

Slide 2: The starting point for this talk is large regional inequality that is common within countries. Within the United States, per capita income in the richest metro area is four times as high as in the poorest. There is a similar disparity within Turkey, the focus of today's talk, between the poorest province Sanliurfa in the eastern part of the country and Istanbul in the western part. In response to these disparities, many countries have introduced place-based policies, aiming to spur investment and economic activity in their poorer regions. Here I've listed a number of prominent place-based programs. Economists, in different research articles, have studied the impacts of these policies. While these analyses have been extremely informative, there has been somewhat less attention paid to place-based policies in developing countries, also relatively little attention to short-run vs. long-run general equilibrium effects, and even less attention to spillovers through the production network.

Slide 3: With this as background, in this talk we'll examine a specific place-based set of policy, introduced in Turkey in 2012. The policy involved a mix of different subsidies to firms: rebates on mandatory social security contributions, investment subsidies, along with other incentives, with greater generosity in certain provinces, mainly in the poorer eastern part of the country, and with firms only in certain industries able to apply. A main stated goal of the policy was to reduce income inequality between the poorer and richer parts of the country.

In the "micro" part of our talk, following much of the literature on place-based policies, we examine the direct impacts of the policy, identifying the impact of additional subsidies on firms' economic activity. Unique relative to the existing literature, we have excellent data on buyer-supplier relationships in Turkey, meaning we can trace out the impact of the subsidies to suppliers or customers of subsidized firms. In the "macro" part of the talk, we apply a dynamic general equilibrium model to assess whether the policy reduced wage inequality within Turkey. The model is useful in that it allows us to gauge the channels through which subsidies in regions the government targeted spill over to parts of the country it didn't.

Slide 4: We have three main research questions. First, narrowly did the policy increase economic activity for firms that were eligible to receive the subsidy? Second, did the subsidies spill over within the production network? And, third, to what extent did the new policy reduce regional wage inequality?

Slides 5-6: Looking at direct effects, we find that that subsidized firms' activity increased along multiple dimensions: higher revenues, employment, and measured total factor productivity, with pretty large effects. Second, we observe meaningful spillovers from subsidized firms to their suppliers and customers. Finally, however, the policy only has a modest impact on reducing real wage inequality between the richer western part and the poorer eastern part of the country. There are two reasons for this modest impact. First, many of the suppliers or customers of heavily subsidized firms are in regions the government did not target, and some of the benefits spill over to them. Second, especially in the long run, the new subsidies induced migration towards the subsidized regions. This increase in labor supply in the poorer parts of the country mitigate the inequality-reducing direct effects of the subsidy policy.

Slide 7: In this paper, we synthesize three separate literatures listed here. We examine spillovers of subsidies among customers and suppliers, and apply existing dynamic multi-

region, multi-industry g.e. models, to understand how place-based policies may impact both targeted and untargeted areas.

Slide 8-9: Here is an outline for the remaining parts of the talk. I'll discuss the institutional background of the subsidy reforms, then discuss how we identify the direct impacts of the subsidy reforms, and how the reforms propagate within the production network. Finally, I will discuss how we use the Caliendo, Dvorkin, and Parro model to evaluate the impacts of the subsidy reforms on regional wage inequality.

Slide 10: In 2012, the Turkish government introduced a set of place-based subsidies, with the aim of increasing aggregate investment and reducing regional inequality. The country was split into six subsidy regions. Here is a map. Region 1 includes the largest and richest cities, in the west, and region 6 includes the southeastern part of the country, bordering Iran and Iraq.

Slide 11: According to the policy, only certain industries were eligible to receive subsidies, mainly within the primary and manufacturing sectors. Higher numbered regions received more generous support. The policy involved a mix of tax reductions, interest rate supports, and rebates on mandatory social security contributions. The way this process works is that eligible firms apply to the Turkish Ministry of Industry and Technology. Those with an approved application receive an investment certificate – upon which the firms get some benefits – where the certificate closes only after the investment is complete, and at this latter point the firm receives the majority of the benefits associated with the reforms.

Slide 12: While there are multiple types of subsidies that firms may receive, in practice these were bundled with one another. Ideally, we would have a firm-specific index of these measures that completely characterizes firms' exposure to subsidization. Not quite able to do that, we are going to pick one measure, the investment tax credit rate, that we feel provides a good albeit imperfect summary of the extent to which firms' inputs are subsidized. What this measure is precisely is the fraction of the investment expenditures that can be deducted from firms' future corporate taxes.

Slide 13-16: Here is again our map. A few important pieces of heterogeneity: First, the policy was targeted towards areas with lower gdp per capita. Second, in the decades before the policy, there was net migration from the eastern to western parts of the country. As we'll see, one of the effects of the policy will be to slow down this migration. Finally, in the years before the policy, the poorer higher numbered regions were growing relatively quickly compared to regions 1 and 2.

Slide 17: Only certain sectors are eligible to receive subsidies. These are primarily in manufacturing, mining, and agriculture. This figure, which presents the average investment tax credits received in 2018 by subsidy region and industry, displays the two dimensions of firms' exposure to the subsidy reforms.

Slide 19: We have access to standard firm balance-sheet data, data on the firm-to-firm production network, measures of subsidy take-up rates, and finally, for the purpose of computing worker flows across province-industry pairs (which will be a key input into our macro model) we have linked employer-employee data.

There are a couple limitations of these micro data that we need to be mindful of. First, these data only cover firms and employees in the formal economy. In Turkey, the fraction of informal workers is on the order 30 percent and is far from evenly distributed across space and industry, with greater informality in the east and in agriculture. Second, with the exception of the number of workers, the balance sheet data that we observe are at the firm level and not the establishment level. And so when we discuss firm-level regressions, we have to be mindful of the fact that some firms may operate multiple establishments with different level of exposure to the subsidy reforms. Both concerns can be confronted, albeit imperfectly. For example, for the latter concern, we can look at regressions using as a sample of firms where all of their establishments are in a single industry-province pairs. For the former concern, there are existing estimates of informality by industry and by province that we're working on incorporating into our analysis. But we haven't yet for today's talk.

Slide 20-21: Our main empirical setup to detect direct effects is one of a difference-in-difference regression. Here,  $y$  is some measure of firm activity. We compare this measure to the level of firm subsidization at that given point in time. We include firm and industry-year fixed effects to control for the overall scale of economic activity in the firm or for macroeconomic shocks that differentially impact different types of industries.

Now there are two concerns with setup. First, the subsidies were targeted to poorer but already-fast growing regions. This prompts a worry about pre-trends. Second, not every firm who was eligible actually applied to or received the subsidy. Meaning that, to compute the average treatment effect, we wouldn't want to simply regress on investment tax credits received. Further, as I mentioned, our subsidy variable is one measured with error.

Slide 23-24: To examine the issue of pre-trends, we'll amend our main regression as follows. On the right-hand side we'll apply the subsidy measure in each province-industry pair at the end of our sample. On the left hand side, we replace our economic activity measure with the same variable relative to its value in 2011. So, for periods before the introduction of the subsidy,  $\beta_{1t}$  will tell us whether industry-province pairs who were heavily subsidized in the second half of the sample grew relatively quickly before the subsidies were introduced. Here is a plot of the  $\beta_{1t}$  using revenues in the industry-province pair as our measure of  $y$ , where industry-province pairs are weighted equally. The point here, is that there is no evidence that heavily-subsidized industry-province pairs were growing relatively quickly (or slowly!) before the subsidies were introduced. The positive coefficients at the end of the sample indicate that heavily subsidized industries had fast-growing revenues in the 6-year period after the subsidies were introduced. Here is the same thing where we apply size-weighted regressions.

Slide 25-26: For the second concern, we'll instrument received subsidies with measures of statutory eligibility/generosity for that province-industry pair at that given point in time. Here are some examples of how the instrument will vary with industry, subsidy region, and time.

Slide 27-28: In the next slide, we revert to our baseline specification, with different sets of fixed effects applied across the two columns. We find, in both the OLS specifications not listed in the slide and in the IV specifications included here, that greater subsidization

increases firm revenues. We see that industries eligible to receive subsidies, especially generous subsidies, grew relatively quickly in terms of revenues. To give you some idea of the magnitudes involved, the difference in investment tax credits rates received by firms in eligible industries between Region 6 and Region 1 is approximately 5 percentage points. Depending on the specification, this amounts to anywhere between 18 and 45 percent higher revenues. In columns 3 and 4, we consider the number of firms in the industry-province pair. Here, we see positive effects as well, though with smaller elasticities.

Slide 29: We next apply a similar setup now with firm-level data. As with the industry-level regressions, we find a positive relationship between investment tax credit rates and revenues. The effects that we find here are somewhat smaller, but still sizable.

Slide 30: We apply a similar regression for firm-level TFP. The total factor productivity measure here is revenue tfp, which we estimate for each firm using standard io methods. Our interpretation here is that the subsidies lowered the unit price at which firms hire labor or rent capital, thus are equivalent to lower marginal costs of production, and in turn higher measured total factor productivity.

Slide 31-32: Next, we amend our regressions to consider what I'll call indirect effects. There are two aims in this section. First, we're inherently interested in documenting how the subsidies spill over to the customers or suppliers of subsidized firms. Second, in the calibration of the model that I'll discuss next, a key object of interest is direct productivity impact of subsidization on productivity. To the extent that (i) firms' own subsidization status is correlated with that of their suppliers or customers, and that (ii) counterparties' subsidization leads to higher own-firm TFP, our previous regression estimates could suffer from omitted variable bias. For a similar reason, we'll want to include an additional control for the wages in the firms' local labor market.

So, we apply a regression in which we now additionally include controls for the average wage in the local labor market in which the firm is operating and the share of the firm's suppliers or customers that receive a subsidy.

Slide 33-35: There are three main results this amended regression. First, inclusion of these extra terms does not alter our main estimate of the direct impact of subsidies on TFP. Second, having subsidized customers and suppliers leads to higher revenues. Third, on the other hand, the evidence for spillovers onto TFP is more mixed and muted.

Slide 36: In the final part of the presentation, we'll assess the impact of the subsidy policy on regional inequality. We apply a dynamic general equilibrium model, due to Caliendo, Dvorkin, and Parro's 2019 paper. This model, helpfully, permits consideration of many of the channels through which a subsidy to firms in one industry and province can dissipate or propagate to other parts of the economy.

Slide 37: In this slide and the next, I'll describe the model to you in words. Within each industry and region there are households who supply their labor and consume in proportion to their labor income; they may also be not employed. Each period they face a dynamic migration decision, deciding whether to switch to another industry or region, fully anticipating the paths of real wages in the future, and subject to a utility cost of switching.

We include landlords in the model to allow for the possibility of inter-regional spillovers through land rental income, but this turns out not to matter quantitatively.

Slide 38: On the firm side, within each industry and subsidy region, we have intermediate goods firms, that hire labor, rent land, and purchase material inputs. They have time-varying total factor productivity. The way that we're thinking of the impact of the subsidies is that they mechanically shift down marginal costs – or, equivalently, shift up TFP – more so in region-industry pairs where firms received generous subsidies. These firms sell their output to final goods producers who bundle the intermediate goods. The share of varieties sourced from a given region depends on suppliers' marginal cost and iceberg trade costs across space.

Slide 39: There are three key spatial spillovers in this model. First due to input-output linkages, the customers of subsidized firms enjoy lower material input prices and the suppliers of subsidized firms have greater demand for their products. Second, there is migration across regions. The subsidy scheme (relative to a world without the policy) will slow net migration out of Regions 5 and 6, depressing (in the long run) real wages in those labor markets relative to a no-policy counterfactual. Finally, in this model, landlords own structures in areas other than where they live. Subsidies in one region lead to higher land rental prices there, but these increased rents may lead to higher consumption in other, untargeted regions. Below we'll isolate the impact of these three spillover channels.

Slide 40: With this model, we're interested in performing the following counterfactual exercise: What would the path of the economy have looked like – including real wages and labor allocations in each industry-region pair – if the subsidy reforms had not taken place? We consider an alternate economy in which the fundamental productivity in each industry-region pair is scaled down in proportion to the direct impact of the subsidies on firms' productivity that we estimated in the previous part of the talk. The approach taken in Caliendo, Dvorkin, and Parro permits us to answer questions like this. Their paper provides a tractable method of determining counterfactual responses to changes in the model's exogenous variables (for example, changes to productivity) without having to identify these variables' levels at any given point in time. Specifying the initial allocation of the economy — in terms of labor supplied to different industries and regions, migration and trade shares, and expenditure of each industry-region pair — as well changes in growth rates of the exogenous variables will suffice.

Slide 41: Briefly about the calibration: the key exogenous process that we feed in is how large the direct productivity impact of the subsidy reforms. From our regressions, before, we have shown that a 1 percentage point increase in the investment tax credit rate leads to a 0.6% increase in TFP. So, we can multiply the average investment tax credits received in each industry-region pair to this 0.6% to get the exogenous change in productivity stemming from the subsidy reforms.

Slide 42: Here is some information about the remainder of our calibration. We have a rich set of trade and migration data that we use in the calibration of our model.

Slide 43: Again, we're interested in understanding what the path of the economy have looked like – when measuring things like real wages or labor allocations– if the policy had not been introduced. We consider an alternate economy in which the fundamental productivity of intermediate goods firms in each industry-region pair is scaled down in proportion to (first) investment tax credits received there and (second) the slope of the relationship between the investment tax credit rate received and firm productivity, a relationship we had estimated in the previous part of the talk.

Here is the impact of the policy on real wages. Five years into the program, the policy led to a 1.6 percent increase in Region 6 real wages, compared to 1.1. percent in Region 1; so real wage inequality falls by half a percentage point. Over time, the impact of the policy on Region 6 vs. Region 1 inequality diminishes.

Slide 44: The reason why the long-run impact is so modest largely has to do with domestic migration. This plot gives the impact of the reforms on population in each of the subsidy regions. As a result of greater subsidy levels in the east, the population in Regions 5-6 increases by 1.5-2.5 percent, and falls in Region 1 by slightly less than 1 percent.

Slide 45: To better understand the modest inequality impacts, we consider three alternate calibrations of our model. In the first, the utility cost of migrating across subsidy regions is infinite. Households can still switch industries within their same region. In the second, we additionally restrict trade flows across the six subsidy regions. Again, there can be trade among industries within the same region. In the final calibration, we impose that the rental income of the landlords equal zero.

Slide 46: Here, we depict the regional inequality impacts of the subsidy policy in the three alternate calibrations. From the table we see a 2 percentage point difference between the first and second calibrations and between the second and third calibrations. The conclusion then is that the actual policy has had a modest impact on regional inequality, especially in the long run, because of trade and labor market spillovers that exist within Turkey. These two sets of spillovers have roughly equal impact.

Slide 47: This is it for the talk. The main results are that the subsidy reforms that we studied had a meaningful impact on the region-industry pairs that received the most generous subsidies. At the same time, towards the more macro goals of the reforms, they only had a modest impact on regional inequality. There are two broader implications for the literature studying place-based policies. First, since migration responds to slowly to real-wage differentials, the short-and long-run general equilibrium impacts will differ considerably. Second, general equilibrium spillovers may come from faraway locations This is an important lesson, as certain papers within the place-based literature apply regressions with larger and larger geographic areas to assess general equilibrium impacts. As I said, this is still a project in its earliest stages. We still have a number of open questions before we complete this paper.