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

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Abstract

We investigate the impact of a set of place-based subsidies introduced in Turkey in 2012. Using firm-level balance-sheet data along with data on the domestic production network, we first assess the policy's direct and indirect impacts. We find an increase in economic activity in industry-province pairs that were the focus of the subsidy program, and positive spillovers to the suppliers and customers of subsidized firms. With the aid of a dynamic multi-region, multi-industry general equilibrium model, we then assess the program's impacts. Based on the calibrated model we find that, in the long run, the subsidy program is modestly successful in reducing inequality between the relatively under-developed and more prosperous portions of the country. These modest longer-term effects are due to the ability of households to migrate in response to the subsidy program and to input-output linkages that traverse subsidy regions within Turkey.

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1 Introduction

Incomes differ markedly within countries. In the United States, for instance, 2021 income per capita in the richest metro area (San Jose, California) was four times greater than in the poorest (McAllen, Texas).[1] In Turkey, the focus of this paper, differences in economic activity are at least as stark.[2] While some of the spatial differences in income per capita reflect variation in workers' human capital, a large portion is due to inequality in economic opportunities. These differences are pervasive, highly persistent, and, when left unchecked, undermine social cohesion (Tabellini, 2010; Algan and Cahuc, 2014).

In response to these types of disparities, governments have implemented a wide range of place-based subsidies. But to what extent do these policies reduce inequality across space? As is well appreciated, place-based subsidies may (by increasing local land prices) benefit landowners (who may or may not reside within the targeted area.) Less well appreciated, since firms' customer and supplier networks extend beyond their localities, and since finding and developing relationships with new trading partners is costly, place-based policies may benefit firms outside of the regions that governments target. Finally, to the extent that workers may migrate in response to the introduction of place-based policies, shifts in labor supply may mitigate some of the place-based policy's impact on regional income inequality.

This paper examines the impact of a prominent place-based policy. In 2012, with Law 2012/3305, the Turkish government introduced a new system of investment and wage subsidies. With levels of generosity varying by province, and with eligibility varying by industry, firms could benefit from a combination of a reduced corporate income tax rate, social security payment assistance, and interest rate subsidies on private loans. In the context of Law 2012/3305, we ask three sets of questions. First, to what extent did this subsidy system increase economic activity among firms directly impacted by the scheme? Second, how large were spillovers, through the production network, to the suppliers and customers of firms who were directly impacted, and to what extent do spillovers extend to customers and suppliers beyond the regions targeted by the Turkish government? And third, what were the aggregate short-run and long-run implications of the subsidy scheme: To what extent did the new subsidies reduce inequality between the relatively poor southeast and the relatively prosperous west of the country?

We address these questions with detailed data on firms' take-up of individual subsidy items; their revenues, investment, employment, and other balance-sheet information; and their customer and supplier relationships. We supplement these data with information on

[1]These figures are taken from the Local Area Personal Income dataset (Bureau of Economic Analysis, 2022). Per capita income in the two metropolitan areas are $136,338 and $34,503, respectively.

[2]In 2020, GDP per capita in İstanbul, in the northwest of the country, was 4.8 times greater than in Şanlıurfa, a province bordering Syria in the southeast (Turkish Statistical Institute, 2022a).

migration flows across regions. Each of these pieces of information is critical. Data on statutory subsidy rates, subsidy take-up, and firm-level measures of economic activity are necessary to evaluate the direct firm-level impact of the new subsidy scheme. Data on buyer-supplier relationships allow us to track indirect spillovers throughout the production network. Data on migration are critical towards understanding whether worker flows act as a countervailing force of the new subsidies on regional wage inequality.

We begin our analysis by considering the time paths of revenues, employment, and firm counts at the industry and province level, comparing economic activity in province-industry pairs with differential exposure to the subsidies. We first check for pre-trends: We confirm that industry-province pairs eligible for exceptionally generous subsidies after the subsidies were introduced did not systematically grow quickly in the years prior to 2012. We then document that industry-province pairs receiving high levels of subsidization had exceptionally strong growth in firm entry, employment, and revenues. Next, we exploit our firm-level balance-sheet data, assessing whether subsidized firms directly increased their revenues, employment, and productivity: At the firm-level, we find that a 5 percentage point increase in the investment tax credit subsidy rate corresponds to a 16.2 percent increase in revenues, an 8.7 percent increase in employment, and a 3.3 decrease in marginal costs.[3]

We then explore how the spillover effects develop and propagate over the firm network. The indirect effects through the production network are sizable, though meaningfully smaller than the direct effects. A 5 percentage point increase in the fraction of a firm's suppliers and customers who are subsidized corresponds to a 0.7 percent increase in revenues and 0.6 percent increase in employment.

In the final step of our analysis, we explore the aggregate implications of the 2012 subsidy program. To do so, we calibrate the dynamic multi-region multi-industry general equilibrium model introduced by Caliendo et al. (2019). We consider two calibrations: In the first, we apply our micro regressions to calibrate the impact of subsidization on firms' marginal costs. In the second, we match moments based on industry-by-subsidy-region revenues before and after the policy's introduction. In both calibrations, we find that the policy's impact of long-run (as of 2036) regional wage inequality to be modest: a 3.6 percent reduction in the calibration based on moment-matching, and an even smaller reduction in the calibration based on estimates from our micro regressions. Domestic trade flows and migration severely mitigate the extent to which the subsidy program reduces inter-province inequality. Absent migration across subsidy regions, the long-run impact of the subsidy program on regional inequality would be nearly four times larger; absent both domestic trade flows and domestic migration, the impact would be nearly seven times larger. Moreover, the policy's impact

[3]This 5 percentage point difference corresponds, for firms in eligible industries, to the difference in investment tax credits received in regions with the most and least generous subsidies.

varies considerably over the short and long run. In the short run, the countervailing effect of migration is limited. In the years immediately after the introduction of the subsidy program, regional real wage inequality declines by as much as 6.9 percent, nearly twice as large as the long-run impact.

From other perspectives the subsidy policy appears somewhat more favorable. The subsidy policy likely slowed domestic migration from the poorer eastern parts of the country to the richer (and increasingly congested) İstanbul and its environs. Before the policy's introduction non-employment was considerably higher in the poorer parts of the country, those which were targeted by the subsidy policy. We find that the policy reduced non-employment, especially in these targeted areas.

Our work contributes to and builds on three related literatures: one which evaluates the direct impact of place-based policies on firms' activity, a second which investigates spillovers within production networks, and a third which examines trade and migration flow responses to broader policy reforms (looking beyond place-based policies). Neumark and Simpson (2015) review the first of these literatures. Among the papers in this review, Bernini and Pellegrini (2011); Givord et al. (2013); Busso et al. (2013); and Criscuolo et al. (2019) assess the impact of place-based subsidies in, respectively, Italy, France, the United States, and the United Kingdom.[4] While the design and implementation of these place-based policies differ — the investment subsidies provided by Law L488 in Italy are determined via a region-specific quota, unlike in other countries; the French subsidies favor firms with fewer than 50 employees, and so on — all four papers find positive employment effects for treated firms. As far as we are aware, we are the first to examine spillovers of place-based policies across the supply chain, the first to use a dynamic general equilibrium model with trade and migration to assess a place-based policy's short-run and long-run general equilibrium spillovers,[5] and the first to examine the direct firm impacts or the general equilibrium impacts of Law

[4]More recent work assessing the productivity and heterogeneous welfare impacts of place-based policies includes Fajgelbaum and Gaubert (2020); Slattery and Zidar (2020); and Gaubert et al. (2021). In a developing economy context, Chaurey (2017), Lu et al. (2019), and Kim et al. (2021) study, respectively, place-based policies in India, China, and South Korea, finding positive impacts of the introduction of place-based subsidies on investment and employment. Also relevant, given that non-targeted decreases in state and local taxes may have similar impacts to that of a place-based policy, are papers which examine the effect of within-country differences in state and local taxes on firm creation, investment, and employment decisions (e.g., Giroud and Rauh, 2019 and Fajgelbaum et al., 2019.)

[5]Exceptional within the literature on place-based policies, Kline and Moretti (2014) examine the long-run impacts of the Tennessee Valley Authority (TVA), a large-scale public infrastructure program introduced in 1933. They develop and estimate a spatial general equilibrium model, with the particular goal of identifying local agglomeration economies. Our model, both in its aims and its components, differs from the model in Kline and Moretti (2014). Our model abstracts from agglomeration economies as they model it, but incorporates features leading economic activity to cluster in certain locations: costly trade of material inputs and costs to migrate across industries and regions. Another unique feature of our framework: we conduct a joint analysis of the short- and long-run impacts of the place-based policy that we study within the same model.

2012/3305 in Turkey.[6]

Second, our work relates to a large literature exploring spillovers within production networks in general, and within Turkish production networks in particular. Barrot and Sauvagnat (2016) and Carvalho et al. (2020), respectively, consider the effect of spillovers between customers and suppliers following from natural disasters in the United States and Japan. Demir et al. (2022a) explore the impact of (foreign) demand shocks to firms' suppliers, customers, and workers, while Demir et al. (2022b) study spillovers of increases in import tariffs within the domestic production network. Our contribution, relative to this second literature, is to investigate the propagation of subsidy-induced shocks among firms within buyer-supplier network.[7]

Third, we build on a literature seeking to understand the general equilibrium trade and migration responses to policy reforms (or to other shocks). Within this literature, Caliendo et al. (2019) analyze shifts in employment across U.S. states and industries in response to the "China shock" (Autor et al., 2013); Monras (2020) explores U.S. inter-industry, inter-state employment shifts in response to migration induced by the 1995 Mexican peso crisis; Faber and Gaubert (2019) study the trade and migration responses to the rise of the Mexican tourism industry; while Caliendo et al. (2021) examine the impacts of EU enlargement on migration and trade.[8] We apply these methods to address a new question—to understand the internal migration flow responses and overall welfare impacts of a prominent place-based policy in a newly industrialized economy.

[6]Sungur (2019) describes the 2012 subsidy program, then demonstrates that investment has increased faster in more heavily subsidized regions. However, since investment growth had been faster in heavily subsidized regions, even before the implementation of the 2012 subsidy program, these aggregate trends documented by Sungur (2019) are difficult to parse.

[7]Without looking directly at firm-to-firm links, but seeking to understand spillovers among firms within the same region, Greenstone et al. (2010) assess the impact of the entry of a large subsidized manufacturing plant on already present establishments. They find substantial TFP gains over the medium term (approximately 5 years), but with substantial heterogeneity in the estimated effects. Closer to the current paper, Etzel et al. (2021) study the introduction of a place-based policy in Germany, one which aimed at increasing manufacturing investment and employment in the relatively low-income East Germany. Like Greenstone et al. (2010), Etzel et al. (2021) find considerable within-region spillovers. They employ county-to-county trade flow data to test for spillovers across regions, and find that these spillovers are of modest import. Finally, in the context of place-based subsidies introduced in Japan in the 1980s and 1990s, LaPoint and Sakabe (2022) examine spillovers *within* firms, among establishments located in areas eligible to receive a subsidy and those located in un-targeted areas.

[8]See also Artuç et al. (2010) and Caliendo et al. (2018), who develop the theoretic foundations for Caliendo et al. (2019, 2021).

2 Institutional Background

Enacted on June 19, 2012, the "Decision on State Aid in Investments" (Law 2012/3305) is a system of investment and wage subsidies introduced by the Turkish government.[9] While the program has multiple stated aims, the one we focus on is its attempt to "reduce regional development disparities."[10] The subsidy program consists of multiple components, with variation in the program design that is both industry and province-specific. The Turkish government partitioned the country into six "subsidy regions," determining the generosity of the individual subsidy items for firms in eligible industries. Figure 1 presents a map of the six regions, with Region 1 receiving the lowest and Region 6 receiving the highest level of support. Region 1 includes the four most populous provinces — İstanbul, Ankara, İzmir, and Bursa — while Region 6 is largely within the east and southeast of the country. Second, for each province, the Turkish government designated only certain sets of industries to be eligible for subsidization. These industries are primarily those in the agriculture, mining, manufacturing, and wholesale sectors, with slight variation across provinces in the exact set of industries that are eligible.[11,12]

Several complementary investment incentives were offered to firms in designated industry-province pairs. Qualified investment projects benefit from:[13,14]

- VAT and customs duties exemptions on machinery and equipment purchased as part of the investment project;

[9] Even though Law 2012/3305 was introduced in June of 2012, subsidies were retroactively applied back to January 2012.

[10] See https://www.sec.gov/Archives/edgar/data/869687/000119312520247247/d30195dex99d.htm. Accessed November 14, 2021.

[11] While we could not find any published government explanation for why these particular industries were chosen, they are consistent with the theoretical predictions of Liu (2019). In the presence of market imperfections, Liu (2019) argues that developing economy subsidies should target relatively upstream industries (which coincide with the industries that the Turkish government has targeted). Another possible rationale is to boost exporting industries. Consistent with this interpretation, the Accommodation and Food Service industry is one of the few subsidized service industries. Beyond manufactured products, which comprise a majority of exports worldwide, tourism is major component of Turkish exports.

[12] We list the correspondence between provinces and industries in Appendix B.1. The source material for these correspondences are at https://www.resmigazete.gov.tr/eskiler/2012/06/20120619-1-2.xls. Accessed November 14, 2021.

[13] See https://www.trade.gov.tr/investment/schemes/regional-investments. Accessed November 14, 2021.

[14] To qualify, the capital investments must exceed a threshold amount, with the size of the threshold varying by region and industry. For most industries, the minimum investment threshold is 500 thousand TL in Region 6, and up to 4 million TL in Region 1. See https://trade.gov.tr/data/5b8f8bcd13b8761f041fe88c/9781b45b7769515c32b157910f46cdfd.pdf. Accessed November 14, 2021. As a result, subsidy take-up will be greater for larger firms. While interesting, we do not consider this source of within industry-by-province heterogeneity in this paper.

Figure 1: Turkish Subsidy RegionsNotes: Source: KPMG (2018).

- investment tax credits, ranging from 15 percent of the value of the investment project in Region 1 to 50 percent in Region 6;[15,16]

- for additional employment created by the investment project, support for the employer's mandatory contribution of their employees' social security payments, ranging from two years after the initiation of the project in Region 1, to 10 years in Region 6;

- for additional employment created by the investment project, support for the employee's contribution of their own social security payments, in Region 6 only; and

- support on interest rates (for loans obtained from banks or other private financial institutions to finance the project-related investments), ranging from no support in Regions 1 and 2 to either (a) 7 percentage points for Lira-denominated loans or (b) 2 percentage points for foreign-currency-denominated loans in Region 6.

[15]These investment tax credits are deducted from firms' corporate tax obligations. These tax credits are deducted over a number of years, with the speed at which firms receive subsidies also varying by region.

[16]In addition to the regional subsidy program introduced in 2012, Turkey has 258 (as of 2021) "Organized Industrial Zones" (OIZs), special economic zones of much smaller geographies. See `https://www.invest.gov.tr/en/investmentguide/pages/investment-zones.aspx` (accessed November 14, 2021). As of 2021, approximately 2 million individuals worked in an OIZ. The first OIZ was introduced in 1960, with the number of OIZs increasing steadily over the last six decades (Cansız, 2010). While the OIZ program precedes and is largely independent of the region-based subsidies introduced in 2012, the subsidies associated with Law 2012/3305 are slightly more generous in OIZs. The generosity levels that we list in this section correspond to those outside of OIZs. In Appendix B.2, we list the subsidy rates in both OIZs and outside of OIZs. In our firm-level and industry-level analysis, the statutory generosity rates that we apply refer to those levels in OIZs.

To receive these subsidies, eligible firms must apply to the Turkish Ministry of Industry and Technology. Firms must demonstrate that their investment project satisfies the rules within Law 2012/3305, applying for an "investment incentive certificate." This certificate describes the subsidy items from which the firm can benefit. Certificates are "open" while the project has been approved but before the investments have been made, and "closed" once the proposed project has been completed. While the project is open, firms benefit from VAT and Customs Tax exemptions and interest rate support. Firms receive investment tax credits and social security support only after the certificate is closed.[17]

While there are multiple types of subsidies that firms may receive, in practice these subsidies are 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 apply the investment tax credit rate — the percentage point credit in corporate taxes linked to the firm's investment — as a suitable albeit imperfect measure of the extent to which firms' inputs are subsidized. In sensitivity analyses, we consider other measures — the number of years of support for employers' mandatory contributions of social security payments, or a whether the firm has a "closed" subsidy certificate (irrespective of the level of generosity). We will find that our estimated relationships between firms' economic activity and the subsidies they receive are similar under these alternate measures of subsidization.

In Table 1, we explore differences in pre-plan economic conditions across the six subsidy regions. Consistent with the stated motivation of the 2012 subsidy program to reduce regional disparities, the more highly subsidized regions had (as of 2011) lower GDP per capita, less than one-third as high in Region 6 as in Region 1. In the years (and decades) prior to the subsidy program, migration within Turkey occurred from the relatively poor Central, Eastern, and Southeastern Anatolia (in Regions 3, 4, 5, and 6) to the large urban centers: İstanbul, İzmir, and Ankara (in Region 1.) Finally, at least in the half-decade prior to the introduction of the subsidy program, GDP per capita growth rates were larger in Regions 5 and 6 relative to Regions 1 and 2. These pre-treatment differences in levels and trends are a threat to identifying the impact of the subsidy program, as it is *a priori* plausible that the government's subsidy program was targeted towards province-industry pairs that were growing exceptionally quickly in the pre-policy period and would have continued to grow faster than average absent the subsidy program. We discuss the issue of pre-trends in Section 4, after introducing our main datasets in the following section.

[17]In Appendix B.3, we provide estimates of government expenditures on investment tax credits and rebates for employers' and employees' mandatory social security contributions, the two most prominent elements of the subsidy program. We estimate that expenditures on these two subsidy items were approximately 10.7 billion TL in 2019 (in 2010 prices), amounting to approximately 0.58 percent of GDP in that year. (According to TürkStat, the Turkish Statistical Institute, nominal GDP was 4.31 trillion TL in 2019, equivalent to 1.84 trillion TL in 2010 prices.)

Table 1: Pre-policy Differences in Subsidy Regions

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

Notes: The data for this table come from Turkish Statistical Institute (2022a,c,d). The first three rows list values as of 2011. The final row lists average (annual) growth rates between 2006 and 2011. All values are reported as 2010 Turkish Liras (TL). As of January 2010, the TL to US dollar exchange rate was 1.50 to 1.

3 Data Sources and Summary Statistics

We merge four firm- and employee-level datasets from the Entrepreneur Information System (EIS) of the Turkish Ministry of Industry and Technology. (In addition, below, when discussing the aggregate implications of the subsidy program in Section 5, we apply information from the World Input-Output Database, from Timmer et al., 2015, 2016.) Our firm-level datasets include: (a) firm balance-sheet data, spanning 2006 to 2019; (b) data on subsidy take-up rates, from 2012 to 2019; (c) the firm-to-firm production network, from 2006 to 2019; and (d) linked employer-employee data, from 2012 to 2019. Since many of our balance-sheet variables are recorded only for firms with at least 20 employees, our main analysis will be restricted to these firms. In Appendices A.1 and A.2, we describe our dataset in greater detail. We assess how closely aggregates based on our EIS data align with those in public-use aggregate datasets in Appendix A.3.

While incredibly rich and detailed, there are two important limitations of these micro data. First, the EIS data only cover firms and employees in the formal economy — i.e., those workers who are registered in the social security system — and additionally exclude most firms in the Agricultural, Financial, and Public Sectors. As of 2017, approximately 34 percent of workers were informal (though, since formal-sector workers earn considerably more than their counterparts in the informal sector, informal workers comprise a substantially smaller share of the aggregate wage bill); see Figures 21 and 51 of Acar and Carpio (2019). Compounding this limitation, the share of formal-sector workers varies considerably by industry and region, with a greater share of informal workers in agriculture and in the southeast of the country, and a greater share of formal workers in western provinces; see Figures 24 and 25 of Acar and Carpio (2019). Thus, our data miss a substantial fraction of economic activity, with the under-representation systematically varying with firms' subsidy eligibility. A second limitation: With the exception of the number of workers, the balance-sheet data we have access to are at the firm level and not at the establishment level. (For subsidized firms, we *do* observe the location and industry of the establishment through which the firm applied for the subsidy.) So, in interpreting firm-level relationships between subsidization and firm-level activity, we have to be mindful that some firms may operate multiple establishments with different levels of exposure to the subsidy program.

Both limitations can be overcome, albeit imperfectly. Regarding the first limitation, in Appendix A.4 we construct estimates of informality by province and industry. We apply these estimates of informality when computing aggregate trade or migration flows across industry-subsidy region pairs — in Figures 2 and 3 in this section and in the calibration of our Section 5 model — from the micro data. Regarding the second limitation, we demonstrate that our evaluation of the subsidy's impact on firm activity is robust to excluding firms with establishments in multiple industry-province pairs.

Table 2: Descriptive Statistics: Firm-Level Balance-Sheet Variables

					Percentile				
		N	Mean	SD	25	50	75	95	99
(1)	Employment	1,039,766	87.13	347.74	24.00	34.50	62.50	268.50	926.50
(2)	Wage-Bill (millions TL)	1,039,766	1.48	9.30	0.24	0.39	0.86	4.51	18.45
(3)	Real Sales (millions TL)	1,039,760	26.76	336.41	1.35	3.75	11.36	65.05	318.07
(4)	PPE Capital (millions TL)	1,039,766	10.36	154.08	0.22	0.81	2.97	22.76	135.82
(5)	$\Delta \log(\text{PPE})$	902,639	0.12	0.78	-0.15	-0.02	0.27	1.33	2.98

Notes: All values are reported as 2010 Turkish Liras (TL). The sample includes firms with at least 20 employees.

Table 2 presents summary statistics related to the firm balance-sheet data. Among the firms in our sample, the median firm-year observation had 35 employees, with revenues of 3.8 million Turkish Lira (equivalent to approximately 2.5 million 2010 US dollars), and 800 thousand Turkish Lira in plant, property, and equipment (henceforth "PPE") capital.

Second, we measure subsidy take-up rates in Table 3. We consider three separate measures of firm subsidization: the fraction of subsidized firms (rows 1 through 3), the average investment tax credit ratio (rows 4 through 6), and the number of years for which the firm receives social security support (rows 7 through 9). The third row describes observations of those who were statutorily eligible to receive a subsidy: These are observations after 2012 where the firm belonged to a subsidized industry-province pair. According to this row, 14.4 percent of the observations could (feasibly, according to Law 2012/3305) receive a subsidy. Among the 14.4 percent, 5.2 percent of observations correspond to a firm which had successfully applied for the subsidy (row 1). An even smaller fraction of firms, 2.5 percent of the sample, has a closed subsidy certificate (row 2). Rows 4 through 6 consider investment tax credit rates. The statutory investment tax credit rate ranges up to 50 percent for firms in the sixth subsidy region (row 6).[18] However, both because many firms were ineligible to receive a subsidy and because investment tax credits were less generous in the lowered-numbered regions, the average investment tax credit rate that firms were eligible to receive is much lower: 3.5 percent. Again, since not all eligible firms received a subsidy, the average investment tax credit received was even lower, at 1.7 percent. Finally, as with the investment tax credit measure, our measure of employment subsidization — here, the number of years that the Turkish government would defray — is also highly skewed (rows 7 through 9).

Table 3: Descriptive Statistics: Subsidy Take-up

				Percentile			
		Mean	SD	90	95	99	Max
(1)	Firms with either an open or closed certificate	0.052	0.222	0	1	1	1
(2)	Firms with closed certificate	0.025	0.155	0	0	1	1
(3)	Eligible to Receive Subsidy	0.144	0.351	1	1	1	1
(4)	Investment Tax Credit Ratio	0.017	0.078	0	0	0.4	0.6
(5)	Investment Tax Credit Ratio, with Closed Certificate	0.008	0.056	0	0	0.4	0.6
(6)	Investment Tax Credit: Statutory	0.035	0.090	0.15	0.25	0.4	0.5
(7)	Social Security Employer Premium–Years of Support Received	0.301	1.468	0	0	7	12
(8)	Social Security Employer Premium–Years of Support Received, with Closed Certificate	0.143	1.042	0	0	7	12
(9)	Social Security Employer Premium Duration–Years of Support: Statutory	0.599	1.649	2	5	7	10

Notes: The sample includes firms with at least 20 employees. For firms not receiving a subsidy, the Investment Tax Credit Ratio in the fourth row and the Social Security Employer Premium in the seventh row is set equal to 0. For firms without a closed subsidy certificate, the Investment Tax Credit Ratio in the fifth row and the Social Security Employer Premium in the eighth row is set equal to 0. Our measures of statutory rates of subsidy generosity refer to those outside of Organized Industrial Zones (see footnote 16). For this reason, the maximum value of the statutory investment tax credit rate is less than the maximum value of the investment tax credit ratios received. N=1,039,766.

Our third database measures information on firms' domestic customers and suppliers. According to Table 4, the median firm in our dataset had 9 suppliers and 6 customers. Consistent with other studies of production networks (Bernard et al., 2019; Carvalho et al., 2020), the degree distribution is highly skewed, somewhat more so for the distribution of the

[18] Regarding the numbers presented in rows 4 and 5, there were seven firms who received investment tax credits greater than 60 percent. We

number of customers than for the distribution of the number of suppliers. A small number of firms have a disproportionate number of suppliers and (in particular) customers. There are a substantial number of inter-firm relationships that traverse different subsidy regions. Approximately 30 percent ($\approx 6.0/19.8$) of relationships occur across subsidy regions.

Table 4: Descriptive Statistics: Firm-to-Firm Production Network

				Percentile					
		Mean	SD	25	50	75	90	95	99
(1)	Number of customers	19.8	69.9	1	6	18	45	76	202
(2)	Number of suppliers	19.8	39.4	3	9	22	45	69	166
(3)	Number of customers in the same subsidy region	13.8	53.5	1	4	12	31	54	149
(4)	Number of suppliers in the same subsidy region	13.8	29.9	2	6	14	32	52	128
(5)	Number of customers in the same province	9.7	36.6	0	2	8	22	39	105
(6)	Number of suppliers in the same province	9.7	20.5	1	4	10	23	36	89

Notes: The sample includes firms with at least 20 employees. N=924,368.

Central to our analysis of the aggregate effects of the subsidy program are measures of linkages across the six subsidy regions. In the remainder of this section, we depict these linkages. In Figure 2, we report the trade flows across region pairs for each industry in our sample. (This figure applies combinations of 2-digit NACE industries, in accordance with the calibration of our Section 5 model.) The shading with each panel depicts the share of the destination region's purchases that are sourced from each of the six regions. In the aggregate, 58 percent of shipment value occurs within subsidy regions. However, downstream firms' reliance on inputs sourced from other subsidy regions varies considerably: For downstream firms located in Region 1, 76 percent of shipment value is sourced from suppliers located in Region 1. For downstream firms located elsewhere, 38 percent of shipment value is sourced from suppliers within the same subsidy region. Taken together, a substantial fraction of each region's purchases are sourced either within-region or from provinces in (the most developed) Region 1.

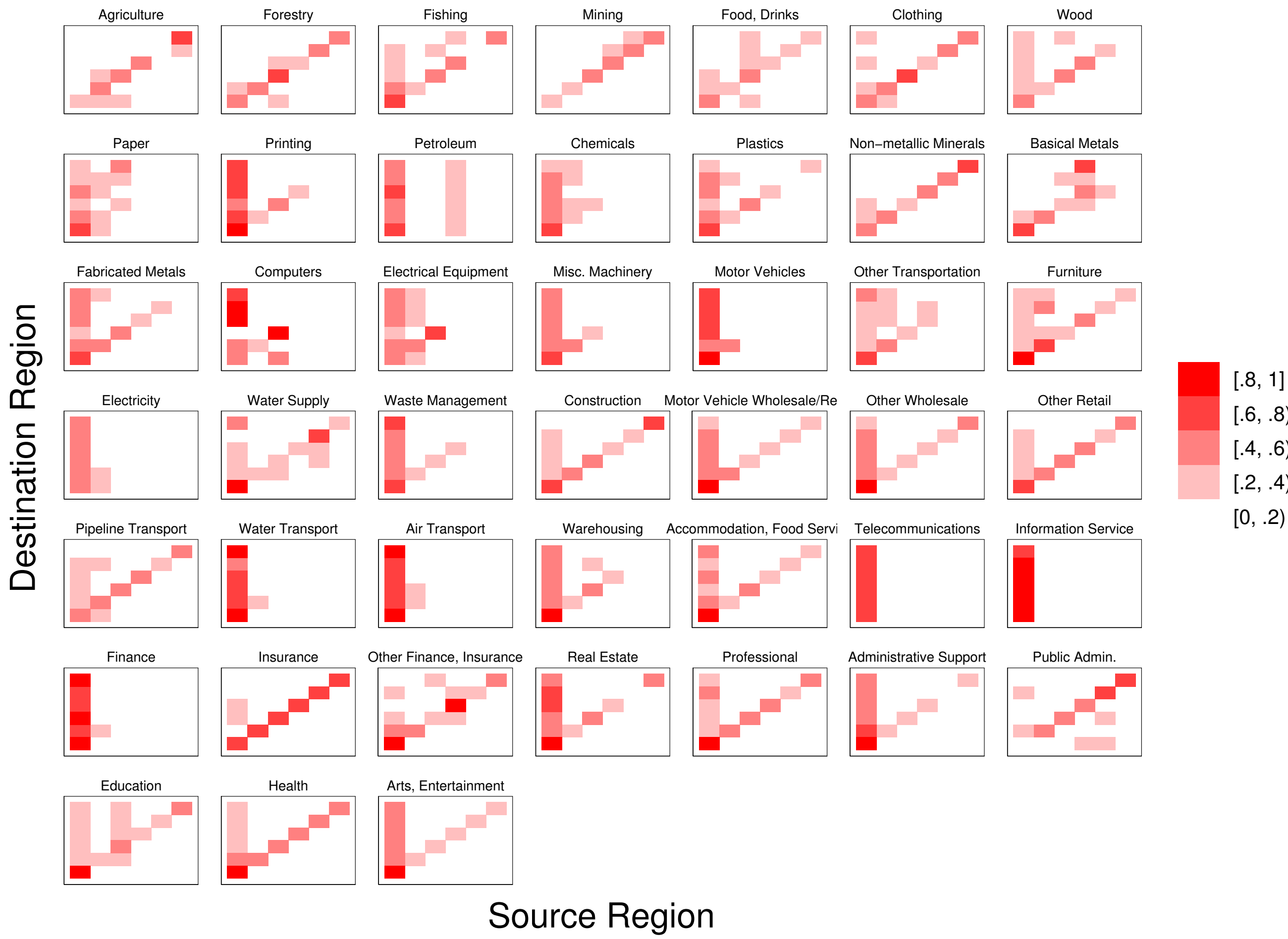

Figure 2: Intermediate Input Flows
Notes: Each panel displays, for a separate commodity, the share of the destination region purchases that come from each source region. Regions are sorted from left to right and bottom to top. This figure uses data from 2012. Within each panel, there are six rows and six columns. Region 1 is in the leftmost column and bottom-most row in each figure; Region 6 is the rightmost column and topmost row in each figure.

Figure 3 depicts labor flows across pairs of subsidy region-industry pairs. The shading within each cell corresponds to the share of individuals in a particular source region-industry pair who end up in each destination region-industry pair. The dark diagonal within this figure indicates that workers tend to migrate across regions–industry pairs infrequently. Indeed, 19.4 percent of workers transition to a different destination industry region-pair, with 1.6 percent of workers switching regions from one year to the next.[19]

[19]The former figure excludes individuals who are transitioning into or out of non-employment. The latter figure is similar to the inter-state migration rate (1.5 percent) observed in the US (Kaplan and Schulhofer-Wohl, 2012).

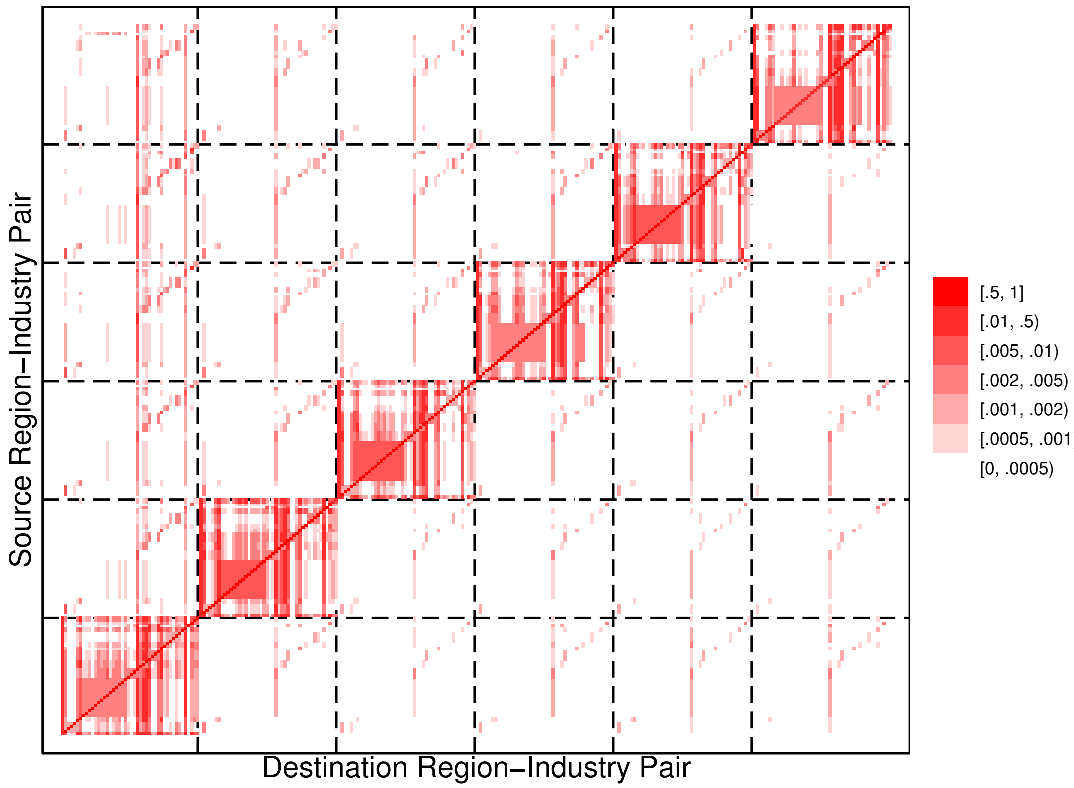

Figure 3: Labor flows
Notes: This figure presents flows of workers across region-industry pairs, between 2012 and 2013. Region-industry pairs are sorted by regions first, then by industries, with Region 1 and the first industry ("Non-Employment") listed in the leftmost column (and bottom row) and Region 6 and the final industry ("Education") listed in the rightmost column (and top row). Dashed lines demarcate each of the six subsidy regions. The shading represents the share of 2012 individuals for a given source region-industry pair who, in 2013, move to the destination region-industry pair.

To summarize, these descriptive statistics indicate that subsidization rates are skewed — concentrated in certain industries and geographies — and that there are considerable trade and migration linkages across the country's six subsidy regions.

4 Direct and Indirect Microeconomic Effects

In this section, we examine the microeconomic impacts of the 2012 subsidy program. In Section 4.1, we describe our empirical setup. We present the relationship between subsidization and economic activity: at the industry-province level in Section 4.2 and at the firm level in Section 4.3. Finally, in Section 4.4 we assess spillovers from subsidized firms to their customers, to their suppliers, or to workers in their local labor market.

4.1 Set-up

Our main empirical setup to detect direct effects is a difference-in-difference type regression:

$$y_{pnt} \quad = \quad \beta_{pn} + \beta_{nt} + \beta_1 S_{pnt} + \varepsilon_{pnt} \ . \tag{1}$$

Here, y_{pnt} is some measure of economic activity in a given province-industry pair p-n in year t. We will compare this measure of economic activity to the level of subsidization, S_{pnt}, at that given point in time. We use industry-province and industry-year fixed effects to control for the overall scale of economic activity in the province-industry pair or for macroeconomic shocks that differentially impact different types of industries.

In interpreting β_1 as a causal estimator of the effect of the subsidy program on economic activity, we face three challenges. First, it is possible that the industry-province pairs most exposed to the subsidy program were growing relatively quickly (or relatively slowly) in the years prior to the introduction of the subsidies. (Our Table 1 finding that heavily subsidized regions, Regions 5 and 6, had relatively fast GDP per capita growth in the five years prior to introduction of Law 2012/3305 lends credence to this concern.) A second challenge is that not every firm eligible to receive subsidies actually applied. To the extent — when comparing firms (or industry-province pairs) within the same industry and subsidy region — firms more likely to select into the program would have grown exceptionally slowly absent the new policy, OLS estimates of Equation 1 will lead us understate the policy's impact on economic activity. Third, and related, as we have discussed in Section 2, whatever measure we apply for S_{pnt} will imperfectly capture industry-province pairs' exposure to subsidization.

In Section 4.2, we discuss our instrumental variables strategy to confront the second and third of these three challenges. Regarding the first, we explore the issue of pre-trends with an amended version of Equation 1, described by:

$$y_{pnt} - y_{pn,2011} \quad = \quad \beta_{nt} + \beta_{pt} + \beta_{1t} \widetilde{S}_{pn} + \varepsilon_{pnt} \ . \tag{2}$$

The aim of this regression is to compare industry-province pairs' pre-policy growth rates to their post-2012 subsidization levels. Equation 2 differs from Equation 1 in four ways. First, given that the aim of Equation 2 is to compare pre-policy growth rates with post-2012 subsidization — and not to compare contemporaneous subsidization and economic activity as in Equation 1 — we replace S_{pnt} with $\widetilde{S}_{pn}$: the statutory investment tax credit rate available post 2012 in province p and industry n. Second, the coefficients that we estimate β_{1t} are allowed to vary by year; this permits the construction of "event-study" plots. Third, given that $\widetilde{S}_{pn}$ is a time-invariant measure, Equation 2 omits the industry-province fixed effects that were present in Equation 1. Fourth, since we have modified our coefficient estimate β_{1t} to vary by year, we include province-year fixed effects as well.

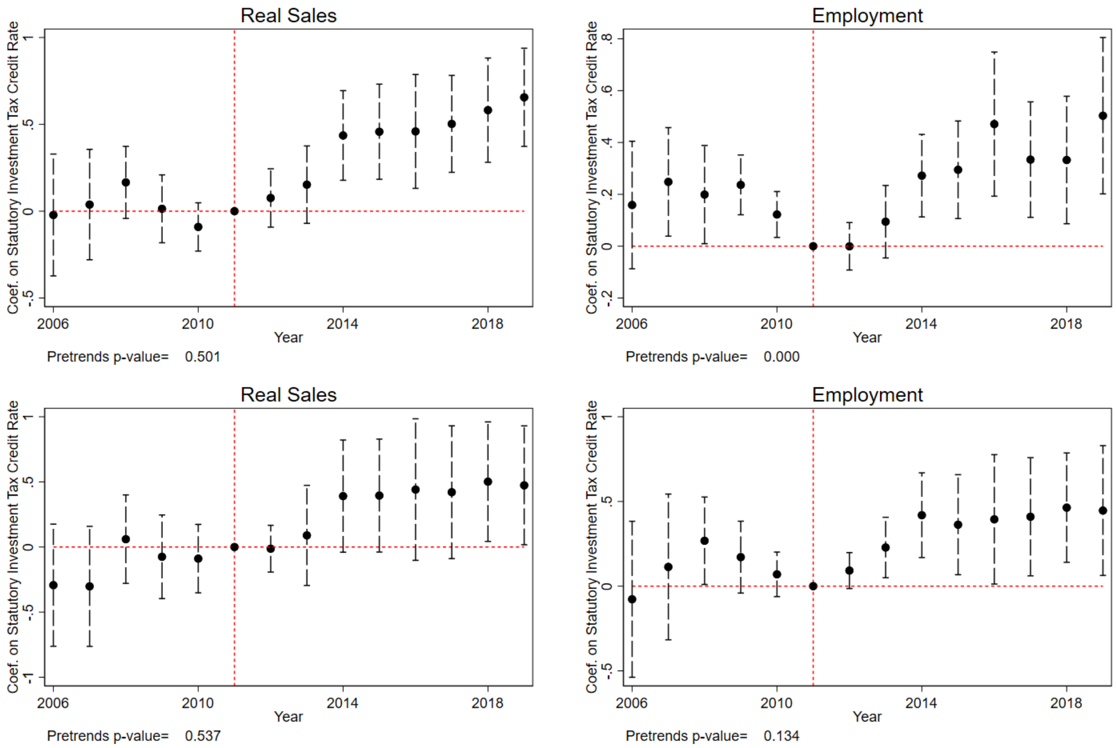

Figure 4: Examination of pre-trends
Notes: Within each panel, we plot estimates of β_{1t}. The dashed lines give 1.96-standard-error confidence intervals, with standard errors clustered by province-year. The sample includes all industry-province pairs for which there are at least 5 firms within the cell every year within the sample period. The top row of panels weights cells according to average firm-count within the sample period; the bottom row of panels weights province-industry pairs equally.

Figure 4 presents our estimates of β_{1t} with two alternate measures of activity: the logarithm of real sales ("revenues") in the industry-province pair, and the logarithm of the number of employed workers in the industry-province pair. In the top panels, we weight province-industry pairs according to the average firm count within the sample period; in the bottom row of panels, province-industry pairs are weighted equally. In three of the four specifications, we cannot reject the null hypothesis that $\beta_{1t} = 0$ for each year between 2006 and 2010. We can reject this null hypothesis in one of the four specifications — with employment as the measure of economic activity and weighting by firm counts. Here, the most heavily subsidized province-industry pairs had exceptionally quick employment growth between 2006 and 2009 and exceptionally slow employment growth between 2009 and 2011. Averaging over the two sub-periods, there is no significant difference in employment growth rates across industry-province pairs of different exposures to the subsidy program. In all four specifications, economic activity is significantly higher at the end of our sample (relative to 2011) in province-industry pairs eligible for relatively generous subsidies.

4.2 Industry-Level Comparisons

Having examined the issue of pre-trends, we return to our baseline specification (Equation 1) and compare contemporaneous measures of economic activity to measures of subsidization.

In columns (1) though (4) of Table 5, we present OLS estimates of the relationship between revenues and subsidization. We consider two measures of subsidization: the average investment tax credit rate received by firms in province p and industry n (columns 1 and 3), as well as the fraction of firms with a closed subsidy certificate (columns 2 and 4). In all four specifications, we find that subsidization significantly increases industry-province revenues. A 5 percentage point increase in the average investment tax credit rate — approximately equal to the end-of-sample difference in average investment tax credit rates between Region 6 and Region 1 — corresponds to a 6.2 percent ($\approx 1.235 \cdot 0.05$) increase in industry-province level revenues (column 3).

Not all firms that are eligible for a subsidy actually apply: There is substantial heterogeneity in subsidy take-up rates both among firms within the same industry-province pair and across industry-province pairs with identical levels of statutory eligibility and generosity.[20] To the extent that firms differ in their propensity to seek and successfully receive a subsidy certificate, and that these differences are correlated with future economic success, our OLS estimates may present a biased estimate of the effect of the subsidy program on economic growth. Further, our explanatory variable measures exposure to subsidization with some error. For these two reasons, we instrument firm (or industry-province) subsidy take-up with measures of subsidy eligibility and generosity. For regressions with the investment tax credit rates received by firms, we instrument by the statutory investment tax credit rate available for firms in the province-industry. For regressions with the share of firms who have received the subsidy as our measure of S_{pnt}, we choose the dichotomous measure of whether the province-industry pair was eligible to receive subsidies as our instrument.[21]

[20]To give one example of the incomplete and heterogeneous subsidy take-up rates, consider Diyarbakır and Batman — two provinces in the sixth subsidy region. These two provinces had, respectively, 22 percent and 40 percent of their rubber and plastics manufacturing firms with a closed subsidy certificate by the end of the sample.

[21]Conceivably, one could choose the statutory investment tax credit rate as an instrument for the share of firms receiving a subsidy. Our results are robust to this alternate instrument choice.

Table 5: Industry-Province Level Observations

Panel A: OLS Estimates	(1)	(2)	(3)	(4)
Investment Tax Credit Rate	1.280***		1.235***	
	(0.181)		(0.216)	
Closed Certificate		0.532***		0.574***
		(0.099)		(0.106)
N	238,206	238,206	237,747	237,747
Year FEs	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes
R^2	0.885	0.885	0.913	0.913
Panel B: IV Estimates	**(5)**	**(6)**	**(7)**	**(8)**
Investment Tax Credit Rate	4.092***		8.222***	
	(0.915)		(1.448)	
Closed Certificate		2.088***		2.076
		(0.742)		(2.170)
N	238,206	212,008	237,747	211,457
Year FEs	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes
	First Stage			
Statutory investment tax credit rate	0.068***		0.082***	
	(0.004)		(0.007)	
Eligible for subsidy?		0.024***		0.023***
		(0.001)		(0.004)

Notes: This dependent variable equals log revenues for the province*NACE (4-digit)*year. All specifications additionally include province-industry fixed effects. The "Closed Certificate" refers to the fraction of firms within the industry-province pair with a "closed" subsidy certificate. The Investment Tax Credit Rate is the average investment tax credit rate for the firms with a subsidy license in the province*NACE pair in a year. Standard errors are clustered at the province level.

Columns (5) though (8) of Table 5 present our IV estimates. In general, our estimates of the subsidy's effect on province-industry revenues are larger, and somewhat less precisely estimated. Among the explanations for these larger coefficient estimates, one possibility is that the industry-provinces who had exceptionally high subsidy take-up rates — relative to other industry-province with similar levels of eligibility and generosity — had relatively low growth rates. Alternatively, the investment tax credit rates received could be an imperfect measure of exposure to the subsidy policy, with such measurement error leading to attenuation of the true effect of subsidization on industry activity.[22,23]

So far, we have demonstrated that the 2012 policy led to increased economic activity in the most heavily subsidized industry-province pairs. These industry-level relationships reflect the direct firm-level impact of the subsidies along with spillovers that exist among firms in the same province and spillovers among firms across provinces. In Sections 4.3 and 4.4, we apply our firm-level balance-sheet and production data to unpack the industry-level impacts uncovered in this section.

4.3 Direct Effects on Subsidized Firms

In this section, we examine the direct effect of the subsidy scheme on firms' revenues, employment, and productivity.

We consider regressions of the form:

$$y_{ft} \quad = \quad \beta_f + \beta_{nt} + \beta_1 S_{ft} + \varepsilon_{ft} \ . \tag{3}$$

Here, y_{ft} is a measure of firm-level activity in year t. We regress this variable against a measure of firm subsidization in year t (S_{ft}), industry-year fixed effects (β_{nt}), and firm fixed effects β_f. In certain specifications, we replace industry-year fixed effects with year fixed effects.[24] Since we employ firm fixed effects, and since firms' eligibility experiences a

[22]In their analysis of the UK Regional Selective Assistant Program's effect on manufacturing employment, Criscuolo et al. (2019) report similar discrepancies between OLS and IV regression results, with IV estimates exceeding OLS estimates by a factor of 7; see their table 4. However, there are at least two relevant differences between the approaches in our papers. In Criscuolo et al. (2019), subsidization varies according to geography, not geography-by-industry as in our paper. Further, the instrument in Criscuolo et al. (2019) exploits plausibly exogenous changes in subsidy rules as an instrument for regions' eligibility for subsidization. For these reasons, our explanations for the differences between OLS and IV estimates will differ from those in Criscuolo et al. (2019).

[23]In Appendix D, we demonstrate that our results are robust to weighting province-industry pairs by the number of firms in the sample, to controlling for Syrian-refugee population share (at the province by year level), and to the inclusion of province-by-industry fixed effects. We also present estimates of Equation 1 with two alternate measures of economic activity: total employment and the number of firms. We find that a 5 percentage point increase in the investment tax credit rate leads to a 19 percent increase in the number of firms (column 7 of Table 26). As with Table 5, our IV estimates are both less precisely estimated and imply a higher impact of subsidization. In contrast to our results with revenues and firm counts, our estimates of the relationship between industry-province employment and subsidization are somewhat sensitive to the specification we apply. Although most specifications yield a positive relationship between the two variables, our IV regressions with year fixed effects (and without year×industry fixed effects) imply a negative relationship between employment and subsidization.

[24]In Appendix D, we consider regressions in which we replace firm fixed effects with industry-province fixed effects and balance-sheet variables. The results are similar to those presented in Tables 6, 7, and 8 below.

Second, we re-estimate Equation 3 with three additional variables: the firm's wage-bill, their real invest-one-time shift in 2012, our sample includes only firms who were present both before and after 2012. As with our industry-level regressions, in certain specifications we instrument firms' received subsidies with variables measuring the statutory subsidy rates firms are eligible to receive.

Table 6: The Impact of the Subsidy Program on Firm Revenues

	OLS				
	(1)	(2)	(3)	(4)	(5)
Investment Tax Credit Rate	0.879***	0.807***			
	(0.072)	(0.065)			
Inv. Tax Credit Rate + Closed Certificate			1.033***	0.984***	
			(0.077)	(0.078)	
Closed Certificate					0.337***
					(0.030)
N	919,931	919,931	901,332	901,332	901,332
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
R^2	0.832	0.836	0.834	0.839	0.839
	IV				
	(6)	(7)	(8)	(9)	(10)
Investment Tax Credit Rate	2.687***	3.254***			
	(0.487)	(0.604)			
Inv. Tax Credit Rate + Closed Certificate			4.061***	5.370***	
			(0.882)	(1.335)	
Closed Certificate					2.989***
					(1.755)
N	881,484	881,088	862,809	862,407	862,408
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
	First Stage				
Statutory investment tax credit rate	0.140***	0.132***	0.087***	0.077***	
	(0.010)	(0.019)	(0.009)	(0.015)	
Eligible for Subsidy?					0.025*
					(0.015)

Notes: The dependent variable is log revenues at the firm-year level. All regressions include firm fixed effects. Standard errors are clustered at the province level.

ment, and the wage-bill per worker. Expenditures on labor are increasing in subsidization levels. In contrast, the sign of the relationship between subsidization and investment — when instrumented with statutory subsidy eligibility and generosity — depends on the precise specification we apply. The relationship between the average wage and subsidization is insignificant in OLS specifications, negative in certain IV specifications, and positive in other IV specifications. The ambiguous results for investment are likely due to the lumpy nature of capital investment, while those for the average wages per employee are consistent with our findings in Section 5.

Finally, we demonstrate that our main conclusions are unchanged with an alternate measure of subsidization for S_{ft}: the number of years for which the firm is relieved from making social security contributions.

Table 6 presents the relationship between subsidization and firm revenues. Overall, more generous subsidization leads to greater revenues. Comparing the first four columns – or the sixth through ninth columns – the relationship for firm revenues and subsidization is stronger for firms with "closed" subsidy certificates. These are the firms who have completed the subsidized investment, and who are able to receive the complete suite of subsidies from the Turkish government. Furthermore, consistent with our industry level-regressions, comparisons of the first five and final five columns indicate that IV specifications lead to a stronger estimated relationship between subsidies and revenues.[25] The results from our preferred specification (column 7) indicate that a 5 percentage point increase in the investment tax credit rate — again, approximately equal to the difference, in 2019, in average subsidy levels between Region 6 and Region 1 — corresponds to a 16.2 log point ($\approx 3.254 \cdot 0.05$) increase in revenues.

Table 7 presents corresponding results for employment. Here, too, subsidies lead to increased economic activity, both in the OLS and IV estimations. As with the estimates in Table 6 (and Table 8, below), the estimates of the relationship between subsidization and economic activity are larger when the firm's subsidy certificate is "closed" (compare columns 1, 2, 6, and 7 to columns 3, 4, 8, and 9). This accords with the timing at which subsidies are received: First firms submit an application, then they begin an investment project when their certificate is "open", and only then receive the full suite of subsidies. According to column 7 of this table, a 5 percentage point increase in investment tax credits received leads to a 8.7 log point increase in firm employment.

Finally, Table 8 records the effect of the investment subsidies on firms' total factor productivity.[26] According to our IV specifications, a 5 percentage point increase in investment tax credit ratios leads to a 3.3 log point increase in TFP (column 7 of Table 8). There are a number of possible mechanisms through which the subsidies may increase firm-level TFP. First, subsidization entails a direct reduction in the effective rental price of capital and wage rate that subsidized firms pay. Thus, the subsidy program led to a reduction in firms' marginal cost of production. Since our measure of TFP is a residual of firms' revenues and their unit input costs, the subsidy program may have led to an increase in measured productivity (revenue productivity, "TFPR", in the nomenclature of Foster et al. (2008))

[25]For firms that operate in multiple industry-province pairs, we apply the following procedure to define the instrument. For firms which receive a subsidy, we define the instrument based on the statutory rate in the industry-province pair of the firm's application. For firms which do not receive a subsidy, we define the statutory rate in the industry-province pair of the firm's headquarters. In Appendix D, we demonstrate that out firm-level regressions are similar for the subsample of firms who have all of their establishments in a single industry-province pair.

[26]We estimate TFP for each 2-digit NACE industry, using the estimator developed by Ackerberg et al. (2015). Appendix C describes our specification in greater detail, then presents the estimated production function parameters.

Table 7: The Impact of the Subsidy Program on Firm Employment

	OLS				
	(1)	(2)	(3)	(4)	(5)
Investment Tax Credit Rate	1.061*** (0.088)	1.005*** (0.080)			
Inv. Tax Credit Rate + Closed Certificate			1.311*** (0.090)	1.260*** (0.087)	
Closed Certificate					0.448*** (0.032)
N	924,368	924,368	905,146	905146	905,146
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
R^2	0.850	0.855	0.853	0.858	0.858
	IV				
	(6)	(7)	(8)	(9)	(10)
Investment Tax Credit Rate	1.561*** (0.427)	1.746*** (0.587)			
Inv. Tax Credit Rate + Closed Certificate			2.320*** (0.689)	2.996*** (0.999)	
Closed Certificate					2.104*** (0.879)
N	885,997	885,617	866,693	866,303	866,304
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
	First Stage				
Statutory investment tax credit rate	0.142*** (0.010)	0.135*** (0.019)	0.088*** (0.009)	0.079*** (0.015)	
Eligible for Subsidy?					0.026* (0.015)

Notes: The dependent variable is log (Employment) at the firm-year level. All regressions include firm fixed effects. Standard errors are clustered at the province level.

even without altering their true efficiency in measuring inputs into outputs.[27] A second possibility, (un-modeled) frictions – to capital or labor markets – have been leading to inefficient scales of production, especially in the southeast of the country. To the extent that the subsidy program relaxed credit constraints, they may have increased firm efficiency. While understanding the precise mechanism through which the subsidies increase firm productivity is necessary to address many interesting economic questions, it is less salient for the purposes

[27] Foster et al. (2008) contrast TFPR with "technical efficiency." The latter characterizes the rate at which firms transform physical inputs into physical outputs. The former relates firms' ability to transform expenditures on inputs into revenues. Differing productivity measures may be more or less salient, depending on the context and question at hand. In terms of understanding the differential welfare impacts of the subsidy program, a task we turn to in Section 5, TFPR provides the relevant measure of productivity.

of evaluating the impact of the subsidy program on regional wage inequality.

Table 8: The Impact of the Subsidy Program on Firm TFP

	OLS				
	(1)	(2)	(3)	(4)	(5)
Investment Tax Credit Rate	-0.022	-0.045**			
	(0.024)	(0.022)			
Inv. Tax Credit Rate + Closed Certificate			-0.013	-0.034	
			(0.040)	(0.035)	
Closed Certificate					-0.019
					(0.013)
N	860,210	860,210	842,918	842,918	842,918
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
R^2	0.618	0.631	0.623	0.635	0.635
	IV				
	(6)	(7)	(8)	(9)	(10)
Investment Tax Credit Rate	0.979***	0.657***			
	(0.170)	(0.2235)			
Inv. Tax Credit Rate + Closed Certificate			1.542***	1.101***	
			(0.271)	(0.434)	
Closed Certificate					0.254
					(0.303)
N	824,585	824,199	807,204	806,805	806,806
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
	First Stage				
Statutory investment tax credit rate	0.142***	0.135***	0.089***	0.079***	
	(0.010)	(0.019)	(0.009)	(0.015)	
Eligible for Subsidy?					0.026*
					(0.016)

Notes: The dependent variable is log(TFP) at the firm-year level, estimated using Ackerberg et al. (2015). All regressions include firm fixed effects. Standard errors are clustered at the province level.

4.4 Indirect Effects via the Production Network and Local Labor Markets

In this section, we examine spillovers in the effects of the subsidy program along input-output relationships and within firms' local labor markets. There are two purposes of this section. First, we are inherently interested in documenting how the subsidies spill over to the customers or suppliers of subsidized firms. Second, in the calibration of our general equilibrium model in the following section, a key input will be the impact of subsidization on productivity. To the extent that (i) firms' own subsidization status is correlated with their suppliers' and customers' subsidization, and that (ii) counterparties' subsidization leads to higher TFP, our Table 8 estimates from the previous section would suffer from omitted variable bias. For a similar reason, we include an additional control for the wages in the firms' local labor market. The average wage rate paid by firms in a given industry-province pair may respond to the share of firms receiving a subsidy, and may affect individual firms' total factor productivity.

We amend the regression specifications from Equation 3 to include information on the share of the firm's customers or suppliers who have received a subsidy:

$$\begin{aligned} y_{ft} &= \beta_f + \beta_{nt} + \beta_1 S_{ft} + \beta_2 \cdot w_{npt} \\ &\quad + \beta_{\text{up}} s^{\text{upstream}}_{\vartheta \to ft} + \beta_{\text{down}} s^{\text{downstream}}_{f \to \vartheta, t} + \varepsilon_{ft} \ . \end{aligned} \tag{4}$$

In Equation 4, y_{ft} refers to a firm-year level activity measure (either log revenues, log employment, log investment, or TFP), $s^{\text{upstream}}_{\vartheta \to f}$ equals the share of firm f's intermediate input expenditures that are sourced from subsidized firms, $s^{\text{downstream}}_{\vartheta \to f}$ equals the share of firm f's intermediate input sales that are sold to subsidized firms, and w_{npt} equals the average daily wage in firm f's local labor market (i.e., the average wage paid by firms in industry n and province p in year t). In addition, we include province-industry fixed effects and controls for firm activity as of 2012. In certain specifications, we include firm fixed effects.

Tables 9 and 10 present our estimates of Equation 4. First, controlling for suppliers' and customers' subsidization and wages in the firms' local labor market yields similar estimates of the productivity gains from subsidization (compare the estimates in columns 7 and 8 of Table 10 to those in columns 6 and 7 of Table 8). Second, firms with more subsidized customers have higher revenues, employment, and investment. The relationship between firms' TFP and the fraction of their customers who are subsidized is not statistically significant. Third, the relationship between the share of a firm's suppliers who are subsidized and their economic activity is sensitive to the activity measure, with revenues and measured productivity yielding a positive estimated relationship and investment yielding a negative relationship.[28] According to our IV estimates, a 5 percentage point increase in the fraction of a firm's suppliers and customers who are subsidized implies an increase in revenues of 0.7 percent, an increase in employment of 0.6 percent, and marginal changes in investment and marginal costs.[29]

[28] Canonical models of input-output linkages, including Acemoglu et al. (2012), predict that decreases in a firm's marginal costs (e.g., through subsidization of inputs) will reduce the marginal costs of the firm's customers, but not their suppliers. This is consistent with the results in columns (7) and (8).

[29] To compute these numbers, multiply the 0.05 with the sum of β_1 and β_2, using the even-numbered columns. For instance, to compute the employment effect, take the numbers from column (4) of Table 10:

Table 9: The Impact of the Subsidy Program on Firm Activity: OLS Estimates

Dependent Variable	Revenues		Employment	
	(1)	(2)	(3)	(4)
Investment Tax Credit	0.698***	0.638***	0.958***	0.930***
Rate	(0.041)	(0.035)	(0.083)	(0.092)
Weight of subsidized	0.100***	0.065***	0.115***	0.098***
firms in total sales	(0.013)	(0.012)	(0.012)	(0.011)
Weight of subsidized	0.104***	0.107***	0.030	0.020
firms in total purchases	(0.015)	(0.014)	(0.020)	(0.017)
Log daily wage	0.055***	0.034***	0.002	0.012*
	(0.012)	(0.010)	(0.007)	(0.007)
N	841,453	841,453	842,514	842,514
Year FEs	Yes	No	Yes	No
Year× Industry FEs	No	Yes	No	Yes
R^2	0.850	0.854	0.875	0.879
Dependent Variable	Investment		TFP	
	(5)	(6)	(7)	(8)
Investment Tax Credit	0.394***	0.357***	-0.085***	-0.115***
Rate	(0.060)	(0.052)	(0.030)	(0.028)
Weight of subsidized	0.030***	0.024***	0.001	-0.007
firms in total sales	(0.009)	(0.009)	(0.007)	(0.007)
Weight of subsidized	-0.022**	-0.053***	0.053***	0.040***
firms in total purchases	(0.010)	(0.010)	(0.011)	(0.012)
Log daily wage	0.012	0.004	-0.014*	-0.008
	(0.013)	(0.008)	(0.007)	(0.006)
N	750,737	750,737	791,523	791,523
Year FEs	Yes	No	Yes	No
Year× Industry FEs	No	Yes	No	Yes
R^2	0.323	0.335	0.643	0.654

Notes: All regressions include firm fixed effects. Standard errors are clustered at the province level.

0.5 percent ($\approx 5 \cdot (0.097 + 0.020)$).

Table 10: The Impact of the Subsidy Program on Firm Activity: IV Estimates

	Revenues		Employment		Investment		TFP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Investment Tax Credit	2.535***	2.548***	0.971**	0.942	1.460***	-0.425*	1.041***	0.647***
Rate	(0.354)	(0.514)	(0.457)	(0.676)	(0.338)	(0.236)	(0.208)	(0.186)
Weight of subsidized	0.095***	0.059***	0.115***	0.097***	0.027***	0.026***	-0.002	-0.009
firms in total sales	(0.012)	(0.012)	(0.012)	(0.010)	(0.009)	(0.008)	(0.007)	(0.007)
Weight of subsidized	0.068***	0.083***	0.030	0.020	-0.043***	-0.043***	0.030**	0.030**
firms in total purchases	(0.012)	(0.013)	(0.020)	(0.015)	(0.010)	(0.011)	(0.015)	(0.012)
Log daily wage	0.051***	0.034***	0.002	0.012*	0.010	0.004	-0.017***	-0.008
	(0.010)	(0.009)	(0.007)	(0.007)	(0.012)	(0.008)	(0.006)	(0.005)
N	791598	791252	792671	792326	710276	709961	744,754	744,384
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No
Year× Industry FEs	No	Yes	No	Yes	No	Yes	No	Yes
First-Stage Estimates								
Statutory investment	0.137***	0.127***	0.137***	0.127***	0.137***	0.125***	0.137***	0.127***
tax credit rate	(0.010)	(0.020)	(0.010)	(0.020)	(0.010)	(0.020)	(0.010)	(0.020)
Weight of subsidized	0.002	0.002*	0.002	0.002*	0.003*	0.002*	0.002	0.002
firms in total sales	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Weight of subsidized	0.017***	0.012***	0.017***	0.012***	0.017***	0.012***	0.018***	0.013***
firms in total purchases	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
Log daily wage	0.001	-0.001	0.001	-0.001	0.001	-0.001	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Notes: All regressions include firm fixed effects. Standard errors are clustered at the province level.

5 Aggregate Implications

In this section, we examine the aggregate implications of the 2012 subsidy program. We focus on the impact of the reforms on regional real wage inequality. There are, indeed, other metrics to evaluate the effectiveness of the subsidy reforms: the costs of these subsidies, whether the reforms increased aggregate economic activity relative to these costs, and whether the reforms reduced overall wage inequality (including wage inequality within regions). However, as we have discussed earlier, a primary goal of the 2012 policy was to reduce the gap between the relatively low-wage southeast and the rest of the country, and so this is our primary object of interest.[30]

In this section, we review and calibrate the model of Caliendo et al. (2019). This is a dynamic general equilibrium model with trade and migration across regions. Despite the large state space — with many industries and multiple regions—Caliendo et al. (2019) present a method (which they call "dynamic hat algebra") allowing one to measure the effects of exogenous policy changes on migration, wages, welfare, and other economic objects of interest. In addition to its tractability, the Caliendo et al. (2019) model is ideally suited to appraise the short-run and long-run spatial spillovers resulting from increased subsidization concentrated in the eastern provinces of the country. Even if — as we have documented in the previous section — the subsidy program spurred investment in targeted regions, domestic trade flows and migration may blunt the policy's impact on inter-regional real wage inequality. A dynamic general equilibrium model is necessary to quantify the importance of these countervailing forces.

5.1 Overview

The model features firms and households, each residing in a given region and tied to a particular industry. Households supply their labor and use their labor earnings to consume; they may also abstain from working. Households neither borrow nor save. Each period, households decide how much of each industry's product to consume and whether to migrate to a different industry-region pair. Firms produce using labor, structures (tied to the region in which the firm resides), and material inputs. Firms' output are sold to consumers and to firms in other provinces. Both migration and flows of intermediate goods across industries and geographies are costly: Households face a utility cost of switching the industry and region in which they are employed. Shipments of intermediate goods across regions are subject to iceberg trade costs. Finally, a third class of economic agents, rentiers, receive

[30] Gaubert et al. (2021) discuss the motivations for place-based redistributive policies. Broadly, there are two classes of motivations: improving the equity-efficiency trade-offs involved in place-blind redistributive policies, and a *per se* societal goal for limiting poverty within distressed areas.

rental income from structures and use this income to consume. Appendix E delineates the model in much greater detail, spelling out household preferences, firm production functions, market-clearing conditions, and the equilibrium definition.

These model ingredients allow one to explore the different channels through which subsidies may dissipate across geographies or industries. First, subsidization of firms in a particular region will lead to in-migration from unsubsidized regions, partially offsetting the real wage gains from the subsidy-induced increase in labor demand. Second, input-output linkages imply that shocks increase factor demands in both the directly affected industry-region pair and in industry-regions that are upstream or downstream of the subsidized firms. Third, subsidization pushes up rental prices in the affected region. To the extent that structures are owned by rentiers located elsewhere in the country, subsidies targeting one region will increase income — and, as a result, consumption, labor demand, and real wages — elsewhere in the country.

5.2 Calibration

We use this model to understand the impact of the 2012 subsidy program. In particular, we solve for the "baseline" model economy — with the observed subsidy program in place – and compare it to a "counterfactual" economy in which investment subsidies were not increased. Table 11 summarizes the moments and data sources necessary to compute the "baseline" and "counterfactual" economies. Critically, however, Caliendo et al. (2019)'s "dynamic hat algebra" method circumvents the need to pin down (i) the productivity level of the industry-region pair at each point in time, (ii) the utility costs of switching industries and regions, and (iii) the iceberg trade costs of trading goods across regions.

We do not model the costs associated with the subsidy program. To the extent that the introduction of new subsidies prompts the national government to raise taxes, borrow, or reduce government expenditures, there will be countervailing effects relative to the ones reported here. So long as these countervailing effects manifest uniformly across geographies (e.g., the prompted tax increases are neither location- nor industry-specific), our results on regional inequality will be unaffected by modeling the policy-related costs.

Of particular importance for our calibration is the direct impact of the subsidy program on productivity within each subsidy region and industry at each point in time from 2012 onward. We pursue two complementary strategies to infer this critical set of parameters.

Table 11: Overview of Calibration

	Moment	Data Source and Description
(1)	Subsidy Take-up and generosity	Avg. share of firms with closed certificates, or Investment tax credits received
(2)	Direct productivity effect of subsidy on firm productivity	Column 8 of Table 10, or Columns 3 and 11 of Table 5
(3)	Trade flows across regions and industries	See Figure 2
(4)	Labor flows across regions and industries	See Figure 3
(5)	Labor costs, value added, and gross output by industry and region	Turkish National Input-Output Tables from the World Input-Output Database
(6)	Consumption preference shares by industry and region	Turkish National Input-Output Tables from the World Input-Output Database
(7)	Materials purchases by upstream industry×downstream industry×destination region	Turkish National Input-Output Tables from the World Input-Output Database

Notes: This table gives a brief description of the data series used to calibrate the Caliendo et al. (2019) model. For additional detail, see Appendix E.2.

Relating Subsidy Take-up to Productivity

Within the context of our model, we view the reforms as leading to a reduction in the per unit cost of hiring labor or renting capital that subsidized firms pay. These lower input costs are equivalent, in the Caliendo et al. (2019) model, as a decrease in subsidized firms' marginal costs or, equivalently, an increase in their total factor productivity. In our primary approach to calibrate the direct impact of the subsidy program, we combine information on subsidy take-up rates and the relationship between subsidization and firm productivity to identify how much the 2012 subsidy program increased productivity in each region-industry pair. While our regressions in Section 4 focused on investment tax credits as the measure of firm subsidization, we emphasize that subsidies to capital investment and hiring labor are bundled with one another and so the subsidy program applies both to capital and labor.[31]

[31] One key abstraction of our model: firms' input choices in the Caliendo et al. (2019) model are static. In practice, firms make dynamic capital investment decisions. Kleinman et al. (2021) extend the Caliendo et al. (2019) model in studying dynamic capital investment within multi-region, multi-industry models with trade and migration linkages. Suppose we amended our analysis to allow some portion of land and structures to be fixed, and some portion that can be augmented via costly investment. We hypothesize that, in this amended model, the reforms would lead to greater increases in labor demand in the targeted regions, and greater migration and real wage impacts than what we report here.

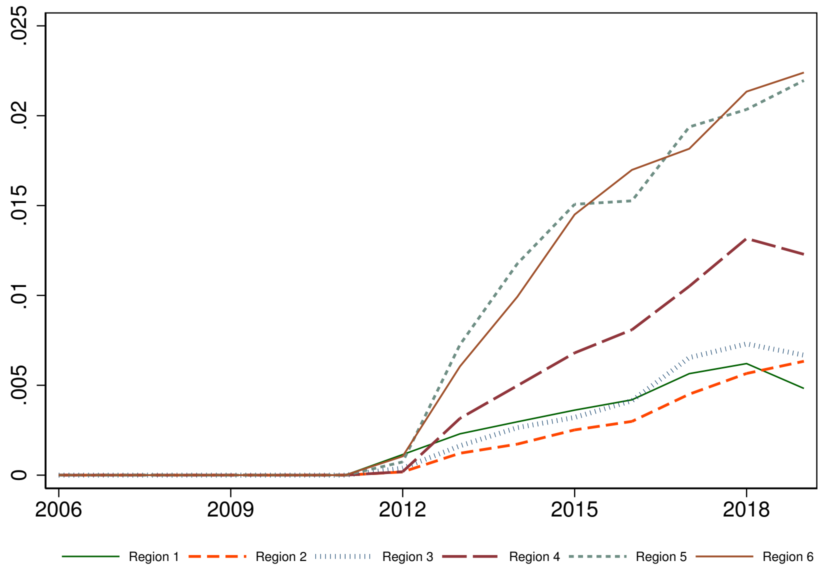

Figure 5: Investment Subsidies
Notes: The plot gives the employment-weighted average investment tax credit rates for each region and year. See Appendix Figure D.3 for investment tax credit subsidy levels by industry and region in 2019.

Figure 5 presents the time path of investment subsidies by region.[32] The time series within the plot give the product of subsidy take-up rates multiplied by investment tax credits for firms successfully applying for the credit. From 2012 on through the remainder of our sample, statutory subsidy generosity is constant. Instead, the fraction of firms who received investment tax credits increased from 2012 to 2016, with these increases decelerating in the final couple years of our sample. Regions 5 and 6 benefited the most from the subsidy program, with Regions 1, 2, and 3 receiving the lowest levels of subsidization.[33,34] To infer

[32]In our calibration, we assign the productivity increases in a region-industry pair on the basis of averages within the cell, abstracting from the substantial heterogeneity which exists in subsidy take-up rates (and productivity gains from subsidies) within industry-region pairs. (Moreover, these within-industry×region differences exist partly on the basis of observable firm characteristics. For example, firms with more employees are more likely to successfully apply for a subsidy.) While interesting, these differences are not of first order-importance for our analysis of regional income inequality.

[33]In Appendix D.3, we supplement Figure 5 with two additional figures. First, we plot average investment tax credits received by industry and subsidy region at the end of our sample period. According to this figure, subsidization was greatest in construction (NACE=b), transportation manufacturing (NACE=c29, c30), sewage, waste collection and waste management (NACE=e37, e38, e39), with subsidization uniformly higher in Regions 5 and 6 relative to Regions 1 and 2. Second, we plot average investment tax credits received among firms in the formal economy. (Figure 5 presents a weighted average of subsidization in the informal economy — firms who were ineligible to receive subsidies — and that in the formal economy.) There our measures of subsidization are greater by a factor of two to three, with the biggest discrepancy in Region 6 (a region in which informal-sector firms are over-represented).

[34]Region 6's employment in construction, manufacturing, waste collection and waste management is substantially lower than in other industries. As a result, the average investment tax credits received in

the direct productivity impact of the subsidy program, we multiply these time series by 0.647 (see column 8 of Table 10) — the incremental productivity gain from the investment tax credit.[35,36]

Matching Observed Revenues Growth to That in Our Calibrated Model

One concern, when applying our Section 4.4 estimates on the impact of subsidization on firm-level TFP to our model, is that there are potentially spillovers across treated and untreated firms, leading us to violate the "stable unit treatment value assumption" (SUTVA) (Angrist et al., 1996). We directly control for subsidization of the firms' customers or suppliers, to potentially account for TFP spillovers across firms sharing production links, and average wages in the firm's province-year-industry, to account for the possibility that the subsidy bid up wages in the firms' local labor market (and thus lowered the firm's TFP.) While the inclusion of these controls mitigate these SUTVA-related concerns, it is possible that there are other unobserved spillovers that we are not able to control for.

As an alternate strategy to estimate the direct productivity impact of the subsidy program, we consider an "indirect inference" approach. We regress (i) industry-region level revenues against subsidy measures in our data; and (ii) industry-region level revenues and subsidy measures in our model. From (i) and (ii) each, we have a single regression coefficient. We choose calibrated value of the "productivity gain from subsidization" to exactly match (i) and (ii).

In more detail, to perform our moment-matching exercise, we consider regressions of the form:

Region 6 is similar to that in Region 5, despite substantially greater statutory rates in Region 6.

[35] Our counterfactual exercises require, as inputs, expected values for TFP trajectories beyond the end of our sample period. We assume that in years after 2019 the subsidy levels (and, consequently, the direct productivity impacts of the subsidy program) are equal to their 2019 values.

[36] Absent in our calibration are any direct TFP spillovers across firms via input-output linkages, spillovers which are explored in Bazzi et al. (2017). In our analysis, TFP increases for subsidized firms. These subsidies then lower marginal costs — through lower materials prices — for those downstream of the subsidized firms, and increase demand for those that are upstream. But these subsidies do not increase, in our model, TFP of unsubsidized firms. Including these spillovers in our analysis will magnify the overall impact of the subsidies on aggregate real wages, but will (depending on how they are modeled) have an ambiguous impact on regional inequality. Since a large fraction of domestic trade flows occurs across subsidy regions, TFP gains that occur via spillovers may benefit both heavily subsidized and less subsidized regions.

We also exclude the related possibility of firm TFP increasing in the density of activity. Existing work (e.g., Greenstone et al., 2010; Fajgelbaum et al., 2019) highlights these spillovers as a potential rationale for place-based policies. Because we find that the subsidy program induced a reallocation of activity from Regions 1 and 2 to Regions 5 and 6, by doing so, we are understating impacts of the subsidies on real wage inequality.

$$y_{rnt} = \beta_{rn} + \beta_{rt} + \beta_1 S_{rnt} + \varepsilon_{rnt} \ . \tag{5}$$

Here, r denotes a subsidy region, n denotes a 2-digit industry (or a combination of 2-digit industries),[37] and t denotes a year. Furthermore, y_{rnt} measures either log revenues in region r, industry n, and year t, or the counterfactual impact of the subsidy program on industry n, region r, and time t revenues. In different regression specifications, we use different subsidy measures (either average investment tax credits received or statutory investment tax credit rates) and either weight observations according to the number of firms in the industry-region pair or weight all observations equally.[38]

In Table 12, we present our estimates of Equation 5. Panel A presents results from industry-level data. In all specifications, subsidization is associated with higher revenues. According to column 3, which we will consider our preferred specification, a 10 percent increase in investment tax credits received is associated with a 34.9 percent increase in revenues in the region-industry pair.

Panel B presents counterfactual impacts from our model, in which we feed in exogenous productivity changes in industry-region pairs to be proportional to investment tax credits received in the industry-province pair. We choose the constant of proportionality so that the impact of subsidization on revenues — according to the specification given in column 3 of Table 12 — exactly matches what we observed in panel A (in column 3).[39] To match the industry-geography level revenue gains from subsidization — i.e., to match columns 3 and 11 in Table 12 — we require that a 1 percent increase in the investment tax credits received leads to a 3.90 percent increase in firm-level TFP (as opposed to the 0.65 percent increase that we discussed in the previous subsection).

[37] See Appendix E.3 for the list of industries.

[38] In Appendix D.3, we consider an alternate set of regressions, using provinces and 2-digit industries as opposed to regions or a combination of 2-digit industries, as our unit of observation.

[39] We assume that agents did not anticipate, in 2011 or before, the subsidy program being enacted in 2012. As a result, the counterfactual impact of the subsidy program on revenues were 0 for $t = \{2006, ..., 2011\}$.

Table 12: Estimates of Equation 5

Panel A: Data	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Investment Tax Credit Rate	3.355***		3.493***		1.410*		1.611*	
	(0.305)		(0.508)		(0.583)		(0.657)	
Statutory Inv. Tax Credit Rate		0.364**		1.006***		0.174		1.053***
		(0.124)		(0.131)		(0.108)		(0.205)
Weight Observations?	Yes	Yes	Yes	Yes	No	No	No	No
Year FEs	Yes	Yes	No	No	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes	No	No	Yes	Yes
N	3,660	3,660	3,660	3,660	3,660	3,660	3,660	3,660
R^2	0.987	0.987	0.996	0.996	0.950	0.950	0.975	0.975
Panel B: Counterfactual	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Investment Tax Credit Rate	2.093**		3.492***		2.263***		2.670***	
	(0.754)		(0.472)		(0.471)		(0.438)	
Statutory Inv. Tax Credit Rate		0.114		0.533**		0.325**		0.651***
		(0.154)		(0.174)		(0.119)		(0.118)
Weight Observations?	Yes	Yes	Yes	Yes	No	No	No	No
Year FEs	Yes	Yes	No	No	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes	No	No	Yes	Yes
N	3,660	3,660	3,660	3,660	3,660	3,660	3,660	3,660
R^2	0.762	0.703	0.817	0.735	0.75	0.588	0.809	0.682

Notes: All regressions additionally include region-industry fixed effects. Standard errors are clustered at the region level.

5.3 Aggregate Impacts on Employment and Real Wages

In this section, we report the results from our calibrated model. We begin with the "indirect-inference" approach to calibrate the relationship between subsidization and firm productivity. We then apply our Section 4.4 regressions to calibrate the impacts of the 2012 subsidy program on productivity for each industry-region pair at each point in time. The section closes with a brief description of additional sensitivity analyses.

Calibration Based on Matching Industry-Regions Pairs' Revenue Growth

Our first set of results assesses the effect of the subsidy program on migration and employment by region. Figure 6 displays the model-implied labor force in each region in our baseline calibration relative to a calibration in which the subsidy program had not been enacted. According to this figure, the subsidy program is responsible for a 14.0 percent increase in the population of Region 6, a 14.9 percent increase in the population of Region 5, a 4.0 percent population decline in Region 1, and a 3.1 percent population decline in Region 2. Most of these changes in population by region occur by 2020, eight years after the introduction of the investment subsidy scheme. However, net migration continues well into the late 2020s. In the right panel, we plot employment by subsidy region. Across all regions, the subsidy program increased the returns to work relative to non-employment, leading to higher employment-to-population ratios throughout the country, but especially in Regions 5 and 6. Employment increased by 17.0 percent in Region 6, 17.9 percent in Region 5; it decreased by 0.5 percent in Region 2 and 1.6 percent in Region 1.

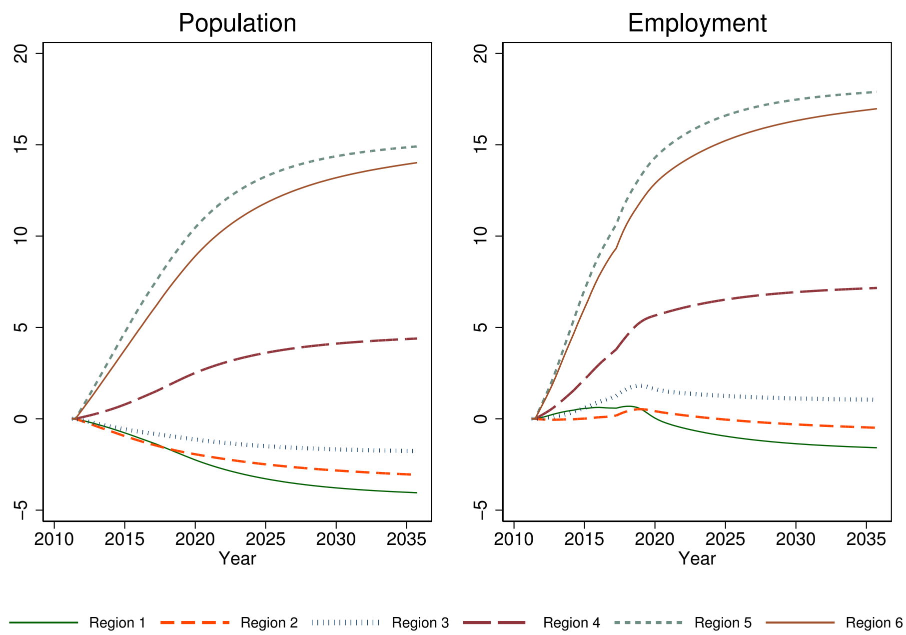

Figure 6: Migration and Employment Effects of the 2012 Subsidy Program
Notes: This figure presents, according to the benchmark calibration, the employment and migration effects effect of the subsidy reforms. The left panel describes the trajectory of population in each subsidy region relative to a counterfactual economy without the subsidy reforms. The right panel describes the employment in each region relative to a counterfactual economy without the subsidy reforms.

Our second set of results considers the impact of the subsidies on real wages in each subsidy region. In the top left panel of Figure 7, we present the results for the benchmark calibration, with domestic input-output linkages, migration, and structures. The 2012 subsidy scheme increased wages most in Regions 5 and 6 (the most heavily subsidized regions) and the least in Regions 1 and 2. Eight years into the subsidy program, at the beginning of 2020, real wages increased by 13.7 percent in Region 1, 6.8 percent in Region 6. Thus, as of the beginning of 2020, we surmise that regional wage inequality declined by 6.8 percent as a result of the subsidy program. This inequality reduction dissipates in subsequent years, as the investment subsidies slow down the (already occurring) migration from southeastern to western Turkey. As of 2026, we forecast that the investment subsidies will have reduced regional inequality by only 4.9 percent. We forecast an even smaller decline, of 3.6 percent, by 2036.

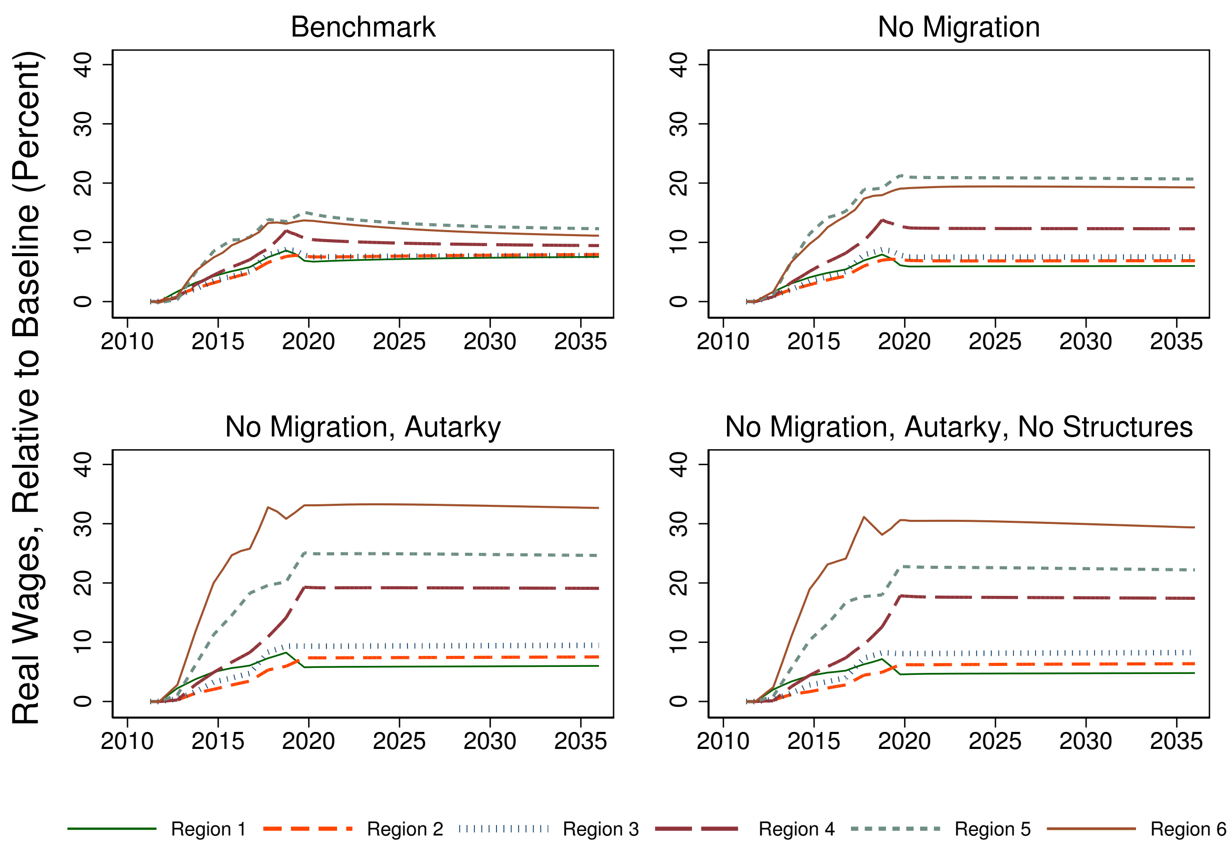

Figure 7: Real Wage Effects of the 2012 Subsidy Program
Notes: Each of the four panels display real wage trajectories for a separate model calibration. Real wages within each region are averages among employed individuals, using baseline industries employment to weight within each region. Compared to the top left panel, in the top right panel, our calibration imposes that workers may not migrate across subsidy regions (they may still move across industries within their regions). In the bottom left panel, we additionally impose that there are no material goods purchases across subsidy regions (input-output linkages still exist within regions). Finally, in the bottom right panel, we set the structures' share in value added to be equal to 0. See Figure 1 or Appendix E.3 for the lists of provinces within each of the six subsidy regions.

With the aim of understanding why the policy had such modest impacts on real wages, we consider three additional calibrations of our model. In these three calibrations, we progressively restrict channels through which subsidies in one region may spill over to others. In our second calibration (labeled "No Migration" in Figure 7), we restrict migration across provinces. In the third (labeled "No Migration, Autarky"), we additionally restrict inter-regional trade flows. In the fourth and final calibration (labeled "No Migration, Autarky, No Structures"), we parameterize firms' production functions so that the cost share of structures in value added is equal to 0, thereby eliminating rents earned by absentee rentiers. Each of the alternate calibrations is to highlight the importance of trade, migration, and capital rent spillovers in shaping the policy's ability to reduce regional inequality.

Comparing the top two panels of Figure 7 highlights the role of migration: In the top right panel, we consider an alternate calibration in which individuals are allowed to switch industries but not regions. Here, our calibrated model suggests that the investment subsidies will have reduced Region 6 versus Region 1 real wage inequality by 13.1 percent as of 2020, 13.4 percent as of 2026, and 13.3 percent as of 2036.[40]

The bottom panels of this figure assess calibration in which both trade flows and worker flows occur only within subsidy regions (bottom left panel) and, additionally, in which rentiers receive no income from renting structures (bottom right panel). In a world without trade flows across regions, this calibration indicates that the impact of the subsidy program on real wage inequality (now between Region 6 and Region 1) would have been even greater: 27.3 percent, 27.3 percent, and 26.7 percent as of 2016, 2026, and 2036, respectively (see the bottom left panel). Comparing the bottom left and bottom right panels of Figure 7 indicates that income spillovers due to rentiers' profits from structures play a minimal role.

In sum, we find that the 2012 policy had a modest impact on regional real wage inequality, especially in the long run. Migration and trade flows that traverse Turkey's six subsidy regions are a key reason why this policy had such a modest impact. These results highlight the limits of a common approach in the place-based literature to study spillovers: applying progressively larger regional and industry definitions in difference-in-difference setups. While a large fraction of spillovers tend to occur among nearby provinces, we show that a substantial portion of migration and flows span Turkey.

[40]The fact that a substantial portion of the potential real wage gains induced by the subsidies are dissipated through migration to subsidized areas (this could be a combination of reduced out-migration and in-migration) raises interesting questions about the Turkish government's views on desired outcomes of the program. Namely, would it find a "quantity" rather than "price" response—stemmed depopulation in place of reductions in per capital income gaps—acceptable, and at what rate would it be willing to trade the two off for one another? Such a trade-off is plausible. There is some evidence that the government believes İstanbul congestion is socially costly and might want to relieve migratory pressure (Milliyet, 2022). Further, to the extent that agglomeration economies, at least on the margin, were stronger in poorer regions than in wealthier ones, limiting migration might be an additional benefit.

Calibration Based on Estimates from Table 10

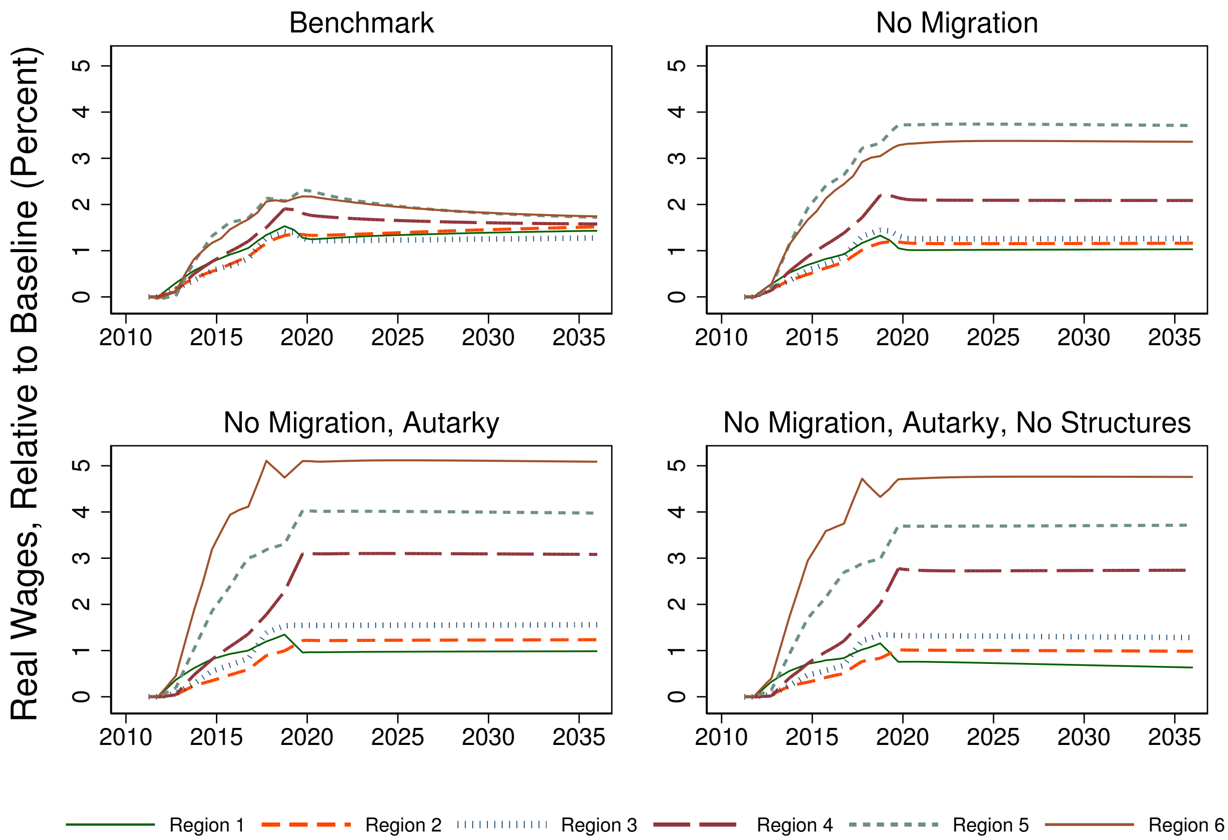

Figure 8: Real Wage Effects of the 2012 Subsidy Program
Notes: See the notes for Figure 7. In contrast to that figure, here we use estimates from Table 10 to estimate the productivity gains from the subsidy program.

Figures 8 and 9 present the migration, employment, and real wage effects of the subsidy program using "micro" approach, in which we apply the estimates from the final column of Table 10 to calibrate the productivity gains from the subsidy program in each region-industry pair. As this calibration imposes a smaller effect of subsidization on productivity, we find smaller effects on migration and real wages in Figures 8 and 9 than in Figures 6 and 7. According to the top left panel of Figure 8, the subsidization led to a decrease in real wage inequality (between Region 6 and Region 1, as of 2036) of approximately 0.3 percentage points. Besides the larger overall impacts, our main conclusions from Figure 7 also pertain to Figure 8: The impacts of the 2012 policy on regional real wage inequality are larger in the short run than in the long run. Spillovers across regions due to migration and trade are both important in limiting the effectiveness of the subsidies on reducing regional inequality.

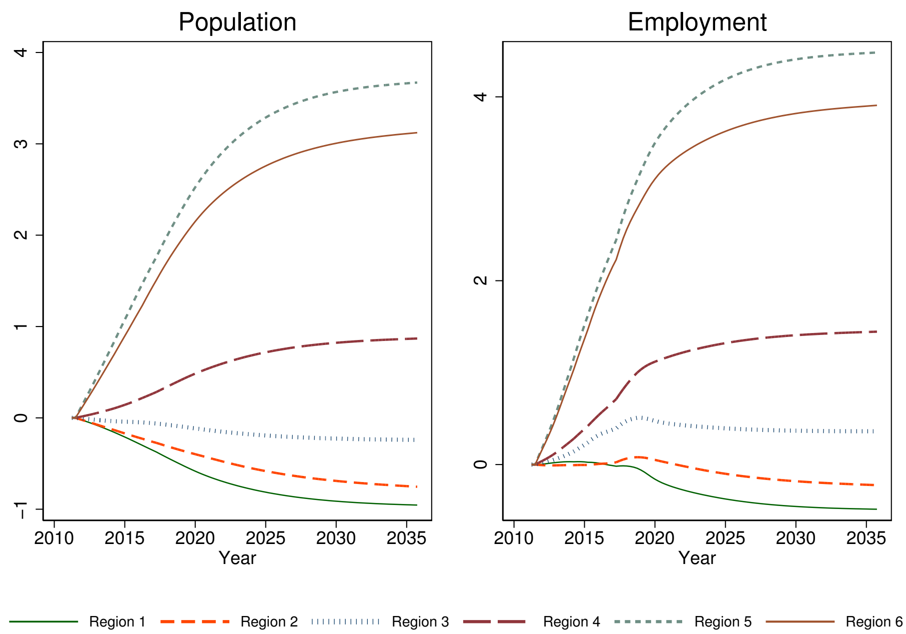

Figure 9: Migration and Employment Effects of the 2012 Subsidy Program
Notes: See the notes for Figure 6. In contrast to that figure, here we use estimates from Table 10 to estimate the productivity gains from the subsidy program.

Additional Sensitivity Analyses

In this subsection, we briefly describe additional sensitivity analyses that are collected in Appendix D.3.

In Figure 18, we plot the impact of the subsidy program on regions' real wages, under an alternate calibration in which the share of firms with a closed subsidy certificate measures the level of subsidization across industries and subsidy regions. Our main results regarding (i) the effect of the subsidy program on real wage inequality, (ii) differences between long-run and short-run impacts, and (iii) differences between the "benchmark" calibration and the calibrations without migration, without inter-regional materials trade flows, or without structures are robust to this alternate measure of firm subsidization.

In the same appendix, in Figure 20 we illustrate the importance of accounting for informality and imperfect coverage in our micro data. That is, when we compute average investment tax credits received, trade and worker flows across subsidy region-by-industry pairs, we re-calibrate our model assuming (incorrectly) that the share of firms and employment in the informal sector are equal to 0 and that our firm-level data comprehensively measured all activity within each industry. We find that the real wage impacts of the subsidy program are considerably larger, primarily because this calibration ignores the roughly 30 percent of the economy that is ineligible to receive subsidies. However, again, we find that the impact of the subsidy program on regional real wage inequality is modest, again due to trade and worker flows that traverse subsidy regions.

5.4 Out of Sample Predictions

In conducting our counterfactual exercises, our primary inputs were the time paths of investment tax credits by industry and subsidy region and the link between investment tax credits received and total factor productivity. We used our model to examine the impact of the subsidy program — through their reduction on firms' unit labor and capital rental costs — on real wages within each industry and subsidy region. In this section, we assess the model's ability to match two sets of non-targeted variables. We examine the counterfactual exercise's predictions for the impact of the subsidy program on employment and revenues, comparing the time paths of these variables to those observed in our data. The overlap between the model-implied counterfactual effects on employment and revenues and those observed in the data serves as a diagnostic on our model and its calibration. Since our "indirect inference" approach to identify the link between investment tax credits and firm productivity relies on the relationship between industry-region revenues and subsidization, we only assess counterfactual effects based on our firm-regression-based calibration.

Figure 10 presents our main comparison. Within this comparison, we group industries as "subsidized" (if their average investment tax credit rate received is greater than 1.0 percent in 2017-2019) or, otherwise, "unsubsidized."[41] For each set of industries, for each subsidy region, we compute the counterfactual sales growth (left panel) or employment growth (right panel), comparing 2011 to 2017-2019. According to our model, subsidized firms in the 6th subsidy region increased their employment by 3.8 percent, and their revenues by 6.1 percent. In contrast, subsidized firms in the first subsidy region had sales growth of 0.7 percent, and employment growth by -0.4 percent. We compare these counterfactual sales and employment growth to its counterpart in the data. To compute this data counterpart, we regress industry-region pair log revenues against industry-region fixed effects and year fixed effects. From this regression, we compute the average residual (from 2017 to 2019) for each region, separately for "subsidized" and "unsubsidized" industries. Overall, we find a strong relationship between this average residual and the model counterfactual. However, the difference in growth rates between subsidized industries in Regions 5 and 6 and other

[41]The list of subsidized industries includes crops (NACE= "a01"), fishing (NACE= "a03"), the mining sector (NACE="b"), the waste management sector (NACE = "e"), air transportation (NACE = "h51"), accommodation and food services (NACE= "i"), and the education sector (NACE= "p"). In addition, all industries within the manufacturing sector (NACE= "c") with the exception of paper manufacturing (NACE="c17"), printing and reproduction of recorded media (NACE="c18"), coke and refined petroleum products (NACE="c19"), and rubber and plastics manufacturing (NACE="22") have an average investment tax credit rate greater than 1.0 percent.

region-industry pairs is substantially greater in the data — with effects approximately five times as large — than according to our model calibration.

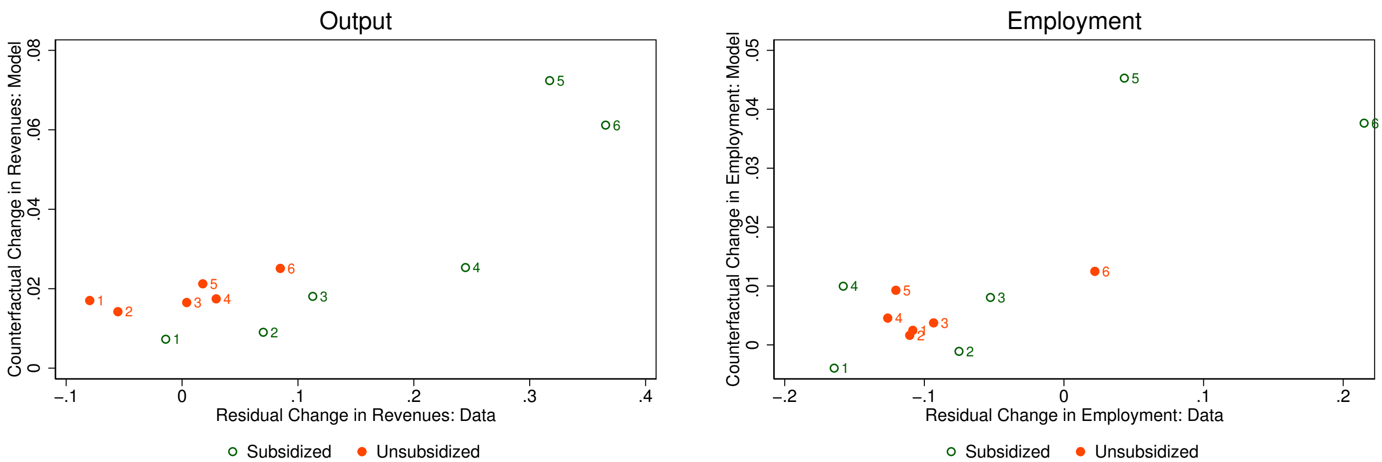

Figure 10: Subsidization, Employment, and Revenues: Model Counterfactuals and Data
Notes: Within each panel, the vertical axis gives the increase — as of 2017-2019, relative to 2011 — in revenues (or employment), relative to a counterfactual economy in which the subsidy program had not been enacted. The horizontal axis gives the average residuals, from a regression with log revenues (or log employment) as the dependent variable and industry-by-subsidy-region pair and year fixed effects as the covariates.

6 Conclusion

In this paper we study the introduction of place-based policies in Turkey. These new subsidies were aimed at promoting investment activity, particularly in the relatively impoverished southeast of the country. We find that each 5 percentage point increase in investment tax credit subsidy rates led to firms' revenues, employment, and TFPR being higher by 16.2 percent, 8.7 percent, and 3.3 percent, respectively. However, our general equilibrium analysis reveals that the 2012 subsidy program had only a modest impact on regional inequality.

There are several caveats to these conclusions. First, as with any piece of research focused on a single historical episode, there are potentially limits to the generalizability of the paper's conclusions to other environments. Among the many unique features of the backdrop to our study, the period after the subsidies were introduced coincided with a large influx of refugees due to the 2010s Syrian Civil War and a significant devaluation of its currency, with the impacts of these events likely differing by geography and industry.[42,43] Given these

[42]Between January 2007 and January 2012, the Turkish Lira lost approximately 30 percent of its value relative to the US dollar. In the following seven years, from January 2012 to January 2019, the value of the Lira depreciated from 1.83 to the US dollar to 5.47 to the US dollar, a three-fold increase.

[43]According to figures compiled by the Turkish government, in 2019 there were approximately 3.7 million

unique aspects, a similarly designed set of investment subsidies may conceivably have a different impact in other countries. Second, the calibration of our Section 5 model requires information on subsidy take-up rates. To understand the long-run impact of the subsidy program, we necessarily extrapolated take-up rates beyond the end of our sample period. We assumed a leveling off of the fraction of firms who received subsidies from the Turkish government. But alternate assumptions, including a continued increase in subsidization, are both reasonable and would lead to an alternate assessment on the policy's long-run impact.

While these issues are certainly valid, many of the lessons from our analysis may prove useful under other assumptions and in other contexts. Inter-regional spillovers — migration, input-output linkages, and landlords' ownership of structures in regions other than where they reside — limit the extent to which the place-based policy specifically benefited the targeted region. We argued, further, that the effects may differ in the short and long run. In the short run, there is relatively little migration across regions. In the long run, however, increases in labor supply to more heavily subsidized regions mute the impact of the subsidy program on inter-regional real wage inequality. Since considerable inter-regional trade and migration flows are a common feature, these insights on the short- and long-run impacts' of place-based policies on regional income inequality are likely to be universal.

Syrian refugees living in Turkey. Across the six subsidy regions, Syrian refugees comprised 3.1 percent of the population in Region 1, 4.1 percent in Region 2, 6.5 percent in Region 3, 6.1 percent in Region 4, 4.3 percent in Region 5, and 6.3 percent in Region 6.

See `https://web.archive.org/web/20190903234802/https://www.goc.gov.tr/kurumlar/goc.gov.tr/Istatistikler/EYLUL/2EYLUL/24_gecici_koruma_kapsamindaki_suriyelilerin_illere_gore_dagilimi_07022019.jpg`. Accessed November 8, 2022.

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A Data

In this section, we discuss our data sources and data cleaning procedures (Appendix A.1 and A.2). In Appendix A.3, we then compare aggregates computed from our micro data sources to those in publicly available datasets. Much of the discrepancy between the two arises due to the lack of information on informal-economy workers in our micro datasets. Part of the discrepancy is due to the lack of coverage of our firm-level dataset in a few industries: Agriculture, Finance, and Public Administration. In Appendix A.4, we compute the share of employment that is informal in each industry-region cell, then re-compare aggregates from our micro data sources to those in publicly available datasets. In the same appendix, we then describe how we account for the lack of micro data coverage in the Agriculture, Finance, and Public Administration industries. Finally, in Appendix A.5 we discuss how we compute labor flows across industry-by-subsidy region pairs.

A.1 Details on Entrepreneur Information System (EIS)

The Entrepreneur Information System (EIS) is administered by the Ministry of Science, Industry and Technology in Turkey as of 2014. Data from seven public institutions (Ministry of Customs and Trade, Revenue Administration (GIB), Social Security Institution (SGK), Small and Medium Enterprises Development and Support Administration (KOSGEB), Turkish Statistical Institute (TÜİK), Turkish Patent Institute (TPI) and the Scientific and Technological Research Council of Turkey (TÜBİTAK) are brought together in the EIS by the Ministry. In this study, we use the following data sets from the EIS: the "Entrepreneurship Registry Microdata Set," the "Workplace Registry Microdata Set," and the "Balance Sheet Micro Dataset." While calculating the indirect effects and detailed employment effects, we also use the "Declaration-Buying/Selling (BA/BS) Micro Dataset" and the "Employee Micro Dataset." The EIS includes data for most Turkish manufacturing and service companies, but excludes the finance sector. Information on the agriculture sector and public personnel is not included in the EIS.

Table 13 lists the number of firms in our sample by year and industry. There are 212,458 unique firms in our sample, and 1,039,766 firm-year observations. At the beginning of the sample, approximately 69 percent of the firms in our sample are headquartered in Region 1; slightly less than 3 percent of the sample are from Region 6. The number of firms in the sample has grown by 5.8 percent per year, with faster growth in Regions 5 and 6 and slower growth in Region 1. By 2017 and 2018, near the end of the sample, 6 percent of the firms were headquartered in Region 6, 61 percent in Region 1.

Table 13: Firm Counts

Year\Region	1	2	3	4	5	6	Total
2006	33,117	5,440	3,797	2,497	1,568	1,286	47,705
2007	36,150	6,177	4,467	3,192	1,966	1,687	53,639
2008	38,758	6,578	4,912	3,651	2,352	2,161	58,412
2009	36,147	6,457	4,978	3,687	2,440	2,314	56,023
2010	39,386	7,243	5,541	4,200	2,769	2,856	61,995
2011	43,780	8,167	6,324	4,743	3,101	3,206	69,321
2012	47,638	9,215	7,229	5,327	3,562	4,025	76,996
2013	50,962	9,582	7,538	5,266	3,525	4,082	80,955
2014	53,743	10,105	8,066	5,531	3,655	4,542	85,642
2015	57,538	11,223	8,801	5,968	3,967	4,684	92,181
2016	56,891	11,430	8,683	5,872	3,998	4,813	91,687
2017	57,954	11,793	9,155	6,028	4,205	5,300	94,435
2018	58,768	11,868	9,294	6,114	4,250	5,571	95,865
2019	50,674	9,040	6,919	2,450	2,083	3,576	74,910
Total	133,887	25,878	20,366	13,858	9,961	12,879	212,458

A.2 Data Cleaning Procedures

To ensure the soundness of the study, some observations are excluded from the sample following a number of criteria. The data of companies with missing, negative or zero total assets, sales, and long-term and tangible assets are excluded from the analysis. In addition, the data of companies whose short-term and long-term liabilities, current assets, total bank loans, payments, other liabilities and long-term debts are negative are also removed from the sample. Apart from these, the variables with outlier observations are winsorized at 1 percent, 2 percent, or 5 percent, when necessary.

A.3 Auditing the Micro Data

In this section, we evaluate the coverage of the micro datasets listed in Appendix A.1. These firm and worker datasets measure activity only in the formal economy. The micro data additionally exclude most firms in the agriculture, finance, and public administration industries, as well as public firms in the education industry. The EIS data thus may miss a substantial fraction economic activity. Furthermore, the coverage of our micro data may vary with geography (with greater coverage in the larger cities and in the west) and industry (with greater coverage in the non-agricultural sectors of the economy). Our goal, for now, is to gauge the severity of these coverage issues. In Appendix A.4 and A.5, we describe how to impute the extent of informality by industry and subsidy region, then discuss how to account for informality when calibrating our Section 5 model.

We provide two sets of comparisons. In the first, we compare province-level employment in our micro data to its counterpart in aggregate datasets compiled by TürkStat (the Turkish Statistical Institute). In the second comparison, we compare industry-level output and factor shares according to our micro data to aggregate statistics derived from the Socio-Economic Accounts from the World Input-Output Database (WIOD).

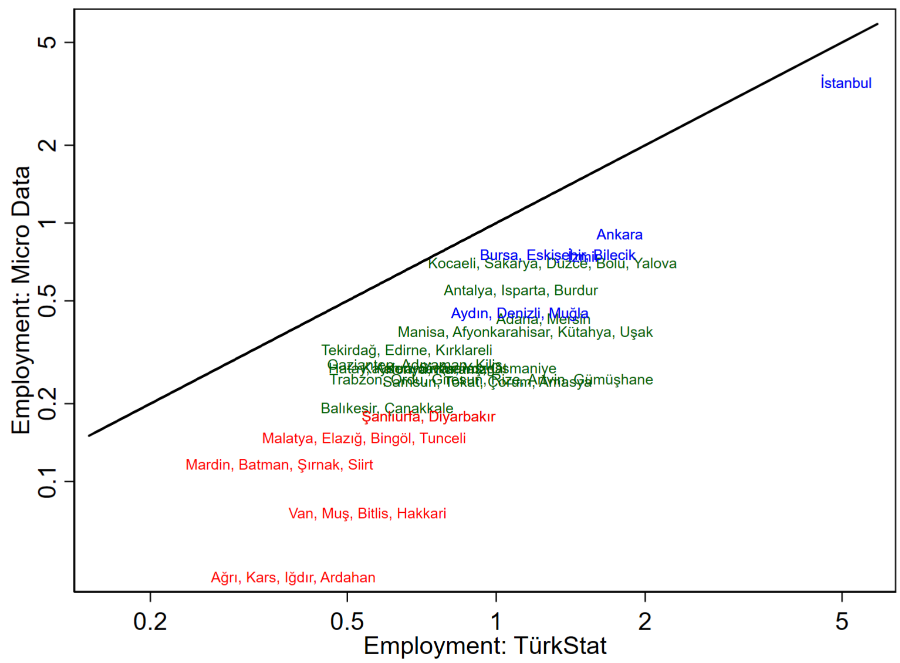

Figure 11: Comparison of Micro to Aggregate Data: Province Employment
Notes: The values on each axis are millions of workers. Groups of provinces overlapping with the least-heavily subsidized Region 1 are colored in blue; groups of provinces overlapping with the most-heavily subsidized Region 6 are colored in red. All other groups of provinces are colored in green.

In our first comparison, we aggregate the total employment among the firms in our micro data, summing across the firms within (groups of) provinces. We compare this employment figure to the number of employed individuals measured in TürkStat. Figure 11 presents this comparison for a single year, in 2014. Since our dataset omits informal-economy workers, the number of workers in our dataset is consistently below that in the aggregate dataset. Furthermore, this relative discrepancy is smaller in the first subsidy region (e.g., Ankara; İstanbul; Bursa, Eskişehir, and Bilecik) than in the sixth subsidy region (e.g., Van, Muş, Bitlis, and Hakkâri; Ağrı, Kars, Iğdır, and Ardahan; and Mardin, Batman, Şırnak, and Siirt).

In our second comparison, we aggregate different output and input measures — total wage compensation, total employment, and total gross output — among the firms in our micro dataset. Using these industry-level measures, we compute, at the industry level, total gross output, total employment, average wages per employee, and the ratio of labor expenditures to gross output. In Figure 12 we compare these four industry-level measures to their corresponding values in the World Input-Output Database. In addition to the two datasets' disparate treatment of informal economy workers, the World Input-Output Database applies a different industry definition relative to that in our micro dataset. For this reason, low concurrence across the two datasets is less of a concern than in Figure 11. With this caveat in mind, the correlations depicted in the four panels of Figure 12 are 0.39 (for gross output), 0.30 (for employment), 0.49 (for average wages), and 0.17 (for the labor share.) The Spearman rank correlations are somewhat higher: 0.57, 0.59, 0.53, and 0.15, respectively. The biggest difference in terms of industries' size is in the agriculture sector: According to the WIOD, the gross output of the agricultural sector was 147.8 billion TL as of 2012. Of this, only 12.0 billion TL are recorded in our micro database. For other industries, the difference is less stark. Overall, there are considerable differences in the output measures across the two data sources.

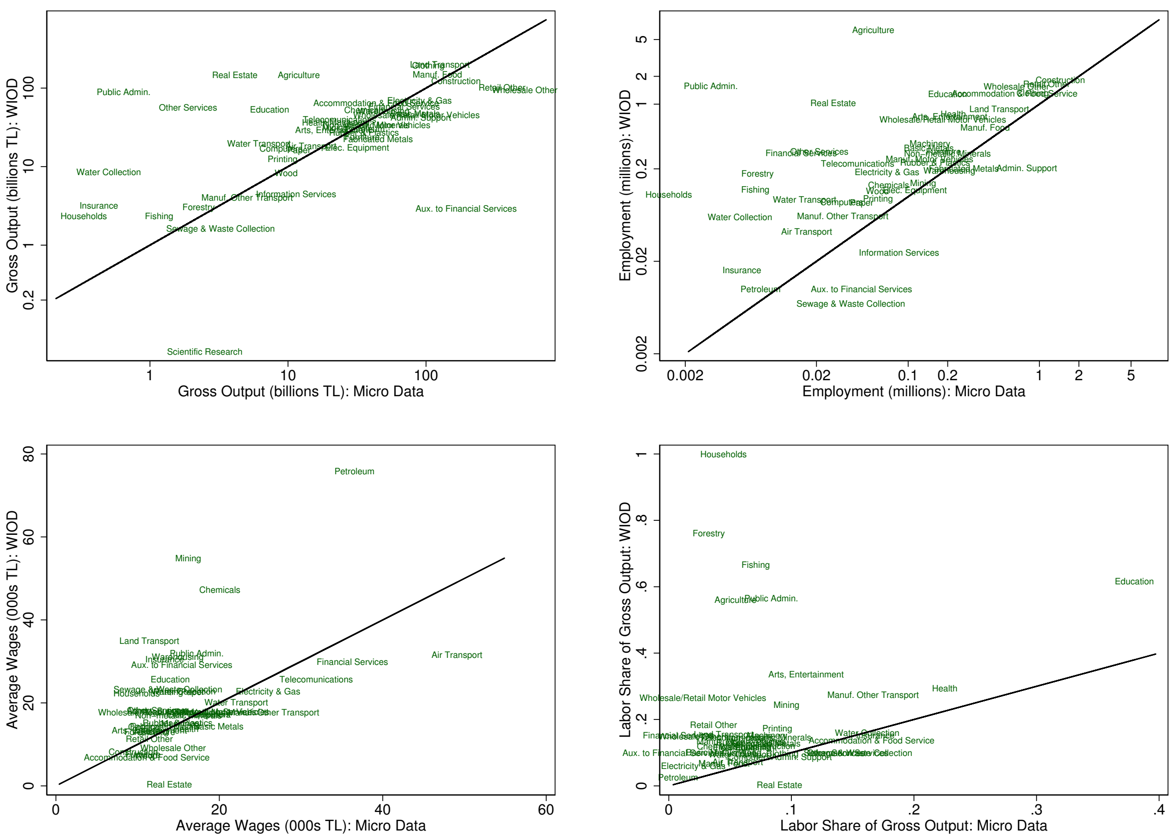

Figure 12: Comparison of Micro to Aggregate Data: Industry Activity
Notes: Values in the top left and bottom left panel are reported in 2010 Turkish Liras.

A.4 Accounting for Informality and Incomplete Data Coverage

In calibrating our aggregate model — in particular when calibrating output and employment by industry and subsidy region, and trade and migration flows across industry-region pairs — we require consistent measures of aggregate activity at the industry-region pair. (Widely available data sources, such as the WIOD, contain measures of economic activity at the industry-by-year level or the province-by-year level. The calibration of our Section 5 model requires information on the latter sets of moments, which we use our EIS data to calibrate.) In the previous subsection, we documented considerable discrepancies between aggregates computed using the EIS micro data and comparable aggregates from publicly available datasets. We hypothesized that part of this discrepancy was due to the fact that the EIS data captures only the formal economy. In addition, part relates to the lack of coverage in the EIS micro data in certain industries: Agriculture, Finance, Insurance, Real Estate, and Public Administration.

In this appendix, drawing on Acar and Carpio (2019), we explain how we estimate informality at the province-industry level. We then reproduce Figures 11 and 12, accounting for the lack of EIS data on the informal economy and, additionally, for incomplete coverage in the industries listed above. The end-result in this section is $\hat{\hat{\varphi}}_{pj,t}$, our estimate of the share of economic activity (in province p and industry j) that the EIS is able to capture.

Accounting for Informality

Acar and Carpio (2019) provide estimates of the share of employment that is formal — by broad sector and by groups of provinces — as of 2017. We reproduce these estimates in Tables 14 and 15. The formal share is lowest in Ağrı, Kars, Iğdır, and Ardahan (32 percent) and highest in Ankara (82 percent). Furthermore, the share of workers in the formal sector is lowest in Agriculture, Forestry and Fishing (17 percent) and highest in Mining (96 percent).

Table 14: Formal Share by Sector

Sector	Formal Share
Agriculture, Forestry, Fishing	17.0%
Mining	96.0%
Manufacturing	83.5%
Services, Transport	73.0%
Construction	64.0%
Wholesale, Retail	72.0%
Accommodation, Food Service	69.0%
Other Services	82.0%

Notes: This table reproduces Figure 25 of Acar and Carpio (2019). Acar and Carpio (2019) provide two estimates of the formal share for manufacturing — 77 percent in low/medium-skilled manufacturing and 90 percent in high-skilled manufacturing — and two estimates of the formal share for services — 69 percent in low/medium-skilled services and 95 percent in high-skilled service. For each sector we take the average of these two numbers.

Table 15: Formal Share by NUTS-2 Region

NUTS-2 Region	Formal Share	NUTS-2 Region	Formal Share
İstanbul	79%	Nevşehir, Aksaray, Kırşehir, Niğde, Kırıkkale	62%
Edirne, Tekirdağ, Kırklareli	67%	Kayseri, Sivas, Yozgat	69%
Balıkesir, Çanakkale	61%	Zonguldak, Karabük, Bartın	56%
İzmir	76%	Kastamonu, Çankırı, Sinop	45%
Denizli, Aydın, Muğla	66%	Samsun, Tokat, Çorum, Amasya	55%
Manisa, Afyonkarahisar, Uşak, Kütahya	61%	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane	49%
Bursa, Eskişehir, Bilecik	77%	Erzurum, Erzincan, Bayburt	52%
Kocaeli, Sakarya, Düzce, Bolu, Yalova	71%	Kars, Ağrı, Iğdır, Ardahan	32%
Ankara	82%	Malatya, Elâzığ, Bingöl, Tunceli	51%
Konya, Karaman	58%	Van, Muş, Bitilis, Hakkâri	37%
Antalya, Isparta, Burdur	68%	Adıyaman, Gaziantep, Kilis	61%
Adana, Mersin	60%	Diyarbakır, Şanlıurfa	38%
Hatay, Kahramanmaraş, Osmaniye	58%	Siirt, Mardin, Batman, Şırnak	60%

Notes: This table reproduces Figure 24 of Acar and Carpio (2019).

In addition Acar and Carpio (2019) present trends in the national economy-wide formality rate. Let $\hat{\varphi}_{p,2017}$ refer to Acar and Carpio (2019)'s estimate of the formal share in 2017 in province p and $\hat{\varphi}_{j,2017}$ refer to the corresponding estimate of the formal share in industry j. Our goal is to impute the formal share in an arbitrary year, for each industry-province pair. Call this object $\hat{\varphi}_{pjt}$.

To compute $\hat{\varphi}_{pnt}$ we follow a two-step procedure. In a first step, using $\bar{\varphi}_t$ to denote the economy-wide formal share in year t, we initially set $\check{\varphi}_{pjt} = \hat{\varphi}_{j,2017} \cdot \frac{\bar{\varphi}_t}{\bar{\varphi}_{2017}} = \hat{\varphi}_{j,2017} \cdot \frac{\bar{\varphi}_t}{0.66}$. This initial variable, $\check{\varphi}_{pjt}$, allows us to match formal shares at the industry level, but does not capture any between-province variation. In a second step, using $\overline{\check{\varphi}}_{pjt}$ to refer to the economy-wide average of $\check{\varphi}_{pjt}$, we replace $\check{\varphi}_{pjt}$ with $\hat{\varphi}_{pjt} = \check{\varphi}_{pjt} \cdot \frac{\hat{\varphi}_{p,t}}{\overline{\check{\varphi}}_{pjt}}$. Figure 13 plots the formal employment share by industry and subsidy region. According to this figure, there is heterogeneity in both dimensions: within each region, formal employment shares are higher in mining and lower in agriculture; and within each industry, formal shares are higher in Region 1 and lower in Region 6.

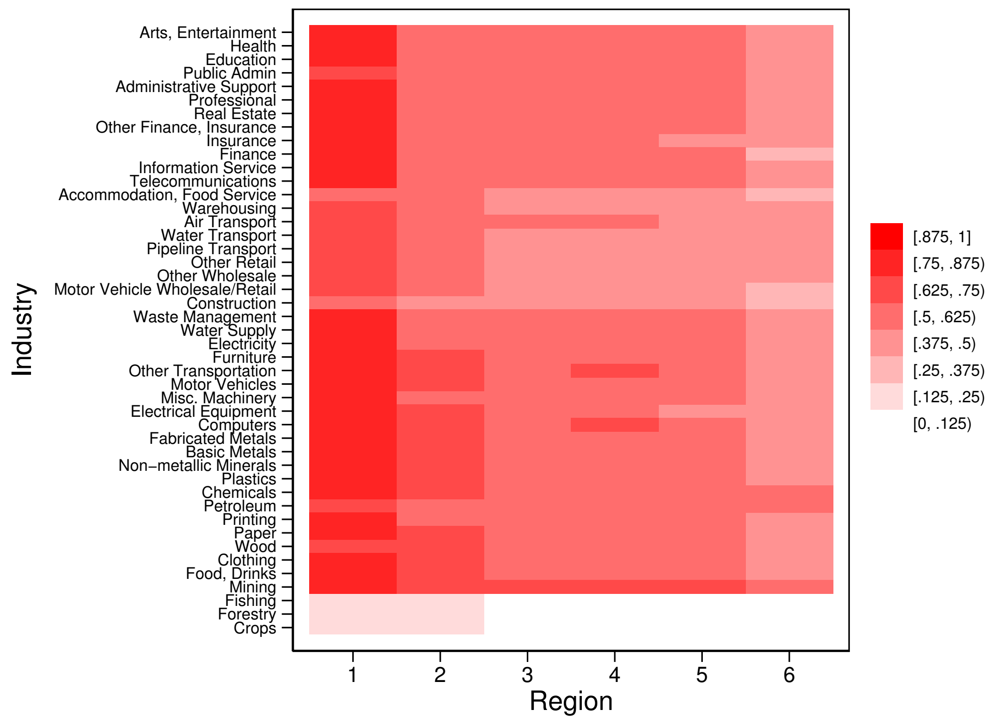

Figure 13: Formal Employment Share by Industry and Region

We reproduce Figure 11 using Acar and Carpio (2019)'s estimates of informality by group of province. For each group of provinces, we divide our measure of the micro data employment by $(1 - \hat{\varphi}_{p,2014}) = \left(1 - \hat{\varphi}_{p,2017} \cdot \frac{0.65}{0.66}\right)$, where the $\frac{0.65}{0.66}$ accounts for the fact that formal share increased by 1 percentage point, from 0.65 to 0.66, between 2014 and 2017.

We plot the informality-adjusted measure of employment in the EIS micro data against employment in the TürkStat data. When adjusted for differences in the share of formal workers by groups of provinces, the discrepancy between the two measures of employment is substantially smaller in Figure 14 than in Figure 11.

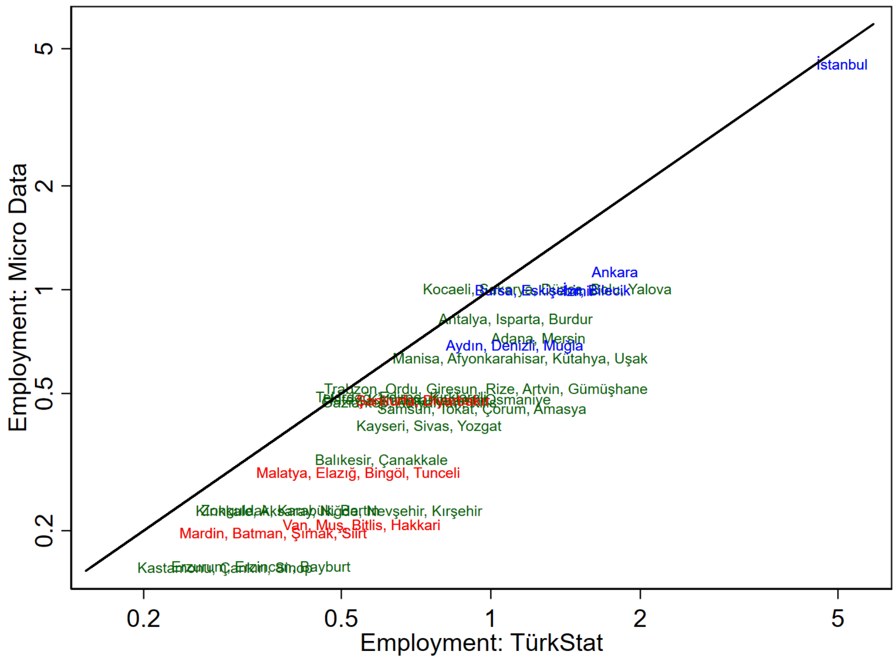

Figure 14: Comparison of Micro to Aggregate Data: Employment by NUTS-2 Geography
Notes: See the notes for Figure 11. In contrast to that figure, we adjust the micro data to account for differences in the share of informality across groups of provinces.

Accounting for Lack of Data in Certain Industries

In addition to informality, the EIS data sample frame only spans certain industries. The EIS aims to measure economic activity in the private sector, excluding as well firms in the Agriculture industry and in the Finance, Insurance, and Real Estate ("F.I.R.E.") sector. In practice, the dataset resulting from the EIS surveys includes a fraction of firms in these industries. Unfortunately, we lack any systematic evidence on the extent to which the EIS dataset under-represents formal-sector firms in these industries. One guide comes in the top two panels of Figure 12: There, we see that the EIS data severely under-represent activity in the Public Administration industry, and substantially (but not quite as severely) under-represent activity in the Agriculture and F.I.R.E. industries. (To be clear, part of these discrepancies are due to the lack of coverage of the informal economy.) We assume that the EIS data cover 25 percent of formal-sector activity in the Public Administration industry, 40 percent of activity in the Agriculture industry, and 40 percent of activity in F.I.R.E. industries. (In unreported exercises, we experiment with alternate assumptions. Our assessment of the regional inequality impacts of the policy are robust to reasonable alternate choices.) Letting $\hat{\varphi}_{pjt}$ denote the share of economic activity in province p and industry j that is covered in year t by the micro EIS dataset, we thus set:

$$\begin{aligned}\hat{\hat{\varphi}}_{pj,t} &= \hat{\varphi}_{pjt} \cdot 0.25, \text{ for j=Public Administration;} \\ &= \hat{\varphi}_{pjt} \cdot 0.40, \text{ for j=Agriculture, Finance, Insurance,} \\ &\qquad\qquad\qquad \text{Other Finance and Insurance, Real Estate; and} \\ &= \hat{\varphi}_{pjt} \cdot 1.00, \text{ for all other industries.}\end{aligned}$$

Auditing the Micro Data after Adjusting for Informality and Missing Data

Figure 15 presents our estimates of $\hat{\hat{\varphi}}_{pjt}$ for t =2012. For all j with the exception of Agriculture, Finance, Insurance, Other Finance and Insurance, Real Estate, and Public Administration, the values displayed in Figure 15 equal those in Figure 13. For these 40 industries, $\hat{\hat{\varphi}}_{pjt} < 1$ only because a share of the firms within these industries are informal. For the remaining five industries, $\hat{\hat{\varphi}}_{pjt} < \hat{\varphi}_{pjt}$.

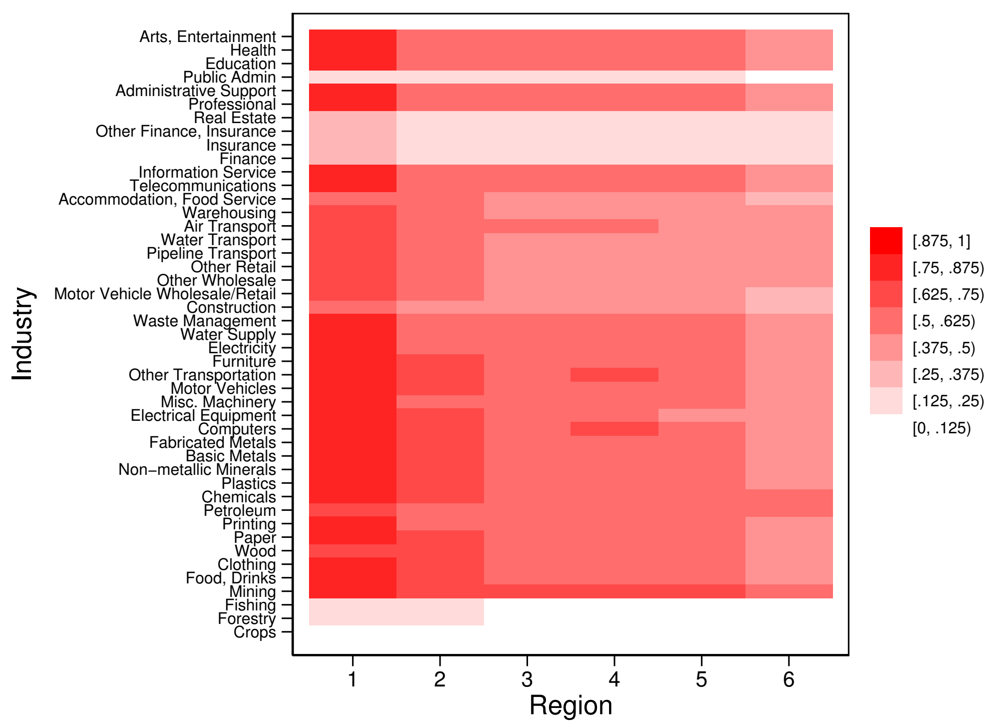

Figure 15: Share of Activity Represented In EIS Data

Figure 16 now compares sales and employment, according to the WIOD and the EIS. In contrast to Figure 12, our EIS measures are scaled up by $1/\hat{\hat{\varphi}}_{\cdot,j,2012}$ (that is, $\hat{\hat{\varphi}}_{pj,2012}$ as averaged across provinces, p). Overall, the two sales and employment measures' are more aligned with one another with this adjustment. The (WIOD-sales-weighted) correlation of log sales in the two data sources is 0.45 (compared to 0.30 in the top left panel of Figure 16). The (WIOD-employment-weighted) correlation of log employment in the two data sources is 0.53 (as compared to 0.28 in the top right panel of Figure 12).

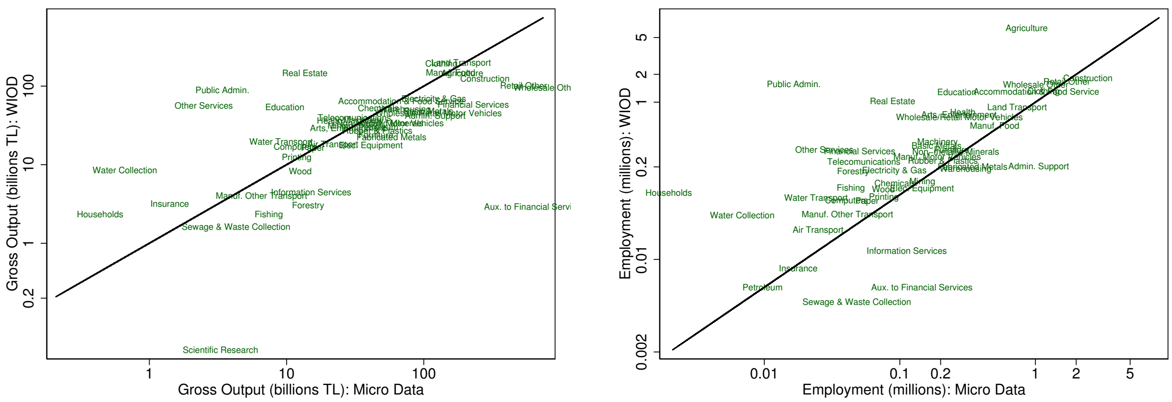

Figure 16: Comparison of Micro to Aggregate Data: Industry Activity
Notes: Values in the top left and bottom left panel are reported in 2010 Turkish Liras.

In sum, the EIS sample frame does not span the entire economy. First, the EIS sample excludes firms in the informal economy. In addition, for firms in certain industries, the EIS dataset does not measure activity even for all formal-economy firms. Accounting for these differences in the extent to which the EIS dataset misses activity within firms in individual province-industry pairs, the EIS data align reasonably well with existing estimates of industries' (or geographies') employment and gross output.

A.5 Imputing Employment Flows

In this section we discuss the construction of Figure 3. This figure describes flows of workers across subsidy region-industry cells across subsequent years. In computing these flows, we face two challenges. First, our micro data do not record transitions into or out of non-employment. (The data track individuals across time, permitting measurement of entry to and exit from firms within our dataset. However, since the dataset does not cover informal-sector firms, and additionally misses most firms in Agriculture, Finance, Insurance, Real Estate, and Public Administration industries, this dataset does not allow one to distinguish whether an individual is not-employed, employed in an informal-sector industry, or employed in a firm missed by our dataset.) Second, to maintain confidentiality, we were permitted by the Ministry of Industry and Technology to disclose flows of workers in slightly aggregated industries.[44] Below, let j denote one of the 45 industries in our baseline sample, and $\tilde{j}$ one of the more aggregated 13 sectors. Let $j = 0$ or $\tilde{j}$=0 denote non-employment. Our goal is to compute transition probabilities, $\mu^{nj,ik}$, giving the share of individuals who transition from industry-region pair nj to industry-region pair ik across two subsequent years. Below, use $\mathfrak{m}^{n\tilde{j},i\tilde{k}}$ to refer to the raw data on the number of transitions among broad-sector-by-region pairs.

In a first step, we compute the vector of the share of workers in each region-industry (n-j) pair. From Eurostat (2021a,b), we retrieve employment-to-population ratios and population (among individuals who are 25 to 64 years old) by NUTS-2 region. We aggregate NUTS-2 regions' employment-to-population ratios up to our 6-subsidy-region categorization, weighting NUTS-2 regions by population. This yields an expression for the employment-to-population by year and subsidy region. Call this object $\bar{l}_{nt}$. From the EIS, we observe the share of formal-sector national employment in region n and industry j . Call this object l_{njt}. To compute the share of total employment in region n and industry j, we divide l_{njt} by $\hat{\hat{\varphi}}_{pj,t}$ (the of subsidy region n and industry j that is captured by the EIS data; see Appendix A.4.) Call the resulting object $\widehat{l}_{njt}$. Given this, we can compute the share of the adult population belonging to region-industry pair n-j as

$$\begin{aligned} \widetilde{l}_{njt} &= \bar{l}_{nt} && \text{for } j = 0 \text{, and} \\ &= \left(1 - \bar{l}_{nt}\right) \hat{\hat{\varphi}}_{pj,t} && \text{for } j = \{1, ...J\}. \end{aligned}$$

In a second step, we account for the fact the flows of individuals across sectors and regions omits workers in firms that are not covered in our dataset. We scale up $\mathfrak{m}^{n\tilde{j},i\tilde{k}}$ by $\hat{\hat{\varphi}}_{n\tilde{j}t}$ where $\tilde{j}$ is the broad sector corresponding to industry j: ${\mu_t}^{n\tilde{j},i\tilde{k}} \equiv \mathfrak{m}^{n\tilde{j},i\tilde{k}}/\hat{\hat{\varphi}}_{n\tilde{j}t}$.

In a third step, we combine information on $\widetilde{l}_{njt}$ and information on flows of formal-sector workers across region-broad-sector pairs to form our estimates of ${\mu_t}^{nj,ik}$. We consider three cases: whether (a) $n = i$ and $j = k$; whether (b) $n = i$ and $j \neq k$, but industries j and

[44] When disclosing the data, we were asked to aggregate crops (NACE= a01), forestry (NACE=a02), finishing (NACE=a03), and Mining (NACE=b) into one sector; food, beverage, and tobacco manufacturing (NACE=c10-c12) and textile, apparel, and leather manufacturing (c13-c15) into a second sector; and all other manufacturing (NACE c16-c33) into a third sector. We group electricity, gas, steam, and air conditioning (NACE=e) and construction (NACE=f) into a fourth sector; wholesale and retail (NACE=g) into a fifth sector; transportation and storage (NACE=h) into a sixth sector; accommodation (NACE=i) into a seventh sector; information and communication (NACE=j) into an eighth sector; finance, insurance, and real estate (NACE=k and NACE=l) into a ninth sector; professional, scientific, and technical activities (NACE=m) and administrative and support service activities (NACE=n) into a tenth sector; public administration (NACE=o) into an eleventh sector; education (NACE=p) into a twelfth sector; and human health and social work (NACE=q), arts, entertainment, and recreation (NACE=r), and other services (NACE=q) into a thirteenth sector.

k belong to the same broad sector; or (c) all other cases (either $n \neq i$, or j and k belong to different broad sectors). In case (c), we define ${\mu_t}^{nj,ik} \propto \widetilde{l}_{ikt}{\mu_t}^{n\widetilde{j},i\widetilde{k}}$ where $\sum_{k\in\widetilde{k}} {\mu_t}^{nj,ik} = {\mu_t}^{n\widetilde{j},i\widetilde{k}}$. That is, within each destination sector, the probability of transitioning to a particular industry is proportional to the employment share of that industry. We could have potentially applied this same definition for cases (a) and (b), as well. However, this would have led us to miss a key feature of transition probabilities documented elsewhere, namely that individuals are substantially more likely to stay within the same industry-region pair across subsequent years. For case (b), we set ${\mu_t}^{nj,ik}$ as the 75$^{\text{th}}$ percentile among the ${\mu_t}^{nj,i'k'}$ for which $i' = n$ and $\widetilde{j} \neq \widetilde{k}$. This definition allows for relatively high values for within-industry, within-broad-sector flows. For case (a), we set ${\mu_t}^{nj,ik}$ as the residual probability.

In a fourth step, we ensure that our μs are consistent with aggregate domestic migration data. The EIS data track individuals across industries and subsidy regions. In principle, these flows broadly align with aggregate migration flows in publicly available data. But, due to the incomplete coverage in the EIS data, there are some modest discrepancies between the two data sources. We compute the number of working-age domestic migrants using data from Turkish Statistical Institute (2022b). This dataset provides the number of migrants across province-pairs. Since we seek to track the number of migrants of individuals who are working age, we multiply these migrant flows by the share of the population that is between 25 to 64, using data from Turkish Statistical Institute (2022c). We sum up across the provinces within each origin and destination subsidy region, resulting in $\mathfrak{m}_{ni,t}$, the share of working-age region i individuals who migrate to region n in year t. We re-scale our flows of individuals across sectors and regions using $\mathfrak{m}_{ni,t}$ so that — for each source and destination region, n, i — the average (across source industries j) of ${\mu_t}^{nj,ik}$ equals $\mathfrak{m}_{ni,t}$.

Table 16 summarizes transition probabilities for a single year in our sample, 2012. The takeaway from this table is that flows are considerably higher when $i = n$ and $j = k$, somewhat lower when either $i = n$ or $j = k$, and lower still when neither $i = n$ nor $j = k$. Approximately 58.4 percent of individuals stay in their same industry-subsidy region pair across years; 40.0 percent($\approx 0.0089 \cdot \frac{12{,}420}{276}$) switch industries but not regions; and 1.6 percent switch subsidy regions.[45]

[45] Flows into and out of non-employment (which is one of our "industries") represent a large majority of the between-industry flows. Excluding these, the share of workers who switch industries from one year to the next is approximately 19 percent.

Table 16: Worker Flows Within and Across Industry-Region Pairs

			Percentile			
Type of Flow	N	Mean	25	50	75	90
Same Industry, Same Region ($i = n, j = k$)	276	0.5840	0.4409	0.6158	0.6813	0.6981
Different Industry, Same Region ($i = n, j \neq k$)	12,420	0.0089	0.0005	0.0019	0.0055	0.0169
Same Industry, Different Region ($i \neq n, j = k$)	1,380	0.0005	0.0000	0.0001	0.0006	0.0014
Different Industry, Different Region ($i \neq n, j \neq k$)	62,100	0.0001	0.0000	0.0000	0.0000	0.0001

B Turkish Investment and Wage Subsidies

This appendix provides additional detail on the 2012 subsidy program.

B.1 Subsidized Industries

According to the 2012 subsidy program, only projects within certain industries are eligible. The Turkish government provides a list of industries receiving subsidies at: `https://www.resmigazete.gov.tr/eskiler/2012/06/20120619-1-2.xls` . The column labeled "US-97 Kodu," within the "2A_Sektörler" worksheet refers to the NACE 1.1 code. The second worksheet, labeled "2B_Iller," provides a mapping between provinces and subsidized industries. In this section, we translate and summarize the key elements of these two Excel worksheets.

Table 17: Mapping Between Turkish Government Industries and NACE Industries

Sector	NACE 2 Industries	Sector	NACE 2 Industries
1	1.41, 1.42, 1.43, 1.44, 1.45, 1.47	26	23
2	3.22	27	24.54
3	10	28	25
4	13	29	25
5	14	30	28
6	15	31	23
7	15.11	32	28.23
8	15.12, 15.20	33	26, 27
9	16	34	26.30
10	17	35	32.50
11	20	36	29
12	20.15	37	33.16
13	20.20	38	30.91, 30.92
14	21.20	39	31, 32.20, 32.30, 32.40, 32.99, 33.20
15	20.42	40	31.09
16	20.51	41	55.10, 55.20, 55.90
17	22.11	42	55.90
18	23	43	52.10
19	23	44	55.10
20	23	45	85
21	23	46	86.10, 86.20, 86.90, 87.20, 87.30, 87.90
22	23	47	
23	23	48	
24	23	49	
25	23	50	

In Table 17, we provide a mapping between the Turkish government's numbering of subsidized sectors and NACE (version 2) industry codes.

In Table 18, we provide a list of subsidized industries and Turkish provinces.

Table 18: Lists of Subsidized Industries By Province

Code	Province	List of Subsidized Industries
1	Adana	1, 2, 3, 4, 8, 9, 10, 11, 20, 27, 28, 30, 32, 33, 34, 35, 36, 37, 39, 41, 42, 43, 44, 45, 46, 47, 48, 50
2	Adıyaman	1, 2, 3, 4, 5, 8, 9, 10, 11, 18, 27, 28, 30, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
3	Afyonkarahisar	1, 2, 3, 4, 5, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
4	Ağrı	1 through 50
68	Aksaray	1, 2, 3, 4, 5, 9, 10, 11, 26, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 48, 50
5	Amasya	1, 2, 3, 4, 5, 8, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
6	Ankara	1, 2, 3, 4, 8, 9, 10, 14, 22, 27, 30, 32, 33, 34, 35, 36, 37, 39, 41, 42, 43, 44, 45, 46, 48, 50
7	Antalya	1, 2, 3, 9, 10, 13, 14, 15, 24, 27, 30, 32, 33, 34, 35, 37, 39, 41, 42, 43, 44, 45, 46, 48, 50
75	Ardahan	1 through 50
8	Artvin	1, 2, 3, 4, 5, 8, 9, 10, 14, 25, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
9	Aydın	1, 2, 3, 4, 9, 10, 20, 27, 28, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48, 50
10	Balıkesir	1, 2, 3, 5, 6, 9, 10, 16, 20, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 48, 50
74	Bartın	1, 2, 3, 5, 8, 9, 10, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
72	Batman	1 through 50
69	Bayburt	1, 2, 3, 4, 5, 8, 9, 10, 14, 19, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
11	Bilecik	1, 2, 3, 4, 5, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
12	Bingöl	1 through 50
13	Bitlis	1 through 50
14	Bolu	1, 2, 3, 4, 6, 9, 10, 11, 21, 27, 28, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 48, 50

Notes: Continued on the following page.

Table 18 (Continued): Lists of Subsidized Industries By Province

Code	Province	List of Subsidized Industries
15	Burdur	1, 2, 3, 4, 5, 8, 9, 10, 13, 14, 15, 24, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 48, 50
16	Bursa	1, 2, 3, 4, 6, 9, 10, 14, 20, 27, 29, 30, 32, 33, 34, 35, 36, 39, 41, 42, 43, 44, 45, 46, 47, 48, 50
17	Çanakkale	1, 2, 3, 9, 10, 20, 27, 28, 30, 32, 33, 34, 35, 39, 41, 42, 43, 44, 45, 46, 48, 49, 50
18	Çankırı	1, 2, 3, 4, 5, 8, 9, 10, 14, 16, 17, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
19	Çorum	1, 2, 3, 4, 5, 8, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
20	Denizli	1, 2, 3, 4, 6, 9, 10, 20, 27, 28, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48, 50
21	Diyarbakır	1 through 50
81	Düzce	1, 2, 3, 4, 5, 9, 10, 11, 21, 27, 28, 30, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 48, 50
22	Edirne	1, 2, 3, 4, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48, 50
23	Elâzığ	1, 2, 3, 4, 5, 8, 9, 10, 14, 25, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
24	Erzincan	1, 2, 3, 4, 5, 8, 9, 10, 14, 19, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
25	Erzurum	1, 2, 3, 4, 5, 8, 9, 10, 14, 19, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
26	Eskişehir	1, 2, 3, 4, 9, 10, 14, 20, 27, 29, 30, 32, 33, 34, 35, 36, 39, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
27	Gaziantep	1, 2, 3, 4, 5, 8, 9, 10, 11, 18, 27, 28, 30, 32, 33, 34, 35, 36, 37, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
28	Giresun	1, 2, 3, 4, 5, 8, 9, 10, 14, 19, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
29	Gümüşhane	1, 2, 3, 4, 5, 8, 9, 10, 14, 19, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
30	Hakkâri	1 through 50
31	Hatay	1, 2, 3, 4, 5, 8, 9, 10, 11, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
76	Iğdır	1 through 50
32	Isparta	1, 2, 3, 4, 6, 9, 10, 12, 13, 14, 15, 24, 27, 28, 30, 32, 33, 34, 35, 36, 37, 39, 41, 42, 43, 44, 45, 46, 48, 50
34	İstanbul	7, 14, 31, 32, 34, 35, 42, 45, 46, 48
35	İzmir	1, 2, 3, 8, 9, 10, 11, 23, 27, 30, 32, 33, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 45, 46, 48, 50
46	Kahramanmaraş	1, 2, 3, 4, 5, 8, 9, 10, 11, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

Notes: Continued on the following page.

Table 18 (Continued): Lists of Subsidized Industries By Province

Code	Province	List of Subsidized Industries
78	Karabük	1, 2, 3, 5, 8, 9, 10, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
70	Karaman	1, 2, 3, 5, 8, 9, 10, 11, 24, 27, 28, 30, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 48, 50
36	Kars	1 through 50
37	Kastamonu	1, 2, 3, 4, 5, 8, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
38	Kayseri	1, 2, 3, 4, 9, 10, 11, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
79	Kilis	1, 2, 3, 4, 5, 8, 9, 10, 11, 18, 27, 28, 30, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
71	Kırıkkale	1, 2, 3, 4, 5, 9, 10, 11, 17, 26, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 48, 50
39	Kırklareli	1, 2, 3, 4, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48, 50
40	Kırşehir	1, 2, 3, 4, 5, 9, 10, 11, 17, 26, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 48, 50
41	Kocaeli	1, 2, 3, 4, 9, 10, 11, 17, 21, 27, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 48, 50
42	Konya	1, 2, 3, 8, 9, 10, 11, 24, 27, 28, 30, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 48, 49, 50
43	Kütahya	1, 2, 3, 4, 5, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
44	Malatya	1, 2, 3, 4, 5, 8, 9, 10, 14, 25, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
45	Manisa	1, 2, 3, 4, 5, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
47	Mardin	1 through 50
33	Mersin	1, 2, 3, 4, 5, 8, 9, 10, 11, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
48	Muğla	1, 2, 3, 4, 9, 10, 20, 27, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
49	Muş	1 through 50
50	Nevşehir	1, 2, 3, 4, 5, 9, 10, 11, 17, 26, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 48, 50
51	Niğde	1, 2, 3, 4, 5, 6, 9, 10, 11, 26, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 48, 50
52	Ordu	1, 2, 3, 4, 5, 8, 9, 10, 14, 19, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
80	Osmaniye	1, 2, 3, 4, 5, 8, 9, 10, 11, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50

Notes: Continued on the following page.

Table 18 (Continued): Lists of Subsidized Industries By Province

Code	Province	List of Subsidized Industries
53	Rize	1, 2, 3, 4, 5, 8, 9, 10, 14, 25, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
54	Sakarya	1, 2, 3, 4, 9, 10, 11, 21, 27, 28, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 48, 50
55	Samsun	1, 2, 3, 4, 5, 8, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 37, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
56	Şanlıurfa	1 through 50
57	Siirt	1, 2, 3, 4, 5, 8, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
58	Sinop	1, 2, 3, 4, 5, 9, 10, 11, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
63	Sivas	1 through 50
73	Şırnak	1 through 50
59	Tekirdağ	1, 2, 3, 4, 6, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48, 50
60	Tokat	1, 2, 3, 4, 5, 8, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
61	Trabzon	1, 2, 3, 4, 5, 8, 9, 10, 14, 25, 27, 28, 30, 32, 33, 34, 35, 37, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
62	Tunceli	1, 2, 3, 4, 5, 8, 9, 10, 14, 25, 27, 28, 30, 32, 33, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
64	Uşak	1, 2, 3, 4, 5, 6, 9, 10, 14, 20, 27, 28, 30, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
65	Van	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31
77	Yalova	1, 2, 3, 4, 9, 10, 11, 21, 27, 28, 30, 32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44, 45, 46, 48, 50
66	Yozgat	1, 2, 3, 4, 5, 9, 10, 11, 19, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50
67	Zonguldak	1, 2, 3, 5, 8, 9, 10, 20, 27, 28, 30, 32, 33, 34, 35, 36, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50

Notes: This table provides the correspondence between provinces and subsidized industries. For the correspondence between these 50 industries and NACE 2 codes see Table 17.

B.2 Criteria for Obtaining a Regional Investment Subsidy Certificate

The largest two investment subsidy programs in Turkey are "Regional Investments Subsidies" and "General Investment Subsidies." The latter program predates the 2012 reforms, and mainly provides VAT and customs duty exemptions for investments regardless of the region in which the firm operates. The Regional Investment Subsidy elements vary across regions, and entail eight different support elements. Among these, the VAT exemption, customs tax exemption, corporate tax credit, insurance premium employer share support, and interest expense support are granted to all complying investments to varying degrees across regions, while income tax withholding support and employee's social security premium support are provided only in the sixth region. The distribution of subsidy elements by regions is shown in Table 19.

Table 19: Support Elements of the Regional Investment Subsidy Programs

			Regions					
Support Elements			1	2	3	4	5	6
VAT exemption			✓	✓	✓	✓	✓	✓
Customs duty exemption			✓	✓	✓	✓	✓	✓
Corporate tax deductions	Investment tax credit rate (ITC)	Non-OIZ	15	20	25	30	40	50
		OIZ	20	25	30	40	50	55
	Deduction rate		50	55	60	70	80	90
Employer's national insurance contribution support (years)			2	3	5	6	7	10
Interest expense support	TL loan		No	No	3pp	4pp	5pp	7pp
	FX loan				1pp	1pp	2pp	2pp
	Cap (,000 TL)				500	600	700	900
Employee's national insurance contribution support			No	No	No	No	No	10 years
Income tax withholding support			No	No	No	No	No	10 years

Notes: OIZ refers to an Organized Industrial Zone.

The most important support elements in regional investment subsidies are the corporate tax credit provided by the investment tax credit (ITC), and social security insurance premium supports. How the corporate tax discount rate and investment contribution rate work is explained with the following example: Let's assume that ABC company is in Region 4 and plans to make an investment of 2,000,000 TL. Also, the annual corporate tax base of the company is 500,000 TL, on average. With the usual corporate tax rate, the company should pay 110,000 TL as corporate tax. In this case, where the investment tax credit rate is 30 percent, the tax deduction rate is 70 percent. The total tax credit amount is initially 600,000 (2,000,000×0.3) TL. The company pays 30 percent of its tax debt for the current year, that is, 33,000 TL. When 77,000 TL of tax credit is deducted from 600,000 TL, 523,000 TL will be transferred to futures years. The company continues to deduct 70 percent of the corporate tax bill from the remaining 523,000 TL. If the same real income and tax levels are maintained in the following years, the company depletes the tax credit in approximately 8 years.

B.3 Subsidy Expenditures

In this appendix, we provide estimates on government outlays of two of the main components of the Turkish subsidy program: those related to investment tax credits and those related to employment.[46]

Table 20 presents our estimates of Turkish government expenditures via investment tax credits. To compute this table, we first multiply the total fixed investment with the investment tax credit rate that each firm receives. We then sum across firms in each subsidy region for subsidy documents opened in each year. According to this table, expenditures on investment tax credits were 2.7 billion TL in 2012, increasing to 7.1 billion in 2019. Overall, investment tax credits were concentrated evenly distributed across the six subsidy regions. Regions 1 and 2 had the most firms and economic activity, but lower subsidization rates. Regions 5 and 6 had fewer firms (and, for Region 6, an even smaller share of firms in eligible industries) but greater subsidization rates.

Table 20: Expenditures on Investment Tax Credits

	2012	2013	2014	2015	2016	2017	2018	2019	Total
Region 1	225.5	407.6	320.9	199.7	250.2	1,160.0	1,560.0	1,582.0	5,705.8
Region 2	261.9	887.8	484.3	1,039.4	425.6	793.3	1,450.1	1,364.0	6,706.5
Region 3	581.3	779.0	672.6	513.1	512.6	993.0	1,448.0	1,311.5	6,811.2
Region 4	319.9	525.3	480.4	491.9	389.9	950.2	786.1	1,025.8	4,969.5
Region 5	662.2	740.8	392.7	560.6	496.4	816.0	952.4	669.8	5,290.9
Region 6	611.6	1,257.9	555.6	577.1	436.0	1,016.7	873.5	1,151.2	6,479.5
Total	2,662.4	4,598.5	2,906.4	3,381.7	2,510.8	5,729.1	7,070.1	7,104.3	35,963.4

Notes: Values are millions of 2010 TL.

Table 21 reports expenditures on employment subsidies. Translating the number of years (call this yrs_r) of social security support — the variable indicating the level of employment subsidy generosity in each region — to government expenditures requires a simple calculation.[47] In contrast to Table 20, Region 6 received the greatest share of employment subsidies.

[46] Government expenditures on customs duties rebates and interest rate support represent a much smaller share of the total expenditures related to the 2012 subsidy program.

[47] Mandated social security payments are paid both by the employer and by the employee. Those paid by the employer are equal to 15.5 percent of the national minimum wage, while those paid by the employee are 19 percent of the national minimum wage. Subsidized firms in all regions receive support for the employer-mandated payment, while those projects in Region 6 additionally receive support for the employee contribution. For each firm (with employment e_f) headquartered in Regions 1 through 5, we compute the employment subsidies received as $sub_f = e_f \cdot 0.155 \cdot mw_t \cdot \frac{1.05^{yrs_r-1}}{0.05}$. For firms in Region 6, we compute the subsidy received as $sub_f = e_f \cdot (0.155 + 0.19) \cdot mw_t \cdot \frac{1.05^{yrs_r-1}}{0.05}$. In other words, we compute the present-discounted subsidies (discounting at a rate of 5 percent per year over the years over which the subsidies will be received) in proportion to the firm's employment and the national minimum wage at the time at which the subsidy was received. To compute the total subsidies received within each region and year, we sum sub_f across all firms who received a subsidy that year.

This reflects both the increased statutory generosity — not only employer-mandated but also employee-mandated social security payments are subsidized in this region — and the fact that mandated social security payments are tied to the *national* minimum wage (which has an outsize effect in the low-wage Region 6).

Combining the two subsidy items and summing over 2012 to 2019, the national government spent approximately 56.6 billion TL on investment tax credits and reduced social security payments, with approximately 64 percent of these subsidies taking the form of investment tax credits. Annual expenditures more than doubled over the 2012 to 2019 period, going from 7.7 billion TL to 15.9 billion TL. Over the period, the regional composition of subsidy expenditures shifted from the high-subsidy to low-subsidy regions. Regions 5 and 6 received 51.4 percent of national government outlays in 2012 and 38.3 percent in 2019, while Region 1 received 9.3 percent in 2012 and 17.5 percent in 2019.

Table 21: Expenditures on Employment Subsidies

	2012	2013	2014	2015	2016	2017	2018	2019	Total
Region 1	167.9	233.4	313.9	163.0	134.9	358.5	351.0	292.7	2,015.3
Region 2	110.4	231.4	160.2	178.3	116.2	229.2	239.5	230.7	1,495.9
Region 3	240.3	260.3	296.5	175.2	149.5	232.6	279.5	214.1	1,848.0
Region 4	153.7	276.0	157.0	138.6	153.3	341.3	607.8	623.8	2,451.6
Region 5	267.7	497.7	395.5	275.6	289.2	556.4	623.4	494.2	3,399.8
Region 6	635.2	1,343.6	754.0	822.7	895.2	1,502.6	1,721.7	1,753.5	9,428.4
Total	1,575.2	2,842.3	2,077.1	1,753.3	1,738.4	3,220.7	3,823.0	3,609.0	20,639.0

Notes: Values are millions of 2010 TL.

C Production Function Estimates

In this section, we present our production function estimates.

For each 2-digit NACE industry in our sample, we estimate a value-added production function, with labor and capital stocks as the two inputs. We use the firm's wage-bill as the measure of labor inputs and the real value of the capital stock (computed from annual data on capital investment expenditures), using a perpetual inventory method, as the measure of the capital input. We estimate the parameters of industries' production functions using the method introduced by Ackerberg et al. (2015), implementing the STATA command developed by Rovigatti and Mollisi (2016). We assume that labor is free to vary intra-period, use the lag of investment and intermediate input purchases as proxy variables.[48]

[48]While we do not present estimated production function parameters under alternate methodological choices, we show in Section D.2 that the impact of subsidization on firm productivity is robust to varying the set of proxy variables or simply to defining productivity as value added per worker.

To estimate productivity, we require measures of firms' real capital stocks. Unfortunately, because of sizable inflation rates before our sample, the reported book values of capital that exist within the EIS dataset are not reliable. Instead, we compute capital stocks using a perpetual inventory method type procedure. We follow, as closely as possible, the methods outlined in the OECD Manual of Measurement of Capital Stocks, Consumption of Fixed Capital and Capital Services.[49] We define firms' real capital stocks iteratively:

$$K_{f,t+1} = K_{ut} \cdot (1-\delta) + \frac{\Delta PPE_{f,t}}{P_t},$$

where $\Delta PPE_{f,t}/P_t$ is the real investment by firm t, and δ is the depreciation rate (which we set to 0.0.83). To apply this equation, we need to compute the initial-period capital stocks. Assuming that firms are near a balanced growth path (whereby investment is growing by 4 percent per year) in their first few years of the sample, we can compute the initial-period capital stocks based on the average investment levels in the first few years of the sample:

$$\begin{aligned} K_{f,2006} &= \sum_{\tau=-\infty}^{2005} \frac{\Delta PPE_{f,\tau}}{P_\tau} \cdot (1-\delta)^{2006-\tau} \\ &= \sum_{\tau=-\infty}^{2005} \frac{\overline{\Delta PPE_f}}{P} \cdot (1-0.04)^{2006-\tau} \cdot (1-\delta)^{2006-\tau} \\ &= \frac{\overline{\Delta PPE_f}}{P} \cdot \frac{1}{1-(1-0.04)(1-\delta)}, \end{aligned}$$

where $\frac{\overline{\Delta PPE_f}}{P}$ equals the average real investment in the first five years of the sample. (The second equation follows from the first under the assumption that pre-2006 investment equals a 4-percent deflated average of investment in the first five years of the sample.)

With measures of real capital stocks in hand, we are able to estimate real value added production functions. Table 22 presents our estimated production function parameters for the ten industries with the greatest number of observations. (Estimates for the other 76 industries are available on request.) For the median 2-digit industry in our sample, the sum of the coefficients on capital and labor equals 1.06, consistent with slightly increasing returns to scale. The coefficient on capital is approximately one-tenth of that of labor.

[49]See https://www.oecd.org/sdd/na/1876369.pdf.

Table 22: Production Function Estimates

	Wage-Bill		Capital			
Industry	$\hat{\beta}$	S.E	$\hat{\beta}$	S.E	Count	Firms
10	0.860	(0.000)	0.205	(0.000)	33,747	5,919
13	0.926	(0.000)	0.116	(0.000)	33,631	5,924
14	0.930	(0.000)	0.100	(0.000)	45,881	10,007
25	0.911	(0.000)	0.143	(0.000)	28,763	6,042
41	0.927	(0.000)	0.0802	(0.002)	70,475	25,968
46	0.954	(0.000)	0.145	(0.000)	93,885	23,515
47	0.847	(0.000)	0.148	(0.000)	69,791	17,030
49	0.933	(0.000)	0.091	(0.000)	31,156	7,778
56	0.942	(0.000)	0.083	(0.000)	38,679	9,773
85	1.003	(0.001)	0.055	(0.005)	26,172	5,949

D Sensitivity Analysis Related to Section 4 and 5

In this section, we collect sensitivity analyses and ancillary plots, complementing the material in Section 4 and 5.

D.1 Sensitivity Analysis Related to Section 4.2

This section considers the sensitivity of the relationship between industry-province level subsidization and economic activity. To preview, under most but not quite all of these sensitivity analyses, we continue to find that greater and more generous subsidies lead to increased economic activity.

In Table 5 we analyzed the relationship between revenues and subsidization at the industry-province level. In Table 23, we re-estimate Equation 1, weighting observations according to the average number of firms in the industry-province pair over the sample. Overall, while there are exceptions (columns 3 and 4), estimates of the relationship between subsidization and revenues are somewhat smaller than in the unweighted specifications. Yet, as in Table 5, the relationship is positive and statistically significant in most specifications.

Table 23: Industry-Province Level Observations

Panel A: OLS Estimates	(1)	(2)	(3)	(4)
Investment Tax Credit Rate	0.981**		1.855***	
	(0.494)		(0.514)	
Closed Certificate		0.346**		0.645***
		(0.166)		(0.166)
N	238,206	238,206	237,747	237,747
Year FEs	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes
R^2	0.949	0.949	0.976	0.976
Panel B: IV Estimates	**(5)**	**(6)**	**(7)**	**(8)**
Investment Tax Credit Rate	2.112*		6.335***	
	(1.275)		(2.081)	
Closed Certificate		0.357		0.884
		(0.884)		(0.970)
N	238,206	212,008	237,747	211,457
Year FEs	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes
	First Stage			
Statutory investment tax credit rate	0.211***		0.161***	
	(0.057)		(0.038)	
Eligible for subsidy?		0.067***		0.052**
		(0.019)		(0.021)

Notes: See the notes for Table 5. In contrast to that table, observations are weighted by the number of firms — on average over the sample — in the industry-province pair.

In Table 24, we consider the impact of additional explanatory variables. In the first four columns, we consider the impact of accounting for the large and geographically heterogeneous inflow of Syrian refugees during the sample period. We control for the share of the population in the province that are Syrian refugees. In columns (5) and (6), we estimate a regression with an even-more comprehensive set of controls, with province-by-year fixed effects. With one exception — the specification listed in column 12, the IV regression with the share of firms with a closed subsidy certificate as our measure of S_{pnt} — the estimated effect of subsidization on firm revenues is similar positive, statistically significant, and similar to that in our baseline estimates depicted in Table 23.

Table 24: Industry-Province Level Observations

Panel A: OLS Estimates	(1)	(2)	(3)	(4)	(5)	(6)
Investment Tax Credit Rate	1.264***		1.217***		0.927***	
	(0.181)		(0.215)		(0.217)	
Closed Certificate		0.526***		0.567***		0.457***
		(0.099)		(0.106)		(0.107)
Syrian Refugee Population Share$_{t-1}$	0.351***	0.357***	0.980***	0.354***		
	(0.110)	(0.110)	(0.325)	(0.099)		
N	238,206	238,206	237,747	237,747	237,747	237,747
Year FEs	Yes	Yes	No	No	No	No
Province× Year FEs	No	No	No	No	Yes	Yes
Industry× Year FEs	No	No	Yes	Yes	Yes	Yes
R^2	0.885	0.885	0.913	0.913	0.914	0.914
Panel B: IV Estimates	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Investment Tax Credit Rate	4.016***		8.039***		4.223***	
	(0.915)		(1.445)		(1.606)	
Closed Certificate		2.071***		2.065		-0.118
		(0.741)		(2.168)		(2.558)
Syrian Refugee Population Share$_{t-1}$	0.326***	0.326***	0.302***	0.332***		
	(0.110)	(0.115)	(0.099)	(0.103)		
N	238,206	212,008	237,747	211,457	237,747	211,457
Year FEs	Yes	Yes	No	No	No	No
Province× Year FEs	No	No	No	No	Yes	Yes
Industry× Year FEs	No	No	Yes	Yes	Yes	Yes
	First Stage					
Statutory investment tax credit rate	0.068***		0.082***		0.073***	
	(0.004)		(0.007)		(0.007)	
Eligible for subsidy?		0.024***		0.023***		0.019***
		(0.001)		(0.004)		(0.004)

Notes: See the notes for Table 5. In addition to the explanatory variables listed in that table, we include controls for the province's population share that are Syrian refugees (columns 1 trough 4) or province-by-year fixed effects (columns 5 and 6).

In Tables 25 and 26, we record the analogous relationship with two additional outcome variables: employment and firm counts. The OLS estimates for the relationships among economic activity and subsidization are positive and significant for these two alternate variables. For the IV specifications, the sign of the relationship between employment and subsidization depends on the set of fixed effects that one uses. Including only year fixed effects and industry-province fixed effects yields a negative relationship between subsidization and employment.

Table 25: Industry-Province Level Observations.

Panel A: OLS Estimates	(1)	(2)	(3)	(4)
Investment Tax Credit Rate	0.892***		1.150***	
	(0.157)		(0.172)	
Closed Certificate		0.419***		0.620***
		(0.092)		(0.090)
N	236,593	236,593	236,148	236,148
Year FEs	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes
R^2	0.886	0.886	0.924	0.924
Panel B: IV Estimates	**(5)**	**(6)**	**(7)**	**(8)**
Investment Tax Credit Rate	-3.414***		3.651***	
	(0.832)		(1.130)	
Closed Certificate		-1.611**		1.741
		(0.657)		(1.814)
N	236,593	210,875	236,148	210,335
Year FEs	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes
	First Stage			
Statutory investment tax credit rate	0.068***		0.082***	
	(0.004)		(0.007)	
Eligible for Subsidy?		0.024***		0.023***
		(0.001)		(0.004)

Notes: See the notes for Table 5. In contrast to that table, the outcome variable is the logarithm of total employment in the industry-province pair.

Table 26: Industry-Province Level Observations.

Panel A: OLS Estimates	(1)	(2)	(3)	(4)
Investment Tax Credit Rate	0.791***		0.679***	
	(0.101)		(0.097)	
Closed Certificate		0.328***		0.334***
		(0.061)		(0.054)
N	238,206	238,206	237,747	237,747
Year FEs	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes
R^2	0.926	0.926	0.962	0.962
Panel B: IV Estimates	**(5)**	**(6)**	**(7)**	**(8)**
Investment Tax Credit Rate	1.713***		3.837***	
	(0.515)		(0.687)	
Closed Certificate		0.963**		1.458
		(0.439)		(0.995)
N	238,206	212,008	237,747	211,457
Year FEs	Yes	Yes	No	No
Industry× Year FEs	No	No	Yes	Yes
	First Stage			
Statutory investment tax credit rate	0.068***		0.082***	
	(0.004)		(0.007)	
Eligible for Subsidy?		0.024***		0.023***
		(0.001)		(0.004)

Notes: See the notes for Table 5. In contrast to that table, the outcome variable is the logarithm of the number of firms in the industry-province pair.

D.2 Sensitivity Analysis Related to Sections 4.3 and 4.4

Additional outcome variables

In this figure, we consider additional estimations of Equation 3 with three alternate dependent variables: (i) the wage-bill, (ii) the change in the real value of plant, property, and equipment capital, and (iii) the wage-bill per employee.

First, Table 27 considers a second measure of labor inputs: the firms' wage-bill. The coefficient estimates are essentially equal to those given in Table 7, in which we compared firms' employment to subsidization rates.

Table 27: The Impact of the Subsidy Program on Firm Wage-Bill

	OLS				
	(1)	(2)	(3)	(4)	(5)
Investment Tax Credit Rate	1.097*** (0.100)	1.015*** (0.089)			
Inv. Tax Credit Rate + Closed Certificate			1.349*** (0.101)	1.270*** (0.095)	
Closed Certificate					0.454*** (0.033)
N	924,285	924,285	905,069	905,069	905,069
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
R^2	0.881	0.885	0.884	0.888	0.888
	IV				
	(6)	(7)	(8)	(9)	(10)
Investment Tax Credit Rate	1.875*** (0.497)	1.370** (0.675)			
Inv. Tax Credit Rate + Closed Certificate			2.780*** (0.810)	2.336** (1.104)	
Closed Certificate					2.004** (0.927)
N	885,918	885,538	866,622	866,232	866,233
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
	First Stage				
Statutory investment tax credit rate	0.142*** (0.010)	0.135*** (0.019)	0.088*** (0.009)	0.079*** (0.015)	
Eligible for Subsidy?					0.026* (0.015)

Notes: The dependent variable is log (Wage-Bill) at the firm-year level. Standard errors are clustered at the province level.

Second, Table 28 estimates Equation 3, using the percent change in the firms' plant, property, and equipment capital as the dependent variable. In contrast to the other variables that we consider, the IV relationships that we estimate are sensitive to the sets of fixed effects we apply. Within firms in a given industry-year pair, firms with increased subsidization had *lower* rates of capital investment. While we do not have a clear intuition as to why the relationships we estimate are sensitive to the specification applied, part of this sensitivity could reflect the lumpy nature of firm investment.

Table 28: The Impact of the Subsidy Program on Firm Investment

			OLS		
	(1)	(2)	(3)	(4)	(5)
Investment Tax Credit Rate	0.455*** (0.060)	0.406*** (0.048)			
Inv. Tax Credit Rate + Closed Certificate			0.405*** (0.056)	0.370*** (0.046)	
Closed Certificate					0.116*** (0.013)
N	817,466	817,466	798,978	798,978	798,978
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
R^2	0.260	0.271	0.265	0.276	0.276
			IV		
	(6)	(7)	(8)	(9)	(10)
Investment Tax Credit Rate	1.351*** (0.315)	-0.776** (0.316)			
Inv. Tax Credit Rate + Closed Certificate			1.860*** (0.535)	-1.521*** (0.485)	
Closed Certificate					-0.253 (0.270)
N	785,313	784,973	757,392	756,946	766,349
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
			First Stage		
Statutory investment tax credit rate	0.139*** (0.010)	0.129*** (0.019)	0.086*** (0.009)	0.075*** (0.015)	
Eligible for Subsidy?					0.024 (0.015)

Notes: The dependent variable is Δlog(PPE) at the firm-year level. Standard errors are clustered at the province level.

Finally, in Table 29 we relate the wages paid per employee and the investment tax credit rate that firms receive. The OLS specifications yield a precisely estimated null relationship between the two variables. The IV estimates are negative in certain specifications (those with industry-by-year fixed effects) and positive (but insignificant) estimates in others. [50] Our main takeaway from Table 29 is that greater subsidies do not lead firms to pay their workers higher wages. This conclusions accords with the results from our aggregate exercise in Section 5, namely that significant positive relationships among subsidization, productivity,

[50]One important caveat in interpreting these coefficient estimates, potentially the composition of firms' workforces may vary according to subsidies received. Indeed, in unreported regressions, we find that greater subsidies lead firms to hire more female relative to male workers. Part of the negative relationships that we report in certain specifications may reflect a shift towards lower-wage workers.

and revenues is consistent with little relationship between subsidization and real wages.

Table 29: The Impact of the Subsidy Program on Firm Average Wages

	OLS				
	(1)	(2)	(3)	(4)	(5)
Investment Tax Credit Rate	0.021	-0.003			
	(0.017)	(0.012)			
Inv. Tax Credit Rate + Closed Certificate			0.008	-0.016	
			(0.022)	(0.016)	
Closed Certificate					-0.002
					(0.006)
N	922,466	922,466	903,269	903,269	903,269
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
R^2	0.918	0.923	0.920	0.924	0.924
	IV				
	(6)	(7)	(8)	(9)	(10)
Investment Tax Credit Rate	0.107	-0.622***			
	(0.131)	(0.136)			
Inv. Tax Credit Rate + Closed Certificate			0.114	-1.128***	
			(0.201)	(0.260)	
Closed Certificate					-0.348*
					(0.205)
N	884,106	883,724	864,830	864,438	864,439
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
	First Stage				
Statutory investment tax credit rate	0.142***	0.135***	0.088***	0.079***	
	(0.010)	(0.019)	(0.009)	(0.015)	
Eligible for Subsidy?					0.026*
					(0.015)

Notes: The dependent variable is log(wage-bill per employee) at the firm-year level. Standard errors are clustered at the province level.

Additional Variable Measuring Subsidization

In Section 4, our primary measures of subsidization were (a) investment tax credits received, or (b) an indicator variable: whether the firm has a closed subsidy certificate. In Table 30, we consider the relationship between firm-level outcomes and an alternate measure of firm subsidization: the number of years for which the firm is relieved of its mandatory contributions to their employees' social security payments. As in Tables 6, 7, and 28, subsidization is positively and significantly related to firm outcomes in all OLS specifications, and in all but one IV specifications. (The negative coefficient in column 10 of Table 30 corresponds to the negative coefficient in column 9 of Table 6.) Furthermore, given that the employment-based measure of firm subsidization is approximately 20 times that of the investment-based measure (compare the fifth and eighth rows of Table 3), the magnitudes depicted in Table 30 are similar to those in Tables 6, 7, and 28. Our finding that the estimated relationships between firm outcomes and subsidization are invariant to the measure of subsidization reflects the fact that the different subsidies tend to be bundled with one another. Firms receiving a successful subsidy application tend to receive both subsidies to new capital investments and those to increasing or retaining employees.

Table 30: The Impact of the Subsidy Program on Firm Outcomes

Panel A: OLS Estimates	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Employment		Investment		Revenues	
SSEP–Years of Support Received+Closed Certificate	0.072***	0.068***	0.020***	0.018***	0.058***	0.054***
	(0.006)	(0.006)	(0.003)	(0.003)	(0.005)	(0.005)
N	905,146	905,146	798,978	798,978	901,332	901,332
Year FEs	Yes	No	Yes	No	Yes	No
Year× Industry FEs	No	Yes	No	Yes	No	Yes
R^2	0.853	0.858	0.265	0.276	0.834	0.839
Panel B: IV Estimates	(7)	(8)	(9)	(10)	(11)	(12)
Dependent Variable	Employment		Investment		Revenues	
SSEP–Years of Support Received+Closed Certificate	0.136***	0.150**	0.087***	-0.075***	0.236***	0.270***
	(0.045)	(0.060)	(0.032)	(0.021)	(0.057)	(0.077)
N	866,693	866,303	766,699	766,349	862,809	862,407
Year FEs	Yes	No	Yes	No	Yes	No
Year× Industry FEs	No	Yes	No	Yes	No	Yes
	First Stage					
Statutory Years of Social Security Support	0.085***	0.082***	0.083***	0.078***	0.084***	0.079***
	(0.010)	(0.016)	(0.010)	(0.016)	(0.010)	(0.016)

Notes: SSEP refers to the number of years of support for employer's mandatory contributions to social security premiums. Investment refers to $\Delta \log \text{PPE}$. All regressions additionally include firm fixed effects. Standard errors are clustered at the province level.

Firms with all of their establishments in a single industry-province pair

The sample in our benchmark analysis includes firms that have establishments in multiple industry-province pairs. For firms that receive a subsidy from the Turkish government, we observe the location and industry through which the firm receives the subsidy. However, for unsubsidized multi-establishment firms, there is no clear way to define the instrument: Because there are multiple industries or provinces through which a firm may apply for a subsidy, there are multiple potential statutory rates that one could defensibly apply. For this reason, we consider a robustness exercise in which we compare firm-level measures of economic activity — revenues, employment, and TFPR — to subsidization for the subset of firms with all of their establishments in a single industry-province pair. Overall, we find similar results with this restricted sample, with the effects of subsidization somewhat larger for certain specifications (e.g., most of the specifications with employment and revenues as the outcome variable) and comparable in other specifications (e.g., most of the specifications with TFP as the outcome variable). In contrast to Table 8, in Table 33 the OLS regression estimates of the relationship between the investment tax credit rate and measured TFP is not statistically significant.

Table 31: The Impact of the Subsidy Program on Revenues

			OLS		
	(1)	(2)	(3)	(4)	(5)
Investment Tax Credit	0.961***	0.816***			
Rate	(0.114)	(0.099)			
Inv. Tax Credit Rate			1.306***	1.196***	
+ Closed Certificate			(0.141)	(0.133)	
Closed Certificate					0.461***
					(0.043)
N	454,877	454,877	445,845	445,845	445,845
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
R^2	0.860	0.866	0.864	0.870	0.870
			IV		
	(6)	(7)	(8)	(9)	(10)
Investment Tax Credit	2.802***	2.587***			
Rate	0.599	0.620			
Inv. Tax Credit Rate			4.539***	4.526***	
+ Closed Certificate			(1.153)	(1.219)	
Closed Certificate					2.757***
					(0.984)
N	422,166	421,542	413,115	412,484	412,485
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
6			First Stage		
Statutory investment	0.134***	0.154***	0.079***	0.090***	
tax credit rate	(0.009)	(0.016)	(0.009)	(0.014)	
Eligible for Subsidy?					0.031***
					(0.010)

Notes: See the notes for Table 6. In contrast to that table, the sample in the current table includes only firms who have all of their establishment in a single province-industry pair.

Table 32: The Impact of the Subsidy Program on Firm Employment

	OLS				
	(1)	(2)	(3)	(4)	(5)
Investment Tax Credit Rate	0.989***	0.883***			
	(0.119)	(0.101)			
Inv. Tax Credit Rate + Closed Certificate			1.377***	1.257***	
			(0.139)	(0.119)	
Closed Certificate					0.476***
					(0.041)
N	458,243	458,243	448,741	448,741	448,741
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
R^2	0.861	0.868	0.864	0.871	0.868
	IV				
	(6)	(7)	(8)	(9)	(10)
Investment Tax Credit Rate	1.849***	1.540**			
	(0.549)	(0.653)			
Inv. Tax Credit Rate + Closed Certificate			2.883***	2.730**	
			(0.955)	(1.099)	
Closed Certificate					2.041***
					(0.032)
N	425,579	424,964	416,014	415,395	415,396
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
	First Stage				
Statutory investment tax credit rate	0.137***	0.159***	0.081***	0.093***	
	(0.009)	(0.017)	(0.009)	(0.015)	
Eligible for Subsidy?					0.032***
					(0.011)

Notes: See the notes for Table 7. In contrast to that table, the sample in the current table includes only firms who have all of their establishment in a single province-industry pair.

Table 33: The Impact of the Subsidy Program on Firm TFP

	OLS				
	(1)	(2)	(3)	(4)	(5)
Investment Tax Credit Rate	0.012	-0.028			
	(0.034)	(0.032)			
Inv. Tax Credit Rate + Closed Certificate			0.012	-0.030	
			(0.055)	(0.049)	
Closed Certificate					-0.012
					(0.016)
N	421,369	421,369	413,105	413,105	413,105
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
R^2	0.663	0.679	0.623	0.636	0.684
	IV				
	(6)	(7)	(8)	(9)	(10)
Investment Tax Credit Rate	1.151***	0.461**			
	(0.185)	(0.223)			
Inv. Tax Credit Rate + Closed Certificate			1.854***	0.608	
			(0.358)	(0.408)	
Closed Certificate					-0.056
					(0.275)
N	391,430	390,768	383,165	382,491	382,492
Year FEs	Yes	No	Yes	No	No
Year× Industry FEs	No	Yes	No	Yes	Yes
	First Stage				
Statutory investment tax credit rate	0.136***	0.157***	0.081***	0.092***	
	(0.009)	(0.017)	(0.010)	(0.015)	
Eligible for Subsidy?					0.031
					(0.010)

Notes: See the notes for Table 8. In contrast to that table, the sample in the current table includes only firms who have all of their establishment in a single province-industry pair.

Alternate Productivity Measures

In this section, we reproduce Tables 9 and 10 with two alternate measures of productivity. In our benchmark analysis, we estimated a value added production function with labor (measured by the wage-bill) and capital (measured by the real value of the capital stock, computed using a perpetual inventory method type procedure) as the two inputs. We estimated this production function using the estimator introduced in Ackerberg et al. (2015), using investment and intermediate inputs purchases as the two proxy variables. We found a negative relationship — sometimes not statistically significant — between productivity and subsidization in our OLS regressions, but a positive relationship when subsidization is instrumented with statutory subsidy eligibility and generosity. In Table 34, we re-estimate these relationships between subsidization and productivity with two alternate productivity measures: the logarithm of value added per worker, and the logarithm of TFP, wherein only investment is used as a proxy variable. We find little differences between the results presented in Table 34 and those in Tables 9 and 10.

Specifications without Firm Fixed Effects

In the results we presented in Sections 4.3 and 4.4, our regressions include firm fixed effects. In this section, we provide corresponding results without firm fixed effects. We include, instead, a set of controls, describing the firm in the year prior to the introduction of the subsidy program. These controls are the logarithm of real total assets, an exporter dummy, the bank loans to total asset ratio, the long term debt ratio, and the total debt ratio. Without firm fixed effects, the OLS estimates of the relationship between economic activity and subsidization are somewhat weaker for revenues and employment; the IV estimates are more modest for investment. (Compare the odd-numbered columns of Tables 9 and 10 to these in Table 35.) Overall, as with our baseline estimates in Section 4.4, we find that greater subsidization (and customers' subsidization) is associated with greater economic activity.

Table 34: The Impact of the Subsidy Program on Firm Activity: IV Estimates

	VA per Worker				TFP, with Investment as a Proxy Variable			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Inv. Tax Credit Rate	-0.343***	-0.402***	0.927**	0.417	-0.080***	-0.108***	0.984***	0.639***
	(0.062)	(0.054)	(0.439)	(0.475)	(0.030)	(0.028)	(0.206)	(0.186)
Weight of subsidized	0.019	-0.000	0.017	-0.002	0.001	-0.006	-0.002	-0.008
firms in total sales	(0.013)	(0.014)	(0.012)	(0.013)	(0.007)	(0.007)	(0.007)	(0.007)
Weight of subsidized	0.040**	0.038*	0.04.316	0.028	0.055***	0.041***	0.033**	0.031**
firms in total purchases	(0.018)	(0.021)	(0.023)	(0.023)	(0.011)	(0.012)	(0.015)	(0.012)
Log daily wage	0.041***	0.021*	0.038***	0.022**	-0.015**	-0.007	-0.018***	-0.007
	(0.010)	(0.011)	(0.010)	(0.010)	(0.007)	(0.006)	(0.007)	(0.006)
N	735,355	735,355	686,630	686,231	791,523	791,523	744,754	744,384
Year FEs	Yes	No	Yes	No	Yes	No	Yes	No
Year× Industry FEs	No	Yes	No	Yes	No	Yes	No	Yes
R^2	0.683	0.693			0.645	0.656		
First Stage Estimates								
Statutory investment			0.130***	0.117***			0.137***	0.127***
tax credit rate			(0.010)	(0.018)			(0.010)	(0.020)
Weight of subsidized			0.002	0.002			0.002	0.002
firms in total sales			(0.002)	(0.001)			(0.002)	(0.001)
Weight of subsidized			0.017***	0.012***			0.018***	0.013***
firms in total purchases			(0.003)	(0.002)			(0.003)	(0.002)
Log daily wage			0.000	-0.001			0.001	-0.001
			(0.001)	(0.001)			(0.001)	(0.001)

Notes: All regressions include firm fixed effects. Standard errors are clustered at the province level.

Table 35: The Impact of the Subsidy Program on Firm Activity

Dependent Variable	Revenues		Employment		Investment		TFP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Investment Tax Credit	0.049	2.696***	0.335*	0.958**	0.381***	0.328**	-0.099***	0.859***
Rate	(0.060)	(0.431)	(0.185)	(0.400)	(0.026)	(0.150)	(0.037)	(0.153)
Weight of subsidized	0.138***	0.131***	0.162***	0.160***	0.024***	0.025***	0.020***	0.018***
firms in total sales	(0.027)	(0.026)	(0.024)	(0.023)	(0.006)	(0.006)	(0.006)	(0.006)
Weight of subsidized	0.433***	0.390***	0.032	0.022	-0.063***	-0.063***	0.040***	0.024
firms in total purchases	(0.013)	(0.014)	(0.033)	(0.035)	(0.005)	(0.005)	(0.015)	(0.015)
Log daily wage	0.090***	0.086***	0.006	0.005	0.001	0.001	-0.013**	-0.015***
	(0.013)	(0.011)	(0.007)	(0.007)	(0.008)	(0.008)	(0.006)	(0.006)
N	841,453	839,112	842,514	840,169	750,737	748,527	791,523	789,196
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year× Industry FEs	No	Yes	No	Yes	No	Yes	No	Yes
R^2	0.556		0.400		0.037		0.278	
First-Stage Estimates								
Statutory investment		0.164***		0.164***		0.167***		0.163***
tax credit rate		(0.011)		(0.011)		(0.011)		(0.011)
Weight of subsidized		0.002		0.002		0.003***		0.002
firms in total sales		(0.001)		(0.001)		(0.001)		(0.001)
Weight of subsidized		0.014***		0.014***		0.014***		0.015***
firms in total purchases		(0.002)		(0.002)		(0.002)		(0.003)
Log daily wage		-0.000		-0.000		0.001		-0.000
		(0.001)		(0.001)		(0.001)		(0.001)

Notes: All regressions include province-industry fixed effects but (in contrast to Tables 9 and 10) exclude firm fixed effects.. Standard errors are clustered at the province level.

D.3 Additional Plots Related to Section 5

In this appendix, we present four additional figures to supplement the analysis in Section 5.

First, Figure D.3 displays the average investment tax credit received by firms, by region and by industry, in 2019. As in Figure 5, investment subsidies differ both because of statutory differences in subsidy generosity as well as the differences in take-up rates across industries and regions. Both take-up rates and subsidy generosity were higher in Region 6 than in other regions, and in manufacturing than in services.

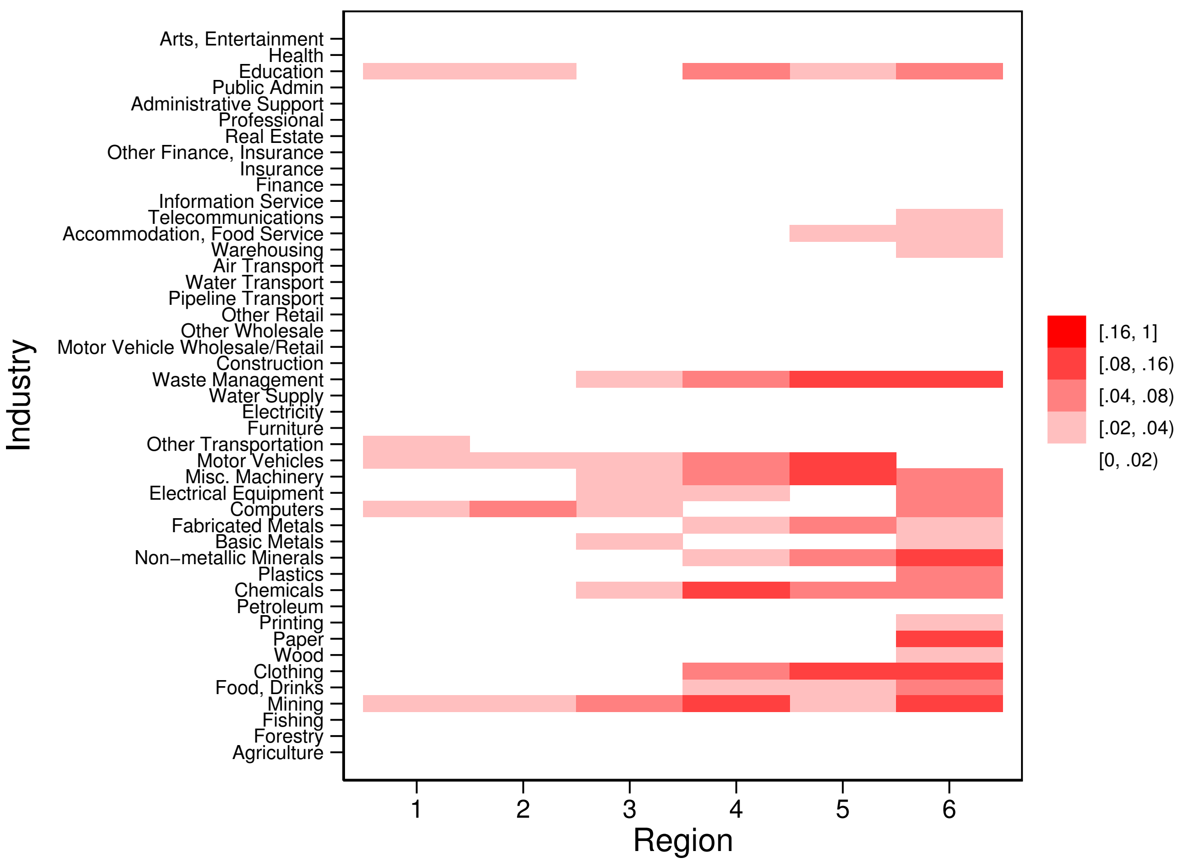

Figure 17: Investment Subsidies

Notes: The plot gives the average investment tax credit for each region and industry.

Second, we assess the sensitivity of our quantification of the 2012 subsidy program to the subsidy measure. In our benchmark analysis, we used the average investment tax credit as our measure subsidy measure. Figure 18 presents the analogue of Figure 7 using the fraction of subsidized firms as our measure. As in Figure 7, Region 5 has the largest real wage increases as a result of the subsidy program, with migration and trade flows substantially mitigating the impact of the policy on inter-regional real wage inequality.

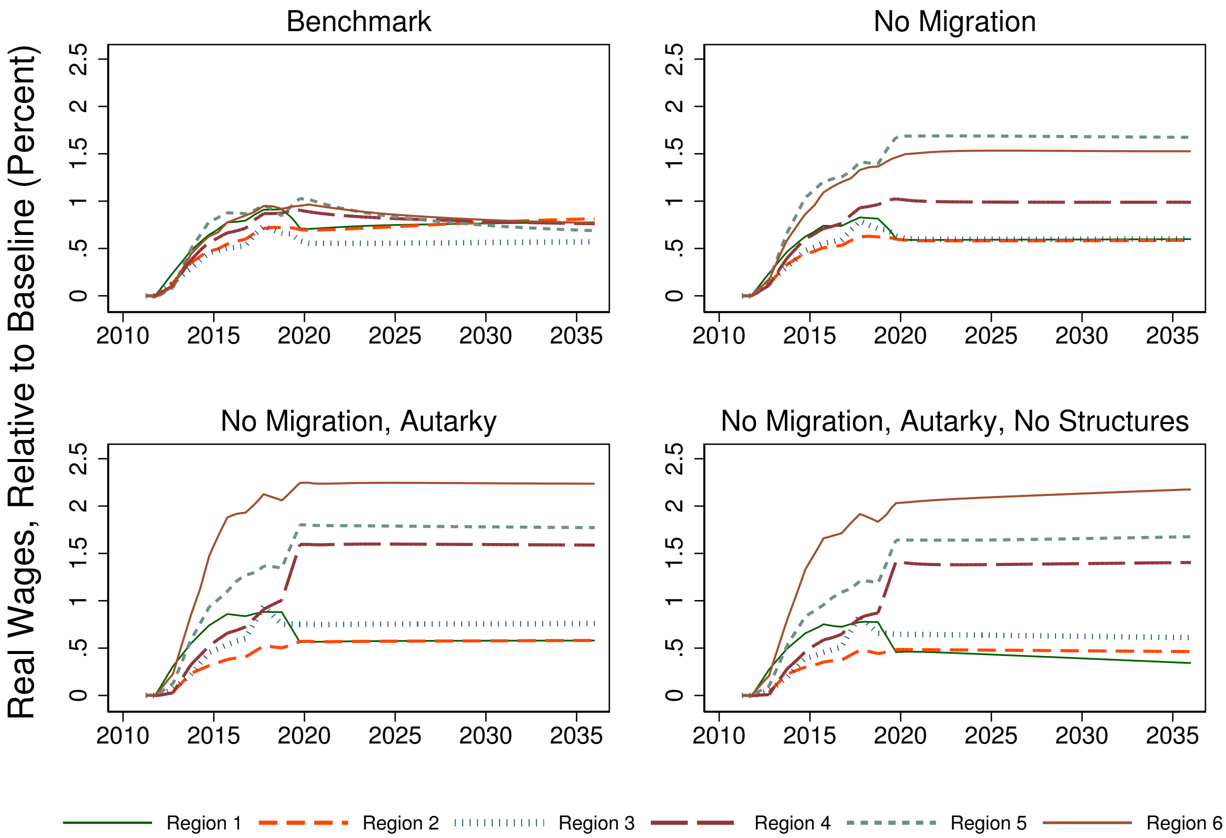

Figure 18: Real Wage Trajectories
Notes: See the notes for Figure 8. In contrast to that figure, here we consider a calibration based on the share of subsidized firms — as opposed to the average investment tax credit received — as our measure of firm subsidization by province-industry year.

Finally, Figure 19 plots average investment tax credits received among firms in the formal economy. (This is the analogue of Figure 5, which presented our measures of subsidization for both formal economy and informal economy firms, and attempts to account for the lack of comprehensiveness of measurement of firms in Agriculture, Finance, Insurance, Real Estate, and Public Administration industries.) The measures of subsidization that we observe in the raw data pertain only to formal economy firms. To produce Figure 5, we used the fact that informal-economy firms are ineligible to receive investment subsidies and thus divided the average investment tax credits received by the share of workers in each industry-region pair that is employed in the formal economy (using the method discussed in Appendix A.4.) In Figure 19, instead, we plot the investment tax credits received by the firms appearing in our dataset. These are substantially higher, especially for Region 6: While the 2019 value for average investment tax credits received was 2.2 percent, here it is 5.9 percent. In Figure 20, we plot counterfactual wage impacts of the subsidy reform in which we apply the subsidization rates in 19. Here, the implied impacts of the subsidy reform are magnified compared to those in Figure 7.

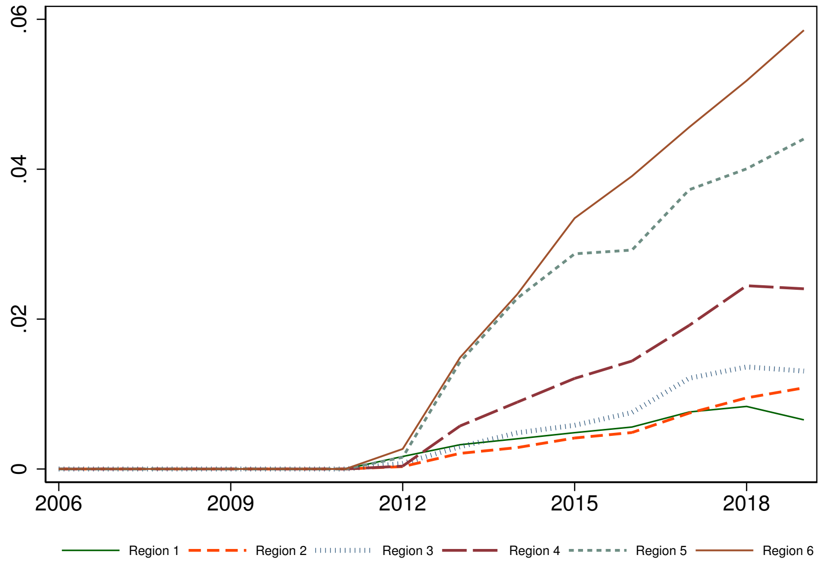

Figure 19: Investment Subsidies
Notes: See the notes of 5. In contrast to that figure, we do not attempt to account for the incomplete nature of the EIS data.

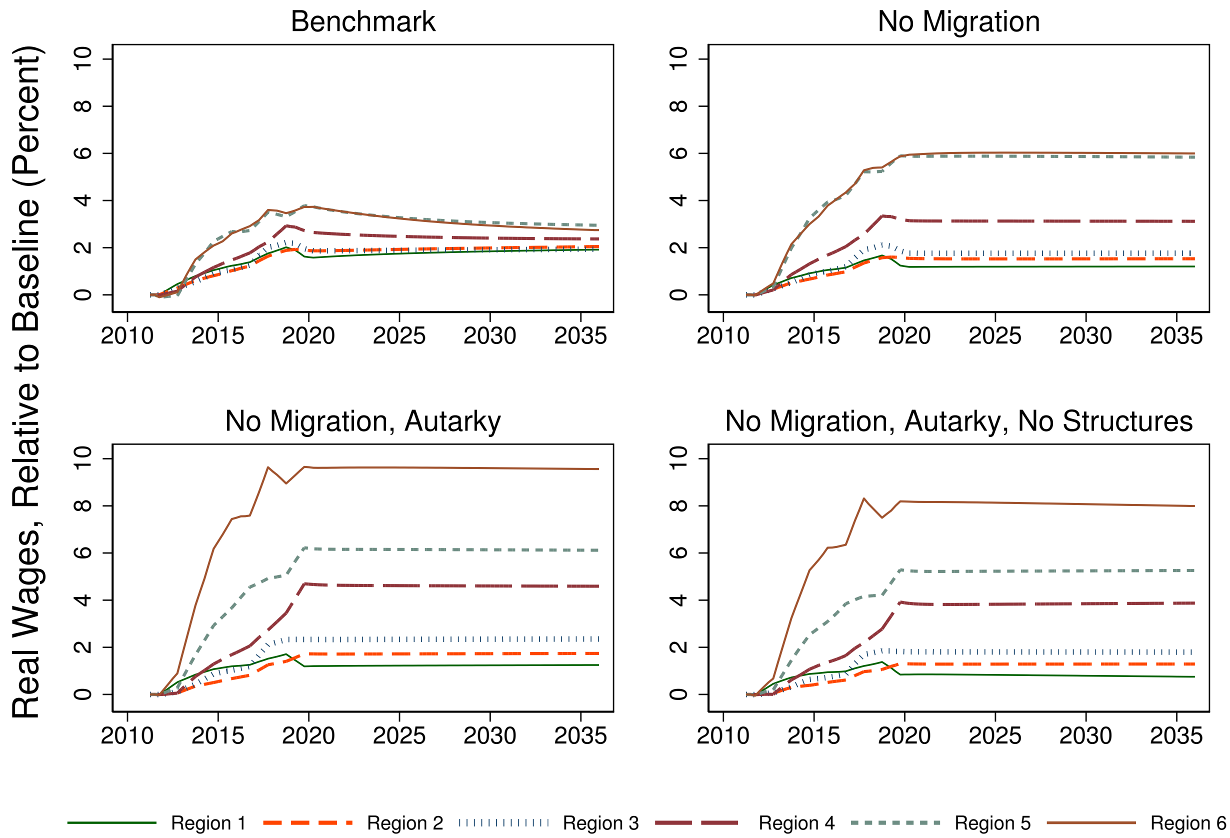

Figure 20: Real Wage Effects of the 2012 Subsidy Program
Notes: See the notes for Figure 8. In contrast to that figure, in our calibration of trade and worker flows across industry-subsidy region pairs and in our calibration of the average investment tax credits received by industry and subsidy region, we do not make any adjustments for firms and employment in the informal economy.

E Description of Caliendo et al. (2019)

E.1 Setup

For the reader's convenience, in this appendix we describe the elements of the Caliendo et al. (2019) framework that are salient for our analysis. The economy consists of intermediate goods producers, households, and rentiers (who own the structures). Both intermediate input producers and households are indexed by the region ($n \in \{1, ...N\}$) in which they reside and the industry ($j \in \{0, 1, ...J\}$) in which they produce/work ($j = 0$ indexes not working), while rentiers are indexed by the region in which they reside. Time is by t.

The innovation of Caliendo et al. (2019)'s *dynamic hat algebra* is to provide a tractable method of determining counterfactual responses to changes in the model's exogenous variables (e.g., changes to trade costs, or changes to productivity) without having to identify these variables' levels at any given point in time.[51] Caliendo et al. (2019) show (in Proposition 3 of their paper) that one can solve for counterfactual dynamic equilibria without knowing the levels of the model's exogenous variables. Specifying the initial allocation of the economy — in terms of labor supplied to different industries and regions, migration and trade shares, and expenditures on each industry-region pair — as well differences in the growth rates of the exogenous variables will suffice.

Households

For each region-industry pair (nj), there is a continuum of households. Within each period, each household earns labor income (w_t^{nj}), and spends this income to purchase the different production goods. (For households who do not work, for whom $j = 0$, their total consumption expenditures equal a constant b^n.) Let $P_t^{nj,k}$ and $c_t^{nj,k}$ respectively denote the unit price and household purchases of the different goods $k \in \{1, ...J\}$ in period t. Moreover, each period households may choose to move to another industry-region pair. Migration involves a utility cost $\tau^{nj,ik} + \nu\epsilon_t^{ik}$; $\tau^{nj,ik}$ equals the systematic, time-invariant utility cost of transitioning from region-industry nj to region-industry ik, while ϵ_t^{ik} is a type-1 extreme value distributed random variable, independent across individual households, time, and industry-region pairs. We assume — following Caliendo et al. (2019) — that the static utility function is Cobb-Douglas and that the intertemporal elasticity of substitution in consumption equals one, so that the discounted expected utility of a household residing in region-industry pair (nj) equals:

$$U_t^{nj} = \sum_{k=1}^{J} \alpha^k \log\left(c_t^{nj,k}\right) + \max_{\{i,k\}} \beta \mathbb{E}\left[U_{t+1}^{ik} - \tau^{nj,ik} + \nu\epsilon_t^{ik}\right] . \quad (6)$$

Let $V_t^{nj} \equiv \mathbb{E}\left[U_t^{nj}\right]$ denote the expected lifetime utility of a representative household in industry-region nj, where the expectation is taken over the ϵ_t^{ik} preference shocks. Given the setup, the expected lifetime utility evolves according to the following system of equations.

$$V_t^{nj} = \sum_{k=1}^{J} \alpha^k \log\left(c_t^{nj,k}\right) + \nu \log\left(\sum_{i=1}^{N}\sum_{k=0}^{J} \exp\left(\beta V_{t+1}^{ik} - \tau^{nj,ik}\right)^{1/\nu}\right)$$

[51] In static setups, the hat algebra approach — to solve for counterfactual impacts of productivity or trade policy changes — traces back to Jones (1965), and was more recently popularized by Dekle et al. (2007). See Dingel (2018) for brief history.

$$= \log\left(w_t^{nj}\right) - \sum_{k=1}^{J} \alpha^k \log\left(\frac{P_t^{nk}}{\alpha^k}\right) + \nu \log\left(\sum_{i=1}^{N}\sum_{k=0}^{J} \exp\left(\beta V_{t+1}^{ik} - \tau^{nj,ik}\right)^{1/\nu}\right) ,$$

where w_t^{nj} equals the wage of workers residing in region n and employed in industry j and P_t^{nk} is the ideal price index for households residing in region n and employed in industry k. The first equation follows from the dynamic optimization of the household over its location and industry choices. The second equation follows from the first given the static optimization over consumption choices.

Household utility maximization, over its decision of which region-industry pair to transition to in period $t+1$, yields relatively simple expressions for the probability that a household in move from region-industry pair nj in period t to region-industry pair ik in period $t+1$:

$$\mu_t^{nj,ik} = \frac{\exp\left(\beta V_{t+1}^{ik} - \tau^{nj,ik}\right)^{1/\nu}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \exp\left(\beta V_{t+1}^{mh} - \tau^{nj,mh}\right)^{1/\nu}} . \quad (7)$$

This probability is increasing in the continuation value of residing in region-industry pair ik in period $t+1$ and negatively on the systematic utility cost, of $\tau^{nj,ik}$, moving from nj to ik.

Intermediate Goods Producers and Final Goods Producers

With industry j and region n, heterogeneous intermediate goods producers operate in a perfectly competitive environment. They combine labor (l_t^{nj}), structures (h_t^{nj}), and material inputs ($M_t^{nj,nk}$) with the following production function:

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

In this equation, A_t^{nj} equals productivity in region n and industry j in period t, while z^{nj} denotes the idiosyncratic productivity (drawn from a Frechet distribution) of an individual firm within the region and industry. The parameters ξ^n, γ^{nj}, and $\gamma^{nj,nk}$ characterize the importance of structures, labor, and material inputs in production. Given this production function, the marginal cost of production equals:

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

Here, r^{nj} and w^{nj} refer to the rental price of structures and the wage rate in industry-region pair nj, and B^{nj} is a constant which depends on the model's underlying parameters.[52]

Shipments of industry j intermediate inputs from region i to region n incur "iceberg" trade costs $\kappa_{nj,ij}$. So, the price of a unit of the intermediate good in destination region-industry nj equals $x_t^{ij} \cdot \kappa_{nj,ij}$.

Within each region and industry, a final goods producer combines intermediate goods to produce an output that can either be consumed or sold as a material input.

The output for a final goods producer in region n and industry j is given by the following constant elasticity of substitution production function:

$$Q_t^{nj} = \left[\int_{R_+^N} \left[\tilde{q}_t^{nj} \left(z^j \right) \right]^{\left(\frac{\eta^{nj}-1}{\eta^{nj}} \right)} d\phi^j \left(z^j \right) \right]^{\left(\frac{\eta^{nj}}{\eta^{nj}-1} \right)} .$$

Here $\phi \left(z^j \right) \equiv \exp \left[- \sum_{n=1}^{N} \left(z^{nj} \right)^{-\theta^j} \right]$ is the joint distribution of idiosyncratic productivity levels of the intermediate goods producers from the different supplying regions n.

For each commodity (j), the final goods producer purchases from the intermediate good producer who can deliver at the lowest price. Given the properties of the Frechet distribution, the probability that region i provides the lowest price variety is given by:

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

This is also equal to the share of intermediate input purchases that are sourced from region n. Cost minimization implies that the price of good j in region n at time t is:

$$P_t^{nj} = \Gamma \left(1 + \frac{1-\eta^{nj}}{\theta^j} \right) \cdot \left(\sum_{i=1}^{N} \left(x_t^{nj} \cdot \kappa_{nj,ij} \right)^{-\theta^j} \right)^{-1/\theta^j} ,$$

where $\Gamma()$ is the Gamma function.

Finally, cost minimization on the part of individual intermediate input producers yields the following equations for labor and structures demand in region n industry j:[53]

$$L_t^{nj} = \frac{\gamma^{nj} \left(1 - \xi^n \right)}{w_t^{nj}} \cdot \left(\sum_{i=1}^{N} \pi_t^{ij,nj} X_t^{ij} \right) , \text{and} \quad (8)$$

[52] $B^{nm} = \left[\left(\xi^n \right)^{\xi^n} \left(1 - \xi^n \right)^{1-\xi^n} \right]^{-\gamma^{nj}} \prod_{k=1}^{J} \left(\gamma^{nj,nk} \right)^{-\gamma^{nj,nk}}$.

[53] The total stock of structures in each industry-region pair is fixed. See Kleinman et al. (2021) for a related model with dynamic capital investment decisions.

$$H^{nj} \quad = \quad \frac{\gamma^{nj}\xi^{n}}{r_t^{nj}} \cdot \left(\sum_{i=1}^{N} \pi_t^{ij,nj} X_t^{ij} \right). \tag{9}$$

Rentiers, Total Expenditures, and Market Clearing

Within each region n a continuum of rentiers earn income from renting out structures. According to the Caliendo et al. (2019) setup, rentiers send their income from renting structures to a global portfolio. Rentiers in region n receive a share ι^n from this global portfolio. Unlike households, rentiers are not allowed to relocate to other regions. We are now in a position to write out the market-clearing condition for intermediate good j produced in region n:

$$X_t^{nj} \quad = \quad \sum_{k=1}^{J} \sum_{i=1}^{N} \gamma^{nk,nj} \pi_t^{ik,nk} X_t^{ik} + \alpha^j \left(\sum_{k=1}^{J} w_t^{nk} L_t^{nk} + \iota^n \sum_{i=1}^{N} \sum_{k=1}^{J} r_t^{ik} H^{ik} \right). \tag{10}$$

The first sum on Equation 10 equals the total purchases through input-output linkages. The second sum equals total purchases of good j to households or rentiers residing in region n.

Equilibrium Definition

Given a path of productivity levels, A_t^{nj}, an equilibrium of this economy consists of a sequence of wages (w_t^{nj}) and prices (P_t^{nj}), expenditures (X_t^{nj}), trade shares ($\pi_t^{ij,nj}$), and labor allocations (L_t^{nj}) such that:

- Across successive periods, migration rates and initial labor supply determine next period-labor supply:
$$L_{t+1}^{ik} = \sum_{n=1}^{N} \sum_{j=1}^{J} \mu_t^{nj,ik} L_t^{nj}, \tag{11}$$
where $\mu_t^{nj,ik}$ is given by Equation 7;
- Within each period, the markets for structures and labor clear (Equations 8 and 9);
- For each intermediate good j produced in region n, the goods market clears (Equation 10);
- Households choose consumption to maximize period utility and migration to maximize lifetime utility, with preferences given by Equation 6; and
- Intermediate input goods producers and final goods producers maximize profits period by period.

E.2 Calibration

Calibration of the model requires information on the time paths of labor flows across industries and subsidy regions, trade flows across regions for each industry, value added in each industry-region pair, employment in each industry-region pair, and productivity changes that are directly due to the subsidy program. Our economy has six regions and 45 industries; we list these industries and regions in Appendix E.3. We record these time paths for t =2011Q1,....2018Q4. While our data are recorded on an annual basis, we follow Caliendo et al. (2019) and set a time period to refer to an individual quarter. In addition, we require parameters governing (i) consumers' preferences, (ii) production function cost shares, (iii) heterogeneity in individual households' preferences over different locations and individual firms' productivity and (iv) the regions in which rentiers' income are spent. These last four sets of parameters are time invariant.

To calibrate our model, we rely on information from the World Input-Output Database and the micro estimates from Section 4.3. The former database is informative about aggregate moments, while the latter will pin down flows of goods across industries and regions and the flows of workers across industries and regions.

Time-Invariant Parameters

The parameters α^k characterize the relative importance of each industry commodity k in consumers' preferences. These parameters are allowed to vary by year. From the 2016 vintage of the World Input-Output Database, for each we compute the sum of the value private household consumption expenditures, consumption expenditures by non-profit organizations serving households, governmental consumption expenditures, and exports. We take data from 2010. We then compute the share of industry k among these total expenditures.

The parameters ξ^n characterize the relative importance of structures, relative to labor, in value added for intermediate goods producers in region n. For the country as a whole, we compute this as one minus the cost share of labor relative to value added. While, in principle, these parameters are allowed to vary by subsidy region, the World Input-Output Database do not capture this geographic variation. As a result, we set ξ^n to be identical across all regions.

The parameters $\gamma^{nj,nk}$ characterize the importance of commodity k in the production of intermediate good j when producing in region n. We set $\gamma^{nj,nk}$ as industry k's share of material input expenditures (from 2010) within the production of commodity j, using the 2016 vintage of the World Input-Output Database. As with ξ^n parameters, while the Caliendo et al. (2019) model permits these parameters to vary by industry, out data do not capture this variation.

We take parameters —θ^j and ν — respectively characterizing the heterogeneity in productivity and individuals' idiosyncratic utility from working in a given industry-region pair from Caliendo et al. (2019). We set $\theta^j = 4.55$ for all industries j and $\nu = 5.3436$. Finally, we set the quarterly discount factor, β, to be 0.99, again following Caliendo et al. (2019).

Finally, we set ι^n — the share of rentier profits accruing to each region — to be proportional to that region's employment: $\iota = [0.523, 0.150\ , 0.129, 0.086, 0.059, 0.054]$. This approach differs from that in Caliendo et al. (2019), who use observed trade imbalances (measured by Equation 10) to identify ι^n.

Time-Varying Trade and Migration Flows, Value Added, Employment, and Counterfactual TFP

First, we describe how we measure $\pi_t^{nj,ij}$, trade shares across region pairs (i supplying n) for a particular commodity j in quarter t. First, for each year y between 2010 to 2018, we compute the trade flows across subsidy regions for each of the 45 aggregated industries j. We record $\tilde{\pi}_y^{nj,ij}$as the share of region i's purchases of industry product j coming from region n. For quarter t, we then interpolate the values of $\pi_t^{nj,ij}$ based on the yearly values of $\tilde{\pi}_y^{nj,ij}$.[54]

To measure flows of workers across industries and subsidy regions, $\mu_t^{nj,ik}$, we draw on information from the Entrepreneur Information System dataset. Given considerably volatility in the observed flows of workers from year to year, the $\mu_t^{nj,ik}$ that we use in our calibration are four-year moving averages of those described in Appendix A.5

For each origin region-industry pair, for each year, we compute the share of workers who end up in each region-industry pair in the subsequent year. Use $\widetilde{\mu}_y^{nj,ik}$ to denote these annual flows in from year y to year $y+1$. Since our model is at the quarter level, we need a couple of simple calculations to compute $\mu_t^{nj,ik}$from the $\widetilde{\mu}_y^{nj,ik}$. Define $\widetilde{M}_y$ as the matrix with $\widetilde{\mu}_y^{nj,ik}$ in its $j+n(J-1)$, $k+i(J-1)$ element. Then define $\mu_t^{nj,ik}$ as the $j+n(J-1)$, $k+i(J-1)$ element of the matrix given by $\left(\widetilde{M}_y\right)^{1/4}$.

Third, to compute L_t^{nj} for each quarter in our sample, we begin by assigning L_0^{nj} using the number of workers in each industry-region pair from the Entrepreneur Information System dataset, using data from 2012.[55] We then iteratively apply Equation 11, using the values of $\mu_t^{nj,ik}$ described in the previous paragraph.

Finally, to compute the direct productivity impact of the subsidy program, we employ information on subsidy take-up rates and the incremental productivity gain from the subsidy. In our benchmark analysis, we compute the average investment tax credit in each year,

[54] For the first quarter of our sample, we set the first value of $\pi_t^{nj,ij}$ as $\tilde{\pi}_y^{nj,ij}$. We then iteratively define $\pi_t^{nj,ij}= \left(\tilde{\pi}_{y+1}^{nj,ij}/\tilde{\pi}_y^{nj,ij}\right)^{1/4} \cdot \pi_{t-1}^{nj,ij}$, where y refers to the year in which quarter t appears.

[55] This is the first observation according to this dataset. Ideally, we would have taken data from 2010.

subsidy region, and industry. For each quarter t in year y, define I_t^{nj} as this take-up rate. We then multiply this average by 0.697, which is, according to Table 8, the treatment effect on log firm-level productivity of a 100 percent increase in the investment tax credit. We consider our counterfactual economy to be one in which these subsidies were not implemented, and so where TFP, A_t^{nj},was lower by a factor of $\exp\left[0.668 \cdot I_t^{nj}\right]$. In sensitivity analysis, in Appendix D.3, we consider an alternate measure of counterfactual A_t^{nj} based on the fraction of firms in region-industry nj which have newly closed subsidy certificates in year y.

E.3 List of Industries

This section lists the 45 industries in the economy of our calibration of Caliendo et al. (2019). The Turkish National Input-Output Tables, as collected by the World Input-Output Database, applies an industry classification scheme with 56 industries. The input-output table includes 11 industries with 0 values in all of the data entries. We drop these 11 industries from our analysis.[56] The 45 industries in our analysis include: Crops (NACE A01); Forestry (NACE A02); Fishing (NACE A03); Mining (NACE B); Food, Drinks (NACE C10-C12); Clothing (NACE C13-C15); Wood (NACE C16); Paper (NACE C17); Printing (NACE C18); Petroleum (NACE C19); Chemicals (NACE C20); Plastics (NACE C22); Non-metallic Minerals (NACE C23); Basic Metals (NACE C24); Fabricated Metals (NACE C25); Computers (NACE C26); Electrical Equipment (NACE C27); Misc. Machinery (NACE C28); Motor Vehicles (NACE C29); Other Transportation (NACE C30); Furniture (NACE C31-C32); Electricity (NACE D35); Water Supply (NACE E36); Waste Management (NACE E37-E39); Construction (NACE F); Motor Vehicle Wholesale/Retail (NACE G45); Other Wholesale (NACE G46); Other Retail (NACE G47); Pipeline Transport (NACE H49); Water Transport (NACE H50); Air Transport (NACE H51); Warehousing (NACE H52); Accommodation, Food Service (NACE I); Telecommunications (NACE J61); Information Service (NACE J62, J63); Finance (NACE K64); Insurance (NACE K65); Other Finance, Insurance (NACE K66); Real Estate (NACE L68); Professional (NACE M74-M75); Administrative Support (NACE N); Public Admin. (NACE O84); Education (NACE P85); Health (NACE Q); and Arts, Entertainment (NACE R-S).

[56] They are Pharmaceutical Manufacturing (NACE C21); Repair and installation of machinery and equipment (NACE C33); Postal and courier activities (NACE H53); Publishing activities (NACE J58); Motion picture, video, and television program production and planning (NACE J58-J59); Legal, accounting, and management consultancy activities (NACE M69-M70); Architectural and engineering activities (NACE M71); Advertising and market research (NACE M73); Activities of extraterritorial organizations and bodies NACE (T); Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use (NACE U).