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

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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.

Background

- Regional inequality is ubiquitous...
  - Income per capita in the poorest US MSA (McAllen, TX) is 20 percent that of the richest MSA (Midland, TX)
  - Similar ratio in Turkey: İstanbul ($15,200 GDP per capita in 2019) vs. Ağrı ($2,900)
- ... and motivates many government place-based initiatives
  - TVA and urban Empowerment Zones in the U.S.; Law 488/1992 in Italy; Zones Franches Urbaines in France
- Little analysis so far on place-based policies in developing countries; spillovers through the production network; short-vs-long-run g.e. effects.

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 to examine impact on regional real wage inequality

Research Questions

1. Did the program increase subsidized firms' (and industries') employment, investment, productivity?

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') employment, investment, productivity?
   Yes: A 5 p.p. increase in the investment tax credits corresponds to a 3.1% 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-tenth effect of direct subsidization.

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

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3. Did the program reduce regional wage inequality? In the short run? In the long run?
   Only very slightly: Regional real wage inequality will decrease by less than 1 p.p. in the long run
   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.
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   Our contribution: Examine spillovers from subsidy reforms

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3. Gen. eq. trade and migrations responses to policy reforms (or to other shocks): Caliendo, Dvorkin, Parro (2019), Monras (2020), Caliendo, Opromolla, Parro, Sforza (2021)
   Our contribution: New application.

Outline

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

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Turkey introduced place-based subsidies in 2012

Subsidies are a mix of tax reductions and other supports:

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 deductions: 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;

Multi-step process to receive subsidies:

- Eligible firms apply Turkish Ministry of Industry and Technology
  - Receive investment certificate, which "closes" only after the investment is complete
- "Open certificate": receive subsidy items (1) and (2)
- "Closed certificate": receive subsidy items (3) and (4)

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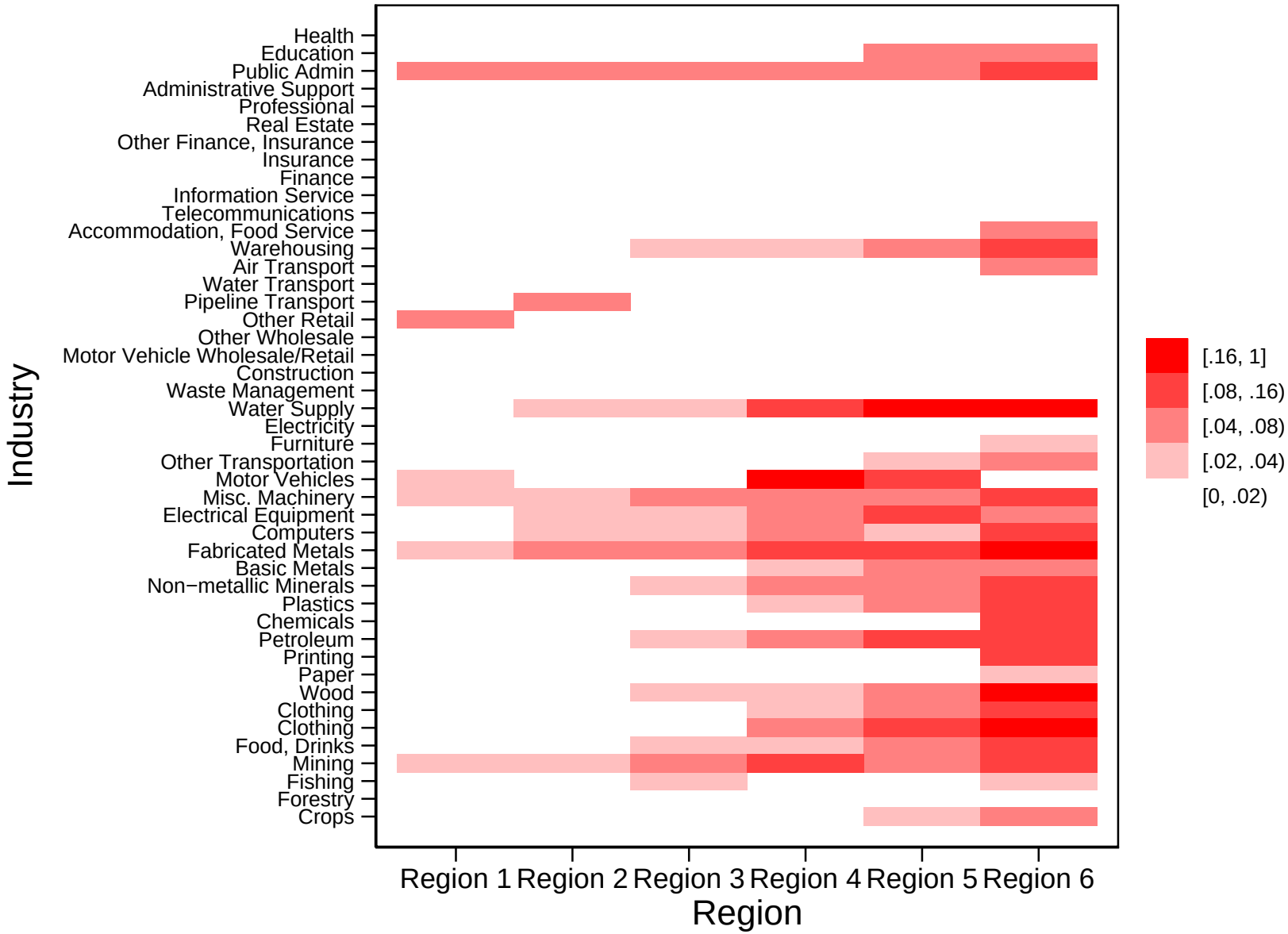
Subsidization varies by geography...

Subsidization varies by geography and industry



Target areas were relatively poor, fast-growing in the pre-reform period

	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 in 2011 (,000 Turkish Lira)	27.36	16.54	14.95	13.38	11.23	8.30	18.95
Net Migration Rate in (%) in 2011	0.86	0.07	-0.33	-0.60	-1.09	-1.24	—
GDP Per Capita in Growth Rate (%), Mean: 2006-2011	1.5	2.0	2.2	3.4	3.9	3.7	2.3

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Data

Main Components

- Firm balance sheet data: 2006-2018
- Firm-to-firm production network: 2006-2018
- Subsidization take-up: 2012-2018
- Linked employer-employee data: 2012-2018: Used to compute migration rates

Caveats

- Only covers firms and employees in the formal economy
- 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

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Two concerns

1. Subsidies were targeted towards already-fast-growing regions: Pre-trends? Explore pre-period growth in industry-provinces before 2012.

2. Not all eligible firms received subsidies
   Instrument received subsidies with measures of statutory eligibility/generosity

Examining pre-trends

$$y_{pnt} - y_{pn,2011} = \beta_{n,t} + \beta_{p,t} + \beta_{1t} S_{pn,2018} + \varepsilon_{pnt}$$

- p=province; n=industry; t=year; $y_{pnt} - y_{pn,2011}$=activity measure relative to 2011; $S_{pn,2018}$=subsidy measure at the end of the sample

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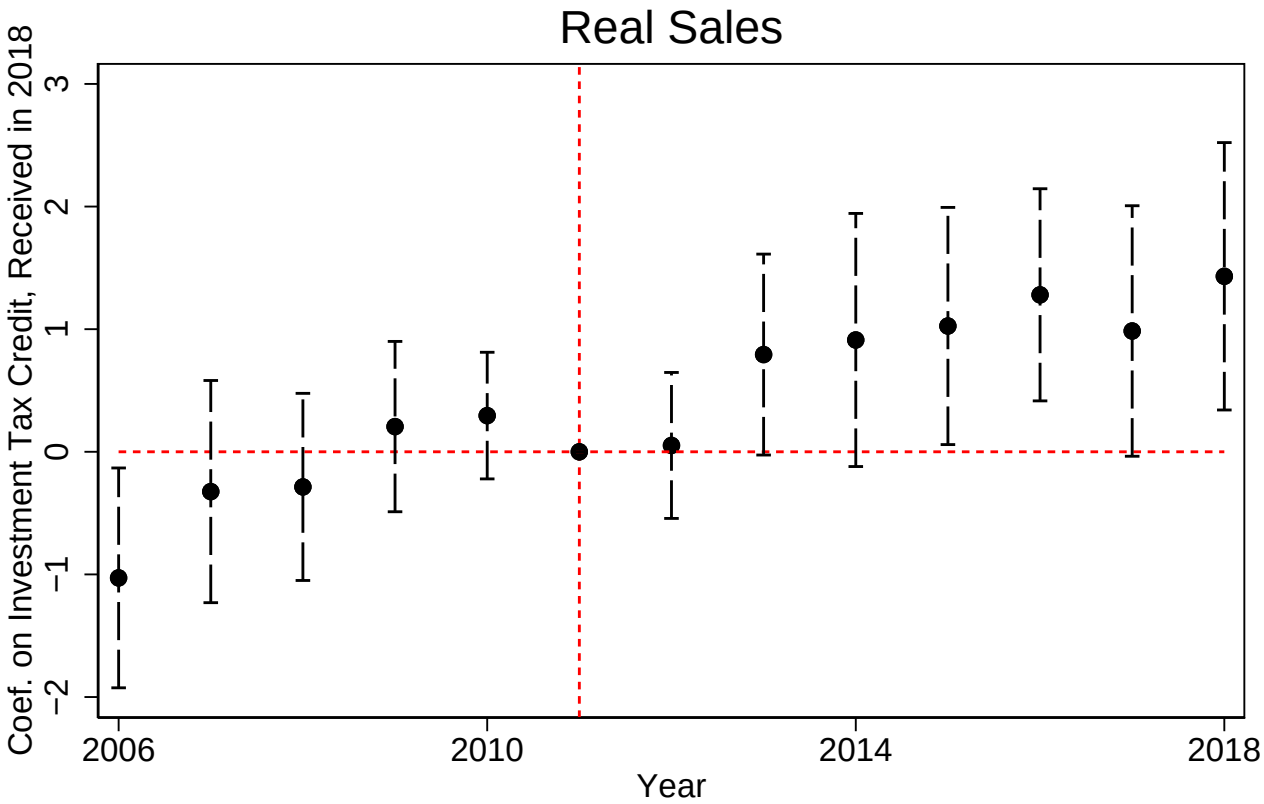

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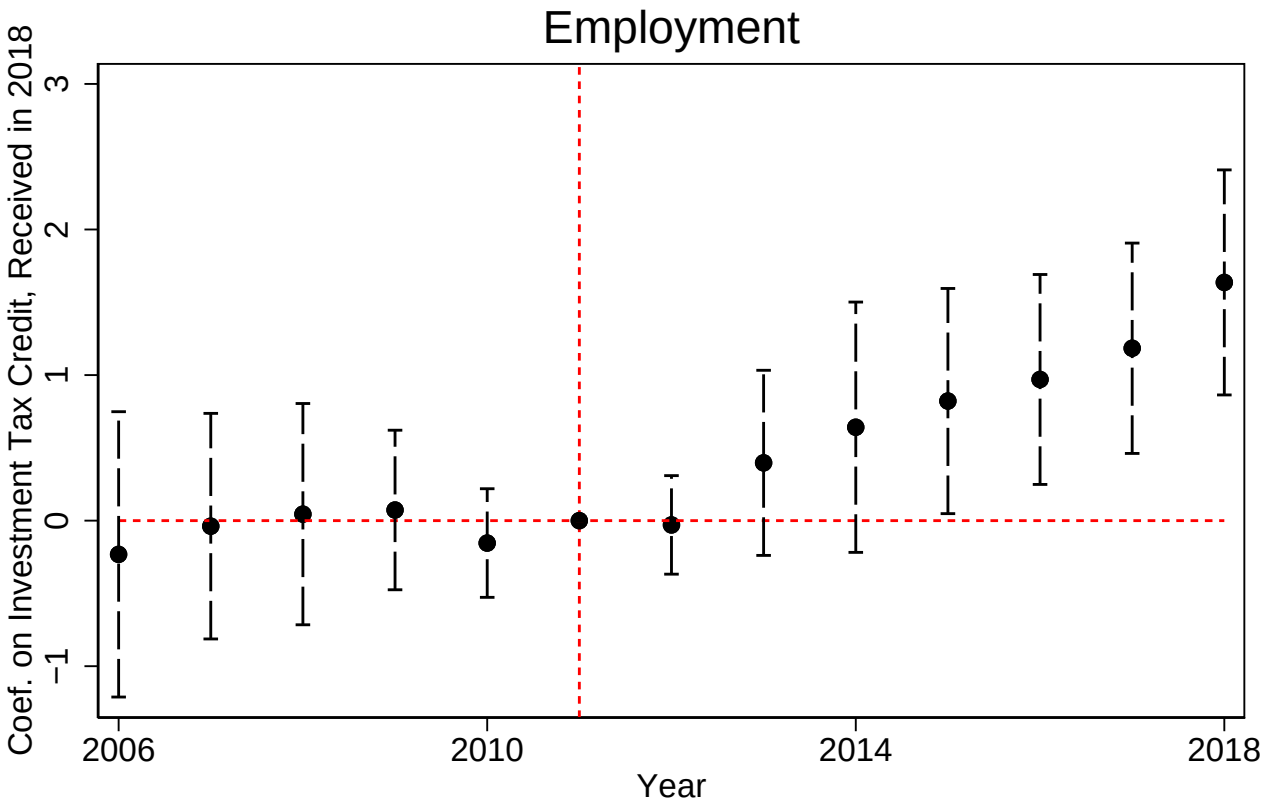

Impact of Subsidies On Industry Sales

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

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

Dependent Variable	Log(Sales)		Log(Employment)		Log(Number of Firms)	
	(1)	(2)	(3)	(4)	(5)	(6)
Investment Tax Credit	1.146***	8.934***	0.817***	3.657***	0.682***	4.003***
Subsidy	(0.279)	(1.610)	(0.207)	(1.235)	(0.122)	(0.766)
Year-Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Province-Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
N	221,366	221,366	219,743	219,743	221,366	221,366
R^2	0.915		0.926		0.962	
First Stage						
Statutory rate, investment		0.075***		0.075***		0.075***
tax credit subsidy		(0.007)		(0.007)		(0.007)

Impact of Subsidies On Firm Revenues

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

	OLS		IV			
	(1)	(2)	(3)	(4)	(5)	(6)
Investment Tax Credit	0.920***		2.561***	2.104***		
Subsidy	(0.063)		(0.501)	(0.485)		
Investment Tax Credit		1.127***			3.579***	2.904***
Subsidy + Closed		(0.078)			(0.780)	(0.734)
Certificate						
N	855,404	841,118	853,158	816,819	838,850	802,431
Firm FEs	Yes	Yes	No	Yes	No	Yes
Province-Industry F.E.	No	No	Yes	No	Yes	No
R^2	0.835	0.837				
			First Stage			
Statutory rate, investment			0.153***	0.138***	0.109***	0.097***
tax credit subsidy			(0.011)	(0.011)	(0.010)	(0.010)

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Statutory rate, investment tax credit subsidy			0.153*** (0.011)	0.138*** (0.011)	0.109*** (0.010)	0.097*** (0.010)

- 5 p.p. ↑ in investment tax credit subsidies received $\iff$ 10.5% higher revenues.

Impact of Subsidies On Firm Employment

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

	OLS		IV			
	(1)	(2)	(3)	(4)	(5)	(6)
Investment Tax Credit	1.149***		1.591***	1.387***		
Subsidy	(0.090)		(0.400)	(0.449)		
Investment Tax Credit		1.453***			2.281***	1.899***
Subsidy + Closed		(0.103)			(0.570)	(0.623)
Certificate						
N	859,099	844,326	856,862	820,579	842,064	805,704
Firm FEs	Yes	Yes	No	Yes	No	Yes
Province-Industry F.E.	No	No	Yes	No	Yes	No
R^2	0.850	0.852				
			First Stage			
Statutory rate, investment			0.154***	0.140***	0.110***	0.099***
tax credit subsidy			(0.011)	(0.011)	(0.010)	(0.010)

- 5 p.p. $\uparrow$ in investment tax credit subsidies received $\Longleftrightarrow$ 6.9% higher employment.

Impact of Subsidies On Firm TFP

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

	OLS		IV			
	(1)	(2)	(3)	(4)	(5)	(6)
Investment Tax Credit	-0.077**		1.618***	0.697***		
Subsidy	(0.031)		(0.272)	(0.242)		
Investment Tax Credit		0.028			2.453***	1.162***
Subsidy + Closed		(0.048)			(0.440)	(0.351)
Certificate						
N	755,282	740,882	753,013	720,311	738,610	705,834
Firm FEs	Yes	Yes	No	Yes	No	Yes
Province-Industry F.E.	No	No	Yes	No	Yes	No
R^2	0.718	0.722				
			First Stage			
Statutory rate, investment			0.151***	0.135***	0.105***	0.093***
tax credit subsidy			(0.011)	(0.011)	(0.010)	(0.010)

- 5 p.p. $\uparrow$ in investment tax credit subsidies received $\iff$ 3.5% higher TFPR.

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

Indirect Effects

In our 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

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

Impact of Subsidies On Revenues and TFP

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

Dependent Variable	Revenues		TFP	
	(1)	(2)	(3)	(4)
Investment Tax Credit Subsidy	2.254***	2.235***	1.337***	0.612*
	(0.480)	(0.370)	(0.345)	(0.355)
Weight of subsidized firms in total sales	0.119***	0.067***	0.157***	0.035***
	(0.021)	(0.014)	(0.019)	(0.010)
Weight of subsidized firms in total purchases	0.357***	0.065***	-0.093**	0.035**
	(0.015)	(0.013)	(0.038)	(0.017)
Log daily wage in local labor market	0.088***	0.049***	0.043***	0.019**
	(0.011)	(0.009)	(0.011)	(0.009)
Instrument for S_{ft}?	Yes	Yes	Yes	Yes
Firm Fixed Effects	No	Yes	No	Yes
N	836,192	785,583	713,096	667,460

- 5 p.p. $\uparrow$ in investment tax credit subsidies received $\iff$ 3.1% higher TFPR

Impact of Subsidies On Revenues and TFP

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

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- 5 p.p. $\uparrow$ increase in customers' and suppliers' subsidization $\Longleftrightarrow$ 0.3% higher TFPR

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4. **Assessing the impact on regional wage inequality**

We apply a dynamic g.e. model with trade and migration to understand the reform's impact on regional inequality

We apply the model of Caliendo, Dvorkin, Parro (2019) 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
- Landlords
  - Rent out structures they own to intermediate goods firms. Consume.

We apply a dynamic g.e. model with trade and migration to understand the reform's impact on regional inequality

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- Intermediate goods firms
  - Operate with CRS production function: labor, structures, material inputs.
  - Time-varying total factor 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 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 structures in subsidized areas benefit landowners throughout the country

Caliendo et al. (2019) apply a "dynamic hat algebra" solution method to assess counterfactuals

Object of interest: What is the effect of the subsidy reforms on real wages (and employment) in each region-industry pair?

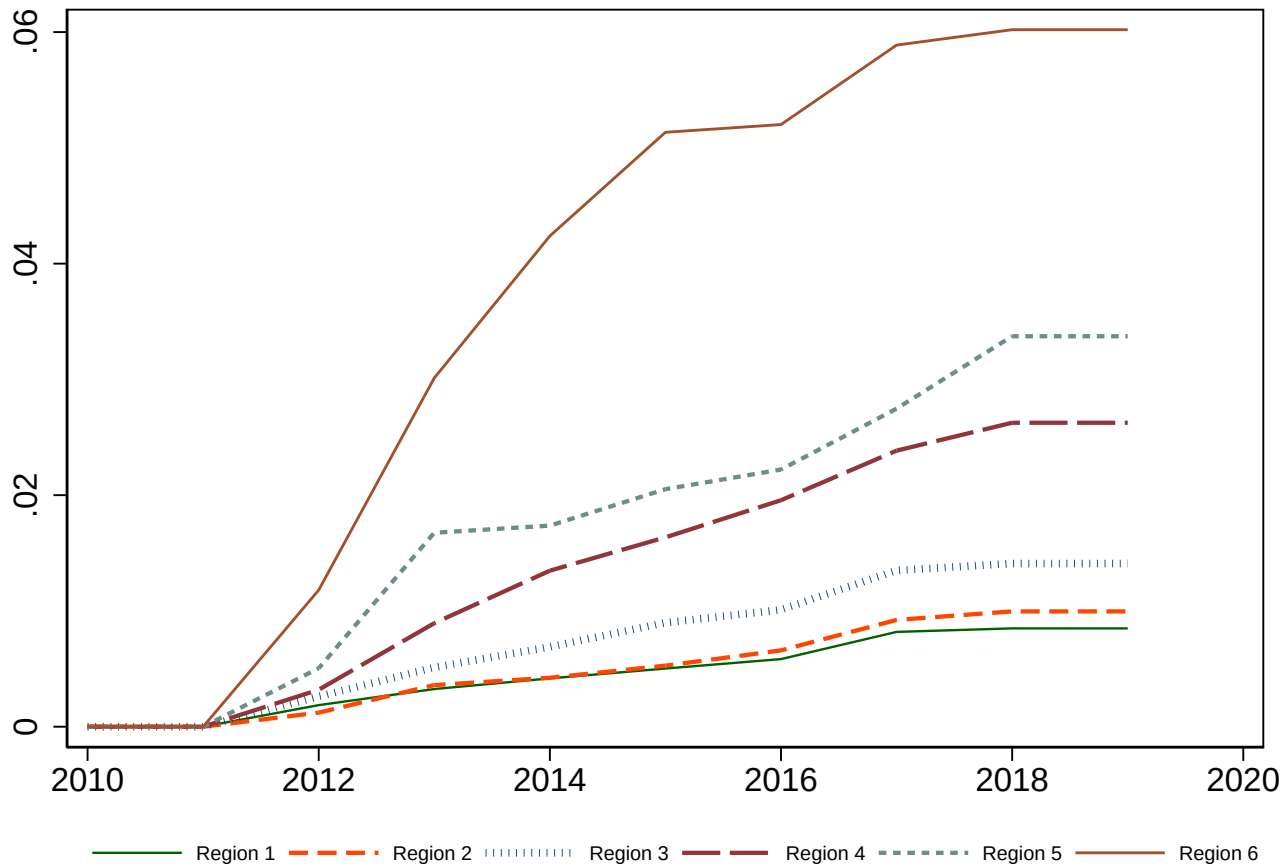
- Consider counterfactual equilibrium: suppose total factor productivity was lower (especially in subsidized region-industries) absent the subsidy reforms

Dynamic hat algebra

- Many of the model's fundamentals – migration utility costs; trade barriers; productivity in each industry-region pair – are difficult to identify.
- Conditioning on observed migration shares, trade shares, output, etc... one can solve for *changes* in the time paths of endogenous variables as a result of shocks to productivity

Calibration

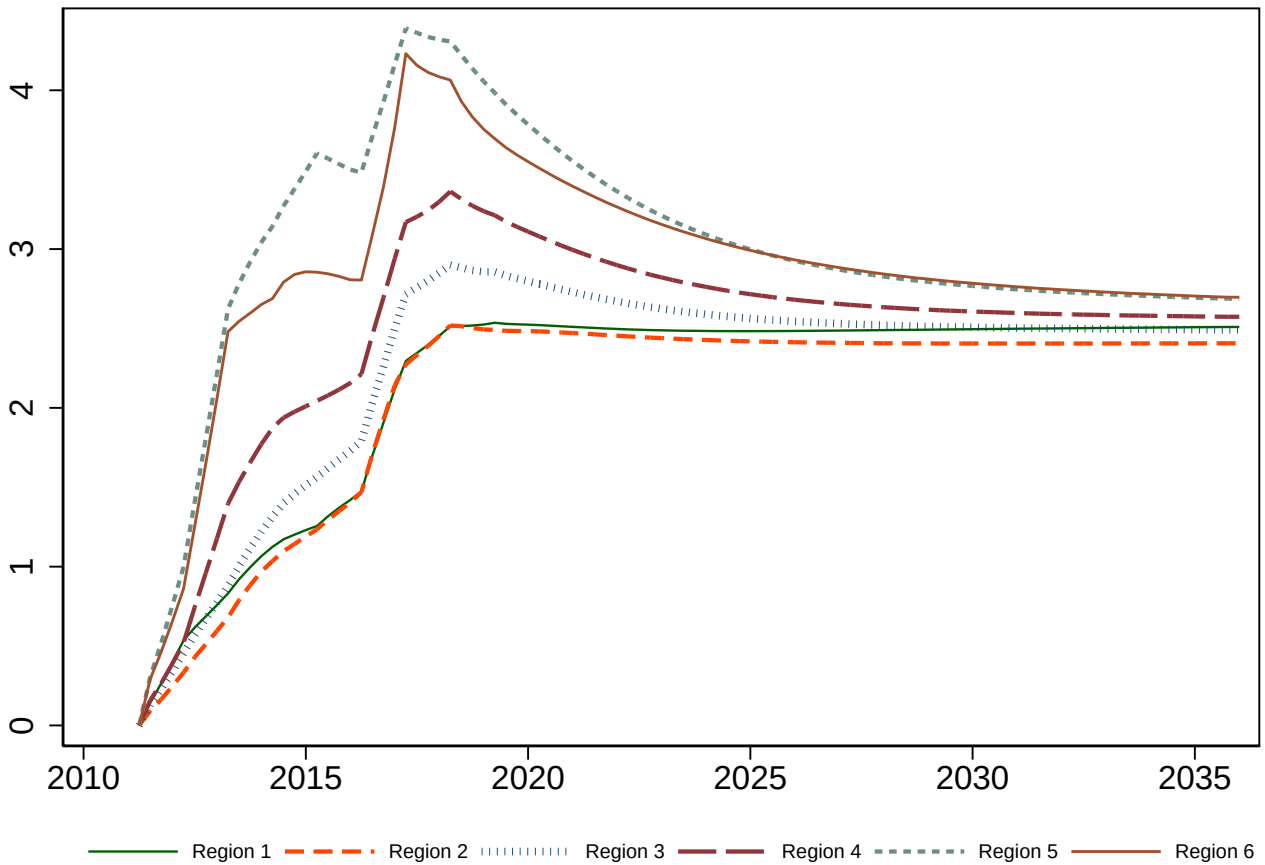
- Direct impact of subsidy on TFP:
  - From previous section of the presentation: a 5 p.p. increase in investment tax credit ratio $\Rightarrow$ 3.1% decrease in marginal costs (a 3.1% increase in TFPR)
  - Average investment tax credit ratio by region-year:



Calibration

- 45 industries; 6 subsidy regions
- Direct impact of subsidy on TFP:
  - From previous section of the presentation: a 1 p.p. increase in investment tax credit ratio $\Rightarrow$ 0.6% decrease in marginal costs (a 0.6% increase in TFPR)
  - Average investment tax credit ratio from previous slide
- Other calibration inputs:
  - From National Input Output Table
    - Production function parameters for each industry
    - Preference parameters on importance of each industry's good
  - From micro dataset:
    - Year-to-year migration across region-industry pairs See data
    - Input flows across region-industry pairs See data

The subsidy reforms had a modest impact on real wage inequality

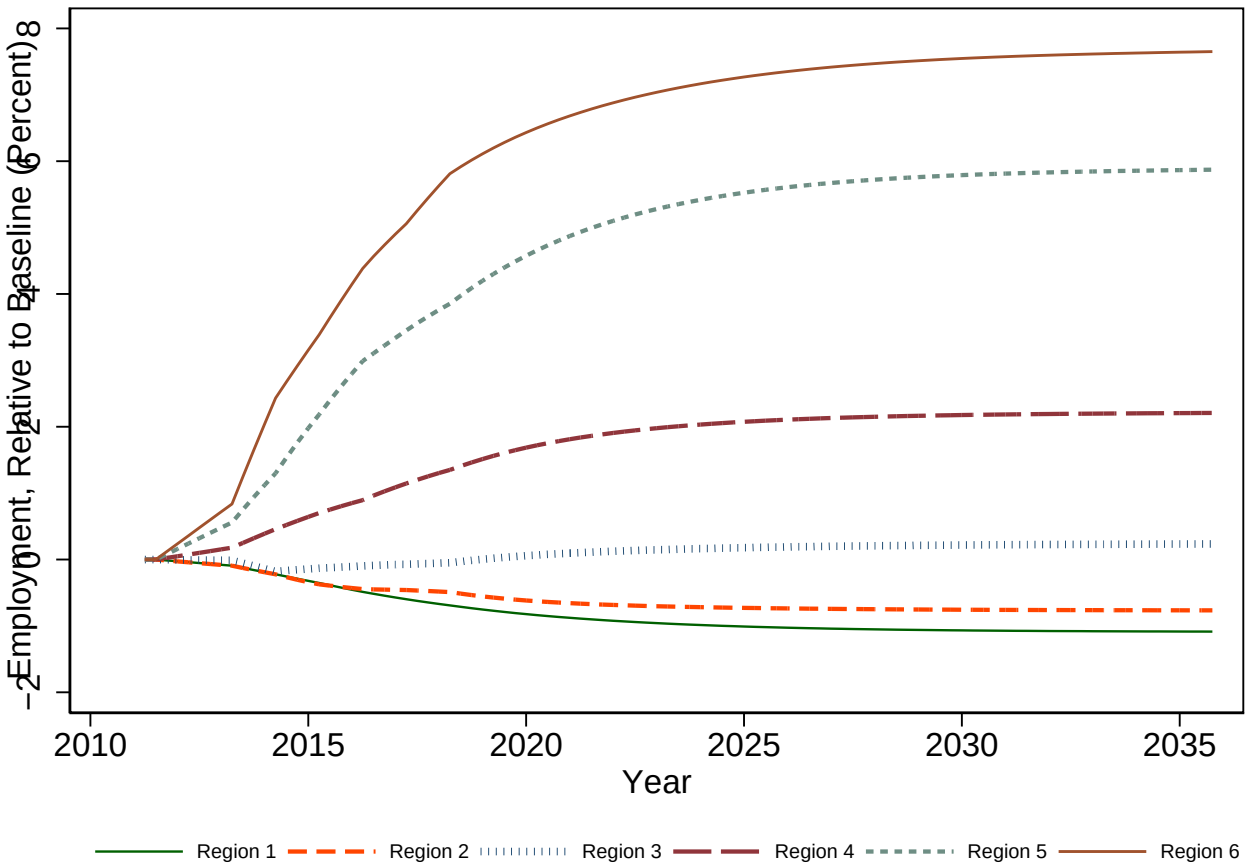


Short- and long-run impacts on regional inequality differ

Impact of subsidy on Region 6 relative to Region 1

- In 2016: 1.4 percentage points (2.8% increase in Region 6 vs. 1.4% in Region 1)
- In 2021: 0.9 p.p.
- In 2026: 0.4 p.p.
- In 2036: 0.2 p.p.

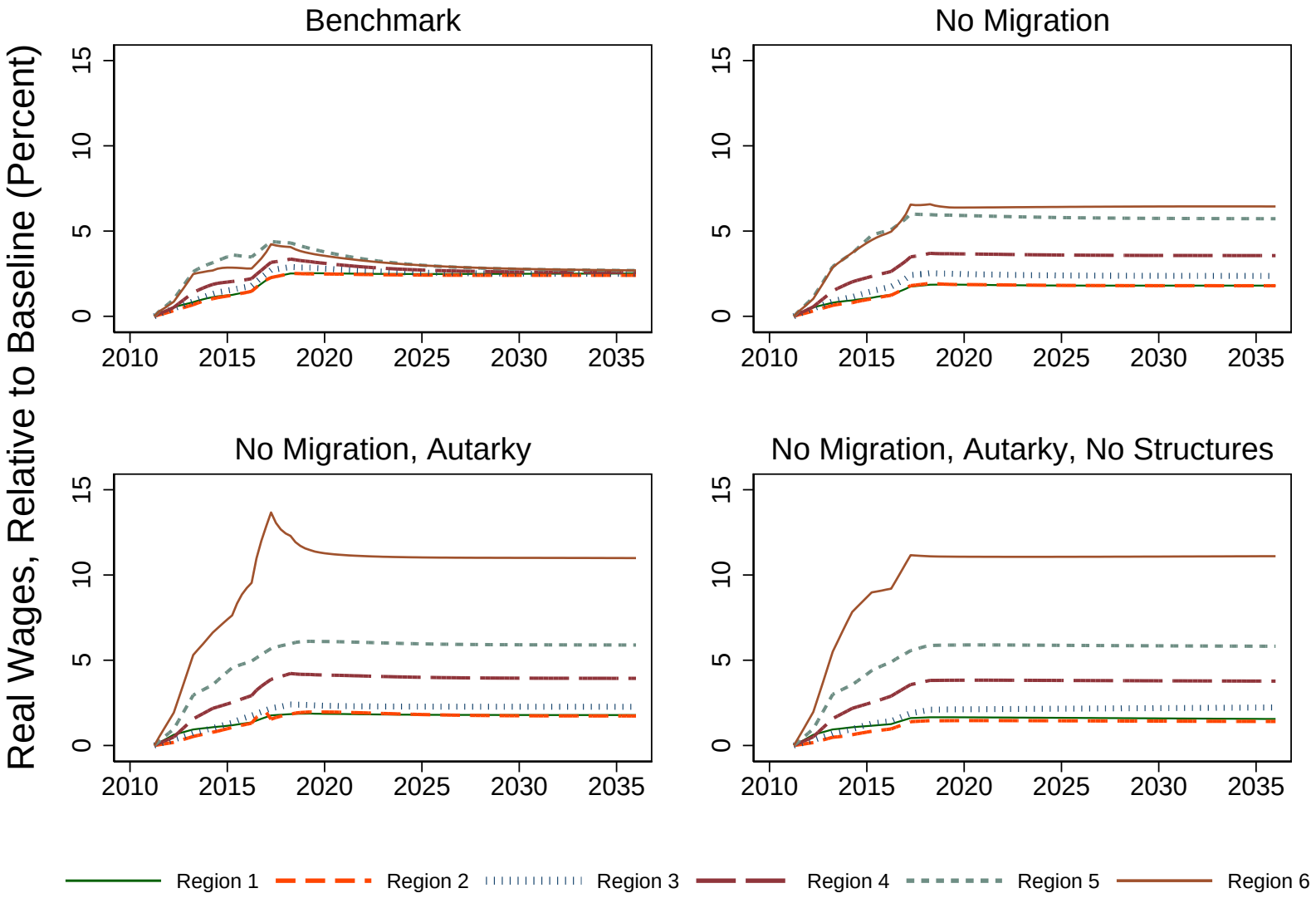
The subsidy reforms reduced migration from the southeast to the west



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 structures": Also, the structures share in value added also equals 0.

Spillovers due to migration and input-output linkages blunt the reform's impact on real wage inequality



Spillovers due to migration and input-output linkages blunt the reform's impact on real wage inequality

	2016	2021	2026	2036
Benchmark	1.4 p.p.	0.9 p.p.	0.4 p.p.	0.2 p.p.
No Migration	3.6 p.p.	4.5 p.p.	4.6 p.p.	4.6 p.p.
No Migration, Autarky	7.9 p.p.	9.3 p.p.	9.2 p.p.	9.2 p.p.
No Migration, Autarky, No Structures	7.9 p.p.	9.4 p.p.	9.5 p.p.	9.5 p.p.

Conclusion

Results

- Micro: Reforms had substantial impact on treated firms' sales, employment, TFP.
- Macro: Reforms had modest impact on regional real wage inequality

Implications for the place-based policy literature:

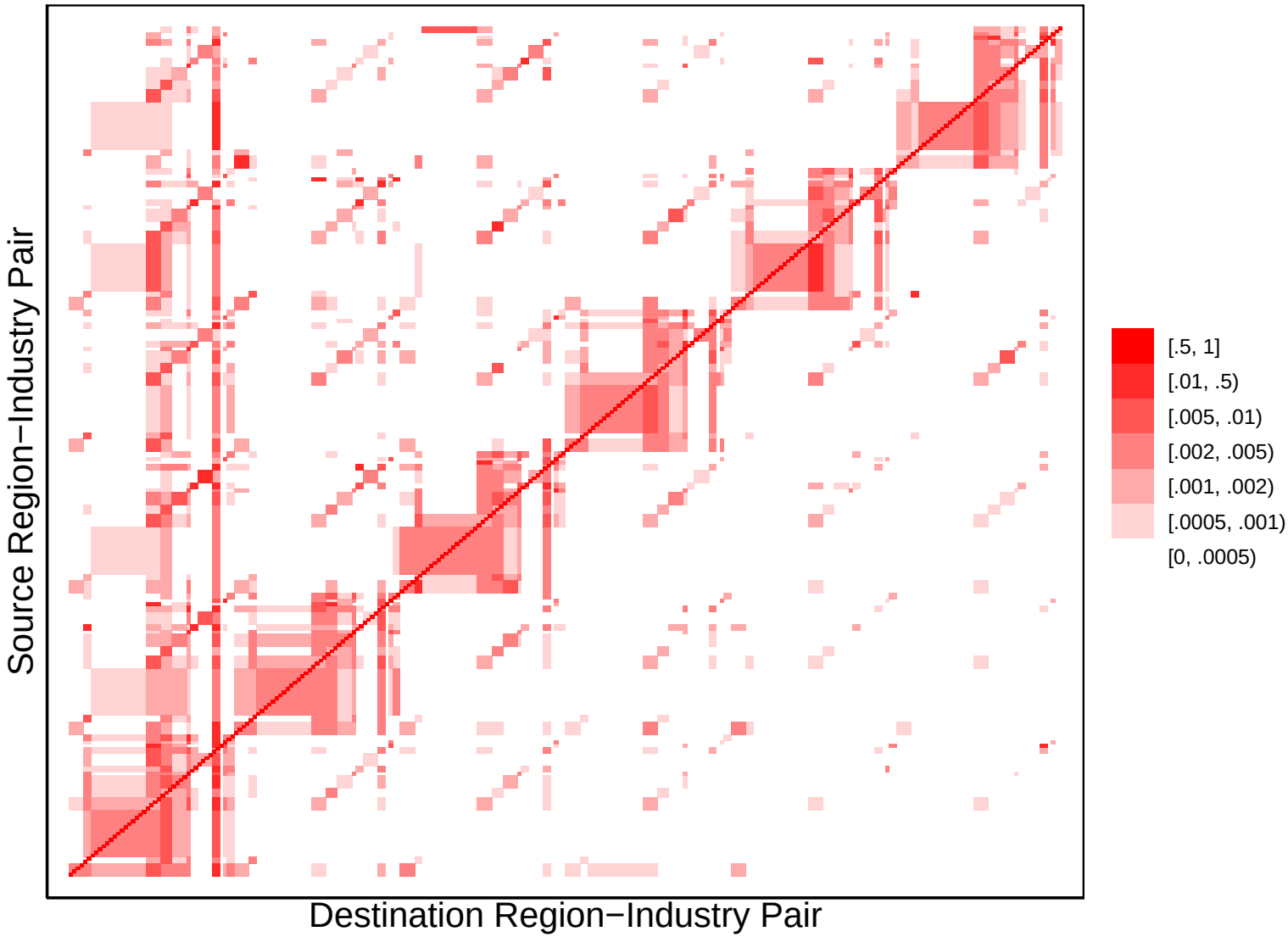
- Migration responds slowly to real-wage differentials $\Rightarrow$Short-run and long-run impacts; partial and general equilibrium impacts of the reform differ considerably
- Spillovers need not be restricted to nearby geographic areas.

Open questions:

- Better treatment of informal economy?
- To what extent did the subsidy reforms boost firm entry?
- To what extent did the policy boost nation-wide investment? Was the policy cost effective?

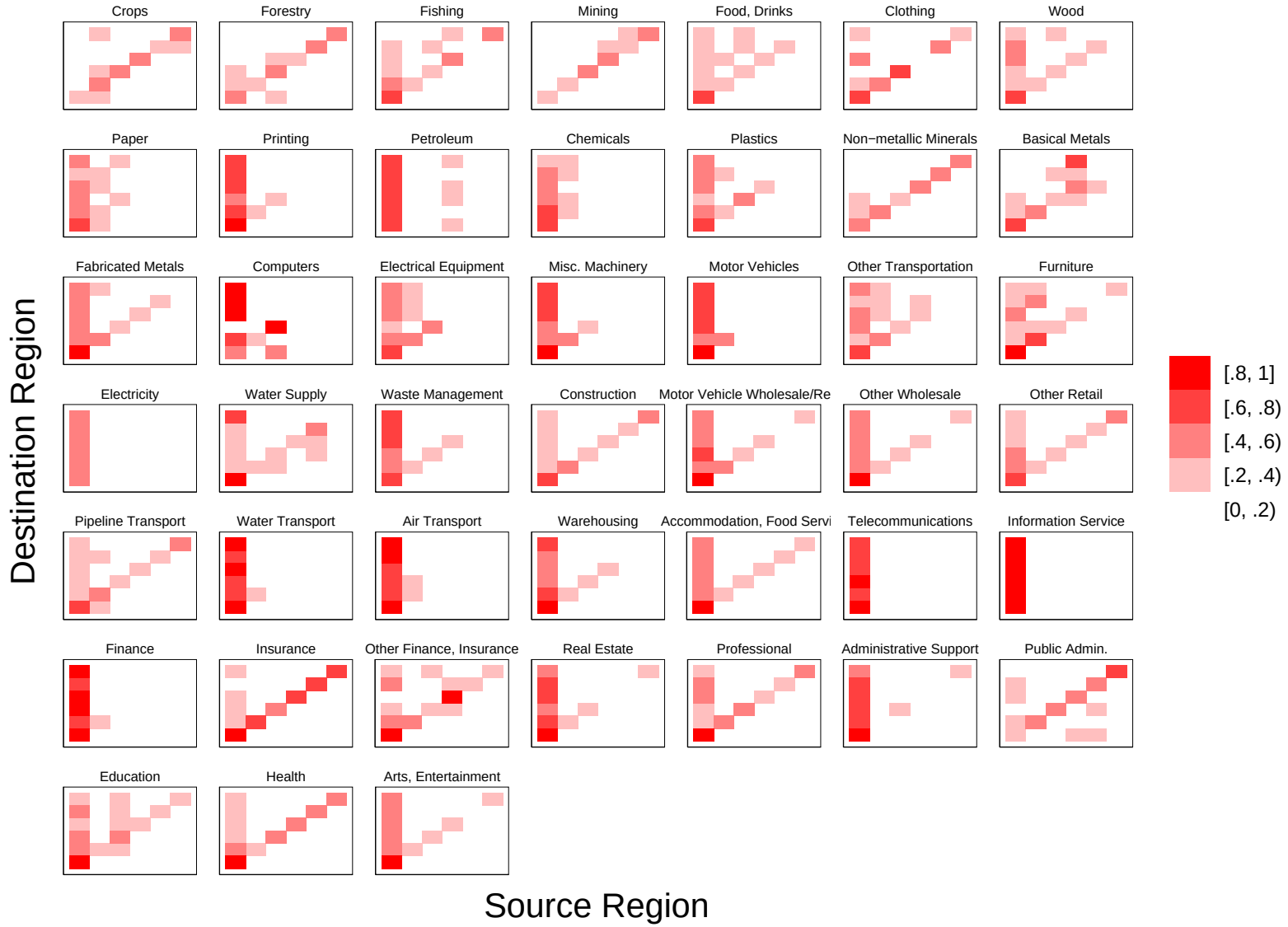
Flows of Individuals Across Region-Industry Pairs

Go back



Trade Flows Across Region-Industry Pairs

Go back



We apply a dynamic g.e. model with trade and migration to understand aggregate effects

We apply the model of Caliendo, Dvorkin, Parro (2019) 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, i.i.d. taste shocks
  - Lifetime utility

$$U_t^{nj} = \sum_{k=1}^{J} \alpha^k \log\left(c_t^{nj,k}\right) + \max_{\{i,k\}} \beta \mathbb{E}\left[U_{t+1}^{ik} - \tau^{nj,ik} + \nu \epsilon_t^{ik}\right]$$

  - Migration probabilities

$$\mu_t^{nj,ik} = \frac{\exp\left(\beta \mathbb{E}\left[U_{t+1}^{ik}\right] - \tau^{nj,ik}\right)^{1/\nu}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \exp\left(\beta \mathbb{E}\left[U_{t+1}^{mh}\right] - \tau^{nj,mh}\right)^{1/\nu}}$$

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

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

$$q_t^{nj} = z^{nj}\left(A_t^{nj}\left(h_t^{nj}\right)^{\xi^n}\left(l_t^{nj}\right)^{1-\xi^n}\right)^{\gamma^{nj}}\prod_{k=1}^{J}\left(M_t^{nj,nk}\right)^{\gamma^{nj,nk}}$$

  - Marginal cost:

$$x_t^{nj} = B^{nj}\frac{\left[\left(r^{nj}\right)^{\xi^n}\left(w^{nj}\right)^{1-\xi^n}\right]^{\gamma^{nj}}}{z^{nj}\left(A_t^{nj}\right)^{\gamma^{nj}}}\prod_{k=1}^{J}\left(P_t^{nk}\right)^{\gamma^{nj,nk}}$$

- Final goods firms
  - Bundle different varieties with a CES production function
  - Source from a given supplier with probability proportional to:

$$\pi_t^{nj,ij} = \frac{\left(x_t^{ij}\cdot\kappa_{nj,ij}\right)^{-\theta^j}}{\sum_{m=1}^{N}\left(x_t^{mj}\cdot\kappa_{nj,mj}\right)^{-\theta^j}}.$$