Online Data and Theory Appendix
The China Syndrome: Local Labor Market Effects of Import Competition in the United States

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I. Online Data Appendix

A. *Matching trade data to industries*

Data on international trade for 1991 to 2007 are from the UN Comrade Database,[1] which gives bilateral imports for six-digit HS products. To concord these data to four-digit SIC industries, we proceed as follows. First, we take the crosswalk in Pierce and Schott (2009), which assigns 10-digit HS products to four-digit SIC industries (at which level each HS product maps into a single SIC industry) and aggregate up to the level of six-digit HS products and four-digit SIC industries (at which level some HS products map into multiple SIC industries). To perform the aggregation, we use data on US import values at the 10-digit HS level, averaged over 1995 to 2005. The crosswalk assigns HS codes to all but a small number of SIC industries. We therefore slightly aggregate the 4-digit SIC industries so that each of the resulting 397 manufacturing industries matches to at least one trade code, and none is immune to trade competition by construction. Details on our industry classification are available on request.

Second, we combine the crosswalk with six-digit HS Comrade data on imports for the United States (for which Comrade has six-digit HS trade data from 1991 to 2007) and for all other high-income countries that have data covering the sample period (Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland) and then aggregate up to four-digit SIC industries. For each importing region (the United States and the eight other high-income countries), we aggregate imports across four export country groups: China; other low-income countries; Mexico, Central America, and the Dominican Republic (which are the neighboring countries with which the United States has free trade agreements); and the rest of the World. All import amounts are inflated to 2007 US$ using the Personal Consumption Expenditure deflator.

Low-income countries are defined according to the World Bank definition in 1989. They are: Afghanistan, Albania, Angola, Armenia, Azerbaijan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Burma, Cambodia, Central African Republic, Chad, China, Comoros, Republic of the Congo, Equatorial Guinea, Eritrea, Ethiopia, The Gambia, Georgia, Ghana, Guinea, Guinea-Bissau, Guyana, Haiti, India, Kenya, Laos, Lesotho, Madagascar, Maldives, Mali, Malawi, Mauritania, Moldova, Mozambique, Nepal, Niger, Pakistan, Rwanda, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Sierra Leone, Somalia, Sri Lanka, Sudan, Togo, Uganda, Vietnam, and Yemen.

B. *Measuring the industry structure of local labor markets*

We derive the potential exposure of Commuting Zones (CZs) to import competition from detailed information on local industry employment structure in the

[1] *http://comtrade.un.org/db/default.aspx*

years 1980, 1990 and 2000, which is taken from the County Business Patterns (CBP) data. CBP is an annual data series that provides information on employment, firm size distribution, and payroll by county and industry. It covers all U.S. employment except self-employed individuals, employees of private households, railroad employees, agricultural production employees, and most government employees. CBP data is extracted from the Business Register, a file of all known U.S. companies that is maintained by the U.S. Census Bureau, and is available for download at *http://www.census.gov/econ/cbp/index.html*.

The CBP does not disclose information on individual employers, and information on employment by county and industry is hence sometimes reported as an interval instead of an exact count. Moreover, some establishments are not identified at the most disaggregate level of the industry classification. The 1980 and 1990 data however always reports the exact number of firms in each of 13 establishment size classes for each county-industry cell. We impute employment by county by 4-digit SIC code using the following procedure: (i) Narrowing the range of possible employment values in cells with bracketed employment counts using the minimum and maximum employment values that are consistent with a cell's firm size distribution, and with the employment count of the corresponding aggregate industry. (ii) Constructing a sample with all non-empty county-level 4-digit industry cells, and regress the employment in these cells on the number of firms in each of the 13 establishment size classes. The starting value of employment for cells with bracketed employment counts is the midpoint of the bracket. The coefficients of the regression yield an estimate for the typical firm size within each firm size bracket. We replace employment counts in cells with bracketed values with the predicted values from the regression, and repeat the estimation and imputation until the coefficients of the establishment size variables converge. (iii) Using the establishment size information in 4-digit and corresponding 3-digit industries, and the coefficients from the preceding regression analysis to compute the employment in firms that are identified only by a 3-digit industry code in the data, and repeating the same step for higher levels of industry aggregation. (iv) If necessary, proportionally adjusting estimated employment in 4-digit industries and in firms that lack a 4-digit code so that they sum up to the employment of the corresponding 3-digit code. Repeat this step for higher levels of industry aggregation. (v) Assign employment of firms that are only identified at the 2-digit industry level to 3-digit industries, proportional to observed 3-digit industry employment in the respective county. Repeat this step for assigning 3-digit employment to 4-digit industries.

The CBP 2000 reports employment by county and industry for 6-digit NAICS codes and the distribution of firm sizes over 9 establishment size classes. We impute suppressed employment counts using the same procedure as outlined for the CBP 1980 and 1990 above. In order to map NAICS to SIC codes, we construct a weighted crosswalk based on the Census "bridge" file (available for download at *http://www.census.gov/epcd/ec97brdg/*). This file reports the number of employees and firms in the 1997 Economic Census for each existing overlap between NAICS and SIC industry codes. Employment counts are reported in brackets for some 6-digit NAICS—4-digit SIC cells while exact firm counts are always available. We impute employment in these cells by multiplying the number of firms in the cell by the average firm size in the corresponding NAICS industry that we observe in the CBP 2000. If necessary, imputed employment counts are proportionally adjusted so that estimated employment in 6-digit NAICS industries correctly sums up to employment in associated 5-digit industries. The resulting weighted crosswalk reports which fraction of a 6-digit NAICS code matches to a given 4-digit SIC code. We use this crosswalk to map the information on employment by county by NAICS industry from the CBP 2000 to the corresponding SIC industries. Finally, we aggregate employment by county to the level of Commuting Zones.

C. *Measuring labor supply and earnings*

Our measures for labor supply, wages, household income, and population are based on data from the Census Integrated Public Use Micro Samples (Ruggles et al. 2004) for the years 1970, 1980, 1990 and 2000, and the American Community Survey (ACS) for 2006 through 2008. The 1980, 1990 and 2000 Census samples include 5 percent of the U.S. population, while the pooled ACS and 1970 Census samples include 3 and 1 percent of the population respectively. We map these data to CZs using the matching strategy that is described in detail in Dorn (2009) and that has previously been applied by Autor and Dorn (2009, 2011) and Smith (2010).

Our sample of workers consists of individuals who were between age 16 and 64 and who were working in the year preceding the survey. Residents of institutional group quarters such as prisons and psychiatric institutions are dropped along with unpaid family workers. Labor supply is measured by the product of weeks worked times usual number of hours per week. For individuals with missing hours or weeks, labor supply weights are imputed using the mean of workers in the same education-occupation cell, or, if the education-occupation cell is empty, the mean of workers in the same education cell. All calculations are weighted by the Census sampling weight multiplied with the labor supply weight.

The computation of wages excludes self-employed workers and individuals with missing wages, weeks or hours. Hourly wages are computed as yearly wage and salary income divided by the product of weeks worked and usual weekly hours. Top-coded yearly wages are multiplied by a factor of 1.5 and hourly wages are set not to exceed this value divided by 50 weeks times 35 hours. Hourly wages below the first percentile of the national hourly wage distribution are set to the value of the first percentile. Wages are inflated to the year 2007 using the Personal Consumption Expenditure Index.

D. Measuring government transfers

Our primary source for data on transfers are the Regional Economic Accounts (REA) of the Bureau of Economic Analysis.[2] The REA data includes information on total receipts of transfers by individuals from governments at the county level. It also hierarchically disaggregates these transfers into different categories and subcategories of transfer payments. The largest transfer categories are medical benefits, retirement and disability benefits, and income maintenance benefits which together account for 93% of the national transfer sum in 2007.

The REA data provides the exact amount of annual transfers by county and transfer type unless the transfer sum is very small (i.e., positive amounts of transfers that are below 50,000 dollars in a given county and year). If county lacks precise transfer amounts in some transfer categories, we distribute its total transfer receipts over these transfer categories in proportion to their relative share of total transfers in the corresponding state. All transfer amounts are inflated to 2007 US$ using the Personal Consumption Expenditure deflator.

Our secondary source for transfer data is the Social Security Administration's *Annual Statistical Supplements* (various years), from which we obtained data on social security payments by county. This data source disaggregates Social Security payments into retirement and disability benefits, and it also reports the number of beneficiaries by county.

II. Online Theory Appendix

A. Small Open Economy Model

In this appendix, we develop a general equilibrium model that considers how increased import competition from China affects employment and wages in a U.S. commuting zone, which we treat as a small open economy. Productivity growth in China and global reductions in trade barriers facing China cause the country's exports to expand. As a commuting zone faces greater competition from China in the U.S. market and in other markets in which its firms sell goods, demand for CZ output contracts, causing CZ wages to fall. As long as the CZ is running a current-account deficit, there is a resulting shift in employment out of traded goods and into non-traded goods. Initially, we ignore the impact of changes in China on wages and income levels outside of a CZ, focusing on the *direct effects* of rising productivity/falling trade costs in China on a commuting zone, which operate through making the CZ's goods less competitive in its export markets. Below, we consider a two-economy model (e.g., for the U.S. and China), in which the same qualitative results obtain. Hsieh and Ossa (2012) model the effects of productivity growth in China in full global general equilibrium.

The total supply of labor in CZ i is L_i, where labor may be employed in traded goods or in non-traded goods. We assume that there is no migration between

[2]Available for download at *http://www.bea.gov/regional/index.htm.*

commuting zones (making the model short to medium run in nature). Allowing CZ labor supply to be an elastic function of the wage is a simple extension of the model. Demand for goods is given by a Cobb-Douglas utility function, with share γ of expenditure going to traded goods and share $1-\gamma$ going to non-traded goods. There is a single non-traded good which is manufactured with the production function,

$$X_{Ni} = L_{Ni}^{\eta}, \tag{1}$$

where L_{Ni} is labor employed in non-traded goods and the coefficient $\eta \in (0,1)$ indicates there is diminishing marginal returns to labor in production (due, e.g., to short-run constraints on expanding production capacity). Profit maximization in the non-traded good implies that

$$W_i = \eta P_{Ni} L_{Ni}^{\eta-1}, \tag{2}$$

where W_i is the wage and P_{Ni} is the price of the non-traded good in commuting zone i. Because of diminishing returns in non-traded production, any shock that expands employment in the sector will tend to push down wages in the commuting zone. (Alternatively, we could consider (1) as an implicit function for the production of leisure and (2) as arising from utility maximization, requiring that wages equal the marginal utility of leisure.)

Market clearing for the non-traded good requires that,

$$P_{Ni} X_{Ni} = (1-\gamma)\left(W_i L_i + B_i\right), \tag{3}$$

where B_i is the difference between expenditure and income in commuting zone i (i.e., $B_i > 0$ implies that CZ i is running a current-account deficit).[3] We treat the trade imbalance as given (due to US macroeconomic conditions) and investigate how its magnitude affects CZ labor-market adjustment. With balanced trade for a commuting zone, a positive shock to productivity in one of China's export sectors generates changes in the CZ wage and non-traded good price that re-equilibrate imports and exports. These adjustments keep total CZ employment in the traded sector from declining (although employment shifts out of the traded sector with positive Chinese productivity growth and into other traded sectors). With imbalanced trade a positive shock to Chinese export productivity reduces employment in CZ traded goods and increases employment in non-traded goods.[4]

Traded goods are produced by firms in a monopolistically competitive sector (Helpman and Krugman, 1985).[5] There are two traded-good sectors, indexed by

[3]Implicitly, China's non-traded good is the numeraire.

[4]The invariance of non-traded employment to trade shocks under balanced trade is due to the assumption of Cobb-Douglas preferences (similar results hold in a two-country model, meaning that the small-country assumption is not driving this outcome).

[5]Our results generalize to other settings that have a "gravity" structure, as in Arkolakis, Costinot, and Rodriquez-Clare (2011).

j, where consumers devote a share of spending $\gamma/2$ on each. It is straightforward to extend the model to multiple traded-good sectors (as in Hanson and Xiang, 2005); doing so does not change the qualitative results. Each of the M_{ij} firms in sector j is the unique producer of a differentiated product variety. The labor used to produce any individual variety in sector j is given by,

$$l_{ij} = \alpha_{ij} + \beta_{ij} x_{ij}, \tag{4}$$

where for sector j α_{ij} is the fixed labor required to produce positive output, β_{ij} is the labor required to produce an extra unit of output, and x_{ij} is the quantity of the variety produced. α_{ij} and β_{ij} (which are identical across firms within CZ i) reflect sectoral productivity in a commuting zone and therefore determine comparative advantage. For each traded sector j, demand for product varieties is derived from a CES sub-utility function, such that total demand for output of an individual variety, x_{ij}, is the sum over demand in each destination market k, x_{ijk}, given by,

$$x_{ij} = \sum_k x_{ijk} = \sum_k \frac{P_{ijk}^{-\sigma_j}}{\Phi_{jk}^{1-\sigma_j}} \frac{\gamma E_k}{2}, \tag{5}$$

where P_{ijk} is the delivered price in market k of a variety in sector j produced in commuting zone i, E_k is total expenditure in market k, and the term $\Phi_{jk}^{1-\sigma}$, which is a function of the price index, Φ_{jk}, for traded goods in sector j and market k, captures the intensity of competition in a particular market. The parameter $\sigma_j > 1$ is the elasticity of substitution between any pair of varieties in j. Under monopolistic competition, the price of each variety is a constant markup over marginal cost,

$$P_{ijk} = \frac{\sigma_j}{\sigma_j - 1} \beta_{ij} W_i \tau_{ijk} \tag{6}$$

where $\tau_{ijk} \geq 1$ is the iceberg transport cost of delivering one unit of a good in sector j from commuting zone i to market k. We assume that free entry in each sector drives profits to zero, implying that the level of output of each variety is $x_{ij} = \alpha_{ij}(\sigma_j - 1)/\beta_{ij}$ (adjustment in sectoral output and employment occurs at the extensive margin, through changes in the sector number of varieties/firms, M_{ij}). The final equilibrium condition is that labor supply equals labor demand:

$$L_i = L_{Ni} + L_{Ti}, \tag{7}$$

where $L_{Ti} = \sum_j M_{ij} l_{ij}$ is total employment in traded goods.

The sectoral price index plays an important role in the analysis for it is the channel through which competition from China affects a CZ. For each sector j, this index is given by,

(8)
$$\Phi_{jk} = \left[\sum_h M_{hj} P_{hjk}^{1-\sigma_j}\right]^{\frac{1}{1-\sigma_j}},$$

where M_{hj} is the number of varieties produced by region h and P_{hjk} is the price of goods from region h sold in market k. Log differentiating (8), and defining $\hat{x} \equiv \Delta \ln x = \Delta x/x$, we obtain for each sector j,

(9)
$$\hat{\Phi}_{jk} = -\frac{1}{\sigma_j - 1} \sum_h \phi_{hjk} \hat{A}_{hjk},$$

where $\phi_{hjk} \equiv M_{jh} P_{hjk} x_{hjk} / \sum_l M_{lj} P_{ljk} x_{ljk}$ is the share of region h in purchases of sector j goods by market k and $\hat{A}_{hjk} \equiv \hat{M}_{hj} - (\sigma_j - 1)\left(\hat{W}_h + \hat{\beta}_{hj} + \hat{\tau}_{hjk}\right)$ is the log change in the "export capability" of region h in market k, determined by changes in the number of varieties region h produces ($\hat{M}_{hj}$), its wages ($\hat{W}_h$), its labor productivity ($\hat{\beta}_{hj}$), and its trade costs ($\hat{\tau}_{hjk}$). The price index for sector j goods in market k declines if China has an increase in the number of varieties that it produces, a reduction in its marginal production costs, an increase in its factor productivity, or a reduction in its trade barriers (each of which causes $\hat{A}_{Cjk}$ to rise, where C indexes China).

To solve the model, we plug (1) into (3), and (for each j) (4) and (6) into (5), which produces a system of five equations in five unknowns, W_i, P_{Ni}, L_{Ni}, and M_{ij} for $j = 1, 2$.[6] After performing these substitutions and log differentiating the five equations, we end up with the following system:

$$\hat{W}_i = \hat{P}_{Ni} - (1-\eta)\hat{L}_{Ni},$$

$$\eta \hat{L}_{Ni} = \rho_i \left(\hat{W}_i + \hat{L}_i\right) + (1-\rho_i)\hat{B}_i - \hat{P}_{Ni},$$

$$\hat{L}_i = \left(1 - \sum_j \delta_{ij}\right)\hat{L}_{Ni} + \sum_j \delta_{ij}\hat{M}_{ij},$$

(10)
$$\sigma \hat{W}_i = \sum_k \theta_{ijk}\left[\hat{E}_k + (\sigma_j - 1)\hat{\Phi}_{jk}\right] = \sum_k \theta_{ijk}\hat{E}_k - \sum_k \theta_{ijk} \sum_h \phi_{hjk}\hat{A}_{hjk},\ j = 1, 2$$

where for commuting zone i $\rho_i \equiv W_i L_i / (W_i L_i + B_i)$ is the initial share of labor income in total expenditure, $\delta_{ij} \equiv M_{ij} l_{ij} / L_i$ is the initial share of traded sector j in total employment, and $\theta_{ijk} \equiv x_{ijk} / \sum_l x_{ijl}$ is the initial share of market k in the total shipments of sector j goods. Because the output of each variety is fixed, labor used in each variety, l_{ij}, is fixed; all adjustment in sectoral employment

[6]For simplicity, we exclude the equation for adjustment in imported varieties. Because of the small-country assumption, changes in imports are determined by the outcomes of other equations in the system and do not affect other variables.

occurs through changes in the number of firms, M_{ij}, as seen in the third line of (10).

By assumption, for commuting zone i the only changes in the $\hat{E}_k$ terms in (10) occur in China, where we treat $\hat{E}_C = \rho_C \hat{W}_C + (1-\rho_C)\hat{B}_C$ as exogenous, and in CZ i itself, where $\hat{E}_i = \rho_i \hat{W}_i + (1-\rho_i)\hat{B}_i$ and we treat $\hat{W}_i$ as endogenous and $\hat{B}_i$ as exogenous. As a trade shock causes wages in a commuting zone to change, the CZ's demand for its own goods will change, which will in turn generate further adjustments in wages. Relatedly, for commuting zone i the only changes in the $\hat{A}_{hjk}$ terms in (10) are for China, where for each sector j we treat $\hat{A}_{Cj} = \hat{M}_{Cj} - (\sigma_j - 1)\left(\hat{W}_C + \hat{\beta}_{Cj} + \hat{\tau}_{Cj}\right)$ as exogenous, and in CZ i itself, where for each sector j, $\hat{A}_{ij} = \hat{M}_{ij} - (\sigma_j - 1)\hat{W}_i$ and we treat $\hat{M}_{ij}$ as endogenous, in addition to $\hat{W}_{ij}$. As a China trade shock causes a CZ's wage and number of firms to change, price indexes in the markets that the CZ serves will change, generating further adjustments in its wages and number of firms.[7]

Imposing the zero migration assumption that $\hat{L}_i = 0$ and rearranging the first two expressions in (10), we obtain the following representation of the system of equations in (10):

$$\begin{aligned}
\hat{P}_{Ni} &= \hat{W}_i + (1-\eta)\hat{L}_{Ni}, \\
\hat{L}_{Ni} &= (1-\rho_i)\left(\hat{B}_i - \hat{W}_i\right), \\
\hat{L}_{Ni} &= -\tilde{\delta}_{i1}\hat{M}_{i1} - \tilde{\delta}_{i2}\hat{M}_{i2}, \\
\hat{W}_i &= a_{i1}\hat{\Gamma}_{i1} + b_{i1}\hat{B}_i - c_{i1}\hat{M}_{i1}, \\
\hat{W}_i &= a_{i2}\hat{\Gamma}_{i2} + b_{i2}\hat{B}_i - c_{i2}\hat{M}_{i2},
\end{aligned} \tag{11}$$

where for sector $j = 1,2$ we employ the following notational definitions: $\tilde{\delta}_{ij} \equiv \delta_{ij}/\left(1-\sum_n \delta_{in}\right)$ is the initial ratio of employment in traded sector j to employment in non-traded goods, the quantity $\hat{\Gamma}_{ij} \equiv \theta_{ijC}\left[\rho_C \hat{W}_C + (1-\rho_C)\hat{B}_C\right] - \sum_k \theta_{ijk}\phi_{Cjk}\hat{A}_{Cj}$ is the China trade shock facing CZ i in industry j, and a_{ij}, b_{ij}, and c_{ij} are each positive constants that are functions of the model parameters or initial sectoral employment or expenditure shares ($a_{ij} \equiv [\sigma_j (1-\sum_k \theta_{ijk}\phi_{ijk}) + \sum_k \theta_{ijk}\phi_{ijk} - \theta_{iji}\rho_i]^{-1}$, $b_{ij} \equiv a_{ij}\theta_{iji}(1-\rho_i)$, and $c_{ij} \equiv a_{ij}\sum_k \theta_{ijk}\phi_{ijk}$). In the first two lines of (11), we see that wage shocks affect non-traded employment and non-traded prices only if trade is imbalanced ($\rho_i \neq 1$). This outcome depends on the first two equations in (10), which applies to the model even if we allow the country to be large enough to affect world prices, as is done below.

For CZ i, the China trade shock in sector j ($\hat{\Gamma}_{ij}$) is the difference between in-

[7]For notational simplicity, we assume that changes in China's trade costs are common across its destination markets–due, e.g., to its accession to the WTO–and that CZ i has no changes in its productivity or trade costs.

creased demand by China for the CZ's exports, given by $\theta_{ijC}\left[\rho_C \hat{W}_C + (1-\rho_C)\,\hat{B}_C\right]$, and increased import competition from China in the markets in which the CZ sells goods, given by $\sum_k \theta_{ijk}\phi_{Cjk}\hat{A}_{Cj}$. Growth in China's demand for CZ i's exports will be smaller the smaller is the share of CZ output that is destined for China (θ_{ijC}) and the more wage growth in China ($\hat{W}_C > 0$) is offset by growth in China's current-account surplus ($\hat{B}_C < 0$). Import competition from China will be more intense the larger is the increase in China's export capabilities ($\hat{A}_{Cj}$) and the larger is China as a source of supply for the markets that CZ i serves (captured by the term, $\sum_k \theta_{ijk}\phi_{Cjk}$).

Solving the system in (11), we obtain changes in the endogenous CZ variables $(\hat{W}_{Ni}, \hat{L}_{Ti}, \hat{L}_{Ni}, \hat{P}_{Ni})$ as functions of model parameters and the exogenous shocks $(\hat{\Gamma}_{i1}, \hat{\Gamma}_{i2}, \hat{B}_i)$, where we show results for the change in total employment in traded goods (rather that for individual traded sectors), given by $\hat{L}_{Ti} = \sum_j \tilde{\tilde{\delta}}_{ij}\hat{M}_{ij}$, where $\tilde{\tilde{\delta}}_{ij} \equiv \delta_{ij}/\sum_l \delta_{il}$ is the share of sector j in total traded-good employment for CZ i. The solutions for the endogenous variables are:

$$\hat{W}_i = \frac{1}{g_i}\left[a_{i1}c_{i2}\tilde{\delta}_{i1}\hat{\Gamma}_{i1} + a_{i2}c_{i1}\tilde{\delta}_{i2}\hat{\Gamma}_{i2} + \left(b_{i1}c_{i2}\tilde{\delta}_{i1} + b_{i2}c_{i1}\tilde{\delta}_{i2} + (1-\rho_i)\,c_{i1}c_{i2}\right)\hat{B}_i\right],$$

$$\hat{L}_{Ti} = \frac{1-\rho_i}{g_i}\left[a_{i1}c_{i2}\tilde{\tilde{\delta}}_{i1}\hat{\Gamma}_{i1} + a_{i2}c_{i1}\tilde{\tilde{\delta}}_{i2}\hat{\Gamma}_{i2} - \left((1-b_{i1})c_{i2}\tilde{\tilde{\delta}}_{i1} + (1-b_{i2})c_{i1}\tilde{\tilde{\delta}}_{i2}\right)\hat{B}_i\right],$$

$$\hat{L}_{Ni} = \frac{1-\rho_i}{g_i}\left[-a_{i1}c_{i2}\tilde{\delta}_{i1}\hat{\Gamma}_{i1} - a_{i2}c_{i1}\tilde{\delta}_{i2}\hat{\Gamma}_{i2} + \left((1-b_{i1})c_{i2}\tilde{\delta}_{i1} + (1-b_{i2})c_{i1}\tilde{\delta}_{i2}\right)\hat{B}_i\right],$$

$$\begin{aligned}\hat{P}_{Ni} &= \frac{1}{g_i}\Big[(1-f_i)\left(a_{i1}c_{i2}\tilde{\delta}_{i1}\hat{\Gamma}_{i1} + a_{i2}c_{i1}\tilde{\delta}_{i2}\hat{\Gamma}_{i2}\right)\\ &+ \Big(\left(b_{i1} + (1-b_{i1})f_i\right)c_{i2}\tilde{\delta}_{i1} + \left(b_{i2} + (1-b_{i2})f_i\right)c_{i1}\tilde{\delta}_{i2}\\ &+ (1-\rho_i)\,c_{i1}c_{i2}\Big)\hat{B}_i\Big] \qquad (12)\end{aligned}$$

where $g_i = c_{i2}\tilde{\delta}_{i1} + c_{i1}\tilde{\delta}_{i2} + (1-\rho_i)\,c_{i1}c_{i2} > 0$, $f_i = (1-\rho_i)(1-\eta) > 0$, and $1 - b_{ij} > 0, j = 1, 2$. To summarize how trade shocks in China affect a CZ, we present the following comparative statics:

$$\frac{\partial \hat{W}_i}{\partial \hat{\Gamma}_{ij}} = \frac{a_{ij}c_{il}\tilde{\delta}_{ij}}{g_i} \geq 0, \quad \{j,l\} = \{1,2\},\{2,1\},$$

$$\frac{\partial \hat{L}_{Ti}}{\partial \hat{\Gamma}_{ij}} = \frac{(1-\rho_i)a_{ij}c_{il}\tilde{\tilde{\delta}}_{ij}}{g_i} \geq 0, \quad \{j,l\} = \{1,2\},\{2,1\},$$

$$\frac{\partial \hat{L}_{Ni}}{\partial \hat{\Gamma}_{ij}} = -\frac{(1-\rho_i)a_{ij}c_{il}\tilde{\delta}_{ij}}{g_i} \leq 0, \quad \{j,l\} = \{1,2\},\{2,1\},$$

$$\frac{\partial \hat{P}_{Ni}}{\partial \hat{\Gamma}_{ij}} = \frac{(1-f_i)a_{ij}c_{il}\tilde{\delta}_{ij}}{g_i} \geq 0, \quad \{j,l\} = \{1,2\},\{2,1\}. \tag{13}$$

In traded sector j, productivity growth in China or a fall in China's trade barriers imply that $\hat{\Gamma}_{ij} < 0$. In (13), we see that the consequence of such a shock is a reduction in CZ nominal wages, a reduction in CZ employment in traded goods, an increase in CZ employment in non-traded goods, and a reduction in CZ prices of non-traded goods. The impact on wages is due to the decreased demand for CZ goods in its export markets (including the broader U.S. economy). The impacts on traded and non-traded employment depend on $\rho_i < 1$, meaning the CZ is running a current-account deficit. Regardless of the shift in employment between traded and non-traded goods, within traded goods there is a reallocation of employment out of sectors in which China's productivity is expanding.

Why does the impact of productivity growth in China on CZ traded and non-traded employment depend on the CZ's trade balance? With balanced trade, productivity growth in China merely reallocates CZ employment between traded sectors based on which sectors face a net increase in import competition from China (CZ employment contracts) and which experience a net increase in export demand by China (CZ employment expands). With imbalanced trade, increases in import competition are not offset by increases in export demand. The excess of imports over exports pushes employment out of exports (relative to balanced trade), with non-traded goods being the residual sector. The logic for a CZ also applies to the United States as a whole, meaning that a U.S. current-account deficit vis-a-vis China implies that greater import competition from China can cause U.S. employment in traded-good sectors to contract on net.

In (12), changes in wages, traded-good employment and non-traded good employment are each weighted averages of changes in trade shocks in each traded-good sector, where these weights are functions of the share of each traded sector in total employment. These expressions motivate our measure of trade exposure in the empirical analysis.

B. *Two Economy Model*

A small open economy is a non-standard application of the monopolistic competition model. Typically, in such models all goods prices are endogenous, which is not the case in the application above where we have arbitrarily shut down price adjustment in all economies except CZ i. To verify that the results we obtain are not special to this setting, we solve a two-economy model, in which we compress CZs into a single aggregate U.S. region. We then examine the impact of productivity growth in China on U.S. wages, traded employment, and non-traded employment. To keep the analysis simple, we ignore trade barriers between the countries and assume the traded sector consists of a single industry (producing many varieties). No qualitative results depend on these restrictions.

Following equations (1)-(3), (6), and (7), we have the following equilibrium conditions for the U.S.:

$$W = \eta P_N L_N^{\eta-1},$$

$$P_N L_N^{\eta} = (1-\gamma)(WL+B),$$

$$P = \frac{\sigma}{\sigma-1}\beta W,$$

$$L = L_N + Ml, \tag{14}$$

where we take China's wage to be the numeraire (such that W is the U.S. wage relative to China's wage) and B is the difference between U.S. aggregate expenditure and U.S. aggregate income (equal to the difference between China's aggregate income and expenditure–i.e., $B + B^* = 0$) and is dominated in units of China's wage. The final equilibrium condition is that supply equals demand for each variety of traded goods:

$$x = \frac{P^{-\sigma}\gamma(WL+L^*)}{M\Phi^{1-\sigma} + M^*\Phi^{*1-\sigma}}. \tag{15}$$

We implicitly treat l, labor used to produce each variety, as exogenous given that its value is pinned down by the zero-profit condition (i.e., $l = \alpha\sigma$); zero profits also imply that x is fixed ($x = \alpha(\sigma-1)/\beta$). For China, there are a corresponding set of equilibrium conditions, where we dominate China values using an $(*)$. Because trade costs are zero, $x/x^* = (P/P^*)^{-\sigma}$, which together with the price-equals-marginal cost conditions in the U.S. and China imply that $W = (\beta^*/\beta)^{(\sigma-1)/\sigma}$, or that the U.S.-China relative wage is a function of relative labor productivities in the two countries.

Combining the conditions in (14) with the corresponding ones for China and incorporating the solutions for W, P, and P^*, we have a system with six equations and xi unknowns (P_N, P_N^*, L_N, L_N^*, M, and M^*). We assume that the only shocks to the system are productivity growth in traded-good production in China ($\hat{\beta}^* < 0$) and an increase in the U.S. trade deficit/China trade surplus ($\hat{B} > 0$). Log differentiating, we have that $\hat{W} = \bar{\sigma}\hat{\beta}^*$, where $\bar{\sigma} \equiv \frac{\sigma-1}{\sigma}$, implying that the U.S. relative nominal wage declines in proportion to productivity growth in China.[8] The other equilibrium conditions are that:

$$\hat{P}_N = \bar{\sigma}\hat{\beta}^* + (1-\eta)\hat{L}_N,$$

$$\hat{P}_N^* = (1-\eta)\hat{L}_N^*,$$

$$\hat{P}_N = \rho\bar{\sigma}\hat{\beta}^* + (1-\rho)\hat{B} - \eta\hat{L}_N,$$

$$\hat{P}_N^* = -(1-\rho^*)\hat{B} - \eta\hat{L}_N^*,$$

[8]U.S. real wages may of course rise owing to lower prices for and increased numbers of Chinese varieties produced.

$$\hat{L}_N = -\frac{\delta}{1-\delta}\hat{M},$$

$$\hat{L}_N^* = -\frac{\delta^*}{1-\delta^*}\hat{M}^*, \tag{16}$$

where $\rho = WL/(WL+B)$ is the initial share of labor income in total U.S. expenditure, $(1-\rho^*) = B/(L^*-B)$ is the initial ratio of China's trade surplus to its aggregate expenditure, $\delta = Ml/L$ is the initial share of U.S. employment in traded goods, and $\delta^* = M^*l^*/L^*$ is the initial share of China's employment in traded goods. Solving the system in (16) we obtain,

$$\hat{L}_N = (1-\rho)\left(\hat{B} - \bar{\sigma}\hat{\beta}^*\right) \geq 0,$$

$$\hat{L}_N^* = -(1-\rho^*)\hat{B} \leq 0,$$

$$\hat{M} = -\frac{1-\delta}{\delta}(1-\rho)\left(\hat{B} - \bar{\sigma}\hat{\beta}^*\right) \leq 0,$$

$$\hat{M}^* = \frac{1-\delta^*}{\delta^*}(1-\rho^*)\hat{B} \geq 0,$$

$$\hat{P}_N = \hat{\beta}^* + (1-\eta)(1-\rho)\left(\hat{B} - \bar{\sigma}\hat{\beta}^*\right) \lesseqgtr 0,$$

$$\hat{P}_N^* = -(1-\eta)(1-\rho^*)\hat{B} \leq 0. \tag{17}$$

It is again the case that productivity growth in the traded sector in China lowers U.S. employment in traded goods ($\hat{M}$¡0) and raises U.S. employment in non-traded goods ($\hat{L}_N > 0$), where these results are conditional on the U.S. running an aggregate trade deficit. There is an ambiguous effect on U.S. non-traded prices. Increases in the magnitude of the U.S. trade deficit reinforce these changes.

C. References

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