Trade Shocks and the Shifting Landscape of U.S. Manufacturing: Online Appendix

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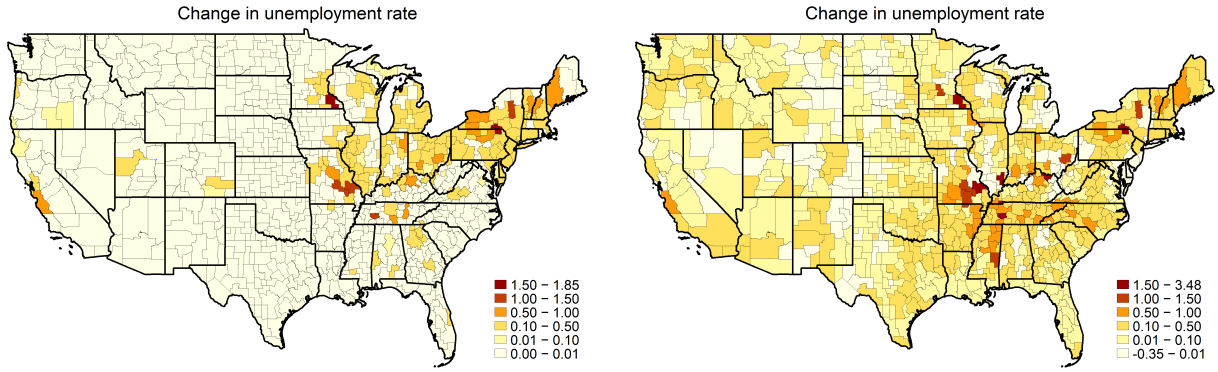
1. Maps of the Moveout Effect

Figures 1a and 2a map the locations of commuting zones where China shock industries were aging out between 1960 and 1980, amplifying the impact of the shock on unemployment rates and detachment from the labor force beyond what the degree of exposure to the shock by itself would have implied. Panels 1b and 2b in each figure show the overall effect of the shock, including the moveout effect, to make the distinction between the overall predicted effect of the shock versus the moveout effect on its own.



(a) "Move-out effect" amplified trade shock in areas industries left 1960-1980

(b) Combined effects of trade shock and move-out indicator across all areas

Figure 1: Predicted increase in unemployment rate 1991-2007 from Table 8, Col (5)

This moveout effect does not seem driven by differences in the presence of upstream industries. We computed the 1990 share of local employment in upstream industries exposed indirectly to the

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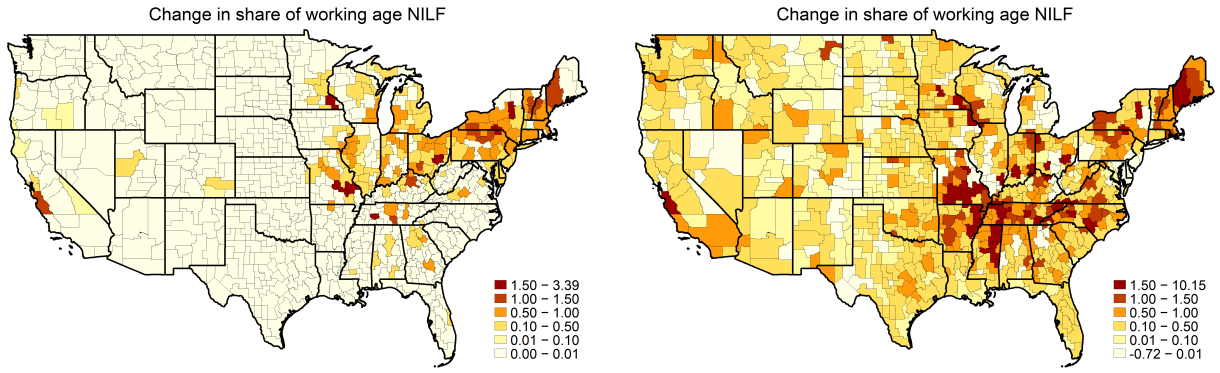

(a) "Move-out effect" amplified trade shock in areas industries left 1960-1980

(b) Combined effects of trade shock and move-out across all areas

Figure 2: Predicted increase in share of working age not in the labor force 1991-2007 from Table 8, Col (6)

China shock as suppliers to industries directly competing with Chinese imports. In unreported regressions, we included this as an additional control and as an additional interaction term with the China shock variable, with no substantial change in this moveout effect. We also create a move-in/moveout set of variables for these upstream industries 1960-80 and find more adverse effects on unemployment rates conditional on the trade shock where they were already moving out.

2. Krugman's 1979 model of the Produce Cycle

Krugman (1979) starts with Dixit and Stiglitz (1977) preferences—utility increasing in the number of varieties n of goods c, including expansion in the number of goods due to ongoing innovation, Δn,

$$U = \left[\sum_{i=1}^{n+\Delta n} c(i)^{\theta} \right]^{\frac{1}{\theta}},$$

with $0 < \theta < 1$. Producing one unit of any good requires one unit of labor and the market for each is perfectly competitive, so that the price of any good equals the wage. Thus, whenever the Northern wage exceeds the Southern wage, only the South produces standardized goods.

Demand and perfect competition imply that the ratio of production of any two goods picked from the North and the South is given by

$$\frac{c_N}{c_S} = \left(\frac{P_N}{P_S} \right)^{-\frac{1}{1-\theta}} = \left(\frac{w_N}{w_S} \right)^{-\frac{1}{1-\theta}}. \tag{1}$$

In the simple case where only the South produces the standardized goods, combining Equation (1) with labor-market clearing equations ($L_N = n_N c_N$,$L_S = n_S c_S$) yields an expression for the relative wage in terms of the ratio of varieties produced in each region and the relative labor supply:

$$\frac{w_N}{w_S} = \left(\frac{n_N}{n_S}\right)^{1-\theta} \left(\frac{L_N}{L_S}\right)^{-(1-\theta)}. \tag{2}$$

Suppose that new products come on line at a rate defined by $\dot{n} = in$ and standardize at a rate $\dot{n}_S = tn_N$ (so that the average time it takes before the South can manufacture a brand-new product is $1/t$). Then, the North ends up producing a fraction of all goods in the economy equal to $\frac{i}{i+t}$ and the geographic variety split is given by

$$\frac{n_N}{n_S} = \frac{i}{t} \tag{3}$$

The relative wage in Equation (2) then reduces to a function of the rates of innovation and standardization, and the relative workforce size,

$$\frac{w_N}{w_S} = \left(\frac{i}{t}\right)^{1-\theta} \left(\frac{L_N}{L_S}\right)^{-(1-\theta)}. \tag{4}$$

Equation (4) indicates that the relative wage in the North is increasing in the rate of innovation relative to the rate of technology transfer or standardization.

To summarize, Krugman (1979) cleanly portrays an economy with two regions, new goods spawning in the North and gradually moving South, but continually replenished by innovation. In the world Krugman assumes where wages are higher in the North, speeding the rate of technology transfer can reduce wage inequality across regions, while increasing the rate of invention of new goods can increase inequality.

We can expand Krugman (1979) to include a third country which we call China for illustrative purposes and, again for simplicity, assume this third country can produce goods as they standardize but does not invent new goods. While technology transfer to the South still occurs at rate t, technology transfer to the third country occurs with more hangups, at a rate $t_C < t$. Like Krugman does for the South, we now assume this that conditions prevail such that wages in China are lower than in the South. If wages are flexible, the first result with the entry of the third country into trade with the U.S. is an increase in wage inequality, as the wage ratio is now given by

$$\frac{w_N}{w_S} = \left(\frac{i}{t - t_C}\right)^{1-\theta} \left(\frac{L_N}{L_S}\right)^{-(1-\theta)}, \tag{5}$$

increasing in technology transfer to China. Arkolakis, Ramondo, Rodriguez-Clare, and Yeaple (2018) do not mention the product cycle, but have a rich quantitative model where trade integration has implications for the location of innovation and production, as well as wage inequality within and across countries. Our purpose with the stylized model here is merely to fix ideas in terms of why variables related to innovation (including education) and wages may tie in with product-cycle timing during the 20th century to understand how severe local labor market effects are in the event of a trade shock.

In Krugman's stylized world, the economy always attains full employment due to wage adjustment. We note that if one assumes that wages do not adjust immediately so that employment can dip below full employment levels in transition until wages adjust as in Dornbusch, Fischer, and Samuelson (1977), then a slight rearrangement of Equation (4) implies that any change in the rate of innovation or the speed of technology transfer (standardization) can reduce employment in the region where the ratio of varieties decreases. In particular, if we denote $\tilde{L}_r$ a level of employment in region r that may be less than full employment before wages adjust, in the new world where the U.S. trades with China, we have

$$\frac{\tilde{L}_N}{\tilde{L}_S} = \frac{i}{t - t_C} \left(\frac{w_N}{w_S} \right)^{-\frac{1}{(1-\theta)}}. \tag{6}$$

In the short run, a drop in the rate of innovation or an increase in the rate of technology transfer may depress employment in the North relative to the South, and vice versa. In addition, products phasing out of the U.S. altogether and offshored to China ($t_C > 0$) may depress employment in the South. If China offers additional skilled labor or incentives for firms to set up foreign affiliates in China and accelerate standardization more generally—an increase in t—we may also see depressed employment in the North, especially in a richer setting where some parts of the North are less innovative than others. The relative wage also can exacerbate the employment effect if wages do not adjust quickly.

3. Supplemental Tables

Table B.1: Correlation of economic indicators with historical exposure to the Tiger shock

	(1) 1910	(2) 1960	(3) 1990
Farm value per acre	0.180***	0.095***	0.090***
Population density	-0.101***	0.182***	0.130***
Patents per capita 1890-1910	0.317***	0.363***	0.133***
Patents per capita 1970-1975	0.268***	0.360***	0.187***
Education			
% 6-14-year-olds enrolled in school	0.128***	.	.
% pop. age 25+ with HS or college	.	-0.015	-0.064***
% pop. foreign born	0.101***	0.122***	-0.030
Median income	.	-0.061	0.067***
Mnfg production wages per worker	0.028***	0.229***	-0.091**
Mnfg value added per worker	-0.140***	0.114***	-0.085
Unemployment rate	.	0.027	0.012
DH Market access 1890	0.247***	0.378***	0.239***

Note: Asterisks ***, **, and * respectively denoting significance at the 1%, 5% and 10% levels.

Table B.2: Change in share of unemployed, not-in-the-labor-force 1990-2007 on presence of Research I university, lowest quintile manufacturing wages per worker

	1990-2007 stacked first differences			
	(1)	(2)	(3)	(4)
	Δ Sh. unempl.	Δ Sh. NILF	Δ Sh. unempl.	Δ Sh. NILF
ADH China shock	0.201***	0.807***	0.166***	0.796***
	(0.060)	(0.176)	(0.066)	(0.182)
Res I $\times$ ADH Ch shock	0.060	-0.748***	0.018	-0.732**
	(0.054)	(0.278)	(0.063)	(0.292)
Research I	-0.132	1.325**	-0.127	1.276**
	(0.118)	(0.542)	(0.152)	(0.567)
Low-wage $\times$ ADH Ch shock			0.029	0.036
			(0.040)	(0.107)
Low-wage			-0.072	0.113
			(0.151)	(0.429)
Res I $\times$ Low-wage $\times$ ADH Ch shock			-1.137***	-0.593
			(0.172)	(0.717)
Research I $\times$ Low-wage			1.920**	3.132***
			(0.850)	(0.807)
ADH controls	Yes	Yes	Yes	Yes
N	1444	1444	1444	1444
R^2	0.403	0.350	0.369	0.351

Notes: Standard errors in parentheses with ***, **, and * respectively denoting significance at the 1%, 5% and 10% levels. Regressions include a constant and a dummy for the 2000-2007 period. ADH controls are Census division fixed effects and lags of the CBP manufacturing employment share, percentage of college-educated population, percentage of foreign-born population, percentage of employment among women, percentage of employment in routine occupations, average offshorability index of occupations, and a squared time trend. Low-wage indicates lowest quintile of manufacturing wages per worker among all CZs. Research I indicates presence of a university designated as such by the Carnegie Endowment located in the CZ.

Table B.3: Change in share of unemployed, not-in-the-labor-force 1970-1990 on Japan shock and controls

	1970-1990 first differences			
	(1)	(2)	(3)	(4)
	Δ Sh. unempl.	Δ Sh. NILF	Δ Sh. unempl.	Δ Sh. NILF
1975-85 Japan shock	0.000	-0.041	0.010	-0.020
	(0.163)	(0.0283)	(0.009)	(0.021)
ADH controls	No	No	Yes	Yes
N	722	722	722	722
R^2	0.000	0.008	0.527	0.254

Notes: Standard errors in parentheses with ***, **, and * respectively denoting significance at the 1%, 5% and 10% levels. Regressions include a constant. Controls are based on ADH (a subset for 1970): Census division fixed effects, 1974 CBP manufacturing employment share, 1970 percentage of college-educated population, 1970 percentage of foreign-born population, and 1970 percentage of employment among women.

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