt\to}$ are the total Portuguese exports of industry j in 1993. This weight is then multiplied by the percentage change of market share of Chinese exports in each individual industry-country market from 1993 to 2008, where $M_j^{chn\to C}$ are imports from China of industry j by country C of the EU14 and $M_{j,93}^{\to C}$ are total imports of that country at the industry-level in 1993. Intuitively, a gain of export market share of China in a given industry of a given EU14 country will represent a greater increase in competition from China, the higher the relevance of that individual market in total Portuguese exports

in the baseline year. In other words, compared to the original specification of the indirect effect, here we consider the changes of China's market share in each industry of each EU14 country, as a percentage of the respective industry-country total imports in 1993 (not changes in the absolute levels of Chinese imports normalised by the size of the Portuguese industry) and we weight each individual market in terms of its importance in Portuguese exports of that industry in 1993 (not using weights from the EU14 country).

Table 10 reports the estimated effects, which are consistent with the main results of Table 3. In particular, the effects on earnings and employment of the increased competition from China in the main Portuguese export markets are significantly negative, while the impacts of direct import competition are not statically significant. To compare these estimates with our baseline results, consider a worker who faces a rise in indirect import exposure at the 75th percentile (44.980 in this alternative metric) and compare to a worker with indirect import competition at the 25th percentile (6.452). The estimates of Column (2) imply that the former earns 38.5% $(-0.999 * (44.980 - 6.452))$ less than the latter over the period (drop of 23.9% in terms of years of employment), because of the stronger increase in indirect trade exposure. In this sense, given the greater magnitude of these effects, our baseline results can be seen as a conservative estimate of the impact of stronger Chinese competition in Portuguese export markets.

Table 10: Robustness: Percentual Changes in Indirect Effects

	OLS	IV
	(1)	(2)
Panel A. Cumulative Earnings		
$\triangle IPdir_j$	0.255	1.001
	(0.605)	(0.766)
$\triangle IPind2_j$	-0.959***	-0.999***
	(0.292)	(0.293)
Panel B. Cumulative Employment		
$\triangle IPdir_j$	-0.020	0.447
	(0.499)	(0.506)
$\triangle IPind2_j$	-0.595***	-0.621***
	(0.178)	(0.180)
First stage $\triangle IPO_j$		0.008***
		(0.001)
First stage F test		195.466
Controls	Yes	Yes

Notes: N= 602,073. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1) and the variable $\triangle IPind2_j$ refers to the measure of indirect import competition from China defined in Equation (10). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, which is defined in Equation (3), and uses imports of selected countries from China. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

Fourth, we test the sensitivity of the baseline results with respect to the construction of the instrumental variable by changing the countries that are included in the instrument group. We use a set of fifteen OECD non-EU14 countries: Australia, Canada, Czech Republic, Hungary, Iceland, Japan, Mexico, New Zealand, Norway, Poland, Slovakia, South Korea, Switzerland, Turkey, and the United States.[15] Table 11 shows that the results are basically unchanged when using this alternative IV, thus suggesting that our findings are robust to the choice of the instrument group.

Table 11: Robustness: Different Instrument Group of Countries

	OLS	IV
	(1)	(2)
	Panel A. Cumulative Earnings	
$\triangle IPdir_j$	0.413	0.608
	(0.624)	(0.776)
$\triangle IPind_j$	-1.534**	-1.573**
	(0.686)	(0.715)
	Panel B. Cumulative Employment	
$\triangle IPdir_j$	0.120	0.337
	(0.496)	(0.557)
$\triangle IPind_j$	-1.073***	-1.116**
	(0.411)	(0.441)
First stage $\triangle IPoecd_j$		0.750***
		(0.054)
First stage F test		194.366
Controls	Yes	Yes

Notes: N= 602,073. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1) and the variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle IPoecd_j$ is the instrument of the variable $\triangle IPdir_j$, and uses imports of selected fifteen OECD non-EU14 countries from China. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

Following Autor et al. (2014), our baseline regressions are based on the full sample of 602,073 workers employed in 1991 and 1993 in manufacturing and non-manufacturing sectors. This sample includes individuals working in the 83 manufacturing industries that were exposed to competition from China, as well as workers employed in non-manufacturing sectors, which have zero trade exposure. Instead of using all private sector workers, we now focus on a more homogeneous group of workers and perform the same analysis as before but only for the 283,272 individuals employed in the manufacturing industry in 1991 and 1993.

The estimation results are presented in Table 12. Even if the statistical significance decreases, the results are very similar, with the effects of direct import competition from China remaining statistically non-significant. Using the estimates of Column 2 to perform the same comparison of an individual initially employed in an industry at the 75th percentile of the Chinese indirect trade competition with a worker employed in an initial industry at the 25th

[15] We only considered countries that are OECD members in our sample period.

percentile of the same distribution, the implied relative reduction in cumulative wage earning is 15.6% (12.5% drop of years of employment). These values are smaller than the ones obtained in our baseline regressions that use a bigger and more heterogeneous sample of workers and, hence, can be seen as a low benchmark of our results.

Table 12: Robustness: Only within Manufacturing

	OLS	IV
	(1)	(2)
Panel A. Cumulative Earnings		
$\triangle IPdir_j$	0.096	0.594
	(0.542)	(0.805)
$\triangle IPind_j$	-0.933*	-1.031*
	(0.530)	(0.554)
Panel B. Cumulative Employment		
$\triangle IPdir_j$	-0.043	0.242
	(0.440)	(0.559)
$\triangle IPind_j$	-0.767**	-0.823**
	(0.351)	(0.378)
First stage $\triangle IPO_j$		8.080***
		(0.615)
First stage F test		172.494
Controls	Yes	Yes

Notes: N= 283,272. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1) and the variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, and uses imports of selected countries from China. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

As described in Section 3.1, to normalise the changes in sectoral trade flows with China, our baseline results use the total wage bill of a given domestic industry as a proxy of the initial industry size. Even if due to data unavailability it is not possible to compute the domestic absorption of each industry in 1993, we test a distinct normalisation of trade exposure to China: the total turnover of each industry in 1993 (1991 in the case of the instrumental variable).[16]

Table 13 shows that using turnover to capture the initial relative dimension of domestic industries does not have a significant impact in our results. We still find no evidence of a negative direct effect of increased imports from China and the impact of Chinese competition in export markets continues to be significant and negative. In economic terms, the magnitude of the results is very similar to the one obtained with the baseline estimates of Table 3. Using turnover as the normalisation factor, the values of the 25th and 75th percentiles of the distribution of indirect import exposure to China in third markets are 0.487 and 18.039, respectively. Comparing individuals initially employed in industries at the 75th

[16]More precisely, we used total turnover of industry j in 1993 and 1991 divided by 100 so that the values of the estimated parameters are more similar to the baseline regressions.

and 25th percentiles of the distribution of the measure of Chinese competition in export markets, the estimates of Column 2 show that the individual in the more affected industry earns 26.9% $(-1.535 * (18.039 - 0.487))$ less when compared to a worker at the 25th percentile (reduction of 16.4% in terms of years of employment).

Table 13: Robustness: Different Normalisation - Turnover

	OLS	IV
	(1)	(2)
Panel A. Cumulative Earnings		
$\triangle IPTdir_j$	0.473	-0.216
	(0.770)	(0.740)
$\triangle IPTind_j$	-1.637***	-1.535**
	(0.560)	(0.610)
Panel B. Cumulative Employment		
$\triangle IPTdir_j$	0.087	-0.414
	(0.581)	(0.496)
$\triangle IPTind_j$	-1.007***	-0.933***
	(0.316)	(0.345)
First stage $\triangle IPTO_j$		2.743***
		(0.442)
First stage F test		38.583
Controls	Yes	Yes

Notes: N= 602,073. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The variable $\triangle IPTdir_j$ is the measure of direct import penetration, the variable $\triangle IPTind_j$ refers to the measure of indirect import competition from China, and $\triangle IPTO_j$ is the instrument of the variable $\triangle IPTdir_j$, and uses imports of selected countries from China. The numerators of these three variables are same as the variables defined in Equation (1), Equation (2) and Equation (3), respectively, but $\triangle IPTdir_j$ and $\triangle IPTind_j$ use total turnover of industry j in 1993 as a normalisation factor and $\triangle IPTO_j$ uses total turnover of industry j in 1991 in the denominator. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

Finally, we consider two different sub-periods for the trade shock variables, 1993-2000 and 2000-2008, still focusing on the same worker-level outcomes of the main sample of workers employed in 1991 and 1993. The estimates in Table 14 show that the negative impacts of increased competition from China in exports markets are concentrated in most recent sub-period, while the direct effect of imports from China continues to be non-significant in both sub-periods. These results are consistent with the distribution of the trade shock over time. For each trade shock variable considered, around 75% of the average increase occurred from 2000 to 2008, when China's international trade accelerated strongly following its accession to the WTO.

Table 14: Robustness: Time Periods

	1993-2000		2000-2008	
	OLS	IV	OLS	IV
	Panel A. Cumulative Earnings			
$\triangle IPdir_j$	5.437	-0.015	0.433	1.317
	(4.078)	(16.967)	(0.661)	(0.924)
$\triangle IPind_j$	-1.353	-1.278	-2.950***	-3.212***
	(1.080)	(0.977)	(0.816)	(0.806)
	Panel B. Cumulative Employment			
$\triangle IPdir_j$	1.838	0.471	0.154	0.661
	(3.604)	(13.801)	(0.534)	(0.570)
$\triangle IPind_j$	-1.098	-1.079	-2.002***	-2.152***
	(0.767)	(0.771)	(0.395)	(0.416)
First stage $\triangle IPO_j$		2.173*		9.084***
		(1.254)		(0.601)
First stage F test		3.001		228.360
Controls	Yes	Yes	Yes	Yes

Notes: N= 602,073. Dependent variables: 100 x Cumulative earnings (1994-2008), normalised by average earnings in 1991 and 1993; 100 x Cumulative years of full-time employment in the private sector. The values of each trade exposure variable for the two sub-periods sum to respective trade exposure variable for the full period used in the baseline regressions of of Table 3. The variable $\triangle IPdir_j$ is the direct import penetration defined in Equation (1) and the variable $\triangle IPind_j$ refers to the measure of indirect import competition from China defined in Equation (2). The variable $\triangle IPO_j$ is the instrument of the variable $\triangle IPdir_j$, which is defined in Equation (3) and uses imports of selected countries from China. Given the large scale of the flows, the instrument variable is divided by 1000. All regressions include a constant and the vector of individual, firm, and sector controls from column (6) of Table 2. All controls are considered at the start-of-period level (1993). Standard errors in parenthesis are clustered at the industry level and are robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1%(***).

6 Concluding Remarks

Recent decades have been characterised by a strong growth of international trade. The integration of emerging and developing economies in world trade and the rise of offshoring and global value chains has dramatically changed the organisation of world production, potentially leading to deep and lasting economic impacts as well as in other social and political domains. Given that China's sudden ascent as a major economic power is arguably one of the most important causes and consequences of these developments, a number of studies have examined the direct effects from China's increased competition on labour markets worldwide. However, the indirect effects ('collateral damage') of increased competition with China in third-country export markets have largely been overlooked so far, especially when considering worker-level data, despite their increasing relevance as China's exports become more sophisticated.

In this paper, we examine these two, direct and indirect, effects simultaneously. Using information on international trade across countries and industries over a long period of time (1993-2008) we propose different measures of these trade shocks. We match them with comprehensive employer-employee panel data from Portugal, linking each worker back in 1993 to the shocks that his or her initial industry was subject to until the end of the next decade. We then assess how cumulative wage earnings and years of employment over the 1994-2008 period are affected by these measures of trade exposure.

Our findings show that countries can be affected in various ways by the emergence of China as a dominant player in the global market for manufactured goods. In contrast to evidence for other countries, we find that an increase in direct import penetration from China does not necessarily significantly decrease individuals' wage earnings and years of employment. However, our results indicate that the indirect dimension associated with increased competition in third-country markets driven by China's exports can generate significant negative labour market effects. More specifically, for Portugal, we find that an increase, from the bottom to the top quartile, of an industry's exposure to China's indirect import penetration in a group of 14 EU countries is associated to a relative drop of 25% in worker's cumulative wages and a 17.4% reduction in employment years.

The negative labour-market effects of increased trade exposure to China are robust to a number of tests but are also heterogeneous across individuals. The impact falls disproportionately on older workers, females and workers without tertiary education. Moreover, the negative effects are also stronger for individuals working in domestic-owned firms. Hence, this paper not only supports the view that trade integration generates losers in the labour market but also contributes to the identification of those most affected, which is essential for public policies aiming at supporting workers more hurt by globalisation.

Overall, our findings contribute to a better understanding of the effects of the 'China shock', not only in Portugal but also in other countries with significant shares of their workforce employed in relatively labour-intensive manufacturing exporting firms. This indirect effect is also increasingly relevant as more and more industries around the world become exposed to the increasing range and quality of China's exports. Of course, as China's emergence led to the important indirect import penetration effects that we examine here, it may also have contributed to relevant indirect export opportunities, namely by selling intermediate goods to firms in third countries that then export final goods to China. This is a topic that we leave for future research.

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Appendices

A Reconciling trade and labour market data

Trade flows of the CEPII - CHELEM database have a product breakdown according to the 4-digit level of the International Standard Industrial Classification of All Economic Activities, rev.3 (ISIC3), while the *Quadros de Pessoal* (QP) dataset makes use of the Portuguese industrial classification – *Classificação Portuguesa das Actividades Económicas* (CAE) – in the version that was in place at the time when the data was collected.

Due to the long time span of the sample, four different revisions of CAE took place from 1991 to 2008. Consistent information on Portuguese firms' main sector activity over time according to CAE rev.3 (CAE3) was provided by *Banco de Portugal*. CAE3 matches, at the 4-digit level, the second revision of the Statistical Classification of Economic Activities in the European Community (NACE2), and the latter links to the ISIC rev.4 (ISIC4). The United Nations Statistics Division offers a correspondence table between NACE2 and ISIC4. Each NACE2 code corresponds to only one ISIC4 code, but one ISIC4 code can incorporate several NACE2 codes. Hence, correspondences between NACE2 and ISIC4 are either 1:1 or m:1.

Trade exposed manufacturing industries were converted from ISIC3 to ISIC4 at the 4-digit level. This conversion process was based on correspondence tables between ISIC3, ISIC3.1 and ISIC4, obtained from the United Nations Statistics Division. Assumptions were made regarding ambiguous correspondences (m:m cases) in order to avoid extremely large and hybrid (4-digit) industry groups. When making these decisions, the specificities of each 4-digit industry parcel were taken into account within the Portuguese context. Non-manufacturing sectors were not part of the conversion process and are, thus, represented by their original ISIC4 code. All detailed correspondence tables used are available from the authors upon request.

Table A.1: Description of the trade-exposed manufacturing industries

Industry	Description	Aggregates
1	Processing and preserving of meat	1
2	Processing and preserving of fish, crustaceans and molluscs	1
3	Processing and preserving of fruit and vegetables	1
4	Manufacture of vegetable and animal oils and fats	1
5	Manufacture of dairy products	1
6	Manufacture of grain mill products, starches and starch products	1
7	Manufacture of other food products	1
8	Manufacture of prepared animal feeds	1
9	Distilling, rectifying and blending of spirits	1
10	Manufacture of wines	1
11	Manufacture of malt liquors and malt	1
12	Manufacture of soft drinks; production of mineral waters and other bottled waters	1
13	Manufacture of tobacco products	1
14	Spinning, weaving and finishing of textiles	2
15	Manufacture of knitted and crocheted fabrics and apparel	2
16	Manufacture of other textiles	2
17	Manufacture of wearing apparel, except fur apparel	2
18	Manufacture of articles of fur; dressing and dyeing of fur	2
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness	2
20	Manufacture of footwear	2
21	Saw-milling and planing of wood	3
22	Manufacture of products of wood, cork, straw and plaiting materials	3
23	Manufacture of pulp, paper and paperboard	3
24	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	3
25	Manufacture of other articles of paper and paperboard	3
26	Printing and service activities related to printing; Reproduction of recorded media	3
27	Manufacture of coke and refined petroleum products	4
28	Manufacture of basic chemicals	4
29	Manufacture of fertilizers and nitrogen compounds	4
30	Manufacture of plastics and synthetic rubber in primary forms	4
31	Manufacture of pesticides and other agrochemical products	4
32	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	4
33	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	4
34	Manufacture of other chemical products n.e.c.	4
35	Manufacture of man-made fibres	4
36	Manufacture of basic pharmaceutical products and pharmaceutical preparations	4
37	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres	5
38	Manufacture of other rubber products	5
39	Manufacture of plastics products	5
40	Manufacture of glass and glass products	5
41	Manufacture of refractory products	5
42	Manufacture of clay building materials and of other porcelain and ceramic products	5
43	Manufacture of cement, lime and plaster	5
44	Manufacture of articles of concrete, cement and plaster	5
45	Cutting, shaping and finishing of stone	5
46	Manufacture of other non-metallic mineral products n.e.c.	5
47	Manufacture of basic iron and steel	6
48	Manufacture of basic precious and other non-ferrous metals	6
49	Manufacture of structural metal products	6
50	Manufacture of tanks, reservoirs and containers of metal	6
51	Manufacture of steam generators	6
52	Manufacture of weapons and ammunition; manufacture of military fighting vehicles	6
53	Manufacture of other fabricated metal products	6
54	Manufacture of electronic components and boards	7
55	Manufacture of computers and office machinery and equipment	7
56	Manufacture of communication equipment and consumer electronics	7
57	Manufacture of measuring, testing, navigating and control equipment	7
58	Manufacture of watches and clocks	7
59	Manufacture of medical, dental and surgical equipment and orthopaedic appliances	7
60	Manufacture of optical instruments and photographic equipment, magnetic and optical media	7
61	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus	7
62	Manufacture of batteries and accumulators	7
63	Manufacture of wiring and wiring devices	7
64	Manufacture of electric lighting equipment	7
65	Manufacture of domestic appliances	7
66	Manufacture of other electrical equipment	7
67	Manufacture of general-purpose machinery	7
68	Manufacture of special-purpose machinery	7
69	Manufacture of motor vehicles	8
70	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	8
71	Manufacture of parts and accessories for motor vehicles	8
72	Building of ships and boats	8
73	Manufacture of railway locomotives and rolling stock	8
74	Manufacture of air and spacecraft and related machinery	8
75	Manufacture of motorcycles	8
76	Manufacture of bicycles and invalid carriages	8
77	Manufacture of other transport equipment n.e.c.	8
78	Manufacture of furniture	9
79	Manufacture of jewellery, bijouterie and related articles	9
80	Manufacture of musical instruments	9
81	Manufacture of sports goods	9
82	Manufacture of games and toys	9
83	Other manufacturing n.e.c.	9

B Definition of variables and descriptive statistics

In this appendix we detail the construction of some of the control variables included in the regressions and report their main descriptive statistics.

The eight formal education categories of the worker are based on the International Standard Classification of Education 2011 (ISCED), as described in the following table. In the regressions, illiterate is the omitted category.

Code	Description
1	Illiterate, no formal education or below ISCED 1.
2	Can read and write, but no formal education or below ISCED 1.
3	4 years completed (Lower primary education - 1st cycle). Included in ISCED 1.
4	6 years completed (Upper primary education - 2nd cycle). Included in ISCED 1.
5	9 years completed (Lower secondary education). Refers to ISCED 2.
6	12 years completed (Upper secondary education). Refers to ISCED 3.
7	Lower tertiary. Refers to ISCED 4-5.
8	Upper tertiary. Refers to ISCED 6-8.

The Portuguese Decree-Law 380/80 establishes that firms should indicate the qualification level of the each worker as in the Collective Agreement. The eight formal categories of worker's qualifications considered are described in the following table. In the regressions, 'Apprentices, interns and trainees' is the omitted category.

Code	Description
1	Apprentices, interns and trainees
2	Non-skilled professionals
3	Semi-skilled professionals
4	Skilled professionals
5	Highly-skilled professionals
6	Supervisors, foremen and team leaders
7	Intermediate executives
8	Top executives

The nine manufacturing industry aggregates used are food, drinks and tobacco; textiles, clothing and footwear; wood and paper; chemicals; plastics, glass and rubber; metals; machinery, equipment and electronics; transport equipment; others. The composition of each of the nine aggregates is detailed in Table A.1. The omitted category in the regressions is the non-manufacturing sector.

The 28 regional location categories of the firm are defined for mainland Portugal according to the 3rd level of nomenclature of territorial units for statistics (NUTS3), version 1989, as follows:

Code	Description
10101	Minho-Lima
10102	Cávado
10103	Ave
10104	Grande Porto
10105	Tâmega
10106	Entre Douro e Vouga
10107	Douro
10108	Alto Trás-os-Montes
10201	Baixo Vouga
10202	Baixo Mondego
10203	Pinhal Litoral
10204	Pinhal Interior Norte
10205	Dão-Lafões
10206	Pinhal Interior Sul
10207	Serra da Estrela
10208	Beira Interior Norte
10209	Beira Interior Sul
10210	Cova da Beira
10301	Oeste
10302	Grande Lisboa
10303	Península de Setúbal
10304	Médio Tejo
10305	Lezíria do Tejo
10401	Alentejo Litoral
10402	Alto Alentejo
10403	Alentejo Central
10404	Baixo Alentejo
10501	Algarve

The measure of overall import penetration of the industry in 1993 is computed as:

$$ipLevelGlobal_{j,93} = \frac{M_{j,93}^{\rightarrow P}}{WB_{j,93}},$$

where $M_{j}^{\rightarrow P}$ represents total Portuguese imports from the World for a specific industry j in 1993 and $WB_{j,93}$ is the total wage bill of the industry j in 1993, used as a proxy of the total size of the industry.

Table B.1: Descriptive statistics - main sample

Variable	Mean	Std. Dev.	Min	Max
Individual controls (1993)				
age	35.506	8.258	17	50
age squared	1328.886	587.239	289	2500
tenure	10.871	7.789	1	35
tenure squared	178.850	224.852	1	1225
female	0.383	0.486	0	1
Education dummies				
2	0.015	0.122	0	1
3	0.430	0.495	0	1
4	0.211	0.408	0	1
5	0.164	0.370	0	1
6	0.130	0.336	0	1
7	0.015	0.121	0	1
8	0.031	0.174	0	1
Qualification dummies				
2	0.074	0.261	0	1
3	0.203	0.402	0	1
4	0.493	0.500	0	1
5	0.062	0.241	0	1
6	0.057	0.232	0	1
7	0.032	0.176	0	1
8	0.033	0.178	0	1
Firm controls (1993)				
ln(turnover+1)	15.174	4.487	0	22.656
number of workers	1188.285	3039.030	1	15875
foreign equity	8.882	26.565	0	100
public equity	10.297	29.672	0	100
Sector controls (1993)				
sector dummies				
1	0.046	0.210	0	1
2	0.190	0.393	0	1
3	0.038	0.190	0	1
4	0.023	0.151	0	1
5	0.046	0.210	0	1
6	0.042	0.201	0	1
7	0.043	0.202	0	1
8	0.024	0.153	0	1
9	0.018	0.132	0	1
ipLevelGlobal	0.254	0.782	0	83.553

Notes: The main sample includes 602,073 workers employed in 1991 and 1993 in both manufacturing and non-manufacturing sectors. Workers' controls include a female dummy variable, eight formal education categories, eight formal categories of worker's qualifications, age and age squared, and tenure and tenure squared. The vector of firm-level controls includes the number of employees and the natural logarithm of turnover, the share of public equity, the share of foreign equity. The vector of firm-level controls also includes twenty eight regional location dummies at the NUTS 3 level as described above. The vector of sector-level controls include a set of dummy variables for 9 broad aggregate categories computed based on the 83 trade-exposed manufacturing industry and a measure of the total import penetration of the industry.

C Gravity-based measures of trade exposure

In this appendix, we describe the procedures used to construct the alternative measures of direct and indirect import competition from China based in the gravity model of trade, which follow the strategy of Autor et al. (2013) and Dauth et al. (2014).

Consider a standard gravity equation as in Anderson and van Wincoop (2003):

$$X_j^{h\to k} = \left(\frac{y_j^h y_j^k}{y_j^W}\right) \cdot \left(\frac{\tau_j^{hk}}{P_j^h P_j^k}\right)^{(1-\sigma_j)}, \tag{C.1}$$

where $X_j^{h\to k}$ are exports from country h to country k in industry j, y_j^h is country h aggregate expenditure in industry j, y_j^W is world expenditure on the goods from that industry, P_j^h is the standard CES price index of industry j in country h, σ_j is the elasticity of substitution for industry j and τ_j^{hk} are the iceberg trade costs between country h and country k in industry j.

In logarithm form:

$$ln(X_j^{h\to k}) = ln\left(\frac{1}{y_j^W} \cdot \frac{y_j^k}{(P_j^k)^{(1-\sigma_j)}}\right) + ln\left(\frac{y_j^h}{(P_j^h)^{(1-\sigma_j)}}\right) - (\sigma_j - 1) ln(\tau_j^{hk}) \tag{C.2}$$

Let Chinese exports to country k in industry j be $X_j^{chn\to k}$ and let Portuguese exports country k in industry j be $X_j^{prt\to k}$. Using the standard gravity specification of Equation (C.2), we obtain the following equation for exports by China to country k in industry j relative to Portuguese exports in logarithm form:

$$ln(X_j^{chn\to k}) - ln(X_j^{prt\to k}) = ln(z_j^{chn}) - ln(z_j^{prt}) - (\sigma_j - 1)[ln(\tau_j^{chnk}) - ln(\tau_j^{prtk})] \tag{C.3}$$

The term $ln(z_j^{chn}) - ln(z_j^{prt})$ captures China's comparative advantage relative to Portugal in industry j, determined by differences between the two countries in wages, labour productivity, number of product varieties produced, domestic expenditure and competition. The term $ln(\tau_{jk}^{chn}) - ln(\tau_{jk}^{prt})$ is the China-Portugal difference in trade costs to country k, i.e., the relative accessibility of market k from China and Portugal, which includes differential levels of transport costs and trade barriers in destination countries. Demand-side factors in destination country k are removed from Equation (C.3), isolating the effects of bilateral differences in productivity and trade costs on exports.

To implement the gravity approach, we estimate the following regression, where we add a dimension for year t:

$$ln(X_{jt}^{chn\to k}) - ln(X_{jt}^{prt\to k}) = \alpha_j + \alpha_k + \varepsilon_{jkt} \tag{C.4}$$

That is, we regress Chinese relative to Portuguese industry exports to various destination countries k, pooled over the period 1993-2008, on industry and destination market fixed-effects.

The residual from the regression in Equation (C.4) in each year t is:

$$\varepsilon_{jkt} = \left[ln\left(\frac{z_{jt}^{chn}}{z_{jt}^{prt}}\right) - \alpha_j \right] + \left[-(\sigma_j - 1) ln\left(\frac{\tau_{jt}^{chnk}}{\tau_{jt}^{prtk}}\right) - \alpha_k \right] \tag{C.5}$$

The first term on the right of Equation (C.5) is China's differential comparative advantage relative to the Portugal for industry j in year t, while the industry fixed-effect absorbs the mean difference in China and Portugal export capacities. The second term on the right of Equation (C.5) is China's differential trade costs relative to Portugal in industry j and year t for country k. The destination country fixed-effect absorbs the mean difference in China-Portugal trade costs, which are presumably driven by geography. Hence, the change over time of the residuals in Equation (C.5) captures the increase in China's competitiveness relative to the Portugal and China's differential improvement in access to foreign markets, including differential changes in trade barriers in the destination countries. These are precisely the components of China's export growth whose impact on the Portuguese labour market we want to measure.

To obtain an alternative to the specification in Equation (1) of the direct effect of import competition from China, we use all 82 individual countries available in the CEPII - CHELEM database, excluding China and Portugal, as destination countries k in the estimation of the Equation (C.4). We recover the residuals from this estimation, take their time-difference between 1993 and 2008 for each industry j and country k, compute a mean change of the residual for each industry j as the average across the 82 different countries, and exponentiate the values. Using these residuals, we compute the following gravity-based measure of direct exposure to imports from China in each industry j from 1993 to 2008:

$$\triangle IPGdir_{j,\tau} = \frac{\triangle\widetilde{\varepsilon_{j,\tau}} M_{j,93}^{chn \to prt}}{WB_{j,93}}, \tag{C.6}$$

where $\triangle\widetilde{\varepsilon_{j,\tau}}$ is the exponentiated mean change in the gravity residuals of Equation (C.5) for industry j across 82 destination markets between 1993 and 2008. When this change in the residuals is multiplied by the initial level of Portuguese imports from China in industry j in 1993, $M_{j,93}^{chn \to prt}$, we obtain the change in Portuguese imports from China predicted by China's increasing competitiveness and falling trade costs over that period.

One of the main contributions of our paper is to consider explicitly the indirect impact of Chinese exports to third countries on the Portuguese labour market. Our argument is that, due to the rise of China, Portuguese producers can be not only displaced in their home but also in

other foreign markets. The increased competition of China in the main destination markets of Portuguese exports is missing in the gravity-based measure of direct trade exposure of Equation (C.6). To address this issue, we develop an analogous gravity measure for the indirect import competition from China. This new measure captures the differential rise of attractiveness of China as a source market relative to Portugal in the main destinations to which Portugal exports to, due to supply and trade cost–driven changes in Chinese export performance.

Starting from the same gravity specification, we now use the other 14 original member-states of the European Union (EU14) as the k destination markets in the estimation of Equation (C.4). We recover the residuals, take their time difference between 1993 and 2008, and exponentiate them. But, in contrast to what was done to obtain the gravity-based measure of direct import competition, we now use the change in the residuals estimated for each individual industry-country market, instead of averaging across countries within each industry. That means that, as in Equation (2), we still consider 1,162 individual markets (83 industries $*$ 14 countries) where the change in Portugal's attractiveness relative to China from k's perspective is allowed to differ.

The alternative measure of indirect import competition from China in each industry j from 1993 to 2008 based on the gravity residuals is:

$$\triangle IPGind_{j,\tau} = \frac{\sum_{C=1}^{14} \omega_{j,93}^{prtC} \triangle \widetilde{\varepsilon_{j,C,\tau}} M_{j,93}^{chn \to C}}{WB_{j,93}}, \qquad \text{with} \qquad \omega_{j,93}^{prtC} = \frac{M_{j,93}^{prt \to C}}{M_{j,93}^{\to C}} \tag{C.7}$$

where $\triangle \widetilde{\varepsilon_{j,C,\tau}}$ is the exponentiated change in the gravity residuals of Equation (C.5) for industry j and country C of the EU14 between 2008 and 1993, which is multiplied with the initial level of imports from China of country C in industry j in 1993, $M_{j,93}^{chn \to C}$. That is, we start from our baseline measure of indirect competition of Equation (2), but instead of using the actual increase in imports from China of each EU14 country in each industry from 1993 to 2008, we now use a predicted level for these imports that results from the rise in competitiveness and fall in trade costs of China relative to Portugal in each of these industry-country markets, estimated from the gravity regression. Then, as before, each individual industry-country market is weighted by the initial share of Portuguese exports in total imports of that market in 1993, as described in Equation (2). The gravity-based measure of indirect trade exposure of Equation (C.7) can be interpreted as a proxy of the potential displacement of Portuguese producers by Chinese exports in the EU14 markets, as a result of changes in China's sectoral productivity and trade costs relative to Portugal in those markets and excluding the effect of possible import demand shocks in the destination countries. These are exactly the elements of the expansion of Chinese exports in the EU14 markets whose effect on the Portuguese labour market we want to quantify.