Micro- and Macroeconomic Impacts of a Place-Based Industrial Policy

Enghin Atalay[1,2] Ali Hortaçsu[3] Mustafa Runyun[4] Chad Syverson[3]
Mehmet Fatih Ulu[5]

2: Federal Reserve Bank of Philadelphia, 3: University of Chicago,

4: Boston College, 5: Koç University

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[1]The views expressed in this presentation are solely those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

This Presentation

- Analyze the impacts of a new set of place-based subsidies, introduced in Turkey in 2012
  - Eligibility varies by industry
  - Generosity varies by geography
- Micro:
  - Firm-level balance sheet and subsidy take-up data to assess direct impacts
  - Production network data to measure indirect effects from subsidized firms to their customers and suppliers
- Macro:
  - Dynamic general equilibrium model with migration and trade to examine impact on regional real wage inequality
  - Measure channels through which subsidies spill over from targeted to non-targeted regions.

Research Questions

1. Did the program increase subsidized firms' (and industries') revenues, productivity (and, in the paper: employment, capital)?

2. Did subsidies spill over from subsidized firms to their customers and suppliers?

3. Did the program reduce regional wage inequality? In the short run? In the long run?

What We Find

1. Did the program increase subsidized firms' (and industries') revenues, productivity (and, in the paper: employment, capital)?
   Yes: A 5 p.p. increase in the investment tax credits corresponds to a 3.2% increase in firms' TFPR.

2. Did subsidies spill over from subsidized firms to their customers and suppliers?
   Yes: Effect of having subsidized customers/suppliers is $\sim$ one-twentieth the effect of direct subsidization.

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3. Did the program reduce regional wage inequality? In the short run? In the long run?
   Yes. But, migration and spillovers via input-output linkages mitigate relative impact on targeted regions.

Contribution to the Literature

1. Evaluations of place-based policies: Bernini and Pellegrini (2011), Pauline, Rathelot, Sillard (2013), Busso, Gregory, Kline, (2013), Kline and Moretti (2014), Criscuolo et al. (2019)
   Our contribution: First to evaluate firm-level and aggregate impacts of Turkey's Law 2012/3305. Long-run vs. short-run and partial-equilibrium vs. general-equilibrium comparisons.

2. Spillovers within production networks: Barrot and Sauvagnat (2016), Carvalho et al. (2020), Demir et al. (2024)
   Our contribution: Examine spillovers from subsidies

3. Gen. eq. trade and migrations responses to policy reforms (or to other shocks): Kleinman, Liu, and Redding (2023), Caliendo, Dvorkin, Parro (2019), Monras (2020)
   Our contribution: New application.

Outline

1. Institutional Background
2. Detecting the direct impacts of the subsidies
3. Identifying indirect effects
4. Assessing the impact on regional wage inequality

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Turkey introduced place-based subsidies in 2012

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Only firms in certain industries — mining, manufacturing, warehousing, a few others — are eligible to receive subsidies.

Multiple subsidy elements:

1. VAT and customs duties exemptions on investment machinery and equipment
2. support on interest rate payments (on private loans): no support in Regions 1 and 2 to 3-7 p.p.in Region 6
3. corporate tax credits: 15% of investment costs in Region 1 to 50% in Region 6;
4. support for contributions to employees' social security payments: 2 years in Region 1 up to 10 years in Region 6.

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Turkey introduced place-based subsidies in 2012

Targeted regions were poorer, prior to 2012

	Region						
	1	2	3	4	5	6	National
Population in 2011 (millions)	30.4	11.2	9.8	7.9	6.6	8.8	74.7
GDP Per Capita, 2011 (,000 TL)	27.36	16.54	14.95	13.38	11.23	8.30	18.95
Net Migration Rate, 2011 (%)	0.86	0.07	-0.33	-0.60	-1.09	-1.24	—
GDP Per Capita Growth Rate: 2006-2011	1.5	2.0	2.2	3.4	3.9	3.7	2.3

Targeted regions were a source of domestic migration

	Region						
	1	2	3	4	5	6	National
Population in 2011 (millions)	30.4	11.2	9.8	7.9	6.6	8.8	74.7
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Targeted regions had faster pre-policy growth

	Region						
	1	2	3	4	5	6	National
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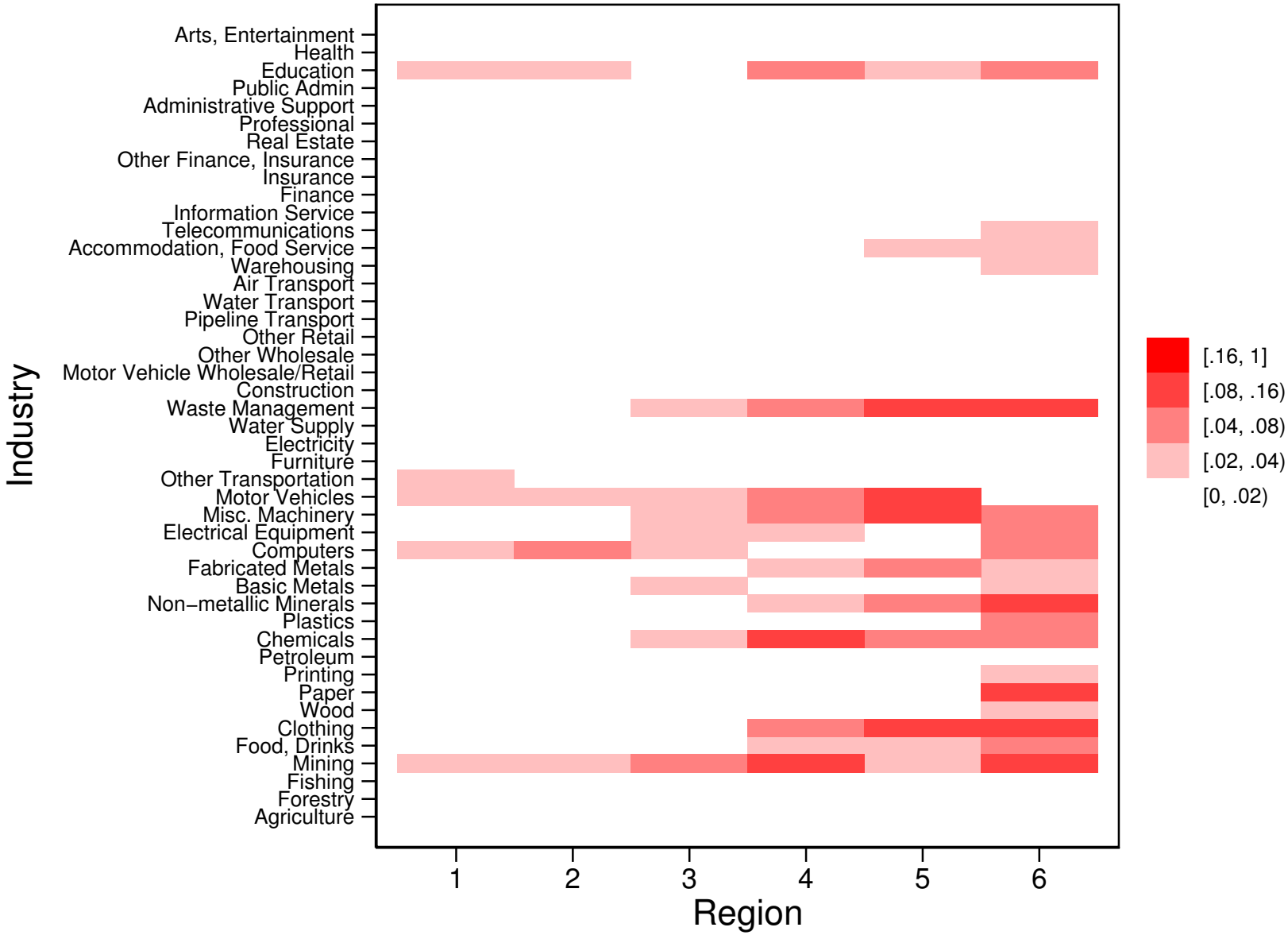
Subsidization varies by geography and industry



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Data

Main Components

- Firm balance sheet data: 2006-2019
- Firm-to-firm production network: 2006-2019
- Subsidization take-up: 2012-2019
- Linked employer-employee data: 2012-2019: Used to compute migration rates

Caveats

- Only covers firms and employees in the formal economy
  - Use estimates of formality by region and by industry when calibrating our aggregate model
- Firm-level balance sheet data links industries provinces to that of the headquarter firm
  - For multi-establishment firms, we can observe employment by establishment & where subsidy took place
  - Industry-level exercises records subsidization at the proper industry and province

Our empirical setup to detect direct effects

$$y_{pnt} = \beta_{pn} + \beta_{nt} + \beta_1 S_{pnt} + \varepsilon_{pnt}$$

- p=province; n=industry; t=year; y_{pnt}=activity measure; S_{pnt}=subsidy measure

Two concerns

1. Subsidies were targeted towards already-fast-growing regions: Pre-trends?

2. Not all eligible firms received subsidies; measurement error in subsidies received

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2. Not all eligible firms received subsidies; measurement error in subsidies received
   Instrument received subsidies with statutory eligibility/generosity; e.g.,
   0.50 for a region 6 firm in an eligible industry post 2012;
   0.15 for a region 1 firm in an eligible industry post 2012;
   0 for a firm in an ineligible industry or before 2012

Examining pre-trends

$$y_{pnt} - y_{pn,2011} = \beta_{n,t} + \beta_{p,t} + \beta_{1t}\widetilde{S}_{pn} + \varepsilon_{pnt}$$

- p=province; n=industry; t=year; $y_{pnt} - y_{pn,2011}$=activity measure relative to 2011; $\widetilde{S}_{pn}$=statutory eligibility/generosity post 2012

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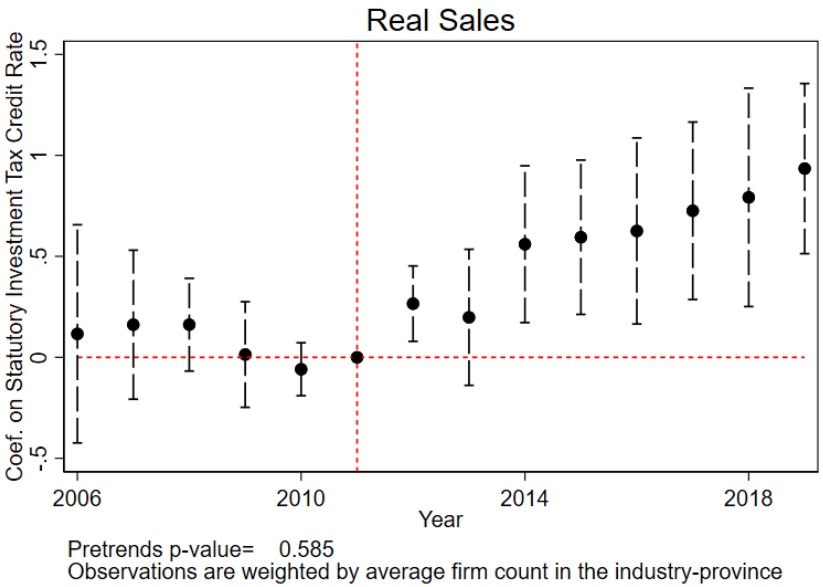

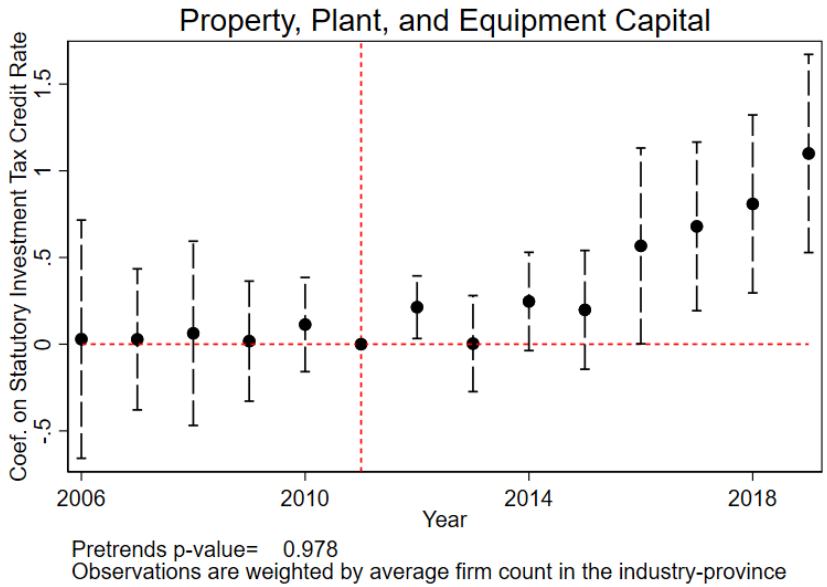

Impact of Subsidies On Industry Revenues

$$y_{pnt} = \beta_{pn} + \beta_{nt} + \beta_1 S_{pnt} + \varepsilon_{pnt}$$

Dependent Variable	Revenues	
	(1)	(2)
Investment Tax Credit Rate	2.112*	6.335***
	(1.275)	(2.081)
First Stage		
Statutory rate on investment tax credits	0.211***	0.161***
	(0.057)	(0.038)
Year FEs	Yes	No
Year ×Industry FEs	No	Yes
N	238,206	237,747

- 5 p.p. ↑ in investment tax credit subsidies received $\Longleftrightarrow$ 10.6% to 31.7% higher revenues.

Impact of Subsidies On Industry Revenues & Capital Stock

$$y_{pnt} = \beta_{pn} + \beta_{nt} + \beta_1 S_{pnt} + \varepsilon_{pnt}$$

Dependent Variable	Revenues		Capital Stock	
	(1)	(2)	(3)	(4)
Investment Tax Credit Rate	2.112*	6.335***	-0.617	6.333***
	(1.275)	(2.081)	(1.012)	(2.282)
First Stage				
Statutory rate on investment tax credits	0.211***	0.161***	0.211***	0.161***
	(0.057)	(0.038)	(0.057)	(0.038)
Year FEs	Yes	No	Yes	No
Year ×Industry FEs	No	Yes	No	Yes
N	238,206	237,747	237,888	237,422

- 5 p.p. ↑ in investment tax credit subsidies received $\iff$ –3.1% to 31.7% change in plant, property, and equipment capital.

Impact of Subsidies On Firm Revenues

$$y_{ft} = \beta_{nt} + \beta_f + \beta_1 S_{ft} + \varepsilon_{ft}$$

Dependent Variable	Revenues	
	(1)	(2)
Investment Tax Credit Rate	2.687***	3.254***
	(0.487)	(0.604)
First Stage		
Statutory rate on investment	0.140***	0.132***
tax credits	(0.010)	(0.019)
Year FEs	Yes	No
Year ×Industry FEs	No	Yes
N	881,484	881,088

- 5 p.p. ↑ in investment tax credit subsidies received $\iff$ 16.3% higher revenues.

Impact of Subsidies On Firm Revenues and TFP

$$y_{ft} = \beta_{nt} + \beta_f + \beta_1 S_{ft} + \varepsilon_{ft}$$

Dependent Variable	Revenues		TFP	
	(1)	(2)	(3)	(4)
Investment Tax Credit Rate	2.687***	3.254***	0.979***	0.657***
	(0.487)	(0.604)	(0.170)	(0.220)
First Stage				
Statutory rate on investment	0.140***	0.132***	0.142***	0.135***
tax credits	(0.010)	(0.019)	(0.010)	(0.019)
Year FEs	Yes	No	Yes	No
Year ×Industry FEs	No	Yes	No	Yes
N	881,484	881,088	824,585	824,199

- 5 p.p. ↑ in investment tax credit subsidies received $\iff$ 3.2% higher TFPR.

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1. Institutional Background
2. Detecting the direct impacts of the subsidies
3. **Identifying indirect effects**
4. Assessing the impact on regional wage inequality

Indirect Effects

In our macro-model calibration: key object of interest is *direct* productivity impact of subsidization on productivity

Subsidies in one firm potentially spill over...

- ... to customers or suppliers: Let $s_{f\to\vartheta}^{\text{upstream}}$ and $s_{\vartheta\to f}^{\text{downstream}}$ denote share of f's suppliers or customers who are subsidized
- ... to local wages: let w_{npt} denote average wage in year t, in industry n, and province p

$$\begin{aligned} y_{ft} &= \beta_f + \beta_{nt} + \beta_1 S_{ft} + \beta_2 \cdot w_{npt} \\ &\quad + \beta_{\text{up}} s_{\vartheta\to ft}^{\text{upstream}} + \beta_{\text{down}} s_{f\to\vartheta,t}^{\text{downstream}} + \varepsilon_{ft} \end{aligned}$$

Impact of Subsidies On Revenues and TFP

$$y_{ft} = \beta_f + \beta_{nt} + \beta_1 S_{ft} + \beta_2 \cdot w_{npt} + \beta_{\text{up}} s^{\text{upstream}}_{\vartheta \to ft} + \beta_{\text{down}} s^{\text{downstream}}_{f \to \vartheta, t} + \varepsilon_{ft}$$

Dependent Variable	Revenues		TFP	
	(1)	(2)	(3)	(4)
Investment Tax Credit Rate Received	2.535***	2.548***	1.041***	0.647***
	(0.354)	(0.514)	(0.208)	(0.186)
Weight of subsidized firms in total sales	0.095***	0.059***	-0.002	-0.009
	(0.012)	(0.012)	(0.007)	(0.007)
Weight of subsidized firms in total purchases	0.068***	0.083***	0.030**	0.030**
	(0.012)	(0.013)	(0.015)	(0.012)
Log daily wage in local labor market	0.051***	0.034***	-0.017***	-0.008
	(0.010)	(0.009)	(0.006)	(0.005)
Instrument for S_{ft}?	Yes	Yes	Yes	Yes
Year FEs	Yes	No	Yes	No
Year $\times$Industry FEs	No	Yes	No	Yes
N	791,598	791,252	744,754	744,384

- 5 p.p. $\uparrow$ in investment tax credit subsidies received $\iff$ 3.2% higher TFPR

Impact of Subsidies On Revenues and TFP

$$y_{ft} = \beta_f + \beta_{nt} + \beta_1 S_{ft} + \beta_2 \cdot w_{npt} + \beta_{\text{up}} s^{\text{upstream}}_{\vartheta \to ft} + \beta_{\text{down}} s^{\text{downstream}}_{f \to \vartheta, t} + \varepsilon_{ft}$$

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- 5 p.p. $\uparrow$ counterparties' subsidization $\Longleftrightarrow$ 0.7%$\uparrow$ revenues

Impact of Subsidies On Revenues and TFP

$$y_{ft} = \beta_f + \beta_{nt} + \beta_1 S_{ft} + \beta_2 \cdot w_{npt} + \beta_{\text{up}} s^{\text{upstream}}_{\vartheta \to ft} + \beta_{\text{down}} s^{\text{downstream}}_{f \to \vartheta, t} + \varepsilon_{ft}$$

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- 5 p.p. $\uparrow$ counterparties' subsidization $\Longleftrightarrow$ 0.7%$\uparrow$ revenues, 0.1%$\uparrow$ TFPR

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1. Institutional Background
2. Detecting the direct impacts of the subsidies
3. Identifying indirect effects
4. **Assessing the impact on regional wage inequality**

We apply a quantitative spatial g.e. model to understand the subsidy policy's impact on regional inequality

We extend a version of the model in Kleinman, Liu, and Redding (2023) See the equations

- Households
  - Consume output specific to their region and industry.
  - Face dynamic migration decision on where to work in the future
    - Depends on expectations over future real wages, time-invariant migration costs, i.i.d. taste shocks
- Capital Investors
  - Also indexed by region and industry
  - Face dynamic capital investment decision on how much capital to invest, where to invest (with a potential home bias.)
  - Returns to investing in a destination industry-region exogenously vary over time.
- Landlords
  - Rent out the land they own to intermediate goods firms. Consume.

We apply a quantitative spatial g.e. model to understand the subsidy policy's impact on regional inequality

We extend a version of the model in Kleinman, Liu, and Redding (2023) See the equations

- Intermediate goods firms
  - Operate with CRS production function: labor, capital, material inputs.
  - Time-varying labor productivity.
  - Sell output to "final goods producers."
- Final goods firms
  - Bundle different varieties with a CES production function.
  - Source inputs from intermediate goods firms. The share of varieties sourced from a given region depends on suppliers' marginal cost, iceberg trade costs
  - Output is bundled, sold to households for consumption and intermediate goods producers as material inputs

Key spatial spillovers in the model

- Input-output linkages
  - Subsidy lowers marginal costs downstream of subsidized firms, increases labor demand upstream
- Domestic migration
  - In-migration to subsidized areas reduces real wages in subsidized region-industries
- Capital rents
  - Increases in rental income of land and capital in subsidized areas benefit landowners and capital investors throughout the country

The subsidy plan had a modest impact on real wage inequality

Object of interest: What is the effect of the subsidy policy's on real wages (and employment, capital intensity, population) in each region-industry pair?

- Consider counterfactual equilibrium: Suppose labor productivity and capital returns were lower (especially in subsidized region-industries) absent the policy
  - We estimated: 1 p.p. increase in investment tax credits $\rightarrow$0.647% increase in TFP.
  - Assume $\frac{1}{3}$ of the benefit of the policy accrues through labor productivity, $\frac{2}{3}$ through capital returns.
  - Combine with info on investment tax credits received by industry$\times$region$\times$year.
  - (In the paper: Alternate calibration based on moment-matching industry-region revenue and employment.

Impact of subsidy on Region 5 relative to Region 1 real wages

- In 2015: 0.8 percentage points (1.3% increase in Region 5 vs. 0.5% in Region 1)
- In 2020: 0.9 p.p.
- In 2025: 0.9 p.p.
- In 2030: 0.9 p.p.
- In 2040: 1.1 p.p.

We consider three additional calibrations of our model

1. "No migration": Utility cost of migrating across subsidy regions is infinite; households may switch industries within regions
2. "No migration, autarky": Also, the iceberg cost across subsidy regions is infinite.
3. "No migration, autarky, no capital flows": Capital investors only invest in their own subsidy region.

Spillovers due to migration, trade linkages, and capital income blunt the policy's impact on real wage inequality

	2015	2020	2025	2030	2040
Benchmark	0.8 p.p.	0.9 p.p.	0.9 p.p.	0.9 p.p.	1.1 p.p
No Migration	0.9 p.p.	1.3 p.p.	1.5 p.p.	1.6 p.p.	1.9 p.p.
No Migration, Autarky	0.8 p.p.	1.4 p.p.	1.7 p.p.	1.9 p.p.	2.8 p.p.
No Migration, Autarky, No Capital Flows	1.0 p.p.	1.8 p.p.	2.4 p.p.	2.8 p.p.	3.6 p.p.

Conclusion

Results

- Micro: 2012 subsidy program had substantial impact on treated firms' sales, TFP (in the paper: investment, employment).
- Macro: 2012 subsidy program had modest impact on regional real wage inequality.

Implications for the place-based policy literature:

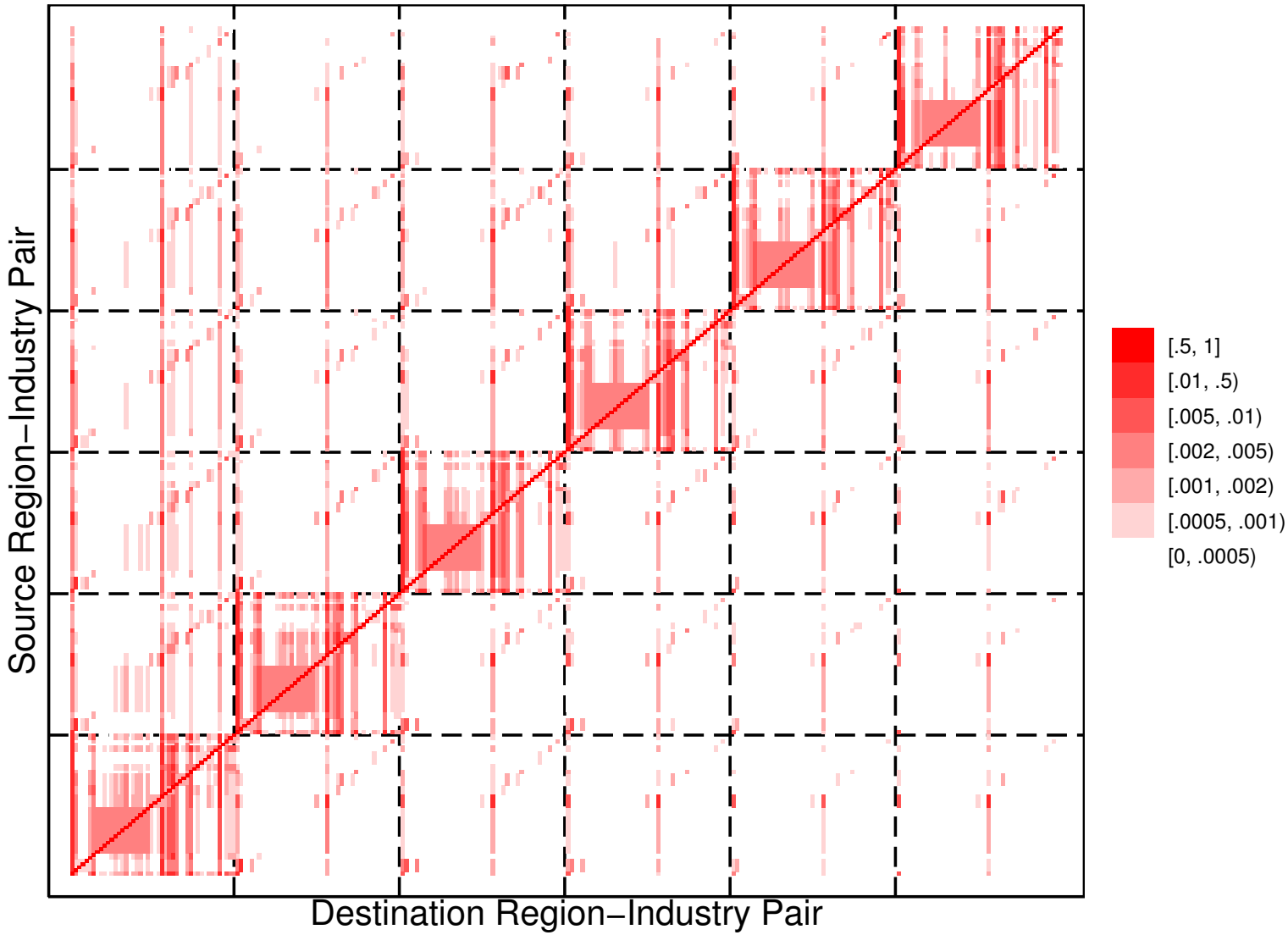
- Migration and capital stocks respond slowly to real-wage differentials $\Rightarrow$Short- and long-run impacts; partial and general equilibrium subsidy impacts differ considerably.
- Spillovers need not be restricted to nearby geographic areas.

Open questions:

- To what extent did the policy boost nation-wide investment? Was the policy cost effective?

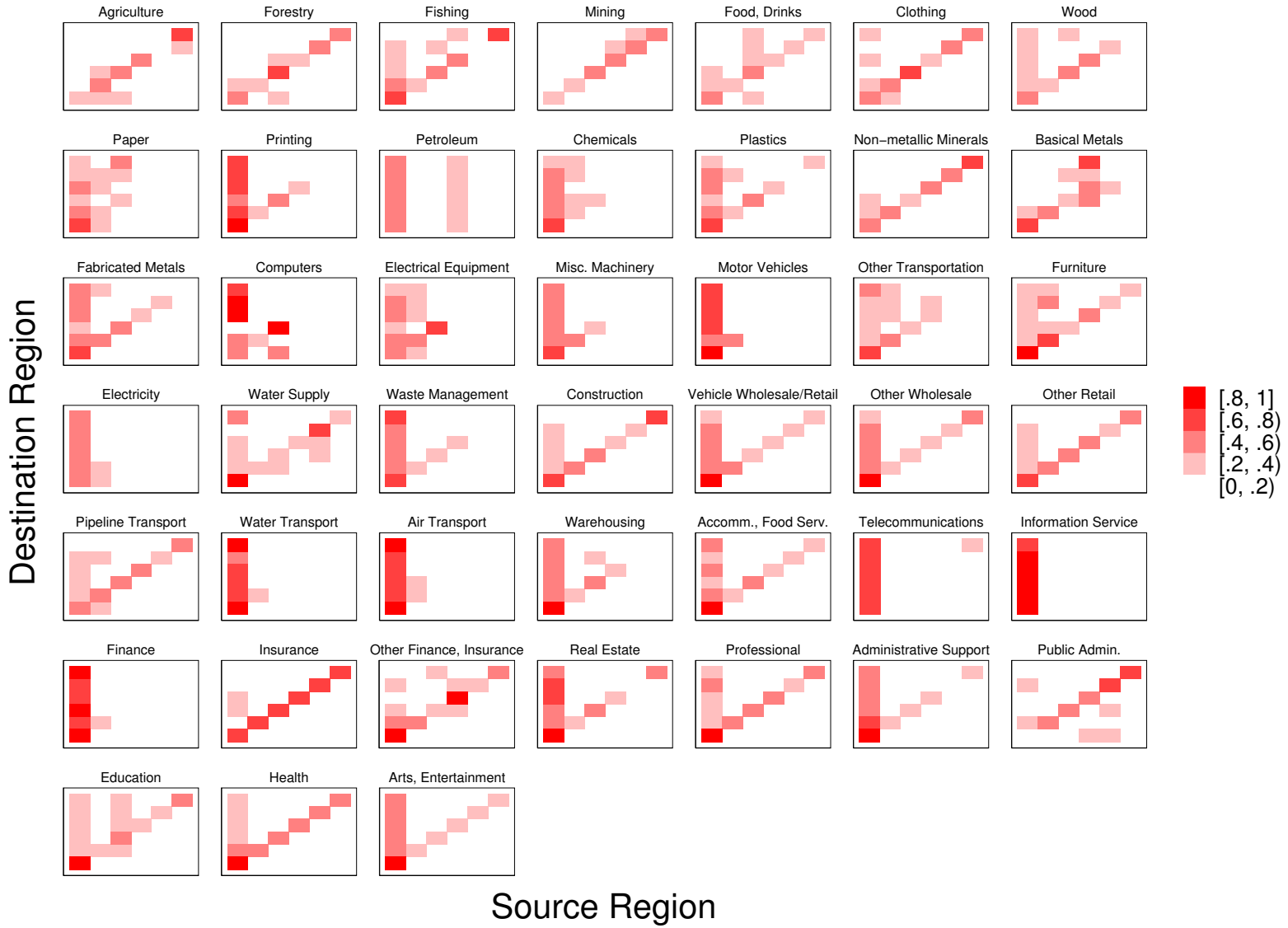
Flows of Individuals Across Region-Industry Pairs

Go back



Trade Flows Across Region-Industry Pairs

Go back



We apply a quantitative spatial g.e. model to understand aggregate effects

We extend the model of Kleinman, Liu, and Redding (2023) Go back

- Households
  - Consume output specific to their region and industry.
  - Face dynamic migration decision on where to work in the future
    - Depends on expectations over future real wages, time-invariant migration costs (κ_{gi}^{hj}), i.i.d. taste shocks (ε_{gt}^{h})
  - Lifetime utility

$$\mathbb{V}_{it}^{j,w} = \log u_{it}^{j,w} + \max_{g,h}\left\{\beta \mathbb{E}_t\left[\mathbb{V}_{g,t+1}^{h,w}\right] - \kappa_{gi}^{hj} + \rho\varepsilon_{gt}^{h}\right\}$$

$$\log u_{it}^{j,w} = \log b_i^j + \sum_{h=1}^{J} \psi^h \frac{\theta+1}{\theta} \log\left[\sum_{n=1}^{N}\left(c_{n,i,t}^{hj,w}\right)^{\theta/(\theta+1)}\right]$$

- Landlords
  - Rent out the land they own to intermediate goods firms. Consume.

We apply a quantitative spatial g.e. model to understand aggregate effects

We extend the model of Kleinman, Liu, and Redding (2023) Go back

- Capital investors
  - Consume output specific to their region and industry i, h.
  - Face dynamic decision on how much to consume vs. invest in capital.
    - Allocate $\phi_{ih \to nj}$ of their portfolio in region region n and industry j
  - Intertemporal/period preferences

$$\mathbb{V}_{it}^{j,k} = \sum_{t=0}^{\infty} \beta^t \log C_{i,t}^{j,k}$$

$$\log C_{i,t}^{j,k} = \sum_{h=1}^{J} \psi^h \frac{\theta+1}{\theta} \log \left[\sum_{n=1}^{N} \left(c_{n,i,t}^{h,j,k} \right)^{\theta/(\theta+1)} \right]$$

  - Returns to holding capital in region n and industry j vary exogeneously

$$\log \mathcal{R}_{i,t}^{h} = \sum_{n=1}^{N} \sum_{h=1}^{J} \phi_{ih \to nj} \log \left[r_{nt}^{j} \cdot \left(\tau_{nj,t}^{K} \right)^{-1} \right]$$

We apply a quantitative spatial g.e. model to understand aggregate effects

We extend the model of Kleinman, Liu, and Redding (2023) Go Back

- Intermediate goods firms
  - Operate with CRS production function: labor, capital, land, material inputs

$$\mathbb{C}_{it}^{j} = \left[\left(\frac{w_{it}^{j}}{z_{it}^{j}}\right)^{\mu^{j}} \left(r_{it}^{j}\right)^{1-\mu^{j}-\alpha^{j}} \left(\tilde{r}_{it}^{j}\right)^{\alpha^{j}}\right]^{\gamma^{j}} \prod_{h=1}^{J} \left(p_{it}^{h}\right)^{\gamma^{j,h}}$$

  - Labor productivity is subject to agglomeration effects:

$$z_{it} = \bar{z}_{it}^{j} \left(\bar{l}_{it}^{j}\right)^{\eta}$$

We apply a quantitative spatial g.e. model to understand aggregate effects

We extend the model of Kleinman, Liu, and Redding (2023) Go Back

- Capital accumulation
  - Capital is industry-region specific

$$\mathcal{K}^j_{i,t+1} = (1-\delta)\,\mathcal{K}^j_{i,t} + \sum_{h=1}^{J}\sum_{n=1}^{N} \iota^{h,j}_{n,i,t}$$

- Goods market clearing
  - Expenditures on good j in region i equal total consumption — by workers, landlords, capital investors — plus intermediate input purchases:

$$y^j_{it} = \sum_{n=1}^{N} S^j_{nit}\left[\psi^j\left(\sum_{h=1}^{J}\left(w^h_{nt}\ell^h_{nt} + r^h_{nt}k^h_{nt} + \tilde{r}^h_{nt}\tilde{k}^h_{nt}\right)\right) + \sum_{h=1}^{J}\gamma^{h,j}y^h_{nt}\right].$$