

# Effects of Immigrants on Non-host Regions Evidence from the Syrian Refugees in Turkey

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## Abstract

This paper investigates how immigration-induced wage shocks can propagate beyond the regions receiving immigrants through the production network. Using the Syrian refugee crisis in Turkey as a quasi-experiment and the near universe of domestic firm-to-firm transaction data from VAT records, I show that the immigration shock propagates both forward and backward along the supply chain. Firms in non-host regions who directly or indirectly buy from host regions demand more labor. Firms who sell to host regions increase their sales. Estimates imply an elasticity of substitution between labor and intermediate goods of 0.79 and an elasticity of substitution of 1.06 between intermediates. Counterfactual analyses show that the spillover effects on non-host regions are economically meaningful when the host regions are central nodes of the domestic trade network. For example, a 1% increase in labor supply in Istanbul decreases real wages in Istanbul by 0.56% and increases real wages in the average non-host city by 0.38%.

*Keywords:* Immigration, production network, trade spillovers

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# 1 Introduction

The last decade has seen a quadrupling of refugees globally, from 11 million in 2012 to 46 million today.<sup>1</sup> During this period, Turkey has received 3.6 million Syrian refugees, which has increased the labor supply of several Turkish provinces by up to 82%. Such a large increase in labor supply in host regions is likely to change the prices of goods, which can induce general equilibrium effects throughout the economy. Therefore, the labor market consequences of this massive labor supply shock for the Turkish economy depend on the magnitude of these general equilibrium effects.

There are three key economic mechanisms by which an immigration shock propagates through the supply network to impact labor demand. First, immigrants reduce the wages and therefore the prices charged by firms in the host region. This reduction in prices propagates forward to firms who directly or indirectly buy from the host region. Whether these “upstream exposed” firms increase or decrease their labor demand is governed by the substitutability between labor and intermediate goods. Immigrants’ effects also propagate backwards in two distinct ways, which I label as “downstream exposure” effects. If intermediate goods are gross substitutes, then firms whose production costs fall more sharply gain market share. Consequently, they demand more from their suppliers, who observe an increase in sales. Furthermore, when intermediates are more substitutable with other intermediates than with labor, immigrant-intensive firms increase their demand for intermediates, which creates a positive demand spillover for their suppliers. Together, these three economic forces shape the labor market effects of immigrants across the economy.

In this paper, I present theoretical analysis formalizing these three forces, empirical evidence testing their existence, and counterfactual exercises that quantitatively examine the impact of immigration on real wages and welfare across regions.

My model captures these mechanisms through two key features. First, firms combine local labor with intermediate inputs using CES production technology, where intermediate inputs themselves are CES aggregates of goods from firms across all regions. Second, firms set prices using exogenous markups, which ensures that changes in production costs, whether from labor or intermediate inputs, are passed through to prices. The general equilibrium effects of immigration on labor demand across regions are governed by two key parameters: the elasticity of substitution (EoS) between labor and intermediates, and the EoS across different intermediates. Combined with the structure of the input-output network, these elasticities are sufficient to determine how immigration-induced wage changes in host regions affect labor demand throughout the economy.

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<sup>1</sup>Author’s calculations using data from UNHCR. Appendix Figure B.2 provides more details.

I estimate these two elasticities by analyzing how Syrian immigration affects manufacturing firms in non-host regions of Turkey. My analysis draws on comprehensive administrative data: VAT records capturing the near universe of firm-to-firm transactions, matched employer-employee records, and firm balance sheet data. These data allow me to calculate model-defined trade exposures for all formal firms in Turkey. To address endogeneity concerns, I construct a shift-share instrument that exploits variation in immigration intensity across regions and years. The shift component captures the aggregate number of Syrian refugees in Turkey in a given year, while the share component reflects the relative travel distance from the Syrian border. The regional immigration shock translates into firm-level trade exposures through firms’ baseline input-output relationships. To strengthen the identification strategy, I apply the Synthetic IV method (Gulek and Vives-i Bastida, 2024) to relax the share-exogeneity assumption typically required in shift-share designs (Goldsmith-Pinkham et al., 2020).

Comparing large firms within the same region-industry cells who are differentially exposed to immigration through their trading network yields three key findings that align with my theoretical mechanisms. First, firms who directly or indirectly buy from host regions increase their labor demand: they hire more workers and increase both payroll and the labor share in production costs. This pattern implies that labor and intermediate goods are gross complements, with an estimated EoS of around 0.79. Second, buyer firms maintain stable spending patterns across their suppliers on average, implying that intermediate good production approximates Cobb-Douglas on average, with an estimated EoS of around 1.06. Third, firms that sell to host regions increase their sales, which implies that intermediate goods are more substitutable with each other than with labor, a finding that reinforces the first two empirical results. These results remain similar in a series of robustness checks of the identification strategy, and the over-identification tests fail to reject the model.

Having established the existence of trade spillovers empirically, I turn to counterfactual analyses to quantify their total effects. I simulate a 1% increase in labor supply for each of Turkey’s 81 provinces separately and calculate the resulting changes in real wages across all regions. For 76 provinces, spillovers are negligible: a 1% increase in local labor supply reduces real wages by approximately 1% in the host region while increasing wages by less than 0.02% in non-host regions. However, immigration to central regions generates substantial spillovers. For instance, a 1% increase in Istanbul’s labor supply reduces local real wages by only 0.56% while increasing real wages in the average non-host region by 0.38%, a spillover effect nearly two-thirds the magnitude of the direct effect. While both population size and economic development correlate with spillover magnitude, I find that a region’s centrality in the production network is the strongest predictor. Greater centrality flattens the labor

demand curve in the host region and shifts it rightward in non-host regions, resulting in smaller wage decreases for natives in host regions and larger wage increases in non-host regions.

I conduct a second counterfactual analysis that holds the absolute number of immigrants fixed across simulations, rather than fixing the immigrant-to-native ratio as in the first exercise. This alternative approach directly addresses a crucial policy question facing governments during refugee crises: how does the spatial allocation of immigrants affect aggregate welfare? My results demonstrate that directing immigrants to economically central regions generates welfare gains that are an order of magnitude larger than placement in non-central regions. When immigrants settle in well-connected regions, their impact on local production costs cascades throughout the economy through trade linkages. The importance of network position extends to skill composition: high-skill immigration generates larger spillovers than low-skill immigration because industries that employ high-skill labor intensively tend to have stronger inter-regional trade connections.

In the final analysis, I quantify the aggregate impact of Syrian immigration to Turkey by simulating a low-skill immigration shock that matches the observed spatial distribution of refugees. Because Syrians predominantly settled in non-central southeastern regions of Turkey, I find that spillover effects have been negligible. The variation in wage effects across regions is almost entirely explained by local immigrant-to-native ratios. While the trade linkages between southeastern host regions and the rest of Turkey are strong enough to estimate the structural parameters with precision, these connections are insufficient to generate economically meaningful spillovers, a finding that underscores the importance of economic centrality in determining the broader impacts of immigration.

This paper contributes to the extensive empirical literature studying the economic effects of immigration (seminal papers include Card (1990, 2001); Borjas (2003); Ottaviano and Peri (2012)).<sup>2</sup> Despite three decades of research, the wage effects of immigration remain debated (Borjas, 2017; Peri and Yasenov, 2019). I advance this literature by demonstrating, both theoretically and empirically, that immigration impacts propagate through supply chains via general equilibrium effects. These spillovers become economically significant when immigrants settle in regions that are central in the domestic trade network. This finding has important implications for identification. Comparing outcomes between host and non-host regions, the standard approach in the immigration literature, may not capture the full effects of immigration. In the Turkish context, such comparisons would have overestimated the wage decline had refugees settled in central nodes. More generally, my model shows that the bias in such research designs can run in either direction, depending on the economy's

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<sup>2</sup>See Hanson (2009); Lewis and Peri (2015); Dustmann et al. (2016) for reviews of the literature.

technological parameters.

This work also contributes to the literature on refugee crises and their economic impacts (Hunt, 1992; Friedberg, 2001; Borjas and Monras, 2017). Recent studies examining refugee crises of the last decade have found stronger displacement effects on native workers compared to traditional immigration studies.<sup>3</sup> My results explain why: refugee settlement patterns differ fundamentally from those of economic migrants. Refugees tend to concentrate in regions near their point of entry, which are often less economically developed, while voluntary immigrants typically gravitate toward major cities (Albert and Monras, 2022). I show that interregional trade acts as a moderating force by flattening the labor demand curve and limiting real wage declines in host regions. This mechanism helps explain the divergent labor market outcomes observed between refugee crises and voluntary immigration episodes.

A related literature examines the interaction between immigration effects and output tradability (Dustmann and Glitz, 2015) and international trade (Caliendo et al., 2021; Brinatti, 2024). Most notably, Burstein et al. (2020) formalize how industry tradability shapes local labor market responses to immigration. I extend their framework by demonstrating that production networks play a crucial role in these adjustments. My analysis shows that beyond industry tradability, the upstream and downstream linkages between industries have first-order effects on local labor market outcomes.

This work also contributes to the growing literature on shock propagation through production networks. Theoretical work by Acemoglu et al. (2012, 2016b, 2017) and Baqaee and Farhi (2019) explores how microeconomic shocks can spread through input-output networks to generate aggregate fluctuations.<sup>4</sup> Empirical studies have documented this propagation for various economic shocks, including trade disruptions (Acemoglu et al., 2016a) and natural disasters (Barrot and Sauvagnat, 2016; Boehm et al., 2019; Carvalho et al., 2021). In the context of immigration, Akgündüz et al. (2024) provide the closest empirical analysis to mine, showing positive spillovers on firms' sales and employment through first-degree trade linkages to regions hosting Syrian refugees in Turkey. I extend their analysis in several important ways: I formalize the mechanisms through which immigrants' effects spillover through the input-output network; I test these mechanisms empirically; I quantify the general equilibrium effects; and I identify the conditions under which such spillovers become economically significant at the aggregate level.

The paper is organized as follows. Section 2 introduces the data and institutional background. Section 3 develops the model and isolates the economic forces by which an immi-

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<sup>3</sup>See Gulek (2024) for the Syrian refugee crisis in Turkey and Bahar et al. (2024) for the Venezuelan refugee crisis in Colombia.

<sup>4</sup>See Carvalho (2014); Carvalho and Tahbaz-Salehi (2019) for a review of the literature on production networks.

gration induced wage shock to a region can spread through the production network to other regions. Section 4 presents the empirical results. Section 5 concludes.

## 2 Background and Data

### 2.1 Syrian Refugee Crisis in Turkey

The Syrian Civil War started in March 2011. By 2017, 6 million Syrians had sought refuge outside of Syria, primarily in the neighboring countries Turkey, Lebanon, Jordan, and Iraq. With 3.6 million registered Syrian refugees, Turkey hosts the highest number of refugees in the world. Figure 1a shows how the number of Syrian refugees in Turkey has evolved over time. It remained small until the end of 2012 but increased substantially after. Turkey hosted around 170 thousand refugees by 2012, 500 thousand by 2013, 1.6 million by 2014, 2.5 million by 2015, and around 3.6 million by 2019.

The Turkish government initially tried to host the Syrians in refugee camps in the south-eastern part of the country across the Turkish-Syrian border. However, the camps quickly exceeded capacity as the number of arriving refugees increased. The refugees thus dispersed across Turkey in heterogeneous quantities.<sup>5</sup> Figure 1c shows the distribution of the number of Syrian refugees per 100 natives in Turkey at the province level. Refugees are more densely located in regions closer to the border. Distance to the populous governorates in Syria strongly predicts the number of refugees per native in a given region, which constitutes the backbone of the identification strategy.

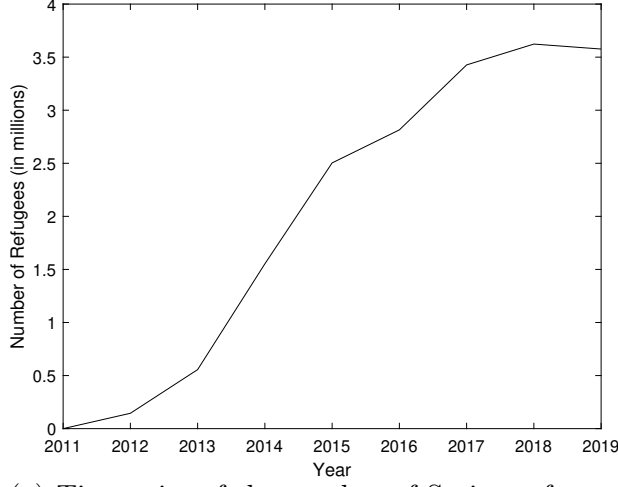
Syrian refugees are less educated than Turkish natives. Figure 1b compares the education levels of Syrian refugees in Turkey with those of Turkish natives. For example, 21% of Syrian refugees did not complete primary school, compared to 12% of Turkish natives. Additionally, 83% of Syrian refugees do not have a high school diploma, in contrast to 61% of Turkish natives. Given the potential for educational downgrading (Dustmann et al., 2013) and that most Syrian refugees have only basic proficiency in Turkish (Turkish Red Crescent and WFP, 2019), the influx of Syrian refugees can be interpreted as a low-skill labor supply shock to the Turkish labor markets.

Most Syrians in Turkey do not have formal labor market access, which further limits the types of firms and industries they can work at. As of March 2019, only 31,000 Syrian refugees (1.5% of the working-age Syrians) had work permits. This feature of the immigration shock does not limit the generalizability of the present paper’s findings. Gulek (2024) shows that informal and formal labor in Turkey are highly substitutable in production. This implies

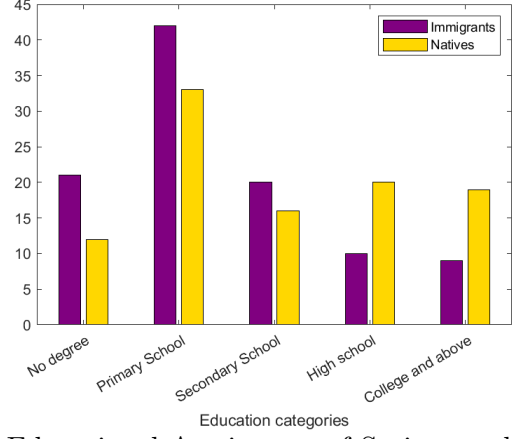
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<sup>5</sup>By 2017, only 8% of the refugees lived inside the camps.

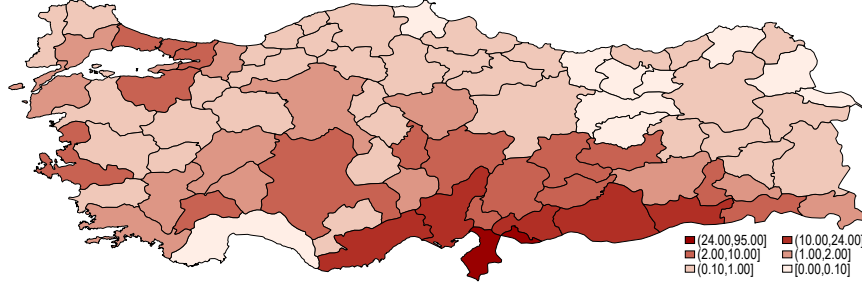
Figure 1: Statistics on the Syrian Refugees in Turkey



(a) Timeseries of the number of Syrian refugees in Turkey



(b) Educational Attainment of Syrians and Natives



(c) Share of Syrian refugees in Turkish population (in%) in 2019

Source: Data on the number of Syrian refugees in a given year and province comes from Directorate Generale of Migration Management of Turkey. Data on the educational attainment of refugees come from surveys on ESSN recipients. Data on natives' educational attainments come from the household labor force surveys conducted by Turkstat.

that the informal immigration shock lowers wages in both the informal and formal sectors.

## 2.2 Data

Studying the network spillovers of immigration shocks requires a comprehensive dataset covering who firms trade with, how much they spend for labor and intermediates, and how much they sell. To achieve this, I integrate five datasets covering all formal firms in Turkey between 2006–2019. The Ministry of Industry and Technology maintains these datasets with a unique and homogenous firm identifier, which enables me to merge them.

These datasets are as follows. First, the value-added tax (VAT) data report the value of all domestic firm-to-firm trade that exceeds 5,000 Turkish liras (about \$3,333 in 2010) in a

given month. Second, from the income statements, I use the yearly gross sales of each firm. Third, from the firm registry, I extract each firm’s province and two-digit industry code according to the Nomenclature Statistique des Activités Économiques dans la Communauté Européenne (NACE), the standard industry classification in the European Union. Fourth, from the customs data, I collect firms’ annual exports and imports. Fifth, from the employer-employee data, I collect the average number of workers, total labor costs and average wages per worker per each year.

I complement the network data with labor force surveys conducted by the Turkish statistical institute. Unlike the census data, these surveys collect information on workers’ education, which allows me to determine the skill intensity of industries and regions.

Data on the number of refugees in Turkey across years and provinces are acquired from the Directorate General of Migration Management of Turkey (DGMM). DGMM does not share the education and age break-down of refugees at the province level, which prevents the empirical investigation from exploiting that variation.

Appendix Section B provides the details and the summary statistics about the data.

## 3 Theory

This section formalizes how a decrease in wages due to immigration in one region can spillover to other regions through the production network, and develops structural equations that directly map to the reduce-form results.

### 3.1 Setup

The economy consists of  $N$  firms indexed by  $i$ ,  $R$  regions indexed by  $r$ , where each region is endowed with  $L_r$  labor.<sup>6</sup> Each firm operates in one region:  $r_i$  denotes the region of firm  $i$ . Firms use intermediate goods and local labor in production and sell their output as both an intermediate good to other producers in all regions and as a final good to local consumers.

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<sup>6</sup>Labor is assumed to be homogeneous in the baseline model, which I later relax to become a CES aggregate of labor with different skill levels.



## Producers

Firm  $i$  chooses labor  $L_i$  and intermediate goods  $\{x_{i,j}\}_{j=1}^n$  to minimize costs subject to a constant returns nested-CES technology:

$$\begin{aligned} \min_{\{x_{ij}\}_{j=1}^n, L_i} \quad & \sum_{j=1}^n p_j x_{ij} + w_r L_i \quad \text{subject to} \\ & A_i (\eta_i m_i^{\frac{\sigma_u-1}{\sigma_i}} + (1-\eta_i) L_i^{\frac{\sigma_u-1}{\sigma_u}})^{\frac{\sigma_u}{\sigma_u-1}} \geq y_i, \\ & m_i = \left( \sum_{j=1}^n \alpha_{ij} x_{ij}^{\frac{\sigma_l-1}{\sigma_l}} \right)^{\frac{\sigma_l}{\sigma_l-1}}, \end{aligned}$$

where  $A_i$  is a Hicks-neutral productivity shifter,  $y_i$  is total output,  $p_j$  is the price of good  $j$ ,  $L_i$  is labor used by firm  $i$ ,  $w_r$  is the wage in region  $r$ ,  $m_i$  is the intermediate good used by the firm, which itself is a CES bundle of goods from different firms.  $x_{ij}$  denotes how much firm  $i$  uses firm  $j$ 's goods in production, where firm  $j$  can be in any region. We assume common elasticities of substitution in both the upper and lower nests:  $\sigma_u$  denotes the elasticity of substitution between labor and intermediate goods, and  $\sigma_l$  is the elasticity of substitution between different intermediate goods.<sup>7</sup> Constant returns to technology requires  $\sum_j \alpha_{i,j} = 1$ . Let  $C_i$  denote the unit cost of firm  $i$ . I assume that firms have constant and exogenous markup  $\mu_i$ , and therefore set price  $p_i = \mu_i C_i$ .

## Final Demand

All final goods consumption as well as the ownership of firms is local. I assume a representative consumer in each region  $r$ , who optimizes her Cobb-Douglas utility subject to budget constraint that equates her spending on final goods with her labor income plus (regional) firm profits.

$$\max_{\{c_{r,i}\}} \Pi_{i \in r} c_{r,i}^{\beta_i} \quad s.t. \quad \sum_{i \in r} p_i x_{0,i} = w_r L_r + \sum_{i \in r} \pi_i$$

where  $c_{r,i}$  is how much the representative agent  $r$  consumes firm  $i$ 's goods, and  $\sum_{i \in r} \beta_i = 1$ .

## Labor Supply

Labor is inelastically supplied in each region, is immobile across regions and perfectly mobile across firms in a region. This simplifying assumption shuts down spillovers across regions in

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<sup>7</sup>The common elasticity of substitution assumption across firms simplifies the exposition but can be relaxed. The empirical analysis relaxes this assumption by estimating heterogeneity across industries and finds limited heterogeneity.

labor supply.<sup>8</sup>

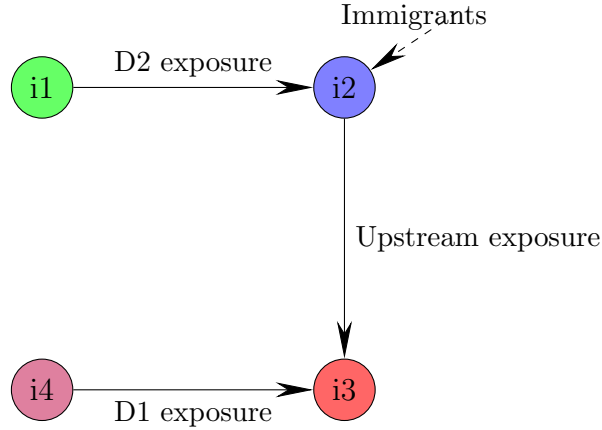
## General Equilibrium

Given exogenous productivities  $A_i$  and markups  $\mu_i$ , equilibrium is a set of prices  $p_i$ , wages  $w_r$ , intermediate good choices  $x_{i,j}$ , labor input choices  $l_i$ , outputs  $y_i$ , and final demands  $c_{r,i}$  such that each producer minimizes its costs subject to technology constraints and charges the relevant markup on its marginal cost, consumers maximize their utility subject to their budget constraint, and the markets for all goods and labor clear.

### 3.2 Three General Equilibrium Forces

The solution to this model is notation heavy and, therefore, hard to follow. To facilitate exposition, we describe the three relevant economic forces here. Figure 2 depicts a simple production network with four firms in four different regions. Firm  $i_1$  sells to  $i_2$ , and both  $i_2$  and  $i_4$  sell to  $i_3$ . Suppose  $i_2$ 's region receives immigrants. This increase in labor supply lowers the wages and therefore the production costs of firm  $i_2$ . As firms have constant markups, a decrease in production costs decreases prices. This creates a chain reaction along the supply chain that propagates both forward and backward.

Figure 2: Spillover Effects of Immigration Along the Input-Output Network



Notes: This figure depicts a simple input-output network where firm  $i_1$  sells to  $i_2$ , and both  $i_2$  and  $i_4$  sell to  $i_3$ . Immigrant arrival to firm  $i_2$  creates a chain reaction that impacts all other firms in this network.

First, firm  $i_3$  benefits from immigration as the price of the input from firm  $i_2$  decreases. As  $i_3$  faces lower input prices, it can increase or decrease its local labor demand depending

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<sup>8</sup>Gulek (2024) shows that changes in in- and out-migration in response to Syrian immigration have been minimal in Turkey.

on the substitutability between intermediates and labor. If labor and intermediates are gross complements, then the reduction in input prices would cause firm  $i_3$  to increase its labor demand. I name this as the “upstream exposure effect” of immigration: upstream because the shock comes from upstream from the recipient  $i_3$ ’s perspective.

Second, the demand for  $i_4$ ’s goods may increase or decrease depending on the substitutability between different intermediate goods. Notice that  $i_2$  and  $i_4$  both supply to  $i_3$ . If intermediate goods are largely substitutable, then as  $i_2$ ’s prices go down compared to  $i_4$ ,  $i_3$  would demand less from  $i_4$ . As the product demand for  $i_4$  shrinks, it reduces its labor demand. In contrast, if intermediate goods are gross complements, the opposite would take place:  $i_3$  would increase its demand of  $i_4$ ’s goods, which would increase  $i_4$ ’s demand for local labor.

Notice that the effects on both  $i_3$  and  $i_4$  are parts of the forward propagation channel of the immigration shock. The difference is that, while  $i_3$  is impacted through its suppliers and therefore is upstream-exposed,  $i_4$  is impacted through its customers and hence is downstream-exposed.

Third, the demand for  $i_1$ ’s goods also changes. Notice that  $i_2$  incurs two effects. First, the price of labor decreases compared to its input from  $i_1$ . More substitutable the two inputs are, less  $i_2$  demands  $i_1$ ’s goods. Second,  $i_1$  incurs a demand shock based on  $i_3$ ’s choice among goods from  $i_2$  and  $i_4$ . More substitutable intermediates are, more  $i_3$  demands from  $i_2$ , which results in  $i_2$  demanding more from  $i_1$ . These two forces oppose each other. As I prove later, the net effect on  $i_1$ ’s sales depends on the relative magnitudes of the two elasticities. If intermediate goods are more substitutable among each other than with labor, then  $i_2$  demands more from  $i_1$ , which increases  $i_1$ ’s labor demand. I call this the second downstream exposure effect, which I denote shortly as  $D2$  for the rest of the paper. This captures the backward propagation of the immigration shock.

Figure 2 only depicts the first-degree trade exposures: that is, firms being impacted from their immediate customers and suppliers. However, these forces expand beyond the first-degree linkages. Firms that indirectly buy from immigrant-intensive firms are also upstream exposed. Same applies for downstream exposures. Moreover, in more complicated input-output networks, firms can have U, D1, and D2 exposures simultaneously. To understand exactly how much each firm is upstream and downstream exposed to immigrants, I use the model.

### 3.3 Input-Output definitions

To derive the impact of regional labor supply shocks on labor demand across all regions, I establish input-output notation following Baqaee and Farhi (2019).<sup>9</sup> My results are comparative statics describing how the labor payments in any host and non-host region change when a host region receives immigrants. I now define accounting objects such as input-output matrices, Leontief inverse matrices, and Domar weights. These quantities have a revenue-based version and a cost-based version, and I present both. All these objects are defined at the initial equilibrium. Without loss of generality, I normalize the nominal GDP to 1. Finally, in my analytical results and counterfactuals, I assume constant markups and technology.<sup>10</sup>

#### 3.3.1 Final Expenditure Shares

Let  $b$  denote the  $R \times N$  matrix whose  $(ri)$ th element is equal to the share of good  $i$  in the budget of the final consumer in region  $r$ :

$$b_{ri} = \frac{p_i c_i}{\sum_{j \in r} p_j c_j}.$$

Let  $\chi$  denote the  $R \times 1$  vector of regional income shares,

$$\chi_r = \frac{\sum_{j \in r} p_j c_j}{\sum_{r'=1}^R \sum_{j \in r'} p_j c_j},$$

where the sum of final expenditures  $\sum_{r'=1}^R \sum_{j \in r'} p_j c_j$  is nominal GDP.

#### 3.3.2 Input-Output Matrices

To streamline the exposition, I treat labor as a special endowment producer that does not use any input to produce. I form an  $(N + R) \times 1$  vector of producers, where the first  $N$  elements correspond to the producers and the last  $R$  elements to the labor in each region. For labor, I interchangeably use the notation  $w_r$  or  $p_{N+r}$  to denote its wage and the notation  $L_{ir}$  or  $x_{i(N+r)}$  to denote its use by firm  $i$ . The revenue-based input-output matrix  $\Omega$  is the  $(N + R) \times (N + R)$  matrix whose  $(ij)$ th element is equal to firm  $i$ 's expenditure on inputs from firm  $j$  as a share of its total revenues:

$$\Omega_{ij} = \frac{p_j x_{ij}}{p_i y_i}.$$

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<sup>9</sup>I maintain their notation except where my model's regional labor markets necessitate modifications.

<sup>10</sup>This decision is driven primarily by the lack of data on prices. Otherwise, the model easily incorporates changes in technology and markups. For more details, see Baqaee and Farhi (2019).

The first  $N$  rows and columns of  $\Omega$  correspond to goods, and the last  $R$  rows and columns correspond to labor. Since labor requires no inputs, the last  $R$  rows of  $\Omega$  are zeros.

The cost-based input-output matrix  $\tilde{\Omega}$  is the  $(N + R) \times (N + R)$  matrix whose  $(ij)$ th element is equal to  $i$ 's expenditure on inputs from  $j$  as a share of its total costs:

$$\tilde{\Omega}_{ij} = \frac{p_j x_{ij}}{\sum_{k=1}^{N+R} p_k x_{ik}}.$$

The revenue-based and cost-based input-output matrices are related by

$$\tilde{\Omega} = \text{diag}(\mu)\Omega,$$

where  $\mu$  is the vector of markups, and  $\text{diag}(\mu)$  is the diagonal matrix with  $i$ th diagonal element equal to  $\mu_i$ .

As labor and intermediate goods are the sole two inputs in the upper nest of the CES production function, defining the labor share and intermediate goods share of costs is useful for exposition. I define the share of labor and intermediate good expenditures of firm  $i$  as:

$$\tilde{\Omega}_{i,L} = \frac{w_r L_i}{\sum_{k=1}^N p_k x_{ik} + w_r L_i} \quad ; \quad \tilde{\Omega}_{i,M} = 1 - \tilde{\Omega}_{i,L}.$$

### 3.3.3 Leontief Inverse Matrices

I define the revenue-based and cost-based Leontief inverse matrices as:

$$\Psi = (I - \Omega)^{-1} = I + \Omega + \Omega^2 + \dots, \quad \text{and} \quad \tilde{\Psi} = (I - \tilde{\Omega})^{-1} = I + \tilde{\Omega} + \tilde{\Omega}^2 + \dots$$

While the input-output matrices  $\Omega$  and  $\tilde{\Omega}$  capture the direct exposures of one firm to another, the Leontief inverse matrices  $\Psi$  and  $\tilde{\Psi}$  capture the total exposures, direct and indirect, through the production network.

Note that the revenue-based Leontief inverse matrix  $\Psi$  encodes the backward propagation of demand, whereas the cost-based Leontief inverse matrix  $\tilde{\Psi}$  encodes the forward propagation of costs.

### 3.3.4 Domar Weights

The revenue-based Domar weight  $\lambda_i$  of producer  $i$  is its sales as a fraction of nominal GDP:

$$\lambda_i \equiv \frac{p_i y_i}{nGDP} = p_i y_i.$$

Similarly, the revenue-based Domar weight  $\lambda_r$  for labor in region  $r$  is its total labor payments  $w_r L_r$ .

Before stating the results, I introduce the following input-output covariance operator,

$$Cov_{\tilde{\Omega}^{(j)}}(d \ln p, \Psi_{(k)}) = \sum_i \tilde{\Omega}_{ji} d \ln p_i \Psi_{ik} - \left( \sum_i \tilde{\Omega}_{ji} d \ln p_i \right) \left( \sum_i \tilde{\Omega}_{ji} \Psi_{ik} \right),$$

where  $\tilde{\Omega}^{(j)}$  corresponds to the  $j$ th row of  $\tilde{\Omega}$ ,  $d \ln p$  is the vector of price changes of all inputs, and  $\Psi_{(k)}$  is the  $k$ th column of  $\Psi$ . Because the rows of  $\tilde{\Omega}$  always sum up to 1, one can formally think of this as a covariance. It answers the question: “Among the suppliers of firm  $j$ , are the ones who decrease their prices more rely on firm  $i$  more or less for intermediate goods?” If the answer is more, the covariance term is negative.

### 3.4 Effects of a Labor Supply Shock on Labor Income

To build intuition as to how an immigration shock in a host region can impact the labor payments in any region, I take the change in prices  $d \ln p$  and  $d \ln w$  as given and describe how the demand for labor and for goods change in response to these changes in prices. Note that the labor income in region  $r$  is the sum of labor payments by all firms in that region:

$$\lambda_r = w_r L_r = \sum_{i \in r} \lambda_i \Omega_{i,L}.$$

Hence, the change in labor payments is determined by the change in sales and the change in labor share of sales:

$$d \ln \lambda_r = \sum_{i \in r} \frac{\lambda_i \Omega_{i,L}}{\lambda_r} (d \ln \lambda_i + d \ln \Omega_{i,L}).$$

Therefore, to understand the impact of immigration on labor payments in all regions, I need to determine the impact on firms’ sales share in GDP and labor share in sales. Propositions 1 and 2 characterize these effects.

**Proposition 1.** *In response to an immigration-induced wage shock, the following equation describes the change in the labor share of production costs:*

$$d \ln \tilde{\Omega}_{i,L} = (1 - \sigma_u) (d \ln w_{r_i} - \sum_{j=1}^n \frac{\tilde{\Omega}_{ij}}{\tilde{\Omega}_{iM}} d \ln p_j). \quad (1)$$

All proofs are in the Appendix.

Equation 1 captures the forward propagation of cost shocks, which is the upstream expo-

sure effect I introduced in Figure 2. Firms' labor share is determined by the trade-off firms face between hiring labor and using intermediate goods in production. Suppose the local wages decrease less than the prices of the suppliers of firm  $i$ . If labor and intermediate goods are gross complements,  $\sigma_u < 1$ , then the firm would increase its labor share in production.

**Proposition 2.** *In response to an immigration-induced wage shock, the following equation describes the change in the Domar weights / sales share of firms:*

$$\begin{aligned}
d \ln \lambda_i = & \sum_{j=1}^n (1 - \sigma_l) \frac{\lambda_j}{\lambda_i \mu_j} \text{Cov}_{\tilde{\Omega}(j)} (d \ln p, \Psi_{(i)}) \\
& + (\sigma_u - \sigma_l) \sum_{j=1}^n \frac{\lambda_j}{\lambda_i} \tilde{\Omega}_{j,l} \left( d \ln w_{r_j} - \sum_{k=1}^n \frac{\tilde{\Omega}_{j,k}}{\tilde{\Omega}_{j,M}} d \ln p_k \right) (\Psi_{ji} - I_{ji}) \\
& + \eta_i,
\end{aligned} \tag{2}$$

where  $I$  is the identity matrix, and  $\eta_i = \frac{1}{\lambda_i} \sum_j \sum_r b_{rj} \Psi_{ji} \chi_r \left( \left( \sum_{i \in r} \frac{\pi_i}{\chi_r} d \ln \lambda_i \right) + \frac{\lambda_r}{\chi_r} d \ln \lambda_r \right)$  captures the demand spillovers of immigrants' demanding locally produced goods.

The first term captures the first downstream exposure effect: demand spillovers from firms substituting across intermediates. The immigration shock propagates forward and lowers costs throughout the supply chain. When different intermediate goods are largely substitutable,  $\sigma_l > 1$ , those who observe larger decreases in costs gain market share and demand more goods from their suppliers. This is captured by the covariance term, which is negative when those that observe larger decreases in costs among the suppliers of firm  $j$  are also more dependent on firm  $i$  for production. Summing across all firms in the economy and their suppliers determines the total demand spillover from substitution among intermediates.

The second term captures the second downstream exposure effect: the demand spillovers from firms substituting between intermediate goods and labor. Assume  $\sigma_l > \sigma_u$ , that is, intermediate goods are more substitutable within each other than with labor. In this case, if firm  $j$  observes larger decreases in local wages than the prices of its intermediate goods,  $\left( d \ln w_{r_j} - \sum_{k=1}^n \frac{\tilde{\Omega}_{j,k}}{\tilde{\Omega}_{j,M}} d \ln p_k \right) < 0$ , then it will spend a larger share of its production costs on intermediate goods. This, in turn, increases the demand for firm  $i$  to the extent that firm  $j$  relies on firm  $i$ 's goods, which is captured by  $\Psi_{ji}$ . Summing over all such firms determines the total demand spillover from substitution between intermediates and labor.

The third term captures the demand spillovers from changing income shares of the regions due to immigration. Immigrants increase the consumer base in the host regions. Firms that sell goods to these host regions directly or indirectly also observe an increase in their

demand.<sup>11</sup>

Given the intuition developed in Propositions 1 and 2, I now move on to fully characterizing the change in equilibrium prices and quantities with respect to an immigration shock  $d \ln L$ . Proposition 3 characterizes the change in prices of firm  $i$  as a function of changes in wages.

**Proposition 3.** *In response to an immigration-induced wage shock, the following equation describes the change in prices charged by firms:*

$$d \ln p_i = \sum_{j=1}^n \tilde{\Psi}_{ij} \tilde{\Omega}_{jL} d \ln w_{r_j}. \quad (3)$$

Proposition 3 shows an intuitive result. As firms have constant markups, any change in their production costs are fully represented in their prices.  $\tilde{\Psi}_{ij}$  captures how much firm  $i$  depends on goods of firm  $j$  for production.  $\tilde{\Omega}_{jL} d \ln w_{r_j}$  captures the change in production costs of firm  $j$  from the change in local wages. Multiplying the two terms and summing across all firm  $j$ 's give us how much the production cost, and hence the price, of firm  $i$  changes in response to changes in wages.

Lastly, note that the share of labor in GDP is simply the wage multiplied by the quantity of labor in that region:  $\lambda_r = L_r w_r$ . Combining this with Propositions 1, 2, 3, I can fully characterize the impact of immigration on this economy.

**Theorem 1.** *The following linear system fully describes the change in equilibrium prices*

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<sup>11</sup>In practice, immigrants and natives can demand different type of goods. Unfortunately, the lack of data on the consumption basket of Syrian immigrants in Turkey prevents me from exploring this dimension in detail without strong assumptions. Hence, in the empirical section I assume that this force enters the error term and is not correlated with the instrument.



and quantities in response to an immigration shock  $d \ln L$ :

$$\begin{aligned}
d \ln \lambda_r &= \sum_{i \in r} \frac{\lambda_i \Omega_{iL}}{\lambda_r} (d \ln \lambda_i + d \ln \Omega_{iL}), \\
d \ln \Omega_{i,L} &= (1 - \sigma_u) (d \ln w_{r_i} - \sum_{j=1}^n \frac{\tilde{\Omega}_{ij}}{\tilde{\Omega}_{iM}} d \ln p_j), \\
d \ln \lambda_i &= (1 - \sigma_l) \sum_{j=1}^n \frac{\lambda_j}{\lambda_i \mu_j} \text{Cov}_{\tilde{\Omega}(j)} (d \ln p, \Psi_{(i)}) , \\
&\quad + (\sigma_u - \sigma_l) \sum_{j=1}^n \frac{\lambda_j}{\lambda_i} \tilde{\Omega}_{j,L} \left( d \ln w_{r_j} - \sum_{k=1}^n \frac{\tilde{\Omega}_{j,k}}{\tilde{\Omega}_{j,M}} d \ln p_k \right) (\Psi_{ji} - I_{ji}), \\
&\quad + \frac{1}{\lambda_i} \sum_j \sum_r b_{rj} \Psi_{ji} \chi_r d \ln \chi_r, \\
d \ln \chi_r &= \left( \sum_{i \in r} \frac{\pi_i}{\chi_r} d \ln \lambda_i \right) + \frac{\lambda_r}{\chi_r} d \ln \lambda_r, \\
d \ln p_i &= \sum_{j=1}^n \tilde{\Psi}_{ij} \tilde{\Omega}_{jL} d \ln w_{r_j}, \\
d \ln w_r &= d \ln \lambda_r - d \ln L_r.
\end{aligned} \tag{4}$$

Equation 4 presents the economic forces I have described in one system of linear equations. Notice that I observe all the parameters in this equation in the pre-shock data except for the elasticity parameters  $\sigma_u$  and  $\sigma_l$ . Therefore, estimating these two elasticities using the immigration shock is sufficient to quantify the total impact of immigration on all host and non-host regions in this model.

This model traces how immigration shocks propagate through supply chains to affect firm-level labor demand and sales throughout the economy, but three important limitations warrant discussion.

First, I assume that labor does not move across regions to isolate trade spillovers. While native migration can help equilibrate regional labor markets in practice (Monras, 2020), the Turkish context supports this assumption: Syrian immigration induced no significant changes in native migration patterns (Gulek, 2024), as shown in the Appendix Figure C.5.

Second, Theorem 1 does not yield a simple sufficient statistic to predict the magnitudes of spillover, making it difficult to intuitively characterize when general equilibrium effects differ substantially from partial equilibrium predictions. I address this limitation through counterfactual analyses in Section 4.5.

Third, the model abstracts from firms' capacity to form new trading relationships. Immigration-

induced wage reductions in host regions could plausibly prompt firms without existing trade ties to these regions to establish new buyer-supplier relationships. While analyzing labor market impacts under endogenous network formation lies beyond this paper’s scope, I address this limitation empirically. The key insight is that most new trade formation occurs within regions or with outside-region firms already maintaining first-degree linkages to the host region. Consider a firm in Ankara (non-host region) with a supplier in Gaziantep (host region): if this supplier exhibits low labor intensity and thus gains little from reduced wages, the buyer firm will more likely source from a new, more labor-intensive supplier within Gaziantep than establish connections in an entirely different region. This logic suggests that region-industry linkages carry more predictive power than firm-to-firm linkages. I exploit this intuition to construct firm-level [U,D1,D2] exposures based on firms’ connections to region-industry cells, with details provided in Appendix Section B.1. For both theoretical clarity and computational tractability, the counterfactual analyses assume representative firms at the region-industry level.

## 4 Empirical Analysis

This section presents evidence on how immigration-induced trade spillovers affect manufacturing firms in non-host regions. I use Propositions 1 and 2 to define three treatments from trade exposure. The causal effects of these three treatments on firms’ labor demand and sales identify the structural elasticity parameters: the elasticity of substitution between labor and intermediates, and the elasticity of substitution between different intermediates. These parameters then allow me to quantify the total equilibrium effects of immigration across all regions.

### 4.1 Treatment Definitions

The model isolates three economic forces that shape immigration’s equilibrium effects: forward cost propagation and two types of demand spillovers. I formalize these as upstream exposure ( $U$ ) and two downstream exposure effects ( $D1$ ) and ( $D2$ ).

**Upstream exposure** captures how immigration reduces costs for firms that buy from host regions. A firm’s upstream exposure at time  $t$  is:

$$U_{it} = \sum_{r=1}^R \tilde{\Psi}_{i,r} \delta_{rt}, \quad (5)$$

where  $\delta_{rt}$  captures Syrian immigration to region  $r$ , and  $\tilde{\Psi}_{i,r}$  measures firm  $i$ ’s cost exposure

to region  $r$ . This exposure increases with the firm’s direct and indirect purchases from region  $r$  and with the labor intensity of its suppliers, since more labor-intensive suppliers experience larger production cost reductions from immigration.

**First downstream exposure** measures how substitution between intermediates creates demand spillovers:

$$D1_{it} = \sum_{j=1}^n \frac{\lambda_j}{\lambda_i \mu_j} Cov_{\tilde{\Omega}(j)} \left( \sum_{r=1}^R \tilde{\Psi}_{(r)} \delta_{rt}, \Psi_{(i)} \right). \quad (6)$$

This expression captures how much firm  $i$ ’s customers observe cost advantages from immigration compared to other suppliers in the economy. The measure reflects whether firm  $i$  gains or loses business as immigration reshuffles demand across different intermediate goods.

**Second downstream exposure** captures how substitution between labor and intermediates affects suppliers’ input demands:

$$D2_{it} = \sum_{j=1}^n \frac{\lambda_j}{\lambda_i} \tilde{\Omega}_{j,l} \left( \delta_{r_j,t} - \sum_{k=1}^n \frac{\tilde{\Omega}_{j,k}}{\tilde{\Omega}_{j,m}} \left( \sum_{r=1}^R \tilde{\Psi}_{k,r} \delta_{rt} \right) \right) (\Psi_{ji} - I_{ji}). \quad (7)$$

summarizes how much firm  $i$ ’s customers represented by  $\Psi_{ji}$  observe *relative* cost declines from their own region’s wages, which is measured by  $\delta_{r_j,t}$ , compared to the immigration shock through their suppliers, which is measured by  $\sum_{k=1}^n \frac{\tilde{\Omega}_{j,k}}{\tilde{\Omega}_{j,m}} (\sum_{r=1}^R \tilde{\Psi}_{k,r} \delta_{rt})$ .

Computing these treatment variables requires substantial computational resources due to the need to invert large matrices. The baseline sample includes approximately 230,000 firms, generating trade matrices with 53 billion elements. While the trade matrices  $\tilde{\Omega}$  and  $\Omega$  remain sparse and computationally manageable, their Leontief inverses  $\tilde{\Psi}$  and  $\Psi$  are dense and memory-intensive. To overcome this computational constraint, I provided a 512 GB RAM workstation to Turkey’s Ministry of Industry and Technology, which houses the confidential datasets. Appendix Section B.1 provides detailed documentation of the matrix construction and treatment variable calculations.

## 4.2 Identification Strategy

There are three threats to identification. First, trade exposures depend on regional immigration intensities ( $\delta_{rt}$ ), which may be endogenous if immigrants select regions with positive labor demand shocks. Second, trade exposures depend on input-output matrices ( $\Omega$  and  $\tilde{\Omega}$ ), creating potential bias if firms with different trade exposures follow different trajectories. Third, Turkey has a large informal sector: 40% of employment and an unknown share of sales remain unregistered and therefore absent from census data. This mismeasurement affects both outcome and treatment variables—the latter non-linearly—potentially biasing

estimates in either direction.

I address these three challenges through a corresponding three-step approach. I use shift-share instrumental variables (SSIV) to tackle the endogeneity problem, combine this with Synthetic Controls (SC) to address the differential trajectories problem, and focus on large firms who are substantially more formal to mitigate the informality problem. I first introduce the instruments, then explain how I utilize the Synthetic Instrumental Variables (SIV) approach of Gulek and Vives-i Bastida (2024) to combine instrumental variables for immigration patterns with synthetic controls for firm trajectories, before finally explaining why focusing on large firms shields the analysis from bias due to the informal sector.

#### 4.2.1 Instruments

My primary shift-share instrument for immigrant location choices combines inverse travel distances between Turkish regions and Syrian governorates (share) with the total Syrian refugee population in Turkey (shift):

$$Z_{r,t} = \underbrace{\sum_{s=1}^{13} \lambda_s \frac{1}{d_{r,s}}}_{\text{Share}} \times \underbrace{\text{Number of Syrians in Turkey in year } t}_{\text{Shift}}, \quad (8)$$

where  $d_{r,s}$  measures travel distance between region  $r$  and governorate  $s$ , and  $\lambda_s$  weights each governorate.<sup>12</sup> Following Aksu et al. (2022), I weight governorates by their population and proximity to Turkey relative to other neighboring countries. Previous work shows that alternative weighting schemes yield similar results (Gulek, 2024).

$$\lambda_s = \frac{\frac{1}{d_{s,T}}}{\underbrace{\frac{1}{d_{s,T}} + \frac{1}{d_{s,L}} + \frac{1}{d_{s,J}} + \frac{1}{d_{s,I}}}_{\text{Relative distance to Turkey}}} \times \underbrace{\pi_s}_{\text{Pop. share}}, \quad (9)$$

where  $d_{s,c}$   $c \in \{T, L, J, I\}$  is the travel distance between Syrian region  $s$  to Turkey, Lebanon, Jordan, and Iraq respectively; and  $\pi_s$  is the population share in 2011, which I calculate using the 2011 census undertaken by the Central Bureau of Statistics of Syria.

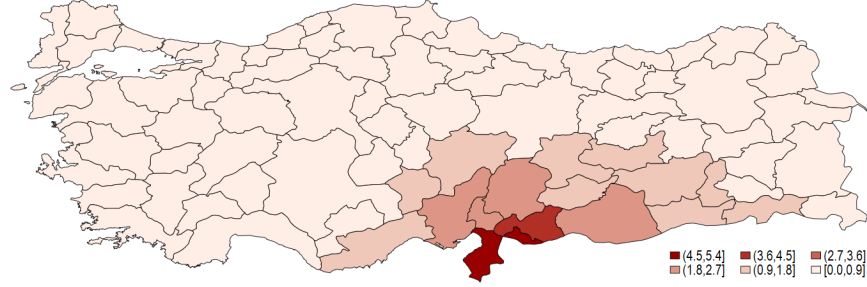
Figure 3a shows the cross-sectional distribution of the distance share component of the instrument. It puts higher weights in southeastern Turkey near northwestern Syria, reflecting the higher Syrian population density around Aleppo (northwest of Syria) compared to Al-Hasakah (northeast of Syria) along the Turkish border. Figure 3b shows the first-stage estimates from a nonparametric event-study design where I regress the immigration treatment

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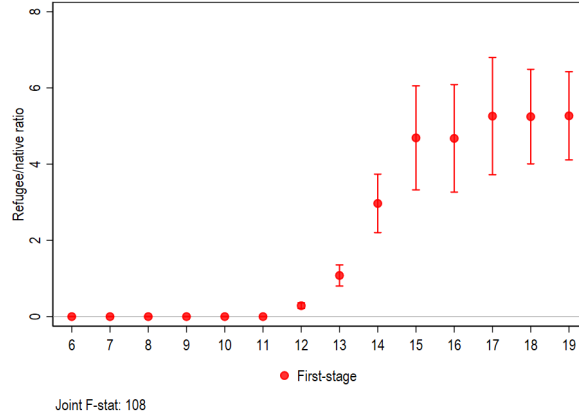
<sup>12</sup>City centers in each region are used to calculate the travel distance. The data is available upon request.

$\delta_{rt}$  on the distance-share  $Z_r$  interacted with year indicators. Estimates between 2006–2011 are zero as there are no Syrian immigrants in Turkey during those years. In the post-period 2012–2019, distance strongly predicts immigrant location choice in all years. The joint F-statistic for the post-period coefficients is 108, which implies that I have a strong instrument.

Figure 3: The Distance instrument



(a) Distance IV heatmap



(b) First-stage

Notes: The heatmap shows the cross-sectional distribution of the distance share  $Z_r$ , where the measure is normalized to have unit variance and to start from 0 for the least exposed region. The event-study figure shows the estimates from a nonparametric event-study regression of the first-stage:  $\delta_{rt} = \sum_{t' \neq 2011} \beta_{t'} \mathbb{1}\{t' = t\} Z_r + \alpha_r + \alpha_t + \epsilon_{rt}$  where we weight each region by its population in 2011. Standard errors are clustered at zero. 95% confidence intervals are plotted.

I validate the main instrument with two alternative shift-share measures. The first one uses the share of Arabic speakers from the 1965 census. Unlike Card (2001)'s past-settlement instrument, the Arabic-speaking population reflects Ottoman Empire demographics rather than previous Syrian migration. The second instrument uses simply a dummy indicator as shares for the regions that receive large weights by either the distance or the language instruments.<sup>13</sup> The dummy share primarily serves as a sanity check as it is arguably easier to

<sup>13</sup>This coincides with the host regions shown in Figure B.1.

interpret reduced-form effects with a dummy indicator. The trade exposure instruments ( $U^z$ ,  $D1^z$ , and  $D2^z$ ) are constructed by replacing the regional immigration  $\delta_{rt}$  with the regional instrument  $Z_{rt}$  in the respective exposure measures. The respective first-stage estimates of these alternative share-exposures can be found in the Appendix Figure C.6.

#### 4.2.2 Synthetic IV Design

Intuitively, I want to compare similar firms that would have followed similar trajectories absent the immigration shock, who happen to be differentially exposed to immigrants through their trading partners. However, as Appendix Section C shows, even within region-industry or region-industry-size cells, firms that are differentially trade-exposed to immigrants follow different trajectories in the pre-period. One contributing factor was stronger employment growth in southeastern Turkey during 2006–2011 (Gulek, 2024), which likely propagated through production networks to firms in non-host regions. This implies that the share-exogeneity assumption embedded in shift-share designs is likely violated (Goldsmith-Pinkham et al., 2020).

To overcome this obstacle, I employ the SIV estimator (Gulek and Vives-i Bastida, 2024), which consists of two steps. First, I find synthetic controls for each firm in the pre-period and generate counterfactual estimates for outcomes, treatments, and instruments. Second, as in standard IV estimation, I use these counterfactual estimates to compute first-stage and reduced-form estimates.

I construct synthetic control weights by matching pre-2011 demeaned values of our two target outcomes: the natural logarithm of labor share and sales. Following Sun et al. (2023), I estimate a single set of weights for both outcomes to improve the signal-to-noise ratio. As Appendix Section O1 demonstrates, this joint estimation outperforms separate weights when predicting unmatched outcomes like payroll and firm size. To identify effects from within-cell variation, I restrict donor pools to firms in the same region and two-digit industry. This approach is equivalent to controlling for region-by-industry-by-time fixed effects in a regression. I incorporate a penalty term following Abadie and L’hour (2021) to mitigate overfitting concerns in our disaggregated setting.

Essentially, I compare firms in the same region and industry cells that *followed similar economic trajectories before the immigration shock* but experienced different exposure to immigrants through their trading network.

## Estimating Equations

Given trade exposure treatments  $U$ ,  $D1$ ,  $D2$ , and their respective instruments  $U^z$ ,  $D1^z$ , and  $D2^z$ , I define the estimating equations following Propositions 1 and 2 as follows. The estimating equations for the labor share and sales are given by:

$$\begin{aligned} \log(\widetilde{LaborShare}_{it}) &= \beta_1 \widetilde{U}_{it} + f_i^L + f_t^L + \nu_{it}^L \\ \widetilde{U}_{it} &= \gamma_1 \widetilde{Z}_{it}^U + g_i^L + g_t^L \omega_{it}^L \end{aligned} \quad (10)$$

$$\begin{aligned} \log(\widetilde{Sales}_{it}) &= \beta_2 \widetilde{D1}_{it} + \beta_3 \widetilde{D2}_{it} + f_i^S + f_t^S + \nu_{it}^S \\ \widetilde{D1}_{it} &= \gamma_2 \widetilde{Z1}_{it}^D + \gamma_3 \widetilde{Z2}_{it}^D + g_i^S + g_t^S + \omega_{1,it}^S \\ \widetilde{D2}_{it} &= \gamma_4 \widetilde{Z1}_{it}^D + \gamma_5 \widetilde{Z2}_{it}^D + h_i^S + h_t^S + \omega_{2,it}^S \end{aligned} \quad (11)$$

Two important considerations guide my specification choices. First, equations 10 and 11 reflect the correct structural relationships for identifying elasticity parameters, which explains the separate treatment of upstream and downstream exposures. Second, the upstream exposure measure  $U$  is estimated with greater precision than downstream exposures  $D1$  and  $D2$ . Including  $U$  in equation 11, while theoretically unnecessary, could capture the causal effects of the noisier downstream measures in a joint estimation. Nevertheless, Appendix Section C demonstrates that our main findings remain robust when estimating upstream and downstream effects simultaneously.

The estimating equations 10 and 11 are theoretically linked through the elasticity of substitution between labor and intermediate goods:

$$\beta_1 = -\frac{(1 - \sigma_U)}{\epsilon^D} \quad ; \quad \beta_2 = \frac{(1 - \sigma_l)}{\epsilon^D} \quad ; \quad \beta_3 = -\frac{(\sigma_l - \sigma_u)}{\epsilon^D}, \quad (12)$$

where  $\epsilon^D$  represents the wage elasticity of labor demand, calibrated to  $-1.27$  based on Gulek (2024). The structural estimation of elasticity parameters from reduced-form estimates is over-identified, with three estimates mapping into two elasticity parameters. This allows me to provide an overidentification test of the model: estimates from both structural equations should be consistent with each other.

To estimate the elasticity parameters efficiently, I use GMM. Let  $\hat{\Sigma}$  be the estimated covariance matrix of the regression parameters  $\beta \equiv [\beta_1, \beta_2, \beta_3]'$ . Let  $\beta(\sigma)$  be a mapping that takes the two structural elasticities given in equation 12. The efficient estimates of  $\sigma_u, \sigma_l$  is the solution to the following optimization problem:

$$\min_{\sigma_u, \sigma_l} (\hat{\beta} - \beta(\sigma))' \hat{\Sigma}^{-1} (\hat{\beta} - \beta(\sigma)). \quad (13)$$

## Event-study Design

The primary advantage of the event-study design is that it allows me to visually and flexibly assess the pattern of outcomes the (debiased) share component of the shift-share instruments capture relative to the beginning of the refugee crisis. The event-study equations of the SIV estimator for labor share are defined as:

$$\widetilde{\log(y_{it}^L)} = \sum_{t' \neq 2011} \beta_{1,t'} \widetilde{U_i^Z} \mathbb{1}\{t = t'\} + f_i^L + f_t^L + \nu_{it}^L \quad (14)$$

and for sales as:

$$\widetilde{\log(y_{it}^S)} = \sum_{t' \neq 2011} \left( \beta_{t'}^{D1} \widetilde{D1_i^Z} + \beta_{t'}^{D2} \widetilde{D2_i^Z} \right) \mathbb{1}\{t = t'\} + f_i^S + f_t^S + \nu_{it}^S \quad (15)$$

where the outcomes and the instrument shares are their *debiased* versions.

### 4.2.3 Focusing on Large Firms to Avoid Bias from Informality

To address bias from informality, I exploit the empirical fact that large firms are less informal, likely due to increased scrutiny from visibility (Ulyssea, 2018). Turkey is no exception. Appendix Figure B.3 shows that informality rates decrease as firms grow larger. While 60% of workers in firms with fewer than 10 employees are informal, less than 5% of workers are informal in firms with more than 50 employees. Firms also face greater regulatory scrutiny after passing the 50 formal employee threshold, which arguably reduces informality in sales reporting. Therefore, in reduced-form analyses, I focus on large firms with at least 50 formal employees in 2010. Appendix Section O1.5 shows robustness of results to including all firms in reduced-form regressions.

## 4.3 Data Cleaning and Final Sample

To ensure that trade exposure effects do not capture direct immigration impacts, I exclude from the estimation sample firms in regions where the immigrant share exceeds 4% of the native population or where the instrument assigns large weights. Appendix Figure B.1 illustrates the excluded regions.

Implementing SIV requires a balanced panel of firms. Therefore, I restrict the sample to firms with non-missing observations in employment, wage bill, and sales between 2006–2019. I also focus exclusively on manufacturing firms in the empirical analysis. There are 19,155 such firms, 1,224 of which had 50+ employees in 2010. In the “large firm” sample, the



average firm has 218 employees and a labor share of costs around 16%. Summary statistics are reported in Appendix Table B.1.

## 4.4 Empirical Estimates

### 4.4.1 Effects of Upstream and Downstream Exposures

I begin by estimating the reduced-form effects of upstream exposure on firms' labor demand. Figure 4 plots the results for three outcomes: number of employees (Panel A), total payroll (Panel B), and labor share (Panel C). Panel D shows the effects of downstream exposures on sales.

Figure 4a reveals two main patterns. First, there are no statistically or economically significant pre-trends. This is not mechanical since SIV weights are generated to match trends in labor share and sales, not payroll or firm size. The absence of pre-trends in Figure 4a, despite the raw IV design showing pre-trends (as demonstrated in Online Appendix Section O1.1), provides strong evidence for the identification strategy. It shows that an unobserved common factor generates differential trends between more- and less-exposed firms, and that SIV successfully partials out this confounder.

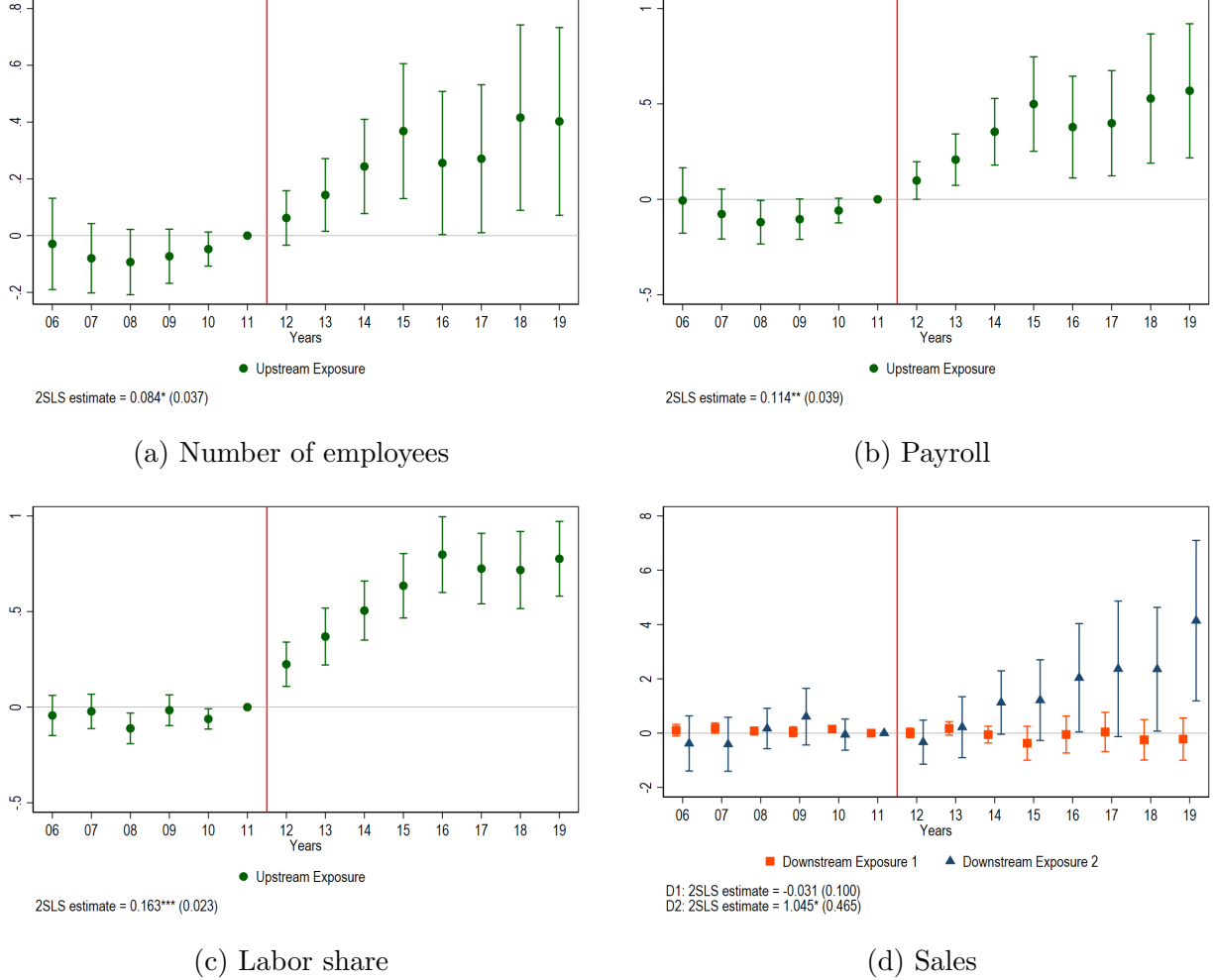
Second, upstream exposure causes firms to expand employment. Firms in non-host regions who directly or indirectly buy from immigrant-intensive firms in host regions hire more workers. The estimated effects grow over time, paralleling the pattern in the first-stage results, a similarity that strengthens the causal interpretation of these findings.

Interpreting coefficients from this reduced-form design requires careful consideration of how general equilibrium exposures propagate. Consider a simple example with two firms,  $i_1$  and  $i_2$ , where each spends half its costs on labor and half on one intermediate good, buys from different suppliers ( $j_1$  and  $j_2$  respectively), and has suppliers that also allocate half their costs to labor. If firm  $j_1$  has two standard deviations higher immigrant exposure through distance than firm  $j_2$ , this creates a 0.5 unit difference in upstream exposure between their customers  $i_1$  and  $i_2$ . The 0.22 coefficient estimated for 2019 in Panel A thus implies that firm  $i_1$  increases its size by 11% relative to firm  $i_2$ .

Figure 4b presents the effects of upstream exposure on payroll. The effects parallel those for employment: no significant pre-trends and a positive, increasing difference between more- and less-exposed firms. The estimated effects on payroll modestly exceed those on employment, indicating that upstream exposure weakly increases wages, although this wage effect is not statistically significant.

Figure 4c shows the effects of upstream exposure on firms' labor share. The absence of pre-trends during 2006–2011 demonstrates good pre-treatment fit in the training period, a

Figure 4: Effects of Trade Exposures on Firms' Labor Demand and Sales



Notes: In Panels A, B, and C, the estimates come from the regression equation  $\widetilde{y}_{it} = \sum_{t' \neq 2011} \gamma_{1,t'} \widetilde{U}_i^Z \mathbb{1}\{t = t'\} + f_i + f_t + \nu_{it}$ , where the outcome variable is the natural logarithm of the number of workers in Panel A, of total payroll in Panel B, and of labor share in Panel C. In Panel D, the estimates come from the regression equation:  $\widetilde{y}_{it} = \sum_{t' \neq 2011} \left( \gamma_{2,t'} \widetilde{D1}_i^Z + \gamma_{3,t'} \widetilde{D2}_i^Z \right) \mathbb{1}\{t = t'\} + f_i + f_t + \nu_{it}$ . Both the outcome and the treatment are their debiased versions following the SIV algorithm. Sample is restricted to manufacturing firms with at least 50 employees in 2010. Standard errors are clustered at the firm level. 95% confidence intervals are plotted.

crucial condition for SIV validity since labor share is included in the matching step. Starting in 2012, upstream-exposed firms show significant increases in labor share: firms in non-host regions that directly or indirectly buy from host regions increase their labor share relative to similar firms in their region-industry cells. The 2SLS estimate, reported in the figure, is highly statistically significant. This result implies that labor and intermediate goods are gross complements.

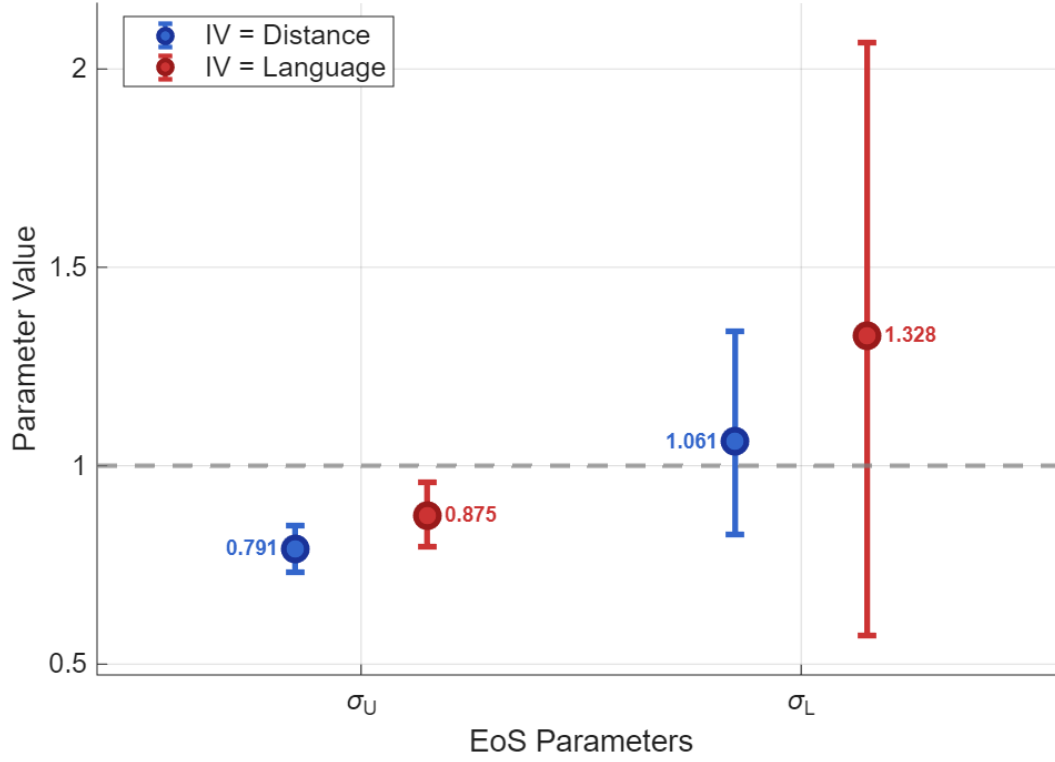
Figure 4d shows the effects of downstream exposure on firms' sales. I observe no significant pre-trend between 2006–2011. In the post-period, while I document precise null effects of  $D1$  exposure on sales (p-value: 0.76),  $D2$  exposure significantly increases firms' sales (p-value: 0.025). This pattern yields two key insights. First, consider a firm with suppliers from both host and non-host regions. The null  $D1$  effect implies that this firm maintains fixed spending across suppliers and, therefore, does not substitute across them. This pattern is consistent with intermediate good production being Cobb-Douglas (elasticity of substitution around 1). Second, the positive  $D2$  effect implies that firms selling directly or indirectly to host regions increase their sales, which occurs only if intermediate goods are more substitutable with each other than with labor. This result is consistent with the positive upstream exposure effect on labor share (implying labor and intermediate goods are gross complements) and the null  $D1$  exposure effect on sales (implying intermediate goods approximate Cobb-Douglas). These mutually consistent estimates provide an intuitive, albeit informal, test of the model.

To estimate the structural elasticity parameters efficiently and provide a formal test of the model, I bootstrap equations 10 and 11 using 1,000 draws with replacement to obtain the covariance matrix of regression parameters  $[\beta_1, \beta_2, \beta_3]$ . Then, I solve equation 13 to obtain GMM estimates of structural elasticity parameters. Figure 5 shows the results. Using the distance instrument, I estimate that labor and intermediates are gross complements, with an elasticity of substitution around 0.79, and intermediate goods very close to Cobb-Douglas, with an estimated elasticity of substitution around 1.09. I can statistically conclude that labor and intermediates are gross complements since the estimated elasticity is statistically less than 1, and I cannot statistically reject the hypothesis that intermediate goods are Cobb-Douglas.

These conclusions remain robust when using the language-based instrument. The language instrument predicts slightly larger substitutability for both technologies, but with lower precision because of weaker first-stage results. I cannot statistically distinguish estimates from distance and language instruments. Furthermore, overidentification tests do not reject the model using either instrument, increasing confidence in the validity of the results.

To summarize, Figure 4 shows that upstream exposure increases firms' labor demand,  $D1$  exposure has a null effect on sales, and  $D2$  exposure increases sales. This means that firms buying from host regions increase their labor demand, firms selling to host regions increase their sales, and firms do not substitute across suppliers on average. Using the preferred distance-based instrument, we estimate the elasticity parameters  $[\sigma_u = 0.79, \sigma_L = 1.09]$ .

Figure 5: Elasticity of Substitution Estimates



This figure shows the 95% confidence intervals of the EoS estimates using two alternative instruments. I draw 1000 bootstrap samples with replacement from the sample of large manufacturing firms. I then run estimate the effects of upstream exposure on labor share and downstream exposures on firms' sales. The joint covariance of the regression parameters from different regressions is calculated by using the bootstrapped distribution of the regression coefficients. 95% confidence intervals are displayed.

#### 4.4.2 Robustness Checks

I perform extensive robustness checks to ensure that estimated effects represent causal impacts rather than differential trends. I report detailed results in the Appendix and summarize key findings here.

#### Alternative Instruments

Results are robust to alternative instruments. Appendix Figure C.7 replicates the results for labor share and sales using travel distance, language share, a dummy indicator for the host regions, and each share interacted with the skill-intensity of industries. The latter exploits the fact that Syrian immigrants are predominantly lower-skilled than Turkish workers and, therefore, overrepresented in low-skill intensive industries. All six weighting schemes yield

identical conclusions: upstream exposure significantly increases labor demand,  $D1$  exposure has a null effect, and  $D2$  exposure increases sales. The only caveat is that the language instrument is less precise, so language- or language-skill-based instruments do not yield statistically significant effects on sales. The results for labor share remain robust, since cost-based measures have much lower variance than sales-based measures.

## Industry Heterogeneity

While the model allows firm-level heterogeneity, I assume constant elasticity of substitution parameters for computational reasons, yielding average estimates across industries. To relax this assumption, I estimate the elasticity parameters separately for each two-digit manufacturing industry, apply Empirical Bayes shrinkage to adjust for small sample bias, and plot results in Figure C.4. Overall, across different specifications, labor and intermediates are gross complements in most industries. Although intermediate goods are Cobb-Douglas in most industries, they are gross substitutes in some (such as textiles and basic metals) and gross complements in others (such as chemicals). Details of industry-level estimation appear in the Appendix Section C.2.

## SIV Validation

Since SIV is a novel estimator that has not yet been used widely, demonstrating its robustness is particularly important. SIV is a synthetic control-based estimator. As common in SC estimation, two key concerns are under-fitting and over-fitting. Under-fitting occurs when no convex combination of donor units can match treated units, while over-fitting occurs when synthetic control weights match noise rather than signal. My estimator does not suffer from these concerns. The absence of pre-trends in targeted outcomes (labor share and sales) demonstrates that more exposed firms are not outliers: I successfully construct synthetic firms with similar trends. Furthermore, the lack of pre-trends in untargeted outcomes (firm size and payroll) provides evidence against over-fitting, since these variables were not used in calculating synthetic control weights.

In addition, I perform several checks to demonstrate the robustness to these concerns. First, I document why employing SC is necessary. Figure OO1.1 compares event-study estimates from IV and SIV designs. IV shows significant pre-trends in most variables. More upstream-exposed firms follow different economic trajectories in employment, labor costs, and labor share between 2006–2011 than less-exposed firms, even when comparing firms within the same region-industry with similar baseline sizes. This demonstrates the need for adjusting for pre-trends to obtain credible estimates.

I continue by showing the importance of matching on labor share and sales jointly rather than separately. The intuition is that with a limited training period, more signal can be obtained by matching on multiple key outcomes. Figure [OO1.2](#) shows that pre-trends in untargeted outcomes (labor costs and employment) remain large and significant when matching separately on labor share and sales.

One advantage of matching separately on labor share and sales is that it improves the pre-treatment fit for each variable as an outcome. when I study the effects on labor share, matching on labor share only results in a better pre-treatment fit than matching on labor-share and sales jointly. Figure [OO1.3](#) shows that my main results remain robust to matching for each outcome separately. This robustness is expected since the main design shows no pre-trends, already providing evidence against under-fitting.

Results also remain robust to back-testing. Figure [OO1.4](#) replicates the analysis when matching on trends during 2006–2009 and 2006–2010 instead of throughout 2006–2011. All results remain robust.

### **Firm Size Sensitivity**

The remaining researcher choice not yet tested is the firm-size restriction. I focus on large firms to address potential concerns regarding informality in both labor costs and sales. The 50-employee threshold was chosen as a legal threshold above which companies face additional liabilities and reporting requirements, making their data more credible. Figure [OO1.5](#) shows estimates of the effects of trade exposures on labor share and sales across firms of different sizes. While upstream exposure effects on labor share are similar across firm sizes, downstream exposure effects on sales (specifically, *D2* exposure effects) are sensitive to the 50+ threshold, above which firms' reporting practices become significantly more trustworthy. Above the 50+ threshold, results are consistent across firms with 60+, 70+, 80+, 90+, or 100+ employees. Online Appendix Section [O1](#) explains how small firm informality can bias *D2* exposure effects.

### **4.4.3 Comprehensive Robustness Tables**

Finally, I present extensive robustness checks where I (i) estimate upstream and downstream exposure effects on each outcome, (ii) estimate trade exposures separately and jointly, (iii) use all manufacturing firms and firms with 50+ employees, and (iv) use alternative instruments. Tables [OA.1](#) through [OA.6](#) show these comprehensive robustness checks, and the Online Appendix Section [O1.5](#) interprets the results in the specifications. Overall, my main results remain robust.

## 4.5 Counterfactuals

This section uses the model to quantify how immigration affects host and non-host regions through counterfactuals. I examine the economic significance of trade spillovers, their dependence on host region and immigrant characteristics, and their implications for the general understanding of immigration’s effects on labor market.

Theorem 1 characterizes immigration’s general equilibrium effects on regional wages and firm prices as a function of the baseline production network and structural elasticity parameters. Having observed the network in the data and estimated the elasticities, I can solve the system of linear equations in Theorem 1 to obtain these general equilibrium effects. For computational feasibility, I use representative firms at the region-industry level. I begin with homogeneous labor within regions as in Section 3, then introduce skill heterogeneity to analyze how the effects vary with immigrant skill levels.

An important consideration is that the model expresses wages relative to nominal GDP, while real wages typically reference local prices. Therefore, I define real wage changes as  $d \ln w_{real} = d \ln w - b * d \ln p$ , where  $b$  denotes the  $R \times N$  matrix of final expenditure shares and  $d \ln p$  is the  $N \times 1$  vector of price changes.

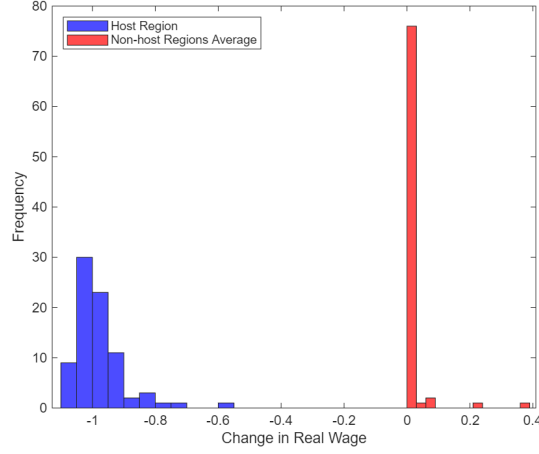
### Counterfactual 1: Spillover Effects of a 1% Labor Supply Shock

In the first counterfactual, I analyze how immigration spillovers vary across potential host regions. I simulate a 1% increase in labor supply separately for each of Turkey’s 81 provinces and calculate two effects: the real wage change in the host province and the average real wage change in the other 80 provinces. This generates 81 pairs of estimates for host and non-host wage effects.

Figure 6a presents the distribution of wage effects, revealing two key patterns. First, a 1% increase in labor supply typically reduces the real wages of the host region by about 1% while leaving non-host regions largely unaffected. In 71 of 81 simulations, average non-host region real wages change by less than 0.01%, and in 76 cases by less than 0.02%. This pattern emerges because most firms predominantly trade within their own region, so host region price changes rarely generate economically meaningful spillovers to non-host regions.

Second, 5 of 81 provinces generate economically meaningful spillovers (greater than 0.04% change in non-host real wages): Bursa, Kocaeli, Izmir, Ankara, and Istanbul. Istanbul and Ankara produce particularly large spillovers, up to two-thirds the magnitude of direct effects. A 1% labor supply increase in Istanbul reduces local real wages by 0.56% while raising the average non-host region’s real wages by 0.38%. Similarly, in Ankara, a 1% shock decreases local real wages by 0.71% and increases average non-host wages by 0.22%. Figure

Figure 6: Real Wage Changes in Host and Average Non-host Region



(a) Histogram of Host and Average Non-host Region effects



(b) Heatmap of Non-host Region effects

Notes: This figure shows the results from 81 counterfactuals, one for each province in Turkey. Each counterfactual consists of a 1% increase in labor supply in the host province. The “non-host mean” refers to the simple average of real wage changes across the 80 non-host regions. Real wages are calculated by the difference between the change in nominal wages and the change in the regional price index.

6b maps these spillover effects across regions. While the largest spillovers come from the most populated cities (Istanbul and Ankara), significant effects also emerge from major agricultural hubs (Manisa and Adana) and resource centers (Zonguldak with its coal deposits).

What explains this variation in regional spillovers? Population offers one explanation: a 1% labor force increase in Istanbul represents seven times the absolute immigration shock of a similar percentage increase in Gaziantep, a major host region. However, population alone cannot explain the pattern. Kocaeli, despite its smaller population than major host regions like Gaziantep, Sanliurfa, and Adana, generates larger spillovers than all three combined. Similarly, while Domar weights correlate with spillover magnitude, they don’t tell the complete story. Consider Adana and Antalya: despite similar populations and Domar weights,



Adana’s spillovers are triple those of Antalya. This difference likely stems from their economic structures: Adana’s role as an agricultural hub involves extensive inter-regional trade, while Antalya’s tourism-focused economy generates mainly local transactions. This suggests that a region’s position in the domestic trade network might better predict spillover effects.

I formally investigate this network position hypothesis using Bonacich centrality measures for both cost-based and sales-based trade matrices:  $\tilde{B} = \tilde{\Psi}'\mathbf{1}$  and  $B = \Psi'\mathbf{1}$ .<sup>14</sup> These measures capture how much other regions depend on a given region  $r$  through costs ( $\tilde{B}_r$ ) and sales ( $B_r$ ). To assess which regional characteristics best predict spillover effects, I regress average non-host wage effects on the host region’s population, Domar weight, and both centrality measures. Table 1 presents these results. In Column 1, a one standard deviation increase in population (normalized to mean zero and unit variance) corresponds to a 4.6% larger change in non-host real wages. Columns 2-4 show similar univariate regressions for Domar weight and both centrality measures, while Column 5 includes all four predictors simultaneously.

Several patterns emerge from these results. While all four variables strongly predict spillover magnitudes (minimum R-squared of 0.88 across 81 observations), centrality measures outperform both population and Domar weights. The sales-based centrality measure proves especially powerful, achieving an R-squared of 0.93. Moreover, sales-based centrality maintains its positive correlation with spillovers even after controlling for population, Domar weight, and cost-based centrality.

These results shed new light on why studies on the effects of immigration on the labor market often reach conflicting conclusions (Dustmann et al., 2016). The standard spatial difference-in-differences (DiD) approach compares host regions to others (Altonji and Card, 1991; Card, 2001). In his seminal paper, Card (1990) examined the Mariel Boatlift’s impact on Miami’s labor markets by comparing Miami to Atlanta, Houston, Los Angeles, and Tampa; and found null effects. This DiD approach relies on the stable unit treatment value assumption (SUTVA): immigration to “treated” (host) regions does not affect “control” (non-host) regions. My results show that SUTVA fails when immigrants arrive at central nodes of the trade network.<sup>15</sup> For example, when Istanbul receives a 1% labor supply increase, “control” region real wages rise by 0.30-0.46% while Istanbul’s fall by 0.56%. A DiD comparison would therefore substantially overestimate immigration’s negative wage impact in Istanbul.

While this potential overestimation does not explain Card’s finding that Cuban migrants did not reduce Miami natives’ wages and employment, my results suggest two alternative

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<sup>14</sup>For more on the Bonacich centrality measure, see Bonacich (1987) and Jackson (2008).

<sup>15</sup>Note that the idea of spatial spillovers of immigration shocks violating SUTVA is not new in the immigration literature. Similar concerns were initially raised by Borjas et al. (1997); Borjas (2003), but the focus was more on natives’ ability to move from host to non-host regions in response to immigration.

Table 1: Provincial Attributes and Spillovers from a 1% increase in Labor Supply

|  | (1)                   | (2)                   | (3)                   | (4)                   | (5)                   |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
|  | $\Delta W_{Non-host}$ | $\Delta W_{Non-host}$ | $\Delta W_{Non-host}$ | $\Delta W_{Non-host}$ | $\Delta W_{Non-host}$ |
| Population                             | 0.046***<br>(0.003)   |                       |                       |                       | 0.0069<br>(0.005)     |
| Domar weight                           |                       | 0.046***<br>(0.004)   |                       |                       | -0.078**<br>(0.033)   |
| Cost-Based Centrality: $\tilde{\Psi}1$ |                       |                       | 0.047***<br>(0.004)   |                       | -0.024<br>(0.039)     |
| Sales-Based Centrality: $\Psi1$        |                       |                       |                       | 0.047***<br>(0.004)   | 0.14**<br>(0.064)     |
| N                                      | 81                    | 81                    | 81                    | 81                    | 81                    |
| R-sq                                   | 0.885                 | 0.883                 | 0.918                 | 0.931                 | 0.966                 |

*Note:* All explanatory variables are standardized to have mean zero and standard deviation of 1. Robust standard errors are used. \* 0.1 \*\* 0.05 \*\*\* 0.01

explanations. First, the sign of the bias depends on technology parameters: if labor and intermediates were gross substitutes, or if intermediates were more substitutable, immigration to central nodes could reduce non-host wages, causing DiD to underestimate the impact on the host region. Second, I find that inter-regional trade flattens the host region's labor demand curve. If Miami firms were sufficiently connected to other US regions or countries, Cuban immigration's effects may have diffused across a broad enough area to minimize local wage impacts.

## Counterfactual 2: Does Where Immigrants Live Matter for Welfare?

Several host countries, including Germany, Sweden, Norway, and Finland, actively direct refugees and asylum seekers to specific regions, often to prevent overcrowding. My analysis of varying spillover effects raises a natural question: could there be meaningful welfare gains from concentrating immigrants in cities that are central to the production network?

To investigate this question, I simulate the arrival of 100,000 immigrants in Turkey's 26 major regions.<sup>16</sup> For each simulation, I calculate the changes in prices across the economy

<sup>16</sup>I use the 26 NUTS-2 regions rather than the 81 NUTS-3 regions because the extreme population heterogeneity across provinces (from 120 thousand in Kilis to 14 million in Istanbul) would make equal-sized immigration shocks generate vastly different percentage changes in local populations.

and the aggregate welfare gains. The regional welfare change  $d \ln Y_r$  is given by:

$$d \ln Y_r = d \ln \chi_r - \sum_{i \in N_r} b_i d \ln p_i, \quad (16)$$

where welfare improves when either the region's share of total GDP ( $\chi_r$ ) increases or the prices of goods in its consumption basket decrease. I aggregate these regional welfare changes into a national measure using population-weighted averages.

Figure 7 maps the welfare effects of placing 100,000 immigrants (a 0.12% population increase) across different Turkish regions. While immigration increases welfare in all simulations, the magnitude varies dramatically by location. In 21 of 26 cases, welfare gains are modest: ranging from 0.02% to 0.09%. However, when immigrants settle in Izmir, Istanbul, or Ankara, welfare gains range from 0.19% to 0.42%, up to 21 times larger than the smallest effect. These cities generate larger welfare gains because they are central nodes in the trade network. Their firms' extensive buying and selling relationships across regions allow immigration-induced cost reductions to benefit more regions, which amplifies total welfare gains.

Figure 7: Heatmap of Total Welfare Effects of Immigration across Host Regions



Notes: This figure shows the results from 26 counterfactuals, one for each NUTS-2 region in Turkey. Each counterfactual consists of an arrival of 100,000 immigrants to the host region. The change in total welfare is calculated by taking a weighted average of the change in regional welfare, where the weights are the share of the population living in that region.

### Counterfactual 3: Does the Skill Composition of Immigrants Impact Spillover Effects?

Immigration shocks often involve skill-specific labor supply changes. Syrian immigrants in Turkey, for example, have lower average education levels than natives and work in less

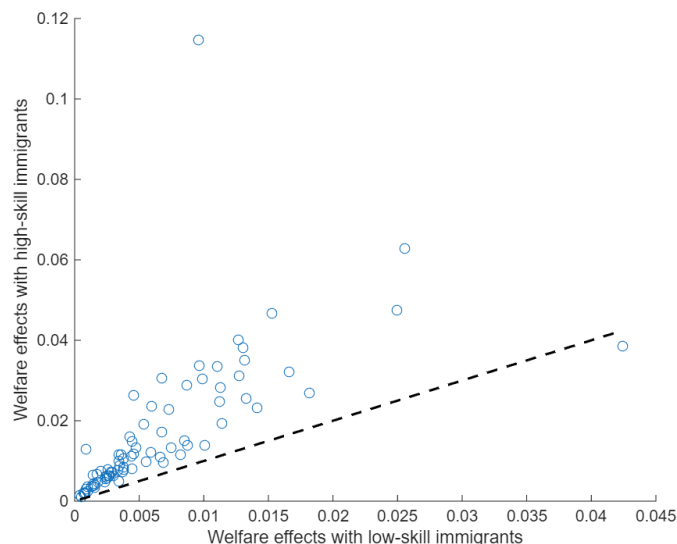
skill-intensive industries like textiles, construction, and agriculture (Turkish Red Crescent and WFP, 2019). When low-skill and high-skill labor are imperfect substitutes, immigrants of different skill levels affect production costs in different industries. The magnitude of spillovers may therefore depend on the extent to which these affected industries trade with other regions.

To analyze skill-specific effects, I extend the baseline model to incorporate both low- and high-skill labor, with details provided in the Appendix Section A.3. One important caveat is that I must assume the elasticity of substitution between low- and high-skill workers ( $\sigma_S = 1$ ) because the employer-employee matched data do not show workers' education.

To examine how spillovers vary with immigrant skill levels, I conduct paired counterfactuals for each of Turkey's 81 provinces. For each province, I simulate two scenarios: one with 10,000 low-skill immigrants and another with 10,000 high-skill immigrants, then compare the resulting welfare effects.

Figure 8 compares the welfare effects of low-skill versus high-skill immigration. Each circle represents one of the 26 NUTS-2 regions, with low-skill immigration effects on the x-axis and high-skill effects on the y-axis. The dashed 45-degree line represents equal welfare effects; points above this line indicate regions where high-skill immigration generates larger welfare gains.

Figure 8: Comparison of welfare effects across low-skill and high-skill immigration



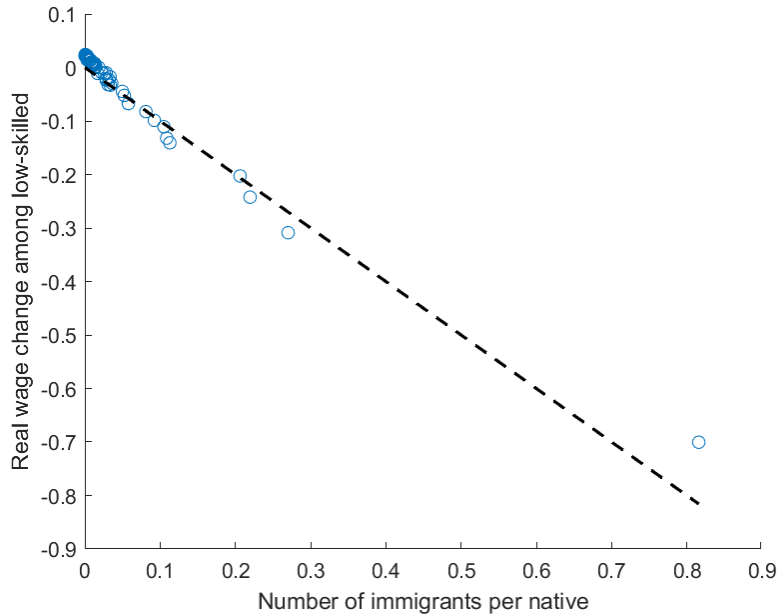
Notes: This figure shows the results from 162 counterfactuals, two for each NUTS-3 region in Turkey. For each region, we calculate the total welfare change when (1) 10,000 low-skill immigrants arrive in the host region and (2) 10,000 high-skill immigrants arrive in the host region. Low-skill is having less than a high school degree, and high-skill is having at least a high school degree.

Figure 8 reveals two key patterns. First, most regions show negligible welfare effects from both low-skill and high-skill immigration. This aligns with the earlier finding that spillover effects, and thus total welfare effects, are minimal when host regions aren't central nodes in the domestic trade network. In these cases, immigrant skill level matters little because cost reductions remain localized within the region. Second, in central regions where welfare gains are substantial, high-skill immigration generates markedly larger benefits. For instance, 10,000 high-skill immigrants in Bursa increase total welfare by 0.064%, compared to only 0.026% for the same number of low-skill immigrants.

## Model-based Factual: Quantifying the General Equilibrium Effects of Syrian Immigration

The counterfactuals suggest that immigration spillovers are largest when host regions are central in the trade network and immigrants are high-skilled. Since Syrian immigrants are concentrated in less-developed southeastern regions and have lower skill levels than native Turkish workers, one would expect limited general equilibrium effects.

Figure 9: Partial vs General Equilibrium Effects of Syrian Immigration in Turkey



Notes: Provincial distribution of the number of immigrants per native in 2019 is used. The general equilibrium changes in wages and prices are calculated as a solution to the system of linear equations given in the Appendix Section A.3. Each blue circle denotes a Turkish province. The dashed line is the  $-45^\circ$  line.

To test this prediction, I calculate how the low-skilled Syrian immigration affects Turkish

natives' real wages and compare these general equilibrium effects with partial equilibrium predictions. Figure 9 plots this comparison across Turkey's 81 provinces, showing changes in low-skill natives' real wages (y-axis) against the 2019 Syrian-to-native ratio (x-axis). The dashed  $-45^\circ$  line represents what would be observed with only partial equilibrium effects. The actual estimates closely track this line: the correlation between wage changes and immigration intensity is  $-0.99$  (R-squared of  $0.97$ ), indicating that partial equilibrium effects accurately predict general equilibrium outcomes.

This finding validates prior studies of Syrian immigration's labor market effects in Turkey. Both Gulek (2024) and Gulek and Vives-i Bastida (2024) document displacement of low-skill natives by Syrian immigrants. Their results accurately capture these effects because Syrian immigrants settled in regions non-central to Turkey's trade network, where SUTVA violations are minimal.

## 5 Conclusion

This paper demonstrates how immigration-induced wage changes propagate through production networks across regions. I find that immigration can generate substantial spillover effects, particularly when immigrants settle in central nodes of the domestic trade network or work in skill-intensive industries. These findings emphasize the crucial role of regional trade structures in shaping immigration's economic impacts.

This network perspective challenges traditional approaches to studying immigration that ignore interregional spillovers and helps explain conflicting results in previous research. By incorporating production networks into immigration analysis, I provide new insights for both research methodology and policy design.

My findings suggest practical guidance for future research when firm-level network data are unavailable. Immigration to smaller, less developed regions generally produces minimal spillovers, allowing traditional difference-in-differences analyses to capture local effects accurately. This explains why studies of refugee settlement in border regions, such as Syrians in southeastern Turkey (Gulek, 2024) or Venezuelans along the Colombian border (Bahar et al., 2024), yield reliable results. In contrast, economic migration often targets larger and more connected cities. For example, European hubs like Brussels, Frankfurt and Munich, which have the highest foreign-to-native ratios in the EU (Mayors of Europe, 2019), are likely to generate significant spillovers throughout Europe, potentially biasing traditional empirical approaches.

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# A Model Appendix

## A.1 Proofs

Before showing the proofs, I introduce some notation. The trade matrix  $\Omega$  is of size  $(N + R) \times (N + R)$ , where the last  $R$  rows are zeros. I decompose this matrix as follows.

$$\Omega = \left( \begin{array}{c|c} \Omega^p & \Omega^f \\ \hline 0 & 0 \end{array} \right)$$

where  $\Omega^p$  denotes the first  $N \times N$  portion.

Similarly, the Leontief inverse is defined as

$$\Psi = \left( \begin{array}{c|c} \Psi^p & \Psi^p \Omega^f \\ \hline 0 & I \end{array} \right)$$

where  $\Psi^p = (I - \Omega^p)^{-1}$

For ease of notation, I use  $r$  only to refer to regions. For example,  $\Psi_{i,r}$  refers to  $i$ th row and  $(N + r)$ th column, while  $\Psi_{i,j}$  refers to  $i$ th row and  $j$ th column.

*Proof of Proposition 1.* The labor share in production of firm  $i$  is given by

$$\tilde{\Omega}_{i,L} = \frac{(1 - \eta_i)^{\sigma_u} w_r^{1 - \sigma_u}}{(1 - \eta_i)^{\sigma_u} w_r^{1 - \sigma_u} + \eta_i^{\sigma_u} p_{m,i}^{1 - \sigma_u}}$$

where  $p_{m,i}$  is the price of the CES aggregate intermediate good of firm  $i$ . Taking the natural logarithm and differentiating, I get:

$$\begin{aligned} d \ln \tilde{\Omega}_{i,L} &= (1 - \sigma_u) d \ln w_r - (1 - \sigma_u) \left( \tilde{\Omega}_{i,L} d \ln w_r + \tilde{\Omega}_{i,m} d \ln p_{m,i} \right) \\ &= (1 - \sigma_u)(1 - \tilde{\Omega}_{i,L}) d \ln w_r - (1 - \sigma_u) \tilde{\Omega}_{i,m} d \ln p_{m,i}. \end{aligned}$$

Using CES attributes, I can write  $d \ln p_{m,i}$  as:

$$\frac{1}{1 - \sigma_L} \frac{\sum_{j=1}^n \alpha_{ij}^{\sigma_L} (1 - \sigma_L) p_j^{-\sigma_L} dp_j}{\sum_{j=1}^n \alpha_{ij}^{\sigma_L} p_j^{1 - \sigma_L}}$$

note that

$$\frac{\alpha_{ij}^{\sigma_L} p_j^{-\sigma_L}}{\sum_{k=1}^n \alpha_{ik}^{\sigma_L} p_k^{1 - \sigma_L}} = \tilde{\Omega}_{i,j} / (1 - \tilde{\Omega}_{i,L})$$

Putting this back into the previous equation, I get:

$$\begin{aligned}
d \ln \tilde{\Omega}_{i,L} &= (1 - \sigma_u)(1 - \tilde{\Omega}_{i,L}) d \ln w_r - (1 - \sigma_u) \sum_{j=1}^n \tilde{\Omega}_{i,j} d \ln p_j \\
&= (1 - \sigma_u)(1 - \tilde{\Omega}_{i,L}) \left( d \ln w_r - \sum_{j=1}^n \frac{\tilde{\Omega}_{i,j}}{\tilde{\Omega}_{i,L}} d \ln p_j \right)
\end{aligned} \tag{17}$$

■

*Proof of Proposition 3.* Prices are given by  $p_i = \frac{\mu_i C_i(p, w, \bar{y}=1)}{A_i}$ . Keeping markups and technology constant,  $d \ln p_i = d \ln C_i$ .

Using Shephard's Lemma, I can show the change in costs as:

$$\begin{aligned}
d \ln C_i &= d \ln \left( \sum_{j=1}^n p_j x_{ij} + w_{r_i} L_i \right) \\
&= \sum_{j=1}^n \tilde{\Omega}_{i,j} d \ln p_j + \tilde{\Omega}_{i,L} d \ln w_{r_i}
\end{aligned}$$

Writing this in vector form, I get:

$$\begin{aligned}
d \ln p &= \tilde{\Omega} d \ln p + \tilde{\Omega}_{,L} \cdot d \ln w \\
&= \tilde{\Psi}^p(\tilde{\Omega}_{,L} \cdot d \ln w)
\end{aligned}$$

which implies

$$d \ln p_i = \sum_{j=1}^n \tilde{\Psi}_{i,j}^p \tilde{\Omega}_{j,L} d \ln w_{r_j}$$

■

*Proof of Proposition 2.* From accounting identity

$$\begin{aligned}
\lambda = b' \Psi &\leftrightarrow \lambda_i = \sum_{j=1}^n b_j \Psi_{ji} = \sum_{j=1}^n b_j \Psi_{ji} = \sum_{j=1}^n \bar{b}_{r_j} \chi_{r_j} \Psi_{ji} \\
d \lambda_i &= \sum_j \bar{b}_{r_j} d \chi_{r_j} \Psi_{ji} + \sum_j \bar{b}_{r_j} \chi_{r_j} d \Psi_{ji}
\end{aligned} \tag{18}$$

Focusing on the first part of equation 18, I can write  $\chi_{r_j}$  as:

$$\chi_r = \sum_{i \in r} \pi_i + w_r L_r$$

which gives

$$d \ln \chi_r = \sum_{i \in r} \frac{\pi_i}{\chi_r} d \ln \lambda_i + w_r L_r d \ln L_r + w_r L_r d \ln w_r$$

Focusing on the second part of equation 18 and using matrix calculus, I can show:

$$d\Psi = \Psi d\Omega \Psi$$

so, I need to get  $d\Omega$ . First, using CES algebra, I can write

$$\tilde{\Omega}_{i,j} = \frac{1}{A_i} \eta_i^{\sigma_u} \alpha_{ij}^{\sigma_l} p_j^{1-\sigma_l} \overline{p_{m,i}}^{\sigma_l-\sigma_u} \overline{p_{y,i}}^{\sigma_u-1}$$

Taking the natural logarithm and totally differentiating gives:

$$d \ln \tilde{\Omega}_{i,j} = (1 - \sigma_l) d \ln p_j + (\sigma_l - \sigma_u) d \ln \overline{p_{m,i}} + (\sigma_u - 1) d \ln \overline{p_{y,i}}$$

where  $\overline{p_{m,i}}$  is the unit price of intermediate goods for firm  $i$  and  $\overline{p_{y,i}}$  is the unit price of production for firm  $i$ . Rewriting these two terms as functions of changes in wages and intermediate good prices gives

$$\begin{aligned} d \ln \Omega_{i,j} = & (1 - \sigma_l) d \ln p_j + (\sigma_u - 1) \tilde{\Omega}_{i,L} d \ln w_r \\ & + (\sigma_l - 1 + (1 - \sigma_u)(1 - \tilde{\Omega}_{i,m})) \frac{1}{\tilde{\Omega}_{i,m}} \sum_{k=1}^n \tilde{\Omega}_{i,k} d \ln p_k \end{aligned}$$

Collecting terms, one can show

$$d \ln \tilde{\Omega}_{i,j} = (1 - \sigma_l) \left( d \ln p_j - \sum_{k=1}^{n+R} \tilde{\Omega}_{i,k} d \ln p_k \right) + (\sigma_l - \sigma_u) \tilde{\Omega}_{i,L} \left( \frac{1}{\tilde{\Omega}_{i,m}} \left( \sum_{k=1}^n \tilde{\Omega}_{i,k} d \ln p_k \right) - d \ln w_{r_i} \right)$$

Using  $d \ln \Omega_{i,j} = d \ln \tilde{\Omega}_{i,j}$  when markups are constant, and using the covariance term, I get:

$$d\Omega_{i,j} = \frac{1 - \sigma_l}{\mu_i} Cov_{\tilde{\Omega}^{(i)}}(d \ln p, I_{(j)}) + \frac{\sigma_l - \sigma_u}{\mu_i} \tilde{\Omega}_{i,j} \tilde{\Omega}_{i,L} \left( \frac{1}{\tilde{\Omega}_{i,m}} \left( \sum_{k=1}^n \tilde{\Omega}_{i,k} d \ln p_k \right) - d \ln w_{r_i} \right)$$

From proposition 3, I know

$$d \ln p_i = \sum_{j=1}^n \tilde{\Psi}_{ij}^p \tilde{\Omega}_{j,L} d \ln w_{r_j}$$

More succinctly, I can write it as:

$$d \ln p = \sum_{r=1}^R \tilde{\Psi}_{(r)} d \ln w_r$$

replacing price changes  $d \ln p$  in the equation for  $d \Omega_{i,j}$ , I get:

$$d \Omega_{i,j} = \frac{1 - \sigma_l}{\mu_i} Cov_{\tilde{\Omega}^{(i)}} \left( \sum_g \tilde{\Psi}_{(g)} d \ln w_g, I_{(j)} \right) + \frac{\sigma_l - \sigma_u}{\mu_i} \frac{\tilde{\Omega}_{i,L}}{\tilde{\Omega}_{i,m}} \tilde{\Omega}_{i,j} \left( \sum_{k=1}^n \tilde{\Psi}_{ik}^p \tilde{\Omega}_{k,L} d \ln w_{r_k} - d \ln w_{r_i} \right)$$

Using  $d \Psi = \Psi d \Omega \Psi$ , I get:

$$\begin{aligned} d \Psi_{o,s} = & \sum_{j=1}^n \frac{\Psi_{o,j}}{\mu_j} (1 - \sigma_l) Cov_{\tilde{\Omega}^{(j)}} \left( \sum_g \tilde{\Psi}_{(g)} d \ln w_g, \sum_i I_{(i)} \Psi_{is} \right) \\ & + \sum_{i=1}^n \Psi_{0,i} \frac{\sigma_l - \sigma_u}{\mu_i} \frac{\tilde{\Omega}_{i,L}}{\tilde{\Omega}_{i,m}} \left( \sum_{k=1}^n \tilde{\Psi}_{ik}^p \tilde{\Omega}_{kl} d \ln w_{r_k} - d \ln w_{r_i} \right) \sum_{j=1}^n \tilde{\Omega}_{i,j} \Psi_{j,s} \end{aligned}$$

Using  $d \lambda_i = \sum_j \bar{b}_{r_j} d \chi_r \Psi_{ji} + \sum_j \bar{b}_{r_j} \chi_{r_j} d \Psi_j$  and combining terms, I get:

$$\begin{aligned} d \ln \lambda_i = & (1 - \sigma_l) \sum_{j=1}^n \frac{\lambda_j}{\lambda_i} \frac{1}{\mu_j} Cov_{\tilde{\Omega}^{(j)}} \left( \sum_g \tilde{\Psi}_{(g)} d \ln w_g, \Psi_{(i)} \right) \\ & + (\sigma_l - \sigma_u) \sum_{j=1}^n \frac{\lambda_j}{\lambda_i} \frac{\tilde{\Omega}_{j,L}}{\tilde{\Omega}_{j,m}} \left( \sum_{k=1}^n \tilde{\Psi}_{ik}^p \tilde{\Omega}_{kl} d \ln w_{r_k} - d \ln w_{r_i} \right) (\Psi_{ji} - I_{ji}) \\ & + \frac{1}{\lambda_i} \sum_j \sum_r \bar{b}_{r_j} \Psi_{ji} \chi_r d \ln \chi_r \end{aligned}$$

where  $d \ln \chi$  is given by:

$$d \ln \chi_r = \sum_{i \in r} \frac{\pi_i}{\chi_r} d \ln \lambda_i + w_r L_r d \ln L_r + w_r L_r d \ln w_r$$

This completes the proves of propositions 1, 2 and 3. Theorem 1 is proven directly by

these propositions. ■

## A.2 Counterfactuals Without Demand Effects

In the main model, immigrants supply labor and consume goods. It is of interest to labor economists to separate the effects of these two actions. To calculate the effects of a scenario in which immigrants supply labor but do not consume goods, I change the system of linear equations in a small way.

$$\begin{aligned}
d \ln \lambda_r &= \sum_{i \in r} \frac{\lambda_i \Omega_{iL}}{\lambda_r} (d \ln \lambda_i + d \ln \Omega_{iL}), \\
d \ln \Omega_{i,L} &= (1 - \sigma_u) (d \ln w_{r_i} - \sum_{j=1}^n \frac{\tilde{\Omega}_{ij}}{\tilde{\Omega}_{iM}} d \ln p_j), \\
d \ln \lambda_i &= (1 - \sigma_l) \sum_{j=1}^n \frac{\lambda_j}{\lambda_i \mu_j} \text{Cov}_{\tilde{\Omega}(j)} (d \ln p, \Psi_{(i)}) , \\
&\quad + (\sigma_u - \sigma_l) \sum_{j=1}^n \frac{\lambda_j}{\lambda_i} \tilde{\Omega}_{j,L} \left( d \ln w_{r_j} - \sum_{k=1}^n \frac{\tilde{\Omega}_{j,k}}{\tilde{\Omega}_{j,M}} d \ln p_k \right) (\Psi_{ji} - I_{ji}), \\
&\quad + \frac{1}{\lambda_i} \sum_j \sum_r b_{rj} \Psi_{ji} \chi_r d \ln \chi_r, \\
d \ln \chi_r &= \left( \sum_{i \in r} \frac{\pi_i}{\chi_r} d \ln \lambda_i \right) + \frac{\lambda_r}{\chi_r} d \ln w_r, \\
d \ln p_i &= \sum_{j=1}^n \tilde{\Psi}_{ij} \tilde{\Omega}_{jL} d \ln w_{r_j}, \\
d \ln w_r &= d \ln \lambda_r - d \ln L_r.
\end{aligned} \tag{19}$$

where on line 4, I change the change in regional labor income  $d \ln \lambda_r$ , which equals the change in wages and labor, into just the change in wages  $d \ln w_r$ .

## A.3 Model with Skill Heterogeneity

### A.3.1 Setup

The economy consists of  $N$  firms indexed by  $i$ ,  $R$  regions indexed by  $r$ , where each region is endowed with  $\ell_r$  low-skill and  $h_r$  high-skill labor. Each firm operates in one region:  $r_i$  denotes the region of firm  $i$ . Firms use intermediate goods and local labor in production, and sell their output as both an intermediate good to other producers in all regions and as a final good to local consumers.

### Producers

Firm  $i$  chooses labor  $\ell_i$ ,  $h_i$ , and intermediate goods  $\{x_{i,j}\}_{j=1}^n$  to minimize costs subject to a constant returns nested-CES technology

$$\begin{aligned} \min_{\{x_{ij}\}_{j=1}^n, L_i} \quad & \sum_{j=1}^n p_j x_{ij} + w_{r_i, \ell} \ell_i + w_{r_i, h} h_i \quad \text{subject to} \\ & A_i (\eta_i m_i^{\frac{\sigma_u - 1}{\sigma_i}} + (1 - \eta_i) L_i^{\frac{\sigma_u - 1}{\sigma_u}})^{\frac{\sigma_u}{\sigma_u - 1}} \geq y_i \\ & m_i = \left( \sum_{j=1}^n \alpha_{ij} x_{ij}^{\frac{\sigma_m - 1}{\sigma_m}} \right)^{\frac{\sigma_m}{\sigma_m - 1}} \\ & L_i = \left( \alpha_{i\ell} \ell_i^{\frac{\sigma_L - 1}{\sigma_L}} + (1 - \alpha_{i\ell}) h_i^{\frac{\sigma_L - 1}{\sigma_L}} \right)^{\frac{\sigma_L}{\sigma_L - 1}} \end{aligned}$$

where  $A_i$  is a Hicks-neutral productivity shifter,  $y_i$  is total output,  $p_j$  is the price of good  $j$ ,  $\ell_i$  and  $h_i$  are the low-skill and high-skill labor used by firm  $i$ ,  $w_{r, \ell}$  and  $w_{r, h}$  are the low-skill and high-skill wages in region  $r$ ,  $m_i$  is the intermediate good used by the firm, which itself is a CES bundle of goods from different firms.  $x_{ij}$  denotes how much firm  $i$  uses firm  $j$ 's goods in production, where firm  $j$  can be in any region. I assume common elasticities of substitution within nests:  $\sigma_u$  denotes the elasticity of substitution between labor and intermediate goods, unlike the text,  $\sigma_m$  is the elasticity of substitution between different intermediate goods, and  $\sigma_L$  is the elasticity of substitution across labor. Constant returns to technology requires  $\sum_j \alpha_{i,j} = 1$ . Let  $C_i$  denote the unit cost of firm  $i$ . I assume that firms have constant and exogenous markup  $\mu_i$ , and therefore set price  $p_i = \mu_i C_i$ .

### Final Demand

All final goods consumption as well as the ownership of firms is local. I assume a representative consumer in each region  $r$ , who optimizes her Cobb-Douglas utility subject to budget



constraint that equates her spending on final goods with her labor income plus (regional) firm profits.

$$\max_{\{c_{r,i}\}} \prod_{i \in r} c_{r,i}^{\beta_i} \quad s.t. \quad \sum_{i \in r} p_i x_{0,i} = w_{r,l} l_r + w_{r,h} h_r + \sum_{i \in r} \pi_i$$

where  $c_{r,i}$  is how much the representative agent  $r$  consumes firm  $i$ 's goods, and  $\sum_{i \in r} \beta_i = 1$ .

## Labor Supply

Both types of labor are inelastically supplied in each region, are immobile across regions and perfectly mobile across firms in a region.

## General Equilibrium

Given exogenous productivities  $A_i$  and markups  $\mu_i$ , equilibrium is a set of prices  $p_i$ , low-skill wages  $w_{r,l}$  and high-skill wages  $w_{r,h}$ , intermediate good choices  $x_{i,j}$ , labor input choices  $l_i$ , outputs  $y_i$ , and final demands  $c_{r,i}$ , such that each producer minimizes its costs subject to technology constraints and charges the relevant markup on its marginal cost; consumers maximize their utility subject to their budget constraint, and the markets for all goods and labor clear.

### A.3.2 Input-Output definitions

I use the same notation as in the baseline model. The only difference worth noting is that the trade matrix  $\Omega$  is of dimension  $(N + 2R) \times (N + 2R)$ , where the first  $N$  columns and rows belong to firms, rows  $N + 1$  to  $N + R$  belong to low-skill labor, and  $N + R + 1$  to  $N + 2R$  belong to high-skill labor.

### Effects of a Labor Supply Shock on labor income

Note that the labor income in region  $r$  is the sum of labor payments by all firms in that region.

$$\lambda_r = l_r w_{rl} + h_r w_{rh} = \sum_{i \in r} \lambda_i \Omega_{i,L}$$

which gives

$$\begin{aligned} d \ln \lambda_r &= \frac{1}{\lambda_r} (\ell_r w_{rl} (d \ln l_r + d \ln w_{rl}) + h_r w_{rh} (d \ln h_r + d \ln w_{rh})) \\ d \ln \lambda_r &= s_{LS}^w (d \ln \ell_r + d \ln w_{rl}) + s_{hs}^w (d \ln h_r + d \ln w_{rh}) \end{aligned}$$

where  $s$  denotes shares of low-skill and high-skill labor expenses.

Proposition 4 characterizes the change in labor share as a function of changes in wages and prices

**Proposition 4.** *In response to an immigration-induced wage shock, the following equation describes the change in the labor share of production costs*

$$d \ln \tilde{\Omega}_{i,L} = (1 - \sigma_u) \left( \frac{1 - \tilde{\Omega}_{i,L}}{\tilde{\Omega}_{i,L}} (\tilde{\Omega}_{il} d \ln w_{rl} + \tilde{\Omega}_{ih} d \ln w_{rh}) - \sum_{j=1}^n \tilde{\Omega}_{ij} d \ln p_j \right) \quad (20)$$

Proof follows the same steps as in the baseline model.

Let  $\bar{w}_j = \frac{1}{\tilde{\Omega}_{j,L}} (\tilde{\Omega}_{j,l} d \ln w_{rj,l} + \tilde{\Omega}_{j,h} d \ln w_{rj,h})$  is the change in the average wage for firm  $j$ . This allows us to write the change in firms' sales using the notation from the baseline model.

**Proposition 5.** *In response to an immigration-induced wage shock, the following equation describes the change in the Domar weights / sales share of firms*

$$\begin{aligned} d \ln \lambda_i &= \sum_{j=1}^n (1 - \sigma_M) \frac{\lambda_j}{\lambda_i \mu_j} \text{Cov}_{\tilde{\Omega}(j)} (d \ln p, \Psi_{(i)}) \\ &+ (\sigma_U - \sigma_M) \sum_{j=1}^n \frac{\lambda_j}{\lambda_i} \tilde{\Omega}_{j,l} \left( d \ln \bar{w}_{rj} - \sum_{k=1}^n \frac{\tilde{\Omega}_{j,k}}{\tilde{\Omega}_{j,M}} d \ln p_k \right) (\Psi_{ji} - I_{ji}) \\ &+ \frac{1}{\lambda_i} \sum_j \sum_r \bar{b}_{rj} \Psi_{ji} \chi_r d \ln \chi_r \end{aligned} \quad (21)$$

where  $I$  is the identity matrix, and  $d \ln \chi_r = \left( \sum_{i \in r} \frac{\pi_i}{\chi_r} d \ln \lambda_i \right) + \frac{\lambda_r}{\chi_r} d \ln \lambda_r$  is the change in regional income.

Proof follows the same steps as in the baseline model.

The following characterizes the change in prices.

**Proposition 6.** *In response to an immigration-induced wage shock, the following equation describes the change in prices charged by firms*

$$d \ln p_i = \sum_{j=1}^n \tilde{\Psi}_{i,j}^p (\tilde{\Omega}_{j,l} w_{rj,l} + \tilde{\Omega}_{j,h} w_{rj,h}) = \sum_{f=1}^F \tilde{\Psi}_{i,f} d \ln w_f \quad (22)$$

where  $f$  denotes factors, which are the low and high-skill labor in regions.

Proof follows the same steps as in the baseline model.

With these propositions at hand, I can fully characterize the effect of an immigration shock on wages and prices.

**Theorem 2.** *The following linear system fully describes the change in equilibrium prices and quantities in response to an immigration shock consisting of  $d \ln l_r$  change in low-skill labor and  $d \ln h_r$  change in high-skill labor.*

$$\begin{aligned}
d \ln w_f &= d \ln \lambda_f - d \ln L_f \\
d \ln p_i &= \sum_{f=1}^F \tilde{\Psi}_{i,f} d \ln w_f \\
d \ln \lambda_i &= \sum_{j=1}^n (1 - \sigma_M) \frac{\lambda_j}{\lambda_i \mu_j} \text{Cov}_{\tilde{\Omega}(j)}(d \ln p, \Psi_{(i)}) \\
&\quad + (\sigma_U - \sigma_M) \sum_{j=1}^n \frac{\lambda_j}{\lambda_i} \tilde{\Omega}_{j,l} \left( d \ln \bar{w}_{r_j} - \sum_{k=1}^n \frac{\tilde{\Omega}_{j,k}}{\tilde{\Omega}_{j,M}} d \ln p_k \right) (\Psi_{ji} - I_{ji}) \\
&\quad + \frac{1}{\lambda_i} \sum_j \sum_r \bar{b}_{rj} \Psi_{ji} \chi_r d \ln \chi_r \\
d \ln \chi_r &= \left( \sum_{i \in r} \frac{\pi_i}{\chi_r} d \ln \lambda_i \right) + \frac{\lambda_r}{\chi_r} d \ln \lambda_r \\
d \ln \lambda_r &= s_{LS}^w d \ln \lambda_{rl} + s_{hs}^w d \ln \lambda_{rh} \\
d \ln \lambda_f &= \sum_{i=1}^n \frac{\lambda_i \Omega_{if}}{\lambda_f} d \ln \lambda_i + \sum_{i=1}^n \frac{\lambda_i \Omega_{if}}{\lambda_f} d \ln \Omega_{if} \\
d \ln \tilde{\Omega}_{il} &= d \ln \tilde{\Omega}_{iL} + (1 - \sigma_L) \left[ d \ln w_{r_i,l} - \frac{1}{\tilde{\Omega}_{iL}} \left( \tilde{\Omega}_{il} d \ln w_{r_i,l} + \tilde{\Omega}_{ih} d \ln w_{r_i,h} \right) \right] \\
d \ln \tilde{\Omega}_{ih} &= d \ln \tilde{\Omega}_{iL} + (1 - \sigma_L) \left[ d \ln w_{r_i,h} - \frac{1}{\tilde{\Omega}_{iL}} \left( \tilde{\Omega}_{il} d \ln w_{r_i,l} + \tilde{\Omega}_{ih} d \ln w_{r_i,h} \right) \right] \\
d \ln \tilde{\Omega}_{iL} &= (1 - \sigma_u) \left[ \frac{1 - \tilde{\Omega}_{iL}}{\tilde{\Omega}_{iL}} (\tilde{\Omega}_{il} d \ln w_{rl} + \tilde{\Omega}_{ih} d \ln w_{rh}) - \sum_{j=1}^n \tilde{\Omega}_{ij} d \ln p_j \right]
\end{aligned} \tag{23}$$

Proof follows the same steps as for the baseline model.

## B Data Appendix

### B.1 Calculating Trade Exposures

This section describes my approach to calculating firm-level and region-industry level trade exposures.

For computational tractability in the counterfactual analyses, I work with representative firms at the region-industry level. I define regions as Turkey’s 81 provinces and 86 industries at the two-digit classification level. Given that not every industry operates in each province, I obtain 4185 region-industry cells in total. Computing the trade exposures  $[U, D1, D2]$  requires inverting  $4185 \times 4185$  matrices, which remains computationally feasible at this level of aggregation.

Working with firm-level data introduces several considerations that merit detailed discussion.

#### B.1.1 Data cleaning

Firm trading relationships, transaction volumes, sales, and labor payments exhibit substantial year-to-year variation. To minimize measurement error, I focus on firms that maintain continuous operations and file complete balance sheet statements throughout the pre-period from 2006 to 2010. I further restrict the sample to firms reporting positive labor costs in the tax records, excluding firms without employees. This yields 285,178 firms in the analysis sample, some with observed trading relationships and others without.

I define material costs as total firm purchases recorded in the VAT data, encompassing both domestic purchases and imports. Firms making no intermediate purchases receive a labor share equal to one.

The data reveal 9006 firms (3.2% of the sample) whose total costs (intermediate purchases plus labor costs) exceed reported sales, even when aggregated over the entire 2006–2010 pre-period. This pattern poses challenges for the model’s validity. Well-defined Leontief inverse matrices require that each row sum in the trade matrices remains less than or equal to one, a condition violated when costs exceed sales. I address this issue by treating sales information from balance sheets as measured with error relative to the more precisely recorded labor costs and purchases from tax records. Accordingly, I adjust these firms’ sales upward to equal their total costs, effectively imposing a markup of one.

#### B.1.2 Measuring Upstream Exposure

The upstream exposure effect on labor share follows from the model:

$$\begin{aligned}
d \ln \tilde{\Omega}_{i,L} &= (1 - \sigma^U) \left[ d \ln w_{r_i} - \sum_{k=1}^n \tilde{\Psi}_{ik} \tilde{\Omega}_{k,L} d \ln w_{r_k} \right] \\
&= \frac{-(1 - \sigma^U)}{\epsilon} \left[ -\delta_{r_i} + \sum_{k=1}^n \tilde{\Psi}_{ik} \tilde{\Omega}_{k,L} \delta_{r_k} \right]
\end{aligned}$$

Since the first component remains constant within region-industry cells and I always compare firms within these cells, the relevant variation comes from the second component. I therefore define upstream exposure as:

$$U_i = \sum_{k=1}^n \tilde{\Psi}_{ik} \tilde{\Omega}_{k,L} \delta_{r_k}$$

Implementing this measure using the full firm-level network would require inverting a  $285,000 \times 285,000$  matrix. While the cost-based trade matrix  $\tilde{\Omega}$  is sparse, its Leontief inverse  $\tilde{\Psi}$  is not. Moreover, the firm-level network approach cannot capture new trading relationships that may form endogenously in response to the immigration shock. Region-industry level trade matrices prove more robust to such endogenous network formation than firm-to-firm matrices, since most new trading relationships form within rather than across regions. Even when cross-regional relationships do emerge, they occur predominantly between firms that already maintain trading connections with that region.

However, using region-industry level aggregation for the reduced-form analysis reduces statistical power and may compromise identification credibility. Consider comparing textile and finance firms in Istanbul because textile firms typically purchase from southeast regions while finance firms do not. This comparison provides less compelling identification than comparing two textile firms in Istanbul that happen to differ in their exposure to immigrant-receiving regions through their specific trading partners.

To balance these competing considerations, I calculate firm-level trade exposures while exploiting region-industry level variation in trading patterns. Two textile firms in Istanbul exhibit differential upstream exposure if one sources inputs from host regions in the southeast while the other sources from non-host regions. For firms purchasing identical quantities from a particular region-industry cell, I do not distinguish between those buying from labor-intensive versus non-labor-intensive suppliers, as changing trading partners across labor intensity dimensions proves more feasible than changing regional sourcing patterns.

Formally, I calculate upstream exposure as:

$$U_{it} = \sum_{j=1}^J \tilde{\Psi}_{Nj} \times \tilde{\Omega}_{j,L} \times \delta_{jt} \quad (24)$$

where  $\tilde{\Psi}_{NJ}$  represents the firm-by-region-industry trade matrix whose  $ij$ th element captures firm  $i$ 's cost dependence on region-industry  $j$ ,  $\tilde{\Omega}_{j,L}$  denotes the labor share of region-industry  $j$ , and  $\delta_{jt}$  measures the region-industry-time level immigration shock.

This approach offers several advantages. First, the  $\tilde{\Psi}_{NJ}$  matrix requires substantially less computational resources than  $\tilde{\Psi}_{NN}$ . Second, while upstream exposure retains firm-level variation, it primarily exploits region-industry level differences in trading relationships.

Having defined upstream exposure using region-industry level trading partners, the downstream exposures follow naturally. Both  $D1$  and  $D2$  depend on how firms' prices and costs respond to the shock, captured by  $d \ln p$ . I calculate  $d \ln p$  using the region-industry level framework and then construct the downstream exposure measures accordingly.

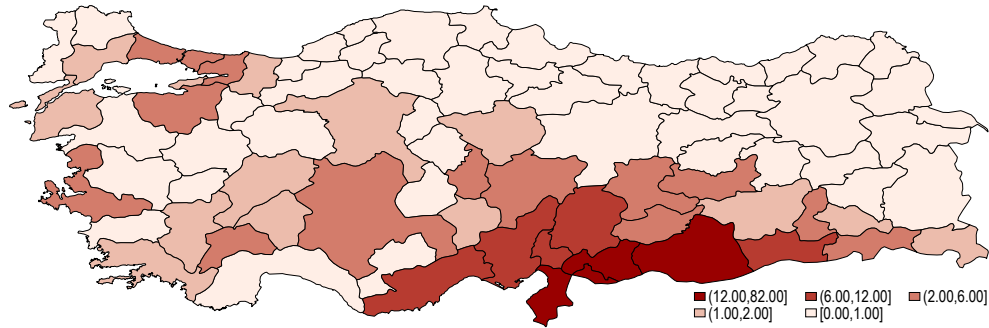
## B.2 Summary Statistics

Table B.1: Summary Statistics

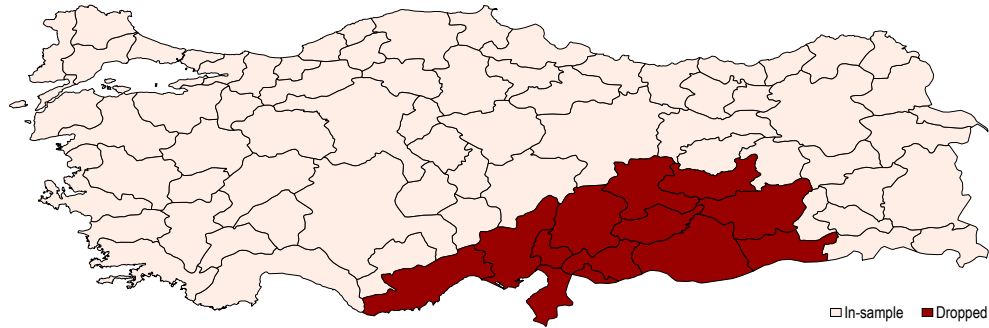
| Number of employees                     | Wage Bill (in million) | Sales (in million) | Exporter       | Labor Share    |
|---|------------------------|--------------------|----------------|----------------|
| Panel A: All sizes                      |                        |                    |                |                |
| 33.11<br>(172.49)                       | 0.52<br>(4.84)         | 7.4<br>(164)       | 0.27<br>(0.44) | 0.31<br>(0.32) |
| Panel B: More than 50 employees in 2010 |                        |                    |                |                |
| 217.74<br>(495.77)                      | 4.00<br>(14.51)        | 68<br>(419)        | 0.71<br>(0.45) | 0.16<br>(0.15) |

*Note:* Data is restricted to Manufacturing firms in non-exposed regions that exist throughout 2006–2019. There are 19505 such firms in the sample. 1112 of these firms have more than 50 employees in 2010.

Figure B.1: Omitted Regions



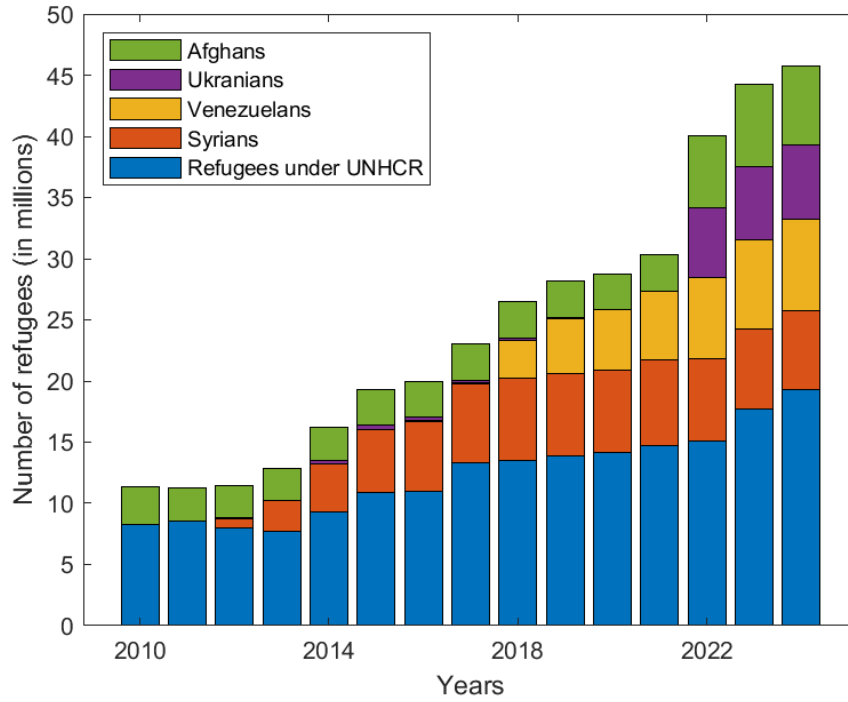
(a) Number of refugees per 100 natives in 2019



(b) Regions omitted from the main analysis

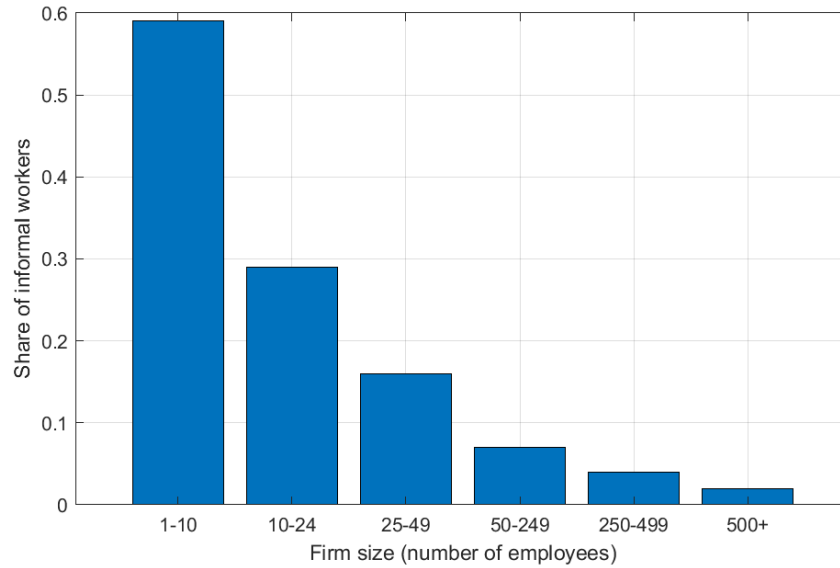
Notes: Panel A uses data acquired from Directorate Generale of Migration Management of Turkey.

Figure B.2: The Evolution of the Number of Refugees Globally



Source: Author's calculations using UNHCR data. This dataset is publicly available from <https://www.unhcr.org/refugee-statistics>

Figure B.3: The Ratio of Informal Workers Across Firm Size



Source: Author's calculations using HLFSS. Informality is defined as the ratio of workers who self-declare that their employer does not pay for social security, which is legally mandated for all formal workers in Turkey.



## C Supporting Evidence

### C.1 New Trade Formation

The model assumes constant trade networks. It allows firms to trade more or less with their existing trade partners endogenously, but it does not address endogenous network formation. In the main text I argue that this is not an important limitation for this paper because what matters first-order is having an existing regional connection, not necessarily the specific firm one trades with within that region. Here, I provide evidence for this claim.

#### Descriptive Evidence

As descriptive evidence, in 2010 there were 6,441,161 unique buyer-seller connections in Turkey. Of these, 3,975,683 did not exist in 2008 or 2009, representing new connections. Among these new connections, 53% occurred between buyers and sellers in the same region. As expected, most firms trade within region, and most new networks form within region.

Of the new connections between firms in different regions, 59% involved buyers who already had a pre-existing supplier in that same region. This pattern shows that even when cross-regional networks form, they are much more likely to occur with firms that already have connections to that region.

#### Regression Analysis

However, this raw comparison might be correlated with firms' size, particular regions, industries, and other factors. To provide more credible evidence, I employ a regression analysis. First, for all firms in my data, I determine whether in 2010 each firm had a supplier from one of the host regions. Then, I examine 2019 and calculate whether this buyer firm established a new connection in host regions (my first outcome of interest) and whether this firm established a new connection in a non-host region (my second outcome, used as a placebo). I then estimate the following equation:

$$y_{irj} = \beta D_i + \theta W_{irj} + \epsilon_{irj}, \quad (25)$$

where  $D$  is an indicator for having a pre-existing supplier in a host region in 2010, and  $W$  includes a cubic function of the number of suppliers and region-by-industry fixed effects. I also restrict the sample to firms in non-host regions. This regression compares firms in the same region-industry cell, examining the predictive power of having a pre-existing supplier in a host region on establishing a new supplier in 2019 in host versus non-host regions.

Table C.2: The Effects of Having an Existing Regional Supplier on New Trade Formation

|  | (1)                 | (2)                 | (3)                 | (4)               | (5)               | (6)               |
|--|---------------------|---------------------|---------------------|-------------------|-------------------|-------------------|
| Panel A: New supplier in host region     |                     |                     |                     |                   |                   |                   |
| Pre-existing regional supplier           | 0.279***<br>(0.052) | 0.214***<br>(0.048) | 0.224***<br>(0.047) | 0.376*<br>(0.187) | 0.387*<br>(0.185) | 0.398*<br>(0.179) |
| Panel B: New supplier in non-host region |                     |                     |                     |                   |                   |                   |
| Pre-existing regional supplier           | -0.029<br>(0.042)   | -0.062<br>(0.041)   | -0.021<br>(0.042)   | -0.046<br>(0.132) | -0.042<br>(0.128) | -0.033<br>(0.133) |
| Sample                                   | All                 | All                 | All                 | Man               | Man               | Man               |
| N  | 97484               | 97487               | 96747               | 20172             | 20172             | 19944             |
| Controls                                 |                     |                     |                     |                   |                   |                   |
| Cubic of number of suppliers             | N                   | Y                   | Y                   | N                 | Y                 | Y                 |
| Region-by-industry F.E.                  | N                   | N                   | Y                   | N                 | N                 | Y                 |

Notes: In Panel A, the outcome is an indicator of whether the firm established a new supplier relationship in 2019 with a firm from a host region, where “new” is defined as a relationship that did not exist in 2008-2009. In Panel B, the outcome is an indicator of whether the firm established a new supplier relationship with a firm in a non-host region in 2019. The treatment variable is an indicator for the buyer firm having at least one supplier in host regions in 2010. The sample includes all firms in columns 1–3 and is restricted to manufacturing firms in columns 4–6. Robust standard errors in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Table C.2 shows the results. Main takeaway: having an pre-existing connection to a region makes firms a lot more likely to have a a new connection in that host region.

## C.2 Industry Heterogeneity in Structural Parameters

In the main text, I argue that structural elasticity estimates are common across industries. Here, I provide empirical evidence for this assumption. I approach this in two ways. First, I focus on large firms as in the main text, estimate equations 10 and 11 separately for each two-digit manufacturing industry, calculate elasticity parameters using GMM estimation, and apply Empirical Bayes shrinkage to avoid bias from small samples. This analysis results in relatively large confidence intervals due to the limited sample size of large firms in certain industries. As a secondary approach, I utilize the fact that the effect of upstream exposure on labor demand is similar among small and large firms, as shown in the Online Appendix Section O1.5. Using this observation, I estimate equation 10 using all manufacturing firms to obtain estimates of the elasticity of substitution between labor and intermediates, which provides more precise estimates due to increased sample size.

### Empirical Bayes

Let  $\beta_j$  be the elasticity of substitution estimate for industry  $j$ . Let  $\hat{\beta}_j$  be an estimate of  $\beta_j$ . Assume that the identification strategy is correct, hence  $\hat{\beta}_j$ 's are consistent estimators of unknown  $\beta_j$ 's:

$$\hat{\beta}_j | \beta_j \sim N(\beta_j, s_j^2)$$

Let  $F$  denote the distribution of industry-specific EoS occupation-specific child penalties. Suppose  $F$  is a normal distribution and independent of  $s_j$ 's. This gives the following hierarchical model:

$$\begin{aligned} \hat{\beta}_j | \beta_j, s_j &\sim N(\beta_j, s_j^2) \\ \beta_j | s_j &\sim N(\mu_\beta, \sigma_\beta^2) \end{aligned}$$

In this normal/normal model, the posterior mean and variance for  $\beta_j$  given  $\hat{\beta}_j$  is given by

$$\begin{aligned} \beta_j^* &\equiv E[\beta_j | \hat{\beta}_j] = \left( \frac{\sigma_\beta^2}{\sigma_\beta^2 + s_j^2} \right) \hat{\beta}_j + \left( \frac{s_j^2}{\sigma_\beta^2 + s_j^2} \right) \mu_\beta \\ s_j^{2*} &\equiv E[s_j^2 | \hat{\beta}_j] = \frac{s_j^2 \sigma_\beta^2}{s_j^2 + \sigma_\beta^2} \end{aligned}$$

I use the following estimators for the hyperparameters  $\mu_\beta, \sigma_\beta^2$ .

$$\hat{\mu}_\beta = \frac{1}{J} \sum_{j=1}^J \hat{\beta}_j$$

$$\hat{\sigma}_\theta^2 = \frac{1}{J} \sum_{j=1}^J \left[ (\hat{\beta}_j - \hat{\mu}_\beta)^2 - s_j^2 \right]$$

Replacing the unknown parameters by their estimates, I obtain the Empirical Bayes posterior mean and variance:

$$\hat{\beta}_j^* = \left( \frac{\hat{\sigma}_\beta^2}{\hat{\sigma}_\beta^2 + s_j^2} \right) \hat{\beta}_j + \left( \frac{s_j^2}{\hat{\sigma}_\beta^2 + s_j^2} \right) \hat{\mu}_\beta$$

$$\hat{s}_j^{2*} = \frac{\hat{s}_j^2 \hat{\sigma}_\beta^2}{\hat{s}_j^2 + \hat{\sigma}_\beta^2}$$

## Results

Figure C.4 presents the heterogeneity of elasticity of substitution estimates across manufacturing industries. Panel A shows the elasticity of substitution between labor and intermediates across two-digit manufacturing industries using large firms only. Panel B shows the elasticity of substitution between different intermediates using the same sample. Panel C presents the elasticity of substitution between labor and intermediates estimated using all manufacturing firms.

**Labor-Intermediate Substitution (Panel A):** The Empirical Bayes estimates show that labor and intermediates are gross complements across all manufacturing industries, with elasticities ranging from approximately 0.65 to 0.90. Most industries cluster around the aggregate estimate of 0.79 from the main text. The confidence intervals overlap substantially across industries, suggesting that the assumption of common elasticity parameters is reasonable for this technology parameter.

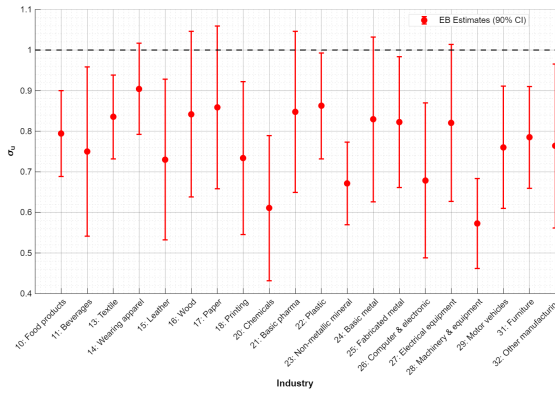
**Intermediate-Intermediate Substitution (Panel B):** The elasticity of substitution between different intermediates shows more heterogeneity across industries. While most industries have elasticities close to 1 (consistent with Cobb-Douglas production), some industries like textiles and basic metals exhibit elasticities above 1 (gross substitutes), while others like chemicals show elasticities below 1 (gross complements).

**Robustness Using All Firms (Panel C):** Panel C presents estimates using all manufacturing firms rather than just large firms, exploiting the finding that upstream exposure effects on labor demand are similar across firm sizes. The pattern mirrors Panel A: labor

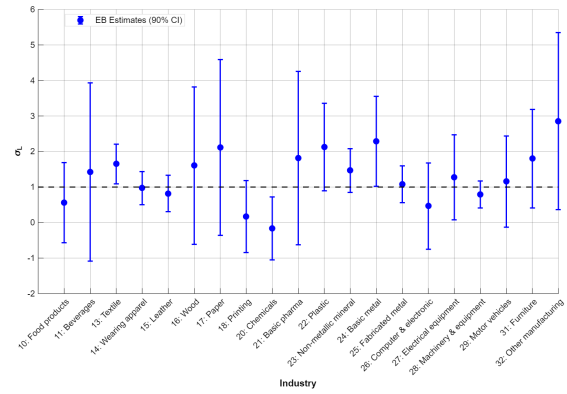
and intermediates are gross complements across all industries, with elasticities ranging from 0.70 to 0.85. The confidence intervals are narrower due to the larger sample size, and the cross-industry variation is smaller, providing additional support for the common elasticity assumption.

The results support the modeling assumption of common structural parameters across industries, particularly for the labor-intermediate substitution elasticity. While some heterogeneity exists, especially for intermediate-intermediate substitution, the estimates are generally consistent with the aggregate parameters used in the main analysis.

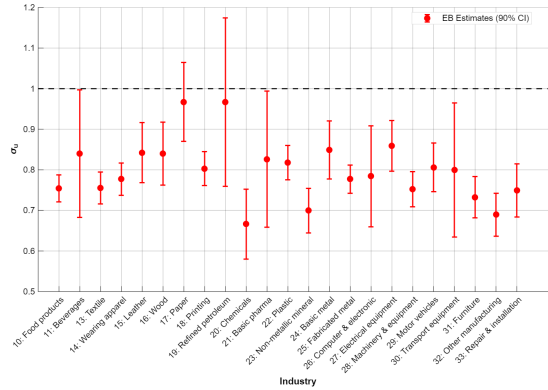
Figure C.4: Heterogeneity of EoS estimates across Manufacturing industries



(a) EoS between labor and intermediates



(b) EoS between intermediates



(c) EoS between labor and intermediates (all manufacturing firms)

Notes: Panels A and B follow the same strategy as in the main text: sample restricted to firms with 50+ employees in 2010, estimate EoS parameters using GMM. Panel C uses the sample from all manufacturing firms, and calculates EoS between labor using the mapping in equation 12. Elasticity estimates using Empirical Bayes are reported. 90% confidence intervals are plotted.

### C.3 Native Migration Responses

In the main text, I argue that Turkish natives do not move in meaningful numbers in response to the Syrian immigration shock. To demonstrate this, I estimate the following event-study and IV designs at the province level. The event-study design is given by:

$$y_{rt} = \sum_{t' \neq 2010} \beta_{t'} Z_r \mathbb{1}\{t = t'\} + f_r + f_t + \epsilon_{rt} \quad (26)$$

where  $f_r$  and  $f_t$  are region and time fixed effects. Similarly, the IV design is given by

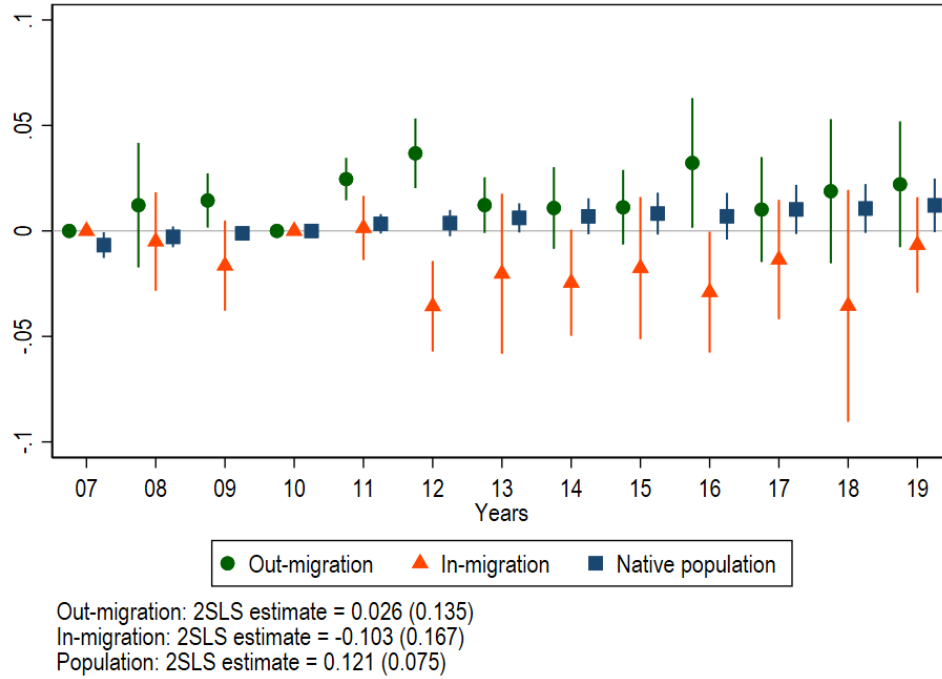
$$\begin{aligned} y_{rt} &= \beta D_{rt} + f_r + f_t + \epsilon_{rt} \\ D_{rt} &= \gamma Z_{rt} + g_r + g_t + \eta_{rt} \end{aligned}$$

where  $D$  is the immigration treatment,  $Z$  is the instrument, and  $f_r$ ,  $f_t$ ,  $g_r$ ,  $g_t$  are region and time fixed effects. I estimate these equations for three separate outcomes: the natural logarithms of in-migration, out-migration, and population.

Figure C.5 shows the results. I observe a mild decrease in in-migration rates and a mild increase in out-migration rates, primarily during the early years of the Syrian civil war (2011 and 2012), before Syrian immigrants arrived in large numbers. In later years, the estimates are not statistically different from zero, with relatively small magnitudes. For example, a one standard deviation increase in the instrument, which leads to approximately a 9% increase in the immigrant/native ratio by 2018, results in a 4% decrease in in-migration rates. Given that in-migration rates constitute less than 3% of the local population in host regions, even if this effect were statistically significant, a 1% increase in the immigrant/native ratio would decrease the native population by only about 0.01%. Similar calculations apply to the out-migration effects: they are small in magnitude.

The minimal effects on migration rates allow the native population to maintain its upward trajectory in southeastern regions. These regions historically experienced higher population growth due to higher birth rates before the Syrian crisis, and this trend continues despite the arrival of Syrian immigrants. I therefore conclude that native labor movements across regions do not play a significant role in disseminating the immigration shock.

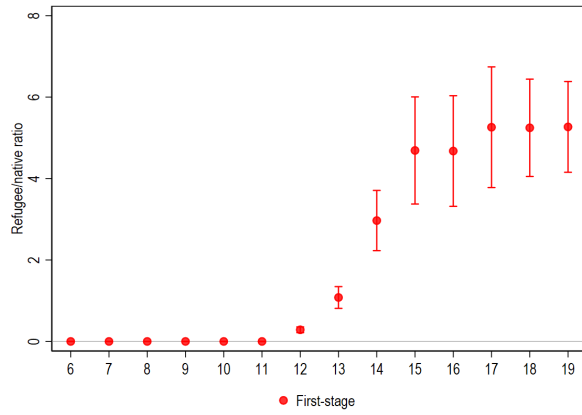
Figure C.5: Native migration responses to Syrian immigration



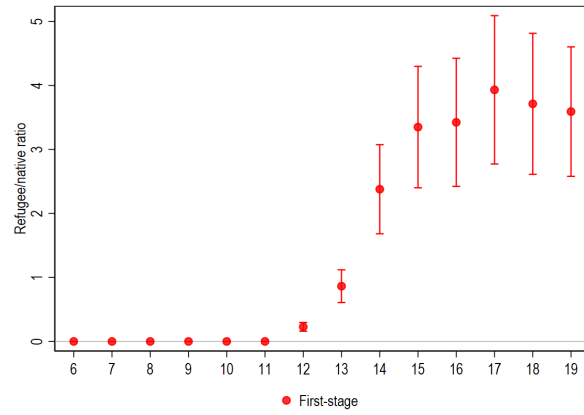
Notes: Event-study estimates come from the regression  $y_{rt} = \sum_{t' \neq 2010} \beta_{t'} Z_r \mathbb{1}\{t = t'\} + f_r + f_t + \epsilon_{rt}$ , where  $Z_r$  is the regional distance share normalized to have standard deviation of one,  $f_r$  and  $f_t$  are region and time fixed effects. Three outcome variables are used: natural logarithms of in-migration, out-migration, and naive population. Address-based tracking data starts from 2007. Therefore, estimates for native population start from 2007, and estimates from migration patterns start from 2008. 2010 is normalized because 2011 is the beginning of the Syrian Civil War. Standard errors are clustered at the region level. 95% confidence intervals are plotted.

## C.4 Alternative Instruments

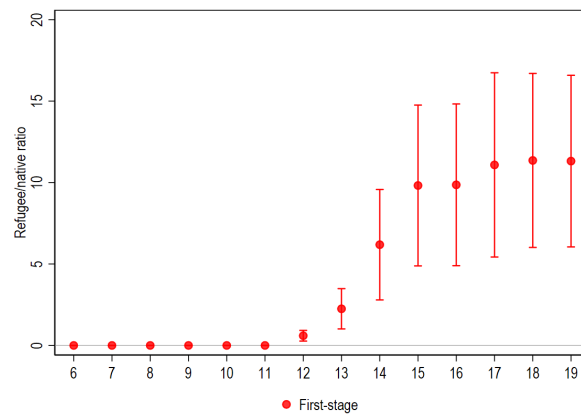
Figure C.6: First-stage estimates across different instruments



(a) First-stage: Distance



(b) First-stage: Language

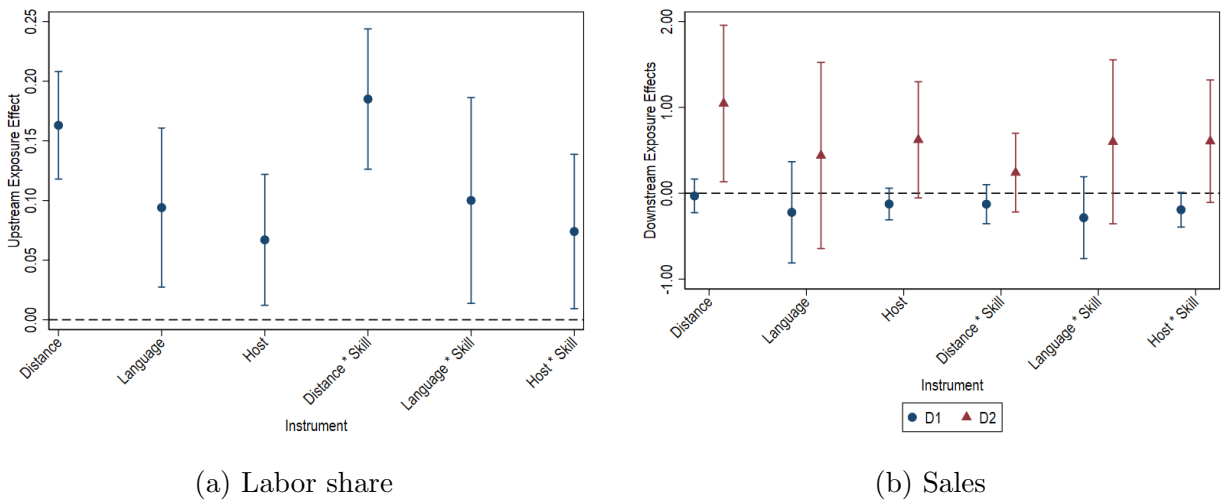


(c) First-stage: Host

Source: Author's calculations. Distance and Language instruments are standardized to have standard deviation of one, while "host" instrument is simply a dummy indicator for the omitted regions.



Figure C.7: Effect of Trade Exposures on Labor Demand and Sales under Alternative Instruments



Notes:

# Online Appendix

## O1 Synthetic IV Robustness Checks

### O1.1 Comparisons between IV and SIV

The main text emphasizes that more and less exposed firms in the same region-industry cells followed different economic trajectories before the immigration shock. This section provides evidence for these claims.

I define the event-study equations for the IV estimator as follows: for labor share:

$$\log(y_{isrt}^L) = \sum_{t' \neq 2010} \beta_{1,t'} U_i^Z \mathbb{1}\{t = t'\} + f_i^L + f_{srt}^L + W_{it}^L + \nu_{it}^L, \quad (27)$$

and for sales,

$$\log(y_{isrt}^S) = \sum_{t' \neq 2010} (\beta_{t'}^{D1} D1_i^Z + \beta_{t'}^{D2} D2_i^Z) \mathbb{1}\{t = t'\} + f_i^S + f_{srt}^S + W_{it}^S + \nu_{it}^S. \quad (28)$$

Here,  $f_{srt}$  denotes industry-region-time fixed effects that partial out industry-region level shocks. In robustness checks, I further group firms into quartiles based on their baseline sizes and control for industry-region-size-time fixed effects. This specification allows me to compare firms within the same region-industry cell that have similar numbers of employees at baseline.

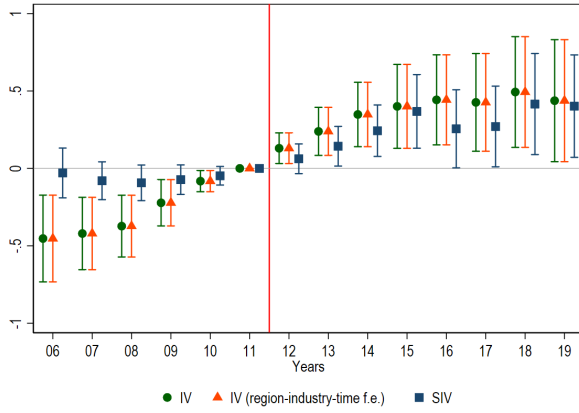
Figure [OO1.1](#) shows the results. In each panel, I plot estimates from the IV design with and without size-region-industry-time fixed effects, together with the baseline SIV estimates using distance-to-border as an instrument. Panels A, B, and C show upstream exposure effects on employment, wage bill, and labor share, respectively, while Panels D and E show downstream exposure effects on sales.

The results reveal that IV is biased in most, if not all, specifications. For example, more upstream-exposed firms followed differential trends from 2006 to 2011 in employment, wage bill, and labor share compared to less-exposed firms. This pattern persists even when controlling for region-industry-size-time fixed effects. Panel D also reveals significant pre-trends in the reduced-form analysis with baseline IV, where D1-exposed firms' sales grew differentially between 2006–2011 compared to less-exposed firms. These persistent differential trends motivate the use of Synthetic IV in the main text.

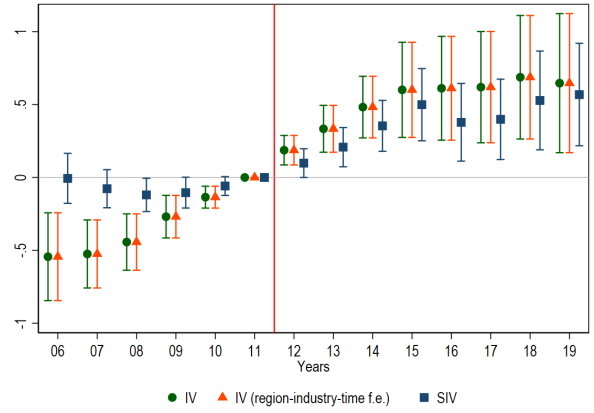
Panel E shows no pre-trends: more and less D2-exposed firms follow parallel trajectories before the immigration shock. However, this finding alone neither supports nor opposes

the use of SIV. To establish causality, I require exogenous variation in all three treatment variables. Since pre-trends appear in two of the three cases, I cannot rely on IV for credible causal inference. This methodological challenge motivates the use of SIV.

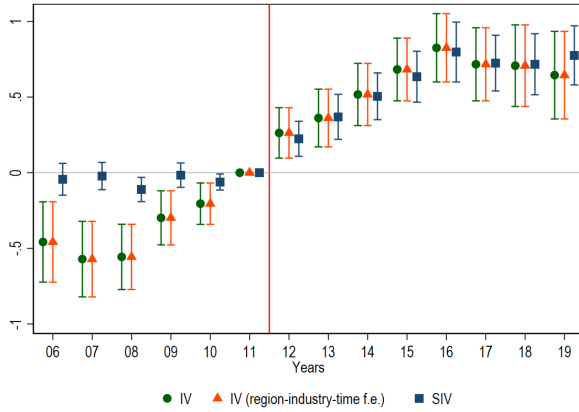
Figure OO1.1: Effects of Trade Exposures on Firms' Labor Demand and Sales



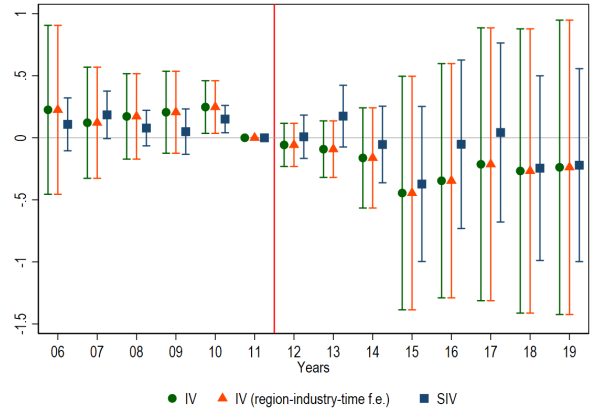
(a) Number of employees



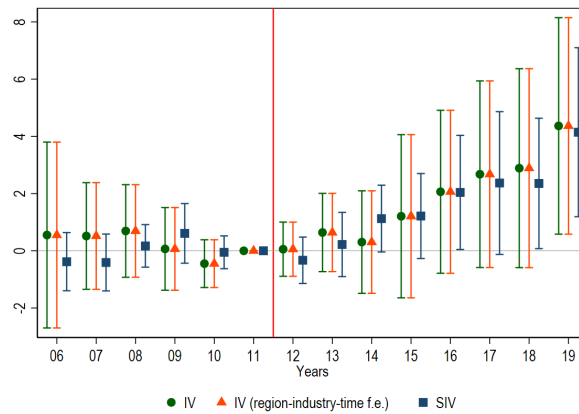
(b) Payroll



(c) Labor share



(d) Sales: Downstream-1



(e) Sales: Downstream-2

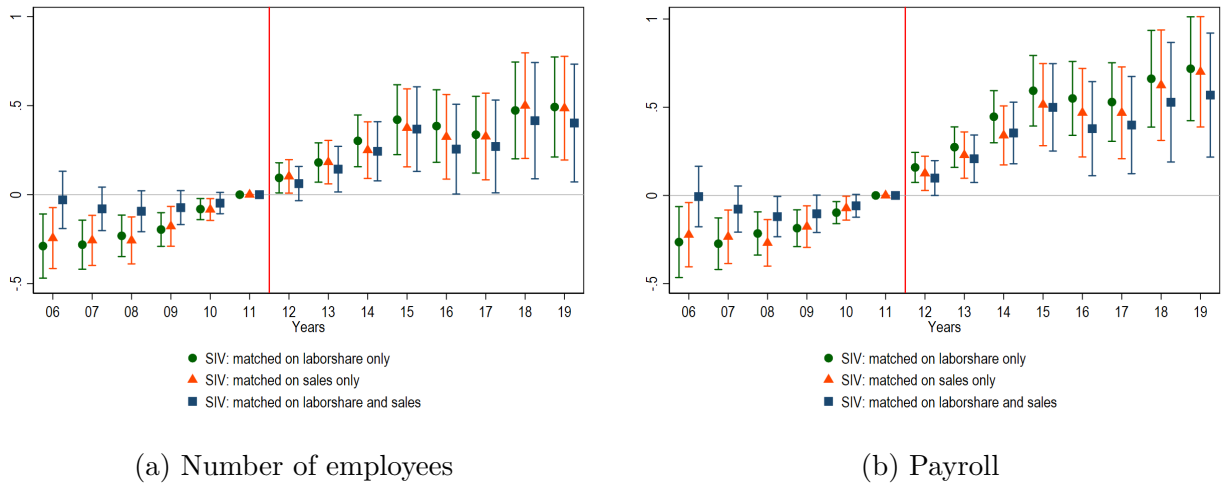
Notes: In Panels A, B, and C, the estimates come from the regression equation  $y_{it} = \sum_{t' \neq 2011} \gamma_{1,t'} U_i^Z \mathbb{1}\{t = t'\} + f_i + f_t + \nu_{it}$ , where the outcome variable is the natural logarithm of the number of workers in Panel A, of total payroll in Panel B, and of labor share in Panel C. In Panels D and E, the estimates come from the regression equation:  $y_{it} = \sum_{t' \neq 2011} (\gamma_{2,t'} D1_i^Z + \gamma_{3,t'} D2_i^Z) \mathbb{1}\{t = t'\} + f_i + f_t + \nu_{it}$ . SIV estimates use the debiased versions of the outcome and exposures, while IV uses the raw versions. SIV matching is based on the demeaned versions of labor share and sales. The instrument is based on the travel distance. Sample is restricted to manufacturing firms with at least 50 employees in 2010. Standard errors are clustered at the firm level. 95% confidence intervals are plotted.

## O1.2 Robustness to Matching on Different Variables

In the main text, I argue that matching on trends in labor share and sales is crucial to create synthetic firms that follow similar economic trajectories. As evidence, I report that pre-trends disappear also in the unmatched outcomes of employment and payroll. Figure OO1.2 shows that the trends do not disappear when I match only on labor share or only on sales.

Figure OO1.2a shows event-study estimates on firms' employment when I match on labor share only, sales only, and when I match on both jointly. Significant pre-trends remain in the pre-period when matching on single variables, which could raise concerns for the empirical design. Notably, the estimated effects in the post-period are similar across all matching types. This occurs because the estimated effects in the post-period are substantially larger than the magnitude of residual differential trends after the matching step. Figure OO1.2b repeats the analysis for payroll and finds the same results.

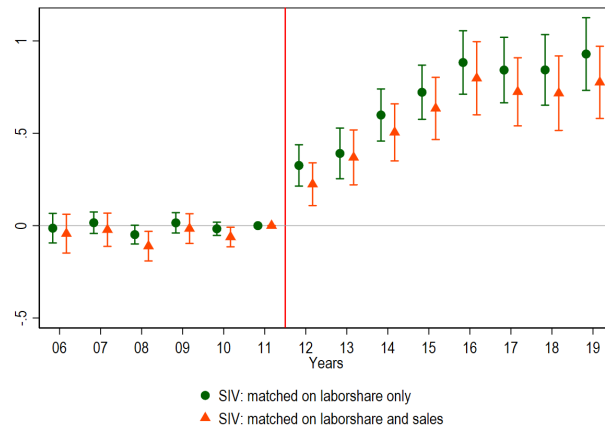
Figure OO1.2: Effects of matching on different variables on unmatched outcomes



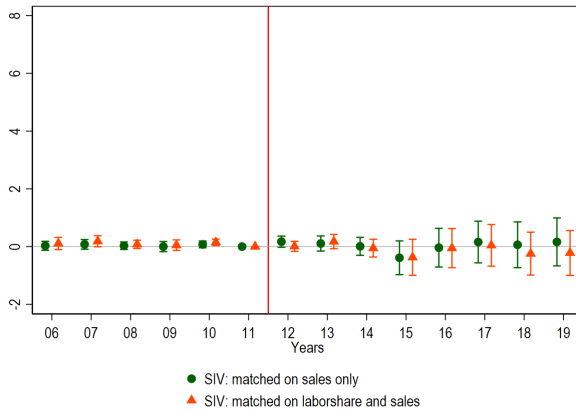
### O1.3 Robustness to Improving Pre-Treatment Fit

Figure OO1.3a shows the estimated effects when I match to improve pre-treatment fit for each specific outcome. Panel A shows upstream exposure effects on labor share when I match only on labor share (which improves pre-treatment fit) versus the default of matching on labor share and sales. Panels B and C show the estimated effects of D1 and D2 exposures, respectively, on sales when I match on sales only. Improving the pre-treatment fit does not change the results, providing evidence against concerns about under-fitting in the joint matching approach.

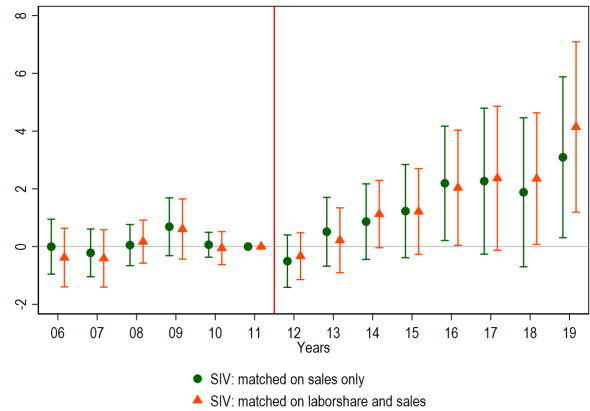
Figure OO1.3: Improving Training Fit: Labor share and Sales



(a) Labor share



(b) Sales: D1 exposure



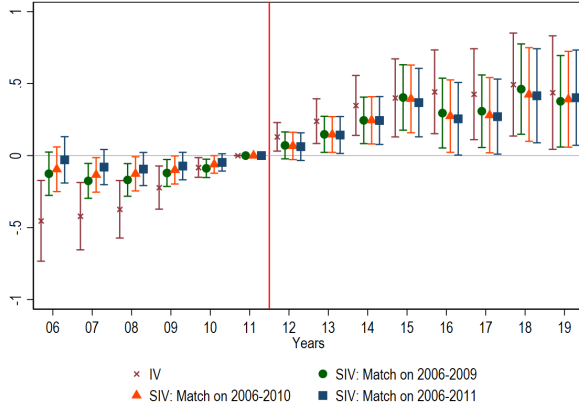
(c) Sales: D2 exposure

## O1.4 Robustness to Different Training Periods

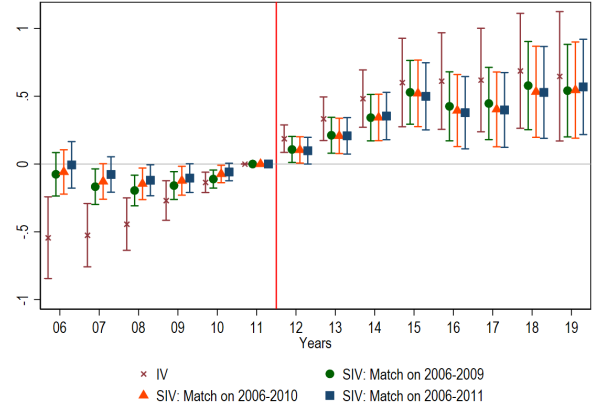
To test for overfitting, I perform back-testing by matching on trends in 2006–2009 and 2006–2010 instead of the default 2006–2011 period. This reduces the amount of information I match on but provides a visual check of sensitivity to particular matching periods.

Figure [OO1.4](#) shows robustness checks of the main results using the travel-based instrument and matching on labor share and sales. Panels A, B, and C show effects of upstream exposure on employment, payroll, and labor share, respectively, while Panels D and E show effects of D1 and D2 exposures on sales. In each panel, I plot four sets of event-study estimates: baseline IV as a comparison, and SIV estimates using different training periods. SIV finds consistent signals across all variables even using the shorter 2006–2009 period. Hence, results are robust to matching on different pre-periods.

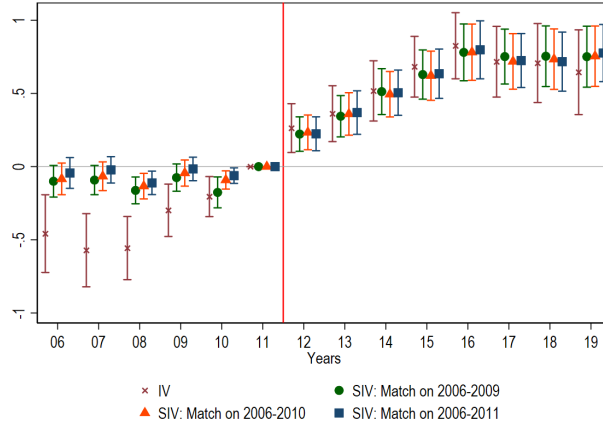
Figure OO1.4: Robustness to Different Training Periods



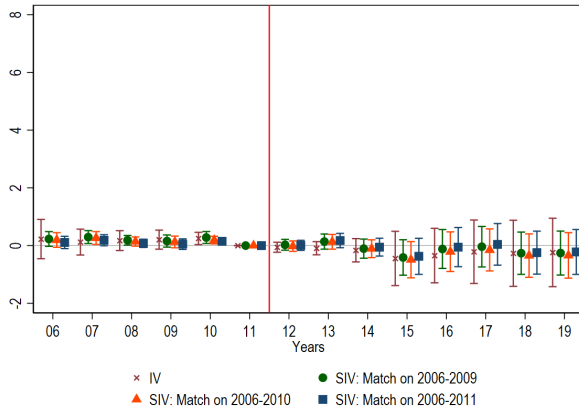
(a) Number of employees



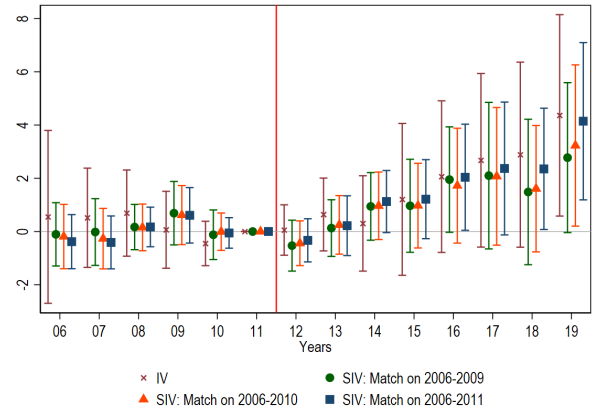
(b) Payroll



(c) Labor share



(d) Sales: D1-exposure



(e) Sales: D2-exposure



## O1.5 2SLS estimates

The main text makes several parametric assumptions. The model states that the effect of upstream exposure on labor share and the effects of downstream exposures on sales are the key structural equations to be estimated. I extend the analysis to include employment and payroll, outcomes of particular interest to labor economists. In this section, I present results across several specifications where I:

- For each outcome, estimate the effect of upstream and downstream exposures
- Estimate results for all manufacturing firms and large manufacturing firms separately
- Estimate effects using alternative instruments

This section reports these robustness checks in six tables, each using a different instrument.

### Table Structure and Interpretation

Each table follows the same structure. Panel A shows results where the sample includes all manufacturing firms, and Panel B reports results restricted to large firms with at least 50 employees at baseline. Columns 1–3 show estimated effects on employment, 4–6 on payroll, 7–9 on labor share, and 10–12 on sales. For each outcome, the first column shows the estimated effect of upstream exposure only, the second column shows estimated effects of downstream exposures only, and the third column shows estimated effects using all three trade forces jointly.

I present results from all these specifications for complete disclosure of how researcher choices, such as focusing on large firms to avoid bias from informality, impact findings. I do not claim causal effects for evidence from small firms; comparisons across small and large firms serve only to identify outcomes where bias from informality becomes a first-order concern.

### Key Findings from Distance Instrument Results

I go over the results of Table [OA.1](#), which shows the effects using the distance instrument, in detail, and leave the comparison across different instruments to the reader. Results are similar across specifications.

**Employment Effects (Columns 1–3):** Upstream exposure increases firms’ number of employees for both large firms (Panel B) and all firms (Panel A). The estimated effects are significant at the 5% level. Effects on all firms are more precise due to increased sample size,

reflecting the familiar bias-variance trade-off in empirical designs. On employment, small and large firms provide largely comparable results.

**Payroll and Labor Share Effects (Columns 4–9):** The estimated effects mirror those for employment. Across both small and large firms, upstream exposure increases firms’ labor demand, and effects remain economically and statistically similar when controlling for downstream exposures.

**Sales Effects (Columns 10-12):** The key difference between small and large firms emerges in sales outcomes. For large firms (Panel B), D1 exposure has a null effect on sales while D2 exposure significantly increases sales. Controlling for upstream exposure does not change this result.

Comparing D1 and D2 exposure effects between small and large firms reveals two patterns. First, D1 effects are small and statistically indistinguishable from zero in both specifications. Second, D2 exposure increases sales of large firms but has a null (or negative but insignificant) effect on all firms’ sales. A negative D2 effect would contradict the model, implying that labor and intermediates are more substitutable than different intermediates, which is inconsistent with upstream exposure estimates.

### **O1.5.1 Mechanism: Coordinated Informality Adjustments**

The substantial role of informality in attenuating estimated effects on sales warrants examination. I propose that the primary mechanism operates through coordinated adjustments across multiple margins of informality. Building on Gulek (2024), which documents that firms substituted informal for formal labor following Syrian refugee arrivals (who lacked work permits and could only work informally), I explore implications for firms’ transaction patterns.

Firms face fundamental accounting constraints when managing formal and informal transactions. Formal revenues generate documented cash flows through the banking system and must finance formal costs requiring official documentation. Similarly, informal revenues (undocumented cash transactions) provide the liquidity necessary to finance informal costs, particularly off-the-books wage payments.

When firms reduce formal labor costs and increase informal labor costs in response to cheaper informal labor, maintaining consistent accounting records becomes challenging. A decrease in formal costs without corresponding adjustments could create implausible profit margins triggering tax authority scrutiny. Firms therefore face pressure to coordinate adjustments across multiple margins.

This coordination manifests through a cascade of informality. As firms reduce formal labor costs, they shift sales from formal to informal channels to generate undocumented

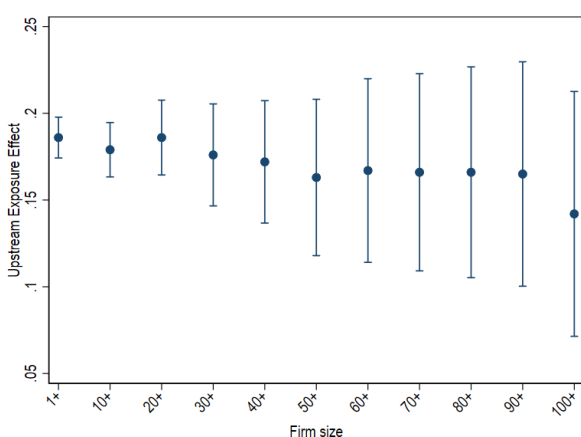
cash for informal wage payments. However, this creates new inconsistencies: lower formal sales and labor costs while formal intermediate input purchases remain unchanged would appear suspicious. Firms therefore also shift some intermediate input purchases from formal to informal suppliers, completing coordination across labor, sales, and intermediate input margins.

This mechanism implies that informality in labor markets begets informality in product markets, which begets informality in input purchases. The coordination is driven by the need to maintain plausible accounting relationships rather than technological considerations. Firms may be relatively indifferent between formal and informal suppliers for certain inputs, making this adjustment feasible without significant productivity losses.

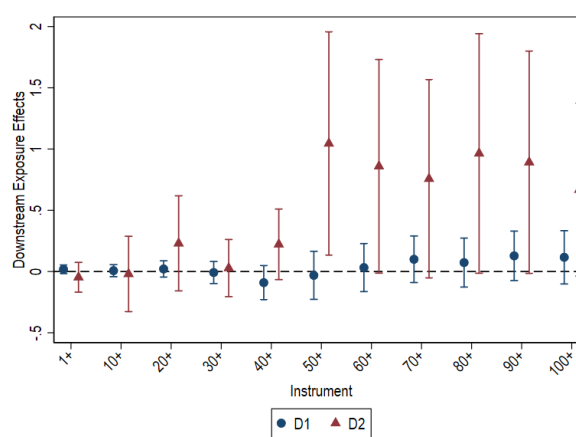
The Syrian refugee shock, by expanding informal labor supply, may have triggered these coordinated adjustments throughout small firms' operations. This explains why measured impacts on formal sales are biased for small firms: a portion of the sales response occurs through informal channels that escape measurement in official data.

Supporting evidence for the claim that D2-exposure effects on sales are biased for small firms due to informality appears in Figure OO1.5, which shows how upstream and downstream exposure effects change across firms of different sizes. There is a clear jump in estimated treatment effects at the 50-employee threshold, precisely when firms become significantly more formal due to increased government scrutiny.

Figure OO1.5: Estimated Effects of Trade Exposures Across Different Firm Sizes



(a) Upstream Exposure Effects on Labor share



(b) Downstream Exposure Effects on Sales

Notes: the 95% confidence intervals of SIV estimates, where the training period is 2006–2010, weights are calculated by matching on the trends in labor share and sales, and travel distance is used as an instrument. Each column shows the estimated effects using a different sample of manufacturing firms, where “x+” denotes firms with at least  $x$  employees in 2010.

Table OA.1: Effects of Trade Exposures on Firms in Non-Host Regions (IV: Distance)

| Number of employees    |                      |                     | Payroll             |                      |                     | Labor Share         |                      |                     | Sales              |                    |                    |
|------------------------|----------------------|---------------------|---------------------|----------------------|---------------------|---------------------|----------------------|---------------------|--------------------|--------------------|--------------------|
| (1)                    | (2)                  | (3)                 | (4)                 | (5)                  | (6)                 | (7)                 | (8)                  | (9)                 | (10)               | (11)               | (12)               |
| Panel A: All sizes     |                      |                     |                     |                      |                     |                     |                      |                     |                    |                    |                    |
| U                      | 0.056***<br>(0.006)  | 0.050***<br>(0.007) | 0.077***<br>(0.006) | -0.129***<br>(0.016) | 0.073***<br>(0.007) | 0.186***<br>(0.006) | -0.221***<br>(0.015) | 0.204***<br>(0.007) | -0.013*<br>(0.007) | 0.018<br>(0.018)   | -0.014<br>(0.009)  |
| D1                     | -0.101***<br>(0.015) | -0.026<br>(0.018)   |                     | 0.033<br>(0.057)     | -0.019<br>(0.020)   |                     | 0.084***<br>(0.017)  |                     |                    | 0.018<br>(0.018)   | -0.003<br>(0.023)  |
| D2                     | 0.048<br>(0.060)     | 0.038<br>(0.059)    |                     |                      | 0.019<br>(0.056)    |                     | 0.108**<br>(0.042)   | 0.069*<br>(0.041)   |                    | -0.047<br>(0.062)  | -0.044<br>(0.063)  |
| Panel B: 50+ employees |                      |                     |                     |                      |                     |                     |                      |                     |                    |                    |                    |
| U                      | 0.084**<br>(0.037)   | 0.077<br>(0.050)    | 0.114***<br>(0.039) | -0.205*<br>(0.120)   | 0.086<br>(0.054)    | 0.163***<br>(0.023) | -0.217***<br>(0.058) | 0.193***<br>(0.031) | 0.012<br>(0.038)   | -0.031<br>(0.100)  | -0.017<br>(0.053)  |
| D1                     | -0.128<br>(0.107)    | -0.013<br>(0.147)   |                     | 0.340<br>(0.380)     | -0.077<br>(0.167)   |                     |                      | 0.073<br>(0.070)    |                    | -0.031<br>(0.100)  | -0.056<br>(0.140)  |
| D2                     | 0.378<br>(0.361)     | 0.354<br>(0.361)    |                     |                      | 0.313<br>(0.380)    |                     | -0.577**<br>(0.292)  | -0.637**<br>(0.283) |                    | 1.045**<br>(0.465) | 1.051**<br>(0.466) |

Notes: Sample is restricted to manufacturing firms that report positive sales throughout 2006–2019. Panel A shows the SIV estimates for firms from all sizes. Panel B shows the results for firms with 50+ employees in 2010. There are 19155 firms in Panel A and 1224 firms in Panel B. U denotes the upstream exposure on firms who directly or indirectly buy from the host regions. D1 is the downstream exposure effect capturing cross-price elasticity between different intermediate goods. D2 is the downstream exposure on firms who directly or indirectly sell to the host region firms. Standard errors are clustered at the firm level.

Table OA.2: Effects of Trade Exposures on Firms in Non-Host Regions (IV: Language)

| Number of employees    |                      |                     | Payroll             |                      |                      | Labor Share         |                      |                     | Sales             |                     |                     |
|------------------------|----------------------|---------------------|---------------------|----------------------|----------------------|---------------------|----------------------|---------------------|-------------------|---------------------|---------------------|
| (1)                    | (2)                  | (3)                 | (4)                 | (5)                  | (6)                  | (7)                 | (8)                  | (9)                 | (10)              | (11)                | (12)                |
| Panel A: All sizes     |                      |                     |                     |                      |                      |                     |                      |                     |                   |                     |                     |
| U                      | 0.054***<br>(0.007)  | 0.042***<br>(0.011) | 0.076***<br>(0.008) | -0.138***<br>(0.030) | 0.067***<br>(0.012)  | 0.173***<br>(0.008) | -0.191***<br>(0.026) | 0.187***<br>(0.012) | -0.002<br>(0.009) | -0.026<br>(0.025)   | -0.009<br>(0.011)   |
| D1                     | -0.117***<br>(0.028) | -0.060<br>(0.037)   |                     | -0.306***<br>(0.104) | -0.047<br>(0.040)    |                     | 0.062<br>(0.038)     |                     |                   | -0.038<br>(0.032)   |                     |
| D2                     | -0.189**<br>(0.089)  | -0.166*<br>(0.088)  |                     |                      | -0.270***<br>(0.100) |                     | -0.182<br>(0.128)    | -0.082<br>(0.105)   |                   | -0.282**<br>(0.129) | -0.287**<br>(0.129) |
| Panel B: 50+ employees |                      |                     |                     |                      |                      |                     |                      |                     |                   |                     |                     |
| U                      | 0.022<br>(0.043)     | -0.142<br>(0.166)   | 0.047<br>(0.045)    |                      | -0.143<br>(0.191)    | 0.094***<br>(0.034) |                      | 0.017<br>(0.151)    | 0.024<br>(0.038)  |                     | -0.097<br>(0.091)   |
| D1                     | -0.346<br>(0.524)    | -0.485<br>(0.564)   |                     | -0.453<br>(0.581)    | -0.594<br>(0.645)    |                     | -0.330<br>(0.350)    | -0.313<br>(0.506)   |                   | -0.222<br>(0.301)   | -0.318<br>(0.313)   |
| D2                     | 0.079<br>(0.838)     | 0.188<br>(0.583)    |                     | -0.188<br>(0.920)    | -0.079<br>(0.641)    |                     | -0.706<br>(0.577)    | -0.719<br>(0.501)   |                   | 0.439<br>(0.553)    | 0.514<br>(0.446)    |

Notes: Sample is restricted to manufacturing firms that report positive sales throughout 2006-2019. Panel A shows the SIV estimates for firms from all sizes. Panel B shows the results for firms with 50+ employees in 2010. There are 19155 firms in Panel A and 1224 firms in Panel B. U denotes the upstream exposure on firms who directly or indirectly buy from the host regions. D1 is the downstream exposure effect capturing cross-price elasticity between different intermediate goods. D2 is the downstream exposure on firms who directly or indirectly sell to the host region firms. Standard errors are clustered at the firm level.

Table OA.3: Effects of Trade Exposures on Firms in Non-Host Regions (IV: Host region indicator)

| Number of employees    |                     |                      |                     |                     |                      |                     |                     |                      |                     |                   |                      |                      |
|------------------------|---------------------|----------------------|---------------------|---------------------|----------------------|---------------------|---------------------|----------------------|---------------------|-------------------|----------------------|----------------------|
| (1)                    | (2)                 | (3)                  | (4)                 | (5)                 | (6)                  | (7)                 | (8)                 | (9)                  | (10)                | (11)              | (12)                 |                      |
| Panel A: All sizes     |                     |                      |                     |                     |                      |                     |                     |                      |                     |                   |                      |                      |
| U                      | 0.049***<br>(0.007) |                      | 0.048***<br>(0.008) | 0.068***<br>(0.007) |                      | 0.072***<br>(0.009) | 0.158***<br>(0.007) |                      | 0.177***<br>(0.009) | -0.004<br>(0.008) |                      | 0.007<br>(0.010)     |
| D1                     |                     | -0.066***<br>(0.018) | -0.007<br>(0.021)   |                     | -0.073***<br>(0.019) | 0.017<br>(0.023)    |                     | -0.135***<br>(0.017) | 0.084***<br>(0.020) |                   | 0.032<br>(0.021)     | 0.040<br>(0.027)     |
| D2                     |                     | -0.063<br>(0.083)    | -0.078<br>(0.082)   |                     | -0.092<br>(0.099)    | -0.116<br>(0.096)   |                     | 0.100<br>(0.080)     | 0.042<br>(0.078)    |                   | -0.297***<br>(0.105) | -0.299***<br>(0.105) |
| Panel B: 50+ employees |                     |                      |                     |                     |                      |                     |                     |                      |                     |                   |                      |                      |
| U                      | 0.067*<br>(0.038)   |                      | 0.029<br>(0.053)    | 0.086**<br>(0.040)  |                      | 0.046<br>(0.054)    | 0.067**<br>(0.028)  |                      | 0.104***<br>(0.037) | 0.076*<br>(0.040) |                      | 0.027<br>(0.057)     |
| D1                     |                     | -0.140<br>(0.099)    | -0.100<br>(0.134)   |                     | -0.174*<br>(0.102)   | -0.112<br>(0.137)   |                     | -0.069<br>(0.055)    | 0.074<br>(0.072)    |                   | -0.125<br>(0.094)    | -0.088<br>(0.132)    |
| D2                     |                     | 0.163<br>(0.336)     | 0.142<br>(0.343)    |                     | 0.119<br>(0.350)     | 0.087<br>(0.361)    |                     | -0.303<br>(0.245)    | -0.375<br>(0.243)   |                   | 0.622*<br>(0.345)    | 0.604*<br>(0.353)    |

Notes: Sample is restricted to manufacturing firms that report positive sales throughout 2006-2019. Panel A shows the SIV estimates for firms from all sizes. Panel B shows the results for firms with 50+ employees in 2010. There are 19155 firms in Panel A and 1224 firms in Panel B. U denotes the upstream exposure on firms who directly or indirectly buy from the host regions. D1 is the downstream exposure effect capturing cross-price elasticity between different intermediate goods. D2 is the downstream exposure on firms who directly or indirectly sell to the host region firms. Standard errors are clustered at the firm level.

Table OA.4: Effects of Trade Exposures on Firms in Non-Host Regions (IV: Distance\*Skill)

| Number of employees    |                      |                     | Payroll             |                      | Labor Share         |                     |                      | Sales               |                    |                   |                   |
|------------------------|----------------------|---------------------|---------------------|----------------------|---------------------|---------------------|----------------------|---------------------|--------------------|-------------------|-------------------|
| (1)                    | (2)                  | (3)                 | (4)                 | (5)                  | (6)                 | (7)                 | (8)                  | (9)                 | (10)               | (11)              | (12)              |
| Panel A: All sizes     |                      |                     |                     |                      |                     |                     |                      |                     |                    |                   |                   |
| U                      | 0.070***<br>(0.007)  | 0.060***<br>(0.009) | 0.097***<br>(0.008) |                      | 0.088***<br>(0.010) | 0.234***<br>(0.008) |                      | 0.251***<br>(0.010) | -0.015*<br>(0.009) |                   | -0.016<br>(0.012) |
| D1                     | -0.134***<br>(0.019) | -0.048**<br>(0.023) |                     | -0.170***<br>(0.020) | -0.043*<br>(0.025)  |                     | -0.285***<br>(0.019) | 0.077***<br>(0.022) |                    | 0.019<br>(0.022)  | -0.004<br>(0.029) |
| D2                     | -0.024<br>(0.034)    | -0.066*<br>(0.038)  |                     | 0.018<br>(0.036)     | -0.044<br>(0.040)   |                     | 0.165***<br>(0.046)  | -0.014<br>(0.047)   |                    | -0.066<br>(0.051) | -0.055<br>(0.052) |
| Panel B: 50+ employees |                      |                     |                     |                      |                     |                     |                      |                     |                    |                   |                   |
| U                      | 0.097**<br>(0.045)   | 0.080<br>(0.062)    | 0.135***<br>(0.048) |                      | 0.093<br>(0.066)    | 0.185***<br>(0.030) |                      | 0.233***<br>(0.039) | 0.026<br>(0.047)   |                   | -0.033<br>(0.065) |
| D1                     | -0.170<br>(0.127)    | -0.056<br>(0.173)   |                     | -0.266*<br>(0.143)   | -0.133<br>(0.197)   |                     | -0.205***<br>(0.070) | 0.131<br>(0.087)    |                    | -0.127<br>(0.116) | -0.174<br>(0.162) |
| D2                     | -0.002<br>(0.227)    | -0.091<br>(0.227)   |                     | -0.001<br>(0.237)    | -0.104<br>(0.239)   |                     | -0.232<br>(0.186)    | -0.491**<br>(0.192) |                    | 0.240<br>(0.234)  | 0.276<br>(0.245)  |

Notes: Sample is restricted to manufacturing firms that report positive sales throughout 2006–2019. Panel A shows the SIV estimates for firms from all sizes. Panel B shows the results for firms with 50+ employees in 2010. There are 19155 firms in Panel A and 1224 firms in Panel B. U denotes the upstream exposure on firms who directly or indirectly buy from the host regions. D1 is the downstream exposure effect capturing cross-price elasticity between different intermediate goods. D2 is the downstream exposure on firms who directly or indirectly sell to the host region firms. Standard errors are clustered at the firm level.

Table OA.5: Effects of Trade Exposures on Firms in Non-Host Regions (IV: Language\*Skill)

| Number of employees    |                      |                     | Payroll             |                      |                     | Labor Share         |                      |                     | Sales            |                   |                    |
|------------------------|----------------------|---------------------|---------------------|----------------------|---------------------|---------------------|----------------------|---------------------|------------------|-------------------|--------------------|
| (1)                    | (2)                  | (3)                 | (4)                 | (5)                  | (6)                 | (7)                 | (8)                  | (9)                 | (10)             | (11)              | (12)               |
| Panel A: All sizes     |                      |                     |                     |                      |                     |                     |                      |                     |                  |                   |                    |
| U                      | 0.070***<br>(0.010)  | 0.053***<br>(0.014) | 0.098***<br>(0.011) | -0.165***<br>(0.037) | 0.086***<br>(0.016) | 0.213***<br>(0.011) | -0.218***<br>(0.031) | 0.232***<br>(0.016) | 0.005<br>(0.011) | -0.039<br>(0.032) | -0.006<br>(0.014)  |
| D1                     | -0.143***<br>(0.035) | -0.074<br>(0.047)   |                     | -0.174*<br>(0.088)   | -0.054<br>(0.052)   |                     | -0.159<br>(0.102)    | 0.081<br>(0.050)    |                  | -0.047<br>(0.041) |                    |
| D2                     | -0.101<br>(0.088)    | -0.109<br>(0.088)   |                     | (0.101)              | -0.188*<br>(0.100)  |                     |                      | -0.197*<br>(0.104)  |                  | -0.100<br>(0.130) | -0.099<br>(0.130)  |
| Panel B: 50+ employees |                      |                     |                     |                      |                     |                     |                      |                     |                  |                   |                    |
| U                      | 0.015<br>(0.054)     | -0.150<br>(0.115)   | 0.044<br>(0.056)    |                      | -0.131<br>(0.129)   | 0.100**<br>(0.044)  |                      | 0.051<br>(0.110)    | 0.033<br>(0.047) |                   | -0.105<br>(0.069)  |
| D1                     | -0.360<br>(0.417)    | -0.485<br>(0.380)   |                     | -0.438<br>(0.433)    | -0.547<br>(0.424)   |                     | -0.257<br>(0.233)    | -0.214<br>(0.355)   |                  | -0.285<br>(0.243) | -0.373*<br>(0.218) |
| D2                     | 0.270<br>(0.637)     | 0.444<br>(0.501)    |                     | -0.058<br>(0.651)    | 0.094<br>(0.515)    |                     | -0.619<br>(0.398)    | -0.678*<br>(0.371)  |                  | 0.599<br>(0.487)  | 0.721<br>(0.458)   |

Notes: Sample is restricted to manufacturing firms that report positive sales throughout 2006–2019. Panel A shows the SIV estimates for firms from all sizes. Panel B shows the results for firms with 50+ employees in 2010. There are 19155 firms in Panel A and 1224 firms in Panel B. U denotes the upstream exposure on firms who directly or indirectly buy from the host regions. D1 is the downstream exposure effect capturing cross-price elasticity between different intermediate goods. D2 is the downstream exposure on firms who directly or indirectly sell to the host region firms. Standard errors are clustered at the firm level.



Table OA.6: Effects of Trade Exposures on Firms in Non-Host Regions (IV: Host-region indicator \* Skill)

|                        | Number of employees |                      |                     | Payroll             |                      |                     | Labor Share         |                      |                     | Sales              |                      |                      |
|------------------------|---------------------|----------------------|---------------------|---------------------|----------------------|---------------------|---------------------|----------------------|---------------------|--------------------|----------------------|----------------------|
|                        | (1)                 | (2)                  | (3)                 | (4)                 | (5)                  | (6)                 | (7)                 | (8)                  | (9)                 | (10)               | (11)                 | (12)                 |
| Panel A: All sizes     |                     |                      |                     |                     |                      |                     |                     |                      |                     |                    |                      |                      |
| U                      | 0.060***<br>(0.008) |                      | 0.058***<br>(0.010) | 0.083***<br>(0.009) |                      | 0.088***<br>(0.011) | 0.192***<br>(0.009) |                      | 0.216***<br>(0.011) | -0.003<br>(0.010)  |                      | 0.010<br>(0.013)     |
| D1                     |                     | -0.085***<br>(0.022) | -0.012<br>(0.027)   |                     | -0.093***<br>(0.023) | 0.017<br>(0.029)    |                     | -0.167***<br>(0.021) | 0.104***<br>(0.026) |                    | 0.040<br>(0.027)     | 0.053<br>(0.034)     |
| D2                     |                     | -0.016<br>(0.080)    | -0.054<br>(0.080)   |                     | -0.025<br>(0.094)    | -0.083<br>(0.093)   |                     | 0.093<br>(0.078)     | -0.050<br>(0.078)   |                    | -0.200***<br>(0.098) | -0.207***<br>(0.100) |
| Panel B: 50+ employees |                     |                      |                     |                     |                      |                     |                     |                      |                     |                    |                      |                      |
| U                      | 0.078*<br>(0.045)   |                      | 0.035<br>(0.063)    | 0.098***<br>(0.047) |                      | 0.056<br>(0.066)    | 0.074**<br>(0.033)  |                      | 0.128***<br>(0.045) | 0.092**<br>(0.046) |                      | 0.019<br>(0.069)     |
| D1                     |                     | -0.175<br>(0.114)    | -0.127<br>(0.157)   |                     | -0.209*<br>(0.116)   | -0.132<br>(0.163)   |                     | -0.056<br>(0.061)    | 0.122<br>(0.082)    |                    | -0.192*<br>(0.103)   | -0.165<br>(0.151)    |
| D2                     |                     | 0.095<br>(0.371)     | 0.061<br>(0.393)    |                     | 0.045<br>(0.386)     | -0.009<br>(0.414)   |                     | -0.321<br>(0.272)    | -0.446<br>(0.279)   |                    | 0.606*<br>(0.364)    | 0.587<br>(0.387)     |

Notes: Sample is restricted to manufacturing firms that report positive sales throughout 2006–2019. Panel A shows the SIV estimates for firms from all sizes. Panel B shows the results for firms with 50+ employees in 2010. There are 19155 firms in Panel A and 1224 firms in Panel B. U denotes the upstream exposure on firms who directly or indirectly buy from the host regions. D1 is the downstream exposure effect capturing cross-price elasticity between different intermediate goods. D2 is the downstream exposure on firms who directly or indirectly sell to the host region firms. Standard errors are clustered at the firm level.

## O2 Additional Counterfactual Estimates

### Comparison between Adana and Antalya

In the main text, I argue that a host region's centrality is the most informative factor in determining the magnitude of trade spillovers from immigration. To strengthen this argument, I compare two cities, Adana and Antalya, that share similar population sizes and Domar weights but differ significantly in their economic connectedness due to their industrial compositions.

Table OB.7 presents baseline statistics for these cities. In 2010, Adana had a population of 2.11 million (5th largest in Turkey), while Antalya had 2.04 million (6th largest). Their Domar weights were similar: 2.48% for Adana (7th highest) and 2.70% for Antalya (6th highest).

Despite these similarities, the cities exhibit marked differences in industrial structure: Adana serves as an agricultural hub, whereas Antalya's economy centers on tourism and services. These distinctions manifest in their cost-based and sales-based Bonacich centrality measures, with Adana's measures being 1.7 and 1.4 times larger than Antalya's, respectively. This difference in economic centrality translates directly into spillover effects: the average spillover wage effect from Adana is 2.4 times greater than that from Antalya.

Table OB.7: Summary Statistics for Adana and Antalya

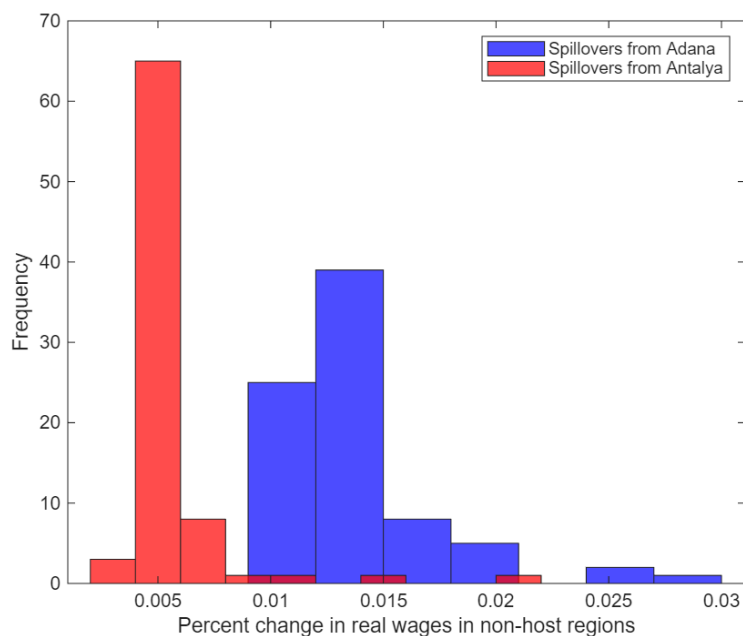
|  | Adana | Antalya |
|--|-------|---------|
| Population (in millions)               | 2.11  | 2.04    |
| Domar weight                           | 0.025 | 0.027   |
| Cost-based centrality: $\tilde{\Psi}1$ | 10.94 | 6.54    |
| Sales-based centrality: $\Psi1$        | 2.21  | 1.60    |
| Spillover effect on real wages         | 1.37% | 0.56%   |

Source: Authors' calculations

A potential concern with the mean spillover difference presented in Table OB.7 is that it could be driven by a small number of outliers. To address this issue, Figure OO2.6 displays the distribution of spillover effects resulting from a 1% immigration shock to each city. The histograms reveal that the spillover distributions for Adana and Antalya barely overlap, with the minimum spillover effect from Adana exceeding the 95th percentile of spillover effects

from Antalya. This stark separation in distributions confirms that the difference in spillover effects is systematic rather than driven by outliers.

Figure OO2.6: Histogram of real wage changes in the non-host regions



Notes: This figure shows the spillover effects from two counterfactuals: a 1% increase in labor supply in Adana and Antalya. Adana and Antalya share similar population sizes and Domar weights but differ significantly in their economic connectedness due to their industrial compositions. Adana is more central as it is an Agricultural hub, while Antalya has a more tourism and services based economy.