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How Did Exchange Rates Affect Employment in US Cities?

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Abstract

We estimate the effects of real exchange rate movements on employment in US cities between 2003 and 2010. We explore the differences in the composition of local industries to construct city-specific changes in exchange rates and estimate their effects on local employment in manufacturing industries and in nonmanufacturing industries. Controlling for year and city fixed effects, we find that a depreciation of the US dollar increased local employment in the manufacturing industries, our proxy for the tradable sector. The depreciation also increased employment in the nonmanufacturing industries, the nontradable sector. Furthermore, the effects on nonmanufacturing employment were stronger in cities that had a higher fraction of manufacturing employment, indicating the exchange rate movements' indirect effects through the manufacturing industries. We also consider an alternative definition of the tradable sector that is broadened to include five service industries. The findings are similar.

JEL classification codes: F3, F1, J2

Key words: exchange rate, employment, and US cities.

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1 Introduction

Substantial US dollar depreciation is sometimes considered a solution to the problems of the large US current account deficit and declining manufacturing employment. However, existing evidence suggests that the effects of exchange rate movements on the US employment are small. Two early studies, Branson and Love (1988) and Revenga (1992), did report large estimated effects. Revenga (1992), for example, finds that the US dollar's appreciation in the early 1980s reduced employment by about 6%. Later studies based on more comprehensive samples, however, report much smaller estimates of the employment effects (Goldberg and Tracy, 2000; Campa and Goldberg, 2001; Klein et al., 2003). Klein, Schuh and Triest (2003), for example, find that two consecutive annual 5.4% (one-standard deviation) appreciations of the cyclical component of the exchange rate reduce net employment growth by 0.7%. All of these previous studies focus on manufacturing industries, which are traditionally regarded as the tradable industries in an economy. Although the manufacturing sector plays an important role in the economy, its share in total employment is typically below 15% in developed countries. Consequently, if the exchange rate affects employment only in the manufacturing industries, its effect on national employment would likely be small. Meanwhile, there are a number of ways in which the exchange rate can affect nonmanufacturing industries, even if those industries have little or no exposure to international trade. The impact is not unambiguous. One the one hand, if a depreciation strengthens the demand for products of the domestic manufacturing industries, these industries, and their workers, will in turn demand more products and services from the domestic nonmanufacturing sector, potentially boosting its employment. We will refer to this effect as the spillover effect through the demand channel. But this is not the only way that exchange rate movements affect the nonmanufacturing sector. Dollar depreciation raises the prices of imported inputs used by the nonmanufacturing industries. If labor and imported inputs are complements (substitutes), then the nonmanufacturing industries will employ less (more) labor.

In this paper, we use more recent data to update the research on the employment effects of exchange rates. More importantly, we broaden the analysis to include the non-manufacturing sector, which hires far more labor than the manufacturing industries. Our central research question is: How do real exchange rate movements affect employment in the manufacturing sector and the nonmanufacturing sector? In order to study the potential spillover effect from the manufacturing sector to the nonmanufacturing sector, we use local industrial and employment data in our analysis, assuming that the spillover through the demand channel is stronger locally than it is nationally.

Specifically, we analyze the data from more than 300 US Metropolitan Statistical Areas (MSAs), which we will refer to as cities. These cities have different mixes of manufacturing industries that have different trade partners. In a particular year, a specific city can be subject to larger or smaller exchange-rate changes than other cities because of different industrial compositions. We will exploit this variation of the exchange rates across cities to identify their effects on manufacturing jobs. In addition, the use of local data is central to our objective to examine the exchange rates' spillover effects on non-manufacturing industries. The key assumption is that the demand for non-manufacturing products is in part local. As a result, the economic fortune of a city's manufacturing sector has a positive impact on the city's non- manufacturing industries. We expect the spillover effect to be stronger in cities that has a large manufacturing base. We will use the differences in sizes of local manufacturing industries to estimate the spillover effects of exchange rates via the demand channel.

Our findings suggest that a depreciation in export-weighted exchange rates (to which we will refer as export exchange rates) increases local employment in the manufacturing sector and employment in the nonmanufacturing sector. Meanwhile, depreciations in import-weighted exchange rates (to which we will refer as import exchange rates) often decrease or do not affect employment. Importantly, we find that the exchange rates' effects on the nonmanufacturing employment are greater in cities that have a higher fraction of manufacturing employment. This is consistent with the hypothesis that the exchange rates indirectly affect the nonmanufacturing employment through their direct impacts on the manufacturing sector. Given that manufacturing industries are only a crude proxy for tradable industries, we broaden the definition of tradable industries to include five service industries: transportation, information, finance and insurance, professional, scientific, and technical services, and management of companies and enterprises. We still find that the exchange rates affect employment in tradable industries and that the effects of the exchange rates spill over to the nontradable industries.

Relative to the literature that studies the employment effects of exchange rates, our paper makes three contributions. First, we find from city-level data that exchange rate depreciations have a positive impact on employment in tradable industries. Our use of local data complements the previous literature that use manufacturing industries as cross-section units, with the exception of Goldberg and Tracy 2000 who study state-level data. Second, to the best of our knowledge, our paper is the first to quantify the effects of exchange rates on employment in nontradable industries. We thus broaden the scope of the analysis to include the much bigger service sector in the economy. Third, our results indicate that export and import exchange rates have different effects. Depreciations in export exchange rates are almost always associated with increased employment, whereas the effects of import exchange rates are often insignificant or negative. The insignificant or negative effects of depreciation in import exchange rates may be caused by the increase in imported input prices, and by a low level of exchange rate pass-through to domestic US prices, a result from the fact that most US imports are priced in the US dollar (Goldberg and Tille, 2008).

2 Theoretical Motivation and Empirical Specifications

Because the empirical specifications in this paper are modified from those of Campa and Goldberg (2001), we briefly discuss their theoretical model to motivate the empirical specifications. In Campa and Goldberg (2001), a representative firm in a tradable industry chooses output for the home market (q_t), output for the foreign market (q_t^*), labor input (L_t), imported inputs (Z_t^*), and domestic inputs (Z_t) to maximize profit

$$\pi(y_t, y_t^*, e_t) = \max_{q_t, q_t^*, L_t, Z_t^*, Z_t} \sum_{t=0}^{\infty} \phi^t \left[p(q_t(y_t, e_t))q_t + e_t p^*(q_t(y_t^*, e_t))q_t^* - w_t L_t - s_t Z_t - e_t s_t^* Z_t^* - c(\Delta(L_t)) \right]$$

subject to the production function

$$Q_t = q_t + q_t^* = L_t^{\beta} (Z_t^*)^{\alpha} Z_t^{1-\alpha-\beta}$$

and the labor adjustment cost, a standard feature in models of dynamic labor supply (Nickell, 1986).

$$c(\Delta(L_t)) = w_t \frac{b}{2} (L_t - L_{t-1})^2.$$

The quantities y_t, y_t^*, ϕ, e_t, p, p^*, w_t, s_t, and s_t^* are home GDP, foreign GDP, the time discount factor, the exchange rate, home price of output, foreign price of output, wage rate, price of home inputs, and price of foreign inputs, respectively. Assuming that the exchange rate follows a random walk and that goods markets are monopolistically competitive, Campa and Goldberg (2001) show that the linearization of the optimal labor demand function leads to a linear estimation equation:

$$\begin{aligned} \Delta L_t = & \lambda_1 + \lambda_2 \Delta y_t + \lambda_3 \Delta y_t^* + \lambda_4 s_t + \lambda_5 s_t^* \\ & + (\lambda_6 + \lambda_7 x_t + \lambda_8 m_t + \lambda_9 \alpha_t) \cdot \Delta e_t + \lambda_{10} \Delta L_{t-1} + u_t, \end{aligned} \quad (1)$$

where α_t is the share of imported inputs in production in period t. The share of export sales in total industrial shipments, x_t, measure the export orientation. The variable m_t

measures import penetration and is defined as the fraction of import in total domestic sales.

The intuition behind (1) is the following. First, changes in the exchange rate (e_t) alters international relative prices and demand for output, leading firms to adjust their labor input. The positive employment effects are stronger when the levels of import penetration (m_t) and export orientation (x_t) are higher. However, there are forces working in the opposite direction. If imported inputs and labor are complements in production, then depreciations can dampen demand for labor if the share of imported inputs (α) is high. Therefore, it is important to include interaction terms ($m_t \Delta e_t$, $\alpha_t \Delta e_t$ and $x_t \Delta e_t$). The prices of other inputs (s_t, s_t^*) also affect demand for labor; they are thus included on the right-hand side of the regressions. Labor demand is also affected by home and foreign aggregate demand, y_t, and y_t^*, respectively. Lastly, because of labor adjustment costs, current adjustment in labor depends on the adjustments made in the previous period; the regression thus has a term for lagged employment adjustment.

Campa and Goldberg (2001) apply equation (1) to manufacturing industries, using individual industries as the cross sectional units. We, on the other hand, will use cities as the cross sectional units. We thus estimate a variant of equation (1). Our specification is

$$\begin{aligned}\Delta L_{c,t} =& \gamma_1 + \gamma_2 \Delta y_{c,t}^* + (\gamma_3 + \gamma_4 x_c + \gamma_5 m_c + \gamma_6 \alpha_c) \Delta e_{c,t} \\ &+ \gamma_7 \Delta L_{c,t-1} + f_c + f_t + u_{c,t}, \end{aligned} \tag{2}$$

where the subscripts c is the index for cities. The variables f_c and f_t are city and year fixed effects, respectively. Compared to (1), we do not include y_t, s_t, and s_t^* measured at national level because these variables are absorbed by the year fixed effects. Meanwhile, we keep $y_{c,t}^*$ in the regression because trade-weighted foreign GDPs vary across cities. Lastly, the city-specific export orientation ratio (x_c), import penetration ratio (m_c), and the share of imported inputs (α_c) will drop out from the regressions, because they are constructed as time-invariant averages over a period and thus are absorbed by the city fixed effects. Their interactions with the exchange rates, however, will remain.

For our main specification, we include both the import exchange rate and the export exchange rate, which are the exchange rates faced by importers and exporters, respectively. First, there are reasons to suspect that the import exchange rate may have weaker effects on domestic US prices relative to the export exchange rate's effects on foreign prices. The literature on exchange rate pass-through (Goldberg and Tille, 2008) documents that most of the international trade that flows to and from the US are invoiced in US dollar.[1] Consequently, domestic prices of imports in the US can be insensitive to the change in US dollar exchange rates (i.e., the exchange rate pass-through is low). In this case, the demands for imports and competing American products are not likely to change, leading to little adjustment in labor demand in the US. Meanwhile, US exports are mostly priced in US dollars. Buyers in foreign countries are likely more exposed to exchange rate fluctuations. Therefore, the effects of import exchange rates and export exchange rates are potentially different; our main specification acknowledges this possibility by treating the two exchange rates differently.

Second, the effects of the import exchange rate on employment are more nuanced compared with the effects of the export exchange rate. When the export exchange rate depreciates, products from US firms become cheaper in foreign markets, leading to a stronger demand for them and in turn a stronger demand for labor by US firms. As for depreciations of the import exchange rate, there are competing effects. On the one hand, depreciations make foreign products more expensive and boost demand for home products and hence domestic labor. On the other hand, imported inputs become more expensive after depreciation, potentially having a negative impact on domestic labor demand if labor and imported inputs are complements in the production process.

[1] The theory in Bacchetta and Van Wincoop (2005) suggest that when exporters in small open economies compete in the US market, it is often optimal for them to price in the US dollar because their market shares are small and because of the high level of substitutability between competing products. Goldberg and Tille (2008) make a similar point by emphasizing a "coalescing"effect in which exporters set prices in the US dollar to limit the changes in their prices relative to the competitors'.

With both import and export exchange rates on the right-hand side, our benchmark specification is

$$\Delta L_{c,t} = \gamma_1 + \gamma_2 \Delta y^*_{c,t} + (\gamma_3 + \gamma_4 x_c)\Delta e^x_{c,t} + (\gamma_8 + \gamma_5 m_c + \gamma_6 \alpha_c)\Delta e^i_{c,t}$$
$$+ \gamma_7 \cdot \Delta L_{c,t-1} + f_c + f_t + u_{c,t}, \quad (3)$$

where $e^i_{c,t}$ and $e^x_{c,t}$ are import and export exchange rates. In all regressions, we remove the sample mean from all the right-hand side variables that are subject to interactions, hence, γ_3 and γ_5 measure the marginal effects of export and import exchange rate at the sample mean.

Here we briefly discuss our pre-regressions hypotheses. First, we expect depreciations ($\Delta e^i < 0$ or $\Delta e^x < 0$) to have a positive impact on labor demand by increasing the market share of domestic firms in home and foreign markets. Thus, it is likely that $\gamma_3 < 0$, $\gamma_4 < 0$, and $\gamma_5 < 0$ in both equations (2) and (3). Secondly, if labor and imported inputs are complements,[2] we expect that $\gamma_6 > 0$ in both equations (2) and (3) because depreciations raise cost of imported inputs. Lastly, because depreciations in the import exchange rate increase demand for products of domestic firms but also increase cost of imported inputs, the marginal effect of the import exchange rate on employment measured at mean is ambiguous. That is, the sign of γ_8 in equation (3) is ambiguous.

Our next step is to estimate whether the exchange rates affect employment in the nonmanufacturing industries or, alternatively, a more finely defined set of nontradable industries.

Compared to the representative firm in a tradable industry, the representative firm

[2] Although the recent literature on international trade and output comovement emphasize the idea that imported and domestic inputs are complements in production (Burstein, Kurz and Tesar, 2008; di Giovanni and Levchenko, 2010; Johnson, 2012), to the best of our knowledge, there are very few empirical papers that estimate the complementarity or substitutability between imported inputs and labor. Based on data of manufacturing industries in West Germany, Falk and Koebel (2002) find that the use of imported inputs did not have significant negative effects on demand for different types of labor. Jara-Diaz, Ramos-Real and Martinez-Budria (2004) estimate that intermediate inputs and labor were complements in the industry of electricity generation in Spain.

in a nontradable industry does not compete with foreign firms in the output market. One channel through which the exchange rates affect the employment in nontradable industries is in the demand of the tradable industries for outputs of nontradable industries. Based on the 2002 Input-Output tables for the US, for the 86 manufacturing industries industries,[3] the average share of inputs from nonmanufacturing industries is 28.4%. Therefore, we posit that in cities with a higher fraction of employment in tradable industries, the exchange rates will have greater effects on the employment in nontradable industries. We thus estimate the following equation

$$\Delta L^n_{c,t} = \theta_1 + (\theta_2 + \theta_3 TS_{c,t-1})\Delta e_{c,t} + \theta_4 TS_{c,t-1} + \theta_5 \Delta L^n_{c,t-1} + f_c + f_t + v_{c,t}, \tag{4}$$

where the variable $L^n_{c,t}$ is the employment in nontradable industries in city c in year t. The variable $TS_{c,t-1}$ is the one-year lag of the fraction of employment in tradable industries in total employment. The variables f_c and f_t are city and year fixed effects. The error term is $v_{c,t}$.

Because depreciations indirectly raise the demand for products of nonmanufacturing industries, we expect that $\theta_2 < 0$ and $\theta_3 < 0$. Of course, changes in import exchange rates may also affect the labor decision of firms in nontradable industries through the channel of imported inputs. That is, depreciations increase the cost of imported inputs used by nonmanufacturing firms. But since we do not have the information on the share of imported inputs for firms in nontradable industries, any effects of import exchange rates via the channel of imported inputs would be absorbed in the mean effect of the exchange rate, the coefficient θ_2.

Due to the presence of lag dependent variables in panel regressions, we use the Arellano-Bond GMM estimator (Arellano and Bond, 1991) to estimate all equations. In the Arellano-Bond GMM estimator, if the error terms are not auto-correlated, the lag values

[3]They are the 86 four-digit manufacturing industries defined in the North American Industry Classification System (NAICS). In the regressions in Table 7, we use the 82 four-digit manufacturing industries for which the relevant data are available.

of valuables are valid instruments in formulating the moment conditions. We include two lags of the dependent variables in the regressions. In all regressions after which the AR(2) test statistics can be computed, the statistics do not reject the null hypothesis that there are not auto-correlations in the error terms. [4] Since the efficiency gain of two-step GMM tends to be small in finite samples in dynamic panel regression with first-differenced data (Bond, Hoeffler and Temple, 2001), we use the one-step GMM in all estimations. Finally, we base our statistical inferences on robust standard errors.

3 Data and Measurement

In this section, we explain the construction of key variables and document additional details about the data in an online appendix. Although the main purpose of the paper is to examine the effects of exchange rates on employment in cities, we explain first the construction of industry-specific exchange rates, the import penetration ratios, the share of imported inputs, and the export orientation ratios for four-digit NAICS manufacturing industries because the construction of MSA-level variables relies on these industry-specific variables.

3.1 Industry-Specific Exchange Rate for Manufacturing Industries

Let e^x_{it} denote the trade-weighted real export exchange rate for industry i. Because the real exchange rate is an index which depends on the relevant countries' base years for price indices, the level of the real exchange rate does not have economic meaning. Therefore we focus on the change in the real exchange rates. We construct the growth rate in real export exchange rate for industry i as

$$\frac{e^x_{i,t} - e^x_{i,t-1}}{e^x_{i,t-1}} = \sum_j \underbrace{\frac{1}{5} \cdot \sum_{k=1}^{5} \frac{export_{i,j,t-k}}{export_{i,t-k}}}_{trade\ weight} \cdot \frac{e_{j,t} - e_{j,t-1}}{e_{j,t-1}}, \tag{5}$$

[4] Although our data are from 2003 to 2010, the inclusion of two lags and use of the third lag as instruments effectively reduce our sample period to 2006 to 2010.

where $export_{i,j,t-k}$ is industry i's export to country j in year $t-k$, $export_{i,t-k}$ is industry i's total export in year $t-k$, and $e_{j,t}$ is the real exchange rate between the US and country j. Our weight is the lag of a 5-year moving average of the ratios of export from country j to total export in industry i. We use the lags of export volume to calculate change in industry-specific exchange rates to avoid the contemporaneous correlation between trade share and exchange rates in the same year.

For the export data, we use the trade data from 1990 to 2006 compiled by Feenstra, Romalis and Schott (2002). To calculate the trade weight, we use a total of 50 trade partners of the US. The 50 partners are the 50 economies studied in Betts and Kehoe (2008) plus Mainland China minus the US. We choose the 50 countries because the Producer Price Index (PPI), which is used in the calculation of the real exchange rates, is available, and because these countries and the US together account for about 80% of world trade from 1980 to 2005.[5]

We obtain the bilateral nominal exchange, defined as the price of country j's currency in the US dollar, from the International Financial Statistics (IFS) published by the International Monetary Fund (IMF). To convert the bilateral nominal exchange rates into real exchange rates, we use the PPI of the relevant countries. As suggested in Betts and Kehoe (2006), when the purpose is to compute the relative price in international trade, producer prices, ideally at the level of industry, should be preferred to consumer prices because the former provide a better measure of prices in trade. Because the output deflators by industries are not available broadly, we choose the aggregate PPI as our price indices. With the definition of exchange rate we use, an increase in the real exchange rate index indicates a real appreciation of the US dollar.

The construction of the trade-weighted real import exchange rate for industry i is symmetric to the export exchange rate and uses the same data sources.

[5]Campa and Goldberg (2001) use 34 trade partners. In Gourinchas (1999), he includes only major trade partners, but the set of major trade partners do vary with industry.

3.2 Import Penetration and Export Orientation in Manufacturing Industries

To measure the degree of participation in international trade, we calculate the import penetration ratios and export orientation ratios for manufacturing industries. The import penetration ratio and export orientation ratio for industry i are calculated as

$$m_{i,t} = \frac{import_{i,t}}{import_{i,t} + shipment_{i,t} - export_{i,t}}$$
$$x_{i,t} = \frac{export_{i,t}}{shipment_{i,t}}.$$

The variable $export_{i,t}$ is the export of industry i in year t and $shipment_{i,t}$ is the shipment of the industry in year t. The source of shipment data is the Annual Survey of Manufacturing (ASM). We do not use the shipment data before 2002 because we find large jumps in shipment value around that year.

Due to data limitations, we can only compute the import penetration ratios and export orientation ratios up to 2006. To utilize data after 2006, we compute the time averages of import penetration ratios and export orientation ratios for each industry and assign the averages to all years from 2003 to 2010.

3.3 Share of Imported Inputs in Manufacturing Industries

Following Campa and Goldberg (1995) and Campa and Goldberg (1997), we construct α_i, the share of imported inputs for industry i, as

$$\alpha_{it} = \frac{\sum_{j=1}^{n-1} m_{jt} p_{jt} q_{jt}^{i}}{VP_{it}}, \tag{6}$$

where m_{jt} is the import penetration ratio for industry j, $p_{jt} q_{jt}^{i}$ is the value of input materials produced by industry j that are used by industry i, and VP_{it} is the total production cost of industry i. We assume that the $m_j t$ share of the input purchased by industry i from industry j is imported, and hence, the numerator $\sum_{j=1}^{n-1} m_{jt} p_{jt} q_{jt}^{i}$ is a measure of the total amount of imported inputs used by industry i. We make the assumption because we do not observe directly the amount of imported inputs. We then rewrite equation (6) as

$$\alpha_{it} = \sum_{j=1}^{n-1} m_{jt} \frac{p_{jt} q_{jt}^i}{VP_{it}}.$$

The term $\frac{p_{jt} q_{jt}^i}{VP_{it}}$ is industry i's share of inputs procured from industry j. To construct this share, we obtain $p_{j,2002} \times q_{j,2002}^i$ from the 2002 Input-Output tables for the US, and compute $VP_{i,2002}$ as the sum of "total intermediate inputs" and "compensation of employees" from the same data source. Therefore, we have

$$\alpha_{it} = \sum_{j=1}^{n-1} m_{jt} \frac{p_{j,2002} \times q_{j,2002}^i}{VP_{i,2002}},$$

Again we can only compute α_{it} up to 2006 because of the limitation on trade data. We compute the time averages of α_{it} for each industry i and assign the averages to all years from 2003 to 2010.

3.4 Foreign Demand in Manufacturing Industries

Under the premise that GDP growth in export-destination countries increases the demand for US products, we use industry-specific trade-weighted foreign (real) GDP growth to proxy for foreign demand. We use the 50 trading partners to construct the demand proxy, and use export volume as weights:

$$\frac{y_{i,t}^* - y_{i,t-1}^*}{y_{i,t-1}^*} = \sum_j \underbrace{\frac{1}{5} \cdot \sum_{k=1}^{5} \frac{export_{i,j,t-k}}{export_{i,t-k}}}_{trade\ weight} \cdot \frac{y_{j,t}^* - y_{j,t-1}^*}{y_{j,t-1}^*}, \tag{7}$$

where $y_{j,t}^*$ is the real GDP in trade partner j in year t. The real GDP series are from the IMF.

3.5 Construction of MSA-level variables

At the MSA level, the Quarterly Census of Employment and Wages (QCEW) program of the Bureau of Labor Statistics (BLS) provides employment data on each four-digit NAICS industry. We assume that the typical firm in an industry in a city shares the same features as the national industry. We then use the features of the national industries to construct the city-specific exchange rates, import penetration, export orientation, and real GDP growth in trade partners. For an individual city indexed by c, the changes in exchange rate (denoted as $\Delta e_{c,t}$) is the weighted average of changes in exchange rates for the group of manufacturing industries in the city; the weights are the lag employment in each manufacturing industry in MSA c. The construction of city-specific import penetration, export orientation, and real GDP growth in trade partners is similar.

3.6 Summary of Data

Tables 1 and 2 summarize the exchange rate, employment growth, shares of employment in different types of industries for the industry-level and MSA-level samples, respectively. Even though the import penetration ratios and export orientation ratios rose on average in the years for which data are available, both ratios differ substantially across industries In the MSAs, the mean of the share of all manufacturing industries in total employment decreased from 13.08% to 10.60% between 2003 and 2010.

As illustrated in the top panel of Figure 1, during the period of 2003 to 2010, the real trade-weighted US dollar exchange rate index experienced depreciations in most years. However, in any given year, there are considerable variations in exchange rate movements faced by individual industries and cities, as can be seen in Tables 1 and 2 and the bottom panels of Figure 1.

Before moving to a regression analysis in the next section, we plot the growth in manufacturing employment against changes in city-specific export exchange rates and against changes in import exchange rates in Figure 2. In the top panel, we see employment in manufacturing industries is negatively correlated with export exchange rates, while the correlation between employment and the import exchange rate is positive. In Figure 3, we see that employment in nonmanufacturing industries is also negatively correlated with export exchange rates, and there's virtually no correlation between employment in nonmanufacturing industries and import exchange rates. It is notable from Figures 2 and 3 that import exchange rates appear to affect employment in a way different from the export exchange rates.

4 Regression Results

4.1 The Effects of the Exchange Rates on Manufacturing Employment

Our first set of regressions, of (2) and (3), assess the effect of exchange-rate movements on city-level manufacturing employment. The dependent variables are the growth rates of total employment in manufacturing industries in a city. Using manufacturing industries as the proxy for tradable industries, we interpret the estimated exchange-rate effects as the direct effects on the tradable sector. Our regressions involve interacted variables. For easier interpretations, we have removed the sample means from the independent variables before the interacting them. As a result, the coefficient on the export exchange rate is the effect of the export exchange rate on employment evaluated at the sample mean.

We present the benchmark regression results in Table 3. There are multiple columns, reflecting different ways that the exchange rates enter the right-hand side. We hypothesize that the import and export exchange rates can have different effects on employment; but we also realize that the two exchange rates are highly correlated. For completeness, we present findings from a range of different specifications. In column (1) of Table 3, we do not distinguish between the import and export exchange rates. Instead, we use a single measure of the exchange rate that is the simple average of the import and export exchange rates. It is this average that enters the right-hand side and is interacted with the import penetration, export penetration, and the share of imported inputs. In column (2), we use only the export exchange rate and its interaction with export orientation. In column (3), we use only the import exchange rate and its interaction with import penetration and share of imported inputs. In column (4), the most general and our preferred specification, we include both import and export exchange rates and their respective interaction terms.

A few patterns are evident in Table 3. First, when we do not distinguish between import and export exchange rates, the effects of depreciations in the average exchange rate on employment (measured at the sample mean) are positive, but not statistically significant. Note that under our definition of real exchange rate, the exchange rates depreciate when the exchange indices decrease. Hence, a negative coefficient on the exchange rate variable implies depreciations have positive effects on employment.

Second, the export exchange rate has significant positive effects on employment, either in column (3) when it enters the regressions without the presence of the import exchange rate, or in column (4) when it enters the regression simultaneously with the import exchange rate. In column (4), the estimate suggests that if a city experiences a depreciation in the export exchange rate that is 1% larger in magnitude than that of the average city, then the manufacturing employment will rise by 1.22%. The estimated effect is only slightly smaller (0.98%) in column (2) where the export exchange rate enters on its own. This finding supports our hypothesis that the effects of a depreciation in export exchange rates are positive ($\gamma_3 < 0$). When the exchange rate depreciates, a higher export orientation ratio magnifies the positive effects of exchange rate on employment, as indicated by the negative sign on the interaction term between export exchange rate and export orientation. This finding is consistent with the hypothesis that a higher export orientation ratio increases the sensitivity of demand to exchange rate ($\gamma_4 < 0$).

Third, on average, the import exchange rate does not have significant effects on employment, even if we exclude the export exchange rate from the regression, as we have done in column (3). As discussed in section 2, a number of factors can lead to an insignificant employment effect of the import exchange rate. One is the low degree of exchange rate pass-through. International trade flows into the US are primarily priced in US dollar. As a result the pass-through of exchange rate to domestic prices is low in the US; changes in the import exchange rates may not move international relative prices enough to trigger significant changes in the US employment. Another possible explanation is that for firms who use heavily imported intermediate products, a depreciation of the US dollar may increase the cost of production, countering the positive effects of lower output prices in the international market.

Fourth, when the import exchange rate depreciates, a city with a higher import penetration ratio will have lower growth in manufacturing employment, as suggested by the positive sign on the interaction term between import exchange rate and import penetration. Meanwhile, a high share of imported inputs do not have significant effects, providing no support for our hypothesis that a higher share has negative effects during depreciations ($\gamma_6 > 0$). The negative effect of high import penetration during depreciations contradicts our hypothesis ($\gamma_5 < 0$). This may be due to the measurement errors in the construction of share of imported inputs. It may also arise from the high correlation between import penetration and the share of imported inputs, which is 0.65 in our sample. As a result of the correlation, the coefficient on import penetration may capture the negative effects of a high share of imported inputs during depreciations.

4.2 The Effects of the Exchange Rates on Nonmanufacturing Employment

In this subsection, we estimate equation (4), in which the dependent variable is the employment in the nonmanufacturing sector, as opposed to the earlier regressions that look at the manufacturing employment. The purpose is to check whether exchange rate movements affect the employment in the non-tradable sector, proxied by nonmanufacturing industries. Acknowledging the fact that manufacturing industries are only a proxy for the tradable sector, we will explore, in the next subsection, an alternative classification that reflects a broader definition of tradability.

The dependent variable in this subsection is the growth in total employment in all nonmanufacturing industries in a city. As in the previous subsection, we use four different specifications for the exchange rates to enter the regressions.

From the regression results reported in Table 4, we first observe that the coefficients on the exchange rates themselves are not significant. Meanwhile, the interactions between exchange rates and the share of employment in manufacturing industries are negative, suggesting that it is important to take into account the interactions between exchange rates and employment share of manufacturing industries. The negative sign of the interactive effect indicates that in a city with a large share of employment in manufacturing industries, if the exchange rate depreciates, then employment in nonmanufacturing industries will increase more substantially. This finding provides supporting evidence for the hypothesis exchange rates indirectly affect employment in nonmanufacturing industries ($\theta_3 < 0$). The coefficient of -0.01 in column (1) of Table 4 means that when a city experiences an extra 1% depreciation and has 10% more employment in manufacturing industries relative to the sample mean, nonmanufacturing employment will increase by 0.1%.

Third, when we include both import and export exchange rates and their respective interactions with the share of employment in manufacturing industries, the coefficients on interactions have negative signs, as hypothesized, but they are not statistically significant. The insignificance may be because the effects of import and export exchange rates on employment of nonmanufacturing industries are similar, so the partial effects are not precisely estimated.

4.3 Alternative Definition of Tradable and Nontradable industries

In the literature that studies the effects of exchange rates on trade and the labor markets, it is conventional to focus on the manufacturing industries, probably due to the availability of high-quality data and that fact that manufacturing products are more easily transportable than some (but not all) products from the service industries. In the previous two subsections, we follow this convention, defining tradable industries as manufacturing industries and the other industries as nontradable.

This narrow definition of the tradable sector may have become a less accurate approximation, however, with the service industries becoming more and more important not just as a share of GDP, but also a share of international trade. In 2006, for instance, the export of total private services amounted to $403 billion dollars, and the import amounted to $307 billion. In comparison, the total export and import values of the manufacturing industries were $779 billion and $1,451 billion, respectively, in the same year. In this subsection, we adopt an alternative classification of industries that reflects a broader definition of tradable industries. Specifically, we expand the definition of the tradable sector to include both (a) all manufacturing industries (NAICS 31-33), and (b) tradable service industries: transportation (NAICS 48), information (NAICS 51), finance and insurance (NAICS 52), professional, scientific, and technical services (NAICS 54), and management of companies and enterprises (NAICS 55).[6]

The main concern about the alternative classification is with the tradable service industries. The existing data on trade in service available from the Bureau of Economic Analysis (BEA)[7] does not provide a great amount of details. The breakdown of the data does not correspond to the NAICS classification. In addition, for most years, the BEA only provides the total export and import amount of private services. Because of these data limitations, we aggregate the data of these five tradable industries and treat them as a single tradable service industry. Although we believe it is important to incorporate the trade in service, we recognize our treatment of the data of the tradable service industries can result in another inaccurate measurement of the tradable industries because of the assumptions involved.

We treat the five service industries above as tradable for two reasons. First, the

[6]Products of the industries of agriculture, forestry, fishing and hunting (11) and mining (21) are tradable, but we do not include them here because they do not account for much employment in cities.

[7]Available at: http://www.bea.gov/international/international_services.htm.

components in the service trade covered by the BEA largely correspond to these five industries as a group. Second, the work of Jensen and Kletzer (2005) provides evidence of high tradability of these industries. The idea behind the method of Jensen and Kletzer (2005) is that highly tradable industries tend to have high geographic concentration. Meanwhile, if an industry, such as retail trade, is present in all locations, then the level of tradability must be low. Jensen and Kletzer (2005) compute a gini coefficient for each industry to measure the unevenness in spatial distribution. They use a gini coefficient of 0.1 as the cutoff between tradable and nontradable industries: an industry with a gini coefficient greater than 0.1 is considered tradable. If a two-digit NAICS industry has a larger fraction of employment in tradable sub industries, the two-digit NAICS industry is also likely to be tradable. All of the five 2-digit service industries listed above have a large fraction of employment in tradable subindustries, with the minimum being 57.19% in transportation (NAICS code 48). Our treatment of the service industries is very similar to Spence and Hlatshwayo (2011), who also make use of findings of Jensen and Kletzer (2005).

Because we now classify five service industries as tradable, we reconstruct the exchange rate faced by the tradable industries in cities. Specifically, we redefine the MSA exchange rate $e_{c,t}$ as the weighted sum of the exchange rate for the group of manufacturing industries ($e^m_{c,t}$) for MSA c, and the exchange rate for the group of tradable service industries ($e^s_{c,t}$) for MSA c:

$$e_{c,t} = \frac{l^m_{c,t-1}}{l^m_{c,t-1} + l^s_{c,t-1}} \cdot e^m_{c,t} + \frac{l^s_{c,t-1}}{l^m_{c,t-1} + l^s_{c,t-1}} \cdot e^s_{c,t},$$

where $l^m_{c,t}$ and $l^s_{c,t}$ are employment of the group of manufacturing industries and the group of tradable service industries in MSA c in period $t-1$. The exchange rate for the group of manufacturing industries (e^m_{ct}) is defined in equation (5). The construction of city-specific import penetration, export orientation, and real GDP growth in trade partners is similar.

We re-estimate the direct effects of exchange rates and report the results in column

(1) of Table 5. Due to the lack of data on export orientation ratios and import penetration ratios for the tradable service industry, we do not include the interaction between exchange rates and these ratios. Overall, the signs of the coefficients are similar to the benchmark results in the last column of Table 3. The export exchange rate has a significant negative effect on employment, while the average exchange rate and the import exchange rate are not significant. The export exchange rate elasticity of employment is -1.12 in column (4) of Table 5, indicating a depreciation of 1% is associated with a 1.12% increase in total employment in tradable industries. This elasticity is very similar in magnitude to the coefficient of -1.22 in column (1) of Table 5.

Next, we re-estimate the effects of exchange rates on employment in nontradable industries and present the results in columns (1) and (2) of Table 6. The results are similar to those in the corresponding benchmark estimations reported in Table 4. In our preferred specification when the export exchange rate and the import exchange rate enter separately, the export exchange rate has a insignificant effect at the sample mean, but the interaction between the exchange rate and the size of local tradable industries have the expected sign and strong statistical significance. This coefficient estimates suggest that if a city experiences an extra 1% depreciation and has 10% more employment in tradable industries compared to the sample mean, the employment in nontradable industries will increase by 0.4%.

Overall, when we refine the tradable industries to include five service industries, we still find evidence that exchange rate have effects on employment in both tradable and nontradable industries in cities.

4.4 Other Robustness Checks

In this subsection, we report three additional robustness checks. First, we replace the year fixed effects with a set of variables measuring macroeconomic conditions that are used in Campa and Goldberg (2001): real US GDP growth rate, change in 10-year real interest rate of treasury bills, and change in real oil prices. The first variable captures the strength of domestic demand, while the last two capture the cost of capital and energy.[8] With the year fixed effects, we effectively use only the cross-section variations in exchange rates to identify the employment effect of exchange rates. In this robustness check, we reintroduce the time-series variation of exchange rates. The estimates, reported in column (2) of Table 5 and column (3) of 6, are similar to the benchmark regressions.

Second, we decompose the changes in exchange rates into permanent components and transitory components and estimate the effects of the permanent components on employment. As discussed in Campa and Goldberg (2001), changes in employment through hiring and firing are costly. Therefore, firms are more likely to adjust employment in response to permanent or long-term changes in exchange rates compared with the transitory changes. Following previous empirical papers on exchange rate (Campbell and Clarida, 1987; Huizinga, 1987; Clarida and Gali, 1994; Campa and Goldberg, 2001), we apply the decomposition method proposed by Beveridge and Nelson (1981).[9] We re-estimate the direct effects and indirect effects using the permanent components in the exchange rates and report the results in column (3) of Table 5 and column (4) of 6. In general, the regressions results for manufacturing employment are similar to previous results, but the results for nonmanufacturing employment are not statistically significant.

Third, we break the sample period into two subperiods, one for the years before the recent recession (2006-2007), and the other for the years of recessions (2008-2010). During the most recent recession, one notable phenomena in the global economy was the dramatic collapse of international trade in 2009. For instance, in 2009 the real export

[8] Because we do not have data to construct these variables at the level of industry or city, the inclusion of year fixed effects excludes them as regressors in our benchmark regressions.

[9] To apply the Beveridge-Nelson decomposition, it is necessary that we assume the log real exchange rate is an $I(1)$ process and the first difference of the log real exchange rate is stationary. We fit an $AR(2)$ model to the first difference of the exchange rate before applying the formula for Beveridge-Nelson decomposition. As discussed in Chen and Rogoff (2003) and Chen and Rogoff (2012), there has been debate whether real exchange rates should be modeled as $I(1)$ a process. Therefore, we recognize it is possible that the Beveridge-Nelson decomposition is not appropriate in this context.

and import of the US dropped by 14.2% and 16.7%, respectively. Therefore, we want to check whether our results are driven by the effects of the recession or not. In the last two columns of Tables 5 and 6, we report the subperiod regression of manufacturing and nonmanufacturing employment, respectively. From the last two columns of Tables 5, we can see that in both subperiods, depreciations of the export exchange rates have positive effects on manufacturing employment, which is consistent with the results based on the whole sample period. As for the effects of exchange rates on nonmanufacturing employment, the last two columns of Table 6, exchange rate depreciations are again associated with increase in employment in both subperiods. Overall, it appears our results are not hinged on the effects of the recession.

5 Discussion

Over the past few decades, the US has increasingly engaged in international trade, whether measured by import penetration or export orientation ratios. With a high degree of participation in trade, the US is more sensitive to the international relative prices caused by exchange rate movements. Over the same period, US employment in manufacturing industries has declined continually. An important question is whether the exchange rates affect employment in the US manufacturing industries and its wider economy. A few recent papers (Goldberg and Tracy, 2000; Campa and Goldberg, 2001; Klein et al., 2003) suggest the exchange rates have only small employment effects. For instance, Campa and Goldberg (2001) report an average employment elasticity of 0.01 associated with the permanent component of the exchange rate; Klein et al. (2003) suggests that if the cyclical component of the exchange rate appreciates by 5.4% in two consecutive years, employment declines by only 0.7%.

Our paper makes three contributions to the literature of employment effects of exchange rates. First, we find that exchange rate depreciations have significant positive effects on employment in tradable industries in US cities. We refer to these as the direct effects of the exchange rates on employment in cities. Second, in cities with higher fractions of employment in tradable industries, the exchange rate depreciations also have significant positive effects on jobs in nontradable industries. These are what we term indirect effects. As far as we are aware, our paper is the first to estimate such indirect effects of exchange rate. Lastly, our empirical work highlights that the export exchange rates and import exchange rates have different effects. In our regressions, depreciations in the export exchange rates consistently have positive effects on employment. We argue this is because depreciations in export exchange rates directly increase demand for tradable industries and indirectly increase demand for nontradable industries. Meanwhile, the effects of depreciations of import exchange rates can be muted because the pass-through of exchange rate into domestic prices is low in the US, and because depreciations increase prices of imported inputs.

Although our estimates of the export exchange rate elasticities of employment in tradable industries, ranging from 0.5 to 0.9, are high, relative to the existing literature. There are a number of differences between our work and earlier papers. First, previous studies use data up to the mid 1990s, while we use data from the last decade, when the level of trade participation was higher. Second, unlike previous studies that use industrial-level data, we look at city-level data instead. The cross-section units are different. Third, because our estimation includes year fixed effects, we are estimating the effects of exchange rate changes relative to the cross-section mean in each year. Meanwhile, for previous studies that do not include the year fixed effects, the estimation of elasticities use information on the average change in exchange rate in each year. Fourth, we differentiate between import and export exchanges, while previous papers focus on a single trade-weighted exchange rate.

To better understand the effects of exchange rates on employment, we use industry-level data from the 2000's to estimate regressions similar to those in Campa and Goldberg (2001). In column (1) of Table 7, the specification is identical to the main employment regression in Campa and Goldberg (2001). In column (2), we add import penetration. In the last column, we use year fixed effects to replace real GDP growth rate of the US, change in 10-year real interest rate of treasury bills, and change in real oil prices. In all three regressions, the exchange rate elasticities of employment are between -0.3 and -0.4, considerably larger in magnitude than the -0.01 reported in Campa and Goldberg (2001).

Given the similar methodologies, there remain two likely reasons why we get larger elasticities than Campa and Goldberg (2001). First, the effects of exchange rates on employment are larger in our sample period. As documented in Table 1, manufacturing industries in the US have participated more in international trade and competition. From the perspective of trade participation, Autor, Dorn and Hanson (2012) find that import competition from China have significant negative effects on local employment in the US. Therefore, it is possible that structural changes in the global economy have lead to greater sensitivity of US employment to exchange rates. Second, it is also possible that the change of industry classification from the Standard Industrial Classification (SIC) system to the NAICS system affect the results.

Lastly, we should recognize that limitations on data warrant caution in interpreting our results. We have to make compromises regarding data. First, because there are no data on trade at the city level, we have to assume a firm in each city has the same exposure to trade and exchange rate as the national industry to which the firm belongs. Second, the data on service trade provide very limited information. Hence, when we use the data on service trade to expand the definition of tradable industries to include five service industries, we are exposed to potentially substantial measurement errors.

6 Conclusion

As most economies in the world become more open to trade, changes in international relative prices caused by changes in exchange rates can alter patterns of trade and production across countries. How do these exchange rates affect employment? We answer this question by exploiting the differences in exposure to trade and exchange rates in US cities. Based on the data of more than 300 US cities between 2003 and 2010, our analysis suggests that depreciations of the US dollar have positive effects on US employment in manufacturing industries. More importantly, however, the depreciations are also associated with employment increases in the nonmanufacturing sector, a much bigger part of the US economy. The effects of depreciations on nonmanufacturing jobs are stronger in cities that have a higher percentage of manufacturing employment. This is consistent with the hypothesis that the exchange rate movements affect the nonmanufacturing industries indirectly: They have a direct effect on the manufacturing sector (a proxy for the tradable sector), before spilling over to the broader economy through the local demand channel. A larger manufacturing sector means a greater direct effect, which in turn means a greater indirect effect in the local area. As a robustness test, we expand our definition of tradable sector to include five services industries, the results are similar; exchange rates affect employment in both tradable and nontradable industries.

Our analysis also indicates that while depreciations in export exchange rates are associated with rises in employment, the effects of depreciations in import exchange rates often have insignificant or negative effects. The weaker employment effects of the import-weighted exchange rate may arise from the low degree of pass-through of import exchange rates into domestic prices in the US, or from the rising cost of imported inputs.

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Table 1: Means and standard deviations of selected variables for 82 four-digit NAICS manufacturing industries and the tradable service industries

industries variables	manu Δ imp ER	manu Δ exp ER	manu import penetration	manu export orientation	manu Δ empl	service Δ imp ER	service Δ exp ER	service Δ empl
2003	-2.13	-3.09	23.74	14.00	-5.26	-5.42	-5.01	-0.74
Std. Dev.	(2.19)	(2.81)	(19.82)	(11.34)	(3.61)	-	-	-
2004	-2.79	-2.64	25.79	14.87	-2.06	-4.04	-3.82	0.86
Std. Dev.	(1.00)	(1.59)	(20.76)	(12.31)	(3.56)	-	-	-
2005	0.60	1.26	26.58	15.22	-1.34	2.75	2.32	2.29
Std. Dev.	(1.05)	(1.60)	(21.32)	(12.28)	(4.02)	-	-	-
2006	-1.54	-1.05	27.69	16.49	-1.52	0.05	0.05	2.46
Std. Dev.	(0.92)	(1.55)	(22.15)	(13.76)	(3.66)	-	-	-
2007	-2.54	-3.43			-2.58	-3.54	-3.27	2.57
Std. Dev.	(0.82)	(1.26)			(4.30)	-	-	-
2008	1.54	-0.49			-3.82	1.37	1.10	0.17
Std. Dev.	(1.26)	(1.81)			(4.58)	-	-	-
2009	0.22	-2.02			-12.37	-.14	-0.59	-4.70
Std. Dev.	(0.92)	(2.38)			(6.79)	-	-	-
2010	-1.75	-0.43			-3.18	1.33	0.59	-1.37
Std. Dev.	(1.28)	(1.85)			(3.46)	-	-	-

Notes: [1] The abbreviation “manu”, “Δ imp ER”, “Δ exp ER”, and “Δ empl” stand for manufacturing, percentage change in import real exchange rate, percentage change in export real exchange rate, and percentage change in employment, respectively. [2] The term “service” in the top row refers to the group of five tradable service industries (two-digit NAICS codes in parenthesis): transportation (48); information (51); finance and insurance (52); professional, scientific, and technical services (54); and management of companies and enterprises (55).

Table 2: Means and standard deviations of selected variables for 319 MSAs

industries variables	manu Δ imp ER	manu Δ exp ER	manu Δ empl	manu empl share	service Δ imp ER	service Δ exp ER	service Δ empl	service empl share	nontradable Δ empl	nontradable empl share
2003	-3.31	-2.54	-4.32	13.08	-5.42	-5.01	3.15	9.41	0.72	77.60
Std. Dev.	(1.42)	(1.16)	(4.98)	(7.24)	-	-	(20.36)	(4.12)	(2.66)	(7.38)
2004	-2.82	-3.03	-1.21	12.65	-4.04	-3.82	4.79	9.59	1.50	77.79
Std. Dev.	(0.79)	(0.49)	(4.22)	(7.06)	-	-	(20.16)	(4.08)	(3.13)	(7.13)
2005	1.22	0.63	-0.39	12.45	2.75	2.32	2.49	9.61	2.00	78.00
Std. Dev.	(0.97)	(0.57)	(4.68)	(6.94)	-	-	(15.46)	(4.09)	(2.55)	(7.03)
2006	-1.20	-1.65	-0.24	12.30	0.05	0.05	5.95	9.70	1.89	78.02
Std. Dev.	(0.83)	(0.56)	(4.86)	(6.82)	-	-	(42.43)	(4.10)	(2.64)	(6.88)
2007	-3.49	-2.58	-2.03	11.95	-3.54	-3.27	2.78	9.75	1.39	78.33
Std. Dev.	(0.77)	(0.46)	(5.09)	(6.61)	-	-	(16.76)	(4.11)	(2.26)	(6.70)
2008	-0.23	1.93	-3.39	11.65	1.37	1.10	1.02	9.81	-0.14	78.55
Std. Dev.	(0.92)	(0.74)	(4.88)	(6.39)	-	-	(14.60)	(4.06)	(2.15)	(6.55)
2009	-1.60	0.35	-13.58	10.79	-.14	-0.59	-4.71	9.70	-3.59	79.54
Std. Dev.	(1.17)	(0.55)	(7.24)	(5.91)	-	-	(14.35)	(4.12)	(2.69)	(6.28)
2010	-0.49	-1.83	-2.96	10.60	1.33	0.59	3.23	9.72	-0.37	79.66
Std. Dev.	(1.13)	(0.73)	(4.25)	(5.92)	-	-	(45.81)	(4.09)	(2.28)	(6.27)

Notes: [1] The abbreviation "manu", "Δ imp ER", "Δ exp ER", and "Δ empl" stand for manufacturing, percentage change in import real exchange rate, percentage change in export real exchange rate, percentage change in employment, and the share in total employment, respectively. [2] The term "service" in the top row refers to the group of five tradable service industries (two-digit NAICS codes in parenthesis): transportation (48); information (51); finance and insurance (52); professional, scientific, and technical services (54); and management of companies and enterprises (55). [3] The term "nontradable" refer to all industries are that neither manufacturing nor the five tradable service industries.

Table 3: Dependent variable: Δ total employment in manufacturing industries

Variables	(1)	(2)	(3)	(4)
Δ avg ER	-.41			
	(0.41)			
Δ avg ER × exp orientation	-.03			
	(0.02)			
Δ avg ER × imp penetration	0.02			
	(0.01)*			
Δ avg ER × share of imp inputs	-.01			
	(0.05)			
Δ exp ER		-.98		-1.22
		(0.34)***		(0.38)***
Δ exp ER × exp orientation		-.02		-.04
		(0.01)		(0.02)**
Δ imp ER			0.15	0.12
			(0.25)	(0.25)
Δ imp ER × imp penetration			0.02	0.02
			(0.01)	(0.01)**
Δ imp ER × share of imp inputs			-.04	0.03
			(0.04)	(0.05)
GDP growth in ROW, exp weighted	-2.00	-2.01	-1.49	-2.07
	(1.18)*	(1.14)*	(1.13)	(1.15)*
1st lag of dependent variable	0.39	0.40	0.40	0.40
	(0.08)***	(0.08)***	(0.08)***	(0.08)***
2nd lag of dependent variable	-.04	-.04	-.04	-.04
	(0.06)	(0.06)	(0.06)	(0.06)
city and year fixed effects	included	included	included	included
Obs.	1372	1372	1372	1372
model χ^2	1509.32	1538.31	1481.03	1542.22
p-value for AR(2) test	0.66	0.57	0.62	0.50

Notes: [1] The abbreviations "imp ER" and "exp ER" refer to import exchange rate and export exchange rate. "avg ER" is the average of import and export exchange rates. [2] All equations are estimated with the Arellano-Bond GMM estimator for dynamic panel regressions (Arellano and Bond, 1991). [3] The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5% and 1% levels, respectively. [4] We demean the independent variables before interacting them; therefore, the coeffcient on the export exchange rate is the marginal effect of the export exchange rate evaluated at the sample mean, and so on. [5] The "model χ^2" is the Wald statistic that measures overall significance of the model. [6] The "p-value for AR(2) test" is the p-value for testing the H0 that the errors are not autocorrelated, a condition under which the Arellano-Bond GMM estimator is consistent.

Table 4: Dependent variable: Δ total employment in nonmanufacturing industries

Variables	(1)	(2)	(3)	(4)
Δ avg ER	-.05			
	(0.1)			
Δ avg ER × lag manu empl share	-.01			
	(0.004)***			
Δ exp ER		-.08		-.09
		(0.1)		(0.1)
Δ exp ER × lag manu empl share		-.009		-.01
		(0.004)**		(0.009)
Δ imp ER			0.003	0.0004
			(0.08)	(0.08)
Δ imp ER × lag manu empl share			-.009	-.001
			(0.006)	(0.01)
lag manu empl share	0.46	0.47	0.44	0.5
	(0.18)**	(0.19)**	(0.19)**	(0.19)***
1st lag of dependent variable	0.41	0.41	0.41	0.41
	(0.13)***	(0.14)***	(0.13)***	(0.14)***
2nd lag of dependent variable	0.003	0.002	0.004	0.004
	(0.03)	(0.03)	(0.04)	(0.04)
city and year fixed effects	included	included	included	included
Obs.	1372	1372	1372	1372
model χ^2	1995.79	1950.09	2021.08	1922.53
p-value for AR(2) test	0.77	0.76	0.68	0.78

Notes: [1] The abbreviations "imp ER" and "exp ER" refer to import exchange rate and export exchange rate. "avg ER" is the average of import and export exchange rates. [2] All equations are estimated with the Arellano-Bond GMM estimator for dynamic panel regressions (Arellano and Bond, 1991). [3] The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5% and 1% levels, respectively. [4] We demean the independent variables before interacting them; therefore, the coeffcient on the export exchange rate is the marginal effect of the export exchange rate evaluated at the sample mean, and so on. [5] The "model χ^2" is the Wald statistic that measures overall significance of the model. [6] The "p-value for AR(2) test" is the p-value for testing the H0 that the errors are not autocorrelated, a condition under which the Arellano-Bond GMM estimator is consistent.

Table 5: Robustness checks: Δ total employment in manufacturing/tradable industries

Variables	+service (1)	no yr FEs (2)	Perm ER (3)	2006-07 (4)	2008-10 (5)
Δ exp ER	-1.12	-.99	-.93	-1.65	-1.17
	(0.49)**	(0.37)***	(0.26)***	(0.62)***	(0.44)***
Δ exp ER $\times$ exp orientation		-.03	-.03	0.007	-.05
		(0.02)	(0.01)**	(0.03)	(0.02)**
Δ imp ER	0.55	0.41	-.10	-.12	0.22
	(0.53)	(0.21)*	(0.19)	(0.52)	(0.28)
Δ imp ER $\times$ imp penetration		0.02	0.02	0.02	0.03
		(0.01)**	(0.01)*	(0.01)	(0.02)
Δ imp ER $\times$ share of imp inputs		0.03	0.02	-.02	0.05
		(0.05)	(0.03)	(0.06)	(0.06)
GDP growth in ROW, exp weighted	-4.78	-1.52	-3.45	-3.33	-1.74
	(2.08)**	(1.12)	(1.20)***	(2.47)	(0.94)*
1st lag of dependent variable	-.02	0.40	0.45	0.24	0.40
	(0.04)	(0.08)***	(0.06)***	(0.15)	(0.09)***
2nd lag of dependent variable	0.06	-.05	-0.10	-.01	-.08
	(0.03)*	(0.06)	(0.05)*	(0.08)	(0.08)
city fixed effects	included	included	included	included	included
year fixed effects	included		included	included	included
Obs.	1356	1372	1147	555	817
model χ^2	400.94	1498.59	1653.05	56.30	1100.24
p-value for AR(2) test	0.43	0.38	0.59	NA	0.40

Notes: [1] The abbreviations "imp ER" and "exp ER" refer to import exchange rate and export exchange rate. "avg ER" is the average of import and export exchange rates. [2] All equations are estimated with the Arellano-Bond GMM estimator for dynamic panel regressions (Arellano and Bond, 1991). [3] The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5% and 1% levels, respectively. [4] We demean the independent variables before interacting them; therefore, the coeffcient on the export exchange rate is the marginal effect of the export exchange rate evaluated at the sample mean, and so on. [5] The "model χ^2" is the Wald statistic that measures overall significance of the model. [6] The "p-value for AR(2) test" is the p-value for testing the H0 that the errors are not autocorrelated, a condition under which the Arellano-Bond GMM estimator is consistent.

Table 6: Robustness checks: Δ total employment in nonmanufacturing/nontradable industries

	+service	+service	no yr FEs	Perm ER	2006-07	2008-10
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Δ avg ER	-.06		-.08	0.03	-.07	-.13
	(0.21)		(0.11)	(0.09)	(0.13)	(0.04)***
Δ avg ER × lag tradable empl share	-.005		-.01	-.004	-.02	-.01
	(0.005)		(0.004)***	(0.003)	(0.006)***	(0.004)***
Δ exp ER		0.03				
		(0.19)				
Δ exp ER × lag tradable empl share		-.04				
		(0.01)***				
Δ imp ER		-.25				
		(0.19)				
Δ imp ER × lag tradable empl share		0.02				
		(0.02)				
lag tradable empl share		0.38	0.46	0.56	0.98	0.88
		(0.18)**	(0.18)**	(0.21)***	(0.27)***	(0.18)***
1st lag of dependent variable	0.07	0.19	0.40	0.68	0.03	0.54
	(0.05)	(0.06)***	(0.13)***	(0.04)***	(0.19)	(0.18)***
2nd lag of dependent variable	-.04	0.06	-0.003	-.04	-.17	0.02
	(0.03)	(0.04)	(0.03)	(0.05)	(0.08)**	(0.05)
city fixed effects	included	included	included	included	included	included
year fixed effects	included	included		included	included	included
Obs.	1356	1356	1372	1147	555	1372
model χ^2	1508.39	859.87	1951.68	2791.93	84.48	1462.22
p-value for AR(2) test	0.17	0.46	0.78	0.63	NA	0.94

Notes: [1] The abbreviations "imp ER" and "exp ER" refer to import exchange rate and export exchange rate. "avg ER" is the average of import and export exchange rates. [2] All equations are estimated with the Arellano-Bond GMM estimator for dynamic panel regressions (Arellano and Bond, 1991). [3] The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5% and 1% levels, respectively. [4] We demean the independent variables before interacting them; therefore, the coeffcient on the export exchange rate is the marginal effect of the export exchange rate evaluated at the sample mean, and so on. [5] The "model χ^2" is the Wald statistic that measures overall significance of the model. [6] The "p-value for AR(2) test" is the p-value for testing the H0 that the errors are not autocorrelated, a condition under which the Arellano-Bond GMM estimator is consistent. [7] In columns (1) and (2), "lag tradable empl share" is to the lagged share of manufacturing industries and the five tradable service industries combined in local employment. In the other columns, it refers to the share of manufacturing industries in local employment.

Table 7: Dependent variable: Δ employment in 82 four-digit NAICS manufacturing industries

Variables	(1)	(2)	(3)
Δ avg ER	-.38	-.38	-.32
	(0.14)***	(0.14)***	(0.17)*
Δ avg ER $\times$ lag exp orientation	0.008	0.01	0.008
	(0.007)	(0.007)*	(0.007)
Δ avg ER $\times$ lag imp input share	-.01	-.0007	-.01
	(0.02)	(0.02)	(0.02)
Δ avg ER $\times$ lag imp penetration		-.006	
		(0.004)	
foreign GDP growth, exp weighted	-.58	-.58	-.70
	(0.47)	(0.47)	(0.81)
US GDP growth	1.80	1.81	
	(0.61)***	(0.61)***	
10-year real interest rate	-1.13	-1.11	
	(0.56)**	(0.55)**	
Δ real oil price	0.03	0.03	
	(0.04)	(0.04)	
linear time trend	0.52	0.51	
	(0.16)***	(0.15)***	
lag employment growth	0.38	0.37	0.39
	(0.05)***	(0.05)***	(0.07)***
industry fixed effects	included	included	included
year fixed effects			included
Obs.	574	574	574
model χ^2	404.74	395.67	490.74
p-value for AR(2) test	0.48	0.46	0.40

Notes: [1] The abbreviations "imp ER" and "exp ER" refer to import exchange rate and export exchange rate. "avg ER" is the average of import and export exchange rates. [2] All equations are estimated with the Arellano-Bond GMM estimator for dynamic panel regressions (Arellano and Bond, 1991). [3] The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5% and 1% levels, respectively. [4] We demean the independent variables before interacting them; therefore, the coeffcient on the export exchange rate is the marginal effect of the export exchange rate evaluated at the sample mean, and so on. [5] The "model χ^2" is the Wald statistic that measures overall significance of the model. [6] The "p-value for AR(2) test" is the p-value for testing the H0 that the errors are not autocorrelated, a condition under which the Arellano-Bond GMM estimator is consistent.

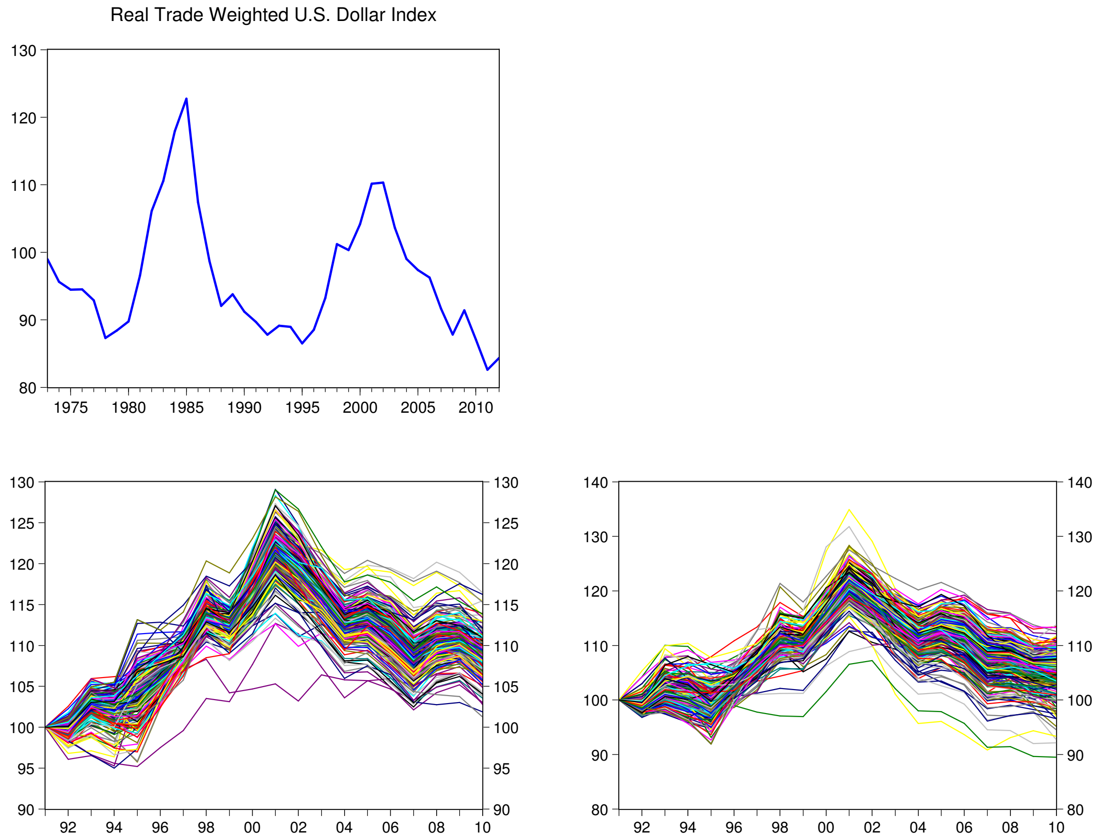

Figure 1: National and city-specific exchange rates

Notes: [1] The top panel: the real trade weighted U.S. dollar index (source: Federal Reserve Bank of St. Louis). [2] The bottom-left panel: each line corresponds to the real export exchange rate index for a city. [3] The bottom-right panel: each line corresponds to the real import exchange rate index for a city.

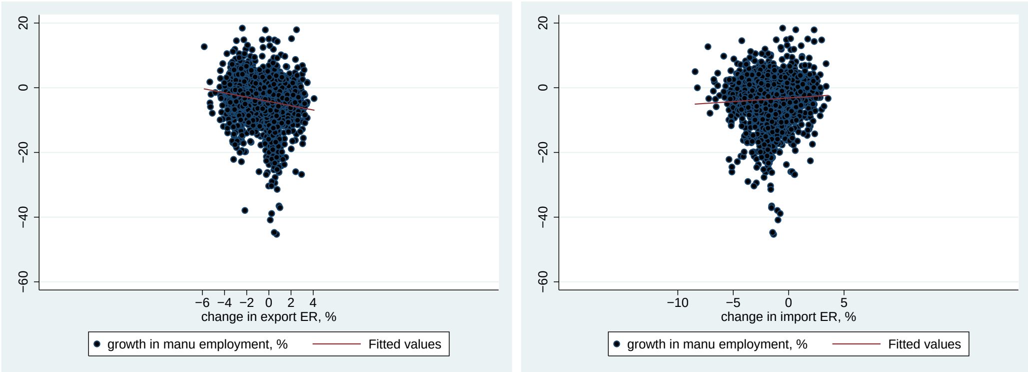

Figure 2: Manufacturing employment and city-specific exchange rates

Notes: [1] Left panel: the growth rate of manufacturing employment vs. changes in export exchange rate. Each dot is a city-year observation. The regression line in the top panel is the following bivariate regression: $\Delta L^T = -4.22 - 0.66 \cdot \Delta exp\ ER$, with $t = -9.17$ on export exchange rates, and $R^2 = 0.04$.

[2] Right panel: the growth rate of manufacturing employment vs. changes in import exchange rate. Each dot is a city-year observation. The regression line in the top panel is the following bivariate regression: $\Delta L^T = -3.15 + 0.22 \cdot \Delta imp\ ER$, with $t = 3.09$ on import exchange rates, and $R^2 = 0.004$.

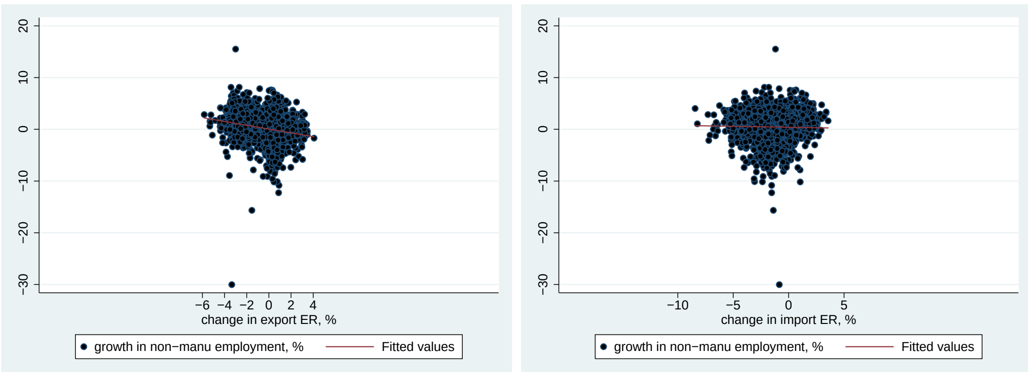

Figure 3: Nonmanufacturing employment and city-specific exchange rates

Notes: [1] Left panel: the growth rates of nonmanufacturing employment vs. changes in export exchange rate. Each dot is a city-year observation. The regression line in the top panel is the following bivariate regression: $\Delta L^N = 0.05 - 0.37 \cdot \Delta exp\ ER$, with $t = -12.61$ on export exchange rates, and $R^2 = 0.06$.

[2] Right panel: the growth rates of nonmanufacturing employment vs. changes in import exchange rate. Each dot is a city-year observation. The regression line in the top panel is the following bivariate regression: $\Delta L^N = 0.40 - 0.04 \cdot \Delta imp\ ER$, with $t = -1.21$ on import exchange rates, and $R^2 = 0.0006$.

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