Migrants, Trade and Market Access*

Barthélémy Bonadio
University of Michigan

June 2021

Abstract

Migrants shape market access: first, they change the geographical location of demand and second, they reduce trade frictions. This paper shows that both effects are quantitatively relevant. It estimates the sensitivity of exports to immigrant population and uses a model of inter- and intra-national trade and migration calibrated to US states to conduct quantitative exercises. Reducing US migrant population share back to 1980s levels increases export trade costs by 3.2% on average and decreases welfare of US natives by 0.13%. The small aggregate effect of this nationwide policy masks larger heterogeneities across US states, with real wage changes ranging from -0.44% to 0.20%. States with higher exposure to international immigrants demand (both from within the state and from other states) than to international migrant labor supply competition suffer more from the removal of migrants. States with higher export exposure suffer more from the increased trade costs.

*I would like to thank Andrei Levchenko and Sebastian Sotelo for their guidance, and María Aristizábal-Ramírez, Jaedo Choi, Nishaad Rao, and workshop participants at the 2019 H2D2 Research Day, the 2019 Economics of Global Interactions Conference, the Swiss National Bank, and the University of Michigan for helpful discussion. Email: bbonadio@umich.edu

1 Introduction

Immigrants affect both the local supply of labor, and the demand for output produced by a geographic unit. The majority of research on the impact of immigration on natives has focused on understanding the wage impact of the migrant labor supply (e.g. Card, 1990; Abramitzky and Boustan, 2017). This paper instead explores the impact of migration on market access – the demand for output produced by a geographic unit. I use data on US states' intra- and inter-national trade and migration to calibrate a multi-region model to estimate and quantify the impact of immigration into the United States on market access faced by US states.

I emphasize two economic mechanisms. First, immigrants increase the intra-national market access. Immigrants demand goods and services from both the state they reside, and other US states. A fall in the US migrant population is a reduction in US states' market access, as overall demand shifts towards higher export trade cost destinations. The effect is heterogeneous: states that rely more on immigrant demand for their output, both from within-state migrants and from immigrants living in other US states, experience greater reductions in market access. In an environment with inter-state trade linkages, this change in market access is distinct from the change in the in-state immigrant population. The left panel of Figure 1 illustrates this point by plotting the share of a state's output sold to migrants residing in the US against the share of migrant population in the state.[1] If the share of migrants was uniform across states, or if each state was a closed economy, all states would line up on the 45-degree line. States located above the line have a bigger exposure to migrant demand than their own immigrant population would imply, predicting they would suffer relatively more from a decrease in overall US migrant population. In this paper, I show that this heterogeneity across states leads to unequal effects of a nationwide change in migrant population.

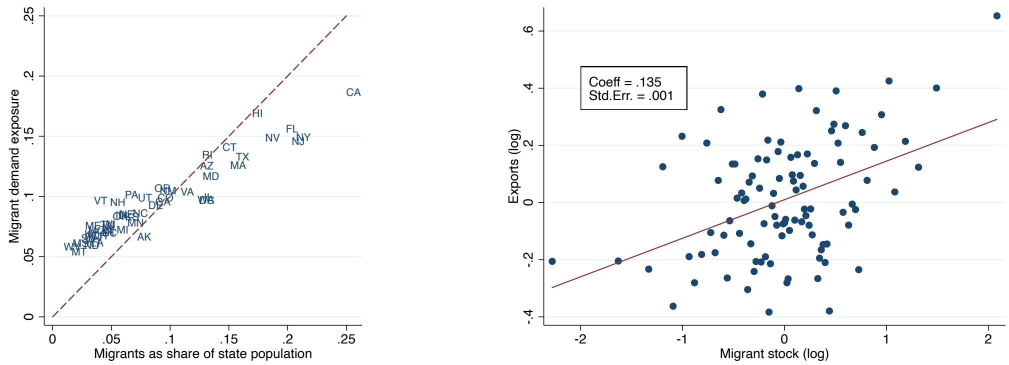
The second mechanism is that immigrants expand international market access, by reducing the costs of foreign trade (see e.g. Gould, 1994; Ottaviano et al., 2018; Cardoso and Ramanarayanan, 2019). The right panel of Figure 1 illustrates this for the US,

[1]Formally, I compute the share of output sold to migrants in the US, for a state i as:

$$share_i = \frac{\sum_{j \in US} X_{ij} * sh\_mig_j}{\sum_j X_{ij}},$$

where sh_mig_j is the share of migrants in j's population.

Figure 1: The two mechanisms in the data



a) Migrant demand exposure against migrant share of population

b) Residuals of exports against residuals of the migrant stock, after controlling for multilateral resistance and distance

by plotting exports from a state to a country against the stock of migrants from that country residing in the state, after controlling for multilateral resistance and distance.[2] In this paper, I estimate the causal impact of migrants on exports in the US using an instrumental variable approach based on push-pull factors similar to Burchardi et al. (2019). I show that migrants have a positive causal impact on exports from US states to their country or origin, and that the positive effect of migrants on trade comes mainly through high-skill rather than low-skill migrants.

I build a model combining Ricardian trade, labor mobility, and an endogenous response of trade costs to migration. I calibrate it to an economy composed of the 50 US states, the District of Columbia, and 56 countries, to provide the first quantitative assessment of the effect of migration on natives' welfare through shaping both intra- and inter-national market access of US states. I estimate an elasticity of exports to migrant population of around 0.2 which I use to calibrate the model. I simulate a counterfactual scenario where migrant population in the US is reduced by half, about the same as bringing migrant population share to 1980 levels. This would increase export weighted trade costs by 3.5% on average across US states, which is of similar magnitude as the 4.9% current ad valorem export tariffs faced by US exporters (WEF, 2016). The reduction in migrant population would lead to a decrease in aggregate US-born welfare by 0.13%. The average real wage change in US states drops by 0.16%, decomposed into

[2]The figure is a bin-scatter plot of the residual of exports from state s to country c after controlling for s and c fixed effects as well as bilateral distance, against the residual of the migrant stock from c living in s, after controlling for s and c fixed effects as well a bilateral distance.

-0.11% due to reduced international market access, -0.31% due to reduced market access from other states, and $+0.26\%$ due to own-state migrant reduction. The effect of own-state migrant reduction captures the reduction of labor competition net of the loss of market access from own-state migrants. There is substantial heterogeneity across US states, with changes in real wages ranging from -0.44% in Vermont to 0.20% in New Jersey. Differences in intra-national migrant demand exposure, export exposure, and local migrant population share explain the regional dispersion of wage changes.

To supplement these results, I also investigate different effects of migration on trade costs by skill. I find that high-skill migrants have a positive effect on exports, while low-skill migrants' effect is muted. The elasticity of exports to high-skill migrant population is around 0.3. Adding a skill dimension to the model induces differential effects on high and low skill workers' wages, and imperfect substitutability between native and migrant workers induces an additional negative effect of the removal of migrants. The two main mechanisms affecting market access, however, are largely unaffected. The reduction of overall migrant share by half would result in a decrease in US native workers' welfare of 0.34% for low-skill and 0.37% for high-skill workers on average. Again, regional heterogeneity would occur because of differential migrant demand exposure across states. The larger overall drop in welfare (0.13 against $0.34-0.37$) is explained by the complementarity between natives and migrants' labor, and a larger increase in export trade costs in the skill model because high-skill migrants have a higher impact on export costs than in the pooled regression.

This paper connects to the literature on quantitative assessment of migration, more particularly in an international trade setting. Di Giovanni et al. (2015) study the importance of trade and remittances in determining welfare effects of migration in a model with exogenous migrant population. Caliendo et al. (2017) use a model with endogenous migration and trade to quantify welfare effects of the European Union expansion. Burstein et al. (2020) point out that an industry's ability to increase output through exports mediates how its native workers wage react to immigrant inflows. Here, I emphasize that migrants themselves lead to a change in market access. The quantitative framework in the present paper not only includes international trade and migration, but also accounts for intra-national regional linkages and the trade costs reduction effect of migrants, which few papers have done before. Combes et al. (2005) models France's internal trade costs as a function of internal migrant stocks, and Cardoso (2019) develops a general equilibrium model based on Melitz (2003), incorporating the trade costs reduction channel of migrants. Here, I also model within-US trade and heterogeneity in migration and trade exposure to analyze the effect of migration on a finer geographical level, connecting to the recent strand of literature emphasizing the regional impact of trade (e.g. Caliendo et al., 2019).

I also contribute to the empirical work on the trade cost reduction effect of migrants. Gould (1994) first documented the fact that US states export more to countries from which they have a lot of migrants, and Dunlevy (2006) showed the correlation depends on language proximity and corruption in the destination country. Cardoso and Ramanarayanan (2019) use Canadian firm level data to show a similar effect. Ottaviano et al. (2018) show that this also holds for exports in services. Bailey et al. (2020) use social connection data based on Facebook to show that countries with more social connection trade more. Some papers have used exogenous variation such as random spatial allocation of refugees (Parsons and Vézina, 2018; Steingress, 2018) to identify the effect, but causal estimation of this phenomenon remains understudied (Felbermayr et al., 2015). In this paper, I confirm that the positive effect of migrants on US exports survives an instrumental variable estimation, and show that the effect is different across skill levels.

I also borrow from the literature on skill level substitutability (Katz and Murphy, 1992) and migrant-native worker substitutability (Ottaviano and Peri, 2012) to add these mechanisms in the model in an additional exercise. While these mechanisms induce heterogeneity across skill, the market access and endogenous trade costs mechanisms remain at play.

The rest of the paper is structured as follows. Section 2 describes the quantitative framework used for the counterfactual analysis, Section 3 estimates the sensitivity of exports to migrant population, and Section 4 presents the main counterfactual results. Section 5 investigates the skill heterogeneity and imperfect substitutability between migrants and natives. Section 6 concludes.

2 Quantitative framework

2.1 Model set up

Preferences and worker efficiency Workers born in region i and living in region n get the following utility:

$$U_{in} = \frac{W_n}{\kappa_{in}}$$

where W_n is a CES aggregator of a continuum of goods and κ_{in} is a migration cost in term of utility. The CES aggregator over goods j is given by:

$$W_n = \left[\int_0^1 (c_n(j))^{\frac{\sigma-1}{\sigma}} \, dj \right]^{\frac{\sigma}{\sigma-1}},$$

where j is a variety, σ is the elasticity of substitution of consumption goods. For a given location, the price index is given by:

$$P_n = \left[\int_0^1 (p_n(j))^{1-\sigma} \right]^{\frac{1}{1-\sigma}}.$$

Workers supply their endowment of labor inelastically in the location they reside, but have a different efficiency depending on where they were born and were they reside. Specifically, worker ω born in region i and living in region n supplies $b_{in}(\omega)$ efficiency units of labor. The efficiency is distributed according to the following Fréchet distribution:

$$F_{in}(b) = e^{-B_{in} b^{-\varepsilon}},$$

where ε is the shape parameter governing the dispersion of efficiencies and B_{in} is a location parameter: workers from region i are in general more efficient in regions n with higher B_{in}. This approach differs slightly from the location specific amenity taste shock used in Redding (2016). It is related to the Roy-Fréchet occupation and industry choice (Lagakos and Waugh, 2013; Hsieh et al., 2019) and has also been used to model internal and international migration decisions (e.g. Bryan and Morten, 2019; Morales, 2019). It takes into account the fact that workers who self select into migration tend to have a higher productivity in their country of destination.

Production and trade costs Labor is the only factor of production. Each location draws an idiosyncratic productivity $z(j)$ for each good j. The productivity draw are iid and followsa Fréchet distribution:

$$F_n(z) = e^{-A_n z^{-\theta}},$$

where θ is the shape parameter governing the dispersion of productivity and A_n is a scale parameter governing average productivity. Assuming perfect competition and an iceberg trade cost d_{ni}, the price at which location n can supply location i with good j is given by:

$$p_{ni}(j) = \frac{d_{ni} w_i}{z_n(j)}.$$

Trade costs are assumed to depend on the share of migrant in the exporter's population, and be given by:

$$d_{ni} = \tau_{ni} \times \begin{cases} \left(\frac{N_{in}}{\sum_j N_{jn}}\right)^{-\eta} & \text{if } N_{in} \neq 0, \text{ and } n \in US, i \notin US \text{ or } i \in US, n \notin US \\ 1 & \text{otherwise} \end{cases},$$

where τ_{ni} is an exogenous iceberg trade cost, and N_{in} is the population born in location i and residing in n. η is the elasticity governing the sensitivity of trade costs to destination-born population residing in the origin location. I assume that migration only matters for cross-border trade costs (when at least one of i or n is not in the US), and not for within-US flows (when both i and n are in the US).

2.2 Trade and migration shares

Expenditure shares Following usual steps from Eaton and Kortum (2002), the expenditure shares are given by:

$$\pi_{ni}^{trade} = \frac{X_{ni}}{\sum_k X_{ki}} = \frac{A_n (d_{ni} w_n)^{-\theta}}{\sum_k A_k (d_{ki} w_k)^{-\theta}},$$

where X_{ni} is the value of i's purchases from n. The price index in location n is given by:

$$P_n = \gamma \left[\sum_s A_s (d_{si} w_s)^{-\theta}\right]^{-\frac{1}{\theta}} = \gamma \left(\frac{A_n (w_n)^{-\theta}}{\pi_{nn}^{trade}}\right)^{-\frac{1}{\theta}},$$

where $\gamma = \left[\Gamma\left(\frac{\theta-(\sigma-1)}{\theta}\right)\right]^{\frac{1}{1-\sigma}}$ and Γ is the Gamma function.

Residential choice shares A worker's indirect utility function can be written as:

$$V_n(\omega) = b_{in}(\omega)\frac{w_n}{P_n}\frac{1}{\kappa_{in}},$$

where w_n is the wage in region n received by the worker, their only source of income. The worker chooses the location with the highest indirect utility, so usual steps using the Fréchet distribution properties give rise to the following residential choice shares:

$$\pi_{in}^{mig} = \frac{N_{in}}{\sum_k N_{ik}} = \frac{B_{in}\left(\frac{w_n}{P_n\kappa_{in}}\right)^{\varepsilon}}{\sum_k B_{ik}\left(\frac{w_k}{P_k\kappa_{ik}}\right)^{\varepsilon}},$$

where N_{in} is the number of people born in i and living in n. The corresponding amount of efficient labor units supplied by workers born in i and living in n, denoted L_{in}, can be shown to be equal to

$$L_{in} = (B_{in})^{\frac{1}{\varepsilon}}\left(\pi_{in}^{mig}\right)^{\frac{\varepsilon-1}{\varepsilon}} N_i\tilde{\gamma},$$

where N_i is the total population born in region i, and $\tilde{\gamma} = \Gamma\left(\frac{\varepsilon-1}{\varepsilon}\right)$.[3]

2.3 Equilibrium

The equilibrium is a set of trade shares π_{ni}^{trade}, wages w_n, efficiency labor units L_{in}, migration shares π_{in}^{mig}, price indices P_n and trade costs d_{in}, which satisfy the following set of equations given primitives A_i, N_i, B_{in}, κ_{in} and τ_{in}.

On the goods market, the trade shares satisfy

$$\pi_{ni}^{trade} = \frac{A_n(d_{ni}w_n)^{-\theta}}{\sum_s A_s(d_{si}w_s)^{-\theta}}, \tag{1}$$

and in the labor market, total labor factor revenue is equal to total output because of a balanced trade assumption:[4]

$$w_n\sum_i L_{in} = \sum_i \pi_{ni}^{trade}\left(w_i\sum_j L_{ji}\right),$$

[3]This expression is equal to the integral over efficiency draws $b_{in}(\omega)$, where the density measure is the density of $b_{in}(\omega)$ conditional on the individual choosing to live in location n, multiplied by the total population in i.

[4]Appendix F.1 shows how to solve the model with trade deficits with little impact on the results.

where:

$$L_{in} = (B_{in})^{\frac{1}{\varepsilon}} \left(\pi_{in}^{mig}\right)^{\frac{\varepsilon-1}{\varepsilon}} N_i \gamma.$$

The migration shares satisfy

$$\pi_{in}^{mig} = \frac{B_{in}\left(\frac{w_n}{P_n \kappa_{in}}\right)^{\varepsilon}}{\sum_k B_{ik}\left(\frac{w_k}{P_k \kappa_{ik}}\right)^{\varepsilon}},$$

where

$$P_n = \gamma \left(\frac{A_n (w_n)^{-\theta}}{\pi_{nn}^{trade}}\right)^{-\frac{1}{\theta}}.$$

Finally, the trade costs are given by

$$d_{ni} = \tau_{ni} \times \begin{cases} \left(\frac{N_{in}}{\sum_j N_{jn}}\right)^{-\eta} & \text{if } N_{in} \neq 0, \text{ and } n \in US, i \notin US \text{ or } i \in US, n \notin US \\ 1 & \text{otherwise} \end{cases} \tag{2}$$

where

$$N_{in} = \pi_{in}^{mig} N_i.$$

2.4 Equilibrium in changes

Following steps similar to Dekle et al. (2008), one can solve for the proportional change in variables ($\hat{y} = y_{post}/y_{pre}$) given data on initial shares. The equilibrium change in endogenous variables ($\hat{\pi}_{ni}^{trade}, \hat{\pi}_{in}^{mig}, \hat{w}_n, \hat{P}_n$ and $\hat{d}_{ni}$) can be obtained from the following system of equations, given changes in exogenous variables ($\hat{A}_n$, $\hat{B}_{in}$, $\hat{\kappa}_{in}$, $\hat{\tau}_{in}$):

$$\hat{\pi}_{ni}^{trade} = \frac{\hat{A}_n (\hat{d}_{ni} \hat{w}_n)^{-\theta}}{\sum_s \hat{A}_s (\hat{d}_{si} \hat{w}_s)^{-\theta} \pi_{si}^{trade}},$$

$$\hat{w}_n \sum_k \left(\hat{B}_{kn}\right)^{\frac{1}{\varepsilon}} \left(\hat{\pi}_{kn}^{mig}\right)^{\frac{\varepsilon-1}{\varepsilon}} \frac{w_n L_{kn}}{X_n} = \sum_i \hat{w}_i \hat{\pi}_{ni}^{trade} \frac{X_{ni}}{X_n} \left(\sum_k \left(\hat{B}_{ki}\right)^{\frac{1}{\varepsilon}} \left(\hat{\pi}_{ki}^{mig}\right)^{\frac{\varepsilon-1}{\varepsilon}} \frac{w_i L_{ki}}{X_i}\right),$$

$$\hat{\pi}_{in}^{mig} = \frac{\hat{B}_{in}\left(\frac{\hat{w}_n}{\hat{P}_n \hat{\kappa}_{in}}\right)^{\epsilon}}{\sum_s \hat{B}_{is}\left(\frac{\hat{w}_s}{\hat{P}_s \hat{\kappa}_{is}}\right)^{\varepsilon} \pi_{is}^{mig}},$$

$$\hat{P}_n = \left(\frac{\hat{A}_n (\hat{w}_n)^{-\theta}}{\hat{\pi}_{nn}^{trade}}\right)^{-\frac{1}{\theta}},$$

$$\hat{d}_{ni} = \hat{\tau}_{ni}\left[1\left(i \mid n \notin US\right)\hat{\pi}_{in}^{mig}\left(\frac{\sum_j \hat{\pi}_{jn}^{mig} N_{jn}}{\sum_j N_{jn}}\right) + 1\left(i, n \in US\right)\right]^{-\eta}.$$

Solving the model in proportional changes enables me to solve for counterfactual quantities by using only data on baseline trade, migration, and wage bill shares (π_{is}^{trade}, π_{is}^{mig}, X_i, and $\Theta_{in} = \frac{w_n L_{in}}{X_n} = \frac{w_n L_{in}}{w_n \sum_k L_{kn}}$), as well as parameter values for ε, θ and η.

Change in the welfare of natives The expected utility of a person born in location i is given by:

$$U_i = \delta\left[\sum_n B_{in}\left(\frac{w_n}{P_n \kappa_{in}}\right)^{\varepsilon}\right]^{\frac{1}{\varepsilon}},$$

where δ is a constant involving the Gamma function. Using the expression for π_{in}^{mig} and solving for the change in welfare, one can show that the change in welfare for a person born in location i is given by:

$$\hat{U}_i = \left[\sum_n \hat{B}_{in}\left(\frac{\hat{w}_n}{\hat{P}_n \hat{\kappa}_{in}}\right)^{\varepsilon}\pi_{in}^{mig}\right]^{\frac{1}{\varepsilon}}. \tag{3}$$

In reporting results, I will compute an aggregate measure of US welfare that is simply the native-population weighted average of $\hat{U}_i$, for $i \in US$.

2.5 A simpler version to illustrate the mechanisms

To illustrate the mechanisms in play, consider a simpler version of the model where migration is exogenous and workers have the same efficiency everywhere. Suppose there are N states and a rest of the world region. Initially, every state is symmetric except for the fraction of migrant in the state's total population. To fix ideas, assume that there is a total number of native US workers equal to L, each attributed to a state in a fixed and exogenous proportion β_i. The overall fraction of migrant in the US is α, and the total migrant population is in the US is equal to $\frac{\alpha}{1-\alpha}L$ and is attributed to a state in a fixed and exogenous proportion γ_i.

It is straightforward to show that a state population is equal to $\frac{\alpha\gamma_i + (1-\alpha)\beta_i}{1-\alpha}L$. The rest of the world native population is given by R, of which $\frac{\alpha}{1-\alpha}L$ live in the US. For simplicity, assume there is no migrants from the US into the rest of the world (RW). This is similar to the full model above, with an exogenous π_{RWi}^{mig} equal to $\frac{\gamma_i \alpha}{R}$ for every state i. This would be achieved by letting the migration elasticity ε going to 0, and setting $B_{RWi} = \frac{\gamma_i \alpha}{R}$ for $i \in US$ and $B_{RWRW} = \frac{R}{\alpha} - 1$.

We are interested in the reaction of wages in different states as the national fraction of migrant α varies.[5]

The labor market clearing implies that:

$$\underbrace{w_n \frac{\alpha\gamma_n + (1-\alpha)\beta_n}{1-\alpha} L}_{\text{labor payment in } n} = \underbrace{\sum_{i\in US} \left\{ \pi_{ni}^{trade} w_i \frac{\alpha\gamma_i + (1-\alpha)\beta_i}{1-\alpha} L \right\}}_{\text{output sold in the US}} + \underbrace{\pi_{nRW}^{trade} w_{RW} \left(R - \frac{\alpha}{1-\alpha} L \right)}_{\text{exports}}$$

Appendix A shows that differentiating the previous equation with respect to α, keeping β_i and γ_i constant, the elasticity of state n's wage with respect to α, denoted ξ_n, satisfies:

$$\begin{aligned} &\left(\xi_n - \sum_i \frac{X_{ni}}{X_n} \xi_i \right) + \theta \left(\xi_n - \sum_{k,i} \frac{X_{nk}}{X_n} \pi_{ik} \xi_i \right) = \\ &\frac{1}{1-\alpha} \left(\underbrace{\sum_{i\in US, i\neq n} \frac{X_{ni} shmig_i}{X_n}}_{\text{other states mig. expos.}} - \underbrace{\left(1 - \frac{X_{nn}}{X_n}\right) shmig_n}_{\text{own mig. share - own mig. expos.}} \right) \\ &+ \underbrace{\frac{X_{nRW}}{X_n}}_{\text{export expos.}} \frac{1}{1-\alpha} \left\{ \theta\eta \left[\underbrace{1 - shmig_n}_{\text{cost decrease}} - \underbrace{\sum_{k\in US} \pi_{kRW}^{trade} (1 - shmig_k)}_{\text{price index}} \right] - \frac{MIGPOP}{RWPOP} \right\}, \end{aligned} \tag{4}$$

where RW denotes rest of the world. This expression implies that the deviation of state n's elasticity (ξ_n) from a weighted average of other regions' elasticities (the left-hand side) depends on the exposure to migrants in other states ($\sum_{i\in US, i\neq n} \frac{X_{ni} shmig_i}{X_n}$), and the difference between own migrant share and own-migrant demand exposure ($\left(1 - \frac{X_{nn}}{X_n}\right) shmig_n$), and the term on the last row that depends on export exposure.

A state with a high exposure to migrants in other states benefits more from an

[5] Because in the full model, the change in B_{in} is equivalent to a change in $\kappa_{in}^{\varepsilon}$, one can think of this comparative static exercise as an approximation of what would happen in the full model if the migration costs to US states were to increase uniformly for all foreign countries.

overall increase in migrant population, as its internal market access increases with additional migrants. When the own absorption share (X_{nn}/X_n) is low, the state is worse off when its own migrant share increases, because the increased labor supply is not compensated by a high enough increase in own expenditure. However, a low absorption share also implies that the state is selling its output to other states as well, so that the two terms in the middle row are correlated. The sum of the two terms is equal to the total migrant demand exposure ($\sum_{i \in US} \frac{X_{ni} shmig_i}{X_n}$) minus the share of migrant in the state's labor force. These are the two quantities depicted in the introduction in the left panel of Figure 1 in the introduction. When overall migrant demand exposure is higher than the migrant share, the wage reacts positively to the influx of migrants because market access increases by more than labor supply.

The term on the last row shows how the reaction of wage depends on export exposure. The first term inside the curly bracket captures the effect of the decrease in export trade costs. It is increasing in the trade elasticity θ, and the migration trade cost elasticity η, which is intuitive: a change in migrant population affects trade costs which in turns affects exports. State n's export trade cost elasticity with respect to the aggregate migrant share α is equal to η multiplied by 1 minus the share of migrant $shmig_n$.[6] Hence the first term in the square brackets represents the decrease in trade costs and subsequent increase in trade share. The second term in the square brackets, labeled "price index", captures the effect of all the US states' decrease in trade cost, which lower the RW price index and dampen the increase in state n's trade share. The second term in the curly brackets ($MIGPOP/RWPOP$) illustrates the loss in revenue from exports, as demand moves towards the US. One might expect this loss of export market access to be compensated by the increased demand in the US. However the increased demand in the US is offset by the increased labor competition from migrants. The offset is broken down when states are not identical and trade with each others, and the middle row in equation (4) governs the relative gains and losses.

Of course, these analytical results only hold for the simplified case where migration shares are exogenous, and don't say anything about the evolution of the price index, which is likely to fall as the labor supply moves toward closer locations in the US. However, even in nominal terms, wages might increase following an increase in migrant share if η is big enough to compensate for the loss in international demand. To estimate

[6]The share of migrants in state n is given by $\frac{\alpha\gamma_n}{\alpha\gamma_n+(1-\alpha)\beta_n}$. The elasticity of the share of migrants with respect to α is equal to $\frac{\beta_n}{[\alpha\gamma_n+(1-\alpha)\beta_n]}$, which is equal to $1 - shmig_n$.

the full effect of migration changes, I now turn to the calibration of the quantitative model required to conduct counterfactuals.

3 Parameter estimation and calibration

To solve for counterfactual changes in the model, all that is left to do is specify values for the trade elasticity θ, the migration cost elasticity ε and the trade cost migration elasticity η. The first two elasticities have been estimated in the literature, while the third one is still relatively understudied. For this reason, I estimate it in this section.

3.1 Trade cost elasticity of migration

To estimate η, I use the gravity equation coming from the model and estimate it using exports from the 50 US state and DC to the rest of the countries. Combining equations (1) and (2) and taking logs gives the following estimation equation, for exports from state s to country i:

$$\log X_{si} = \gamma_s + \delta_i - \theta \log \tau_{si} + \theta\eta \log\left(N_{is}\right) + \varepsilon_{si}.$$

I parametrize trade costs as a function of distance, and common border dummy:

$$\log X_{si} = \gamma_s + \delta_i + \theta\eta \log\left(N_{is}\right) - \beta_1 \log dist_{si} + \beta_2 COMMON_{si} + \varepsilon_{si}. \tag{5}$$

Note that all country level determinants of trade costs common to all US states, such as tariffs, are included in the destination fixed effect.

Instrument Migrants might choose to settle in a state because unobservable trade frictions between their home country and the host state are correlated with unobservable migration costs, leading to an upward bias in an OLS regression. Migrants could also target states that have low exports to their home country, because that is where their country-specific skill would be especially beneficial in lowering export costs. In that case, the OLS regression would have a downward bias.

Because of these endogeneity concerns, I instrument for migrant population using a similar approach as Burchardi et al. (2019). I first define a leave-out pull factor for migration destination state i at time t, computed as the share of migrants who have entered the US at time t and who reside in state i, excluding migrants from countries located in the same continent as j:

$$pull_{it}^{j} = \frac{\sum_{j' \notin continent_j} M_{j'i,t}}{\sum_{j' \notin continent_j} \sum_i M_{j'i,t}},$$

where $M_{j'i,t}$ is the number of migrants from country j' residing in state i, who migrated at time t. This leave-out pull factor represents the attractiveness of state i to migrants from other continents at the year of migration t. I then construct a leave-out push factor capturing population outflow from country j, by computing the total migration from country j to the US at time t, minus those from country j to state i ($M_{j,t}^{-i} = \sum_{i' \neq i} M_{ji',t}$). Multiplying the pull and push factors provides with an instrument for the number of migrants from country i who entered the US at time t and reside in state j that does not rely on any bilateral migration information. Finally, summing over all years of migration provides with an instrument of the stock of migrant population from country j in state i:

$$miginstr_{ji} = \sum_t pull_{it}^{j} M_{j,t}^{-i}$$

The main identifying assumption is that the shares ($pull_{it}^{j}$) are uncorrelated with unobservables affecting trade between state i and country j. In other words, migrants from different continents should not be choosing their state of destination based on that state's exports to country j. This is likely to be satisfied, as migrants might consider their own country's or its neighbors' ties to a specific destination, but not that of countries in other continents. The estimation will use $miginstr_{ji}$ as an instrument for migrant stocks L_{ij}.

Other studies have dealt with endogeneity concerns by using natural experiments distributing the migrants of a single country across US states (e.g. Parsons and Vézina, 2018). An advantage of my estimation strategy is that it uses many countries which allows me to include importer and exporter fixed effects in the regression to control for multilateral resistance terms.

Data sources for the estimation I use data from two sources to obtain a dataset of migrant stocks, as well as trade flows, for the 50 US states (and the District of

Table 1: Estimation of the effect of migrants on exports

	OLS regression	IV regression
	$\log(exports)$	$\log(exports)$
$\log(migrants)$	0.152***	0.208***
	(0.059)	(0.065)
Adjacency	✓	✓
Distance	✓	✓
Imp. and exp. FE	✓	✓
Country clust. SE	✓	✓
First stage KPF-stat		791
N	2511	2511

Notes: Results from estimating equation 5, using the instrument described in the text. Standard errors in parenthesis, *: $p < 0.1$, **: $p < 0.05$, ***: $p < 0.01$

Columbia) and 56 countries, with the reference year 2013.[7] The data source for migrant stocks in US states is the American Community Survey (ACS). The ACS also contains the year of migration to the US, the state of residence, and the country of origin which I use to construct the instrument. For trade flows at the state-destination level, I use US Census Bureau data on state-level exports.

Results Table 1 shows the results of the estimation. The structural interpretation of the coefficients on $\log(migrants)$ is $\theta \times \eta$. The results show a positive effect of overall migrant population on exports, consistent with a reduction of export trade costs. The elasticity of 0.2 is in line with existing estimates ranging from 0.1 to 0.4 (Peri and Requena-Silvente, 2010). The OLS coefficient is slightly lower, at 0.15. This is consistent with migrants selecting their state of destination based on low exports, or could be due to an attenuation bias due to measurement error.

Full results, first stage results and robustness checks are relegated to Appendix B. The positive effects of migrants on exports is robust to PPMLE estimation, preserving observations with 0 migrants, and using a larger set of countries.

[7] I use 56 countries because they are those for which I have data required to solve the quantitative model in the next section. Appendix B shows consistent regression results using a larger sample of countries.

3.2 Calibration

I calibrate the model to the 50 US states, the District of Columbia, and 56 countries, and a composite "Rest of the World" (ROW), for a total of 108 regions.[8] Table 2 summarizes the parameters and their calibrated value, as well data for the data shares needed to solve the model (trade, migration and wage shares).

Data sources I use migration data from the World Bank's Bilateral Migration Matrix for 2013, and combine it with the American Community Survey (ACS) to construct measures of migrant stock in every regions. International trade data comes from the OECD Inter-Country Input-Output table for 2013, and within-US trade data comes from the Commodity Flow Survey (CFS).[9] Wage bill shares are calibrated using survey data from the ACS for US states, and from other national surveys for other countries, obtained through IPUMS-International (MPC, 2019). Section D in the Appendix provides additional details on the sources and the exact mapping between the data and the model objects.

Parameter values For the trade elasticity and the migration elasticity, I take values from the literature. I set the trade elasticity θ to 4, following Simonovska and Waugh (2014), and the migration elasticity ε to 2.3 as in Caliendo et al. (2017). For the elasticity of trade costs to migration, I use my estimate of 0.2 from above, whose structural interpretation is $\eta \times \theta$, and thus set $\eta = 0.2/\theta = 0.05$. In Appendix E, I explore different values of elasticities, with no significant differences in the results interpretation.

4 Counterfactual simulations

To quantify the effect of migration, I conduct the following counterfactual: I increase migration costs to the US uniformly for all foreign countries (κ_{iUS}) such that the

[8]The large majority of US trade flows and migrant stock are covered by the 56 countries: the ROW only accounts for 10% of US exports and 30% of migrant population.

[9]See Appendix D.2 for a discussion of the data coverage in the CFS, and a robustness check for its limitations.

Table 2: Link between the model and the data

	Description	Value	Source
Parameter			
ε	migration elasticity	2.3	Caliendo et al. (2017)
θ	trade elasticity	4	Simonovska and Waugh (2014)
η	migration-elasticity of trade costs	$\eta = 0.2/\theta$	own estimate
Exogenous object			
$\hat{A}_n$, $\hat{B}_{in}$,$\hat{\tau}_{in}$		1	keep constant
$\hat{\kappa}_{in}$	migration costs		uniformly increased for $i \notin US$, $n \in US$, to target a reduction of 50% in total migrant stock living in the US
Data			
π_{in}^{mig}, N_{in}	population data		ACS, World Bank
π_{in}^{trade}, X_n	trade data (including services)		Census data on state level exports and imports, OECD ICIO, Commodity Flow Survey
Θ_{in}	share of wage bill to migrants from i in n's output		American Community Survey, IPUMS-International

Notes: see section D in the appendix for details on the sources and exact mapping between the data and the model objects.

migrant share of US population is reduced by 50%. This is similar to reducing the migrant population shares to that of 1980.[10] It is also consistent with proposed legislation that aim to reduce legal annual immigration flows by half.[11] The resulting changes in variables can be interpreted as if the economy moved to a different steady state.

To further understand the role of migration in shaping market access of each state, I also run three additional counterfactuals for each state: the first increases migration costs in the particular state only, the second increases migration costs in all other states except the state of interest, and the third leaves migration costs unchanged but increases the export trade costs to the level they reach in the main counterfactual.[12] These counterfactuals provide an approximate decomposition of the full effect of the nation-wide increase in migration costs into:

1. A shock to the labor supply and migrant-induced within-state market access in state s, leaving demand from international migrants in other states unaffected (outside of general equilibrium forces) and export trade costs unchanged. I define the wage changes from this counterfactual as the "own-state effect".

2. A shock to internal market access due to a decrease in demand from international migrants living in other states, leaving the labor supply and export trade costs in state s unaffected. I define wage changes from this counterfactual as the "intra-national market access effect".

3. A shock to international market access due to the increase in export trade costs. I define wage changes from this counterfactual as the "international market access effect".

[10] In 1980, the share of migrant population in the US was 6.2%. Reducing the migrant population in 2013 (base year for my analysis) by half would bring the migrant share to around 6.8%.

[11] While the proposed legislation reduces immigration flows by 50%, there is no concept of flows in the model and I assume that the reduction in flows would translate in a long-run reduction of migrant stock by half. See the following link for details of the proposed bill: https://www.congress.gov/bill/115th-congress/senate-bill/354

[12] Precisely, I use the value of $\hat{\kappa}_{iUS}, \forall i \notin US$ necessary to achieve the 50% reduction in migrant share in the main counterfactual, and the resulting change in export trade cost $\hat{d}_{ij}, \forall i \in US, j \notin US$. I construct the first additional counterfactual by setting $\hat{\kappa}_{is} = \hat{\kappa}_{iUS}, \forall i \notin US$ for state s, and $\hat{\kappa}_{is'} = 1, \forall s' \neq s$, and no effect of migrants on trade costs ($\eta = 0$). The second additional counterfactual uses $\hat{\kappa}_{is} = 1, \forall i \notin US$ for state s, and $\hat{\kappa}_{is'} = \hat{\kappa}_{iUS}, \forall s' \neq s$, and no effect of migrants on trade costs ($\eta = 0$). The third is constructed using $\hat{\kappa}_{ij} = 1$ and $\hat{\tau}_{ij} = \hat{d}_{ij}$.

Table 3: Average changes

	Constant trade costs	Endogenous trade costs
% Change in state export costs, exports weighted	0 (0)	3.7 (0.16)
% Change in exports as share of output	1.56 (0.56)	-4.47 (1.07)
% Change in natives' welfare	-0.01 (0.10)	-0.13 (0.09)

Notes: The table shows the percentage changes, after reducing the share of migrants in the US population by half. Numbers are average across US states, with standard deviation in parenthesis.

4.1 Results

I present first the aggregate US-wide results, before turning to the regional impacts and their decomposition.

Aggregate results Table 3 shows the average change in export trade costs across US states and the average change in exports as share of state output, as well as the average change in welfare in the US. Standard deviations across states are also shown in parentheses.

On average, export trade costs faced by US states increase by 3.7%, which is of similar magnitude as the 4.9% current ad valorem export tariffs faced by US exporters (WEF, 2016). The average change in welfare is close to 0 when trade costs are not allowed to react to migrant population, but becomes negative at -0.13% when export costs increase because of the reduction in migrant population. This underpins the importance of the trade cost reduction channel of migrants. In fact, exports as a share of output increase in the first case, as demand moves out of the US, but decreases in the second case, as the increase in export trade costs is high enough to offset the geographical shift in demand.

The standard deviation of trade costs changes is low compared to the average effect. This is because the uniform increase in migration costs leads, to a first order approximation, to a proportional reduction of migrant population of every country in every state, hence affecting trade costs similarly.[13] The dispersion of welfare changes across US states is however of the same order of magnitude as the average effect and I therefore analyze the geographical dispersion in the next subsection.

Regional heterogeneity This section investigates what drives the heterogenous response to the drop in migrant population across states, focusing on explaining the variation in real wage change across US states.[14]

Figure 2 plots the percentage change in a state's real wage for the main counterfactual as well as the three additional counterfactuals. The first bar (in blue) displays the change in real wage for the main counterfactual, the second bar (in grey) displays the own-state effect (defined as the change in real wage when only own-state migrant population is reduced), the third bar (in white) displays the intra-national market access effect (defined as the change in real wage when other-state migrant population is reduced), and the last bar shows the international market access effect (defined as the change when only export trade costs are changed). While the sum of the additional counterfactuals is not exactly identical to the main counterfactual, it is extremely close to it, so that they can be thought of as a decomposition of the main counterfactual.[15]

The average real wage change of -0.16% can thus be decomposed into an own-state effect of $+0.26\%$, an intra-national market access effect of -0.31 and and international market access effect of -0.11%. The state-level results reveal several interesting patterns.

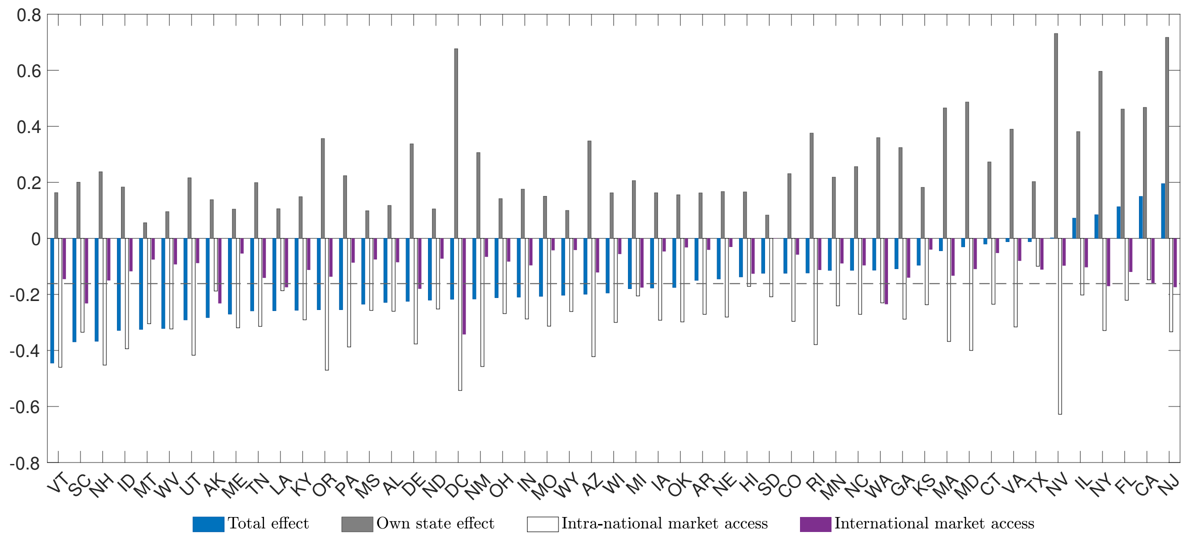
First, it is clear that the nationwide reduction of migrant population has heterogeneous effects across states, from Vermont's real wage dropping by around .44% to New Jersey's wage increasing by around .20%.

[13]Some states are affected differentially depending on the composition of their migrant population. For example, almost 10% of Mexican-born population resides in the USA. About half of these move to Mexico in the counterfactual, thereby increasing labor supply in Mexico and leading to a drop in real wage, which compensates the drop in attractivity of the US due to the increased migration cost. Hence states with a high share of Mexican migrants will experience a slightly lower drop in migrant population, leading to a lower increase in trade costs. These effects, however, are all second-order, which is why the increase in trade costs are fairly homogenous.

[14]Note that because of migration, the change in state-level real wage is somewhat different from the change in welfare of the state's natives. I focus on change in real wages in this section as it is easier to interpret its reaction to migrant demand and export exposure through the lens of the model. Change in state's native welfare is highly correlated with the change in the state's welfare because the initial share of native population in the state is high (see equation 3).

[15]The correlation between the sum of the decompositions and the main counterfactual is 0.99, and the average absolute difference is around 0.002 percentage points.

Figure 2: Decomposition of the change in real wage



Notes: The figure plots the counterfactual real wage change in each state in the main counterfactual and the three decompositions.

Second, even small state-level wage changes can mask large underlying changes caused by labor supply reduction or market access. For example, Nevada (NV)'s real wage barely reacts to the nationwide migrant share reduction. However, if its migrant population were to decrease leaving the rest of the US's migrant population constant, real wage would increase because the drop in labor supply would be larger than the drop in market access, as illustrated in the positive grey bar. However, because of its exposure to migrant demand from other states due to trade linkages with large migrant states such as California, its wage falls when migrants in other states disappear, as indicated by the negative white bar. Furthermore, the drop in international market access due to the increase in export costs depresses the wage even further, as evidenced by the negative purple bar.

Finally, the size of the intra-national market access effect is larger and more disperse than the international market access effect, implying that the heterogeneity across states is mostly driven by internal rather than international market access. The international component still remains sizable at negative 0.11% on average.

To clearly illustrate the mechanisms at play, Figure 3 plots the value of each decomposition bar against the relevant heuristic measures mentioned in Section 2.5. The left panel plots the own-state effect against the difference between own migrant share and own migrant demand exposure. As expected, the relationship is positive. States with a higher migrant share than own-migrant absorption benefit from the removal of migrants in their state, because their labor supply drops by more than the demand for their output. The middle panel plots the intra-national market access effect on exposure to migrants from other states. The relationship is negative, as states who sell a larger share of their output to migrants in other states experience a larger decline in market access. Finally the right panel of Figure 3 plots the international market access effect against the export exposure. The relationship is negative as states with a higher export exposure suffer more from the increase in trade costs.

5 Skill heterogeneity and migrant-native work substitutability

The importance of skills and the imperfect substitutability between migrant and native workers in determining the effects of migration has long been recognized (e.g. Ottaviano and Peri, 2012). In this section, I show that the skills shape the effect of migration on trade costs, but leaves the importance of regional exposure to migrant demand unchanged.

5.1 Empirical evidence on skill heterogeneity

To investigate the differential impact of skilled and unskilled migration on trade costs, I run the same regression as in section 3.1, separating high-skill migrants (defined as migrants with some college level education) and low-skill migrants. The instrumental variable approach is the same, except for the instrument being computed at the skill level.

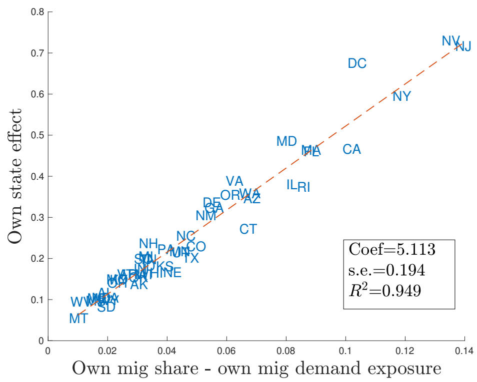
Formally, I run the following regression:

$$\log X_{ni} = \gamma_s + \delta_i + \theta\eta^H \log\left(N_{is}^H\right) + \theta\eta^L \log\left(N_{is}^L\right) - \beta_1 \log dist_{si} + \beta_2 COMMON_{si} + \varepsilon_{si} \quad (6)$$

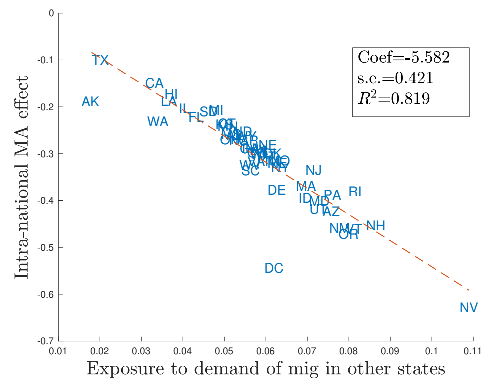
where N_{is}^H and N_{is}^L are the number of high- and low-skill migrants from country i residing in state s. Table 4 reports the results of the regression, together with the pooled results from above for convenience.

The results reveal that high-skill migration is responsible for the positive impact of migration on exports, with an elasticity of around 0.3, while low-skill migration has no

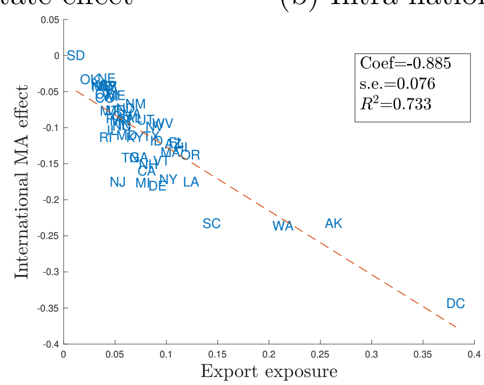
Figure 3: Heuristic measures



(a) Own-state effect



(b) Intra-national market access



(c) International market access

Notes: The left panel plots the change in real wage in the own-state counterfactual, where only migration costs to the specific state are increased, against the difference between own-migrant share and own-migrant demand exposure. The middle panel plots the change in real wage when migration costs in other states increase, against the exposure to migrants from other states. The right panel plots the change in real wage when only export costs increase, against export exposure. Own migrant exposure is defined as $shmig_i X_{ii}/X_i$, exposure to demand from other stated is defined as $\sum_{j \neq i} shmig_j X_{ij}/X_i$, and export exposure is defined as X_{iRW}/X_i.

Table 4: Estimation of the effect of migrants on exports by skill

	OLS regression		IV regression	
	$\log(exports)$	$\log(exports)$	$\log(exports)$	$\log(exports)$
$\log(migrants)$	0.152**		0.208***	
	(0.059)		(0.065)	
$\log(HSmig)$		0.091*		0.308***
		(0.052)		(0.105)
$\log(LSmig)$		0.057		-0.056
		(0.038)		(0.077)
Adjacency	✓	✓	✓	✓
Distance	✓	✓	✓	✓
Imp. and exp. FE	✓	✓	✓	✓
Country clust. SE	✓	✓	✓	✓
First stage KPF-stat			791	141
N	2511	2511	2511	2511

Notes: Results from estimating equation 5, using the instrument described in the text. Standard errors in parenthesis, *: $p < 0.1$, **: $p < 0.05$, ***: $p < 0.01$

significant effect. High-skill migrants are probably more likely to perform managerial tasks or occupy jobs with higher responsibility, where finding new customers is more common.

The OLS results are upward biased for low-skill migrant and downward biased for high-skill migrants. This is consistent with low-skill migration taking place towards states that have lower unobservable migration cost correlated with lower unobservable trade costs, while high-skill migrants target states for which their knowledge allow them to lower an otherwise higher trade cost.

5.2 Model

I modify the model in Section 2 to include different skilled and unskilled labor, as well as imperfect substitutability between migrant and native workers. Details of the model are relegated to Appendix C and are mostly the same as the model in Section 2. I present the main differences below.

Production There are now four types of labor used for production: migrant and native, high- and low-skill labor. Low-skill and high-skill labor (L^L and L^H) are measured in efficiency units of labor, with migrant and domestic labor being imperfectly substitutable. More precisely, the production function for good j is given by:

$$y(j) = z(j) \left[\phi^L \left(L^L\right)^{\frac{\rho-1}{\rho}} + \phi^H \left(L^H\right)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}},$$

where $z(j)$ is a location-specific idiosyncratic productivity for each good j and ρ is the elasticity of substitution across skills. The amount of s-skill labor, L^s, is itself a CES aggregate of native and migrant workers:

$$L^s = \left[\phi^{sd} \left(L^{sd}\right)^{\frac{\lambda-1}{\lambda}} + \phi^{sm} \left(L^{sm}\right)^{\frac{\lambda-1}{\lambda}}\right]^{\frac{\lambda}{\lambda-1}},$$

where λ is the elasticity of substitution across native and migrant labor, L^{sd} is the amount of domestic (native) units of labor of skill s and L^{sm} is the amount of migrant units of labor of skill s.

Preferences and worker efficiency Workers of skill s born in region i and living in region n get the following utility:

$$U^s_{in} = \frac{W_n}{\kappa^s_{in}},$$

where W_n is the same CES aggregator of the continuum of goods as in the baseline model and κ^s_{in} is a migration cost in term of utils.

Workers supply their endowment of labor inelastically in the location they reside, but have a different efficiency depending on where they were born and were they reside. Specifically, worker ω of skill s born in region i and living in region n supplies $b^s_{in}(\omega)$ of efficiency units of labor.

Skill level can be either high ($s = H$) or low ($s = L$). The efficiency is distributed according to the following Fréchet distribution:

$$F^s_{in}(b) = e^{-B^s_{in} b^{-\varepsilon}},$$

where ε is the shape parameter governing the dispersion of efficiencies and B^s_{in} is a location parameter: workers of skill s from region i are in general more efficient in regions n with higher B^s_{in}.

Trade costs Consistent with the evidence in section 5.1, trade costs depend on the high and low-skill migration as follows:

$$d_{ni} = \tau_{ni} \times \begin{cases} \left(\frac{N^L_{in}}{\sum_{j,s} N^s_{jn}}\right)^{-\eta^L} \left(\frac{N^H_{in}}{\sum_{j,s} N^s_{jn}}\right)^{-\eta^H} & \text{if } N^s_{in} \neq 0, n \in US, i \notin US \text{ or opposite} \\ 1 & \text{otherwise} \end{cases}.$$

Trade costs are negatively affected by the share of migrants of skill s in the exporter's population, but the effect of different skill level is heterogeneous, governed by the two elasticities η^H and η^L.

The rest of the model follow the quantitative framework in section 2, and additional description of the equilibrium with skill as well as calibration of the parameters is relegated to Appendix C. For the trade elasticity and migration elasticity, the parameter values are similar to the ones in the main model. Regarding trade cost elasticities, I set $\eta^H = 0.3/\theta$ and $\eta^L = 0$ consistent with the estimates in 5.1. Finally, the elasticity of substitution between skills ρ is set to 1.6 following Katz and Murphy (1992), and the elasticity of substitution between native and migrant work λ is set to 20 following Ottaviano and Peri (2012). Alternative calibration is explored in Appendix E.

5.3 Counterfactual results

Table 5 shows the average change in export trade costs across US states and the average change in exports as share of state output, as well as the average change in wages in the US for different skill levels, defined as the native-population weighted average of wage changes in each state. Standard deviations across states are also shown in parentheses.

The average change in welfare is negative, at -0.17% and -0.22% for low and high skill respectively, when trade costs are left constant. Exports as a share of output increase, as demand moves out of the US when the migrants leave the US. When trade costs are endogenous, export trade costs faced by US states increase by 5.49% on average, a larger increase than in the results that don't account for skill differential, because the elasticity of trade costs on high-skill migrants is higher. The resulting drop in welfare of low- and high-skill US natives are around 0.34 and 0.37% respectively. The larger drop in average welfare than in the baseline model is explained by the larger increase in export costs and by the complementarity between native and foreign labor.

Table 5: Imperfect substitutability scenario: average changes across US states

	Constant trade costs	Endogenous trade costs
% change in state export costs, exports weighted	0 (0)	5.49 (0.23)
% change in exports as share of output	1.46 (0.60)	-7.14 (1.34)
% change in US low-skill welfare	-0.16 (0.16)	-0.34 (0.18)
% change in US college welfare	-0.20 (0.07)	-0.37 (0.07)

Notes: The table shows the percentage changes going from current migrant population in the US to a population of half. Numbers are weighted average across US states, with standard deviation in parenthesis.

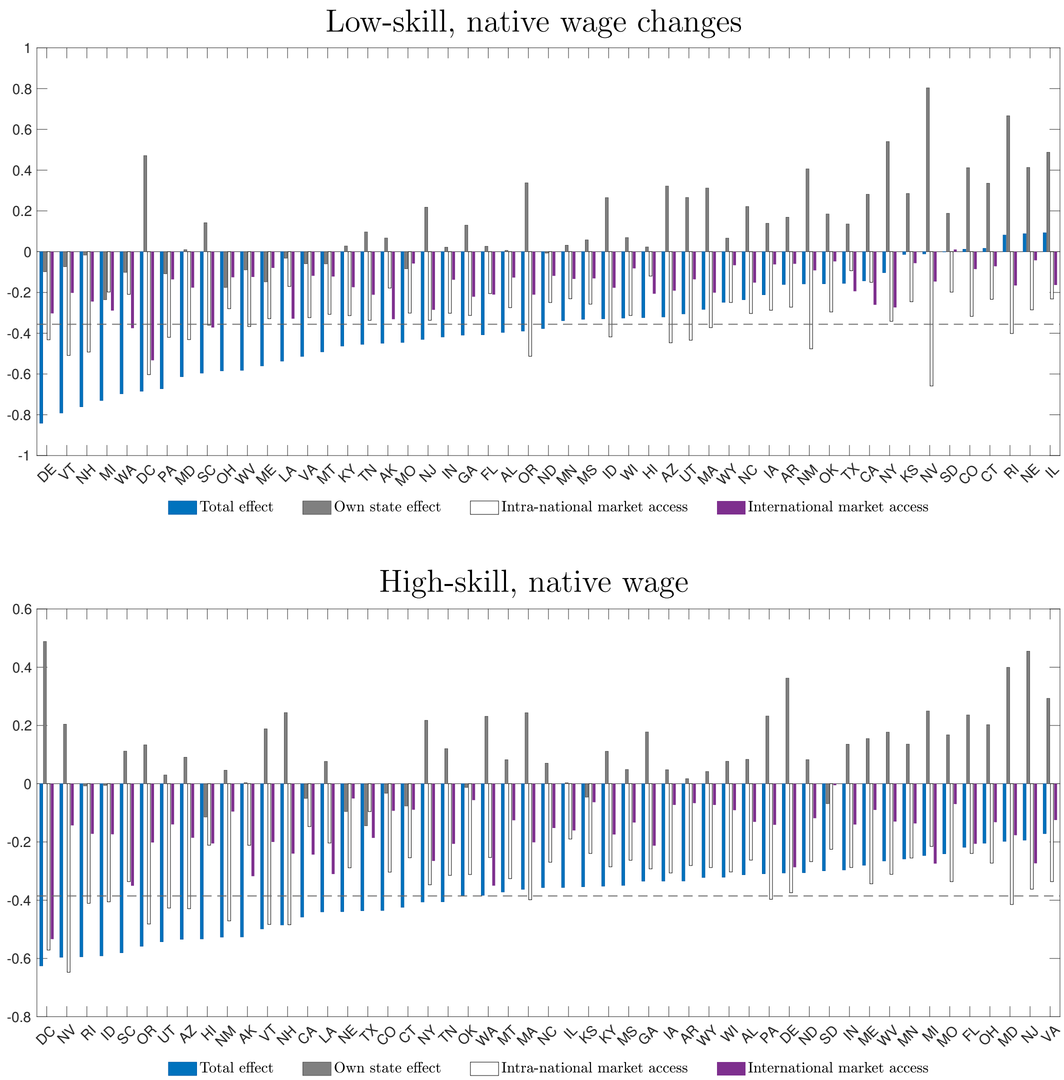
Appendix E shows that the changes in welfare are dampened when the elasticity of substitution between migrants and natives' labor is increased.

Regional heterogeneity As for the main counterfactual, I decompose the effect into an "own-state" reduction of migration an intra-national market access effect, and an international market access effect. Figure 4 displays the total change in real wage (first bar in blue), the own-state effect (second bar in gray), the intra-national market access effect (third bar in white), and international market access effect (fourth bar in purple). Subfigure 4 shows the response of native low-skill wages, while subfigure 4 depicts the reaction of native high-skill wages.

The shock to own-state migrant population, while having a positive impact on average, is negative in some states, as complementarities induce a lower wage for native workers after the reduction of migrant labor supply. Both intra- and international market access effects are negative, as the negative demand shock affects wages negatively.

Overall, the skill and native-migrant imperfect substitutability dimensions affect how the labor supply shock feeds in the economy: it affects the magnitude, and even

Figure 4: Imperfect substitutability scenario: decomposing regional effects



Notes: The figure plots the counterfactual real wage change in each state in the main counterfactual and the three decompositions, for the model with skills and imperfect substitutability between native and foreign workers.

Table 6: Comparison between baseline and imperfect substitutability model

	$corr\left(w_i^{base}, w_i^{low}\right)$	$corr\left(w_i^{base}, w_i^{high}\right)$	$corr\left(w_i^{high}, w_i^{low}\right)$
Own effect	0.556	0.552	-0.233
Internal MA	0.991	0.994	0.975
International MA	0.992	0.993	0.998

Notes: The table shows the correlation between the real wage changes resulting from own-migrant removal (first row), other-states migrant removal (middle row), and increased trade costs (third row). The first column shows the correlation across states between the wage change in the baseline model and the low-skill wage in the imperfect substitutability model. The middle column displays the correlation between baseline and high-skill wages, and the right column displays the correlation between the high- and low-skill wage changes.

sometimes the sign of the own-state effect. The market access effect of reducing migrant population, however, remains unaffected by these production elasticities. Table 6 makes this point clear by displaying the correlation between the baseline model and imperfect substitutability model decompositions. The correlation is high at 0.99 for the internal and international market access effects: these mechanisms operate through the demand channel and their regional impact are similar regardless of the production elasticities. The own-migrant effect correlation is lower between the baseline and imperfect substitutability model, because the production elasticities λ and ρ affect the reaction of the wage to the increased labor supply.

6 Conclusion

This paper shows the impact of migrants on trade market access. Migrants shape market access through two channels. They change the geographical location of demand, thereby benefiting regions closer to their migration destination, and they reduce trade frictions, thereby easing access of their host country to their home country's market.

The evidence shows that migrants have a causal impact on exports from their host state to their home country, particularly so for high-skill migrants. Using a model of intra- and inter-national trade and migration calibrated to the US states, I show that a nationwide reduction in migrant population produces heterogeneous responses in wage through different effects on intra- and inter-national market access. States with a high exposure to migrants inside the US relative to their own migrant population are hurt more by the removal of migrants, and those with a high export exposure are hurt more by the increase in trade costs.

While policy discussions typically emphasize the effect of migrants' labor supply, this paper shows that their effect on labor demand through increased market access is important as well.

References

Ran Abramitzky and Leah Boustan. Immigration in American Economic History. *Journal of Economic Literature*, 55(4):1311–45, 2017.

Michael Bailey, Abhinav Gupta, Sebastian Hillenbrand, Theresa Kuchler, Robert J Richmond, and Johannes Stroebel. International Trade and Social Connectedness. Working Paper 26960, National Bureau of Economic Research, April 2020.

Gharad Bryan and Melanie Morten. The Aggregate Productivity Effects of Internal Migration: Evidence from Indonesia. *Journal of Political Economy*, 127(5):2229–2268, 2019.

Konrad B Burchardi, Thomas Chaney, and Tarek A Hassan. Migrants, Ancestors, and Foreign Investments. *The Review of Economic Studies*, 86(4):1448–1486, 2019.

Ariel Burstein, Gordon Hanson, Lin Tian, and Jonathan Vogel. Tradability and the Labor-Market Impact of Immigration: Theory and Evidence From the United States. *Econometrica*, 88(3):1071–1112, 2020.

Lorenzo Caliendo, Luca David Opromolla, Fernando Parro, and Alessandro Sforza. Goods and Factor Market Integration: A Quantitative Assessment of the EU Enlargement. Working Paper 23695, National Bureau of Economic Research, August 2017.

Lorenzo Caliendo, Maximiliano Dvorkin, and Fernando Parro. Trade and Labor Market Dynamics: General Equilibrium Analysis of the China Trade Shock. *Econometrica*, 87(3):741–835, 2019.

David Card. The Impact of the Mariel Boatlift on the Miami Labor Market. *ILR Review*, 43(2):245–257, 1990.

Miguel Cardoso. The Trade-Creation Effect of Migrants: a Multi-Country General Equilibrium Analysis. mimeo, Brock University, 2019.

Miguel Cardoso and Ananth Ramanarayanan. Immigrants and Exports: Firm-Level Evidence from Canada. mimeo, Brock University, 2019.

Pierre-Philippe Combes, Miren Lafourcade, and Thierry Mayer. The Trade-Creating Effects of Business and Social Networks: Evidence from France. *Journal of International Economics*, 66(1):1–29, 2005.

Robert Dekle, Jonathan Eaton, and Samuel Kortum. Global rebalancing with gravity: Measuring the burden of adjustment. *IMF Staff Papers*, 55(3):511–540, 2008.

Julian Di Giovanni, Andrei A. Levchenko, and Francesc Ortega. A Global View of Cross-Border Migration. *Journal of the European Economic Association*, 13(1):168–202, 2015.

James A. Dunlevy. The Influence of Corruption and Language on the Protrade Effect of Immigrants: Evidence from the American States. *Review of Economics and Statistics*, 88(1):182–186, 2006.

Jonathan Eaton and Samuel Kortum. Technology, Geography, and Trade. *Econometrica*, 70(5):1741–1779, 2002.

Gabriel Felbermayr, Volker Grossmann, and Wilhelm Kohler. Migration, International Trade, and Capital Formation: Cause or effect? In *Handbook of the Economics of International Migration*, volume 1, pages 913–1025. Elsevier, 2015.

David M Gould. Immigrant Links to the Home Country: Empirical Implications for US Bilateral Trade Flows. *The Review of Economics and Statistics*, pages 302–316, 1994.

Chang-Tai Hsieh, Erik Hurst, Charles I Jones, and Peter J Klenow. The Allocation of Talent and US Economic Growth. *Econometrica*, 87(5):1439–1474, 2019.

Lawrence F Katz and Kevin M Murphy. Changes in Relative Wages, 1963–1987: Supply and Demand Factors. *The Quarterly Journal of Economics*, 107(1):35–78, 1992.

David Lagakos and Michael E Waugh. Selection, Agriculture, and Cross-Country Productivity Differences. *American Economic Review*, 103(2):948–80, 2013.

Marc J Melitz. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6):1695–1725, 2003.

Nicolas Morales. High-Skill Migration, Multinational Companies and the Location of Economic Activity. *SSRN 3336003*, 2019.

MPC. Integrated Public Use Microdata Series, International: Version 7.2. Technical report, Minnesota Population Center, 2019.

Gianmarco Ottaviano and Giovanni Peri. Rethinking the Effect of Immigration on Wages. *Journal of the European Economic Association*, 10(1):152–197, 2012.

Gianmarco Ottaviano, Giovanni Peri, and Greg Wright. Immigration, Trade and Productivity in Services: Evidence from UK Firms. *Journal of International Economics*, 112:88–108, 2018.

Christopher Parsons and Pierre-Louis Vézina. Migrant Networks and Trade: The Vietnamese Boat People as a Natural Experiment. *The Economic Journal*, 128 (612):F210–F234, 2018.

Giovanni Peri and Francisco Requena-Silvente. The Trade Creation Effect of Immigrants: Evidence from the Remarkable Case of Spain. *Canadian Journal of Economics/Revue canadienne d'économique*, 43(4):1433–1459, 2010.

Stephen J. Redding. Goods Trade, Factor Mobility and Welfare. *Journal of International Economics*, 101:148–167, 2016.

JMC Santos Silva and Silvana Tenreyro. The Log of Gravity. *The Review of Economics and statistics*, 88(4):641–658, 2006.

Ina Simonovska and Michael E Waugh. The Elasticity of Trade: Estimates and Evidence. *Journal of international Economics*, 92(1):34–50, 2014.

Walter Steingress. The Causal Impact of Migration on US Trade: Evidence from Political Refugees. *Canadian Journal of Economics/Revue canadienne d'économique*, 51(4):1312–1338, 2018.

WEF. The Global Enabling Trade Report 2016. *World Economic Forum*, 2016.

A Simplified model derivation

Start from the labor market clearing equation:

$$w_n \left[\frac{\alpha}{(1-\alpha)} \gamma_n + \beta_n \right] = \sum_{i \in US} \pi_{ni} w_i \left[\frac{\alpha}{(1-\alpha)} \gamma_i + \beta_i \right] + \pi_{nRW} w_{RW} \left(\frac{R}{L} - \frac{\alpha}{1-\alpha} \right)$$

Define P_n as the total population of region n: $P_n = \frac{\alpha\gamma_n + (1-\alpha)\beta_n}{1-\alpha} L$ if $n \in US$, and $P_{RW} = R - \frac{\alpha}{1-\alpha} L$. We have that:

$$w_n P_n = \sum_i \pi_{ni} w_i P_i$$

Before taking the derivative of equation (A), consider first the partial derivatives with respect to α of P_n and π_{ni}.

$$\frac{\partial P_n}{\partial \alpha} = \frac{1}{(1-\alpha)^2} \gamma_n L,$$

when $n \in US$, and for the rest of the world:

$$\frac{\partial P_{RW}}{\partial \alpha} = -\frac{1}{(1-\alpha)^2} L$$

Regarding the trade shares, we have:

$$\frac{\partial \pi_{ni}}{\partial \alpha} = \pi_{ni} \left[-\frac{\theta}{w_n} \frac{\partial w_n}{\partial \alpha} + \theta \sum_k \pi_{ki} \frac{\partial w_k}{\partial \alpha} \frac{1}{w_k} \right], i \in US$$

And when i is the rest of the world, we also have to take into account changes in export trade costs from the US:

$$\frac{\partial \pi_{ni}}{\partial \alpha} = \pi_{ni} \Bigg[-\frac{\theta}{w_n} \frac{\partial w_n}{\partial \alpha} + \theta \sum_k \pi_{ki} \frac{\partial w_k}{\partial \alpha} \frac{1}{w_k} + \theta\eta \frac{1}{\alpha} \frac{1 - migsh_n}{1-\alpha} - \theta\eta \frac{1}{\alpha} \sum_{k \in US} \pi_{ki} \frac{1 - migsh_k}{1-\alpha} \Bigg], i = RW$$

Take the derivative of the labor market clearing condition with respect to α:

$$\frac{dw_n}{d\alpha}P_n + w_n\frac{dP_n}{d\alpha} = \sum_i \frac{d\pi_{ni}}{d\alpha}w_iP_i + \pi_{ni}\frac{dw_i}{d\alpha}P_i + \pi_{ni}w_i\frac{dP_i}{d\alpha}$$

Plug in for trade share change:

$$\begin{aligned}\frac{dw_n}{d\alpha}P_n + w_n\frac{dP_n}{d\alpha} = \sum_i &\left(-\frac{\theta}{w_n}\pi_{ni}\frac{dw_n}{d\alpha} + \theta\pi_{ni}\sum_k \pi_{ki}\frac{dw_k}{d\alpha}\frac{1}{w_k}\right)w_iL_i \\ &+ \pi_{ni}\frac{dw_i}{d\alpha}L_i + \pi_{ni}w_i\frac{dL_i}{d\alpha} \\ &+ \theta\eta\frac{1}{\alpha}\pi_{nRW}w_{RW}P_{RW}\left(\frac{1-migsh_n}{1-\alpha} - \sum_{k\in US}\pi_{kRW}\frac{1-migsh_k}{1-\alpha}\right),\end{aligned}$$

and rearange:

$$\begin{aligned}\frac{dw_n}{d\alpha}P_n + \theta\frac{dw_n}{d\alpha}\frac{1}{w_n}\sum_i \pi_{ni}w_iL_i + w_n\frac{dP_n}{d\alpha} = \sum_i &\left(\theta\pi_{ni}\sum_k \pi_{ki}\frac{dw_k}{d\alpha}\frac{1}{w_k}\right)w_iP_i \\ &+ \pi_{ni}\frac{dw_i}{d\alpha}P_i + \pi_{ni}w_i\frac{dP_i}{d\alpha} \\ &+ \theta\eta\frac{1}{\alpha}X_{nRW}\left(\frac{1-migsh_n}{1-\alpha} - \sum_{k\in US}\pi_{kRW}\frac{1-migsh_k}{1-\alpha}\right)\end{aligned}$$

Plug in for change in population:

$$\begin{aligned}\frac{dw_n}{d\alpha}P_n + \theta\frac{dw_n}{d\alpha}\frac{1}{w_n}\sum_i X_{ni} + w_n\frac{1}{(1-\alpha)^2}\gamma_nL = \theta\sum_i X_{ni}\left(\sum_k \pi_{ki}\frac{dw_k}{d\alpha}\frac{1}{w_k}\right) - \\ \pi_{nRW}w_{RW}\frac{1}{(1-\alpha)^2}L + \sum_i \pi_{ni}\frac{dw_i}{d\alpha}P_i + \sum_{i\in US}\pi_{ni}w_i\frac{\gamma_iL}{(1-\alpha)^2} \\ + \theta\eta\frac{1}{\alpha}X_{nRW}\left(\frac{1-migsh_n}{1-\alpha} - \sum_{k\in US}\pi_{kRW}\frac{1-migsh_k}{1-\alpha}\right)\end{aligned}$$

Multiply by α and rewrite as an elasticity, with $\xi_n = \frac{dw_n}{d\alpha}\frac{\alpha}{w_n}$:

$$\begin{aligned}\xi_n w_n L_n + \theta\xi_n \sum_i X_{ni} + w_n \frac{\alpha\gamma_n L}{(1-\alpha)^2} = \theta \sum_i X_{ni} \left(\sum_k \pi_{ki}\xi_k\right) \\ + \sum_i \pi_{ni}\xi_i w_i P_i + \sum_{i\in US} \pi_{ni} w_i \frac{\alpha}{(1-\alpha)^2}\gamma_i L \\ - \pi_{nRW} w_{RW} \frac{\alpha}{(1-\alpha)^2} L \\ + \theta\eta X_{nRW} \left(\frac{1-migsh_n}{1-\alpha} - \sum_{k\in US} \pi_{kRW} \frac{1-migsh_k}{1-\alpha}\right)\end{aligned}$$

Divide by $w_n L_n = X_n$ and rearange:

$$\begin{aligned}\left(\xi_n - \sum_i \frac{X_{ni}}{X_n}\xi_i\right) + \theta\left(\xi_n - \sum_{i,k} \pi_{ki}\frac{X_{ni}}{X_n}\xi_k\right) = -\frac{w_n}{X_n}\frac{\alpha\gamma_n L}{(1-\alpha)^2} \\ + \sum_{i\in US} \pi_{ni}\frac{w_i}{X_n}\frac{\alpha}{(1-\alpha)^2}\gamma_i L - \pi_{nRW}\frac{w_{RW}}{X_n}\frac{\alpha}{(1-\alpha)^2}L \\ + \theta\eta\frac{X_{nRW}}{X_n}\left(\frac{1-migsh_n}{1-\alpha} - \sum_{k\in US}\pi_{kRW}\frac{1-migsh_k}{1-\alpha}\right)\end{aligned}$$

Realize that $\frac{\alpha\gamma_n L}{(1-\alpha)}$ is equal to the migrant population in state n, and $\frac{\alpha L}{1-\alpha}$ is equal to the total migrant population:

$$\begin{aligned}\left(\xi_n - \sum_i \xi_i\frac{X_{ni}}{X_n}\right) + \theta\left(\xi_n - \sum_{i,k}\pi_{ki}\xi_k\frac{X_{ni}}{X_n}\right) = -\frac{w_n}{X_n}\frac{migpop_n}{(1-\alpha)} + \sum_{i\in US}\pi_{ni}\frac{w_i}{X_n}\frac{migpop_i}{(1-\alpha)} \\ - \pi_{nRW}\frac{w_{RW}}{X_n}\frac{MIGPOP}{(1-\alpha)} \\ + \theta\eta\frac{X_{nRW}}{X_n}\left(\frac{1-migsh_n}{1-\alpha} - \sum_{k\in US}\pi_{kRW}\frac{1-migsh_k}{1-\alpha}\right)\end{aligned}$$

Realize that $\frac{w_{RW}}{X_n}\frac{MIGPOP}{(1-\alpha)} = \frac{w_{RW}L_n}{X_n}\frac{migsh_n}{(1-\alpha)} = \frac{migsh_n}{(1-\alpha)}$:

$$\left(\xi_n^w - \sum_i \xi_i \frac{X_{ni}}{X_n}\right) + \theta\left(\xi_n - \sum_{i,k} \pi_{ki}\xi_k \frac{X_{ni}}{X_n}\right) = -\frac{migsh_n}{(1-\alpha)} + \sum_{i\in US} \frac{X_{ni}}{X_n}\frac{migsh_i}{(1-\alpha)}$$
$$+\frac{1}{1-\alpha}\frac{X_{nRW}}{X_n}\left(\theta\eta\left(1 - migsh_n - \sum_{k\in US} \pi_{kRW}\left(1 - migsh_k\right)\right) - \frac{MIGPOP}{RWPOP}\right),$$

which is equation (4).

B Additional regression results

Table 7 displays the full results of the regression presented in the main body of the paper. All first stage results are strong, and the sign of bilateral controls are as expected.

Table 8 shows additional results. Columns 1 and 2 show results of a PPMLE (see Silva and Tenreyro (2006)) estimation, columns 3-4 show the results using $\log(1 + mig)$ in order to avoid droping observations where states have positive exports, but no migrant population, and columns 5-6 show results using all countries to which a US state has positive exports.[16] All regressions use the same instrumental variable strategy as the main ones. In all robustness checks, the positive effect of migrants remains, and the difference in skills as well.

C Skill and imperfect substitutability model

C.1 Model details

The following set of equations characterize the equilibrium in the skill model. Most of the derivations are the same as the ones presented for the main model.

On the goods market, the trade shares satisfy

$$\pi_{ni}^{trade} = \frac{A_n(d_{ni}C_n)^{-\theta}}{\sum_s A_s(d_{si}C_s)^{-\theta}},$$

where the labor bundle cost C_n is given by:

[16] In the bigger sample, there are a total of 135 countries, but not all states export to them. Due to convergence issues, the PPMLE standard errors are not clustered at the importing country level.

Table 7: Full Results and First Stage Regressions

	log (*exports*)				First stage		
	OLS		IV		ln(mig)	ln(HSmig)	ln(LSmig)
ln (*migrants*)	0.152*** (.059)		0.208*** (.065)				
ln (*HSmig*)		0.091+ (.052)		0.308*** (.105)			
ln (*LSmig*)		0.057 (.038)		-0.056 (.077)			
ln(*distance*)	-1.377** (.621)	-1.387** (.622)	-1.325** (.595)	-1.342** (.593)	-0.364+ (0.213)	-0.752+ (.377)	-0.443 (.282)
Adjacency	0.348*** (0.164)	0.346*** (.161)	0.304*** (0.164)	0.289*** (.168)	0.097 (0.180)	0.513*** (.087)	0.345 (.224)
ln (*instr.*)					0.753*** (0.026)		
ln (*instr.HS*)						0.520*** (.058)	
ln (*instr.LS*)							0.404*** (.027)
KP F-Stat			791.3	140.7			
Imp. and exp. FE	✓	✓	✓	✓	✓	✓	✓
Country clust. SE	✓	✓	✓	✓	✓	✓	✓
N	2511	2511	2511	2511	2511	2511	2511

Notes: Standard errors in parenthesis, +: $p < 0.1$, **: $p < 0.05$, ***: $p < 0.01$

$$C = \left[\phi^L \left(C^L\right)^{1-\rho} + \phi^H \left(C^H\right)^{1-\rho}\right]^{\frac{1}{1-\rho}}$$

and each skill labor bundle cost is itself given by:

$$C^s = \left[\phi^{sd} \left(w^{sd}\right)^{1-\lambda} + \phi^{sm} \left(w^{sm}\right)^{1-\lambda}\right]^{\frac{1}{1-\lambda}}$$

where the labor bundle costs are derived from the firm's profit maximization problem.

Total revenue is equal to total output:

Table 8: Robustness results

	(1)	(2)	(3)	(4)	(5)	(6)
	PPMLE		$migrants = 1 + mig$		Extended sample	
$\ln(migrants)$	0.275***		0.204***		0.141***	
	(.056)		(.054)		(0.033)	
$\ln(HSmig)$		0.489***		0.305***		0.316***
		(.127)		(.099)		(.064)
$\ln(LSmig)$		-0.121		-0.041		-0.098**
		(.090)		(.067)		(.047)
KP F-Stat			586.2	99.2	2387.5	352.9
Imp. and exp. FE	✓	✓	✓	✓	✓	✓
Standard Errors	robust	robust	imp. clust.	imp. clust.	imp. clust.	imp. clust.
N	2719	2517	2704	2552	5918	5150

Notes: Standard errors in parenthesis, *: $p < 0.1$, **: $p < 0.05$, ***: $p < 0.01$

$$X_n = \sum_i \pi_{ni}^{trade} X_i.$$

On the labor market, for each skill s:

$$C_n^s \left[\phi^{sd} \left(L^{sd} \right)^{\frac{\lambda-1}{\lambda}} + \phi^{sm} \left(L^{sm} \right)^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}} = w_n^{sd} L_{nn}^s + w_n^{sm} \sum_{i \neq n} L_{in}^s$$

where labor supply from migration choices implies that:

$$L_{nn}^s = \left(B_{nn}^s \right)^{\frac{1}{\varepsilon}} \left(\pi_{nn}^{s,mig} \right)^{\frac{\varepsilon-1}{\varepsilon}} N_n^s \gamma,$$

$$\sum_{i \neq n} L_{in}^s = \sum_{i \neq n} \left(B_{in}^s \right)^{\frac{1}{\varepsilon}} \left(\pi_{in}^{s,mig} \right)^{\frac{\varepsilon-1}{\varepsilon}} N_i^s \gamma,$$

where $\gamma = \Gamma(\frac{\varepsilon-1}{\varepsilon})$ and $\Gamma(.)$ is the gamma function. And total revenue is equal to total labor revenue:[17]

$$X_n = \sum_{s\in\{L,H\}} \left[w_n^{sd} L_{nn}^s + w_n^{sm} \sum_{i\neq n} L_{in}^s \right].$$

The migration shares satisfy

$$\pi_{in}^{s,mig} = \frac{B_{in}^s \left(\frac{\left(w_n^{sd}\right)^{(i=n)} \left(w_n^{sm}\right)^{(i\neq n)}}{P_n \kappa_{in}^s} \right)^{\varepsilon}}{\sum_k B_{ik}^s \left(\frac{\left(w_k^{sd}\right)^{(i=k)} \left(w_k^{sm}\right)^{(i\neq k)}}{P_k \kappa_{ik}^s} \right)^{\varepsilon}},$$

where

$$P_n = \gamma \left(\frac{A_n (C_n)^{-\theta}}{\pi_{nn}^{trade}} \right)^{-\frac{1}{\theta}}.$$

Finally, the trade costs are given by

$$d_{ni} = \tau_{ni} \prod_s \left(1\left(i \mid n \notin US\right) \frac{1 + N_{in}^s}{\sum_{s,j} N_{jn}^s} + 1\left(i, n \in US\right) \right)^{-\eta^s},$$

where

$$N_{in}^s = \pi_{in}^{s,mig} N_i^s.$$

C.1.1 Equilibrium in changes

Following steps similar to Dekle et al. (2008), one can solve for the proportional change in variables. The equilibrium changes in endogenous variable ($\hat{\pi}_{in}^{s,mig}$, π_{in}^{trade}, $\hat{w}_n^{sd}$, $\hat{w}_n^{sm}$, $\hat{P}_n$, $\hat{d}_{ni}$, $\hat{C}_n$, $\hat{C}_n^s$, $\hat{X}_n$) following changes in exogenous parameters ($\hat{B}_{in}^s$, $\hat{\kappa}_{in}^s$, $\hat{A}_n$, $\hat{\tau}_{in}$) can be obtained from the following system of equations (where $\hat{y} = y_1/y_0$ is the ratio between the value of variable y before and after the counterfactual shock to exogenous variables):

[17] For expositional convenience, I am omitting the fact that when $n \in US$, workers from every US states get wage w_n^{sd}. In that case, one would have:

$$X_n = \sum_{s\in\{L,H\}} \left[w_n^{sd} \sum_{i\in US} L_{in}^s + w_n^{sm} \sum_{i\notin US} L_{in}^s \right].$$

$$\hat{\pi}_{in}^{s,mig} = \frac{\hat{B}_{in}^{s}\left(\frac{\left(\hat{w}_n^{sd}\right)^{(i=n)}\left(\hat{w}_n^{sm}\right)^{(i\neq n)}}{\hat{P}_n\hat{\kappa}_{in}}\right)^{\epsilon}}{\sum_k \hat{B}_{ik}^{s}\left(\frac{\left(\hat{w}_k^{sd}\right)^{(i=n)}\left(\hat{w}_k^{sm}\right)^{(i\neq n)}}{\hat{P}_k\hat{\kappa}_{ik}^{s}}\right)^{\varepsilon}\pi_{ik}^{s,mig}}$$

$$\hat{\pi}_{ni}^{trade} = \frac{\hat{A}_n(\hat{d}_{ni}\hat{C}_n)^{-\theta}}{\sum_k \hat{A}_k(\hat{d}_{ki}\hat{C}_k)^{-\theta}\pi_{ki}^{trade}}$$

$$\hat{P}_n = \left(\frac{\hat{A}_n(\hat{C}_n)^{-\theta}}{\hat{\pi}_{nn}^{trade}}\right)^{-\frac{1}{\theta}}$$

$$\hat{C}_n = \left[\left(\hat{C}_n^L\right)^{1-\rho}\sum_i \Theta_{in}^L + \left(\hat{C}_n^H\right)^{1-\rho}\sum_i \Theta_{in}^H\right]^{\frac{1}{1-\rho}},$$

where Θ_{in}^s is the initial share of the wage bill going to s-skill workers from i, in country n ($\Theta_{in}^s = \frac{w_n^{sm}L_{in}^s}{X_n}$ if $i \neq n$, $\Theta_{nn}^s = \frac{w_n^{sd}L_{in}^s}{X_n}$), and when $n \notin US$:

$$\hat{C}_n^s = \left[\left(\hat{w}_n^{sd}\right)^{1-\lambda}\frac{\Theta_{nn}^s}{\sum_i \Theta_{in}^s} + \left(\hat{w}_n^{sm}\right)^{1-\lambda}\frac{\sum_{i\neq n}\Theta_{in}^s}{\sum_i \Theta_{in}^s}\right]^{\frac{1}{1-\lambda}},$$

When $n \in US$:

$$\hat{C}_n^s = \left[\left(\hat{w}_n^{sd}\right)^{1-\lambda}\frac{\sum_{i\in US}\Theta_{in}^s}{\sum_i \Theta_{in}^s} + \left(\hat{w}_n^{sm}\right)^{1-\lambda}\frac{\sum_{i\notin US}\Theta_{in}^s}{\sum_i \Theta_{in}^s}\right]^{\frac{1}{1-\lambda}}$$

Trade cost changes are given by:

$$\hat{d}_{ni} = \hat{\tau}_{ni}\prod_{s\in L,H}\left[1\left(i \mid n \notin US\right)\left(\frac{1+\hat{\pi}_{in}^{s,mig}N_{in}^s}{1+N_{in}^s}\right)\left(\frac{\sum_j \hat{\pi}_{jn}^{s,mig}N_{jn}^s}{\sum_{s,j}N_{jn}^s}\right) + 1\left(i,n \in US\right)\right]^{-\eta^s}$$

$$\hat{X}_n X_n = \sum_i \hat{\pi}_{in}^{trade}\pi_{in}^{trade}\left(\hat{X}_i X_i\right)$$

$$\hat{X}_n = \hat{C}_n^H\hat{L}_n^H\sum_i \Theta_{in}^H + \hat{C}_n^L\hat{L}_n^L\sum_i \Theta_{in}^L$$

$$\hat{C}_n^H\hat{L}_n^H = \hat{C}_n^L\hat{L}_n^L\left(\frac{\hat{C}_n^H}{\hat{C}_n^L}\right)^{1-\rho}$$

For $n \notin US$:[18]

$$\frac{\hat{w}_n^{sd}}{\hat{w}_n^{sm}} = \frac{\left(\sum_{i \neq n} \hat{L}_{in}^s \frac{\Theta_{in}^s}{\sum_{k \neq n} \Theta_{kn}^s}\right)^{-\frac{1}{\lambda}}}{\left(\hat{L}_{nn}^s\right)^{-\frac{1}{\lambda}}}$$

For $n \notin US$:[19]

$$\hat{C}_n^s \hat{L}_n^s = \hat{w}_n^{sd} \hat{L}_{nn}^s \frac{\Theta_{nn}^s}{\sum_k \Theta_{kn}^s} + \hat{w}_n^{sm} \sum_{i \neq n} \hat{L}_{in}^s \frac{\Theta_{in}^s}{\sum_k \Theta_{kn}^s}$$

Solving the model in changes enables me to solve for counterfactual quantities given exogenous changes in technology A, B, and migration and trade costs κ and τ, by using only data on trade, migration, and age bill shares (π_{ik}^{trade}, $\pi_{ik}^{s,mig}$, X_i, N_{ik}^{sd}, N_{ik}^{sm}, Θ_{in}^s), as well as parameter values for ε, θ, ρ, λ and η^s. Subsection C.2 details how to map these objects into the data.

C.2 Calibration of the skill model

Table 9 lists the value of the parameters and their source. The following subsections provide additional details on the link between the data and the model.

D Data and calibration

D.1 Population data

Total migrant stock To get the total number of migrants born in i and living in j, I combine the American Community Survey 2013 data that provides information on place of birth of residents in each US states with estimates from the World Bank on residing population in each country (POP_i), and estimates of Bilateral Migration

[18]When $n \in US$

$$\frac{\hat{w}_n^{sd}}{\hat{w}_n^{sm}} = \frac{\left(\sum_{i \notin US} \hat{L}_{in}^s \frac{\Theta_{in}^s}{\sum_{k \neq n} \Theta_{kn}^s}\right)^{-\frac{1}{\lambda}}}{\left(\sum_{i \in US} \hat{L}_{in}^s \frac{\Theta_{in}^s}{\sum_{k \neq n} \Theta_{kn}^s}\right)^{-\frac{1}{\lambda}}}$$

[19]When $n \in US$

$$\hat{C}_n^s \hat{L}_n^s = \hat{w}_n^{sd} \sum_{i \in US} \hat{L}_{in}^s \frac{\Theta_{in}^s}{\sum_k \Theta_{kn}^s} + \hat{w}_n^{sm} \sum_{i \in US} \hat{L}_{in}^s \frac{\Theta_{in}^s}{\sum_k \Theta_{kn}^s}$$

Table 9: Link between the model and the data

	Description	Value	Source
Parameter			
ϵ	migration elasticity	2.3	Caliendo et al. (2017)
ρ	Elasticity of substitution between skill	1.6	Katz and Murphy (1992)
λ	Elasticity of substitution between native and migrant work	20	Ottaviano and Peri (2012)
θ	trade elasticity	4	Simonovska and Waugh (2014)
η^s	migration-elasticity of trade costs	$\eta^H = 0.3/\theta$ $\eta^L = 0$	own estimate
Exogenous object			
$\hat{A}_n$, $\hat{B}^s_{in}$,$\hat{\tau}_{in}$		1	keep constant
$\hat{\kappa}^s_{in}$	migration costs		Uniformly increased to target a reduction of 50% in total migrant stock living in the US
Data			
$\pi^{s,mig}_{in}$, N^s_{in}	population data		ACS, World Bank, OECD
π^{trade}_{in}, X_n	trade data (including services)		Census data on state level exports and imports, WIOD, CFS
Θ^s_{in}	initial wage bill shares		ACS, IPMUS-International

Notes: see below for details on the sources and exact mapping between the data and the model objects.

Matrix for 2013 (MIG_{ij} for $i \neq j$, which translates directly into N_{ij} in the model).[20] The 2013 ACS is the survey used in the construction of the 2013 World Bank Bilateral Migration Matrix, ensuring consistency.

For $i \notin US$, I construct the total number of native from in country i (N_i in the model) as:

$$N_i = POP_i + \sum_{j \neq i, j \notin US} (MIG_{ij} - MIG_{ji}) + (MIG_{i,US} - MIG_{US,i})$$

For i or j in the US, I first use the ACS to construct $N_{i,US}$, which I define as the total population born in state i and residing in the US ($N_{i,US} = \sum_{j \in US} N_{ij}$, where N_{ij} comes directly from the ACS data). I then use the aggregate World Bank data on US natives living abroad and attribute them to each state proportionally to $N_{i,US}$. That is, for a US state i and an other country j, I compute L_{ij} as:

$$N_{ij} = MIG_{US,j} \frac{N_{i,US}}{\sum_{n \in US} N_{n,US}}.$$

When both i and j are US states, N_{ij} comes directly from the ACS data. I can then construct $N_i = \sum_j N_{ij}$.

Skill and unskilled migration shares For the model with different skill levels, I collect additional data on education attainment. I defined skill as having completed some tertiary education (ISCED ≥ 5). To compute the shares of skill and unskilled workers per country pair, I use various data sources.

When $j \in US$, I use the ACS data obtained through IPUMS to compute the share of skill and unskilled migrants from country i: $shskill^s_{ij} = \frac{ACS^s_{ij}}{ACS_{ij}}$.

When $j \in \{CAN, MEX\}$, I use survey data from IPUMS-International (corresponding to the 2011 Census for Canada and 2010 Census for Mexico[21]) and compute the skill share: $shskill^s_{ij} = \frac{IPUMS^s_{ij}}{IPUMS_{ij}}$. When $i \in US$, there is no information on the state of origin. In that case, I use the ACS data to apportion the skilled and unskilled

[20] http://www.worldbank.org/en/topic/migrationremittancesdiasporaissues/brief/migration-remittances-data

[21] The 2013 World Bank Bilateral Migration Matrix is based on the United Nations database POP/DB/MIG/Stock/Rev.2013, which uses country-level Census rounds. The 2011 Canada and 2010 Mexico censuses were the last one available for the construction of these datasets, thus ensuring consistency between the migration data and the skill shares.

by state i: $shskill^s_{ij} = \frac{\frac{ACS^s_{iUS}}{\sum_{n\in US} ACS^s_{nUS}} IPUMS^s_{USj}}{\frac{ACS_{iUS}}{\sum_{n\in US} ACS_{nUS}} IPUMS_{USj}}$.

When $j \notin \{US, CAN, MEX\}$ and $i = j$, I impute $shskill^s_{jj}$ as the overall skill share in the country, using data from the OECD's World Indicators of Skills for Employment database.[22]. As long as the total migrant share is low, this provides a good approximation of the native's skill composition. When $i \neq j$, I impute sh^s_{ij} using the average skill shares of natives from i in countries where I have data: $shskill^s_{ij} = \overline{shskill}^s_{i,REST}$.

Finally I compute N^s_{ij} as: $N^s_{ij} = shskill^s_{ij} * N_{ij}$.

It is important to note that migrant stocks for population residing in US states come directly from the ACS and are precisely measured. Similarly, data for Canada and Mexico (countries that will be most relevant in my counterfactual) comes from survey data. Imputation only occurs for foreign countries, where the counterfactual only has a second order effect. Hence the results won't be sensitive to the imputation method.

D.2 Expenditure data

I combine data from the OECD Inter-Country Input Output Table (ICIO) for 2013, the Commodity Flow Survey, and Census data on state level exports and imports to compute expenditure data.

If $i, j \notin US$, I simply use the total ICIO exports from i to j:

$$X_{ij} = X^{ICIO}_{ij}$$

If $i \in US, j \notin US$:

$$X_{ij} = X^{ICIO}_{US,j} \frac{X^{census,EX}_{ij}}{\sum_{n\in US} X^{census,EX}_{nj}},$$

where $X^{census,EX}_{ij}$ is the Census Origin of Movement export value. That is, I allocate the US export value from the ICIO to each state using the share of exports originating from the state.

If $i \notin US, j \in US$:

$$X_{ij} = X^{ICIO}_{i,US} \frac{X^{census,IM}_{ij}}{\sum_{n\in US} X^{census,IM}_{nj}},$$

where $X^{census,IM}_{ij}$ is the Census state of destination import value. That is, I allocate

[22]https://stats.oecd.org/Index.aspx?DataSetCode=WSDB

the US import value from the ICIO to each state using the share of imports going to the state.

If $i, j \in US$:

$$X_{ij} = X_{US,US}^{ICIO} \frac{X_{ij}^{CFS}}{\sum_{n,m \in US} X_{nm}^{CFS}},$$

where X_{ij}^{CFS} is the total value of shipments from state i to state j in the Commodity Flow Survey public use micro data. This potentially overestimate the total trade between states, as industries covered in the CFS don't include services, which are more tradable.[23] In Appendix E, I check the robustness of my results to this assumption by assuming that the same fraction of service output that is exported by the US to the rest of the world is also traded within the US. More precisely, define the share of tradable in services as $\sigma = X_{US,ROW}^{SERVICE} / \left(X_{US,US}^{SERVICES} + X_{US,ROW}^{SERVICES}\right)$. Then when computing X_{ij} for $i \neq j$, $i, j \in US$, use that same share to compute trade flows:

$$X_{ij} = \left(X_{US,US}^{ICIO,NOSERVICE} + \sigma X_{US,US}^{ICIO,SERVICES} \frac{emp_i^{SERVICES}}{emp_{US}^{SERVICES}} \right) \frac{X_{ij}^{CFS}}{\sum_{n,m \in US} X_{nm}^{CFS}}$$

where I use sectoral employment data to attribute the service production to each state. For own-state flow, I use:[24]

$$\begin{aligned} X_{ii} = & (1-\sigma) X_{US,US}^{ICIO,SERVICES} \frac{emp_i^{SERVICES}}{emp_{US}^{SERVICES}} \\ & + \left(X_{US,US}^{ICIO,NOSERVICE} + \sigma X_{US,US}^{ICIO,SERVICES} \frac{emp_i^{SERVICES}}{emp_{US}^{SERVICES}} \right) \frac{X_{ii}^{CFS}}{\sum_{n,m \in US} X_{nm}^{CFS}}. \end{aligned}$$

D.3 Wage bill data by origin and skill

For the US states, Canada and Mexico, I compute the shares of wage bill required to solve the model (Θ_{in} in the main model, Θ_{in}^{s} in the skill model) directly from the survey data also used to construct the migration shares.[25] This ensures that the migration and wage bill data are consistent with each other.

For other countries where survey data is not readily available, I simply use migrant

[23]In the ICIO data, the share of US exports in US service output is around 5%, while it is around 15% for non-services. I define services as anything that is not agriculture, mining or manufacturing.

[24]This is probably an underestimation of within US service trade flows, as services are probably more tradable domestically than internationally.

[25]I use the average wage of migrants fo skill s from i in n, multiplied by the total number of migrants N_{in}^{s}, to get the total wage bill paid to migrants from i in n, and compute the shares from there.

population shares to input the wage bill shares. This assumes that the average wage of all workers in the country is the same, which ignores selection into migration. However, when using the same method to impute wage bill shares for US states, Canada and Mexico, the correlation is high at 0.99. Furthermore, the counterfactual will mostly affect the US, Canada and Mexico to a lesser extent, and the rest of the world much less. Hence the parameters for the rest of the world imputed from US, Canada and Mexican data don't have a significant quantitative importance.

D.4 List of regions in the model

Table 10 lists the regions in the model. It is comprised of the US 50 states plus the District of Columbia, as well as 56 countries and a composite Rest of the World (ROW). A large majority of migrant population and trade flows are covered by the individual countries. The ROW accounts for on average 10% of a state's exports and 31% of a state's migrant population. The main missing migrant countries are Central American countries such as El Salvador, Cuba, the Dominican Republic or Guatemala, which are all small trading partners.

E Robustness checks

In this section, I assess the robustness of the results to different values of the trade and migration elasticity, as well as an alternative way of computing within-US trade flows.

Main model Table 11 displays the average changes in trade costs, export as share of output, and welfare for alternative calibration for the main counterfactual. Overall, the results are fairly stable when changing the migration elasticity. The change in export trade costs is sensitive to the trade elasticity, because I calibrate $\eta = 0.2/\theta$, but the effect on exports as share of output is stable. The change in welfare is larger for a small trade elasticity, as wages need to fall by more to achieve the same change in exports. Figure 5 shows the average changes in real wages across US states, decomposed into the average own-state effect, internal market access effect, and international market access, for the same set of robustness checks. In all cases, the own-state effect is positive, because the reduced labor supply is not offset by a larger reduction in market access when only migrant population in the state is reduced. The intra- and international market access effects are negative throughout.

Table 10: List of regions in the model

US States		Countries	
Alabama		Argentina	Iceland
Alaska	Nebraska	Australia	Israel
Arizona	Nevada	Austria	Italy
Arkansas	New Hampshire	Belgium	Japan
California	New Jersey	Bulgaria	Kazakhstan
Colorado	New Mexico	Brazil	Korea
Connecticut	New York	Canada	Lithuania
Delaware	North Carolina	Switzerland	Latvia
Dist. of Columbia	North Dakota	Chile	Morocco
Florida	Ohio	China	Mexico
Georgia	Oklahoma	Colombia	Malaysia
Hawaii	Oregon	Costa rica	Netherlands
Idaho	Pennsylvania	Cyprus	Norway
Illinois	Rhode Island	Czech Republic	New Zealand
Indiana	South Carolina	Germany	Peru
Iowa	South Dakota	Denmark	Philippines
Kansas	Tennessee	Spain	Poland
Kentucky	Texas	Finland	Portugal
Louisiana	Utah	France	Romania
Maine	Vermont	United Kingdom	Russia
Maryland	Virginia	Greece	Saudi Arabia
Massachusetts	Washington	Hong Kong	Singapore
Michigan	West Virginia	Croatia	Slovakia
Minnesota	Wisconsin	Hungary	Sweden
Mississippi	Wyoming	Indonesia	Thailand
Missouri		India	Vietnam
Montana		Ireland	South Africa

Table 11: Sensitivity analysis for the main model

	Migration elasticity		Trade elasticity		Less tradable services
	$\varepsilon = 1.5$	$\varepsilon = 3$	$\theta = 2$	$\theta = 6$	
Change in state export costs (exports weighted)	3.67% (.16)	3.69% (.16)	7.52% (.34)	2.44% (.10)	3.68% (0.16)
Change in exports as share of output	-4.97% (0.92)	-4.27% (1.10)	-4.06% (1.00)	-4.62% (1.08)	-4.59% (1.18)
Change in natives' welfare	-0.13% (0.06)	-0.13% (0.10)	-0.23% (0.14)	-0.09% (0.06)	-0.07% (0.05)

Notes: The table shows the percentage changes, after reducing the share of migrants in the US population by half. Numbers are average across US states, with standard deviation in parenthesis. See section D.2 for details on the "Less tradable services" scenario.

Figure 5: Real wage change decomposition: robustness

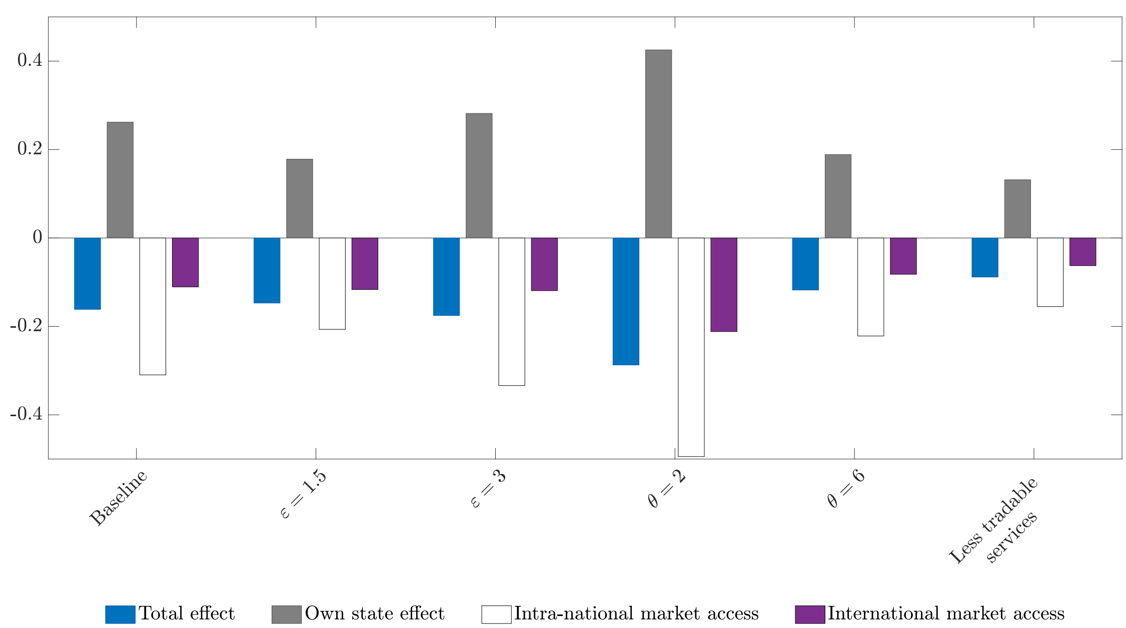


Table 12: Sensitivity analysis for the skill and imperfect substitutability model

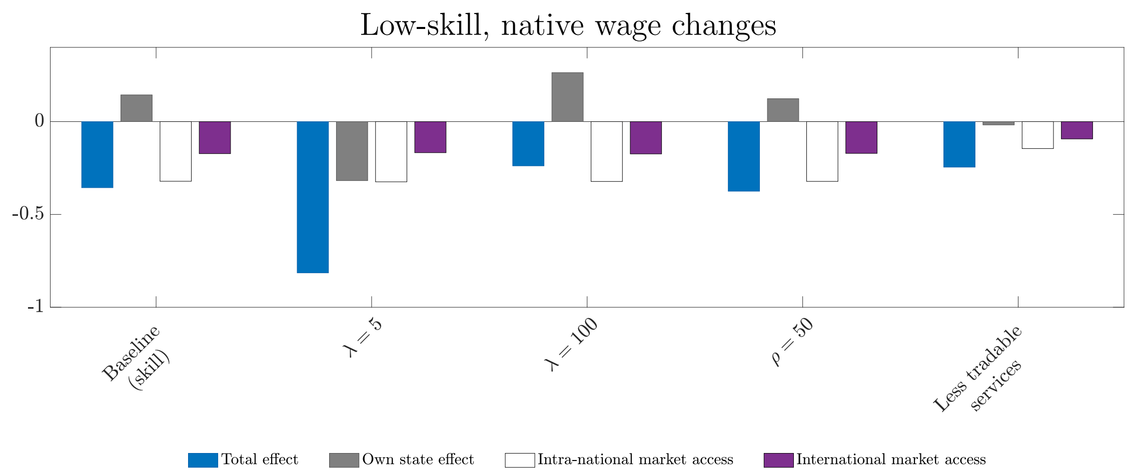
	Native/migrant substitutability $\lambda = 5$	Native/migrant substitutability $\lambda = 100$	Skill substitutability $\rho = 50$	Less tradable services
Change in state export costs (exports weighted)	5.44%	5.50%	5.49%	5.48%
	(0.22)	(0.23)	(0.23)	(0.23)
Change in exports as share of output	-6.82%	-7.22%	-7.09%	-7.35%
	(1.35)	(1.34)	(1.34)	(1.39)
Change in US low-skill welfare	-0.84%	-0.21%	-0.36%	-0.25%
	(0.24)	(0.21)	(0.06)	(0.16)
Change in US college welfare	-0.93%	-0.23%	-0.36%	-0.30%
	(0.19)	(0.07)	(0.05)	(.07)

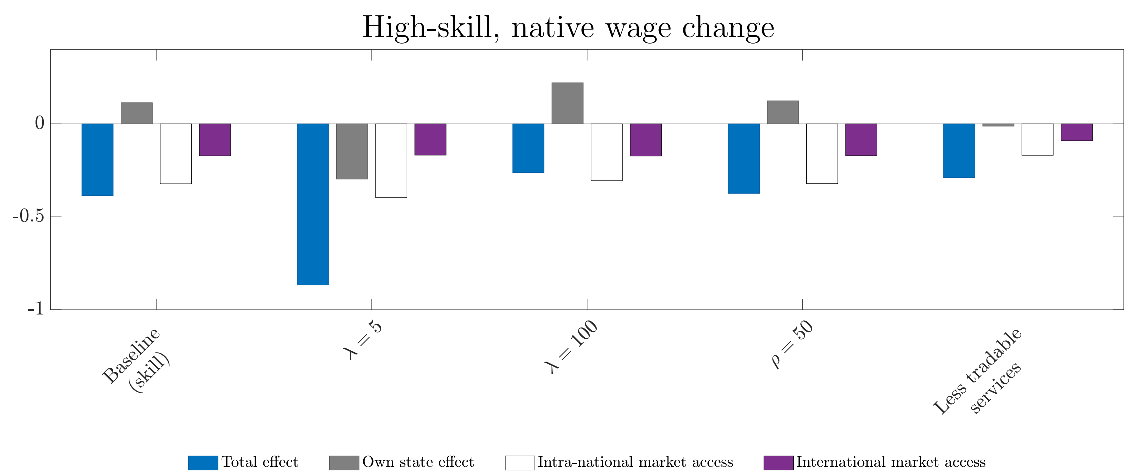
Notes: The table shows the percentage changes, after reducing the share of migrants in the US population by half. Numbers are average across US states, with standard deviation in parenthesis. See section D.2 for details on the "Less tradable services" scenario.

Skill and imperfect substitutability model Table 12 displays the average changes in trade costs, export as share of output, and welfare for alternative calibration for the main counterfactual with the skill and substitutability model. Figure 6 shows the average changes in real wages across US states, decomposed into the average own-state effect, internal market access effect, and international market access. The native/migrant elasticity of substitution plays an important role in determining wether the own-state effect (driven mainly by the labor supply effect) is positive or negative. With a low elasticity of substitution, the effect of the reduction in migration is large and negative, while a high substitutability moves the results closer to the main model.[26] The skill substitutability matters less. Overall, both the intra- and international market access effects stay large and negative, regardless of the production function elasticities.

[26]The baseline model without skills and imperfect native-migrant substitutability does not produce exactly the same results as the refined model even when both λ and ρ are set to infinity, because of the different migration shares of skilled and unskilled workers. Since the model interprets high migration shares as reflecting a high B^s_{in}, the fall in effective labor supply is different in the two models even with infinite substitutability.

Figure 6: Imperfect substitutability scenario robustness: decomposition





F Algorithms

F.1 Algorithm for the main model

This section describes how to solve the model in changes. This solution allows for trade deficits D_n to exist, hence the relevant income for location is not wage w_n but $v_n = w_n + D_n/L_n$.[27] Results in the paper come from first creating a deficit-free equilibrium by solving the system of equation below setting $\hat{D}_n = 0$ while keeping other exogenous variables constant, and then using the resulting trade, migration and wage bill shares to solve for a counterfactual change in migration costs.[28]

1. Guess $\hat{\pi}^{mig}_{in}$

2. Solve for $\hat{N}_{ni}$ and $\hat{d}_{ni}$ using

$$\hat{N}_{ni} = \hat{\pi}^{mig}_{in}$$

$$\hat{d}_{ni} = \hat{\tau}_{ni} \left(\frac{1 + \mathbf{1}\left(\boldsymbol{i,n \notin US}\right)\hat{N}_{in}N_{in}}{1 + \mathbf{1}\left(\boldsymbol{i,n \notin US}\right)N_{in}} \right)^{-\eta} \left(\frac{\sum_j \hat{N}_{jn}N_{jn}}{\sum_j N_{jn}} \right)^{-\eta}$$

3. Solve for $\hat{w}_i$: guess for $\hat{w}_i$

   (a) Solve for $\hat{\pi}^{trade}_{ni}$ using

$$\hat{\pi}^{trade}_{ni} = \frac{\hat{A}_n(\hat{d}_{ni}\hat{w}_n)^{-\theta}}{\sum_s \hat{A}_s(\hat{d}_{si}\hat{w}_s)^{-\theta}\pi^{trade}_{si}}$$

[27] That is, I assume that the deficit is redistributed uniformly to each efficiency unit of labor. Using the following equation, one can solve for $\hat{v}_n$:

$$X^{cons}_n v_n \sum_i L_{in} = X^{outp}_n + D_n$$

$$\hat{v}_n \sum_i \hat{L}_{in} \frac{v_n L_{in}}{X^{outp}_n} = \hat{X}^{outp}_n + \frac{D_n}{X^{outp}_n}\hat{D}_n$$

$$\hat{v}_n \sum_i \left(\hat{B}_{in}\right)^{\frac{1}{\varepsilon}} \left(\hat{\pi}^{mig}_{in}\right)^{\frac{\varepsilon-1}{\varepsilon}} \hat{N}_i \Theta_{in} \frac{X^{cons}_n}{X^{outp}_n} = \hat{X}^{outp}_n + \frac{D_n}{X^{outp}_n}\hat{D}_n$$

[28] The new wage bill shares can be computed as:

$$\Theta^{'}_{in} = \frac{w^{\prime}_n L^{\prime}_{in}}{X^{\prime}_n} = \frac{\hat{w}_n \hat{L}_{in}}{\hat{X}_n}\Theta_{in} = \frac{\hat{w}_n \left(\hat{B}_{in}\right)^{\frac{1}{\varepsilon}} \left(\hat{\pi}^{mig}_{in}\right)^{\frac{\varepsilon-1}{\varepsilon}} \hat{N}_i}{\hat{X}_n}\Theta_{in}$$

(b) Solve for $\hat{X}_n^{outp}$ using

$$\hat{X}_i^{outp} X_i^{outp} = \sum_j \hat{\pi}_{ij}^{trade} \pi_{ij}^{trade} \left(\hat{X}_j^{outp} X_j^{outp} + \hat{D}_j D_j \right)$$

and normalize the new output such that total world output remains constant, that is:

$$\sum_i \hat{X}_i^{outp} X_i^{outp} = \sum_i X_i^{outp}$$

(c) Solve for $\hat{w}_n$ using

$$\hat{X}_n^{outp} = \hat{w}_n \sum_i \left(\hat{B}_{in} \right)^{\frac{1}{\varepsilon}} \left(\hat{\pi}_{in}^{mig} \right)^{\frac{\varepsilon - 1}{\varepsilon}} \hat{N}_i \Theta_{in}$$

(d) Go back to (a) using updated $\hat{w}_n$

4. Solve for $\hat{v}_n$,$\hat{P}_n$ and $\hat{\pi}_{in}^{mig}$ using:

$$\hat{v}_n \sum_i \left(\hat{B}_{in} \right)^{\frac{1}{\varepsilon}} \left(\hat{\pi}_{in}^{mig} \right)^{\frac{\varepsilon - 1}{\varepsilon}} \hat{N}_i \Theta_{in} \frac{X_n^{cons}}{X_n^{outp}} = \hat{X}_n^{outp} + \frac{D_n}{X_n^{outp}} \hat{D}_n$$

$$\hat{P}_n = \left(\frac{\hat{A}_n (\hat{w}_n)^{-\theta}}{\hat{\pi}_{nn}^{trade}} \right)^{-\frac{1}{\theta}}$$

$$\hat{\pi}_{in}^{mig} = \frac{\hat{B}_{in} \left(\frac{\hat{v}_n}{\hat{P}_n \hat{\kappa}_{in}} \right)^{\epsilon}}{\sum_k \hat{B}_{ik} \left(\frac{\hat{v}_k}{\hat{P}_k \hat{\kappa}_{ik}} \right)^{\varepsilon} \pi_{ik}^{mig}}$$

5. Go back to 1 using updated $\hat{\pi}_{in}^{mig}$

F.2 Algorithm for the skill model

This section describes how to solve the model in changes. This solution allows for trade deficits D_n to exist, hence the relevant income for location is not wage w_n^{sm} or w_n^{sd} but v_n^{sm} or v_n^{sd}, where I assume that deficits are redistributed proportionally to income.[29] Results in the paper come from first creating a deficit-free equilibrium by solving the system of equation below setting $\hat{D}_n = 0$ while keeping other exogenous

[29]That is:

$$L_{nn}^s v_n^{sd} = L_{nn}^s w_n^{sd} + \Theta_{nn}^s D_n = \Theta_{nn}^s \left(X_n^{outp} + D_n \right)$$

variables constant, and then using the resulting trade and migration shares to solve for a counterfactual change in migration costs.

1. Guess $\hat{\pi}_{in}^{s,mig}$
2. Solve for $\hat{N}_{in}^{s}$, $\hat{L}_{in}^{s}$ and $\hat{d}_{ni}$ using

$$\hat{N}_{in}^{s} = \hat{\pi}_{in}^{s,mig}$$

$$\hat{L}_{in}^{s} = \left(\hat{B}_{in}\right)^{\frac{1}{\varepsilon}} \left(\hat{\pi}_{in}^{s,mig}\right)^{\frac{\varepsilon-1}{\varepsilon}} \hat{N}_{i}$$

$$\hat{d}_{ni} = \hat{\tau}_{ni} \prod_{s\in L,H} \left[1\left(i \mid n \notin US\right) \left(\frac{1+\hat{N}_{in}^{s} N_{in}^{s}}{1+N_{in}^{s}} \right) \left(\frac{\sum_j \hat{N}_{jn}^{s} N_{jn}^{s}}{\sum_{s,j} N_{jn}^{s}} \right) + 1\left(i,n \in US\right) \right]^{-\eta^{s}}$$

3. Solve for $\hat{w}_{n}^{sd}$, $\hat{w}_{n}^{sm}$: guess $(\hat{w}_{n}^{sd}, \hat{w}_{n}^{sm})$
   (a) Solve for $\hat{C}_{n}^{s}$ and $\hat{C}_{n}$ using

$$\hat{C}_{n}^{s} = \left[\left(\hat{w}_{n}^{sd}\right)^{1-\lambda} \frac{\Theta_{nn}^{s}}{\sum_i \Theta_{in}^{s}} + \left(\hat{w}_{n}^{sm}\right)^{1-\lambda} \frac{\sum_{i\neq n} \Theta_{in}^{s}}{\sum_i \Theta_{in}^{s}} \right]^{\frac{1}{1-\lambda}},$$

$$\hat{C}_{n} = \left[\left(\hat{C}_{n}^{L}\right)^{1-\rho} \sum_i \Theta_{in}^{L} + \left(\hat{C}_{n}^{H}\right)^{1-\rho} \sum_i \Theta_{in}^{H} \right]^{\frac{1}{1-\rho}}.$$

   (b) Solve for $\hat{\pi}_{ni}^{trade}$ using

$$\hat{\pi}_{ni}^{trade} = \frac{\hat{A}_{n}(\hat{d}_{ni}\hat{C}_{n})^{-\theta}}{\sum_k \hat{A}_{k}(\hat{d}_{ki}\hat{C}_{k})^{-\theta}\pi_{ki}^{trade}}$$

$$L_{in}^{s} v_{n}^{sm} = L_{in}^{s} w_{n}^{sm} + \Theta_{in}^{s} D_{n} = \Theta_{in}^{s}\left(X_{n}^{outp} + D_{n}\right)$$

In changes:

$$\hat{L}_{nn}^{s} \hat{v}_{n}^{sd} = \hat{\Theta}_{nn}^{s} \frac{\left(\hat{X}_{n}^{outp} X_{n}^{outp} + \hat{D}_{n} D_{n}\right)}{\left(X_{n}^{outp} + D_{n}\right)} = \frac{\hat{w}_{n}^{sd} \hat{L}_{nn}^{s}}{\hat{X}_{n}^{outp}} \frac{\left(\hat{X}_{n}^{outp} X_{n}^{outp} + \hat{D}_{n} D_{n}\right)}{\left(X_{n}^{outp} + D_{n}\right)}$$

so:

$$\hat{v}_{n}^{sd} = \frac{\hat{w}_{n}^{sd}}{\hat{X}_{n}^{outp}} \frac{\left(\hat{X}_{n}^{outp} X_{n}^{outp} + \hat{D}_{n} D_{n}\right)}{\left(X_{n}^{outp} + D_{n}\right)}, \; \hat{v}_{n}^{sm} = \frac{\hat{w}_{n}^{sm}}{\hat{X}_{n}^{outp}} \frac{\left(\hat{X}_{n}^{outp} X_{n}^{outp} + \hat{D}_{n} D_{n}\right)}{\left(X_{n}^{outp} + D_{n}\right)}.$$

(c) Solve for $\hat{X}_n^{outp}$ using

$$\hat{X}_n^{outp} X_n^{outp} = \sum_j \hat{\pi}_{nj}^{trade} \pi_{nj}^{trade} \left(\hat{X}_j^{outp} X_j^{outp} + \hat{D}_j D_j \right)$$

and normalize the new output such that total world output remains constant, that is:

$$\sum_i \hat{X}_i^{outp} X_i^{outp} = \sum_i X_i^{outp}$$

(d) Compute $\hat{w}_n^{sd}$,$\hat{w}_n^{sm}$ using:

$$\hat{C}_n^L \hat{L}_n^L = \hat{X}_n / \left(\sum_i \Theta_{in}^L + \left(\frac{\hat{C}_n^H}{\hat{C}_n^L} \right)^{1-\rho} \sum_i \Theta_{in}^H \right)$$

$$\hat{C}_n^H \hat{L}_n^H = \hat{C}_n^L \hat{L}_n^L \left(\frac{\hat{C}_n^H}{\hat{C}_n^L} \right)^{1-\rho}$$

$$\frac{\hat{w}_n^{sm}}{\hat{w}_n^{sd}} = \frac{\left(\sum_{i \neq n} \hat{L}_{in}^s \frac{\Theta_{in}^s}{\sum_{k \neq n} \Theta_{kn}^s} \right)^{-\frac{1}{\lambda}}}{\left(\hat{L}_{nn}^s \right)^{-\frac{1}{\lambda}}}.$$

$$\hat{C}_n^s \hat{L}_n^s = \hat{w}_n^{sd} \hat{L}_{nn}^s \frac{\Theta_{nn}^s}{\sum_k \Theta_{kn}^s} + \hat{w}_n^{sm} \sum_{i \neq n} \hat{L}_{in}^s \frac{\Theta_{in}^s}{\sum_k \Theta_{kn}^s}$$

(e) Go back to (a) using updated $\hat{w}_n^{sd}$.

4. Solve for $\hat{v}_n^{sd}$, $\hat{v}_n^{sm}$, $\hat{P}_n$ and $\hat{\pi}_{in}^{s,mig}$ using:

$$\hat{v}_n^{sd} = \frac{\hat{w}_n^{sd}}{\hat{X}_n^{outp}} \frac{\left(\hat{X}_n^{outp} X_n^{outp} + \hat{D}_n D_n \right)}{\left(X_n^{outp} + D_n \right)}, \ \hat{v}_n^{sm} = \frac{\hat{w}_n^{sm}}{\hat{X}_n^{outp}} \frac{\left(\hat{X}_n^{outp} X_n^{outp} + \hat{D}_n D_n \right)}{\left(X_n^{outp} + D_n \right)}.$$

$$\hat{P}_n = \left(\frac{\hat{A}_n (\hat{w}_n)^{-\theta}}{\hat{\pi}_{nn}^{trade}} \right)^{-\frac{1}{\theta}}$$

$$\hat{\pi}_{in}^{s,mig} = \frac{\hat{B}_{in}^s \left(\frac{\left(\hat{v}_n^{sd} \right)^{(i=n)} \left(\hat{v}_n^{sm} \right)^{(i \neq n)}}{\hat{P}_n \hat{\kappa}_{in}} \right)^{\epsilon}}{\sum_k \hat{B}_{ik}^s \left(\frac{\left(\hat{v}_k^{sd} \right)^{(i=n)} \left(\hat{v}_k^{sm} \right)^{(i \neq n)}}{\hat{P}_k \hat{\kappa}_{ik}^s} \right)^{\varepsilon} \pi_{ik}^{s,mig}}$$

5. Go back to 1 using the updated $\hat{\pi}_{in}^{s,mig}$