Appendix to "How Did Exchange Rates Affect Employment in US Cities?"

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In this appendix, 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.

1 Industry-Specific Exchange Rate for Manufacturing Industries

Let $e^x_{i,t}$ 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

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

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

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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.[1]

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 that 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.

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

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

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.

[1] 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.

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 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

$$\alpha_{i,t} = \frac{\sum_{j=1}^{n-1} m_{j,t} p_{j,t} q_{j,t}^i}{VP_{i,t}}, \tag{2}$$

where $m_{j,t}$ is the import penetration ratio for industry j, $p_{j,t}q_{j,t}^i$ is the value of input materials produced by industry j that are used by industry i, and $VP_{i,t}$ is the total production cost of industry i. We assume that the m_jt share of the input purchased by industry i from industry j is imported, and hence, the numerator $\sum_{j=1}^{n-1} m_{j,t} p_{j,t} q_{j,t}^i$ 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 (2) as

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

The term $\frac{p_{j,t} q_{j,t}^i}{VP_{i,t}}$ 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

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

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

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:

$$\frac{y^*_{i,t} - y^*_{i,t-1}}{y^*_{i,t-1}} = \sum_j \underbrace{\frac{1}{5} \cdot \sum_{k=1}^{5} \frac{export_{i,j,t-k}}{export_{i,t-k}}}_{trade\ weight} \cdot \frac{y^*_{j,t} - y^*_{j,t-1}}{y^*_{j,t-1}}, \tag{3}$$

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

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