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Value Added Exports and U.S. Local Labor Markets: Does China Really Matter?

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Abstract

Measuring the effects of international trade on labor market outcomes has never been more important given the increasing interconnections among economies around the globe. However, using measures of exposure to trade flows based on gross exports may lead to a misleading picture given that production processes have essentially become globalized, allowing firms to have access to imported inputs as an example. We consider the effects of international trade by building a model with firm heterogeneity where firms have the ability to offshore the production of inputs. Our model highlights that international trade offers an opportunity for firms to become more productive by engaging in off-shoring activities while they face competition from imports of final goods in the domestic market. We then construct a measure of U.S. exposure to Chinese goods using value added trade to analyze its effects on U.S. local labor markets. Using value added trade, we find that continuously rising exports from China to the U.S. do not have significant effects on employment and wages. We further decompose the measure of exposure into value added trade in intermediate and in final goods. In line with the theoretical framework, we find that an increase in value added exports from China in final goods leads to a decrease in employment across U.S. local labor markets, while the effects from a change in the exposure to trade in intermediate goods are not significant.

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"What we call "Made in China" is indeed assembled in China, but what makes up the commercial value of the product comes from the numerous countries that preceded its assembly in China in the global value chain, from its design to the manufacture of the different components and the organization of the logistical support to the chain as a whole"

Pascal Lamy, former WTO director

1 Introduction

The world media have dedicated significant attention to China's return to the post of world's largest manufacturing producer by the end of 2010, a position last occupied by the country in the first half of the 19^{th} century.[1] This fact marks the phenomenal transition of the Chinese economy from a centrally planned economy by the end of the 1970s to a global trading partner, inclusive of its WTO membership accession process, during the first decade of the 2000s. The shift in the world manufacturing base towards China has been a source of jubilation and, at the same time, of apprehension among policy makers and scholars.[2] One of the most contentious issues has been the effects of economic growth in China on the U.S. economy. This is particularly important as China's astonishing economic growth over the last decades coincides with a contraction in manufacturing employment in the U.S. economy and with the formation of a burgeoning trade deficit with the same economy of about $273 billion in 2010.[3]

These facts have not been ignored by the economic literature. In particular, Autor, Dorn and Hanson (ADH, 2013) conclude that the growing exposure of the U.S. economy to Chinese gross exports has had a negative effect on manufacturing and non-manufacturing employment levels, as well as on wages, across U.S. local labor markets (commuting zones). Their results suggest that increasing exposure to Chinese competition can explain 26 percent[4] of the decline in U.S. manufacturing employment for the years 2000 to 2007.[5] However, the

[1]For example, the British newspaper *Financial Times* published material related to this issue in "http://www.ft.com/cms/s/0/002fd8f0-4d96-11e0-85e4-00144feab49a.html"

[2]World Bank (2006) summarizes the opportunities and potential challenges faced by Latin American economies due to China's emergence as an economic power.

[3]Information provided by the U.S. census bureau. The importance of the U.S. trade deficit with China can be gauged by the fact that it represents a substantial fraction of the $500 billion trade deficit of the U.S. economy in that year.

[4]Moreover, ADH (2013) find that the increase in U.S. exposure to Chinese gross exports explains 21 percent of the decline in the share of manufacturing employment between the years 1990 and 2007.

[5]In a recent paper, Acemoglu et al. (2014) investigate the effects of increasing exposure to exports from China on U.S. employment at the industry level. They find a negative direct effect of competing exports from China on industry employment levels. Moreover, they conclude that this effect on sectorial employment is magnified by the presence of substantial negative effects of competition from China on downstream industries.

contribution of Chinese competition to U.S. labor market outcomes has to be gauged with caution. This is particularly important as the world economy has become more integrated and access to imported materials and technologies has never been more important. In particular, Kee and Tang (2013) show that most Chinese exports emerge from the so-called "export processing firms", which correspond to firms that can import materials free of duty for assembling and pure exporting. This information suggests that the contribution of China to changes in labor market outcomes overseas should take into account that the value added by companies exporting from China may be significantly different from Chinese gross exports.

In this paper, we consider the role played by value added exports from China in the recent changes that have taken place in the U.S. local labor markets. Considering the role played by value added exports rather than gross exports is important for several reasons. First, recent papers by Koopman, Wang and Wei (KWW, 2014) and by Johnson and Nogueira (2012) have compiled datasets on bilateral value added exports across sectors, enabling researchers to map the contributions of each country to the production processes of various goods.[6] A striking conclusion from these papers is that value added exports can be very different from gross exports. In the case at hand, Johnson and Nogueira (2012) point out that the U.S. trade deficit with China measured by value added exports is at least 30 percent lower than the deficit measured using gross exports.

Second, they suggest that usual economic inference based on gross exports can be misguiding. In the case of revealed comparative advantage, KWW (2014) show that the ranking of comparative advantage based on value added exports supports very different conclusions from the ranking based on gross exports. Third, the effects of trade flows on labor market outcomes should depend on the role played by imported goods in the production process. It is plausible that imports of goods for final consumption may generate different effects than imports of intermediary goods on labor market outcomes. For instance, Görg, Hanley and Strobl (2008) argue that international outsourcing may increase the productivity of firms by providing them with access to higher quality materials or services. Moreover, access to foreign inputs could effectively increase productivity by allowing firms to focus on the core activities in which they are most efficient.[7] The dataset organized by KWW (2014) dis-

[6] In another paper, Wang, Wei and Zhu (2014) extends the original KWW's (2014) analysis by incorporating additional measures of value added exports based on backward linkages. Moreover, they provide a more detailed analysis of the different components that add to gross exports.

[7] Goldberg et al. (2010) provide empirical evidence that firms from India have become more productive given the greater access to imported inputs after the implementation of a trade liberalizing reform in the early 1990s, and, most importantly, they show that access to new imported inputs have increased the product scope of those firms.

tinguishes the contribution of each country in terms of value added exports used for final consumption and those used as inputs in the production of goods sold domestically. We consider these different elements in our analysis.

Our strategy follows the insights provided by a two-country model of international trade in the presence of firm heterogeneity. Similar to Antràs and Helpman (2004), we consider a North economy and a South economy where wages are lower in the south and firms based in the North can offshore the production of low-tech variety-specific inputs. We extend their analysis in directions that allow us to consider the labor market effects of exports from China (South) to the U.S. (North) market. First, we consider that the South economy also produces and exports varieties of the final tradable good. Second, we follow the approach used in Demidova (2008) to consider differences in technology between the South and North economies.

Our theoretical framework suggests two main insights. The first is that a productivity improvement in the South economy necessarily decreases the employment level in the tradable sector of the North economy. This happens since an increase in the productivity of Southern-based firms that produce the final tradable good leads to a decline in the sales (domestic and exports) of Northern-based firms. This effect is meant to represent the expansion of the exports of final goods from China and its expected effects on U.S. local labor markets.

The second insight of the model suggests that the opportunity to offshore the production of low-tech inputs to the South, effectively increases the productivity of firms based in the North. Our model suggests that firms that offshore should be more productive than firms that only sell in the domestic market. This is in line with empirical evidence available in Tomiura (2007) for Japanese firms, and in Görg, Hanley and Strobl (2008) for Irish firms. Our model indicates that the opportunity to offshore increases the average productivity of firms producing varieties of the tradable good in the North, and increases employment in the tradable sector of that economy, relative to the situation where Northern-based firms can export final goods but do not have the opportunity to offshore. The main conclusion is that the effects of international trade should be investigated considering the role played by traded goods in the production process, where imported final goods and imported materials can have different effects on labor market outcomes.

Our empirical analysis considers these main elements. In particular, we use information on value-added exports across countries and products available in KWW (2014). Our main focus is the change in U.S. exposure to value added exports from China between the years

2000 and 2007. This time interval corresponds to the peak of export growth from China to the U.S. economy.[8] During this time interval, gross exports from China to the U.S. grew by 303 percent while value added exports grew by 256 percent. The decomposition of value added exports from China in the year 2007 suggests that about 54 percent correspond to value added to products sold as final goods in the U.S. market, while the remainder corresponds to value added to products used as inputs in the production of domestic goods sold in that economy. The bottom line is that a significant share of value added in China is related to products that serve as inputs in the production of goods produced and sold in the U.S.

We calculate U.S. exposure to Chinese value added exports across local labor markets following the approach used in ADH (2013) and we instrument it using Chinese value added exports to other developed countries. The distribution of U.S. exposure to Chinese value added exports displays important characteristics that are in line with the discussion above, and also highlight some new features that we also explore in our econometric analysis. In line with the discussion above, we find that the average increase in the U.S. local labor market exposure to Chinese value added exports is significantly lower than the average measure used in ADH (2013), which is based on gross exports. Moreover, we find that these measures are positively, but not strongly, correlated.

Most importantly, while we conclude that most of the U.S. increase in exposure to Chinese value added exports is due to value added exports in final goods, we also find a significant increase in U.S. exposure to value added exports from China in intermediate products. This is line with the facts described in Wang, Wei and Zhu (2014) that lead to the conclusion that China has evolved from an economy that assembles final goods to an economy that increasingly serves as a source for intermediate products, participating fully in the different stages of the (international) production of goods.[9]

Our econometric strategy considers these insights. The results provide a different, albeit complementary, picture that emerges from the results obtained by ADH (2013). We begin our analysis by exploring the average effect of an increase in U.S. exposure to value added exports from China without focusing on the role played by trade flows in the production process. Our main specification suggests that an increase in U.S. exposure to Chinese value added exports leads to a decrease in the share of manufacturing employment, but this result

[8]Autor, Dorn and Hanson (2013) employ a dataset covering the years from 1990 to 2007. However, Koopman, Wang and Wei (2014) provide information on value added exports from 1995 to 2009. Thus, we can not cover the years from 1990 to 2000 in our analysis.

[9]Their paper provides an important example related to U.S. exports of transportation equipment. In that case, Wang, Wei and Zhu (2014) provide evidence that China had emerged as the main source of foreign value added to that industry, surpassing even Japan, by the end of the first decade of the 21st century.

is not very statistically robust. Essentially, the statistical significance of this result tends to disappear as we control for U.S. local labor market characteristics.

Then, we explore the additional features of our dataset. In particular, the theoretical framework suggests that the effects of traded goods on labor market outcomes should depend on the role they play in the production processes. This issue seems to be very relevant for China and U.S. trade relations. A comparison between the increase in U.S. exposure to Chinese value added exports, with the U.S. exposure to other countries, reveals that while the U.S. increase in exposure towards China is slightly biased towards value added in final goods, for other groups of countries (High income, Middle income and Transition economies) the U.S. increase in exposure is biased towards value added in intermediate products. This is in line with the idea suggested by Wang, Wei and Zhu (2014) that the production chain is becoming longer, and that trade in intermediate products is becoming more important over time.

Our econometric results suggest that the role played by trade goods in the production process is paramount in explaining the effects of Chinese exports on U.S. local labor markets. We find that an increase in U.S. exposure to value added exports from China in final goods leads to a strong and statistically robust decline in manufacturing employment across U.S. local labor markets, while the same does not apply to the case of an increase in the exposure to value added exports in intermediate goods. Our results suggest that the average increase in exposure to value added exports in final goods from China explains 37 percent of the decline in the share of manufacturing employment across U.S. local labor markets. These effects are statistically robust to controlling for U.S. value added exports to China. Our results suggest that the contribution of China to changes in U.S. local labor markets depends more on the role played by Chinese exported goods in the production process rather than the total trade amount.

On the other hand, we find no statistical evidence that an increase in U.S. exposure to Chinese exports causes an average decline of wages across U.S. local labor markets. This finding is in line with recent results obtained by Acemoglu et al. (2014) at the industry level, and it seems robust to either using measures of gross exports or value added exports for the period between the years 2000 and 2007. Moreover, we find that our results are robust to changes in the measure of exposure, and to using the dataset described in Johnson and Noguera (2012). We also highlight how the effects of value added exports from China differ from the effects generated by changes in U.S. exposure to other countries. In this case, it is also important to consider the role played by trade flows in the production process.

The rest of the paper proceeds as follows. Section 2 discusses our theoretical framework where we highlight the importance of distinguishing between economic exposure to value added exports in the form of intermediate goods versus final goods. Section 3 presents our econometric strategy and the dataset used in our empirical analysis. Section 4 describes the econometric results while Section 5 concludes the paper.

2 A Model of Firm Heterogeneity with Offshoring

We consider a two-country model of firm heterogeneity where we label the two economies as North (U.S.) and South (China). The objective of the model is to consider two important facets of trade between the U.S. and China. First, we apply this model to investigate the consequences for the U.S. labor market of an expansion of Chinese exports due to an increase in the productivity of firms based in that country and that produce varieties of the final tradable good. This is in line with the notion that economic growth in China may have deleterious effects on employment in other countries since it is related to the increase of Chinese exports, which compete with products produced domestically, thereby reducing the demand for domestic labor in the tradable sector.

Second, we extend the model with trade in varieties of a final good to a model of trade where the two economies trade varieties of a final good and also allows for offshoring, i.e., the model considers that firms based in the North may purchase low-tech variety-specific inputs from the South. The ability to offshore represents an increase in the productivity of Northern-based firms that decide to offshore. As we show below, the increase in productivity of these firms translates into more sales for them, leading to a net increase in the demand for labor in the tradable sector of the North economy. Thus, the effects of trade on labor markets depends on the role played by traded goods in the production process.

2.1 Basic Setup

The representative consumer in each country can purchase a homogenous non-tradable good and different varieties of a tradable good. We represent the non-tradable (tradable) good by subscript N (T). There are different varieties of the tradable good produced in the North and in the South economies. We represent Southern variables by superscript $\tilde{}$. On what follows, we focus on describing several relationships using notation for the Northern economy but a similar rationale applies to the Southern economy. The consumer maximizes his utility:

$$U = \frac{Q_T^{1-\varepsilon}}{1-\varepsilon} + \frac{Q_N^{1-\varepsilon}}{1-\varepsilon}$$

subject to the budget constraint $PQ_T + Q_N = wL$, where price of the non-tradable good is normalized to 1 and labor is inelastically supplied. This utility specification has been used in the literature on life-cycle models where two goods are consumption and leisure. It has also been used by Esposito and Arkolakis (2014) to generate elastic labor supply in Melitz type models. Our use of this utility specification generates changes in the amount of labor employed in the tradable and non-tradable sectors, which allows us to test the predictions of our model using share of manufacturing employment later in the empirical section.

The aggregated demand in the tradable good sector Q_T in each economy is given by

$$Q_T = \left[\int_{i \in \Omega} q(i)^{\rho} di \right]^{1/\rho}, \qquad 0 < \rho < 1, \tag{1}$$

where the elasticity of substitution between different varieties is given by $\sigma = 1/(1-\rho) > 1$. Using first order conditions, it is straightforward to show that the aggregate demand in the tradable sector depends on the aggregate price index, $Q_T = \frac{1}{P + P^{1/\varepsilon}} wL$, and aggregate price index is given by

$$P = \left[\int_{i \in \Omega} p(i)^{1-\sigma} di \right]^{\frac{1}{1-\sigma}}. \tag{2}$$

We follow Antras and Helpman (2004) by assuming that the production of each final good variety requires two variety-specific inputs, $h(i)$ and $m(i)$, which are associated with high-tech and low-tech inputs, respectively. The production function of variety i is described by

$$q(i) = \theta_i \left(\frac{h(i)}{1-z} \right)^{1-z} \left(\frac{m(i)}{z} \right)^{z}, \tag{3}$$

where z represents offshore intensity. A larger z indicates that the tradable sector is more offshore-intensive since the high-tech inputs can only be produced in the North. Each input requires one unit of labor for one unit of output.

The demand for the non-tradables is $Q_N = \dfrac{P^{1/\varepsilon}}{P + P^{1/\varepsilon}} wL$. A decrease in the aggregate price index, or equivalently, an increase in average productivity, leads to a decrease in demand for non-tradable good, which implies labor shifts away from the non-tradable good sector to the tradable good sector.

Labor is the only factor of production. In the tradable good sector, we follow Melitz

(2003) by assuming that firms must pay a sunk entry cost f_E to enter. Next, firms draw their productivity from a common distribution $g(\theta)$ with positive support over $(0,\infty)$ and a cumulative distribution $G(\theta)$. Upon observing its productivity, each firm decides to produce or exit the market. Labor used is a linear function of output $q(i)$ with a fixed overhead cost. In the non-tradable sector, a constant returns to scale technology pins down the wage in each economy and we assume $w > \tilde{w}$. We proceed now to consider the equilibrium under different trade policy regimes. Our main focus continues to be the analysis of the equilibrium in the North (U.S.) economy.

2.2 Autarky

In this case, trade in final and intermediary (low-tech) goods is not allowed. Firms pay a fixed organization cost of f_d per period in the domestic production. Profit is maximized by setting the price to

$$p(\theta) = \frac{w}{\rho\theta}. \tag{4}$$

As in Melitz (2003), the equilibrium productivity cutoff can be described by two conditions. The zero profit condition can be written as $\bar{\pi} = wf_d\left[\left(\frac{\bar{\theta}}{\theta^*}\right)^{\sigma-1} - 1\right] = wf_d k(\theta^*)$ while the free entry condition ensures $\bar{\pi} = \delta w f_E\left[1 - G(\theta^*)\right]$, where $\bar{\pi}$ is the expected profit of a potential entrant, $\bar{\theta}$ is the aggregate productivity in the tradable sector, and f_E is the sunk entry cost. The free entry condition and the zero profit condition yield the following expression[10]:

$$\frac{f_d}{\delta} j(\theta^*) = f_E. \tag{5}$$

where $j(\theta) = [1 - G(\theta)]\, k(\theta)$ and it is decreasing in θ as discussed in Demidova (2008).

The aggregate price index in the tradable sector, P, can be written as a function of θ^* (see A.1 in the appendix). In addition, P decreases as θ^* increases (see A.2 in the appendix). This implies that when a country's domestic productivity cut-off increases, aggregate price index decreases. This leads to a decrease in demand for non-traded good and increase in demand for traded good, resulting in shifts in labor from the non-tradable good sector to the tradable good sector, or an increase in manufacturing employment.

[10]Notice that we can isolate the ratio $\frac{\bar{\pi}}{w}$ in the free entry condition and replace it in the zero cutoff profit condition.

2.3 Trade without offshoring

Firms pay a fixed cost f_x in each period if firms decide to export. Similar to the asymmetric countries setup in Demidova (2008), we allow firms to draw from different productivity distributions in the North and the South, $G(\theta)$ and $\tilde{G}(\theta)$, which captures the fact that the technology available varies across countries. In addition, countries can also vary by size (L and $\tilde{L}$).

Firms charge price $p_x(\theta) = \tau p(\theta)$ in the export market, where $\tau > 1$ represents the iceberg transport cost and firm's profit in the export market depends on the revenue earned in the South. In this case, there exists a domestic productivity cutoff θ^* and an export productivity cutoff θ_x^* below which firms do not sell domestically or export.

The expected profit for potential North entrants is the sum of expected profit from domestic sales (if $\theta > \theta^*$) and from exporting (if $\theta > \theta_x^*$).This can be written as:

$$\bar{\pi} = E(\pi) = wf_d k(\theta^*) + wf_x p_x k(\theta_x^*) \tag{6}$$

where $p_x = \frac{1-G(\theta_x^*)}{1-G(\theta^*)}$ is the probability of exporting. We can write $\theta_x^* = \tilde{\theta}^* \phi \omega^{1/(\sigma-1)}$, where $\phi = (f_x/f_d)^{1/(\sigma-1)}\tau$,using zero profit conditions (as shown in appendix A.3). Therefore, the expected profit can be written as $\bar{\pi} = wf_d k(\theta^*) + wf_x p_x k(\tilde{\theta}^* \phi \omega^{1/(\sigma-1)})$, together with free entry $\bar{\pi} = \delta w f_E / [1 - G(\theta^*)]$, we get the following expression for the North:

$$\frac{f_d}{\delta} j(\theta^*) + \frac{f_x}{\delta} j\left[\tilde{\theta}^* \phi \omega^{1/(\sigma-1)}\right] = f_E \tag{7}$$

A similar expression applies to the South economy:

$$\frac{f_d}{\delta} \tilde{j}\left(\widetilde{\theta}^*\right) + \frac{f_x}{\delta} \tilde{j}\left[\theta^* \phi \omega^{1/(1-\sigma)}\right] = f_E \tag{8}$$

where the functions $j(\theta)$ and $\tilde{j}(\theta)$ are defined as before. The system of expressions (7) and (8) can be used to find the productivity cutoffs for the North (θ^*) and South ($\widetilde{\theta}^*$) economies. If we assume that both economies produce varieties of the tradable good in equilibrium (see appendix for this condition), and that the hazard rate of the probability distribution function in the North dominates the probability distribution in the South[11], we can follow Demidova (2008) to conclude that the equilibrium productivity cutoffs ($\theta^*$and $\widetilde{\theta}^*$) are unique and that surviving firms in the North are more productive than in the South,

[11]This implies that $g(\theta)/(1-G(\theta)) > \widetilde{g}(\theta)/(1-\widetilde{G}(\theta))$. Intuitively, this assumption means that, given any level of productivity θ, entrant firms in the North economy have a greater chance of having a higher productivity level than entrants in the South.

$\theta^* > \widetilde{\theta}^*$, illustrated by Figure 1.[12]. The exporting firm productivity cutoffs (θ_x^* and $\widetilde{\theta}_x^*$) can be calculated using expressions from appendix A.3 as a function of θ^* and $\widetilde{\theta}^*$, respectively.

The system of equations (7) and (8) also highlights that cutoffs θ^* and $\tilde{\theta}^*$ necessarily move in opposite directions under international trade. It is sufficient to consider each expression separately. Consider expression (7) and an increase in cutoff $\tilde{\theta}^*$. In this case, θ^* needs to decrease since the right hand side of (7) is constant. Intuitively, a higher South domestic cutoff decreases Northern entrants' expected profits through two channels. The first is by decreasing the range of profitable exporters (i.e. $\theta_x^* = \tilde{\theta}^* \phi \omega^{1/(\sigma-1)} \uparrow$). The second is by making the Southern business environment ($\tilde{B}$ in appendix A.3) tougher for existing Northern exporters.

The discussion above can be readily applied to investigate the effects of a technology improvement in the South economy on the labor market of the North economy. This follows the essence of the argument delineated by ADH (2013) about how a supply shock in China (South) affects the U.S. (North) labor market. In our framework, a technological improvement in the South translates into a change of the productivity distribution function for that country, where the new function's hazard rate statistically dominates the previous one. Figure 2 illustrates the changes in productivity cutoffs for the North and the South following a technology improvement in the South. These changes affect the equilibrium expression for the South economy represented by expression (8). The new expression can be represented by

$$\frac{f_d}{\delta}\widetilde{j}'\left(\widetilde{\theta}^*\right) + \frac{f_x}{\delta}\widetilde{j}'\left(\theta^* \phi \omega^{1/(1-\sigma)}\right) = f_E \tag{9}$$

The new system of expressions (7) and (9) yield a modified set of productivity cutoffs. In essence, the schedule of cutoff points described by expression (9) shifts as productivity changes in the South, leading to an increase in the productivity cutoff ($\tilde{\theta}^* \uparrow$) for that economy. As discussed above, this leads to a decline in the productivity cutoff ($\theta^* \downarrow$) in the North since we are moving along the equilibrium expression (7). Again, a higher Southern domestic cutoff decreases Northern entrants' expected profits. This implies that fewer firms enter the tradable sector in the North economy, decreasing the demand for labor in the tradable sector of that economy. The dislocated workers find a position in the nontradable sector. Thus, we

[12] As usual, it can be demonstrated that as each economy moves from autarky to a situation where the economies have costly trade then the productivity cutoff for surviving firms in each economy tends to rise. Consider the situation of the North economy. In this case, expression (7) says that under autarky, the second term on the right hand side is zero, while it is positive in the case of trade. That means that the left hand side of (7) shifts to the right. Since the right hand side of that expression is constant, that implies that the productivity cutoff θ^* is greater under costly trade than under autarky.

have that an increase in value added exports from the South economy to the North economy in the form of final goods tends to decrease employment in the tradable sector of the North economy.

2.4 Offshoring

In this section, we extend the model of the previous section to the presence of offshoring. We follow Antràs and Helpman (2004) by assuming that only the North has the ability to offshore. Let f_o be the additional organizational cost of offshoring every period. In this case, we assume that the additional organizational cost related to offshoring means that low productivity firms do not engage in offshoring.

Assuming that there are no costs related to trade of intermediate inputs, the profit maximizing price under offshoring is:

$$p^o = \frac{w^{1-z}\tilde{w}^z}{\rho\theta} = \frac{w}{\rho\theta\omega^z}, \tag{10}$$

where $\omega = w/\tilde{w} > 1$. This implies that the lower the wage rate in the South relative to the North, the lower the domestic price of a firm that offshores the low-tech productivity input.

We identify the productivity cutoffs related to offshoring by a superscript "o". Assume that θ_d^{*o} refers to the productivity cutoff for firms that offshore and sell domestically and θ_x^{*o} denotes the productivity cutoff for firms that offshore and export. In this case, productivity cutoffs are sorted in two possible ways. The first case is where all exporters are offshoring firms, or $\theta^* < \theta_d^{*o} < \theta_x^{*o}$. The second case is where all offshoring firms are exporters, or $\theta^* < \theta_x^* < \theta_x^{*o}$. We focus on the first case where offshoring effectively increases the productivity of incumbent firms, and, therefore, lowers the export productivity cutoff compared to the situation where offshoring is not permissible. As we discuss below, the cutoff productivity level for firms that remain on the market increases in the North with offshoring, forcing the least productive firms ($\theta < \theta^*$) to exit. At the same time, new exporters arise from an increase in effective productivity from offshoring.

We can now describe the expected profit for potential North entrants. This expression corresponds to the sum of expected profit from domestic sales with no offshoring ($\theta^* \leq \theta$), the additional profit from domestic sales with offshoring ($\theta_d^{*o} \leq \theta$) and from exporting ($\theta_x^{*o} < \theta$). Following the approach and notation used in the previous section we can obtain:

$$\bar{\pi} = E(\pi) = wf_d k(\theta^*) + wp_o f_o k(\theta_d^{*o}) + wp_x f_x k(\theta_x^{*o}) \tag{11}$$

where $p_o = \frac{1-G(\theta_d^{*o})}{1-G(\theta^*)}$ and $p_x = \frac{1-G(\theta_x^{*o})}{1-G(\theta^*)}$. In addition, we can use zero profit conditions to rewrite productivity cutoffs $\theta_x^{*o} = \tilde{\theta}^* \omega^{1/(\sigma-1)} \omega^{-z}$ and $\theta_d^{*o} = \theta^* \phi^o \omega^{-z}$, where $\phi^o = (f_o/f_d)^{1/(\sigma-1)}$, as shown in Appendix A.4. This information about productivity cutoffs can be used to rewrite expected profit as $\bar{\pi} = wf_d k(\theta^*) + wp_o f_o k(\theta^* \phi^o \omega^{-z}) + wp_x f_x k(\tilde{\theta}^* \phi \omega^{1/(\sigma-1)} \omega^{-z})$. In equilibrium, expected profit before entry is zero. Thus, the free entry condition ensures that $\bar{\pi} = \delta w f_E / [1 - G(\theta^*)]$. These two equilibrium schedules for the North economy, along with their analogous schedules for the foreign economy, can be used to obtain the following expressions:

$$\frac{f_d}{\delta} j(\theta^*) + \frac{f_o}{\delta} j\left(\theta^* \phi^o \omega^{-z}\right) + \frac{f_x}{\delta} j\left(\tilde{\theta}^* \phi \omega^{1/(\sigma-1)} \omega^{-z}\right) = f_E \tag{12}$$

$$\frac{f_d}{\delta} \tilde{j}\left(\tilde{\theta}^*\right) + \frac{f_x}{\delta} \tilde{j}\left(\theta^* \phi \omega^{1/(1-\sigma)}\right) = f_E \tag{13}$$

where the functions $j(\theta)$ and $\tilde{j}(\theta)$ are defined as before, and we continue to assume that the hazard rate of the productivity distribution in the North stochastically dominates the productivity distribution in the South. This system of equations allows us to obtain the equilibrium cutoffs for surviving firms (θ^* and $\tilde{\theta}^*$) in the same manner as discussed in the previous Section, and we can obtain the remaining cutoffs using expressions in appendix A.4.

More importantly, a comparison between the equilibrium that emerges when trade in final goods and trade in intermediate inputs are allowed, which is represented by expressions (12) and (13), and the equilibrium when only trade in final goods is allowed, which is represented by expressions (7) and (8), highlight how the surviving firm cutoffs in the North and in the South economies (θ^* and $\tilde{\theta}^*$) change due to the presence of offshoring. Figure 3 displays the two equilibria. In this case, point a represents the equilibrium when offshore is not permitted. As we compare the two systems of equations, we clearly notice that the main difference is the term related to the productivity cutoff for offshoring ($\frac{f_o}{\delta} j(\theta^* \phi^o \omega^{-z})$) and the productivity cutoff for exporting under offshoring ($\frac{f_x}{\delta} j\left(\tilde{\theta}^* \phi \omega^{1/(\sigma-1)} \omega^{-z}\right)$), which only affects expression (12)[13], while expressions (8) and (13) are identical. Thus, the presence of offshoring essentially shifts the schedule representing the equilibrium in the North economy, moving then the equilibrium along the South economy schedule to point b in the graph.

Figure 3 reveals that offshoring increases the productivity cutoff for surviving firms in

[13]If $z = 0$, expression (12) becomes expression (7).

the North economy ($\theta^* \uparrow$) while it decreases the productivity cutoff in the South economy ($\tilde{\theta}^* \downarrow$). The intuition is that offshoring allows existing exporters to offshore, which effectively increases their productivity, and tends to increase these firms outputs. As a result, the demand for workers in the tradable sector of the North economy rises, which increases real wages in the North economy since the aggregate price index decreases in the North. This change in real wages forces the least productive firms to exit the market in the North economy. On the other hand, an increase of the productivity cutoff in the North decreases the expected profits of entrants in the South economy as discussed in the previous section. Notice that expressions in appendix A.4 suggest that the productivity cutoff for exporting firms decreases ($\theta_x^{*o} \downarrow = \tilde{\theta}^* \omega^{1/(\sigma-1)} \omega^{-z} \downarrow$) in the North increasing probability of export.

The results in this section allow us to conclude that value added exports from the South (China) to the North (U.S.) in intermediate goods should lead to an increase in employment in the tradable sector in the North, which is the opposite of the case of value added exports from the South in final goods. Moreover, real wages also increase in the North. Thus, the net effect of increases in value added exports from the South to the North is ambiguous and it depends on the role played by traded goods in the production process.

Our model could be clearly extended to incorporate an additional Northern economy. In this case, the objective would be to investigate how the presence of offshoring could affect the competition between two Northern economies in the market for final goods (Appendix B and C illustrate an extension of our model in which there are many asymmetric countries and productivity follows the Pareto distribution). Consider the same model described above but in the presence of Northern economies labeled as economies 1 and 2. Suppose that these two Northern economies are identical except for the additional organizational cost of offshoring that we assume to be greater in the Northern economy 1, $f_{o1} > f_{o2}$. This implies that the possibility of offshoring generates a greater productivity gain in Northern economy 2 relative to the situation where offshore is not present. This happens since more firms in Northern economy 2 are able to offshore, which then implies that productivity will increase more in economy 2. This additional feature of the model could explain why indirect exports from the South economy through Northern economy 2 to Northern economy 1 may have deleterious effects on economy 1's employment in the tradable sector. We explore this additional feature in the empirical Section.

3 Empirical Strategy

This section has two main objectives. First, we describe the econometric model used to investigate the effects of trade flows between the U.S. and China on the former economy's local labor markets. Our analysis focuses on changes in trade flows between these two economies between the years 2000 and 2007, and it highlights the importance of considering the role played by value added exports on labor market effects as well as the role played by imports in the production process. On one hand, we allow for different effects due to changes in gross exports and in value added exports, while, on the other, we explore the potentially different effects generated by trade in final and in intermediate goods.

Second, we describe the dataset used in this paper, which relies on data made available by ADH (2013), KWW (2014) and by other sources described below. In this case, we elaborate on the definition of value added exports used in KWW (2014) and on the differences between the U.S.-China measures of trade flows using gross and value added exports. We also provide a comparison between the measures of change in the U.S. local labor market exposure to trade with China using gross and value added exports. Notice that we use below the words sector and industry interchangeably.

3.1 Econometric Model

The key variable in our empirical exercises is the measure of U.S. local market exposure to value added exports from China. Following ADH (2013), we measure the effects of international trade on local labor markets on a per-worker basis, while weighting the importance of sectorial trade in a particular labor market by using the share of national sectorial employment for a particular labor market. Our basic measure of U.S. local labor market exposure can be described as follows:

$$\Delta LEXP\_VAE_{it} = \sum_{s} \frac{L_{ist}}{L_{st}} \frac{\Delta VAE_{st}}{L_{it}} \tag{14}$$

where ΔVAE_{st} stands for the change in value added exports from China to the U.S. in industry (sector) s between the years 2000 and 2007. For this reason, we refer to the year 2000 as the base year. The variable L_{it} represents employment in local market i for the base year while L_{st} represents U.S. employment in industry s for the base year.

We explore variations in the manner in which we measure the exposure of local labor markets to international trade flows. We also use the measures of exposure based on changes in gross exports from China originally calculated by ADH (2013) for comparison purposes. This strategy allows us to consider whether the effects of changes in value added exports from China to the U.S. differ from the effects of changes in gross exports. Moreover, we also calculate the exposure measure (14) separately for value added exports from China to the U.S. in final goods, and in intermediate goods exported by China to the U.S., as well as value added exports in goods sold to the U.S. indirectly, i.e., intermediate products sold by China to a third country before being sold in the U.S. economy as a final product. Finally, we consider the role played by net value added trade between U.S. and China on U.S. labor market outcomes. The latter measure controls for the effects of economic growth in China in promoting employment and in raising wages across U.S. local labor markets through the increase of U.S. value added exports to China.

Our econometric specification considers the effects of changes in U.S. local labor market exposure to trade with China, as defined in expression (14), on changes in employment and in wage levels. More specifically, our basic model is represented by the following econometric specification:

$$\Delta \frac{L_{it}^{m}}{WP_{it}} = \alpha + \gamma_1 \Delta LEXP\_VAE_{it} + \gamma_2' \mathbf{X}_{it} \qquad (15)$$

where $\Delta \frac{L_{it}^{m}}{WP_{it}}$ represents the change in the manufacturing employment share of the working age population in local market i. As is clear from expression (15), we include a set of local market controls described by the matrix $\mathbf{X}_{it}$. These controls include possibly relevant characteristics of local labor markets, measured during the base year, such as the percentage of the employment in manufacturing, the percentage of the college-educated population, the percentage of the foreign-born population, among others. The idea is that, controlling for these local market characteristics, we can capture the effects of changes in market exposure on the manufacturing employment share. A similar strategy is used to gauge the effects of local labor market exposure to trade on average wage levels. In addition, all estimated versions of expression (15) weight observations by the local labor market's share of national employment at year 2000 and standard errors are clustered at the state level.

The key remaining problem is that there may be variables missing from expression (15) and that are correlated with the measure of change in local market exposure, possibly generating biases in the econometric results from the estimation of this expression. To address this issue, we follow the strategy proposed by ADH (2013) and use the following variable to instrument the change in local labor market exposure ($\Delta LEXP\_VAE_{it}$)

$$\Delta IVEXP\_VAE_{it} = \sum_s \frac{L_{ist-1}}{L_{st-1}} \frac{\Delta VAE^{rich}_{st}}{L_{it-1}} \tag{16}$$

The variable ΔVAE^{rich}_{st} represents the change in value added exports from China to other selected developed countries in industry s between 2000 and 2007.[14] The instrumental variable described by expression (16) uses employment-based variables measured in 1990, ten years prior to the base year. This explains the application of subscript $t-1$ in expression (16). In this case, the objective is to mitigate possible simultaneity bias generated by the employment-based variables used to calculate the instrumental variable. Our strategy is to estimate expression (15) using a 2-stage least square strategy where expression (16) instruments our measure of change in labor market exposure described by expression (14). Our strategy also provides information about the quality of the instrumental variable, including a statistical test for weak instruments.

An additional component of our strategy is to investigate the effects of traded products on labor market outcomes controlling for their role in the production process. In these cases, we calculate the instrumental variable described by (16) in line with our strategy. For instance, if we measure the change in exposure described by expression (14) using value added exports from China to the U.S. in final goods, then we also use value added exports in final goods from China to selected developed countries in order to construct our instrumental variable. In addition, our analysis also considers the effects of net trade flows between China and the U.S. on labor market outcomes. In this particular case, we calculate an additional instrumental variable, based on expression (16), using data on U.S. gross and value added exports to middle income and transition economies.

3.2 Dataset and Basic Statistics

The key variable for estimating expression (15) is the measure of change in local labor market exposure to value added exports from China described by (14). Moreover, we need to instrument this variable as explained above, which requires value added exports from China to other developed countries' markets. For this reason, we use information on bilateral value added exports provided by KWW (2014). Their dataset is organized at the sectorial level using the European Union classification system (NACE) and it provides sectorial value added exports among 40 countries. The employment information for the years 1990 and 2000 are provided by ADH (2013) and they are organized at the 4-digit of the Standard Industrial

[14]The list of developed countries used in this case can be found below.

Classification (SIC). We proceed by applying a concordance to the employment information from the 4-digit of the SIC to the NACE since the latter classification is more aggregated, allowing us to relate several SIC codes to a particular code of the NACE.[15] We are then able to calculate the change in exposure to value added exports by using information on value added exports and on employment according to expression (14). A similar approach is used to calculate the instrumental variable described by (16) and for the other variables that consider the role of value added exports in the production process.[16]

Notice that sectorial value added exports provided by KWW (2014) measure the domestic value added that originates from a particular NACE industry, and is either exported directly to a particular country by that industry or is exported via forward linkages to ultimately be absorbed abroad.[17] A similar definition is also used in Johnson and Noguera (2012). Importantly, this information implies that our data on sectorial value added exports are not bound by sectorial gross exports since value added generated by a particular sector can be exported by downstream sectors as well.

We can consider a couple of cases involving exports from China to the U.S. to shed light on this issue. The dataset provided by KWW (2014) indicates that gross exports from China to the U.S. of machinery (NACE code 28) in 2007 were smaller than their counterpart in value added terms by about $10 billion. This makes sense since many Chinese-made machines are used by downstream industries in China before a product is exported to the U.S. On the contrary, the same dataset indicates that gross exports from China to the U.S. of textiles (NACE code 13) were greater than their counterpart in value added terms by about $13 billion.[18]

Table 1 provides information related to the change in U.S.-China trade flows measured

[15]We have also applied the concordance to the value added export measures from the NACE to the 4-digit of the SIC. Most of the econometric results are robust to this approach as well. However, this approach forces us to disaggregate value added exports measured at the NACE level into various SIC codes, which requires an assumption about how this should be done. For this reason, we proceeded by aggregating the employment-related variables to NACE since this does not require additional assumptions to concord the data.

[16]The instrumental variable uses information about Chinese value added exports to eight developed countries, namely: Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland.

[17]Wang, Wei and Zhu (2014) explain in detail the differences between measuring value added exports using forward linkages and using backward linkages. The former focuses on the contribution of a sector to value added, while the later focuses on the contribution of upstream sectors to the exports of a particular sector. The former is not bound by sectorial gross exports, while the latter is bound by it.This is why (like us) Wang, Wei and Zhu (2014) focus on value added exports via forward linkages in measuring revealed comparative advantage across countries.

[18]Both cases suggest significant measurement differences. In the case of machinery, gross exports totalled only $23 million while value added exports totalled $10.018 billion. In the case of textiles, gross exports totalled $24.8 billion while value added exports totalled $11.7 billion.

between the years 2000 and 2007. First, we note that aggregate Chinese gross exports to the U.S. tend to be greater than aggregate Chinese value added exports, while the inverse may happen for Chinese imports from the U.S. Second, gross trade flows between the U.S. and China have grown at a faster pace than value added trade flows. These two points lead to the result that the U.S. trade deficit with China measured using gross exports in 2007 (about $223 billion) is about 26 percent greater than the U.S. trade deficit measured using value added exports (about $177 billion). The fact that the U.S. trade deficit with China is smaller in value added terms is corroborated by other trade flow measures, such as the ones provided by Johnson and Noguera (2012), which tend to yield numbers of a similar magnitude.

Table 2 shows a comparison between the changes in the measure of local labor market exposure to trade flows using gross and value added exports. Panel A of Table 2 suggests that the change in the average local labor market exposure using gross exports tends to be significantly higher than the change in the average exposure using value added exports. This is in line with the discussion involving the pace at which gross exports from China to the U.S. have grown relative to value added exports. The numbers suggest average increases in exposure to gross Chinese exports of $2.64 thousand per worker during the years 2000 and 2007, while the average change in exposure based on value added exports suggests increases of $1.76 thousand per worker. It is also clear that the dispersion of the distribution of changes in exposure based on gross exports is greater than the dispersion of the distribution using value added, as suggested by the ratio between the standard deviation and the average change in exposure.

Notice that the data indicate that the correlation between the two measures of exposure across U.S. local labor markets is 0.23. This suggests that they are positively albeit not strongly correlated. Panel B of Table 2 seems to confirm this information. If we consider the top 3 U.S. local labor markets in terms of the greatest increases in exposure, as defined by gross exports from China, it is noticeable that they are distinct from the top 3 markets as defined by value added exports.[19] Moreover, as discussed above, the increase in exposure tends to be greater using gross exports rather than value added exports. Likewise, the bottom 3 markets facing the lowest increases in exposure according to gross exports is distinct from

[19]By definition, a commuting zone (czone) consists of a set of counties where labor mobility is high but where changes in labor markets conditions would lead to very small exit from, as well as entry to, its labor market. For instance, the czone 25401 is formed by Livingston county (KY), Marshall county (KY), Ballard county (KY), Massac county (IL), Pope county (IL), Carlisle county (KY), and McCraken county (KY). Similarly, czone 37602 is formed by Humbolt county (NV) and Pershing county (NV). It is clear that these two czones are geographically far apart from each other.

the bottom 3 markets according to value added exports. Actually, the former group shows decreases in exposure while the latter group shows an increase. This is in line with the fact that changes in exposure based on gross exports from China have greater dispersion than the changes based on value added exports. These facts embedded in the data will be important for understanding the distinct results we obtain using value added exports instead of gross exports.[20]

Table 3 provides information about the relationship between the average increase in exposure across U.S. local labor markets to value added exports from China, as well as from other groups of countries, and the role played by traded goods in the production process. It is clear from Table 3 that 53 percent of the increase in the average U.S. exposure to Chinese value added exports is due to an increase in Chinese value added exports in final goods. This is followed by a 37 percent increase in U.S. exposure to Chinese value added exports in intermediate goods, and the remainder corresponds to the increase in U.S. exposure to value added exported from China in indirect form. In this case, our theoretical framework suggests that most of the increase in value added exports from China represents direct competition to U.S. products in the domestic market and may have negative effects on manufacturing employment.

On the contrary, for all other groups of countries, most of the increase in U.S. exposure is due to increases in value added exports in intermediate products. This fact is in line with the idea that trade in intermediate products has become more important because the production chain has become longer. This dichotomy between the value added originating from China and from other countries may be part of the explanation related to the concern that exists in many policy circles regarding the increase in exports from China to the U.S. In this case, it is clear that an increase in U.S. exposure to value added exports from China may have different effects on labor markets from an increase in exposure to value added exports from other countries.

The dependent variable and other control variables used to estimate (15) were provided by ADH (2013). As explained above, we also consider other definitions of exposure, such as exposure defined by net trade flows where we use imports and exports. We also consider exposure depending on the role played by value added trade in the production process. Finally, we consider a traditional measure of exposure based on the import penetration

[20] It is worth noticing that the the top 3 U.S. local labor markets measured in terms of changes in exposure based on value added exports are not among the top 40 local markets based on gross exports. This represents additional evidence that changes in exposure based on gross exports are significantly distinct from changes in exposure based on value added exports.

ratio, which is defined as the ratio between the value of imports and the value of shipments at the sectorial level. In this case, information on the value of shipments was made available by the U.S. Bureau of Census for the years of 2002 and 2007 and these data are organized according to the 6-digit of the North American Industrial Classification System (NAICS). We use a concordance between the 6-digit of the NAICS and the 4-digit of the SIC made available by David Dorn, and, we can then aggregate the data on the value of shipments from the 4-digit of the SIC to the NACE following the same strategy used for employment-related variables as detailed above. Our results are robust to these different measures of exposure as we discuss in the next Section.

4 Econometric Results

4.1 Basic Results

We can now proceed to the description of our econometric results. Our benchmark model corresponds to the estimation of expression (15) using a 2-stage least square strategy where we instrument the measure of exposure described by (14) using the variable represented by (16). Our basic results are shown in Table 4. In this case, columns (1)-(3) show the results that use gross exports from China to the U.S. in order to measure the change in trade exposure across U.S. local labor markets, while columns (4)-(6) show results that instead use value added exports. The sample used in each column of Table 4 covers information on 722 U.S. local labor markets (commuting zones) and covers the changes in exposure between the years 2000 and 2007.

The results displayed in columns (1)-(3) are in line with the results found in ADH (2013) where the contribution of China to changes in U.S. local labor market outcomes is measured using gross exports rather than value added exports. In essence, these results suggest that an increase in exposure to gross exports from China between the years 2000 and 2007 tends to decrease the share of manufacturing employment in U.S. local labor markets. The results seem robust to the presence of local labor market controls as is evident from a comparison between the parsimonious model used in column (1) relative to the more comprehensive model used in column (3). Moreover, the estimated results show that the instrumental variable is highly correlated with the measure of changes in trade exposure, and that it also passes the weak instrumental variable test found at the bottom of the Table. It is also apparent that the other labor market controls have the same expected signs as obtained by

ADH (2013).[21]

These results can be used to gauge the relative importance of changes in trade exposure based on gross exports. Table 2 indicates that the average increase in trade exposure based on gross exports is $2.64 thousand dollars per worker. This information can be used to conclude that, if we were to use gross exports to measure the contributions of China to changes in U.S. local labor market outcomes, the increase in exposure to gross exports from China would have decreased (on average) the share of manufacturing employment across local labor markets by 1.24 percentage points.[22] This is a significant result given that the average decrease in the share of manufacturing employment across local labor markets in this time frame was 2.3 percentage points. In a nutshell, the model suggests that using gross exports from China to measure trade exposure allows us to explain 54 percent of the average decline in the share of manufacturing employment across U.S. local labor markets.

However, as explained in ADH (2013), this measured effect would overstate the effect of the supply shock resulting from economic growth in China over the last decade. In particular, this total effect combines changes in supply related to economic growth in China and changes in relative demand for products in which China has become an important exporter. To disentangle the two effects, and more properly measure the contribution related to Chinese economic growth, we follow ADH's (2013) strategy that relies on an interplay between OLS and the IV estimations without using controls for commuting zone characteristics.[23] This procedure allows us to conclude that about 59 percent of the change in U.S. exposure to gross exports from China is due to supply changes related to economic growth in China. As such, if we were to use gross exports to measure exposure, a more appropriate measure is that the increase in exposure to Chinese gross exports would be responsible for 32 percent of the average decline in the share of manufacturing employment across U.S. labor markets.

A different picture emerges when considering the role played by value added exports from China on the share of manufacturing employment across U.S. local labor markets. In this

[21] We have decided to include estimates of the effect of changes in exposure to gross exports from China since we focus on the changes between the years 2000 and 2007, while ADH (2013) focus on the discussion of the results using data from 1990 to 2007. This is the case since we do not have information on value added exports for the first half of the 1990s.

[22] This effect is the result of the product between the average increase in exposure (2.64) multiplied by the coefficient of the change in exposure (-0.469).

[23] The OLS version of column (1) of Table 4 yields a coefficient equal to -0.436. The regression of the dependent variable on the difference between the variable measuring exposure and its intrumental variable yields a coefficient equal to -0.03. Using the coefficient for column (1) of Table 4 and these two coefficients, yields an estimated effect of Chinese growth on the total exposure to Chinese gross exports equal to 0.59. Instead, ADH (2013) suggest a contribution of Chinese growth of 0.48. The difference between our results is due to using data between the years 1990 to 2007 in their case, and our using a sample covering the year 2000 to 2007. See the appendix in ADH (2013) for more details.

case, the results are presented in columns (4)-(6) of Table 4. Notice that the coefficient of our measure of changes in exposure based on value added exports is also negative, suggesting that increases in exposure to value added exports from China have also led to a decrease in the share of manufacturing employment across U.S. local labor markets. However, this result is not very statistically robust, since, as we move from the parsimonious model described in column (4) to the results described in columns (5) and (6), it is clear that the degree of statistical significance of the coefficient of changes in trade exposure substantially declines. This happens since while the coefficient of changes in exposure using value added exports is statistically significant in the parsimonious model used in column (4) of Table 4, it becomes statistically insignificant in the presence of controls for local labor market characteristics as the results described in columns (5) and (6) strongly indicate. In addition, the point estimates suggest that the average effect of changes in exposure to value added exports from China is significantly smaller than the effect obtained measuring exposure using gross exports as a comparison between the results in columns (3) and (6) seem to indicate.[24]

The lack of robust statistical evidence showing that changes in exposure to value added exports from China affects the share of U.S. manufacturing employment is not entirely surprising. Our theoretical framework discussed in Section 2 provides key insights about why this is the case. Our model clearly suggests that trade flows may have different effects on the level of employment depending on their role in the production process. In this case, the main message of the model indicates that an increase in Chinese value added exports in the form of final goods should have a negative effect on the share of manufacturing employment in the U.S.. On the contrary, Chinese value added exports in the form of intermediate goods could have a positive effect on the share of manufacturing employment as U.S. manufacturing firms would become more competitive and their growth could lead to higher employment levels. Table 3 suggests that the share of the increase in U.S. exposure to Chinese value added exports due to intermediate goods is 37 percent, which is more than enough to guarantee that the average effect of Chinese exposure is ambiguous.

We then proceed to investigate the effects of the changes in U.S. exposure to Chinese value added exports taking into account the role played by traded goods in the production process. Table 5 shows the results using value added exports according to their use in the production

[24]This fact can be verified by taking the product between the average increase in exposure based on value added exports of 1.76 in Table 2, the coefficient of the measure of change in exposure found in column (6) of Table 4, and multiplying also by 0.59 given that we are concerned with the supply side effects related to Chinese growth. This yields an average decline in the share of manufacturing employment of 0.37 percentage point, which corresponds to about 16 percent of the observed change in the share of manufacturing employment.

process. The specifications used in columns (1) - (3) of that Table are parsimonious since they do not control for local labor market characteristics, while the specifications used in columns (4) - (6) are more comprehensive since they control for all labor market characteristics that we use in this study, the same ones used also in column 6 of Table 4. In this case, the specifications in columns (1) and (4) define our measure of change in exposure using value added exports in final goods, the specifications in columns (2) and (5) measure the change in exposure using value added exports in intermediate goods, while the specifications in columns (3) and (6) measure exposure using value added exports in indirect form.

The results in columns (1) and (4) of Table 5 confirm that an increase in value added exports from China in the form of final goods tends to decrease the share of manufacturing employment across U.S. local markets, regardless of whether or not local labor market characteristics are controlled for. The results described in column (4) indicate that changes in U.S. exposure to value added exports from China in final goods have significant negative effects on local labor markets. Table 3 indicates that the average increase in U.S. exposure to value added exports from China in final goods was $0.94 thousand per worker. Taking into account the coefficient of -1.558 from Column (4), as well as the 59 percent contribution of economic growth in China to changes in U.S. exposure, allows us to conclude that the U.S. increase in exposure to value added exports from China in final goods can (on average) explain 37 percent of the decline in the share of manufacturing employment across labor markets.

The results in columns (2) and (5) of Table 5 show an instability in the predicted effect of changes in U.S. exposure to value added exports from China in intermediate goods. In this case, these results also indicate that the coefficient for changes in exposure is imprecisely estimated. In the case of value added exported in indirect form, the results in columns (3) and (6) suggest that an increase in U.S. exposure to Chinese value added exports leads to a decline in share of manufacturing employment. However, this effect is not statistically robust as suggested by the comparison between the results in columns (3) and (6).

In general, these results are in line with our theoretical model that suggests distinct effects on labor markets depending on the role played by traded goods in the production process. The results seem to suggest that value added exports from China in the form of final goods, or indirectly in the form of inputs used in final products sold by other countries to the U.S., have the expected negative effect on the share of manufacturing employment in the U.S. The estimated effect of Chinese indirect value added exports follows our model's prediction. When a third country offshores the intermediate inputs to China, and exports the final product to the U.S., this may lead to a decrease in U.S. manufacturing employment levels.

4.2 Robustness Tests

We establish above that the average effect of an increase in exposure to value added exports from China on the U.S. share of manufacturing employment is neither statistically robust nor very economically important compared to the pronounced effect found for exposure to gross exports from China. We have also found that the effects of changes in value added exports from China depend on the role of exports in the U.S. production processes. In particular, we found that the effect of value added exports in final goods may differ from value added exports in intermediate goods. This means that it is important to consider the role played by traded goods in the production process in order to evaluate the contributions of China to changes in the U.S. local labor markets. We can now explore other results related to trade flows between the U.S. and China.

We notice from Table 1 that U.S. value added exports to China grew by more than 200 percent between the years 2000 and 2007, certainly a substantial rate of growth although smaller than the growth rate of value added exports from China to the U.S. The question is whether or not our main conclusions related to the average role played by value added exports on the U.S. economy changes by taking into account the substantial growth of U.S. value added exports to China. Table 6 investigates this issue and considers the effect of U.S. net trade exposure with China in terms of gross exports and in terms of value added exports. In this case, column (1) considers the effects of U.S. net trade exposure based on gross exports and we find that increases in gross exports from China have deleterious effects on the share of manufacturing employment in U.S. local labor markets. The estimates described in column (1) suggest that the increase in the U.S. net exposure to trade with China has decreased the U.S. share of manufacturing employment across labor markets by 0.42 percentage points, which corresponds to 19 percent of the actual average decrease in the share of manufacturing employment.[25] Needless to say, the effects of U.S. exposure to trade with China decreases significantly by considering the contribution of U.S. exports to China.

Next, we focus on the effects of U.S. net exposure to trade with China using value added exports. Column (2) makes it clear that taking into account the effects of U.S. value added

[25]This result can be obtained by multiplying the coefficient of the change in U.S. net exposure (0.33) by the average change in U.S. net exposure ($2.2 thousand) across local labor markets, and by the contribution of economic growth in China of 0.59.

exports, means that changes in the exposure to value added trade with China have no statistical effect on the level of employment in U.S. local labor markets. In this case, the results described in Column (6) of Table 4 are re-enforced since the effects of U.S. value added exports to China may have the opposite effect of Chinese value added exports to the U.S. However, as we consider the effects of value added trade controlling for the role played by traded goods in the production process, a more clear picture of the different effects emerge. Columns (3) - (5) confirm that the net effect of changes in value added trade with China on U.S. employment is negative and statistically significant for an increase in the net exposure to value added exports in final goods, while the effects for value added exposure in intermediate and in indirect form are not statistically significant. Again, the bottom line is that the net effect of changes in value added trade with China on U.S. manufacturing employment seems to depend on the role played by traded goods in the production process.[26][27]

So far we have measured changes in U.S. exposure to trade flows with China using changes in gross exports or changes in value added exports. However, it is apparent that many strands of this literature refer to exposure of an industry to foreign competition by relying on measures of import penetration. This is the case of Ebenstein et al. (2013) and Acemoglu et al. (2014) that measure the exposure of an industry to globalization using import penetration ratios. A similar argument can be found in most of the literature on the political economy of trade (Grossman and Helpman (1994)). In Table 7, we investigate the effects of changes in the U.S. exposure to trade with China using changes in import penetration instead of the changes in trade flows used in previous results.

The results described in Table 7 are quite in line with the results found in Tables 4 - 6. Column (1) of Table 7 indicates that an increase in U.S. exposure to trade with China based on gross import penetration leads, on average, to a decrease in the share of manufacturing employment across local labor markets. In column (2), we calculate import penetration using value added exports from China to the U.S., and the results again show a decrease in the statistical significance of the coefficient related to changes in exposure relative to the significance of the coefficient found in column (1). The results in columns (3) - (5) confirm that an increase in U.S. exposure to trade with China in final goods tends to decrease the share of manufacturing employment in local labor markets, but the same is not true of an increase in exposure based on intermediate products or on indirect form. Thus, calculating

[26]Table 6 controls for U.S. local labor market characteristics but the same result applies whether or not we omit these controls or selectively control for only some of them.

[27]It is also worth noticing that the instrumental variable used in Table 6 passes the weak IV test in columns (2) - (6) where we measure U.S. exposure using value added exports, but does not pass the weak IV test using gross exports.

changes in exposure using trade flows or import penetration yields similar results.

It is also important to consider whether the effects of changes in U.S. exposure to trade with China differ from the effects of changes in exposure to trade with other countries. For instance, Ebenstein et al. (2013) find that an increase in U.S. offshoring activities to low income countries decreases the real wages of professions that perform routine tasks, while the opposite is found for an increase in U.S. offshoring activities to high income countries. Table 3 provides strong evidence that the profile of the change in the U.S. exposure to value added exports from China differs from the profile of the change in exposure to other groups of countries. This is the case since the change in U.S. exposure to China is biased towards final goods while for all other groups it is biased towards intermediate products. As pointed out by our theoretical model, we should expect that these two different profiles yield different effects on labor market outcomes.

The dataset made available by KWW (2014) allows us to calculate changes in exposure following expression (14) using gross and value added exports from middle income and high income countries. The division of countries into these two groups follows the criteria used to define high and middle income economies adopted by the World Bank.[28] We eliminate from both groups the transition economies since these were economies that for decades have been subject to a substantial degree of central planning, and, therefore, differ in their economic structure from most other members of both groups. Moreover, the change in U.S. exposure to exports from transition economies is very petite as the numbers in Table 3 clearly indicate. Table 7 shows the results of changes in U.S. trade exposure to exports from each group of countries on the share of manufacturing employment across U.S. local labor markets.

It is clear that there is a dichotomy in the results for these two groups. A comparison between columns (1) and (6) shows that an increase in U.S. exposure to gross exports from middle income countries leads to a decline in the share of U.S. manufacturing employment, while the predicted effect of an increase in exposure to gross exports from high income countries is positive but this effect is not statistically significant. This dichotomy is in line with those obtained by Ebenstein et al. (2013). Instead, columns (2) and (7) use value added exports to the U.S. to calculate the measure of exposure. The results shown in these two columns suggest that an increase in U.S. exposure to high income countries has a positive and statistically significant effect on the share of manufacturing employment, while the effect is not statistically significant for middle income countries. The results described in columns

[28]According to the World Bank's criteria, the only low income country in the KWW's (2014) dataset is India. Thus, we include India as part of the group of middle income countries. Notice that we exclude exports from China to the U.S. from both groups of countries.

(3) - (5) and in columns (8) - (10) reveal that the positive effect of an increase in U.S. exposure to value added exports from high income countries is due to an increase in U.S. exposure to value added in intermediate products, in line with the growing participation of intermediate products in trade flows and with the expected effect of trade in intermediate products on labor market outcomes highlighted by our model.

One important issue that we have yet to address is how changes in U.S. exposure to international trade affects average wages and whether or not the effects vary depending on the role played by traded goods in the production process.[29] Our strategy consists in replacing the dependent variable in expression (15) by the change in average wages for U.S. local labor markets, while we calculate changes in U.S. exposure to trade using gross exports and value added exports from China as we did for Tables 4-6. The results can be found in Table 9. In general, they make it clear that changes in exposure, either using gross exports from China or using value added exports, are not statistically significant in explaining changes in wage levels across U.S. local labor markets. However, the results depend on the role played by traded goods, as suggested by the positive effect on wages found by an increase in U.S. exposure to value added exports from China in intermediate products. Acemoglu et al. (2014) find similar results by measuring U.S. exposure to Chinese import penetration at the industry level.[30]

Our analysis has so far relied on the measures of value added exports made available by KWW (2014). Next, we investigate whether our findings discussed in Tables 4 and 6 remain intact using other measures of value added exports. In this case, the main alternatives available are the measures of value added exports provided by Johnson and Noguera (2012). Their dataset about bilateral value added exports across sectors is different from the dataset made available by KWW (2014) in three main ways. First, Johnson and Noguera's (2012) dataset is cross-sectional in nature, and offers measures of value added exports for the year 2004. This implies that we can't replicate the strategy used above in Tables 4-9 when we consider how changes in exposure over the years affect changes in the share of manufacturing employment and changes in wage levels. Second, Johnson and Noguera (2012) apply the "proportionality assumption" that assumes that the employment of imported inputs in the

[29]Hummels et al. (2014) find that offshoring has also lead to increases in within-group and across-group inequality. Our results are not in contradition with their results, as we are measuring the effects of value added exports that may or not represent offshoring activities. Moreover, we measure the effects of trade on average wages for workers whose exposure to trade will vary at the firm-level, job status and skill set.

[30]The results can be found on column 5 of Table 5 of their paper. Moreover, notice that we can find the results described in ADH (2013) on wages, using information on gross exports from China to the U.S., if we incorporate changes from 1990-2000 into the dataset. However, this result may be sensitive to the timeframe used as made evident by Table 9.

production of goods sold in the domestic market and in the production of goods sold abroad are the same. Third, Johnson and Noguera (2012) use the GTAP (Global Trade Analysis Project) industry definition in their aggregation of the data across industries.

We address the first difference between these two datasets by estimating equation (15) at levels where we calculate the dependent variable using data for the year 2007, while the measure of exposure now uses data on value added exports from China to the U.S. for the year 2004. We continue adopting the same control variables described in column 6 of Table 4 that rely on data for the year 2000. Second, we address the issue of aggregation at the GTAP level by concording all data on gross trade flows and employment from the 4-digit of the SIC to the GTAP aggregation level. The estimated results can be found in Table 10. Again the results in column (1) suggest that the greater the U.S. exposure to gross exports from China, the lower the U.S. share of manufacturing employment across local labor markets. Column (2) suggests that this remain true even considering the effects of U.S. gross exports to China. However, we find in columns (3) and (4) that the same does not apply to value added exports. These results reinforce our findings that the statistical significance of the average effect of an increase in U.S. exposure to value added exports from China to the U.S. is not robust.

5 Conclusion

This paper highlights that the contribution of China to U.S. local labor market outcomes has to be gauged with caution for two main reasons. First, Chinese exports contain a significant degree of content that originates in other trading partners including the U.S. economy. Second, Chinese exports do not consist only of final goods, i.e., a significant share of exports from China consists of intermediate products. Recent results by ADH (2013) find strong negative effects of the growth of Chinese gross exports to the U.S. in terms of manufacturing employment and wages across U.S. commuting zones.

We extend the literature in two main points. First, we consider a two-country model of firm heterogeneity where firms based in the North (U.S.) have on average access to better technology than firms in the South (China). We show that trade with the South leads to an increase in employment in the tradable sector in the North. However, most importantly, the model indicates that an improvement in the technology available in the south tends to decrease exports from the North, while increasing exports from the South, which leads to a decrease in the employment level in the tradable sector in the North. We extend the model to consider the presence of offshoring, which essentially leads to an increase in the productivity of Northern firms, and conclude that offshoring leads to a higher employment level in the tradable sector in the North. These results suggest that the role played by traded goods in production matter in determining the effects of international trade on labor market outcomes.

We investigate the effects of trade between U.S. and China on the former country's labor market outcomes using the recent dataset organized by KWW (2014). Their dataset provides information on Chinese value added exports to the U.S. and also decomposes them according to their role in production. Our results suggest that value added exports from China have a significant effect on the share of manufacturing employment only when controlling for the role played by traded goods. In this case, we find that the increase in U.S. exposure to Chinese value added exports in final goods has led to a decrease in the share of manufacturing employment, while the same is not found for value added exports in intermediate products and value added exports in indirect form. These findings are robust to controlling for U.S. value added exports to China. Finally, we do not find any average effect on wages due to an increase in U.S. exposure to Chinese exports during this time frame, except when controlling for the role played by traded products in the production process. In this case, a positive effect is found for value added exports in intermediate products from China. The results also make it clear that the effects of U.S. exposure to China are different from U.S. exposure to high income countries, and this is also due to the role played by traded goods in the production process.

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Figure 1

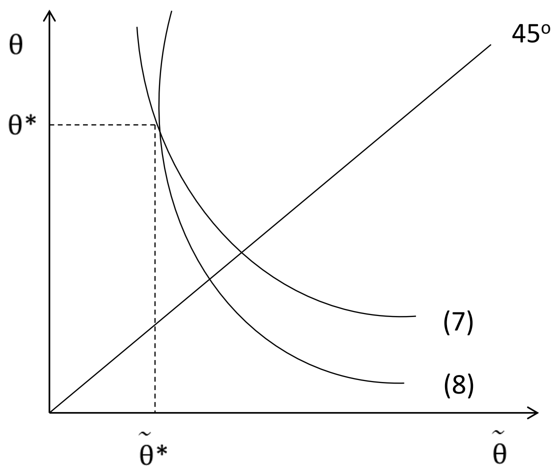

Figure 2

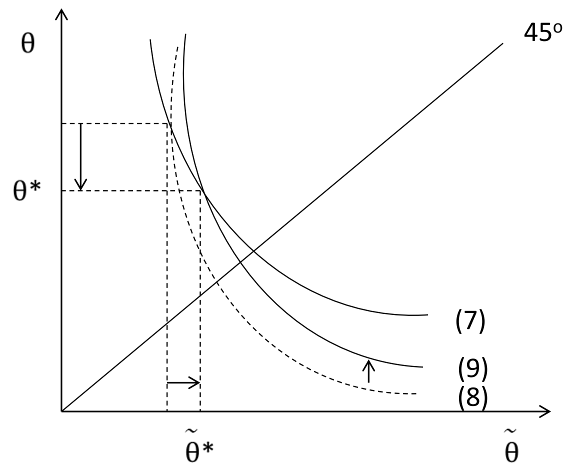

Figure 3

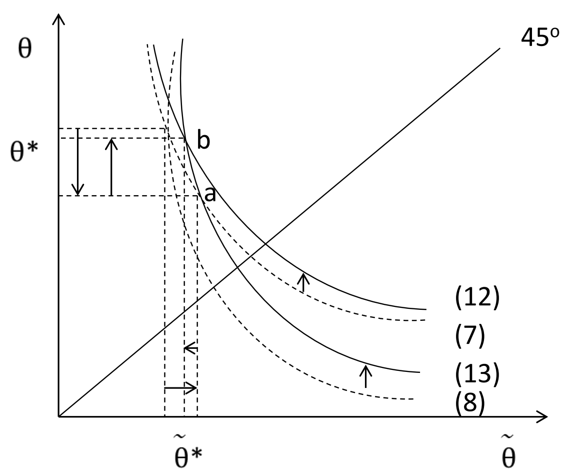

Table 1: U.S.-China Trade Flows[a]

Year	Chinese Gross Exports	Chinese Gross Imports	US Gross Trade Deficit
2000	74524	19167	55357
2007	300791	77931	222860
Percent Change	303.6	306.6	303
Year	Chinese Value Added Exports	Chinese Value Added Gross Imports	US Value Added Trade Deficit
2000	68818	21845	46973
2007	245564	68749	176815
Percent Change	256.8	214.7	276

Table 2: U.S. local market exposure to China[b]

Panel A - Basic Exposure Figures

	U.S. exposure in gross exports	U.S. exposure in value added
Change (2000 - 2007) - average	2.64	1.76
Change (2000 - 2007) - std. dev.	3.02	0.76

Panel B - Distribution of Exposure

Top 3 local markets			
Gross Exports		Value added exports	
Czone	Change in Exposure	Czone	Change in Exposure
(25401)	43.08	(37602)	6.95
(28001)	28.83	(35002)	6.43
(21201)	16.66	(34601)	6.15
Bottom 3 local markets			
Gross Exports		Value added exports	
Czone	Change in Exposure	Czone	Change in Exposure
(28603)	-0.63	(26603)	0.44
(29202)	-0.55	(27605)	0.46
(33801)	-0.39	(32603)	0.48

[a] Trade flows defined in millions of US dollars.
[b] Trade flows defined in thousands of US dollars.

Table 3: Content of the Change in U.S. Value-Added Exposure[b]

China

Type	Average Change in U.S. Exposure (1,000s dollars)	Share (percent)
Final	0.94	53.1
Indirect	0.17	9.7
Intermediate	0.65	37.2

Rich Economies

Type	Average Change in U.S. Exposure (1,000s dollars)	Share (percent)
Final	0.40	17.0
Indirect	0.43	18.3
Intermediate	1.52	64.7

Middle Income Economies

Type	Average Change in U.S. Exposure (1,000s dollars)	Share (percent)
Final	1.09	37.0
Indirect	0.27	9.1
Intermediate	1.59	53.9

Transition Economies

Type	Average Change in U.S. Exposure (1,000s dollars)	Share (percent)
Final	0.02	4.9
Indirect	0.13	31.7
Intermediate	0.26	63.4

[b] The list of high income countries includes Australia, Austria, Belgium, Canada, Cyprus, Germany, Denmark, Spain, Finland, France, Great Britain, Greece, Ireland, Italy, Japan, Korea, Luxemburg, Malta, Netherlands Portugal, Sweden and Taiwan; The list of middle income countries includes Brazil, China, Indonesia, India, Mexico and Turkey; The list of transition economies includes Bulgaria, Estonia, Hungary, Lithuania, Latvia, Polony, Romania, Russia, Slovakia and Slovenia.

Table 4: Value Added Exports from China and Change in U.S. Manufacturing Employment[b]

	I. 2000-2007 2SLS					
	(1)	(2)	(3)	(4)	(5)	(6)
(Δ gross exports from China to US) / worker	-0.718***	-0.426***	-0.469***			
	(0.064)	(0.116)	(0.123)			
(Δ value-added exports from China to US) / worker				-1.391***	-0.382	-0.354
				(0.501)	(0.112)	(0.323)
Percentage of employment in manufacturing$_{-1}$		-0.100***	-0.083***		-0.162***	-0.162***
		(0.027)	(0.025)		(0.019)	(0.021)
Percentage of college-educated population$_{-1}$			0.000			-0.015
			(0.021)			(0.019)
Percentage of foreign-born population$_{-1}$			0.057***			0.045***
			(0.013)			(0.011)
Percentage of employment among women$_{-1}$			0.064*			0.065*
			(0.039)			(0.035)
Percentage of employment in routine occupations$_{-1}$		-0.111	-0.143		-0.055	-0.078
		(0.105)	(0.093)		(0.094)	(0.084)
Average offshorability index of occupations$_{-1}$		0.036	-0.670*		-0.601	-1.129***
		(0.368)	(0.344)		(0.396)	(0.353)
Census division dummies	No	Yes	Yes	No	Yes	Yes
R^2	0.14	0.52	0.53	0.19	0.57	0.60
	II. 2SLS first stage estimates					
(Δ exports from China to OTH) / worker	0.767***	0.536***	0.528***	0.935***	0.799***	0.799***
	(0.085)	(0.097)	(0.099)	(0.046)	(0.035)	(0.037)
Adjusted R^2	0.45	0.52	0.52	0.75	0.85	0.85
Kleibergen-Paap's Weak IV Test	80.715	20.522	27.821	404.813	512.089	466.397
(pass 5 percent critical value?)	Y	Y	Y	Y	Y	Y

[b] Dependent variable: Annual changes in manufacturing emp/working-age pop (in percentage points). Information on trade exposure available using thousands of US dollars per worker. Sample size in all columns is 722, which corresponds to the number of commuting zones available in the dataset. Superscripts "***", "**" and "*" represent statistical significance at the 1, 5 and 10 percent levels, respectively.

Table 5: The Role of Trade Flows in the Production Process and the Share of Manufacturing Employment[b]

	I. 2000-2007 2SLS					
	(1)	(2)	(3)	(4)	(5)	(6)
(Δ value-added exports in final goods	-3.646***			-1.558**		
from China to US) / worker	(0.853)			(0.706)		
(Δ value-added exports in intermediates		-0.580			0.423	
from China to US) / worker		(1.244)			(0.655)	
(Δ value-added indirect exports from China			-9.163**			-1.533
to US through a third country) / worker			(4.515)			(2.489)
Percentage of employment				-0.139***	-0.179***	-0.170***
in manufacturing$_{-1}$				(0.020)	(0.022)	(0.020)
Percentage of college-educated				-0.021	-0.010	-0.013
population$_{-1}$				(0.019)	(0.019)	(0.019)
Percentage of foreign-born				0.045***	0.046***	0.045***
population$_{-1}$				(0.011)	(0.011)	(0.011)
Percentage of employment				0.059*	0.071**	0.067*
among women$_{-1}$				(0.036)	(0.034)	(0.034)
Percentage of employment in				-0.094	-0.061	-0.071
routine occupations$_{-1}$				(0.081)	(0.087)	(0.085)
Average offshorability index				-1.022***	-1.228***	-1.174***
of occupations$_{-1}$				(0.342)	(0.367)	(0.355)
Census division dummies	No	No	No	Yes	Yes	Yes
R^2	0.26	0.03	0.12	0.60	0.59	0.60
	II. 2SLS first stage estimates					
(Δ corresponding type of exports from	0.939***	0.879***	0.762***	0.910***	0.815***	0.675***
China to OTH) / worker	(0.038)	(0.064)	(0.035)	(0.036)	(0.046)	(0.028)
Adjusted R^2	0.78	0.66	0.75	0.85	0.82	0.86
Kleibergen-Paap's Weak IV Test	591.863	183.127	460.942	442.947	303.998	555.725
(pass 5 percent critical value?)	Y	Y	Y	Y	Y	Y

[b] Dependent variable: Annual changes in manufacturing emp/working-age pop (in percentage points). Columns 1-3 do not use controls for local labor market characteristics, while columns 4-6 use the same local labor market controls used in column 6 of Table 3.

Table 6: The Effects of Net Trade Exposure on the Share of Manufacturing Employment[b]

	I. 2000-2007 2SLS				
	(1)	(2)	(3)	(4)	(5)
(Δ net gross exports from China to US) / worker	-0.336***				
	(0.107)				
(Δ net value-added exports from China to US) / worker		-0.491			
		(0.394)			
(Δ net value-added exports in final goods from China to US) / worker			-1.658**		
			(0.725)		
(Δ value-added net exports in intermediates from China to US) / worker				1.077	
				(0.959)	
(Δ value-added indirect net exports from China to US through a third country) / worker					-2.910
					(2.915)
R^2	0.57	0.60	0.60	0.59	0.60
	II. 2SLS first stage estimates				
(Δ corresponding type of exports from China to OTH) / worker	0.616***	0.705***	0.782***	0.287***	0.746***
	(0.113)	(0.062)	(0.055)	(0.049)	(0.058)
Δ corresponding type of exports from USA to OTH) / worker	-0.335***	-0.465	-1.755	1.367***	-0.871***
	(0.095)	(0.580)	(1.731)	(0.438)	(0.249)
Adjusted R^2	0.48	0.83	0.84	0.82	0.86
Kleibergen-Paap's Weak IV Test	19.941	182.628	239.007	140.955	238.663
(pass 5 percent critical value?)	N	Y	Y	Y	Y

[b] *Dependent* variable: Annual changes in manufacturing emp/working-age pop (in percentage points). We use the same controls applied in column (6) of Table 3 in all columns of this Table.

Table 7: The Effects of Import Penetration on the Share of Manufacturing Employment[b]

	I. 2000-2007 2SLS				
	(1)	(2)	(3)	(4)	(5)
(Δ U.S. gross import penetration from China) / worker	-23.682*				
	14.067				
(Δ U.S. value-added import penetration from China) / worker		-26.225			
		31.737			
(Δ U.S. value-added import penetration in final goods from China) / worker			-27.989**		
			12.804		
(Δ U.S. value-added import penetration in intermediates from China) / worker				36.721	
				82.457	
(Δ U.S. value-added indirect import penetration from China) / worker					-84.366
					131.841

Table 8: The Effects of Changes in Net Exposure from Middle and High Income Countries[b]

	Exporters									
	High income countries					Middle income countries				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(Δ gross exports from specified exporter to US) / worker	0.096					-0.204**				
	(0.067)					(0.086)				
(Δ value-added exports from specified exporter to US) / worker		0.193*					0.009			
		(0.105)					(0.081)			
(Δ value-added exports in final goods from specified exporter to US) / worker			1.004					-1.062		
			(0.687)					(0.718)		
(Δ value-added exports in intermediates from specified exporter to US) / worker				0.221*					0.337	
				(0.120)					(0.969)	
(Δ value-added indirect exports from specified exporter to US) / worker					1.037					0.049
					(0.736)					(0.104)

[b] *D*ependent variable: Annual changes in manufacturing emp/working-age pop (in percentage points). We use the same controls applied in column (6) of Table 3 in all columns of this Table.

Table 9: Value Added Trade with China and the Effects on Wages across U.S. Local Labor Markets[b]

	I. 2000-2007 2SLS				
	(1)	(2)	(3)	(4)	(5)
(Δ gross exports from China to US) / worker	-0.134				
	(0.359)				
(Δ value-added exports from China to US) / worker		0.970			
		(0.780)			
(Δ value-added exports in final goods from China) / worker			1.240		
			(1.799)		
(Δ value-added exports from China in intermediates from China) / worker				3.024**	
				(1.507)	
(Δ value-added indirect exports from China) / worker					9.339
					(6.230)

[b] *Dependent* variable: Ten-year equivalent changes in average log weekly wage (in log pts). We use the same controls applied in column (6) of Table 3 in all columns of this Table.

Table 10: The effects of exposure to trade with China using the dataset by Johnson and Noguera (2012) [b]

	I. 2007 2SLS			
	(1)	(2)	(3)	(4)
(gross exports from China to US) / worker	-0.776***			
	(0.259)			
(gross net exports from China to US) / worker		-0.868***		
		(0.281)		
(value-added exports from China to US) / worker			-0.541*	
			(0.314)	
(value-added net exports from China to US) / worker				0.167
				(0.273)
Percentage of employment in manufacturing$_{-1}$	0.452***	0.447***	0.397***	0.374***
	(0.027)	(0.025)	(0.023)	(0.021)
Percentage of college-educated population$_{-1}$	-0.047**	-0.050**	-0.060**	-0.055**
	(0.02)	(0.022)	(0.024)	(0.024)
Percentage of foreign-born population$_{-1}$	0.029**	0.029***	0.024**	0.025**
	(0.011)	(0.011)	(0.012)	(0.012)
Percentage of employment among women$_{-1}$	0.211***	0.212***	0.204***	0.210***
	(0.036)	(0.036)	(0.035)	(0.034)
Percentage of employment in routine occupations$_{-1}$	0.059	0.057	0.124**	0.150***
	(0.082)	(0.080)	(0.059)	(0.058)
Average offshorability index of occupations$_{-1}$	0.985*	0.982*	0.583	0.528
	(0.564)	(0.554)	(0.405)	(0.392)
Census division dummies	Yes	Yes	Yes	Yes
R^2	0.85	0.85	0.85	0.85
	II. 2SLS first stage estimates			
(Δ imports from China to OTH) / worker	0.681***	0.609***	0.756***	4.717***
	(0.058)	(0.053)	(0.033)	(0.655)
Adjusted R^2	0.74	0.70	0.85	0.69

[b] Dependent variable: manufacturing emp/working-age pop (in percentage pts). We use the same controls applied in column (6) of Table 3 in all columns of this Table.

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Appendix

A.1 The price index. By definition, $M = PQ_T/r(\bar{\theta})$, where $PQ_T = \frac{P}{P+P^{1/\varepsilon}}wL$ from consumer utility maximization, and $r(\bar{\theta}) = r(\theta^*)(\frac{\bar{\theta}}{\theta^*})^{\sigma-1} = \sigma wf(\frac{\bar{\theta}}{\theta^*})^{\sigma-1}$.As a result, $P = M^{1/(1-\sigma)}w/(\rho\bar{\theta})$ can be written as

$$P = \left(\frac{P}{P+P^{1/\varepsilon}}wL\frac{1}{\sigma wf}\right)^{1/(1-\sigma)}\frac{\bar{\theta}}{\theta^*}\frac{w}{\rho\bar{\theta}} = \left(\frac{P}{P+P^{1/\varepsilon}}wL\frac{1}{\sigma wf}\right)^{1/(1-\sigma)}\frac{1}{\theta^*}w.$$

A.2 We can show $\partial P/\partial\theta^* > 0$. Similarly for $\partial\tilde{P}/\partial\tilde{\theta}^* > 0$.

Rewrite $P = (PQ_T)^{1/(1-\sigma)}\frac{1}{\theta^*}w\left(\frac{1}{\sigma wf}\right)^{1/(1-\sigma)} = (PQ_T)^{1/(1-\sigma)}\frac{1}{\theta^*}C$,where $C = w\left(\frac{1}{\sigma wf}\right)^{1/(1-\sigma)}$.

$\partial PQ_T/\partial P < 0$ because $\partial Q_N/\partial P > 0$, and wL is fixed. From the budget constraint, an increase in P leads to an increase in Q_N, and a decrease in PQ_T.

Now, take derivative of P as an implicit function of θ^*,let P' denote $\partial P/\partial\theta^*$:

$$P' = \frac{1}{1-\sigma}(PQ_T)^{1/(1-\sigma)-1}(\partial PQ_T/\partial P)P'\frac{1}{\theta^*}C - (PQ_T)^{1/(1-\sigma)}C\frac{1}{\theta^{*2}}$$

Since $\partial PQ_T/\partial P < 0$,we can write

$$P'(1+\xi) = -(PQ_T)^{1/(1-\sigma)}C\frac{1}{\theta^{*2}} < 0$$

$P' < 0$.

A. 3 The productivity cutoffs under trade without offshoring are related according to the following expressions:

$\pi_d(\theta^*) = 0 \quad B\theta^{*\sigma-1} = wf_d$

$\pi_x(\theta_x^*) = 0 \quad \tilde{B}\theta_x^{*\sigma-1} = wf_x\tau^{\sigma-1}$,

where $B = (1-\rho)R(P\rho w^{-1})^{\sigma-1} = (1-\rho)(\rho/w)^{\sigma-1}A$ and $\tilde{B} = (1-\rho)\tilde{R}(\tilde{P}\rho w^{-1})^{\sigma-1} = (1-\rho)(\rho/w)^{\sigma-1}\tilde{A}$. In addition,

$\tilde{\theta}_x^*/\theta^* = (\frac{\tilde{w}f_x}{wf_d})^{1/(\sigma-1)}\tau = \omega^{1/(1-\sigma)}\phi$

$\theta_x^*/\tilde{\theta}^* = (\frac{wf_x}{\tilde{w}f_d})^{1/(\sigma-1)}\tau = \omega^{1/(\sigma-1)}\phi$.

where $\omega = \dfrac{w}{\tilde{w}} > 1$ is the relative wage and does not depend on the productivity cutoffs. We assume that some firms in both countries do not export. The existence of non-exporters in both countries in the symmetric case, where they have identical technologies ($\theta_x^* = \tilde{\theta}_x^*$ and $\theta^* = \tilde{\theta}^*$) and same size, requires that $\phi > 1$. In the asymmetric case, for $\theta_x^* > \theta^*$, it must be that $(B/\tilde{B})^{1/(\sigma-1)}\phi > 1$.

A. 4 Productivity cutoffs θ^*, θ_d^{*o} and θ_x^{*o} can be found from the following expressions:

$\pi_d(\theta^*) = 0 \Longrightarrow B\theta^{*\sigma-1} = wf_d$

$\pi_d^o(\theta_d^{*o}) = 0 \Longrightarrow \omega^{z(\sigma-1)}B\theta_d^{*o\sigma-1} = wf_o$

$\pi_x\left(\theta_x^{*o}\right) = 0 \Longrightarrow \omega^{z(\sigma-1)}\tilde{B}\theta_x^{*o\sigma-1} = wf_x\tau^{\sigma-1}.$

where similar expressions apply for the South economy. Assumption $\theta^* < \theta_d^{*o}$ requires $\omega^z(f_d/f_o)^{1/(\sigma-1)} < 1$, and assumption $\theta_d^{*o} < \theta_x^{*o}$ requires $\left(\tilde{B}f_o/Bf_x\tau^{(\sigma-1)}\right)^{1/(\sigma-1)} < 1$. Finding the cutoff θ^* enables us to obtain the other cutoffs using expressions above and their analogous cutoffs for the South economy.

In addition, we can use the above cutoffs for the North economy, and their equivalent ones for the South economy, to relate the ratio of productivity cutoffs between these two economies:

$\theta_x^{*o}/\tilde{\theta}^* = (\frac{wf_x}{\tilde{w}f_d})^{1/(\sigma-1)}\tau\omega^{1/(\sigma-1)}\omega^{-z} = \phi\omega^{1/(\sigma-1)}\omega^{-z}$

$\tilde{\theta}_x^{*o}/\theta^* = (\frac{\tilde{w}f_x}{wf_d})^{1/(\sigma-1)}\tau = \phi\omega^{1/(1-\sigma)}$

$\theta_d^{*o}/\theta^* = (f_o/f_d)^{1/(\sigma-1)}\omega^{-z} = \phi^o\omega^{-z} > 1.$

B. N country model.

We extend our two country model with one non-tradable good sector and one tradable good sector with differentiated varieties, in which there are many asymmetric countries and productivity follows the Pareto distribution.[b] There are fixed costs in terms of labor supplying each market, f_{ij}, incurred in the country of production i. Wage is fixed for simplicity. Values of fixed and variable trade costs (τ_{ij}) are assumed to be sufficiently large that there is selection into export markets: $\theta_{ij}^* > \theta_{ii}^*$ for all countries $j \neq i$.

B.1 Production and Export without offshoring

CES preferences imply the following demand for a variety produced in country i and consumed in country j:

$q_{ij}(\theta) = P_j Q_{T,j}\dfrac{p_{ij}(\theta)^{-\sigma}}{P_j^{1-\sigma}},$

where the CES price index is:

$P_j^{1-\sigma} = \sum\limits_s \int_0^\infty p_{sj}(\theta)^{1-\sigma}M_{sj}g_{sj}(\theta)d\theta$

where $g_{sj}(\theta)$ is the ex-post distribution of productivity conditional on a variety being produced in country i and consumed in country j.

The FOC for profit maximization implies:

$p_{ij}(\theta) = \dfrac{w_i}{\rho\theta}\tau_{ij}$

The firm revenue from market j for a firm based in country i is:

[b] This is similar to Arkolakis et al. (2008) in the use of Pareto distribution. Our utility specification is different and allows us to generate employment changes in the tradable and non-tradable good sector.

$$r_{ij}(\theta) = p_{ij}(\theta)q_{ij}(\theta) = \left(\frac{w_i}{\rho\theta}\tau_{ij}\right)^{1-\sigma}\frac{P_jQ_{T,j}}{P_j^{1-\sigma}} = \left(\frac{w_i}{\rho\theta}\tau_{ij}\right)^{1-\sigma}\frac{w_jL_j}{\left(P_j + P_j^{1/\varepsilon}\right)P_j^{-\sigma}}$$

Firm profit from market j for a firm based in country i is:

$$\pi_{ij}(\theta) = \frac{r_{ij}(\theta)}{\sigma} - w_if_{ij}$$

The cut-off productivity for market j for a firm based in country i is therefore:

$$\left(\theta_{ij}^*\right)^{\sigma-1} = \frac{\sigma w_i f_{ij}}{\left(\frac{w_i}{\rho}\tau_{ij}\right)^{1-\sigma}\frac{w_jL_j}{\left(P_j + P_j^{1/\varepsilon}\right)P_j^{-\sigma}}}$$

B.2 Free Entry

The free entry condition is $\bar{\pi}_i = \delta w_i f_E / \left[1 - G(\theta_{ii}^*)\right]$,

with a Pareto productivity distribution:

$$\left[1 - G(\theta_{ii}^*)\right] = \left(\frac{\theta_{i\min}}{\theta_{ii}^*}\right)^k.$$

The expected profit $\bar{\pi}_i$ conditional on successful entry is:

$$\bar{\pi}_i = \sum_s \int_{\theta_{is}^*}^{\infty} \left(\frac{1 - G(\theta_{is}^*)}{1 - G(\theta_{ii}^*)}\right)\left[\frac{r_{is}(\theta)}{\sigma} - w_if_{is}\right]\frac{g(\theta)d\theta}{1 - G(\theta_{is}^*)},$$

which can be re-arranged to obtain the following free entry condition:

$$\bar{\pi}_i = \sum_s f_{is}\left(\frac{\theta_{ii}^*}{\theta_{is}^*}\right)^k\left(\frac{\sigma - 1}{k - \sigma + 1}\right) = \frac{f_e}{\theta_{i\min}^k}\theta_{ii}^*$$

From the expression above, we can show $\partial\theta_{ii}^*/\theta_{is}^* < 0$. This is (7) and (8) in our two country model.

An increase in technology improvement in the South leads to an increase in θ_{is}^*, and a decrease in θ_{ii}^*.

B.3 Price Index

From the last equation in A.3.1,

$$(\theta_{ii}^*)^{\sigma-1} = \frac{\sigma w_i f_{ii}}{\left(\frac{w_i}{\rho}\right)^{1-\sigma}\frac{w_iL}{\left(P_i + P_i^{1/\varepsilon}\right)P_i^{-\sigma}}} = \frac{\sigma f_{ii}}{\left(\frac{w_i}{\rho}\right)^{1-\sigma}L}\left(P_i + P_i^{1/\varepsilon}\right)P_i^{-\sigma}$$

We can show $\partial P_i/\partial\theta_{ii}^* < 0$. Since employment in the non-tradable sector is directly related to the demand for non-tradable good $Q_{N,i} = \frac{P_i^{1/\varepsilon}}{P_i + P_i^{1/\varepsilon}}w_iL$, and $\partial Q_{N,i}/\partial P_i > 0$, a decrease in θ_{ii}^* leads to an increase in employment in the non-tradable good sector and a decrease in employment in the tradable good sector, or vice versa.

C. Suppose trade cost related to intermediate input is also τ_{ij}. Trade cost of intermediate input is required so not all countries offshore to China. Let f_{is}^o be the additional organizational cost of offshoring where the high-tech input is produced in country i and the low-tech input is produced in country s for a variety and $f_{ii}^o = 0$. Values of fixed (f_{ij}, f_{is}^o) and variable trade costs (τ_{ij}) are assumed to be sufficiently large that there is selection into offshoring and exporting: $\theta_{ij}^{s*} > \theta_{ii}^{s*} > \theta_{ii}^{*}$ for all countries $j \neq i$.

C.1 Production and Export with Offshoring

The FOC for profit maximization under offshoring for a variety in which its high-tech input is produced in country i, low-tech input is produced in country s, and consumed in country j is:

$$p_{ij}^{s}(\theta) = \frac{w_i^{1-z}\left(w_s\tau_{is}\right)^z}{\rho\theta}\tau_{ij}$$

Firm will only offshore to country s if $w_s\tau_{is} = \min\{\tau_{ij}w_j\}$. If country $s = i$, the firm is producing all parts domestically, and $p_{ij}^{s}(\theta) = p_{ij}^{i}(\theta) = p_{ij}(\theta)$ in B.1.

The firm revenue from market j for a firm based in country i that offshores in country s is:

$$r_{ij}^{s}(\theta) = p_{ij}^{s}(\theta)q_{ij}(\theta) = \left(\frac{w_i^{1-z}\left(w_s\tau_{is}\right)^z}{\rho\theta}\tau_{ij}\right)^{1-\sigma}\frac{P_jQ_{T,j}}{P_j^{1-\sigma}}$$

$$= \left(\frac{w_i^{1-z}\left(w_s\tau_{is}\right)^z}{\rho\theta}\tau_{ij}\right)^{1-\sigma}\frac{w_jL_j}{\left(P_j + P_j^{1/\varepsilon}\right)P_j^{-\sigma}}$$

Firm profit from market j for a firm based in country i that offshores to country s is:

$$\pi_{ij}^{s}(\theta) = \frac{r_{ij}^{s}(\theta)}{\sigma} - w_if_{ij} - w_if_{is}^{o}$$

The cut-off productivity for market i for a firm based in country i that does not offshore is therefore:

$$(\theta_{ii}^{*})^{\sigma-1} = \frac{\sigma f_{ii}}{\left(\frac{w_i}{\rho}\right)^{1-\sigma}L_i}\left(P_i + P_i^{1/\varepsilon}\right)P_i^{-\sigma}$$

The cut-off productivity for market j for a firm based in country i that offshores in country s is therefore:

$$\left(\theta_{ij}^{s*}\right)^{\sigma-1} = \frac{\sigma\left(w_if_{ij} + w_if_{is}^{o}\right)}{\left(\frac{w_i^{1-z}\left(w_s\tau_{is}\right)^z}{\rho\theta}\tau_{ij}\right)^{1-\sigma}w_jL_j}\left(P_j + P_j^{1/\varepsilon}\right)P_j^{-\sigma}$$

C.2 Free Entry

The free entry condition is $\bar{\pi}_i = \delta w_if_E/\left[1 - G(\theta_{ii}^{*})\right]$,

with a Pareto productivity distribution:

$$\left[1 - G(\theta_{ii}^{*})\right] = \left(\frac{\theta_{i\min}}{\theta_{ii}^{*}}\right)^k.$$

The expected profit $\bar{\pi}_i$ conditional on successful entry is:

$$\bar{\pi}_i = \sum_s \int_{\theta_{is}^{t*}}^{\infty}\left(\frac{1 - G(\theta_{is}^{t*})}{1 - G(\theta_{ii}^{*})}\right)\left[\frac{r_{is}^{t}(\theta)}{\sigma} - w_if_{is} - w_if_{it}^{o}\right]\frac{g(\theta)d\theta}{1 - G(\theta_{is}^{t*})},$$

which can be re-arranged to obtain the following free entry condition:

$$\bar{\pi}_i = \sum_s (f_{is} + f_{it}^o) \left(\frac{\theta_{ii}^*}{\theta_{is}^*}\right)^k \left(\frac{\sigma - 1}{k - \sigma + 1}\right) = \frac{f_e}{\theta_{i\min}^k} \theta_{ii}^*.$$

This is (12) in our two country model. The only difference between $\bar{\pi}_i$ under offshoring and $\bar{\pi}_i$ without offshoring is the additional term $\sum_s f_{it}^o \left(\frac{\theta_{ii}^*}{\theta_{is}^*}\right) \left(\frac{\sigma - 1}{k - \sigma + 1}\right)$. This implies that when there is an increase in θ_{is}^*, the decrease in θ_{ii}^* is smaller than without offshoring.

C.3 The Price Index

From the last equation in B.1,

$$(\theta_{ii}^{s*})^{\sigma-1} = \frac{\sigma \left(f_{ii} + f_{is}^o\right)}{\left(\frac{w_i^{1-z} \left(w_s \tau_{is}\right)^z}{\rho\theta} \tau_{ij}\right)^{1-\sigma} L_i} \left(P_i + P_i^{1/\varepsilon}\right) P_i^{-\sigma}$$

Suppose τ_{is} decreases or the offshoring fixed cost through country s is decreased, θ_{ii}^{s*} decreases, which implies P_i decreases. This leads to increase in θ_{ii}^*. An increase in the domestic productivity cut-off in country i leads to a decrease in domestic cut-off in country j, $j \neq i$. This is the example we used in the three country case. If the trade cost of intermediate input or the offshoring cost between the South and North economy 2 decreases, more firms will be able to offshore in economy 2, ($\theta_{ii}^{s*} \downarrow$) , and economy 2's domestic productivity cut-off increases ($\theta_{ii}^* \uparrow$), which leads to a decrease in domestic cut-off in economy 1, which then leads to an increase in price index in economy 1, and thus less employment in the tradable good sector.