MIT 14.662 Spring 2018: Lecture 11 – The Importance of Place

David Autor, MIT and NBER

March 19, 2018
Agenda

1. The Enduring Understanding: Blanchard and Katz, 1992
2. The Economics of Place
3. What are the questions?
4. Agglomeration and regional equilibrium
Starting Observation: Employment Growth Rates Persistent Across States 1950 – 1990

Figure 1. Persistence of Employment Growth Rates across U.S. States, 1950–90

Annual employment growth, 1970–90 (percent)

Annual employment growth, 1950–70 (percent)

Source: Authors' calculations using data from Employment and Earnings. See the appendix for more information.

Trends and Fluctuations in Relative Employment Over the last forty years, U.S. states have experienced large and sustained differences in employment growth rates. This experience is illustrated in figure 1, which plots average nonfarm employment growth from 1950 to 1970 against average nonfarm employment growth from 1970 to 1990. (A few states have a later starting date. The appendix gives exact definitions, sources and coverage for the series used in this paper.) The line is a regression line and has a slope of 0.70 and an $R^2$ of 0.75.

Arizona, Florida, and Nevada have consistently grown at 2 percent above the national average. Even leaving these states out, the $R^2$ is still equal to 0.60.

Massachusetts, New York, Pennsylvania, Rhode Island, and West Virginia have consistently grown at rates much below the national average.

Blanchard and Katz 1992
Table 1. Univariate Models of Relative Employment, Unemployment, and Wages

<table>
<thead>
<tr>
<th>Result</th>
<th>Log employment change</th>
<th>Unemployment rate</th>
<th>Log wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression results</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient on</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lagged dependent variable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One lag</td>
<td>0.492</td>
<td>0.899</td>
<td>1.072</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.032)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Two lags</td>
<td>-0.099</td>
<td>-0.159</td>
<td>-0.129</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.033)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>Three lags</td>
<td>0.010</td>
<td>. . .</td>
<td>0.057</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td></td>
<td>(0.034)</td>
</tr>
<tr>
<td>Four lags</td>
<td>-0.054</td>
<td>. . .</td>
<td>-0.074</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td></td>
<td>(0.024)</td>
</tr>
<tr>
<td>Standard error</td>
<td>0.017</td>
<td>0.083</td>
<td>0.016</td>
</tr>
</tbody>
</table>

Implied impulse responses

| Year 1 | 1.00  | 1.00  | 1.00   |
| Year 2 | 1.49  | 0.90  | 1.07   |
| Year 3 | 1.63  | 0.65  | 1.02   |
| Year 4 | 1.67  | 0.44  | 1.01   |
| Year 5 | 1.62  | 0.29  | 0.94   |
| Year 10| 1.52  | 0.04  | 0.57   |
| Year 20| 1.53  | 0.01  | 0.19   |

Figure 7. Response of Employment, Unemployment, and Labor Force Participation to an Employment Shock

Effect of shock (percent)

Source: Authors’ calculations based on the system of equations described in the text, using data described in the appendix. All 51 states are used in the estimation. The shock is a −1 percent shock to employment. Bands of one standard error are shown around each line.
Lasting Takeaway of Blanchard and Katz

Quoting Blanchard and Katz

- Booms and slumps for states are best described as transitory accelerations or slowdowns of employment growth.
- Growth eventually returns to normal, but the path of employment is permanently affected.
- These transitory changes in growth lead to transitory fluctuations in relative unemployment and wages.
- The dominant adjustment mechanism is labor mobility, rather than job creation or job migration.
- Labor mobility, in turn, appears to be primarily a response to changes in unemployment, rather than in consumption wages.
Agenda

1. The Enduring Understanding: Blanchard and Katz, 1992
2. The Economics of Place
3. What are the questions?
4. Agglomeration and regional equilibrium
Rationale for considering ‘places’ rather than people?

Many policies are targeted at ‘job creation’ for local residents

- Large literature estimates the local employment effects of such policies
- Usual goal: compute the number of jobs created per dollar spent
- Lit does not speak to welfare consequences: *equity* and/or *efficiency*
- Equity rationales popular among policy makers
  - By subsidizing disadvantaged areas, governments hope to help the disadvantaged residents of those areas
Rationale for considering ‘places’ rather than people?

**Reason for skepticism on equity-based arguments**

1. Location used to serve a fundamentally *person-based* motive: subsidizing poor households
2. Can’t this be done more directly by making the tax system more progressive or strengthening means-tested transfer programs?
3. Worse, spatial targeting might fail due to worker and firm mobility
A simple equilibrium place-based model (Kline-Moretti ’14)

Policy: A subsidy to the wagebill of firms in a targeted location

- Two cities $a$ and $b$
- Continuum of workers of measure one
  - Each worker supplies a unit of labor, rents a unit of housing
  - Workers free to move cities, but must work in city where they live
- Workers’ indirect utility in a location depends on nominal wages, the cost of housing, taxes, and local amenities

\[ U_{ic} = w_c - r_c + A_c - t + e_{ic} \]

where $w_c$ is the nominal wage in city $c$, $r_c$ is housing cost, $A_c$ is a local amenity, $t$ is a lumpsum tax, and $e_{ic}$ is worker $i$’s idiosyncratic preference
Preferences

- Worker’s utility of city $c$ is sum of $\nu_c \equiv w_c - r_c + A_c - t$ and $e_{ic}$
- Preferences $e_{ic}$ assumed to be iid type I extreme value distribution with scale parameter $s$ and $E[e_{ic}] = 0$
- Difference in idiosyncratic preferences for $a$ and $b$ is distributed across workers by logistic distribution

$$\frac{(e_{ia} - e_{ib})}{s} \sim \text{Logistic}(0, 1)$$

where $s$ governs the strength of idiosyncratic preferences
Housing supply

Land is fixed, so housing cost has upward slope

\[ r_c = z_c N_c^{k_c} \]

- where \( k_c \geq 0 \) is the inverse supply elasticity

Landlord profits

\[ \Pi_c = \int_0^{N_c} (r_c - z_c x_c^{k_c}) \, dx = \frac{k_c}{k_c + 1} r_c N_c, \]

- The more elastic is inverse housing supply—the less elastic is housing supply—the greater are landlord profits

- Assumption: Workers are renters, distinct from landowners
Production

Firms in each city produce a single good $Y_c$ using labor and a local amenity.

$Y_c$ is a traded good sold on international markets at price one.

Production is

$$Y_c = X_c N_c^\alpha K_c^{1-\alpha},$$

where

- $X_c$ is a local productivity shifter
- $N_c$ is the number of workers in $c$
- $K_c$ is local supply of capital
- Capital elastically supplied at price $\rho$ on global markets
Here’s the policy:

- Government provides an ad valorem wage credit $\tau_c$ to employers in community $c$.
- This subsidy will be financed by lumpsum tax $t$ with balanced budget

$$ w_a \tau_a N_a + w_b \tau_b N_b = t $$
Wages and rental rates

Wages and capital rental rate

\[ w_c (1 - \tau_c) = \frac{\alpha Y_c}{N_c} \]

\[ \rho = \frac{(1 - \alpha) Y_c}{K_c} \]

\[ \Rightarrow \ln w_c = C + \frac{\ln X_c}{\alpha} + \left( \frac{1 - \alpha}{\alpha} \right) \ln \rho - \ln(1 - \tau_c) \]

where \( C = \ln \alpha - ((1 - \alpha)/\alpha) \ln (1 - \alpha) \)

1. Why is \( W_c \) independent of \( N_c \)?
2. Why doesn’t \( K \) receive any of the incidence of the subsidy \( (1 - \tau_c) \)?
3. What is \( X_c \) doing here?
4. Why doesn’t housing cost appear in this equation?
Wages and rental rates

1. Why is $W_c$ independent of $N_c$?
   - Because supply of $K$ perfectly elastic at price $\rho$, no diminishing marginal product of labor

2. Why doesn’t $K$ receive any of the incidence of the subsidy $(1 - \tau_c)$?
   - Again b/c of perfectly elastic supply. Cannot bear subsidy or benefit from it

3. What is $X_c$ doing here?
   - It’s like local TFP

4. Why doesn’t housing cost appear in this equation?
   - This the producer wage not the consumer wage. It’s the marginal product of labor, not the real cost of living. Firms pay the MRPL: cannot pay a different wage simply because a worker’s cost of living is higher
[Aside: Eliminating $K$ and $N$ from Wage Equation]

\[
\rho = \frac{(1 - \alpha) Y_c}{K_c}
\]

\[
K_c = \frac{(1 - \alpha) Y_c}{\rho} = \frac{(1 - \alpha) X_c N_c^\alpha K_c^{1-\alpha}}{\rho}
\]

\[
K_c^\alpha = \frac{(1 - \alpha) X_c N_c^\alpha}{\rho} K_c = \frac{(1 - \alpha) X_c^{1/\alpha} N_c}{\rho^{1/\alpha}}
\]

\[
K_c = \frac{(1 - \alpha) X_c^{1/\alpha} N_c}{\rho^{1/\alpha}}
\]

\[
w_c (1 - \tau_c) = \frac{\alpha Y_c}{N_c} = \frac{\alpha_c \rho K_c}{N_c (1 - \alpha)} = \frac{\alpha_c \rho (1 - \alpha) X_c^{1/\alpha} N_c}{N_c (1 - \alpha) \rho^{1/\alpha}} = \alpha_c \rho \left( \frac{\alpha - 1}{\alpha} \right) X_c^{1/\alpha}
\]

\[
w_c (1 - \tau_c) = \frac{\alpha_c \rho \left( \frac{\alpha - 1}{\alpha} \right) X_c^{1/\alpha}}{(1 - \tau_c)}
\]
Equilibrium: Where do workers choose to live?

Workers choose city $a$ or $b$ to maximize individual utility

$$N_a = \Lambda \left( \frac{\nu_a - \nu_b}{s} \right) \Lambda(\cdot) = \exp(\cdot)/(1 - \exp(\cdot))$$

- $N_a$ is increasing in $[(w_a - r_a) - (w_b - r_b)]$ and in $A_a - A_b$
- With population elasticity

$$\frac{d \ln N_a}{d \ln (\nu_a - \nu_b)} = \frac{N_b}{s} (\nu_a - \nu_b)$$
Equilibrium size of city $a$

Equilibrium population of $a$ is

$$sA^{-1}(N_a) = (w_a - r_a) - (w_b - r_b) + (A_a - A_b)$$

Rewrite in terms of primitives

$$sA^{-1}(N_a) = \exp \left( \frac{C}{\rho} \frac{X_1^{1-\alpha}}{1 - \tau_a} - \frac{X_1^{1-\alpha}}{1 - \tau_b} \right) + \{A_a - A_b\}$$

$$- \left( z_1 N_a^{k_a} - z_a (1 - N_b)^{k_b} \right)$$
Spatial equilibrium—(1) Laissez-Faire; and (2) $\tau_a = 0.25$

Figure 1
Equilibrium in the two-city example. This figure was constructed by setting $s = 1$, $k_a = k_b = 0.5$, $z_a = z_b = 1$, $A_a = A_b = 0$, $X_a^{1/\alpha} = X_b^{1/\alpha} = 1$, and $\tau_b = 0$.

Q: What gives the purple line its downward slope?
How do subsidies affect wages, housing costs

Nominal wage effects

\[
\frac{dw_a}{\tau_a} = \frac{w_a}{1 - \tau_a} \quad \text{and} \quad \frac{dw_b}{\tau_a} = 0 \quad \text{Why?}
\]

Rents

\[
\frac{dr_a}{d\tau_a} = \frac{k_a r_a N_b}{s + k_b r_b N_a + k_b r_b N_a} \times \frac{w_a}{1 - \tau_a} > 0,
\]

\[
\frac{dr_b}{d\tau_a} = -\frac{k_b r_b N_a}{s + k_b r_b N_a + k_b r_b N_a} \times \frac{w_a}{1 - \tau_a} < 0
\]

Notice that \( \frac{k_a r_a N_b}{s + k_b r_b N_a + k_b r_b N_a} < 1 \), meaning that

\[
\frac{dw_a}{d\tau_a} > \frac{dr_a}{d\tau_a} \implies \frac{d(w_a - r_a)}{d\tau_a} > 0 \quad \text{and} \quad \frac{dw_b}{d\tau_a} > \frac{dr_b}{d\tau_a} \implies \frac{d(w_b - r_b)}{d\tau_a} > 0
\]

If subsidy raises \((w - r)\) in both cities, what are we overlooking?
Why can't wage subsidies improve welfare in the basic model?
Wage subsidies cannot improve welfare in the basic model

Why can’t wage subsidies improve welfare in basic model?

- *The distortion is in the housing market*
  - Wages go up in both $a$ and $b$
  - The marginal cost of producing housing is not equated across cities
  - The increase in the lumpsum tax means that real wage falls in city $b$
  - Total landlord profits rise
  - Welfare rises in city $a$ in absolute (and relative) terms but at the expense of city $b$

- *Why might you even consider this policy?*
  - Perhaps for reasons outside the model, you want to assist residents of city $a$
Welfare maximized when city populations equalized

The blue line depicts aggregate landlord profits $P_a + P_b$. Because in this example the two cities are initially identical, and housing costs increase non-linearly in city size, aggregate worker utility is maximized when half the workers live in city $a$ and half in city $b$, which is the decentralized equilibrium. At this point, housing prices in the two cities are minimized, and the sum of worker utility and landlord profits is maximized. This is a natural implication of the first welfare theorem: In the absence of subsidies, our model exhibits complete markets and no externalities. Hence, we expect the decentralized equilibrium to maximize total economy-wide welfare, which in this case is the sum of worker welfare and landlord profits.

Instituting a wage subsidy for community $a$ distorts prices, which shifts the equilibrium to a socially suboptimal allocation $N_a^*/C$, where average worker utility is slightly lower and landlord profits are slightly higher. The resulting decrease in total social welfare is the standard deadweight loss familiar from the study of taxation (Auerbach & Hines 2002).

In exchange for these deadweight losses, our place-based policy may yield socially desirable effects on the distribution of utility. Suppose that, for reasons outside of our model, we are interested in transferring resources from the residents of city $b$ to those of city $a$, perhaps because the residents of city $a$ have been mistreated in the past. Does the wage subsidy reach its intended target population?

Figure 2
Welfare as a function of city $a$’s share in the two-city example.
What are the welfare costs of subsidies?

Welfare costs of subsidies?

- Average worker utility given optimization is

\[ V \equiv E \max \{ U_{ia}, U_{ib} \} = s \left[ \exp \left( \frac{\nu_a}{s} \right) + \exp \left( \frac{\nu_b}{s} \right) \right] \]

- Effect of subsidy to \( a \) on expected welfare

\[ \frac{dV}{d\tau_a} = N_a \frac{d}{d\tau_a} (w_a - r_a) + N_b \frac{d}{d\tau_a} (w_b - r_b) - \frac{dt}{d\tau_a} \]

- Welfare benefit to 1\(^{st}\) approximation is wage gains minus rent increases evaluated at initial allocation of workers to \( a \) and \( b \)

- Movers don’t show up in expression b/c they were indifferent at margin (envelope thm)
Welfare costs of subsidies: Full solution

\[
\frac{dV}{d\tau_a} = N_a \frac{d}{d\tau_a} (w_a - r_a) + N_b \frac{d}{d\tau_a} (w_b - r_b) - \frac{dt}{d\tau_a}
\]

\[
= \left( \frac{\tau_a w_a N_a}{1 - \tau_a} \right)
\]

Wage subsidy

\[
- \frac{1}{1 - \tau_a} \left[ \frac{k_a r_a N_a N_b}{s + k_a r_a N_b + k_b r_b N_a} - \frac{k_b r_b N_a N_b}{s + k_a r_a N_b + k_b r_b N_a} \right]
\]

Rent changes

\[
- \frac{d w_a}{d\tau_a} N_a \tau_a
\]

Tax hikes incumbents

\[
- \tau_a w_a \frac{dN_a}{d\tau_a}
\]

Tax hikes movers
Gains and losses for movers and stayers from increment to $\tau_a$

Figure 3 shows the utility of each resident of our economy under each possible location choice. Workers are ordered in terms of their relative taste for city a, from greatest to least. The solid blue line is downward sloping because the taste for city a declines as we move to the right. Similarly, the solid red line is upward sloping because the taste for city b increases as we move to the right.

Subsidizing city a shifts the blue line up by the amount of the change in real wages net of taxes and the red line down by the corresponding effect on disposable income there. From the figure, we see that the subsidy yields a windfall to the original residents of city a, who receive higher real wages. This gain is accomplished via a transfer from the residents of city b who are made worse off by higher taxes. Workers who are not too attached to city b respond by moving to city a. For some of these workers, this move leaves them better off than they were under the prior unsubsidized regime. But others, who felt a stronger attachment to city b, are worse off, even after moving.

From Figure 2, we know that the gains to original residents of city a and movers are outweighed by the losses to prior residents of city b. These aggregate losses stem both from a transfer to landlords (particularly those in city a) and from the aforementioned deadweight loss. Deadweight losses result from worker mobility. We note that, in Figure 3, even movers who gain from the subsidy experience less of a gain than the original residents of city a. Yet, by moving, they add to the revenue cost of the wage subsidy, just like original residents. Thus, there is a subgroup for whom an extra dollar of wage credits is valued at less than a dollar, which is the source of the program’s efficiency cost.

Figure 3 plots these functions holding $(v_a, v_b)$ at their equilibrium values, that is, for $v_a = v_a/C_0 N_a/C_1$ when $\tau_a = 0$ and $v_a = v_a/C_0 N_a/C_0$ when $\tau_a = 0.25$.

**Figure 3**
Worker utility by city in the two-city example.
Welfare costs of subsidies: Full solution (simplified)

\[
\frac{dV}{d\tau_a} = N_a \frac{d}{d\tau_a} (w_a - r_a) + N_b \frac{d}{d\tau_a} (w_b - r_b) - \frac{dt}{d\tau_a} = -[k_a r_a - k_b r_b] \left[ \frac{N_a N_b}{s + k_a r_a N_b + k_b r_b N_a} \right] \frac{1}{1 - \tau_a}
\]

- Cost of living increase
- DWL

\[
-w_a \tau_a \left[ \frac{N_a N_b}{s + k_a r_a N_b + k_b r_b N_a} \right]
\]

1. Wage gains are a wash net of taxes
2. But: this policy is a transfer to landlords
3. And: it yields a DWL due to distorting housing market

Irony: as \( s \to \infty, DWL \to 0 \). Why?
Is that it? What else we can do with this model

1. Local public goods

- Suppose that consumption amenities are produced via a linear technology where a $\lambda$ dollar increase in government investment $t$ yields a dollar increase in the local amenity level.

- A small government-driven increase in city $a$’s amenity level yields

$$
\frac{dV}{dA_a} = N_a \left( 1 - \frac{dr_a}{dA_a} \right) - N_b \frac{dr_b}{r_{A_a}} - \frac{dt}{dA_a}
= \frac{(s + k_b r_b) N_a}{s + k_a r_a N_b + k_b r_b N_a} - \lambda
$$
Local public goods

- A small government-driven increase in city $a$’s amenity level yields

$$\frac{dV}{dA_a} = N_a \left(1 - \frac{dr_a}{dA_a}\right) - N_b \frac{dr_b}{r_{A_a}} - \frac{dt}{dA_a}$$

$$= \frac{(s + k_b r_b) N_a}{s + k_a r_a N_b + k_b r_b N_a} - \lambda$$

- If workers are immobile ($s = \infty$), then

$$\frac{dV}{dA_a} = 1 - \lambda,$$

So local public goods provision raises welfare if $\lambda < 1$

- If workers perfectly mobile ($s = 0$), then worker welfare rises if

$$\frac{k_b r_b N_a}{k r_a N_b + k_b r_b N_a} > \lambda$$
2. Agglomeration economies

- A common rationale for location-based incentives is to foster local agglomeration externalities
- Common way to model agglomeration

\[ \ln X_c = g \left( \frac{N_c}{R_c} \right), \]

where \( N_c \) is population, \( R_c \) is land area (e.g., square mileage) and \( g'(\cdot) > 0 \)

- If agglomeration is strong enough, can produce multiple equilibria
- Would provide a rationale for place-based subsidy—even though this also distorts prices
Multiple equilibria absent subsidy – but subsidy $\tau_a$ yields high $N_a$ equilibrium

3.2.1. Agglomeration economies in production. A common way to model agglomeration economies in production is to assume that the productivity of firms in a locality is a function of the density of economic activity. Explanations for agglomeration economies of this sort include technological externalities that may arise through social interactions and learning (Black & Henderson 1999; Glaeser 1999, 2001; Henderson 2003; Moretti 2004a,b; Arzaghi & Henderson 2005, Greenstone et al. 2010) or through thick market effects either in the labor market or in the intermediate input market (Marshall 1890). [Duranton & Puga (2004) provide a review.] In the context of the previous section’s model, this amounts to assuming that local total factor productivity is a function of employment density:

$$\ln X_c = g/c + r_c/C_{18}$$

where $c$ indexes a locality, and $R_c$ is its square mileage.

When agglomeration forces are strong enough, multiple equilibria can arise. As noted by Kline (2010), this can in principle provide a compelling role for government intervention, as the welfare benefits of equilibrium selection can easily trump the efficiency costs of distorting prices, which are typically second-order small in the absence of prior distortions (Harberger 1964).

Consider, for example, how Figure 1 would change in the presence of significant agglomeration economies. Figure 4 depicts our two cities for the case in which $R_a = R_b = 1$ and $g(z) = \ln 3z$. Unlike in Figure 1, community $a$ now becomes relatively more attractive as it grows. This occurs because

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

$-3 -2 -1 0 1 2 3$

Fraction in city $a$

Utility

Figure 4

Equilibrium with agglomeration in the two-city example.
In general, either extreme preferable to mid-point

Figure 5

Welfare with agglomeration in the two-city example.
Agglomeration can also be inefficient

Agglomeration gain in one locale is a loss in another

- Need a non-linearity to make agglomeration efficient
- ‘Agglomeration elasticity’

\[
\sigma_c \left( \frac{N_c}{R_c} \right) \equiv \frac{d \ln X_c}{d \ln \left( \frac{N_c}{R_c} \right)} = g' \left( \frac{N_c}{R_c} \right) \times \frac{N_c}{R_c}
\]

- If \( \sigma_c \) is constant, then losses from de-agglomeration equal gains from agglomeration—no net gain

Kline-Moretti ’14 QJE “Big Push”

- Their finding: manufacturing has this property, i.e, \( \sigma_c \approx \) constant
- Big Push benefited Tennessee Valley but not nation as a whole
More interesting if posit that human capital 

\[ \ln X_c = g \left( \frac{N_c}{R_c}, HC_c \right), \]

with

- \( g_1 > 0 \)
- \( g_2 > 0 \)
- \( g_{12} > 0 \)
Agenda

1. The Enduring Understanding: Blanchard and Katz, 1992

2. The Economics of Place

3. What are the questions?

4. Agglomeration and regional equilibrium
What are the big questions?

1. Are places more productive for any intrinsic reason?
2. Path dependence and multiple equilibria?
3. Regional divergence?
4. Are Blanchard-Katz conclusions still relevant?
5. How does the Blanchard-Katz mechanism work in practice?
6. What is the role of sectors/industries on outcomes of places?
7. What are the causal effects of places on residents?
Agenda

1. The Enduring Understanding: Blanchard and Katz, 1992
2. The Economics of Place
3. What are the questions?
4. Agglomeration and regional equilibrium
Sector-level tariff changes in Brazil, 1990 – 1995

“Trade liberalization and regional dynamics,” Dix-Carneiro & Kovak, AER ’16

Figure 1: Tariff Changes

![Graph showing sector-level tariff changes in Brazil from 1990 to 1995. The x-axis represents different sectors, and the y-axis shows the change in ln(1+tariff), ranging from 0.00 to -0.25. Industries are sorted based on 1991 national employment (largest on the left, and smallest on the right). Data from Kume et al. (2003), aggregated to allow consistent industry definitions across data sources. See Appendix Table A1 for details of the industry classification.]
Exposure map

\[ RTC_r = - \sum_i \beta_{ri} d \ln (1 + \tau_i) \]

\[ \beta_{ri} = \frac{\lambda_{ri} \frac{1}{\varphi_i}}{\sum_j \lambda_{rj} \frac{1}{\varphi_j}} \]

\( \tau_i \) is industry \( i \)'s tariff

\( \lambda_{ri} \) is \( i \)'s share of traded-sector employment in \( r \)

\( \varphi \) is the non-labor share of value-added in industry \( i \)

---

Figure 2: Regional Tariff Reductions

<table>
<thead>
<tr>
<th>percentile</th>
<th>mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.044</td>
</tr>
<tr>
<td>25</td>
<td>0.002</td>
</tr>
<tr>
<td>50</td>
<td>0.012</td>
</tr>
<tr>
<td>75</td>
<td>0.031</td>
</tr>
<tr>
<td>90</td>
<td>0.066</td>
</tr>
<tr>
<td></td>
<td>0.107</td>
</tr>
</tbody>
</table>

Dix-Carneiro and Kovak 2017
Conceptual model: ‘Specific factors’ with agglomeration Economies

\[ Y_{ri} = A_{ri} L_{ri}^{1-\varphi_i} \left( T_{ri}^{\zeta_i} K_{ri}^{1-\zeta_i} \right)^{\varphi_i} \]

- \( Y_{ri} \) is output of industry \( i \) in region \( r \)
- \( \varphi_i, \zeta_i \in (0, 1) \): \( 1 - \varphi_i \) is labor’s share in industry \( i \)
- \( L_r \) is labor perfectly mobile across industries \( i \) within a region \( r \)
- \( T_{ri} \) is specific factor usable only in its region and industry and is \textit{fixed}
- \( K_{ri} \) is capital usable only in its region and industry but \textit{not} fixed
- \( A_{ri}, L_r, \) and \( K_{ri} \) can change over time
- [Ignore agglomeration initially]
Conceptual model: ‘Specific factors’ with agglomeration

\[ Y_{ri} = A_{ri} L_{ri}^{1-\varphi_i} \left( T_{ri}^{\zeta_i} K_{ri}^{1-\zeta_i} \right)^{\varphi_i} \]

- Let \( a_{Li}, a_{Ti}, a_{Ki} \) be the unit demands for Labor, Specific Factor, and Capital for producing one unit \( Y_i \). (Suppress region \( r \))

\[
\sum_i a_{Li} Y_i = L, \\
a_{Ti} Y_i = T_i \forall i, \\
a_{Ki} Y_i = K_i \forall i \\
a_{Li} w + a_{Ti} s_i + a_{Ki} R_i = P_i \forall i
\]

- Using hats to denote log changes, cost minimization implies

\[
(1 - \varphi_i) \hat{w} + \varphi_i \zeta_i \hat{s}_i + \varphi_i (1 - \zeta_i) \hat{R}_i = \hat{P}_i + \hat{A}_i \forall i
\]
Impact of tariff change on regional wage premium

\[ \hat{w}_r = \sum_i \hat{\beta}_{ri} \hat{P}_i + \sum_i \beta_{ri} \hat{A}_{ri} - \delta_r \left( \hat{L}_r - \sum_i \lambda_{ri} (1 - \zeta_i) \hat{K}_{ri} \right) \]

where \( \lambda_{ri} = \frac{L_{ir}}{L_r} \), \( \beta_{ri} \equiv \frac{\lambda_{ri}}{\sum_j \lambda_{rij}} \frac{1}{\phi_i} \), \( \delta_r \equiv \frac{1}{\sum_j \lambda_{rij}} \frac{1}{\phi_i} \)

1. **Increasing** in share of regional labor \( \lambda_{ri} \) allocated to affected industries
2. **Increasing** in labor’s share of output \((1 - \phi_i)\) in affected industries
3. **Declining** in specific factor-shares of affected industries \( \zeta_i \). **Why?**
Impact of tariff change on regional wage premium

\[ \hat{w}_r = \sum_i \beta_{ri} \hat{P}_i + \sum_i \beta_{ri} \hat{A}_{ri} - \delta_r \left( \hat{L}_r - \sum_i \lambda_{ri} (1-\zeta_i) \hat{K}_{ri} \right) \]

where \( \lambda_{ri} = \frac{L_{ir}}{L_r} \), \( \beta_{ri} \equiv \frac{\lambda_{ri} \frac{1}{\varphi_i}}{\sum_j \lambda_{ri} \frac{1}{\varphi_i}} \), \( \delta_r \equiv \frac{1}{\sum_j \lambda_{ri} \frac{1}{\varphi_i}} \)

1. Increasing in share of regional labor \( \lambda_{ri} \) allocated to affected industries
2. Increasing in labor’s share of output \((1 - \varphi_i)\) in affected industries
3. Declining in specific factor-shares of affected industries \( \zeta_i \)

- Specific factors bear some incidence because immobile
- Note that absent specific factors, there would be no differences in industry structure across regions
Exposure map

\[ RTC_r = - \sum_i \beta_{ri} d \ln (1 + \tau_i) \]

\[ \beta_{ri} = \frac{\lambda_{ri} \frac{1}{\varphi_1}}{\sum_j \lambda_{rj} \frac{1}{\varphi_j}} \]

\( \tau_i \) is industry \( i \)'s tariff

\( \lambda_{ri} \) is \( i \)'s share of traded-sector employment in \( r \)

\( \varphi \) is the non-labor share of value-added in industry \( i \)

---

**Figure 2: Regional Tariff Reductions**

<table>
<thead>
<tr>
<th>Mean</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.044</td>
<td>0.002</td>
<td>0.012</td>
<td>0.031</td>
<td>0.066</td>
<td>0.107</td>
</tr>
</tbody>
</table>

Dix-Carneiro and Kovak 2017
Tariff change vs. cumulative change in log formal sector employment, 1987 – 2010

Figure 4: Regional log Formal Employment - 1987-2010

Each point reflects an individual regression coefficient, $\hat{\beta}_t$, following (3), where the dependent variable is the change in regional log formal employment and the independent variable is the regional tariff reduction ($RTR_r$), defined in (2). Note that $RTR_r$ always reflects tariff reductions from 1990-1995. For blue circles, the employment changes are from 1991 to the year listed on the x-axis. For purple diamonds, the changes are from 1986 to the year listed. All regressions include state fixed effects, and post-liberalization regressions control for the 1986-1990 outcome pre-trend. Negative estimates imply larger employment declines in regions facing larger tariff reductions. Vertical bars indicate that liberalization began in 1991 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 112 mesoregion clusters.

Dix-Carneiro and Kovak 2017
Each point reflects an individual regression coefficient, $\hat{\theta}_1$, following (3), where the dependent variable is the change in regional log formal earnings premium and the independent variable is the regional tariff reduction ($RTR_r$), defined in (2). Note that $RTR_r$ always reflects tariff reductions from 1990-1995. For blue circles, the earnings changes are from 1991 to the year listed on the x-axis. For purple diamonds, the changes are from 1986 to the year listed. All regressions include state fixed effects, and post-liberalization regressions control for the 1986-1990 outcome pre-trend. Negative estimates imply larger earnings declines in regions facing larger tariff reductions. Vertical bars indicate that liberalization began in 1991 and was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 112 mesoregion clusters.
What could be going on?

Some possibilities

1. Urban decline [Glaeser Gyourko '05, Noto '13]
2. Changing worker composition (adverse selection)
3. Slow response of imports or exports
4. Dynamic labor demand adjustment
What could be going on?

Some possibilities

1. Urban decline [Glaeser Gyourko ‘05, Noto ‘13], AKA ‘specific factors’
2. Changing worker composition (adverse selection)
3. Slow response of imports or exports
4. Dynamic labor demand adjustment
‘Putty-clay:’ House prices rise & fall asymmetrically with population growth v. contraction

Fig. 3.—Price appreciation and urban growth

Glaeser and Gyourko, JPE 2005
Fall in the regional earnings premium is somewhat smaller after accounting for regional cost of living changes.

Table 2: Regional log Formal Earnings Premia and Employment - 2000, 2010

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Panel A: log Formal Earnings Premia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td>-0.451***</td>
<td>-0.638***</td>
</tr>
<tr>
<td></td>
<td>(0.152)</td>
<td>(0.154)</td>
</tr>
<tr>
<td>Formal earnings pre-trend (86-90)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State fixed effects (26)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.040</td>
<td>0.225</td>
</tr>
<tr>
<td>Panel B: log Formal Real Earnings Premia (regional deflators following Moretti (2013))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formal earnings pre-trend (86-90)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State fixed effects (26)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.238</td>
<td>0.449</td>
</tr>
</tbody>
</table>

Dix-Carneiro and Kovak 2017
Formal employment falls by proportionately more than earnings

Table 2: Regional log Formal Earnings Premia and Employment - 2000, 2010

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td>-3.748*** (0.516)</td>
<td>-3.545*** (0.563)</td>
</tr>
<tr>
<td>Formal employment pre-trend (86-90)</td>
<td>-0.0331 (0.147)</td>
<td></td>
</tr>
<tr>
<td>State fixed effects (26)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.072</td>
<td>0.291</td>
</tr>
</tbody>
</table>

Dix-Carneiro and Kovak 2017
No measurable impact on size of working-age population

Table 3: Regional log Working-Age Population - 2000, 2010

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td>0.333 (0.243)</td>
<td>-0.061 (0.330)</td>
</tr>
<tr>
<td>Population pre-trend (80-91)</td>
<td>0.406** (0.164)</td>
<td>0.328* (0.171)</td>
</tr>
<tr>
<td>Population pre-trend (70-80)</td>
<td></td>
<td>0.297*** (0.072)</td>
</tr>
<tr>
<td>State fixed effects (26)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.654</td>
<td>0.557</td>
</tr>
</tbody>
</table>

Dix-Carneiro and Kovak 2017
Informal employment rises but informal sector earnings are unaffected

Table 4: Regional log Informal Employment and Earnings Premia - 2000, 2010

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td><strong>Panel A: log Informal Employment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td>2.017*** (0.431)</td>
<td>1.706*** (0.344)</td>
</tr>
<tr>
<td>Informal employment pre-trend (80-91)</td>
<td>0.069 (0.115)</td>
<td>0.050 (0.114)</td>
</tr>
<tr>
<td>All employment pre-trend (70-80)</td>
<td>0.121** (0.056)</td>
<td>0.110** (0.044)</td>
</tr>
<tr>
<td>State fixed effects (26)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.579</td>
<td>0.589</td>
</tr>
</tbody>
</table>

**Panel B: log Informal Earnings Premia**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td>-0.027 (0.161)</td>
<td>-0.217 (0.160)</td>
</tr>
<tr>
<td>Informal earnings pre-trend (80-91)</td>
<td>-0.191*** (0.049)</td>
<td>-0.193*** (0.048)</td>
</tr>
<tr>
<td>All workers' earnings pre-trend (70-80)</td>
<td>0.008 (0.064)</td>
<td>-0.016 (0.060)</td>
</tr>
<tr>
<td>State fixed effects (26)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.676</td>
<td>0.654</td>
</tr>
</tbody>
</table>

Positive (negative) coefficient estimates for the regional tariff reduction imply larger increases (declines) in informal earnings or employment in regions facing larger tariff reductions. Outcomes calculated using Census data. 405 microregion observations. Regional earnings premia calculated controlling for age, sex, education, and industry of employment. Efficiency weighted by the inverse of the squared standard error of the dependent variable estimate. Pre-trends computed for 1980-1991 and 1970-1980. Standard errors (in parentheses) adjusted for 112 mesoregion clusters. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Dix-Carneiro and Kovak 2017
What could be going on?

Some possibilities

1. Urban decline [Glaeser Gyourko ‘05, Noto ‘13], AKA ‘specific factors’

2. Changing worker composition (adverse selection)

3. Slow response of imports or exports

4. Dynamic labor demand adjustment

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td></td>
</tr>
<tr>
<td>Panel A: Main specification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td>-0.096</td>
<td>-0.529***</td>
<td>-1.294***</td>
<td>-1.594***</td>
</tr>
<tr>
<td></td>
<td>(0.120)</td>
<td>(0.141)</td>
<td>(0.139)</td>
<td>(0.169)</td>
</tr>
<tr>
<td>Panel B: Earnings premia controlling for individual fixed effects (fixed returns)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td>-0.193*</td>
<td>-0.514***</td>
<td>-1.119***</td>
<td>-1.271***</td>
</tr>
<tr>
<td></td>
<td>(0.115)</td>
<td>(0.144)</td>
<td>(0.147)</td>
<td>(0.172)</td>
</tr>
<tr>
<td>Panel C: Earnings premia controlling for individual fixed effects (time-varying returns)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td>-0.230**</td>
<td>-0.551***</td>
<td>-1.322***</td>
<td>-1.454***</td>
</tr>
<tr>
<td></td>
<td>(0.093)</td>
<td>(0.098)</td>
<td>(0.094)</td>
<td>(0.119)</td>
</tr>
<tr>
<td>Formal earnings pre-trend (86-90)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>State fixed effects (26)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Dix-Carneiro and Kovak 2017
What could be going on?

Some possibilities

1. Urban decline [Glaeser Gyourko ‘05, Noto ‘13], AKA ‘specific factors’

2. Changing worker composition (adverse selection)

3. **Slow response of imports or exports**

4. Dynamic labor demand adjustment
Tariff change vs. regional imports, exports, and net exports per worker, 1987 – 2010

Figure 5: Regional Imports, Exports, and Net Exports Per Worker - 1991-2010

Each point reflects an individual regression coefficient, \( \hat{\beta}_t \), following (3), where the dependent variable is the change in regional imports per worker (blue circles), exports per worker (red triangles), or net exports per worker (green diamonds), measured in \( \$100,000 \) units. The independent variable is the regional tariff reduction (RTR), defined in (2). Note that RTR always reflects tariff reductions from 1990-1995. All regressions include state fixed effects, but do not include pre-liberalization trends due to a lack of Comtrade trade data before 1989. Positive estimates imply larger increases in trade flow per worker in regions facing larger tariff reductions. Vertical bar indicates that liberalization was complete by 1995. Dashed lines show 95 percent confidence intervals. Standard errors adjusted for 112 mesoregion clusters.
Timing of import/export changes does not seem to line up with timing of wage changes
What could be going on?

Some possibilities

1. Urban decline [Glaeser Gyourko ‘05, Noto ‘13)], AKA ‘specific factors’
2. Changing worker composition (adverse selection)
3. Slow response of imports or exports
4. Dynamic labor demand adjustment
Impact of tariff change on regional wage premium

\[ \hat{w}_r = \sum_i \beta_{ri} \hat{P}_i + \sum_i \beta_{ri} \hat{A}_{ri} - \delta_r \left( \hat{L}_r - \sum_i \lambda_{ri} (1 - \zeta_i) \hat{K}_{ri} \right) \]

where \( \lambda_{ri} = \frac{L_{ir}}{L_r} \), \( \beta_{ri} \equiv \frac{\lambda_{ri}}{\sum_j \lambda_{ri} \varphi_i} \), \( \delta_r \equiv \frac{1}{\sum_j \lambda_{ri} \varphi_i} \)

1. **Increasing** in share of regional labor \( \lambda_{ri} \) allocated to affected industries

2. **Increasing** in labor’s share of output \((1 - \varphi_i)\) in affected industries

3. **Declining** in specific factor-shares of affected industries \( \zeta_i \)

- Specific factors bear some incidence
- *Absent specific factors, no differences in industry structure across regions*
Adding agglomeration economies

Simplify by assuming

1. Identical changes in capital rental rate across regions \( \hat{R} = \hat{R}_{ri} \forall r, i \)
2. Identical technologies across industries \((\varphi_i = \varphi \ \forall i \text{ and } \zeta_i = \zeta \ \forall i)\)

Perfectly mobile capital

• \( \therefore \) substitute change in capital, \( \hat{K}_{ri} \), for the change in capital’s price

Two additional elasticities needed

1. \( \eta \) labor supply elasticity
2. agglomeration elasticity of formal employment: \( \hat{A}_{ri} = \kappa \hat{L}_r, \kappa \geq 0 \)
Adding agglomeration economies

Two additional elasticities

1. \( \eta \) labor supply elasticity
2. agglomeration elasticity of *formal employment*: \( \hat{A}_{ri} = \kappa \hat{L}_r, \kappa \geq 0 \)

After a lot of algebra

\[
\hat{w}_r = \sum_i \beta_{ri} \hat{P}_i \frac{\eta}{\eta [1 - \varphi (1 - \zeta) - \kappa + \varphi \zeta]} - \frac{\varphi (1 - \zeta) \eta}{\eta [1 - \varphi (1 - \zeta) - \kappa + \varphi \zeta]} \hat{R}
\]

If agglomeration elasticity \( \kappa > 0 \), amplifies the wage impact of changes in regional labor supply or changes in the rental rate of capital
Scenarios for wage adjustment

\[ \hat{w}_r = \sum_i \beta_{ri} \hat{P}_i + \sum_i \beta_{ri} \hat{A}_{ri} - \delta_r \left( \hat{L}_r - \sum_i \lambda_{ri} (1-\zeta_i) \hat{K}_{ri} \right) \]

1. **Regional labor supply only factor to respond to liberalization:** 
   \( \hat{A}_{ri} = \hat{K}_{ri} = 0 \). \( \hat{w}_r \) falls following liberalization. Decline in \( L_r \) in formal sector buffers wage losses because \( \delta_r > 0 \). *Shock dies out over time (at lower wage levels)*

2. **Both \( \hat{L}_r \) and \( \hat{K}_{ri} \) adjust:** Sign \( (\hat{w}_r) \) depends on relative speed of \( L, K \) adjustment. If \( L_r \) fixed and \( K_{ri} \) falls, MRPL falls, \( \rightarrow \hat{w}_r \) falls further. *Adverse earnings impacts can rise over time*

3. **Add agglomeration of formal employment:** \( \hat{A}_{ri} = \kappa \hat{L}_r \). Trade shock decreases wages on impact. Formal employment falls due to \( \eta \). *Regional productivity drops due to de-agglomeration. \( \hat{w}_r, \hat{L}_r \) fall further*
Interesting testable implication

Negative cross-industry employment spillovers?

\[
\hat{L}_{ri} = \frac{1}{\varphi \zeta} \hat{P}_i - \frac{1}{\varphi \zeta} \times \frac{\eta [1 - \varphi (1 - \zeta)] - \kappa}{\eta [1 - \varphi (1 - \zeta) - \kappa + \varphi \zeta]} \sum_i \beta_{ri} \hat{P}_i
\]

\[
- \frac{\varphi (1 - \zeta) \eta}{\eta [1 - \varphi (1 - \zeta) - \kappa + \varphi \zeta]} \hat{R}
\]

Own price effect on industry employment is positive \( \frac{1}{\varphi \zeta} \hat{P}_i \)
Interesting testable implication

Cross industry employment effects

\[- \frac{1}{\varphi \zeta} \times \frac{\eta [1 - \varphi (1 - \zeta)] - \kappa}{\eta [1 - \varphi (1 - \zeta) - \kappa + \varphi \zeta]} \sum_i \beta_{ri} \hat{P}_i\]

Cross-Industry Employment effects

- **If** \( \kappa = 0 \), **decline in price of sector** \( i' \) **causes labor to flow into sector** \( i \)

- **If** \( \kappa > 0 \), **possible for this expression to be positive**—so flows not offsetting

  - **De-agglomeration more than offsets the buffering mechanism of elastic labor demand in non-shocked sectors**
Testing for agglomeration economies: Impact of other industry tariff reductions on own industry employment

\[
\hat{L}_{ri} = \gamma_0 + \gamma_1 \hat{P}_i + \gamma_2 RTR_r + \epsilon_{ri}
\]

Table 7: Test for Agglomeration Economies

<table>
<thead>
<tr>
<th>Change in log Region × Industry Employment:</th>
<th>All Industries</th>
<th>Tradable Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Regional tariff reduction (RTR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-7.751***</td>
<td>-6.084***</td>
<td>-6.183***</td>
</tr>
<tr>
<td>(0.625)</td>
<td>(0.623)</td>
<td>(0.631)</td>
</tr>
<tr>
<td>Industry tariff reduction</td>
<td>-1.790***</td>
<td>-1.666***</td>
</tr>
<tr>
<td>(0.294)</td>
<td>(0.290)</td>
<td>(0.291)</td>
</tr>
<tr>
<td>Formal employment pre-trend (86-90)</td>
<td>-0.106***</td>
<td>-0.147***</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.032)</td>
</tr>
</tbody>
</table>

Industry fixed effects (20) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
State fixed effects (26)   | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Dix-Carneiro and Kovak 2017
Log # of formal establishments and log average formal establishment size (workers), 1987 – 2010

Figure 7: Regional log Number of Formal Establishments and log Average Formal Establishment Size (Number of Workers) - 1987-2010
Log formal establishment exit and entry, 1987 – 2010: Suggests slow capital adjustment

Figure 8: Regional log Cumulative Formal Establishment Entry and Exit - 1987-2010
Scenarios for wage adjustment

\[ \hat{w}_r = \sum \beta_{ri} \hat{P}_i + \sum \beta_{ri} \hat{A}_{ri} - \delta_r \left( \hat{L}_r - \sum \lambda_{ri} (1-\zeta_i) \hat{K}_{ri} \right) \]

1. **Only regional labor supply responds to liberalization:**
   \( \hat{A}_{ri} = \hat{K}_{ri} = 0. \) \( \hat{w}_r \) falls following liberalization. Decline in \( L_r \) in formal sector buffers wage losses because \( \delta_r > 0. \) **Shock dies out over time (at lower wage levels).**

2. **Both \( \hat{L}_r \) and \( \hat{K}_{ri} \) adjust.** \( \hat{w}_r \) depends on relative speed of \( L, K \) adjustment. If \( L_r \) fixed and \( K_{ri} \) falls, MRPL falls, \( \rightarrow \hat{w}_r \) falls further. **Adverse earnings impacts can rise over time.**

3. **Add agglomeration of formal employment:** \( \hat{A}_{ri} = \kappa \hat{L}_r. \) Trade shock decreases wages on impact. Formal employment falls due to \( \eta. \) **Regional productivity drops due to de-agglomeration.** \( \hat{w}_r, \hat{L}_r \) fall further.
Table 8: Agglomeration Elasticity Estimates

<table>
<thead>
<tr>
<th>Panel A: Inverse labor supply elasticity ($\eta$)</th>
<th>0.363***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.060)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Agglomeration elasticity ($\kappa$)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Specific factors’ share of non-labor inputs ($\zeta$):</td>
<td>low (0.152)</td>
</tr>
<tr>
<td>Wage-based agglomeration elasticity ($\kappa$)</td>
<td>0.042*</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
</tr>
<tr>
<td>Employment-based agglomeration elasticity ($\kappa$)</td>
<td>0.215***</td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
</tr>
</tbody>
</table>

Labor supply elasticity, $\eta$, estimated from (12) using $RTR_r$ as an instrument for the change in regional log earnings premium. The first-stage partial F-statistic (Kleibergen-Paap) for this regression is 59.14. Given the estimate of $\eta$, the agglomeration elasticity, $\kappa$, is estimated using two alternative methods. The earnings-based approach estimates (13), and the employment-based approach estimates (14), both using nonlinear least squares, and both including 1986-1990 pre-liberalization outcome trends and state fixed effects. The employment-based estimates control for industry price changes as in column (3) of Table 7, and results using other approaches are very similar. We present estimates for three different values of $\zeta$, specific factors’ share of non-labor inputs, based on Valentinyi and Herrendorf (2008). See text for details. Standard errors (in parentheses) bootstrapped by regional resampling. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.
Inferred capital adjustment, 1987 – 2010

\[ \sum_{i} \beta_{ri} \hat{A}_{ri} + \varphi (1 - \zeta) \sum_{i} \lambda_{ri} \hat{K}_{ri} = \hat{w}_{r} - \sum_{i} \beta_{ri} \hat{P}_{i} + \varphi \hat{L}_{r} \]

\[ \eta = 0.363 \]
\[ \varphi = 0.544 \]
\[ \zeta = \{0.15, 0.35, 0.55\} \]
“A growing literature has shown in a variety of contexts that trade and trade policy have heterogeneous effects across regions in the short-run. However, most researchers, ourselves included, generally assumed that these effects would be upper bounds on the long-run effects, as labor reallocation would arbitrage away regional differences. This paper finds precisely the opposite.”
Some open questions

1. What *causes* agglomeration economies?
   - Input-output linkages
   - Marshallian knowledge spillovers

2. What is the role of the formal versus informal sector in generating ‘agglomeration’?

3. Why is there so little regional mobility?

4. What is the correct definition of a regional/local labor market?