

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

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¹The 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 25 percent that of the richest MSA (Midland, TX)
 - ▶ Similar ratio in Turkey: İstanbul (\$13,900 GDP per capita in 2019) vs. Şanlıurfa (\$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 3.2% increase in firms' TFP.
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.
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 at most 2 p.p. in the long run (much less in our main calibration)
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. (2020)

Our contribution: Examine spillovers from subsidies

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.

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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

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 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;

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...

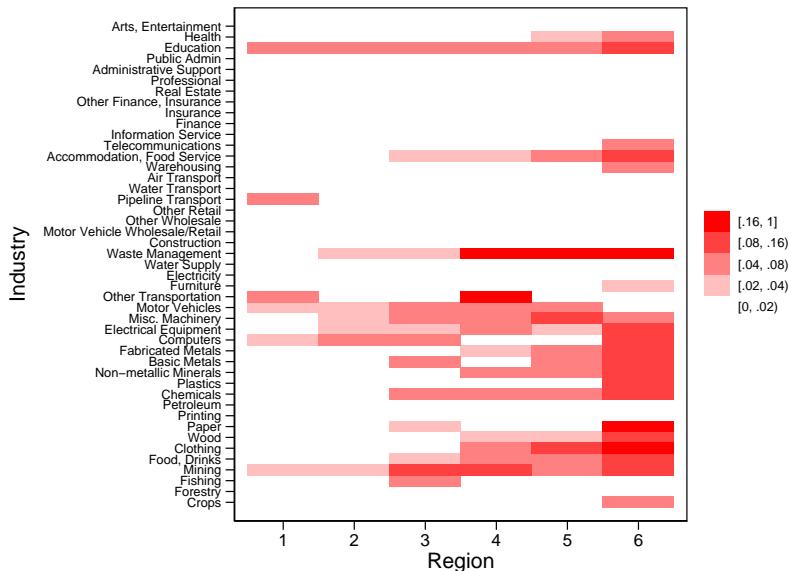


REGIONS

- 1
- 2
- 3
- 4
- 5
- 6

Summary Stats by Region

Subsidization varies by geography and industry



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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
 - ▶ 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

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

- f=firm; n=industry; t=year; y_{pnt} =activity measure; S_{ft} =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

Impact of Subsidies On Firm Revenues

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

	OLS		IV			
	(1)	(2)	(3)	(4)	(5)	(6)
Investment Tax Credit Subsidy	0.852***		2.607***	3.194***		
	(0.073)		(0.467)	(0.559)		
Inv. Tax Credit Subsidy + Closed Certificate		1.075***			3.723***	5.093***
		(0.083)			(0.797)	(1.172)
N	909,085	890,629	870,557	870,557	852,000	851,507
Year FEs	No	No	Yes	No	Yes	No
Year-Industry F.E.	Yes	Yes	No	Yes	No	Yes
R ²	0.837	0.838				
			First Stage			
Statutory rate, inv. tax credit subsidy			0.142***	0.136***	0.091***	0.081***
			(0.010)	(0.019)	(0.009)	(0.016)

► 5 p.p. ↑ in investment tax credit subsidies received \Longleftrightarrow 16.0% higher revenues.

Impact of Subsidies On Firm TFP

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

	OLS		IV			
	(1)	(2)	(3)	(4)	(5)	(6)
Investment Tax Credit	-0.064***		0.989***	0.649***		
Subsidy	0.023		(0.153)	(0.220)		
Investment Tax Credit		-0.040			1.520***	1.065***
Subsidy + Closed		0.034			(0.237)	(0.393)
Certificate						
N	851,592	834,403	815,855	815,377	798,558	798,071
Firm FEs	Yes	Yes	No	Yes	No	Yes
Province-Industry F.E.	No	No	Yes	No	Yes	No
R ²	0.631	0.636				
			First Stage			
Statutory rate, investment			0.143***	0.139***	0.093***	0.083***
tax credit subsidy			(0.010)	(0.019)	(0.009)	(0.016)

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

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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 $s_{f \rightarrow \vartheta}^{\text{upstream}}$ and $s_{\vartheta \rightarrow f}^{\text{downstream}}$ 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

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

Impact of Subsidies On Revenues and TFP

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

Dependent Variable	Revenues		TFP	
	(1)	(2)	(3)	(4)
Investment Tax Credit Subsidy	2.235*** (0.370)	2.488*** (0.646)	1.054*** (0.222)	0.668*** (0.190)
Weight of subsidized firms in total sales	0.067*** (0.014)	0.025** (0.012)	-0.003 (0.008)	-0.013* (0.007)
Weight of subsidized firms in total purchases	0.065*** (0.013)	0.071*** (0.012)	0.035** (0.014)	0.025** (0.012)
Log daily wage in local labor market	0.049*** (0.009)	0.035*** (0.009)	-0.016** (0.006)	-0.008 (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	785,579	785,220	735,915	735,531

► 5 p.p. \uparrow in investment tax credit subsidies received \Leftrightarrow 3.2% higher TFP

Impact of Subsidies On Revenues and TFP

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

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► 5 p.p. \uparrow increase in customers'/suppliers' subsidization \Leftrightarrow 0.06% higher TFP

Outline

1. Institutional Background
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3. Identifying indirect effects
4. **Assessing the impact on regional wage inequality**

We apply a dynamic g.e. model with trade and migration to understand the subsidy policy'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.

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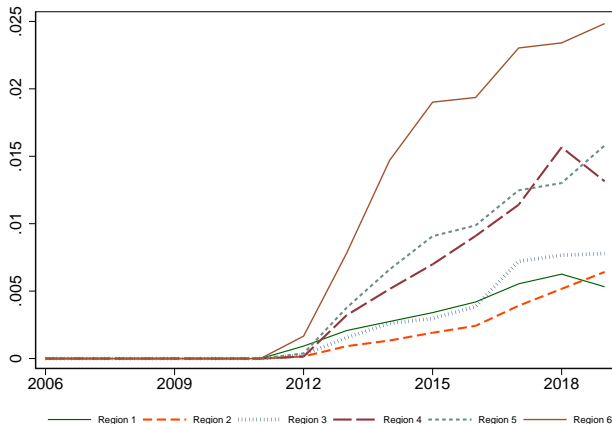
- ▶ Intermediate goods firms
 - ▶ Operate with CRS production function: labor, structures, material inputs.
 - ▶ Time-varying total factor productivity
 - ▶ Sell output to “final goods producers”
- ▶ Final goods firms
 - ▶ Bundle different varieties with a CES production function.
 - ▶ Source inputs 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 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 structures in subsidized areas benefit landowners throughout the country

Calibration

- ▶ Direct impact of subsidy on TFP:
 - ▶ From previous section of the presentation: a 5 p.p. increase in investment tax credit ratio \Rightarrow 3.2% decrease in marginal costs (a 3.2% 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 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) in each region-industry pair?

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

Impact of subsidy on Region 6 relative to Region 1

- ▶ In 2017: 0.5 percentage points (1.6% increase in Region 6 vs. 1.1% in Region 1)
- ▶ In 2022: 0.3 p.p.
- ▶ In 2027: 0.2 p.p.
- ▶ In 2032: 0.1 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 structures”: Also, the structures share in value added also equals 0.

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

	2017	2022	2027	2032
Benchmark	0.5 p.p.	0.3 p.p.	0.2 p.p.	0.1 p.p.
No Migration	1.7 p.p.	2.0 p.p.	2.0 p.p.	2.0 p.p.
No Migration, Autarky	5.8 p.p.	4.2 p.p.	4.1 p.p.	4.1 p.p.
No Migration, Autarky, No Structures	3.8 p.p.	4.2 p.p.	4.1 p.p.	4.1 p.p.

Conclusion

Results

- ▶ Micro: 2012 subsidy program had substantial impact on treated firms' sales, employment, TFP.
- ▶ Macro: 2012 subsidy program 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 subsidies 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?

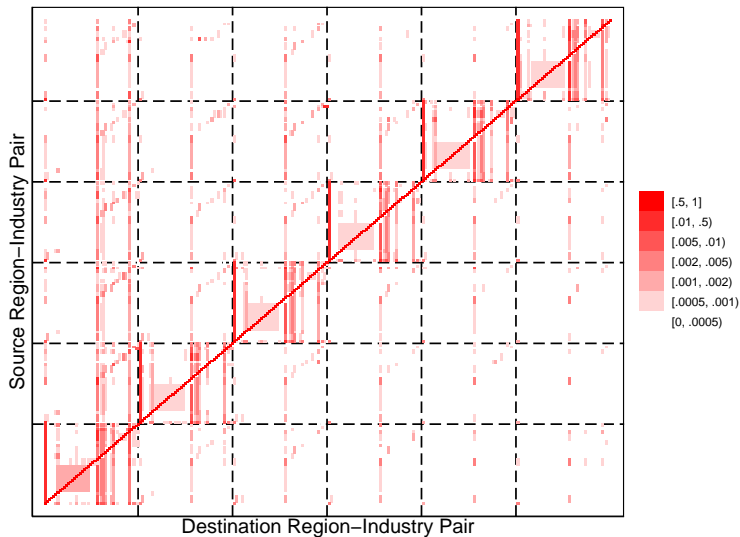
Target areas were relatively poor, fast-growing in the pre-subsidy period

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	Region						National
	1	2	3	4	5	6	
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

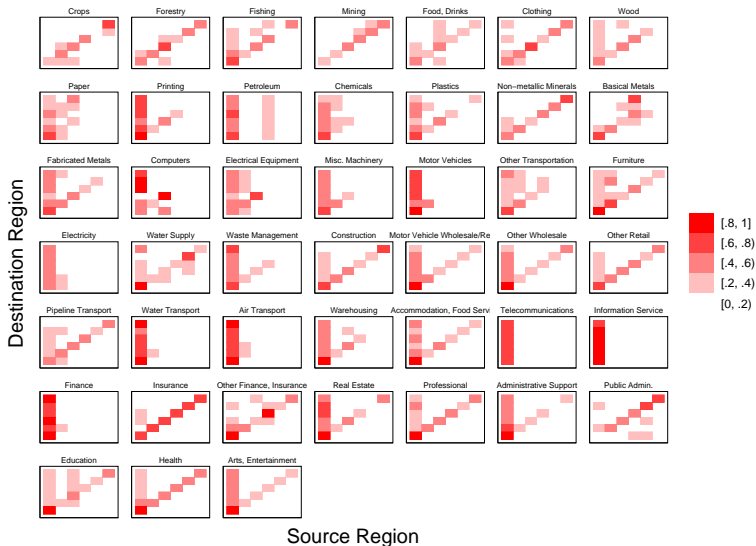
Flows of Individuals Across Region-Industry Pairs

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Trade Flows Across Region-Industry Pairs

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

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► 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

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

► Migration probabilities

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

► 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:

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