NBER WORKING PAPER SERIES

# BORDER WALLS

Treb Allen
Cauê de Castro Dobbin
Melanie Morten

Working Paper 25267
http://www.nber.org/papers/w25267

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 2018, Revised May 2024

We thank audiences at Stanford, UC Santa Cruz, U.S.C, University of Connecticut, Princeton, Boston University, MIT/Harvard, the UCLA/UCSD trade and development mini-conference, the 2018 Migration and Development Conference, 2018 SED, the 2018 NBER Labor Studies Summer Institute, SITE, and the CEGA faculty retreat for comments. We thank Ran Abramitzky, David Atkin, Sam Bazzi, Kirill Borusyak, Levi Boxell, Michael Clemens, Alonso De Gortari, Rebecca Diamond, Pascaline Dupas, Christian Dustmann, Liran Einav, Matthew Gentzkow, Gordon Hanson, Caroline Hoxby, Diego Jiménez, John Kennan, Brian Kovak, Ethan Lewis, Ana Raquel Minian, Caylee O'Connor, Steve Redding, Enrique Seira, and Na'ama Shenhav for helpful comments. We are grateful to Julián Rodríguez at the Ministry of Foreign Affairs and Rodrigo Garibay Aymes at the Department of Consular Affairs for generously assisting us with the matrícula consular database. This material is based upon work supported by the National Science Foundation under Grants SES-1658838 (Allen) and SES-1753002 (Morten). Carlos Bustos, Keso Kakachia, Stone Kalisa, Devika Lakhote, Dante Mangiaracina, and Yihang (Genna) Liu provided excellent research assistance. All errors are our own. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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JEL No. F11,F22,J2,R23

**ABSTRACT**

Between 2006 and 2010 the U.S. government built an additional 548 miles of border wall along the U.S.-Mexico border. Combining survey data from all major border crossing points with administrative data on 5.7 million primarily unauthorized Mexican migrants, we study how the border wall expansion affected migration patterns and local labor markets. The wall changed migrants' choice of route, their choice of destination within the United States, and their decision to migrate in the first place. On net, we estimate the wall decreased migration flows by three hundred thousand migrants, roughly one-third of the observed decline in Mexican migration between 2005 and 2015. Incorporating the decrease in migration into a spatial equilibrium model, we estimate that the wall increased (decreased) wages of low-skill (high-skill) U.S. workers by a modest $9 ($21) per year.

Treb Allen
Department of Economics
Dartmouth College
6106 Rockefeller Hall
Hanover, NH 03755
and NBER
treb@dartmouth.edu

Melanie Morten
Department of Economics
Stanford University
579 Jane Stanford Way
Stanford, CA 94305
and NBER
memorten@stanford.edu

Cauê de Castro Dobbin
Georgetown University
caue.dobbin@gmail.com

# 1 Introduction

There has been substantial debate over the merits of a possible wall along the U.S.-Mexico border. The political debate over funding a wall on the southern border led to a shutdown of the U.S. government for 35 days in December 2018 and January 2019, and a declaration of a "National Emergency" in February 2019.[1] Proponents argue that a border wall is necessary to stem unauthorized immigration, whereas opponents contend a border wall is expensive and ineffective. Empirical evidence on the efficacy of a border wall, however, is scant. This is due primarily to two difficulties. First, it is difficult to measure unauthorized migration. Second, there are many possible responses to a border wall: migrants could choose alternative routes, they could choose alternative destinations, or they could choose not to migrate at all. Knowing the effect of a border wall requires knowing both the magnitude of each of these potential responses and how these responses ultimately affect U.S. labor markets.

This paper overcomes these difficulties to assess the economic impact of a border wall. To overcome data limitations, we combine several rich sources of data on unauthorized migration flows. To disentangle the various responses to a border wall, we develop a migration model that allows for flexible responses of migrants' choices of route, destination, and whether or not to migrate in the first place. We then embed this migration model into a general equilibrium framework to determine the impacts of migration on local labor markets. Combining data and theory, we assess the magnitude of each of these margins using a large expansion in the border wall between 2006 and 2010. Finally, we use our framework and estimates to both assess the impact of a counterfactual completion of a wall along the entire border and to compare the existing border wall expansion to all possible alternative border walls that could have been constructed instead.

We find that both migrants' choices of route and destination within the United States and their choice of whether to migrate at all are quite responsive to the border wall expansion. We estimate that the border wall expansion reduced migration flows by about three hundred thousand persons, roughly one-third of the observed decline in Mexican migration from 2005 to 2015. However, the broader economic impacts are small, with slight losses for high-skill U.S. workers and slight gains for low-skill U.S. workers. Given our estimates and the fact that almost all of the crossing points in our dataset end up with a wall, our model predicts that while its roll-out was haphazard, the current locations of the border wall maximally reduce migration and a complete border wall would result in

[1] Proclamation 9844, "National Emergency Concerning the Southern Border of the United States", February 15 2019. For background on the shutdown, see, e.g., Jacobs and Lartey (2019).

only modest additional reductions.

Our empirical analysis relies on the several sources of data. First, we use survey data (*La Encuesta sobre Migración en la Frontera Norte de México (EMIF)*) at seventeen major border crossing points that enable us to observe where migrants from a particular origin to a particular destination choose to cross the border. Second, we use confidential administrative data from the Mexican government's *Matrícula Consular* ID database to observe the bilateral migration patterns of 5.7 million (primarily unauthorized) Mexican migrants. Third, we assemble high resolution spatial data of the location and year of construction of each segment of the U.S.-Mexico border wall. Fourth, we use survey data in both Mexican origin municipalities and U.S. destination CBSAs to assess the relationship between migration and local labor markets.

To guide our empirical analysis, we begin by presenting a simple model of migration. Individuals choose whether or not to migrate, where to migrate to, and which route to get to their destination. When they arrive in the destination, they then compete in a labor market with other workers. The model highlights four mechanisms through which a border wall expansion can affect migration: (1) a *detour* effect, where migration flows decrease because migrants either have to surmount the wall or avoid it by using longer or more difficult routes; (2) a *diversion* effect, where migrants change their destinations to those less affected by the border wall expansion; (3) a *deterrence* effect, where individuals may choose to stay in Mexico and not to migrate at all; and (4) a *destination* effect, where wages in the destination respond to changes in migration.

We then combine our model and data to assess the impact of a large border wall expansion. In 2006, motivated by a concern that the United States needed to regain "control of its borders,"[2] the U.S. Congress authorized the construction of 548 additional miles of border wall. Figure 1 shows that the border wall expansion occurred at the same time as the flow of Mexican migrants to the United States declined substantially from 1.4 million recently arrived Mexican-born workers in 2005 to 400,000 in 2015. The purpose of our study is to determine what fraction of this decline is due to the border wall expansion versus other facors (such as diminished employment opportunities due to the Great Recession).

We first examine how the border wall expansion affected migrants' choice of which route to take (the detour effect). We consider 17 high-frequency border-crossing locations surveyed in the EMIF data (separate survey data suggests 94% of migrants cross at one of these 17 locations). In 2004, 8 of the 17 border crossing already had a border wall; by 2010, all but one had a border wall. By relying on the the haphazard nature of the

[2]See, e.g., President Bush's 2006 address to the nation on immigration reform (Bush (2006)).

timing of the roll-out due to unforeseen legal delays along certain sections of the border, we estimate that migrants' choice of where to cross the border, conditional on their origin and chosen destination, is sensitive to the presence of a border wall, with an elasticity of 0.5. This result shows no evidence of pre-trends, is robust to controlling for Border Patrol resources and crime rates at each border crossing, and is similar for both discrete and continuous measures of border wall exposure.

Next, we estimate how the border wall expansion affected where individuals migrated to within the United States (the diversion effect). To do this, we use the matrícula consular database to estimate how migration between a Mexican origin municipality and a U.S. destination CBSA pair changed after the wall. The fact that we observe both migration and the exposure to the border wall expansion at the pair level allows us to control for origin-year and destination-year fixed effects in the regression. As a result, we can identify the effect of the wall on migration holding constant any "pull" factors (such as the Great Recession) of a particular destination. By similar logic, we can control shocks to the "push" factors of a particular origin by comparing migration to different destinations. We estimate that migrants' choice of destination within the United States is sensitive to changes in migration costs, with the diversion effect roughly half the size of detour effect. We find no evidence of pre-trends, account for possible non-random spatial variation in the border wall exposure using the re-centering approach suggested by Borusyak and Hull (2023), and show the result is robust to controlling for a number of alternative explanations, e.g., differential exposure to the Great Recession.

We then measure whether the border wall expansion deterred individuals from migrating at all (the deterrence effect). To do this, we combine the matrícula consular data with Mexican Census data on population stocks to estimate how the out-migration rate from a Mexican municipality responded to the municipality's exposure to wall expansion. This analysis estimates the elasticity of migration to the United States to the value of migrating. A standard gravity model of migration assumes an "independence of irrelevant alternatives" (IIA) where this elasticity is one; in other words, IIA assumes individuals treat destinations in Mexico and the United States symmetrically. Instead, we estimate a relative elasticity of 3.7, indicating that demand for migration to the United States is relatively more elastic than demand for destinations within the U.S. If some destinations in the United States become relatively more costly, individuals are less likely to migrate at all than to choose to migrate elsewhere in the United States. This result is consistent with destination networks being economically important. As above, the deterrence result shows no evidence of pre-trends, accounts for the non-random spatial variation in border wall exposure, and is robust to controlling for a number of potential confounds.

Finally, we allow local wages and the supply of other types of workers in destination labor markets to respond to the border wall expansion (the destination effect). To do this, we combine the matrícula consular data with U.S. ACS data on wages and labor supplies in destination CBSAs to estimate how changes in the supply of Mexican workers in destination labor markets affect relative wages of migrants and native born workers. We find that declines in the relative supply of Mexican-born workers as a result of the border wall expansion increased the relative wage of Mexican-born workers, implying an elasticity of substitution between foreign-born and native-born low skill workers of roughly 7. Like the previous results, we document no evidence of pre-trends and show the estimate remains similar after controlling for a host of possible confounds.

Armed with our estimated elasticities governing the strength of these four effects, we calculate the aggregate impact of the border wall expansion. We find that it reduced the flow of migrants to the United States by 311,000 persons (with a 5%/95% confidence interval of 219,000-378,000), one third of the observed decline in Mexican migration between 2005 and 2015. This result relies importantly on relaxing the IIA assumption standard in much of the literature: had we assumed IIA between U.S. and Mexican destinations, for example, we would have understated the impact of the border wall expansion by roughly two-thirds. Despite the decline in Mexican migration, however, the impact of the border wall expansion on U.S. labor markets was negligible: high skill U.S. workers lose $21 (0.04%) a year, whereas low skill U.S. workers gain $9 (0.02%) a year due to the increased scarcity of low-skilled workers. While there is substantial heterogeneity across space in the effects, in no location did the gains to low-skill U.S. workers (or losses to high-skill U.S. workers) exceed 0.25%.

Finally, we use our framework and estimated parameters to consider two policy-relevant counterfactuals. First, we estimate the impact of completing a wall along the entire border, finding that doing so would have only small additional effects reducing migration and negligible additional effects on U.S. local labor markets. To understand this result, we consider a second counterfactual where we compare the actual border wall expansion to all possible alternative expansions. Consistent with the haphazard roll-out due to unexpected delays that provided our identification above, we find that the actual border wall expansion was far from optimal in its first few years. However, when it was completed, the crossing points chosen were those that maximized the reduction in migration. This highlights why a complete border wall is estimated to have a small additional effect: because all the most highly used crossing points now have border walls, additional expansion will not result in substantial additional declines.

This paper contributes to a number of strands of the literature. First, our paper contributes to a growing quantitative literature examining how spatial frictions affects population movement.[3] In particular, like Ahlfeldt, Redding, Sturm, and Wolf (2015), this paper examines the impact of a wall on the spatial distribution of economic activity, albeit in the context of the U.S.-Mexico border wall and migration instead of the Berlin wall and commuting. Unlike that paper, however, here we observe bilateral migration flows both before and after the wall expansion, allowing us to directly estimate the cost of traversing a border wall of different types (while accounting for migrants' endogenous route choice). Also, like Allen and Arkolakis (2022), this paper embeds the endogenous route choice problem of agents into a spatial framework, although here the choice is over places to cross a border rather than paths to take through an infrastructure network. Unlike that paper, however, here we use survey data on migrants' choice of different routes to estimate the elasticity of route choice to route cost. Finally, like Burstein, Hanson, Tian, and Vogel (2020) and Caliendo, Parro, Opromolla, and Sforza (2021), we allow for workers to differ by their nativity and skill levels. However, we abstract from the heterogeneity in tradability across different occupations in the former and forward-looking migration decisions in the latter. Instead, we focus on the heterogeneous impacts of shocks to bilateral migration costs by relaxing the IIA assumption implicit in spatial migration models exhibiting gravity.[4]

Second, our paper contributes to the literature examining the causes and consequences of Mexico-U.S. migration by using a confidential version of the matrícula consulardatabase. Matrícula consular cards are identification cards that are issued by the Mexican government to Mexican citizens residing in the United States. Previous works (see, e.g., Clemens (2015); Massey, Rugh, and Pren (2010); Caballero, Cadena, and Kovak (2018)) have used a publicly available version (matching Mexican origin municipality to U.S. destination state) of this database, whereas we have been granted access to a confidential individual-level database where we observe sub-state (Mexican municipality to U.S. county) location information as well as observing each time (after the initial year of 2006) that migrants have renewed their cards.[5] The sub-state variation allows us to exploit more local variation in migration patterns as well as control for state-level shocks that may impact migration. The fact that we observe individuals instead of aggregate counts also allows us to separate out renewed matrícula cards from first-time issuances. We show that the

[3]See, e.g., Allen and Arkolakis (2014); Tombe and Zhu (2019); Redding (2016); Monte, Redding, and Rossi-Hansberg (2018); Bryan and Morten (2019); Morten and Oliveira (2024); Caliendo, Parro, Opromolla, and Sforza (2021) and summarized in the review article (Redding and Rossi-Hansberg, 2017).

[4]In this way, the paper is related to Adao, Costinot, and Donaldson (2017), who show how to conduct counterfactual analysis in quantitative trade models when IIA may not hold.

[5]A notable exception is Caballero, Cadena, and Kovak (2023), who uses the confidential version matrícula consular to which we were able to assist them in getting access.

latter more closely correlate to measures of the number of newly arrived migrants in the American Community Survey (ACS).

Third, our paper contributes to a growing migration literature examining the efficacy of migration enforcement. The literature has thus far primarily focused on the role of the U.S. Border Patrol in deterring migrants (Hanson and Spilimbergo (1999); Lessem (2018); Bazzi, Burns, Hanson, Roberts, Whitley, Wein, Bazzi, Chang, and Hanson (2021)); we focus instead on the role of physical barriers. One exception is Feigenberg (2020), who examines the impact of the same border wall expansion we consider. Unlike that paper, however, our analysis relies on bilateral migration flow data and bilateral variation in exposure, allowing us to disentangle the impact of the border wall expansion estimate from other contemporaneous economic shocks in both origins and destinations. This allows us to estimate the aggregate and distributional impacts of the existing and counterfactual border wall expansions.

Finally, our paper complements the expansive literature on the effect of immigration on U.S. labor markets (see, e.g., Clemens, Lewis, and Postel (2018); Piyapromdee (2021); Card (2001); Borjas, Grogger, and Hanson (2012)) by using estimates from that literature to embed our migration model into a framework with many labor markets spanning two countries and separated by flexible migration frictions, where wages of different worker types are determined in equilibrium. This allows us to use our estimates of the impact of a border wall expansion to perform policy-relevant counterfactuals in a general equilibrium framework.

The rest of the paper is organized as follows. We first provide a brief description of the border wall expansion we consider and the data we use to assess its effect. Section 3 provides a model of migration used to guide the empirical analysis, which follows in Section 4. We then combine our model with our empirical results to estimate the aggregate and distributional impacts of the border wall expansion and other counterfactual border wall scenarios in Section 5. Section 6 concludes.

## 2 Empirical context and data

This section briefly describes the border wall expansion we examine and the different data sources we use to evaluate its impact on Mexican migration to the United States; we refer interested readers to Online Appendices A and B for more details. Throughout the paper our unit of analysis for the United States is the CBSA, a definition constructed to capture distinct labor markets, adjusted to constant boundaries between 2000 and 2010. Dropping observations in Hawaii and Alaska yields 977 unique markets. Our unit of analysis is the Mexican *municipio* (municipality), adjusted to consistent boundaries over time. This yields 2331 unique markets in Mexico.

## 2.1 The Secure Fence Act border wall expansion

Between 2000 and 2005, approximately 1.2 million people—95% of whom were Mexican nationals—were apprehended each year attempting to cross the U.S.-Mexico border, increasing the pressure on policy makers to do something about unauthorized migration. This pressure culminated in the passage of the 2006 Secure Fence Act (SFA), which resulted in the construction of 548 additional miles of border wall between 2006 and 2010—a five-fold increase—at a construction cost of $2.3 billion (United States Government Accountability Office (2017b,a)).[6]

To study the border wall expansion, we use GIS shape files generously shared with us by Guerrero and Castañeda (2017), which provide the year of construction for each border wall segment. Figure 2 depicts the roll-out of the border wall expansion.[7] Both the existing border wall and its expansion occurred primarily in more populated areas, as migrants often travel to the border by bus from nearby towns before finally crossing the border by foot. However, the roll-out of the expansion was idiosyncratic. The primary objective in the roll-out appears to be one of speed; as a result, the expansion occurred first in locations where the federal government already owned the land adjacent to the border. In contrast, construction was delayed in areas in Texas where ranchers who owned the land along both sides of the border mounted legal challenges against the construction and refused to allow government surveyors on their land (see, e.g., Miller, Collier, and Aguilar (2017)). Consistent with this haphazard roll-out, in Section 4.1 we exploit the timing of wall construction to empirically show that areas fenced earlier did not have differential migration patterns prior to those fenced later.

Figure 2 also highlights 17 of the most commonly used border crossing locations, as identified by the *Encuesta sobre Migración en la Frontera Norte de México* (EMIF). Migration

[6] This number does not account for maintenance costs of the fence. Between 2007 and 2015, $0.45 billion was spent on maintenance. The Government Accountability Office estimated lifetime maintenance costs of the fence to be estimated to be an additional $1 billion dollars (United States Government Accountability Office, 2017b). The border walls constructed under the SFA took one of two forms: 288 additional miles of "pedestrian walls" meant to deter crossings on foot, and 260 additional miles of "vehicular fences" meant to deter crossings by vehicle; at the border crossings we focus on below, the new construction was entirely pedestrian walls.

[7] Appendix Table A2 shows correlations of location characteristics with the wall expansion. Across the whole border, places that were cooler, more populated, and not in Texas were more likely to have a wall constructed between 2005 and 2009. For the 17 EMIF border crossing locations, there is no statistical relationship between any observable correlates and where the wall was expanded.

history data collected by the Mexican Migration Project reports that 96.1% of people who report where they crossed the border used one of the 17 EMIF crossing points. These 17 EMIF border crossing locations will form the basis of our empirical analysis; in the counterfactual results below, we also include an 18th "outside option" in to account for the remaining migrants who cross elsewhere. For each border crossing location, we identify it as having a border wall in a particular year if there is any wall within a 2 mile radius of the center of the crossing location, which is consistent with the evidence that migrants tend to travel to the crossing point location prior to traversing the border[8]. For robustness, however, we also show that a variety of alternative continuous measures of what fraction of the nearby border of various bandwidths yield similar results; see Online Appendix B.1 for details.

As the EMIF crossing locations tend to be in more populated areas, 8 of the 17 EMIF locations already had a barrier in 2004. Between 2005 and 2009, 8 further border crossing locations had a barrier constructed.[9] By 2010, only Guerrero, in the state of Coahuila, did not have a border wall.

In what follows, we will use yearly data on crossing attempts to show the effect a border wall had on migration. Our identification assumption will be that, consistent with the haphazard nature of the roll-out, the year a fence is built is uncorrelated with unobserved trends in variables that affect migrant flows. We will provide further evidence in support of this assumption below.

## 2.2 Migration and economic data

We briefly describe the datasets we have assembled, see Appendix B for more details, including summary statistics of each sample.

**Measuring where unauthorized migrants choose to cross the border** To examine the route choice of migrants, we rely on the EMIF data. This survey is conducted in 17 traditional border-crossing locations spanning the width of the U.S.-Mexico border. We use data from 2004 to 2012. We observe a total of 52,336 individuals traveling from 2,103 different Mexican municipalities to 214 different U.S. CBSAs; see Appendix Table A3 for

[8]Additional data collected by the EMIF on returnees to Mexico shows between 85-95% of migrants travel to the border by either foot or bus; see Appendix Table A1 for details.

[9]The barrier in Nuevo Laredo was constructed in 2005 prior to the Secure Fence Act. We include it in the wall expansion and consider robustness to excluding this segment. The remaining expansions were all authorized by the SFA, including the 3 points that were first fenced in 2006 which were in Arizona. Of the three 2006 locations one was a temporary fence; for all three, the segment of fence around each border point was finished in 2008.

descriptive statistics of the dataset. From this data, we calculate the probability that a migrant going from a given origin to a particular destination chooses to cross the border at each of the crossing locations. We use these data to assess how responsive migrants' choice of route is to the crossing point having a barrier constructed.[10]

While unique in providing information on the actual route a migrant takes to cross the border, this data-set does have three shortcomings. First, unauthorized migration is a clandestine activity, and so the sample may not be representative of all migrants attempting to cross the border. Second, the data-set measures migration attempts, which may differ from successful crossings. Third, the surveyed locations are all traditional crossing points and hence do not capture all possible routes across the border; as mentioned above, however, retrospective evidence from the Mexican Migration Project reports that the vast majority of respondents who reported their crossing point reported one of the EMIF locations. Despite these concerns, the route choices of migrants in the EMIF data is strongly correlated with both border apprehension data and the matrícula consular data; see Online Appendix Table A4 for details.

**Measuring the travel time along each possible route** We calculate both the overland distance and the cost-weighted distance of traveling from each of the 2,311 Mexican municipalities to each of the 977 U.S. CBSAs through each of the 17 EMIF border crossing points. To calculate the cost-weighted distance, we partition the continental United States and Mexico into grid cells of 0.25 square miles. We then assign a cost of traversing each grid cell based on four factors: ruggedness, climate (i.e., whether or not it is desert), composition (i.e., land or water), and the presence and type of any roadway or railway.[11] We then calculate the origin-border-destination triad travel cost by integrating these costs over the least-cost route traversed.[12] To calculate the overland distance, we follow the same procedure but treat all land pixels as equally costly.

[10]Given the large number of origin Mexican municipalities, destination U.S. CBSAs, and possible routes, there are many origin-route-destination triplets which are not observed in the data. We address this sparseness in both the empirics and counterfactuals below.

[11]In the presence of infrastructure, we assume the speed of travel is 60 mph on freeways, 45 mph on highways, 30 mph on other roads, and 25 mph on railroads. In the absence of infrastructure, we assume a speed of 10 mph (capturing the possibility of minor roads) and, following Naismith's rule, add an additional hour of travel time for every 2,000 foot change in elevation. If the maximum July temperature is between 40 and 44 C (45+ C), we slow the speed of walking by half (three quarters). Rivers or lakes can be crossed at 1/100 the speed of walking. The results that follow are robust to varying each of these assumptions.

[12]This calculation is achieved using the "Fast Marching Method" developed by Tsitsiklis (1995) and Sethian (1996) and originally applied to economics by Allen and Arkolakis (2014).

**Measuring where unauthorized migrants choose to migrate** To measure Mexican origin (municipality) to U.S. destination (CBSA) bilateral migration, we use a confidential version of the Mexican government's matrícula consular database. The matrícula consular is an identification document issued by Mexican consulates in the United States to Mexican citizens residing in the United States and valid for five years. The card requires proof of Mexican citizenship but no proof of legal status in the United States. It is widely accepted by U.S. banks and financial institutions. We observe 5.6 million individuals who are issued a total of 8.1 million cards over the period 2006-2015. In order to conduct pre-trend analysis below, we also consider an extended version of the data-set that begins in 2002 that does not distinguish between new cards and renewals.

For each individual, we see their birth municipality in Mexico, the U.S. county where they were living each time a card was issued (which we match to CBSA), as well as a few demographic details such as age, gender, occupation, and education. The primary benefit of the matrícula consular database is that we see the birthplace municipality in Mexico and the destination U.S. CBSA, allowing us to measure bilateral migration flows. This is in contrast to databases such as the ACS, where only the country (and not the municipality) of origin is observed. Appendix Table A5 shows that 96% of matrículas are issued to individuals with a high-school education or less. This group is highly likely to be unauthorized: Passel (2007) estimates that 72% of unauthorized migrants have this level of education, compared with 45% of authorized migrants.

The highly disaggregated geographical coverage in the matrícula card dataset allows us to recover rich patterns of migration. To illustrate these patterns, panel (a) of Appendix Figure A1 plots the share of matrículas consulares that were issued in California for each origin municipality in Mexico. The figure shows both that there is a geographic pattern to migration (74% of migrants from Baja California migrate to nearby California), but also that geography is not the only predictor of migration (71% of migrants from the Yucatán Peninsula, in the far south of Mexico, also migrate to California). Such patterns likely reflect historical migration patterns and the fact that migration networks are very persistent (Munshi (2003); Card (2001)). Panel (b) plots the relative share of migrants who travel to Los Angeles compared with the Bay Area. There is rich heterogeneity in regional specialization – for example, 32% of migrants from Yucatán go to the Bay Area, whereas migrants from Baja California are much more likely to migrate to Los Angeles, with only 4% moving to the Bay Area. Panels (c) and (d) shows similar patterns for migration to Texas.

The matrícula consular database does have some shortcomings. First, applying for a card is voluntary. This concern is partly attenuated by the fact that the richness of the data allows us to control for origin-year, destination-year, and pair fixed effects, so we can allow for take-up rates to vary across time and space. Second, migrants who have been in the United States for many years may also apply for a matrícula card, so changes in the number of cards could reflect a change in the take-up rate of preexisting migrants rather than newly arrived migrants. Third, a card is valid for five years, so some observations are renewals rather than new cards. However, we can directly observe renewals as we see all cards issued to each individual from 2006 onward.

To allay these concerns, we pursue two strategies. First, we undertake a substantial verification exercise in Online Appendix B.7 comparing the matrícula card database to the ACS and Mexican census to quantify how the observed matrícula data match with independent estimates of the migrant population in both the US and in Mexico. We estimate that each matrícula card corresponds to somewhere between 0.88 and 0.99 of a recently arrived migrant (i.e., one who has been in the country for five years or less) in the ACS, whether varied over time or over time and across space. Second, because we are less confident that the precise year-to-year variation in the number of matrículas will be as closely aligned with migration flows we rely on observed changes in the bilateral patterns of migration before and after the complete border wall expansion rather than relying on annual variation during the roll-out.

**Migration flows and economic outcomes within the United States** We use the ACS and Census waves from 2000 to 2012 to examine within-U.S. migration, population stocks, and wages of different types of workers. We follow Borjas, Grogger, and Hanson (2012) and Ottaviano and Peri (2012) in the construction of the sample.[13] The sample includes all adults aged 18–64, who are not residing in group quarters and who have worked at least one week in the year prior to the Census. We omit self-employed workers from both the computation of wages (following the argument that returns to self-employment may also include returns to non-labor inputs) and from the counts of population. We classify workers into two education groups: high-skill (if they have completed at least some college) and low-skill (if they have completed high school or less).[14]

[13] In our preferred specification, we differ from the sample definition used in Borjas, Grogger, and Hanson (2012) in two ways. Because 40% of matrícula cards are issued to women, we keep women in the sample. We also do not drop from the population counts people who worked zero hours, as not working is likely an endogenous outcome. We undertake robustness to the sample definition in Section 4.4.

[14] Our focus is to understand the elasticity of substitution between low-skill US-born and Mexican-born workers. We highlight that the education threshold we choose is not central within the distribution of Mexican workers (88% of all Mexican workers in the US census in 2006 had high school education or lower). Additionally, if occupational downgrading is present, high-skill Mexican-born workers may be more closely substitutable to low-skill US workers (Dustmann, Frattini, and Preston (2013)). We undertake robustness to different assumptions about how high-skill Mexican-born workers are affected by the wall and whether

To measure CBSA-to-CBSA migration flows of a particular worker type during the period before adoption of the SFA, we convert the annual migration flows from the 2005 and 2010 ACS, converting from the measured *migpuma* (an aggregated statistical unit used for confidentiality reasons), and apportion population flows to CBSA using a population-based country concordance. We then multiply by five to accord with the definition of an across-country migrant as someone who has been in the country for five years or less. In addition to using the ACS and Census to measure migration flows within the United States, we also observe the stock of workers of a given type within a year and their wage, where the wage is defined as the average weekly wage, multiplied by 52 to convert to annual wages. We use the wage data from the 2000 Census ("pre" border wall expansion) when estimating aggregate economic impacts and counterfactuals to align with the year of the Mexican census.

**Migration flows and economic outcomes within Mexico** We proceed similarly for measuring within-Mexico values using the Mexican Census waves from 1990, 2000, 2005, 2010, and 2015. We follow the same definition for the variables as we did for the United States data. We calculate within-Mexico migration flows of a particular worker type by computing the municipality-to-muncipality flows, which are computed using data from where an individual reported living five years earlier. To match the wall construction period, we use the retrospective migration data from the 2015 (i.e., location in 2010) and 2010 (i.e., location in 2005) censuses. We compute wages as the monthly income earned adjusted by the number of hours worked, multiplying by 12 to be comparable with the U.S. data. We follow the same education classifications and define workers as low-skill if they have completed high school or less and high-skill if they have completed some college. We keep self-employed individuals in the income data. Wage data is only collected in the decennial census, so we use the wage data from 2000 Census ("pre" border wall expansion) when estimating aggregate economic impacts and counterfactuals.

# 3 A simple model of migration

To guide the subsequent analysis, we begin by presenting a simple static model of migration. The model serves three purposes: (1) it decomposes the impact of a border wall on migration into four separate effects, (2) it provides estimating equations that can be brought to the data to estimate those effects, and (3) it shows how the border wall can affect labor markets in the destination.

high-skill Mexican-born workers are more similar to high-skill or low-skill US-born workers.

## 3.1 Setup

Consider an individual $\omega$ who in period $t$ starts in an origin location $o$ and makes a three-step decision of where to reside at the end of the period.[15] First, she decides in which country to reside. Second, conditional on her choice of country, she decides where to live in that country. Third, conditional on her choice of destination, she chooses how to get there. The economy comprises $N$ locations, $N_{MEX}$ of which are in Mexico and $N_{US}$ of which are in the United States.

Let the payoff of individual $\omega$ initially residing in origin $o$ in year $t$ and migrating to destination $d$ (in country $c(d)$) via route $r$ be $V_{odrt}(\omega)$, where:

$$V_{odrt}(\omega) = \frac{V_{dt} V_{od}}{C_{odrt}} \times \xi_{odrt} \times \epsilon_{odrt}(\omega),$$

where $V_{dt}$ is the value of residing in location $d$ at year $t$ (which includes e.g., the real wage and/or the amenity value in location $d$), $V_{od}$ is a time-invariant origin-destination specific value of moving from $o$ to $d$ (capturing e.g., existing social networks), $C_{odrt}$ is the migration cost incurred traveling from $o$ to $d$ via route $r$ in year $t$, $\xi_{odrt}$ are aggregate shocks observable to the agents but unobservable to the econometrician, and $\varepsilon_{odrt}(\omega)$ are migration shocks idiosyncratic to each individual $\omega$.

Without loss of generality, we decompose the migration shocks into route ($R$), destination ($D$), and country ($C$) shocks, as follows:

$$\xi_{odrt} = \frac{\xi^{D}_{odt} \xi^{C}_{oc(d)t}}{\xi^{R}_{odrt}}, \; \epsilon_{odrt}(\omega) = \frac{\epsilon^{D}_{odt}(\omega)\, \epsilon^{C}_{oc(d)t}(\omega)}{\epsilon^{R}_{odrt}(\omega)}$$

For tractability, we make both a timing and a parametric assumption on the idiosyncratic

[15] Historically, Mexican workers migrated back-and-forth between Mexico and the US, assisted by a porous border (Massey, Durand, and Malone (2003); Thom (2010); Angelucci (2012); Lessem (2018); Minian (2018)). Starting with the 1986 Immigration Reform and Control Act (IRCA), the US tightened immigration policy. IRCA legalized over 3 million migrants, increased funding for border security, and introduced criminal penalties for the first time for US employers hiring unathorized migrants. Scholars and policymakers argue that the resulting tightened measures decreased the pattern of circular migration (Massey, Durand, and Malone (2003); Pew Research Center (2012); Congressional Research Service (2012). In Appendix Figure A3 we use migration history data from the Mexican Migration Project to show that indeed, patterns of migration changed substantially and migration patterns are closer to a single migration episode rather than repeated episodes. Panel (a) of shows that the share of migrants who make at least one additional trip within 10 years was 50% in 1980, but only 10% in 2005. Panel (b) shows that a migrant who traveled for the first time in 1890 made one additional trip, but a migrant crossing for the first time in 2005 made 0.15 additional trips. Given our focus on migration patterns after 2005, we therefore abstract from repeat migration in the model.

preference terms. Our timing assumption is that $\epsilon_{odt}^{D}(\omega)$ is realized only after individual $\omega$ decides which country to reside in and $\epsilon_{odrt}^{R}(\omega)$ is realized only after an individual decides to which destination to migrate. This assumption captures, for example, the uncertainty that migrants face concerning where they will be delivered in the United States and how they will get there when enlisting the help of smugglers to cross the border. Our parametric assumption is that $\epsilon_{odrt}^{R}(\omega)$, $\epsilon_{odt}^{D}(\omega)$, and $\epsilon_{c(d)t}^{C}(\omega)$ are all independent and identically distributed with the extreme value Frechet distribution with shape parameters $\theta^R$, $\theta^C$ and $\theta^D$, respectively.[16]

## 3.2 Migration patterns

The model is solved through backwards induction.

**Step #3: Which route should an individual take?** Consider an individual who has decided to migrate from $o$ to $d$: how does she get there? She chooses her route $r$ in order to minimize the migration cost incurred. Let $\mathcal{R}_{od}$ be the set of routes from $o$ to $d$. Given the assumed extreme value distribution of $\varepsilon_{odrt}$, the probability she chooses route $r$, conditional on choosing origin $o$ and destination $d$, $\pi_{r|odt}$, is:

$$\pi_{r|odt} = \frac{\left(C_{odrt}\xi_{odrt}^{R}\right)^{-\theta^R}}{\sum_{r'\in\mathcal{R}_{od}}\left(C_{odr't}\xi_{odr't}^{R}\right)^{-\theta^R}} \tag{1}$$

and her expected cost of migrating is $\mu_{odt} \equiv E_{\epsilon^R}\left[\min_{r\in\mathcal{R}_{od}} C_{odrt}\xi_{odrt}^{R}\epsilon_{odrt}^{R}(\omega)\right]$ is given by:

$$\mu_{odt} = \mathcal{C}^R \times \left(\sum_{r\in\mathcal{R}}\left(C_{odrt}\xi_{odrt}^{R}\right)^{-\theta^R}\right)^{-\frac{1}{\theta^R}}, \tag{2}$$

where $\mathcal{C}^R = \Gamma\left(\frac{\theta^R-1}{\theta^R}\right)$ is a constant.

**Step #2: Where should an individual migrate to within a country?** Conditional on the choice of her country $c$ and taking into account expected migration costs $\mu_{odt}$ given her optimal route choice, individual $\omega$ will choose her destination within that country in order to maximize her payoff. Given the assumed extreme value distribution of $\epsilon_{odt}^{D}$, the

[16]Neither the timing assumption nor the assumption that the error terms are independent from each other is necessary, as an alternative framework where the three draws are arbitrarily correlated and realized simultaneously is isomorphic to our setup (see Appendix C.3 for details).

probability an individual from origin $o$ chooses to reside in destination, conditional on her choice of country $c$, $\pi_{d|oct}$, is:

$$\pi_{d|oct} = \frac{\left(\frac{V_{dt}V_{od}\xi^D_{odt}}{\mu_{odt}}\right)^{\theta^D}}{\sum_{d'\in\mathcal{D}_c}\left(\frac{V_{d't}V_{od'}\xi^D_{od't}}{\mu_{od't}}\right)^{\theta^D}}, \tag{3}$$

where $\mathcal{D}_c$ is the set of destinations in country $c$. The expected value of choosing country $c$ is $\mathcal{V}_{ct} \equiv E_{\epsilon^D}\left[\max_{d\in\mathcal{D}_c}\left(V_{dt}V_{od}\xi^D_{odt}/\mu_{odt}\right)\times\epsilon^D_{odt}(\omega)\right]$, and it is given by:

$$\mathcal{V}_{ct} = \mathcal{C}^D \times \left(\sum_{d\in\mathcal{D}_c}\left(\frac{V_{dt}V_{od}\xi^D_{odt}}{\mu_{odt}}\right)^{\theta^D}\right)^{\frac{1}{\theta^D}}, \tag{4}$$

where $\mathcal{C}^D = \Gamma\left(\frac{\theta^D-1}{\theta^D}\right)$ is a constant.

**Step #1: Should an individual migrate or not?** Taking into account her expected payoffs from steps #2 and #3, individual $\omega$ will choose in which country to reside in order to maximize her expected payoff of doing so. Given the assumed extreme value distribution of $\epsilon^C$, the probability an individual from origin $o$ chooses to reside in country $c \in \{US, MEX\}$, $\pi_{c|ot}$, is:

$$\pi_{c|ot} = \frac{\left(\mathcal{V}_{ct}\xi^C_{ct}\right)^{\theta^C}}{\sum_{c'\in\{US,MEX\}}\left(\mathcal{V}_{c't}\xi^C_{c't}\right)^{\theta^C}}. \tag{5}$$

The unconditional probability that an individual from origin $o$ chooses to reside in destination $d$, $\pi_{d|ot}$, is simply the product of the two probabilities above:

$$\pi_{d|ot} = \pi_{d|oc(d)t} \times \pi_{c(d)|ot}. \tag{6}$$

Applying the law of large numbers, $\pi_{d|ot}$ is also the fraction of individuals from origin $o$ who choose to migrate to destination $d$.

## 3.3 How does a border wall expansion affect migration flows?

We now use this simple framework to study how a border wall expansion affects migration patterns. Suppose that the economy is in equilibrium in period $t_0$. A border wall expansion then occurs, and the economy moves to a new equilibrium in period $t_1$. Suppose the border wall expansion increases the origin-destination-route migration cost from $\{C_{odrt_0}\}$ to $\{C_{odrt_1}\}$ and changes the vector of destination payoffs from $\{V_{dt_0}\}$ to $\{V_{dt_1}\}$ but leaves the unobserved aggregate shocks unchanged, i.e., $\xi_{odrt_0} = \xi_{odrt_1}$. Let $\left\{\pi_{d|ot_0}\right\}$ and $\left\{\pi_{d|ot_1}\right\}$ be the migration patterns of the economy before and after the border wall expansion, respectively. Finally, let $\widehat{C}_{r|od} \equiv \frac{C_{odrt_1}}{C_{odrt_0}}$, $\widehat{V}_d \equiv \frac{V_{dt_1}}{V_{dt_0}}$, and $\widehat{\pi}_{d|o} \equiv \frac{\pi_{d|ot_1}}{\pi_{d|ot_0}}$ denote the changes (measured in ratios) of the migration costs, destination payoffs, and migration patterns between periods $t_0$ and $t_1$.[17]

From equations (1), (3), (5), and (6), we can write the change in migration flows as:

$$\widehat{\pi}_{d|o} = \frac{\overbrace{\left(\sum_r \pi_{r|odt_0} \widehat{C}_{r|od}^{-\theta^R}\right)^{\frac{\theta^D}{\theta^R}}}^{\text{detour effect}} \overbrace{\widehat{V}_d^{\theta^D}}^{\text{destination effect}}}{\underbrace{\sum_{d' \in N_c} \pi_{d'|oct_0} \left(\widehat{V}_{d'}/\widehat{\mu}_{od'}\right)^{\theta^D}}_{\text{diversion effect}}} \times \underbrace{\left(\frac{\left(\sum_{d' \in N_c} \pi_{d'|oct_0} \left(\widehat{V}_{d'}/\widehat{\mu}_{od'}\right)^{\theta^D}\right)^{\frac{\theta^C}{\theta^D}}}{\sum_{c \in \{US,MEX\}} \pi_{c(d)|ot_0} \left(\sum_{d' \in c} \pi_{d'|oct_0} \left(\widehat{V}_{d'}/\widehat{\mu}_{od'}\right)^{\theta^D}\right)^{\frac{\theta^C}{\theta^D}}}\right)}_{\text{deterrence effect}}, \quad (7)$$

where $\widehat{\mu}_{od} \equiv \left(\sum_r \pi_{r|odt_0} \widehat{C}_{r|od}^{-\theta^R}\right)^{-\frac{1}{\theta^R}}$. Since the total destination population is the sum of migrants from all possible origins, the change in migration flows allow us to calculate the change in destination population as $\widehat{L}_d = \sum_o \left(\frac{\pi_{d|o} L_o}{L_d}\right) \widehat{\pi}_{d|o}$.

Equation (7) highlights four possible effects of a border wall expansion. First, there is a *detour effect*: by increasing the cost of certain origin-destination-routes, migrants either have to incur those costs along those routes or choose alternative routes. This raises the cost of migrating, reducing migration flows. From equation (7), we see that the impact of an increase in the cost of a route on the expected migration cost is larger the more that route is used (i.e., the higher the $\pi_{r|odt_0}$). This is intuitive: a border wall expansion increases migration costs more for origin-destination pairs that use that border crossing more intensively, thereby reducing migration flows.

Second, increases in migration costs elsewhere can divert migrants to destinations less affected by the border wall. This *diversion effect* will be larger if (1) $\theta^D$ is larger (i.e., migrants are more homogeneous in their preferences for destinations within a country and hence more responsive to changes in payoffs) and/or (2) $\pi_{d|oct_0}$ is larger (in which

[17] The discussion applies the "exact hat algebra" approach pioneered by Dekle, Eaton, and Kortum (2007) in the international trade literature to the migration literature; see Costinot and Rodríguez-Clare (2014) for an excellent review.

case there are a greater fraction of migrants who are affected by the higher costs and hence more migrants who will be considering substituting elsewhere).

Third, increases in migration costs in any destination within the United States will make migrating less attractive; this *deterrence effect* will, all else equal, result in a decline in the number of migrants to all destinations in the United States. The deterrence effect will be large if $\theta^C/\theta^D$ is larger, i.e., potential migrants are more homogeneous in their preferences for countries than they are in their preferences for locations within countries. The extent to which a border wall reduces total migration depends crucially on the relative values of $\theta^C$ and $\theta^D$. For example, in the extreme case that $\theta^C = 0$, the expansion of the border wall will only result in migrants changing where they migrate within the United States; the total flow of migrants to the United States will remain unchanged. More generally, if $\theta^C > \theta^D$ (conversely, $\theta^D < \theta^C$), the increase in the share of migrants to unaffected destinations in the United States will be less than proportional (conversely, more than proportional) to their initial unconditional migration shares.[18]

Finally, by changing the supply of labor, a border wall expansion may directly change the payoffs of certain destinations, e.g., by changing the equilibrium wage in the destination. We refer to these effects on the destination labor market as the *destination* effect, an effect we now examine in detail.

## 3.4 How does a border wall expansion affect destination labor markets?

How do the changes in migration from Mexico resulting from the border wall expansion affect labor markets in the U.S.? To answer this question, we embed a labor market structure featuring imperfectly substitutable labor types differing in skill and nativity originally developed in the immigration literature into our framework.[19]

Suppose workers are differentiated by their skill $s$ (high-skill $h$ and low-skill $l$) and their nationality $n$ (Mexican $M$ and United States $U$). In each location $d$, the four types of workers combine their labor to produce a homogeneous numeraire good using a nested constant elasticity of substitution (CES) production function. Production occurs under perfect competition and a worker in location $d$ in period $t$ of nationality $n$ and skill $s$ is

[18] In the knife-edge case $\theta^C = \theta^D$, the redistribution of migrants from the impacted location $d'$ to all other destinations will be proportional to their unconditional migration shares – this is the "independent of irrelevant alternatives" (IIA) assumption underpinning the substitution effects in standard "gravity" models of migration, see, e.g., Tombe and Zhu (2019); Desmet, Nagy, and Rossi-Hansberg (2018).

[19] See, for example, the works of Katz and Murphy (1992); Card (2001); Borjas (2003); Borjas and Katz (2007); Ottaviano and Peri (2012) and the excellent review article of Dustmann, Schönberg, and Stuhler (2016).

paid a wage $w_{dt}^{n,s}$ equal to her marginal product:

$$w_{dt}^{n,s} = Q_{dt}^{\frac{1}{\rho}} \times \left( \left( \sum_{n \in \{M,U\}} A_{dt}^{n,s} \left( L_{dt}^{n,s} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)} \times A_{dt}^{n,s} \times \left( L_{dt}^{n,s} \right)^{-\frac{1}{\rho}}, \tag{8}$$

where $A_{dt}^{n,s} > 0$ is the productivity of a worker of nationality $n$ and skill $s$ in location $d$ in period $t$, $\rho \geq 1$ is the elasticity of substitution across the nationalities of workers of a given skill, $\lambda \geq 1$ is the elasticity of substitution across high-skill and low-skill workers, and $Q_{dt}$ is the CES aggregate quantity produced. From equation (8), we can write the ratio of wages of Mexican to U.S. workers of a given skill in a destination $d$ as:

$$\ln \left( \frac{w_{dt}^{M,s}}{w_{dt}^{U,s}} \right) = -\frac{1}{\rho} \ln \left( \frac{L_{dt}^{M,s}}{L_{dt}^{U,s}} \right) + \ln \left( \frac{A_{dt}^{M,s}}{A_{dt}^{U,s}} \right). \tag{9}$$

Equation (9) says the number of Mexican-born workers in a destination declines, the relative wage of U.S.-born workers will increase, with the elasticity of substitution $\rho$ determining the extent of the relative wage change: if Mexican-born and U.S.-born workers are close substitutes ($\rho$ is high), the relative wages will respond less than if workers of different nativities are imperfect substitutes ($\rho$ is low).

How does the border wall expansion affect wages? Let $\hat{w}_d^{n,s} \equiv w_{dt_1}^{n,s} / w_{dt_0}^{n,s}$ and $\hat{L}_d^{n,s} \equiv L_{dt_1}^{n,s} / L_{dt_0}^{n,s}$ be the ratio of wages and labor supply of worker type $\{n, s\}$, respectively, after the expansion relative to before the expansion. Assuming that the border wall expansion leaves worker productivities unchanged, equation (9) yields:

$$\widehat{w}_d^{n,s} = \underbrace{\left( \frac{\left( \sum_{n \in \{M,U\}} y_{dt_0}^{n,s} \left( \widehat{L}_d^{n,s} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1} \frac{\lambda-1}{\lambda}}}{\sum_{s \in \{h,l\}} \eta_{dt_0}^{s} \left( \sum_{n \in \{M,U\}} y_{dt_0}^{n,s} \left( \widehat{L}_d^{n,s} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1} \frac{\lambda-1}{\lambda}}} \right)^{-\frac{1}{\lambda-1}}}_{\text{change in relative skill scarcity}} \times \underbrace{\left( \frac{\left( \widehat{L}_d^{n,s} \right)^{\frac{\rho-1}{\rho}}}{\sum_{n \in \{M,U\}} y_{dt_0}^{n,s} \left( \widehat{L}_d^{n,s} \right)^{\frac{\rho-1}{\rho}}} \right)^{-\frac{1}{\rho-1}}}_{\text{change in relative nationality scarcity}}, \tag{10}$$

where $\eta_{dt}^{s} \equiv \frac{\sum_{n \in \{M,U\}} w_{it}^{n,s} L_{it}^{n,s}}{\sum_{s \in \{h,l\}} \sum_{n \in \{M,U\}} w_{it}^{n,s} L_{it}^{n,s}}$ is the share of income in location $d$ earned by workers of skill $s$ (of both nationalities) in period $t$ and $y_{dt}^{n,s} \equiv \frac{w_{dt}^{n,s} L_{dt}^{n,s}}{w_{dt}^{MEX,s} L_{dt}^{MEX,s} + w_{dt}^{US,s} L_{dt}^{US,s}}$ is the share of income earned by workers of skill $s$ in location $d$ that is paid to workers of nativity $n$ in period $t$; see Appendix C.2 for the derivation. Equation (10) highlights two ways in which a migration shock can affect the wages in a particular destination. First, it can change the relative scarcity of a given nationality of worker within a skill type. Second, it can change the relative scarcity of workers of different skill types. The magnitude of the relative nationality scarcity effect depends on the elasticity of substitution between workers of different nativities ($\rho$). Similarly, the magnitude of the relative skill scarcity effect depends on the elasticity of substitution between workers of different skill groups ($\lambda$).

Equations (8) and (9) are standard in the immigration literature and equation (10) is a direct "exact hat algebra" corollary to these expressions. What is new here, however, is that migration flows can endogenously respond to changes in destination wages by allowing a feedback loop between the "destination effect" emphasized in the migration equation (7) and the changes in relative labor supplies emphasized in the labor market equation (10). To emphasize this endogenous interaction between migration flows and destination labor markets, in Section 5 we consider two variants of the framework: a "baseline" case where migration flows do not respond to changes in destination wages (i.e., $\widehat{V}_d^{n,s} = 1$); and a "wage feedback loop" case where they do (i.e., $\widehat{V}_d^{n,s} = \widehat{w}_d^{n,s}$).

# 4 Disentangling the effects of the border wall expansion on migration flows and destination labor markets

We now estimate how the border wall expansion affected migration flows and local labor markets through each of the four effects described in Section 3. by following a four-step estimation procedure that closely mirrors the backwards induction process used above to solve the model.

## 4.1 The detour effect: How does the border wall affect which route should an individual take?

We first examine whether the border wall expansion caused Mexican migrants to change how they traveled into the U.S.

**Estimation strategy** Suppose we observe the fraction of individuals who have decided to migrate from $o$ to $d$ in period $t$ who have chosen route $r$, $\pi_{r|odt}$. Taking logs of equation

(1) yields:

$$\ln \pi_{r|odt} = -\theta^R \ln C_{odrt} - \theta^R \ln \xi^R_{odrt} - \ln \sum_{r' \in \mathcal{R}} \left( C_{odr't} \xi^R_{odr't} \right)^{-\theta^R}.$$

We parameterize migration costs $C_{odrt}$ as:

$$\ln C_{odrt} = \beta_W Wall_{rt} + \beta_d \log dist_{odr} - \ln \delta^R_r,$$

where $Wall_{rt}$ is a dummy variable equal to one if there is a border wall present along route $r$ and zero otherwise, $dist_{odr}$ is either the overland or cost-weighted distance from origin $o$ to destination $d$ along route $r$, and $\ln \delta^R_r$ is a route fixed effect. Combining the previous two equations yields the following regression:

$$\ln \pi_{r|odt} = -\theta^R \beta_W Wall_{rt} - \theta^R \beta_d \log dist_{od,r} - \theta^R \ln \delta^R_r + \ln \delta^R_{odt} - \theta^R \ln \xi^R_{odrt}, \tag{11}$$

where $\ln \delta^R_{odt} \equiv -\ln \sum_{r' \in \mathcal{R}} \left( C_{odr't} \xi^R_{odr't} \right)^{-\theta^R}$ is an origin-destination-period fixed effect that summarizes the overall expected cost of the origin-destination pair in time $t$ across all routes. Regression (11) identifies the product of the direct effect of the border wall on the cost of migration and the elasticity of migrants to this cost, $\theta^R \beta_W$.

To estimate equation (11), we define a route $r$ as the choice of border crossing location. This allows us to measure $\ln \pi_{r|odt}$ directly from the EMIF data, as it reports the number of migrants from each Mexican municipality origin $o$ traveling to each U.S. CBSA destination $d$ using each border crossing $r$ in each year $t$. Identification of $\theta^R \beta$ then arises from variation in the timing of the border wall expansion across border crossings. As discussed in Section 2.1, while all border crossings except one eventually received a wall, the timing of the expansion was idiosyncratic in part due to variation across locations in who owned the land along the border and the degree to which they resisted the construction of a border wall.

**Results** We start by considering an event-study of how migration flows changed in the years after the initial construction of the border wall at a border crossing. The time-varying roll-out of the wall implies that standard event studies result in biased estimates. Hence, we follow Borusyak, Jaravel, and Spiess (2024) and estimate pre-trends and treatment effects separately. To estimate pre-trends, we restrict the sample to untreated observations, including never-treated border points, and estimate the regression:

$$\ln \pi_{r|odt} = \sum_{\tau=-4}^{-1} \beta_\tau Wall_{rt+\tau} + \gamma_{odt} + \gamma_r + \varepsilon_{odtr},$$

and to estimate treatment effects, we use the full sample and estimate the regression:

$$\ln \pi_{r|odt} = \sum_{\tau=0}^{3} \beta_\tau Wall_{rt+\tau} + \gamma_{odt} + \gamma_r + \varepsilon_{odtr},$$

where $\pi_{r|odt}$ is the share of people traveling between $o$ and $d$ that travel through crossing point $r$ (measured in the EMIF data). Each observation is weighted by the total number of migrants from origin $o$ going to destination $d$ in year $t$ so that the regression is representative at the migrant level. Standard errors are clustered at the crossing point level. Panel (a) of Figure 3 depicts the results.[20] Consistent with the idiosyncratic timing of the roll-out of the border wall, there is no evidence of differential trends in migration flows prior to the construction. Immediately after the construction of the border wall, however, there is a marked decline in migration flows, consistent with the border wall construction increasing migration costs.

Table 1 presents the results of regression (11), where again each observation is weighted by the total number of migrants from origin $o$ going to destination $d$ in year $t$. In columns 1-3, we use an ordinary least squares (OLS) specification, which constrains the sample only to origin-destination-route-year tuplets with positive migration flows. Regardless of whether we control for overland distance (panel (a), columns 1 and 2), cost-weighted distance (panel (b), columns 1 and 2), or origin-destination-route fixed effects (column 3), we find that the presence of a border wall results in a decline in migration flows. Given the sparseness of the trilateral origin-crossing points-destination shares, columns 4-6 use a Poisson psuedo-maximum likelihood (PPML) estimator, which allows us to include all triplets in the estimation (see e.g., Silva and Tenreyro (2006)). Again, we find a strong negative effect of the border wall on migration flows across all specifications. In our preferred specification of panel (b) column 5—which uses PPML and cost-weighted distance so that the estimate is based on the entirety of the sample —the presence of a border wall reduces migration flows at the border crossing by 0.55 log points.

A couple of notes about statistical inference are necessary. The standard errors re-

[20]Note that none of the coefficients in Figure 3 is normalized to zero because never-treated units are included in the regression, as suggested by Borusyak, Jaravel, and Spiess (2024). As a robustness, Appendix Figure A5 presents the estimates of a standard event study (i.e., without never-treated units), and the results are similar.

ported in Table 1 are clustered at the crossing-point level, which allows for arbitrary correlation over time within a border crossing. However, because there are only 17 border crossing locations, we also conduct a permutation analysis, where we consider all 280 possible permutations of how the border wall expansion could have occurred following the same aggregate timing (i.e., 1 additional crossing received a border wall in 2005, 3 new crossings received a border wall in 2006, and 4 new crossing received a border in 2008). For each possible permutation of the roll-out schedule, we then re-estimated regression (11) for each specification. We use the distribution of coefficients across regressions in order to calculate the exact permutation p-values. The permutation p-value are reported in the table in brackets. Across specifications, this happened between 1% and 15% of the time, suggesting that it is unlikely that the observed migration decline after the construction of the border wall was due to chance.

**Robustness** One potential concern with the results in Table 1 is that it is not the border wall expansion *per se* that is causing the decline in migration flows but rather that the border wall expansion is occurring at the same time as other changes along the border which are reducing migration flows. For example, perhaps the border wall expansion is happening concurrently to an increase in Border Patrol resources at that crossing. Or perhaps the border wall expansion is a reaction to increased crime at a particular crossing, and it is the increase in crime that is causing the decline in migration. In columns 2 and 3 of Online Appendix Table A11, we run our preferred PPML estimate (column 5) and control directly for the number of Border patrol staff and the homicide rates, respectively, at the crossing and find that our estimate of the impact of the border wall is unchanged, alleviating such concerns.

As mentioned in Section 2.1, the border wall expansion occurred in 2005, one year prior to the passage of the SFA, for Nuevo Laredo. One might be concerned that this premature expansion may be driven by local concerns rather than the passage of federal law. In column 4 of Online Appendix Table A11, we include Nuevo-Laredo-year fixed effects so that identification of the border wall coefficient only arises from expansion elsewhere; again, the estimated coefficient remains unchanged.

A third concern is that our simple of border wall expansion may be too coarse, as the extent to which a border wall affects migration patterns may depend not only on whether or not there is a border wall at the crossing location, but also on the extent of the border wall near the crossing location. Recall that our baseline measure is whether there is any wall within a 2 mile radius around the EMIF border crossing location. In Online Appendix Table A12, we instead use a continuous measure of exposure of the share of the border walled within a 2 mile, 10 mile, and 20 mile radius of the border crossing location. We find these alternative measures of exposure yield coefficients of similar magnitudes to our discrete measure.

A fourth concern is that if there are heterogeneous treatment effects, running a panel regression with fixed effects assuming homogeneous treatment effects results might give negative weights to some observations. Following Borusyak, Jaravel, and Spiess (2024), we test the robustness of our results by re-estimating regression (11) while allowing for treatment effect heterogeneity in different dimensions. Appendix Table A13 presents the results. In each column, we re-estimate regression (11) allowing for heterogeneity in the treatment effect under a different dimension. We then calculate the corresponding average treatment effect, finding that the estimated average treatment effects are not statistically different across the different specifications.

We conclude that the border expansion causes migrants to substitute toward less affected routes when migrating.

## 4.2 The diversion effect: How does the border wall affect where an individual migrates within a country?

Armed with estimates on how the border wall expansion affected migrants' choice of route, we proceed with the second step of the estimation procedure: examining how the border wall expansion affected migrants' choice of where to migrate within the U.S.

**Estimation strategy** Suppose we observe the share of migrants to country $c$ from origin $o$ who choose to migrate to destination $d$ in period $t$, $\pi_{d|oct}$. Taking logs of equation 3 yields:

$$\ln \pi_{d|oct} = \theta^D \ln V_{dt} + \theta^D \ln V_{od} + \theta^D \ln \xi^D_{odt} - \theta^D \ln \mu_{odt} - \ln \sum_{d' \in \mathcal{D}_c} \left(V_{d't} V_{od'} \xi_{od't} / \mu_{od't}\right)^{\theta^D} \quad (12)$$

Note that the expected migration cost $\ln \mu_{odt}$ defined in equation (2) can be written as a function of parameters estimated in the previous step of the estimation procedure, i.e., regression (11) implies that $\ln \mu_{odt} = \log \mathcal{C}^R + \frac{1}{\theta^R} \ln \delta^R_{odt}$.[21] We can then re-write equation

[21] To minimize estimation error, we follow Dingel and Tintelnot (2023) and do not use the error term when calculating migration costs. That is, we make $\xi_{odrt} = 1$ and get $\delta^R_{odt} = -\ln \sum_{r \in \mathcal{R}} \exp\left(-\theta^R \beta_W Wall_{odrt} - \theta^R \beta_d \log dist_{odr} + \delta^R_r\right)$. See Appendix (B.6) for details.

(12) as follows:

$$\ln \pi_{d|oct} = -\theta^D \log \mathcal{C}^R - \frac{\theta^D}{\theta^R} \ln \delta^R_{odt} + \ln \delta^D_{dt} + \ln \delta^D_{oct} + \ln \delta^D_{od} + \theta^D \ln \xi^D_{odt}, \qquad (13)$$

where $\ln \delta^D_{dt} \equiv \theta^D \ln V_{dt}$ is a destination-year fixed effect that captures the value of migrating to that destination, $\ln \delta^D_{od} \equiv \theta^D \ln V_{od}$, and $\ln \delta^D_{oct} \equiv -\ln \sum_{d' \in \mathcal{D}_c} \left( V_{d't} V_{od'} \xi_{od't} / \mu_{od't} \right)^{\theta^D}$ is an origin-year fixed effect that is proportional to the expected value of migrating to country $c$. Regression (13) identifies the relative elasticity of migrants to routes and destinations, $\theta^D/\theta^R$.

To estimate regression (13), we regress the observed share of migrants from origin $o$ choosing destination $d$ in period $t$ from the matrícula dataset on the estimated origin-destination-year fixed effects from the route-level detour regression using the EMIF data. Recall from Section 2.2 that migrants vary in the time they take to apply for their matrícula consular card after migrating. As a result, in what follows we primarily examine the long-differences in migration flows, relying on the year-to-year variation only as evidence to support the parallel trends assumption. In particular, we estimate regression (13) on only two periods: a "pre"-period ($t_0 = 2006$) prior to the passage of the SFA; and a "post"-period ($t_1 = 2010$) at which time the border expansion was complete. The identifying assumption is that conditional on the origin-year, origin-destination and destination-year fixed effects, the estimated origin-destination-year fixed effects from the detour regression are uncorrelated with other unobserved shocks to the bilateral costs of migrating. We discuss potential threats to identification below.

**Results** We begin by using an event study approach to estimate the diversion effect over time. We define the exposure of an origin-destination pair as the difference in its fence exposure before and after the fence expansion, i.e., $\widehat{\delta}^R_{od} \equiv \delta^R_{od,t_1}/\delta^R_{od,t_0}$. One important concern about equation (12) is that even if the border wall expansion was random, it is possible that it will generate spatial correlations in the degree of exposure of origin-destination pairs. For example, origin-destination pairs located closer to the U.S.-Mexico border will tend to be more exposed to any border wall expansion than origin-destination pairs further away. If migration flows between origin-destination pairs closer to the border are on a different trend than origin-destination pairs further away, this would bias the estimates of $\theta^D/\theta^R$. We confront this concern directly using the re-centering procedure suggested by Borusyak and Hull (2023).[22] To do so, we first construct 500 random border wall expansion permutations that match the same year-by-year scope (e.g., in the pre-

[22] The authors thank Kirill Borusyak for helpful discussions regarding how to best apply this procedure.

period 9 of the 17 border crossing points had a border wall and in the post-period 16 of the 17 crossing points had a border wall), but randomize where the expansion occurs.[23] Then, for each permutation $k$, we re-estimate the the detour effect using regression (2), recovering a $k$-specific estimate of the origin-destination-year $\delta^R_{od,t,k}$. Intuitively, the mean origin-destination-year $k$-specific fixed effect across all permutation captures the average impact that any border wall expansion would have costs due to the spatial correlation in the shocks. Finally, we recenter the actual origin-destination-year fixed effect by subtracting off this mean across permutations, i.e., $\delta^{R,\text{recenter}}_{od,t,k} \equiv \delta^R_{od,t} - \sum_{k=1}^{500} \delta^R_{od,t,k}$, which we treat as the new regressor. An additional benefit of this procedure is that we can use these alternative permutations to determine what fraction of permutations result in larger t-statistics than the actual estimate. We then regress the observed migration flows in a given year on this recentered exposure measure, conditional on origin-destination, origin-year, and destination-year fixed effects, i.e.:

$$\ln \pi_{d|oct} = \sum_{\tau} \beta_\tau \mathbf{1}\{t = \tau\} \ln \widehat{\delta}^R_{od} + \gamma_{od} + \gamma_{ot} + \gamma_{dt} + \varepsilon_{odt}.$$

Panel (b) of Figure 3 shows the results. We estimate the regression using OLS. The regression is weighted by the number of migrants. Standard errors are two-way clustered by origin bin (1 degree x 1 degree) and destination-bin (1 degree x 1 degree). As is evident, there is no evidence of trends in the bilateral migration flows prior to the border wall expansion, but there is a marked decline in migration flows between the most affected bilateral pairs after 2006.

Table 2 presents the results of regression (13), where we again weight observations by the total contemporaneous migration flow so that, as above, the results are for the representative migrant. Both column 1 (OLS) and column 2 (PPML) find that the estimated increases in migration costs resulted in statistically significant declines in bilateral migration flows, with coefficients of 0.65 and 0.54, respectively, suggesting that migrants' elasticity across routes ($\theta^R$) is 54%-85% larger that of their elasticity across destinations ($\theta^D$). Standard errors are two-way clustered by origin bin (1 degree x 1 degree) and destination-bin (1 degree x 1 degree). Columns 3 (OLS) and column 4 (PPML) of Table 2 show that re-centering to control for this spatial correlation has no substantial effect on the results. Exact permutation p-values are computed as in Borusyak and Hull (2023) and are displayed in the table in brackets. In our preferred PPML specification from column 4, we

[23] The permutation differs from the EMIF regressions. There, we permuted the timing of which locations got a wall, holding which locations initially had a wall fixed. With long-differences, however, such a strategy only generates 17 possible permutations, as 16 of the 17 crossing locations are eventually walled. We instead permute all locations of the wall, including the initially-walled locations.

estimate $\theta^D/\theta^R = 0.47$ (with a standard error of 0.24), of which only 3.8% of alternative permutations result in a larger t-statistic in magnitude. To give a sense of magnitudes of the estimated effect, the average $\widehat{\mu}_{od}^{-\theta_d}$ across all Mexican origins and U.S. destinations is 0.85, i.e., all else equal, the direct "detour" effect (as defined in equation (7)) from the border wall expansion was to reduce migration on average by 15%.

**Robustness** Beyond the spatial correlation in treatment, there are several potential concerns with the estimation of regression (13). First, it might be the case that the estimated bilateral migration costs are changing not because of the border wall expansion, but rather because of other time-varying effects that happen to be occurring contemporaneously. In columns 2 and 3 of Online Appendix Table A14, we consider two such plausible time-varying shocks: the number of border control staff and homicide incidence. We show results are robust to controlling for a weighted average of each measure.

A second concern is that the diversion effect is being driven by only a subset of the origin-destination pairs. To assess this, column 4 of Online Appendix Table A14 restricts the sample to only destinations in states where there is a permanent Mexican consul that issues matrícula cards and column 5 drops pairs that have flows in the top 1% of observed data. As can be seen, the coefficient changes very little, although dropping the largest bilateral flows does cause our estimated coefficient to decline by roughly two-thirds and lose statistical significance.

A third concern is that there may exist time-varying origin-destination pair shocks to migration costs that are correlated with exposure to the border wall expansion. For example, it could be that origin-destination pairs that were disproportionately exposed to the border wall were also concurrently exposed to economic shocks resulting from the Great Recession. As the Great Recession disproportionately affected the housing sector, one could imagine that municipalities where migrants were disproportionately employed in the construction sector would have been more affected. To assess this, we control directly for the interaction of the origin share of migrants in the construction sector and the housing shock in the destination (as measured by Mian and Sufi (2014)). Column 6 of Online Appendix Table A14 presents the results; as can be seen, controlling for the housing shock has very little effect on the estimated fence coefficients. More generally, there may be unobserved sector-specific shocks in the destination that disproportionately affect migrants from origins also employed in those sectors. To address this, column 7 of Online Appendix Table A14 controls directly for the interaction of the share of migrants from an origin employed in an industry and the employment share of that industry in the destination for two major industries: agriculture and mining, and services (with construction as the omitted category). As is evident, the impact of the border wall remains stable.

We conclude that there is robust evidence that the border wall expansion resulted in a substitution of migration toward less exposed destinations.

### 4.3 The deterrence effect: How does the border wall affect whether an individual migrates or not?

We now turn to our third step in the estimation procedure, where we use the estimates from the previous step to examine whether the border wall expansion led to an overall decrease in migration from Mexico to the U.S.

**Estimation strategy** Suppose we observed the fraction of individuals initially residing in a Mexican municipality origin $o$ who have chosen to reside in country $c$. Taking logs of equation (5) and taking the difference (to difference out the denominator) between the U.S. and Mexico as a destination country yields:

$$\ln \pi_{US|ot} - \ln \pi_{MEX|ot} = \theta^C \left( \ln \left( \mathcal{V}_{o,US,t} \xi^C_{o,US,t} \right) - \ln \left( \mathcal{V}_{o,MEX,t} \xi^C_{o,MEX,t} \right) \right). \quad (14)$$

Like above, the explanatory variable of this regression can be recovered from fixed effects of the previous regression. The value of residing in the US, $\pi_{US|ot}$ is proportional to the origin-year fixed effects estimated in the diversion regression, i.e., regression (13) implies that $\ln \mathcal{V}_{oct} = \ln \mathcal{C}^D - \frac{1}{\theta^D} \ln \delta^D_{oct}$. The value of residing in Mexico, $\pi_{MEX|ot}$ is constructed from a similar gravity equation estimated on internal Mexican migration flows.[24] We can then write regression equation(14) as:

$$\ln \pi_{US|ot} - \ln \pi_{MEX|ot} = -\frac{\theta^C}{\theta^D} \left( \ln \delta^D_{o,US,t} - \ln \delta^D_{o,MX,t} \right) + \delta^C_o + \delta^C_{s(o)t} + \eta^C_{ot},$$

where $\delta^D_{o,US,t} - \delta^D_{o,MX,t}$ can be interpreted as the relative value of being in the US compared to in Mexico and we have projected the unobserved aggregate shocks from the model onto a time-invariant municipality fixed effect $\delta^C_o$, a Mexican state-year fixed effect $\delta^C_{s(o)t}$, and a residual $\eta^C_{ot}$ that captures other within-state municipality deviations, i.e., $\theta^C \left( \xi^C_{o,US,t} - \xi^C_{o,MX,t} \right) = \delta^C_o + \delta^C_{s(o)t} + \eta^C_{ot}$. Appendix Figure A6 depicts the spatial variation in the change value of being in the U.S. relative to remaining in Mexico as a result

[24] To minimize estimation error, we again follow Dingel and Tintelnot (2023) and do not use the error term when calculating the value of migrating. That is, we make $\xi_{odt} = 1$ and get $\delta^D_{oct} \approx -\ln \sum_{d' \in \mathcal{D}_c} \left( V_{d't} V_{od'} / \mu_{od't} \right)^{\theta^D}$. Moreover, because some origin-destination pairs have no observed migration flows, we impute $V_{od}$ for these pairs; see Appendix (B.6) for details.

of the border wall expansion; as expected, panel (a) shows that Mexican municipalities nearer to border crossings where the border wall expanded experienced greater declines in the relative value of migrating, whereas panel (b) shows that with the inclusion of state-year fixed effects, identifying variation appears to arise primarily through idiosyncratic municipality-specific exposure to particular destination-routes. Intuitively, the greater the decline in migration to the United States (relative to the staying in Mexico) in response to a fall in the expected value of migrating to the United States (relative to staying in Mexico), the stronger the deterrence effect.

**Results** As above, we start by using an event study approach to estimate the deterrence effect over time. We define the exposure of an origin as the change over time between the relative value of going to the US versus staying in Mexico after the fence expansion, i.e., $\ln \widehat{\delta}_o^{US-MX} \equiv \left(\ln \delta^D_{o,US,t_1} - \ln \delta^D_{o,MX,t_1}\right) - \left(\ln \delta^D_{o,US,t_0} - \ln \delta^D_{o,MX,t_0}\right)$. One concern with this approach is that attributes of the origin that are correlated with the effect of the wall would independently affect migration patterns. For example, origins that are closer to the US-Mexico border are likely more affected by a given wall because there are fewer opportunities to divert and choose a different path to cross the border. However, if migration patterns themselves were changing over time for places that were closer to the border than further away, then the results may be picking up this time trend rather than the impact of the wall. To address this concern, we again use the re-centering procedure suggested by Borusyak and Hull (2023). We use the same 500 random border wall expansion permutations as we did for the detour step. For each of the 500 permutations, we run the detour regression, save the relative fixed effects, and then compute the relative difference between Mexico and the US. We then recenter the point estimate of the relative difference between Mexico and the US with the average expected difference. We use this re-centered variable in the analysis. We regress the number of matrículas from a given origin in a given year on this recentered exposure measure, conditional on origin and state-year fixed effects, i.e.:

$$\ln N_{ot} = \sum_{\tau} \beta_\tau \mathbf{1}\left\{t = \tau\right\} \Delta \ln \widehat{\delta}_o^{US-MX} + \gamma_o + \gamma_{s(o)t} + \varepsilon^C_{ot}.$$

We only have Mexican population data for the censal and intercensal years (2000, 2005, and 2010). The event-study regression therefore uses the year-to-year variation in the number of matrícula cards issued by origin. The regression is weighted by the total number of cards. Standard errors are clustered at the origin bin (1 degree x 1 degree). Panel (c) of Figure 3 shows the results. As is evident, there is no evidence of trends in the total number of migrants traveling to the US prior to the border wall expansion, but there is a marked increase in the number of migrants deterred from migrating to the US after 2006, which gets larger until 2010, consistent with the border wall expansion deterring migrants (even if the matrícula data is not sufficiently precise to measure the exact year of migration).

Table 3 shows the regression results from defining the dependent variable as the change in the share staying in Mexico minus the share traveling to the US, using the 2005 and 2010 Mexican census data. We estimate the regression using OLS. Standard errors are clustered at the origin-grid (1 degree by 1 degree) level. Exact permutation p-values are computed as in Borusyak and Hull (2023) and are displayed in the table in brackets. Column 1 is our baseline estimate. We estimate a relative elasticity of $\frac{\theta^C}{\theta^D}$ of 3.74. This means that migrants are more than three times more responsive to the choice of country than the destination within the country. This is consistent with migration networks being very strong: migrants tend to stop migrating rather than switch destinations when it gets costlier to travel to their preferred destination. The permutation standard error is never above 0.01, suggesting that the estimated elasticity (and associated decline in migration) is unlikely due to chance.

**Robustness** In addition to the concern that attributes of origins are correlated with wall exposure which we address above by recentering, two other concerns exist. A first concern with the results above is that there are time-varying trends correlated with border wall exposure causing the decline in observed migration. The lack of obvious pre-trends in the event study depicted in Panel (c) of Figure 3 allays such a concern. A second concern is that other time-varying shocks affect migration and are correlated with an origin's relative change in the value of migrating to the US compared with staying in Mexico. For example, during the same period of the wall construction, the US experienced the Great Recession. If origins closer to the border tend to be more likely to specialize in construction work, these origins could have faced a larger negative labor demand shock which decreased the value of migrating rather than the increased costs from the wall. The parallel trend analysis already presented helps alleviate concerns about differential pre-trends, and we assess the robustness of our estimates of $\theta^C/\theta^D$ to the inclusion of a variety of time-varying municipality-level controls which could plausibly directly affect the changes in relative United States/Mexico migration shares: distance to the border (column 2), industrial composition (column 3), and push/pull factors including rainfall shocks in the origin, homicide rates in the origin, and the share-weighted housing shock in the destination (columns 4). Columns 5 combine all explanatory variables in one regression. We find that the point estimate remains consistent throughout.

We conclude that the deterrence effect is substantially larger than would be implied by the IIA assumption underlying a typical gravity migration model where $\theta^C = \theta^D$. As well as causing changes in the routes and destinations, the wall also stopped people from migrating altogether. In Section 5, we quantify the relative effect of each substitution effect on the total change in migration resulting from the wall.

### 4.4 The destination effect: How does the border wall affect the labor market in the destination?

In the last step of our estimation strategy, we turn to examining how changes in the number of migrant workers affected destination labor markets. As highlighted in Section (4.4), determining this effect depends crucially on the elasticity of substitution, $\rho$, between low-skill US-born and Mexican-born workers.[25]

**Estimation strategy** Re-writing equation (9) to include destination fixed effects and state-year fixed effects to control for time-invariant and state-wide-changes in relative productivities yields:

$$\ln\left(\frac{w_{dt}^{M,s}}{w_{dt}^{U,s}}\right) = -\frac{1}{\rho}\ln\left(\frac{L_{dt}^{M,s}}{L_{dt}^{U,s}}\right) + \gamma_{s(d)t} + \gamma_d + \varepsilon_{dt}. \tag{15}$$

Equation (15), however, highlights an endogeneity issue: any unobserved migrant productivity shock not controlled for by the state-year and destination fixed effects will increase relative wages and increase migration, causing an upward bias in the elasticity of substitution. To proceed, we construct an instrument for the number of Mexican-born workers using the border wall expansion. We start by building an instrument for the number of Mexican migrants arriving to each destination. By definition, the total number of migrants is the sum of migrants from each origin, $N_{dt} = \sum_o N_{odt}$, which allows us to write the number of migrants after the border wall expansion in period $t_1$ relative to the baseline period $t_0$ as follows:

[25]We abstract from other effects that immigrants may have on the economy. For example, Cortes (2008) shows that an increase in low-skill immigration reduces the price of services produced by low-skill labor, increasing consumer purchasing power. This channel would suggest that an additional channel that a reduction in immigration could affect welfare would be by increasing prices. Our welfare estimates may then be considered a lower bound of the actual welfare effects.

$$\widehat{N_d} = \sum_o \widehat{\pi}_{d|o} \widehat{N}_o \left( \frac{N_{odt_0}}{N_{dt_0}} \right),$$

where $\widehat{\pi}_{d|o}$ is the change in migration arising from the border wall expansion (calculated using our estimated parameters), $\widehat{N}_o$ is the change in population at the origin, and $\left(\frac{N_{odt_0}}{N_{dt_0}}\right)$ is a term that acts to weight changes in migration from a specific origin by how important that origin is for the destination's population in the pre-period. Our goal is to isolate changes in $N_{dt}$ due to the border wall expansion. For this, we make two modifications in the formula above. First, to ensure the identifying variation does not arise from aggregate shocks in the origin, we do not use variation coming from changes in total migration from each origin $\widehat{N}_o$. Second, following the same logic as earlier, we recenter the change in migration by its demeaned value to to account for spatial correlations in the degree of exposure of destinations, following Borusyak and Hull (2023). We use the same 500 wall permutations we computed for the deter step.[26] Finally, we re-scale $\widehat{N}_d$ to convert from the change in number of migrants to the change in number of workers, yielding the following instrument for the change in Mexican-born workers in destination $d$:

$$\ln \widehat{Z}_d = \frac{N_{dt_0}}{pop_{dt_0}} \cdot \left( \log \widehat{N}_d \right).$$

**Results** We start by examining the first-stage and reduced-form effects on the number low-educated Mexican-born and low-educated US-born workers in a destination and their relative wages. To do so, we run the following event-study regression, where $Y_{dt}$ is an outcome (e.g., the number of low-educated Mexican-born workers) for location $d$ in time $t$:

$$Y_{dt} = \sum_\tau \beta_\tau \cdot \mathbf{1}\{t = \tau\} \cdot \ln \widehat{Z}_d + \gamma_{s(d)t} + \gamma_d + \varepsilon_{dt}.$$

We estimate the event studies by OLS using data from the Census and ACS. We weight the regressions using the inverse population weight suggested in Borjas, Grogger, and Hanson (2012). Standard errors are clustered at the US state. Figure 4 shows that the instrument increases the ratio of low-educated Mexican-born to low-educated US-born workers (panel a), and reduces the relative wages of low-educated Mexican-born workers to low-educated US-born workers (panel b). There is no evidence of pretrends across either variable.

[26] As above, we follow Dingel and Tintelnot (2023) and do not use the error term $(\xi_{odt})$ in the predictions.

Table 4 reports the result of estimating Equation 15 to estimate the elasticity of substitution between low-skilled US-born and Mexican-born workers. We estimate the regression using 2SLS, again weighting by the inverse population weight from Borjas, Grogger, and Hanson (2012). Standard errors are clustered at the US state. Columns 1 and 2 show the first stage and second-stage of the baseline regression. For the first-stage regressions (columns 1 and 3), we report permutation p-values in square brackets, which is equal to 0.024 in both cases. In the baseline results reported in column 2, we estimate an elasticity of relative wages to relative population of -0.196, corresponding to an elasticity of substitution of 5.1 (with a standard error of 2.0).

One concern with these results is that there may be contemporaneous shocks to destination labor markets that correlates with the instrument that would bias the estimate of the elasticity of substitution. For example, the construction sector employs a large number of migrants, so shocks to the construction sector will likely affect both relative quantities of migrants and non-migrants as well as their relative wage rates. Texas, a border state, was particularly hard hit by the Great Recession and was also likely affected by the wall, so it is possible that the elasticity we measure is picking up the time-varying effects of the Great Recession and not the wall. Columns 3 and 4 therefore repeat the exercise allowing for a time-varying effect of the Great Recession, proxied by the housing shock measure from Mian and Sufi (2014). We estimate a similar (and statistically indistinguishable) elasticity of substitution, 6.8, which is our preferred estimate in what follows.

Our estimated elasticity is similar to the estimate of Burstein, Hanson, Tian, and Vogel (2020), who find a value between 7-9.[27] We use our estimated parameter for our baseline estimates and show that the results are quantitatively and qualitatively very similar across a large range of alternative parameters in Section 5.2 below.

**Robustness** Although we find no evidence of pre-trends in the event study regression and our preferred estimates directly control for the Great Recession, there may be additional destination-level shocks affecting our results. We consider several shocks in Appendix Table A15. Column 2 replicates the recession controls, Column 3 includes only the states containing Mexican consuls; Column 4 includes distance to the border trends;

[27] Other estimates in the literature are typically higher, including Ottaviano and Peri (2012), who estimate an elasticity of substitution of around 12.5 for low-skill workers; Piyapromdee (2021), who estimates a value of 18; Card (2009), a value of 20; and Borjas, Grogger, and Hanson (2008) who estimate an infinite elasticity. However, theses papers differ in whether the unit of observation is that national or regional level, whether skill is defined as purely education or also education and experience, and in the underlying variation used to identify the shock. As discussed by Dustmann, Schönberg, and Stuhler (2016), national-level regressions estimate different structural parameters than regional-level analyses, and so the wide range may be expected.

Column 5 includes sectoral trends; and Column 6 includes all variables. Across the specifications we estimate point estimates of the elasticity of substitution between 2.9 to 6.8. We also include robustness to alternative definitions of the labor supply and wage sample in Appendix Table A16. Our baseline sample includes both men and women, and keeps unemployed people in the labor supply definition. Columns 3 and 4 drop unemployed workers from labor supply. Our estimated elasticity of substitution is slightly higher, at 7.1. Columns 5 and 6 keep the baseline sample but drop women. The estimated elasticity of substitution increases to 12.2. In what follows we will use our preferred point estimate of 6.8 but will consider robustness to this parameter.

### 4.5 Taking stock

The estimation results above suggest the following facts about the impact of the border wall on migration patterns and destination labor markets. First, migrants changed their routes to avoid the border wall expansion, suggesting that the border wall did increase migration costs. Second, migrants' choice of route is approximately twice as responsive to increases in costs than their choice of destination. Third, migrants' choice of whether or not to migrate at all was approximately three times as responsive to increases in costs than their choice of destination. Put together, these two results suggest that migrants are most inelastic about the particular destination to which they migrate, consistent with the presence of strong social ties to particular destinations. Finally, we find that changes in migration do lead to changes in the relative wages of U.S.-born and Mexican-born workers in the destination, suggesting the possibility that the border wall expansion could have substantial economic impacts in U.S. labor markets.

## 5 The economic effects of a border wall

In this section, we estimate the economic effects of both the existing border wall expansion and alternative border walls expansions that could have occurred. To do so, we combine the detailed migration and labor market data described in Section 2, our migration and labor market framework from Section 3, and the estimated model parameters from Section 4. We first describe this process.

## 5.1 Counterfactual process

There are two key equations from the theoretical framework developed in Section 3 necessary to generate the counterfactual results that follow. First, equation (7) shows how any change in trilateral migration costs and/or the value of residing in a destination affects migration flows. Second, equation (10) shows how any change in the labor supply of a given type of worker in a destination affects the wages in that destination.

These two equations highlight which data and parameters are necessary for conducting the counterfactuals. The data requirements for counterfactual analysis are two-fold: (a) the initial trilateral origin-route-destination migration flows; and (b) the earnings shares of each group of worker. We construct the trilateral flows by combining the EMIF and matrícula database and we calculate the income shares from the Mexican Census and American Community Survey datasets; see Online Appendix D.1 for details of both processes.

The counterfactual analysis requires six structural parameters, summarized in Table 5. The first four we estimate. In Section 4.1 we estimate that the presence of a border wall (the "detour effect") reduced migration flows at a particular border crossing by $\widehat{C}_{od,r}^{-\theta^R}$=exp $(0.55)$. In Section 4.2, we estimate that bilateral migration flows declined with expected migration costs (the "diversion effect") with an elasticity of $\theta^D/\theta^R = 0.47$. In Section 4.3, we estimate that the increases in expected migration costs reduced overall migration from Mexico to the United States (the "deterrence effect") with an elasticity $\theta^C/\theta^D = 3.74$. Finally, in Section 4.4, we estimate that the decline in migration increased the relative wage of U.S.-born workers to Mexican-born workers with an implied elasticity of substitution between Mexican and U.S. workers of $\rho = 6.8$.

We consider two counterfactual variants. In the first ("baseline") case, we assume that the value of migrating to a destination is unchanged by the border wall expansion, i.e., $\widehat{V}_d = 1$. This ensures that the migration results from equation (7) depend only on the structural parameters that we estimate directly. In this baseline case, the wage effects depend on the four estimated parameters and the elasticity of substitution between high skill and low skill workers ($\lambda$), which we follow Piyapromdee (2021) and set to $\lambda = 2$, although the results are quantitatively and qualitatively very similar for alternative values of this parameter (see columns 2 and 3 of Appendix Table A20).

To incorporate how wage changes may feedback into migration decisions, we also consider a "wage feedback loop" variant where we allow for the value of migrating to change proportionally to the change in wages, i.e., $\widehat{V}_d = \widehat{w}_d$ and solve equations (7) and (10) simultaneously. To incorporate this wage feedback loop requires us to specify a migration elasticity. We follow the mid-point of the literature and and set $\theta^D = 3$, although the results are again quantitatively and qualitatively very similar for alternative values of this parameter (see columns 4 and 5 of Appendix Table A20).[28]

We use a three-step bootstrap procedure to generate appropriate confidence intervals for our counterfactual results. We first construct 500 different bootstrapped samples; then, for each sample, re-estimate all four structural parameters; finally, we re-calculate the counterfactual results using these new estimates; see Appendix D.2 for details. This procedure has the advantage of both incorporating the covariance in estimates across the different parameters and accounting for the fact that the estimated results themselves arose from a multi-step estimation procedure.[29] Bootstrapped standard errors are clustered at the destination level.[30] Column 3 of Table 5 reports the bootstrapped confidence intervals of each structural parameter.

## 5.2 The effects of the actual border wall expansion

We first estimate the effects of the actual border wall expansion. The first panel of Column 1 of Table 6 presents the results. We find that the border wall expansion reduced migration from Mexico to the U.S. by 311,205 persons (with a 5%/95% confidence interval of a decline between 218,578 and 377,763), or roughly a one-third of the observed decline in migration between 2005 and 2015. The "deterrence effect" was larger than the "detour effect" and "diversion effects", as 89,250 migrants changed their routes (with a 5%/95% confidence interval of 60,843-112,897) and 14,261 migrants changed their destinations within the United States (with a 5%/95% confidence interval of 8,327-19,649).

Where is this decline in migrants coming from? Table 7 illustrates the various mechanisms in the model. In column 2 of Table 7, we prevent migrants from choosing alternative routes in response to the border wall expansion; this increases the decline in

[28] Burstein, Hanson, Tian, and Vogel (2020) use a value of 1.5; Bryan and Morten (2019) estimate a value of 2.7 for the US; and Morten and Oliveira (2024) estimate a value of 4.5 for Brazil.

[29] Incorporating the covariance between parameter estimates into the construction of the confidence intervals is important. For example, we estimate a strong positive correlation between the strength of diversion effect $\left(\frac{\theta^D}{\theta^R}\right)$ and the effect of the wall on migration costs $\left(\widehat{C}_{od,r}^{-\theta^R}\right)$, as shown in Appendix Figure A8. Intuitively, the reason for this is that, empirically, we find that a large wall shock did not lead to a large change in choice of destination within the US. The underlying explanation is either that the wall shock did not lead to a large change in migration costs (i.e., $\left(\widehat{C}_{od,r}^{-\theta^R}\right)$ is small) or that migrants have strong preferences for specific destinations (i.e., $\left(\frac{\theta^D}{\theta^R}\right)$ is small). Because of the positive correlation between the two parameters, the confidence intervals on the effects of the wall on migration are tighter than they would be without accounting for the correlation in estimation error across parameters.

[30] As shown in Menzel (2021), there is no bootstrap procedure with multi-way clustering that achieves uniform consistency. We therefore cluster at the destination level because correlated errors are likely to be more problematic at the destination level, in particular for the wage regressions, due to the Great Recession.

migration by 8% to 336,531. Similarly, in column 3 of Table 7, we prevent migrants from choosing alternative destinations in the U.S. in response to the border wall expansion; this too has only a small effect on the total decline in migration. Taken together, these results suggest that the "detour" and "diversion" effects are small relative to the "deterrence effect."

What does turn out to matter a great deal, however, is the ability of our framework to allow for migrants to respond differently to these different margins. Column 4 of Table 7 shows that if we were to have imposed that the elasticity of migrants to route and destination choices were equal (i.e., $\theta^D = \theta^R$), we would have overestimated the impact of the border wall expansion by two-thirds. Conversely, column 5 of Table 7 shows that if we were to have imposed that the elasticity of migrants across destinations and countries were equal (i.e., $\theta^C = \theta^D$), we would have underestimated the impact of the border wall expansion by more than two-thirds. This latter comparison is especially illuminating, as it corresponds to the typical "independence of irrelevant alternatives" (IIA) assumption underpinning much of the migration literature. Put another way, our estimates of the "deterrence effect" suggest that migrants are much more responsive to the choice of country than they are to the choice of destination within a country; ignoring this by instead imposing IIA would substantially underestimate the impact of the border wall on migration.

How did the border wall affect labor markets in the United States? The second panel of Column 1 of Table 6 presents the results. While the impacts of the border wall expansion on low-skill Mexican migrants are substantial—an average decline of $77 in annual income, or roughly 1% of total annual income—the effects on all other workers types are much more modest. Low-skill U.S. workers annual income increases on average by $9 (0.02%) due to the decline in competition with low-skill Mexican workers, whereas high-skill U.S. workers annual income declines by on average $21 (0.04%), as low-skill workers become increasingly scarce.

Column 2 of Table 6 incorporates the general equilibrium wage feedback loop, modestly attenuating the decline in migration to 270,529; intuitively, as fewer Mexican-born workers migrate to the U.S., the wage they would earn in the destination increases, reducing the decline in migration.

These average effects belie substantial heterogeneity across space. Figure 5 depicts the spatial incidence of the border wall expansion. Panel (a) shows that the border wall expansion resulted in a decline in Mexican migration to southern California, Nevada, eastern Texas, and the Chicago area, which in turn resulted in a modest increase in the population of low-skill U.S.-born workers in these locations. Panel (b) depicts the the resulting labor-market impacts on each of the worker types. As is evident, the wage increases for low-skill U.S. born workers (and decreases for high-skill U.S. born workers) are concentrated in these locations as well, although in no location did the gains to low-skill U.S. workers (or losses to high-skill U.S. workers) exceed 0.25%.

We undertake several robustness checks. Appendix Table A17 shows that the effect of the wall is similar if a continuous, rather than discrete, measure of wall exposure is used. Next, we show in Appendix Table A18 that the results are quantitatively similar if we instead assume that high-skill Mexican migrants are also affected by the border wall expansion or if we assume that high-skill Mexicans work in low-skilled jobs upon migrating to the U.S. (As mentioned in Section 2.2, the assumption that the wall only affects low-skill Mexican workers is consistent with the empirical evidence; for example 96% of matrícula card holders have a high school level of education or less). Appendix Table A19 shows that both the impacts on migration and the local labor market remain qualitatively and quantitatively very similar for higher assumed values of the elasticity of substitution $\rho$ between U.S. born and Mexican born workers. Similarly, Appendix Table A20 considers robustness over the elasticity of substitution between low-skill and high-skill workers and the migration elasticity and shows that the results remain similar to larger or smaller values.

To summarize, we estimate that while the border wall expansion accounted for roughly one third of the observed reduction in migration flows from Mexico to the U.S. between 2005 and 2015, it had only modest impacts on U.S. labor markets.

## 5.3 The effects of alternative border wall expansions

We now consider how alternative border wall expansions would have affected migration patterns and local labor markets.

**A complete border wall** We begin by assessing what would have occurred if the all seventeen border crossing points (and the outside option) received a border wall expansion, i.e., there was a complete border wall. Columns 3 and 4 of Table 6 present the results. A complete border wall has only modest additional effects, reducing total migration by only an additional 19,000 migrants. This is because the actual border wall expansion was close to the optimal expansion, a point we will return to below. Accordingly, the impacts on wages of U.S. workers are virtually unchanged with a counterfactual complete border wall. Appendix Figure 6 shows that a complete border wall would also yield a similar spatial distribution of impacts across locations as the existing border wall expansion.

These estimates abstract from the construction and maintenance costs of such a border wall, which are upwards of $67 billion, roughly $200 for every U.S. citizen (Devaney (2017)).

**The optimal border wall expansion** Given the high cost of a complete border wall, is there an alternative (partial) border wall expansion that would achieve greater reductions in migration than the observed expansion? The effect of a border wall on an origin-destination pair is a weighted average of the change in border walls across routes, where the routes are weighted by the share of migrants using them. As a result, placing a wall at the crossing points where a greater number of migrants initially cross will be more effective at reducing migration than crossing points where there are fewer migrant flows. Recall that in 2004, 8 of 17 of the border crossing points has a border wall and by 2010, 16 of 17 locations had a border wall. To answer this question, we can then compare the actual border wall expansion to every possible alternative expansion sequence.

Figure 6 presents the results. Consider panel (a). The x-axis is the number of border crossings with a border wall. The y-axis depicts the change in migration relative to the initial period. The yellow diamonds depict the change in migration flows for each additional border crossing covered by a border wall in the actual border wall expansion we observe. Each blue dot represents the change in migration flows for an alternative sequence of border wall expansion that covers the same number of border crossings. Several patterns are evident. First, in the early stages of the border wall expansion, it was far from optimal, with most other alternative expansion sequences resulting in greater declines in migration flows. This result is consistent with the evidence discussed above about the idiosyncratic way that the border wall expansion actually occurred and provides credence to the identification strategy above based on the timing of the roll-out. Second, as the border wall expansion progressed, it became closer and closer to optimal, dominating most other alternative border wall expansions. Third, by the time that 16 of 17 border crossings were covered by a border wall, the actual sequence was optimal in that it maximized the migration reduction. Or, put another way, the actual border wall expansion optimally selected which of the 17 border crossings that did not need a border wall. Fourth, the border crossing that is estimated to have the largest impact on migration flows is the Sasabe border crossing (the Sonoran desert), which was the twelfth border crossing to which the actual border wall expanded. This makes intuitive sense, as the Sasabe border crossing is the second most popular border crossing in the EMIF data (behind Tijuana, which already had a border wall prior to the expansion), with 28% of migrants reporting crossing there. Hence, alternative border wall expansions that expanded to Sasabe earlier would have greater reductions in migration earlier in the expansion.

Panels (b)-(e) show analogous figures for the changes in average wages for each of the types of workers. The results are similar, as the border wall expansions that maximized the reduction in migration also maximized the average wage increases for low-skill U.S.-born workers (and maximized the wage decreases for high-skill U.S. born workers).

To summarize, a comparison of the actual border wall expansion to alternative roll-outs that could have occurred shows that the actual expansion maximized the reduction of migration when complete, but was far from optimal during its roll-out.

# 6 Conclusion

In this paper, we contribute some empirical evidence to the debate over a U.S.-Mexico border wall. We combine confidential administrative data on the bilateral migration patterns of 5.7 million migrants with survey data on the exact migratory path of migrants to study how migration patterns responded to the construction of 550 new miles of border wall between 2007 and 2010. Guided by a simple model of migration, we document that the border wall expansion changed migrants' choice of route, their choice of destination within the United States, and their choice of whether or not to migrate in the first place. We estimate that while the border wall expansion can account for roughly one-third of the observed decline in Mexican-U.S. migration between between 2005 and 2015, its effects on U.S. labor markets were small. Counterfactual simulations suggest that a completed border wall would have only modest additional effects and while the roll-out of the border wall was haphazard, its current configuration optimally targets the crossing points to minimize migration flows.

This paper highlights the importance of accounting for the many ways in which migrants can react to changes in immigration policy when assessing its impact. In the context of a border wall, we show that the choice of how to enter a country and where to reside within that country are both important margins in the migration decision. More generally, however, there are likely additional margins from which this paper abstracts that also play an important role, e.g., the choice of occupation and/or sector of employment, dynamic considerations including the choice of whether to move within the destination country or return home, or the extent to which to rely on the assistance of one's social networks. We look forward to future research incorporating such forces.

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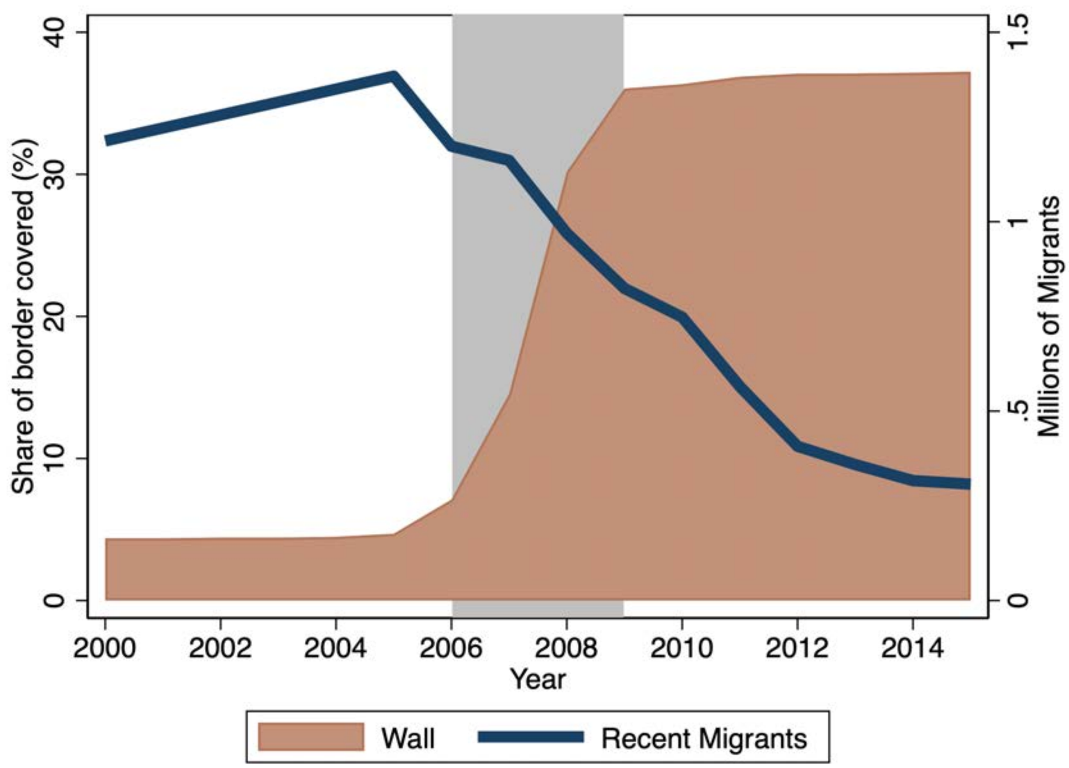
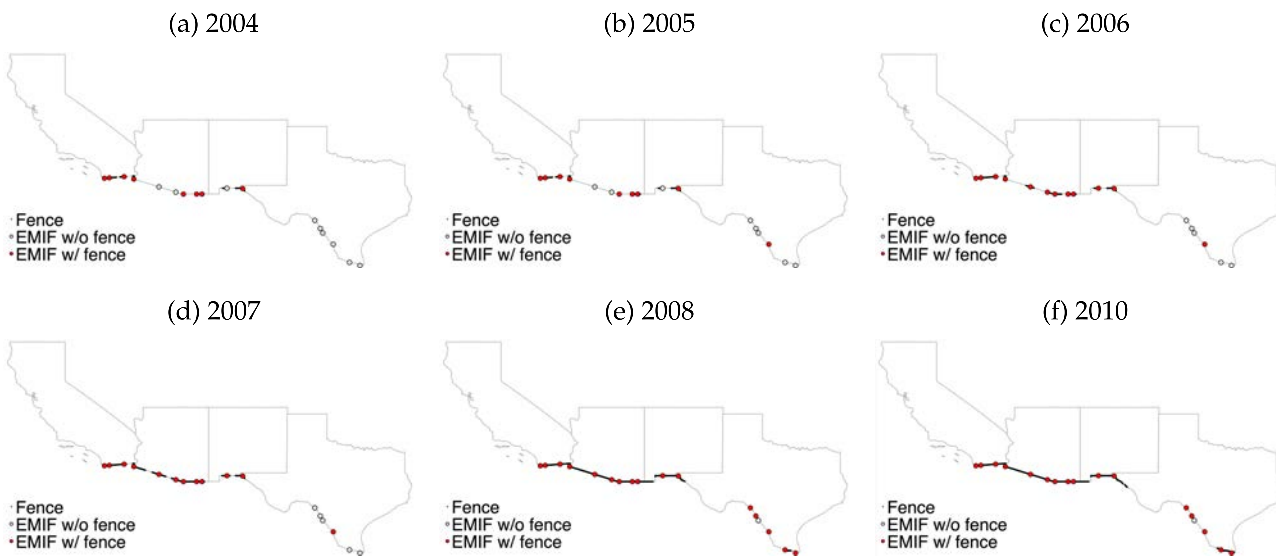
Figure 1: The border wall expansion and Mexico-U.S. migration flows




*Notes*: The left y-axis shows the share of the Mexico-U.S. border that is covered by some barrier. Data on location and timing of the border wall from Guerrero and Castañeda (2017). The right y-axis shows the number of 18 to 65 old Mexican citizens who have been in the United States for five years or less. The source is the U.S. Census (for the year 2000) and the U.S. American Community Survey (for 2005 onwards). The shaded area is the period in which the Secure Fence Act border wall expansion occurred.

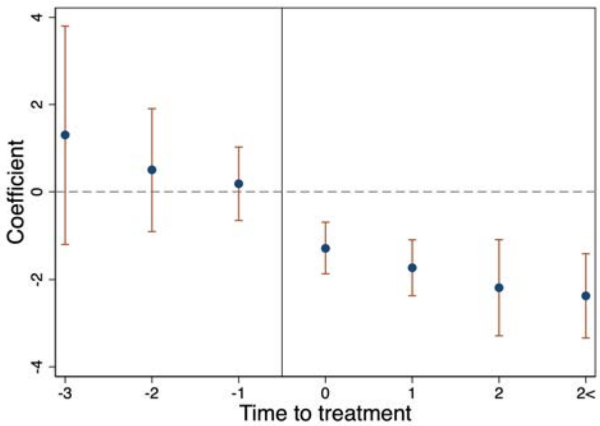
Figure 2: The border wall expansion



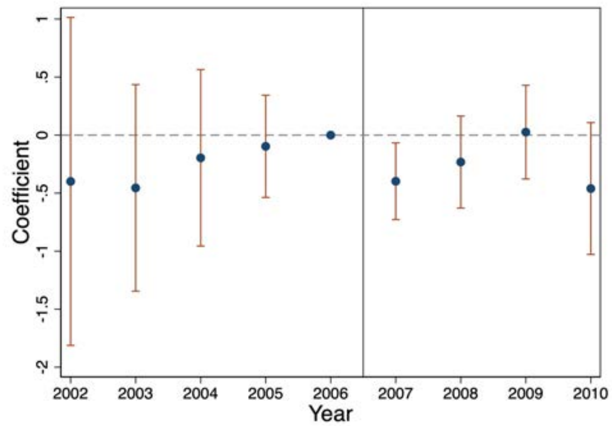

*Notes*: This figure shows the expansion of the U.S. Mexico border wall over time and the 17 EMIF locations along the border. Data source: Data digitized from Michael Baker Jr. Inc. (2013). Some wall segments are small and not always visible in the figure but are accounted for in the analysis.

Figure 3: Effect of the border wall expansion on migration flows: Event studies

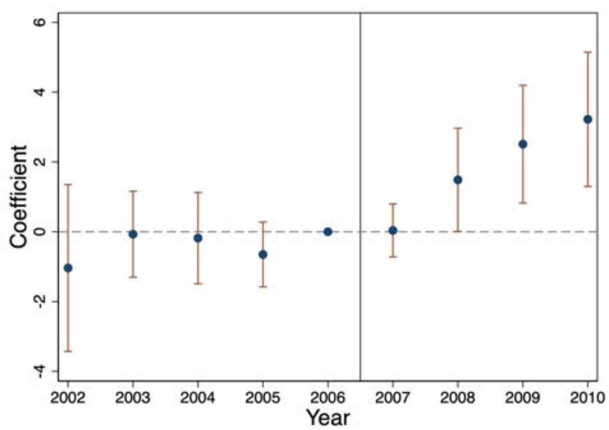
(a) Detour effect (change route)




(b) Diversion effect (change destination)



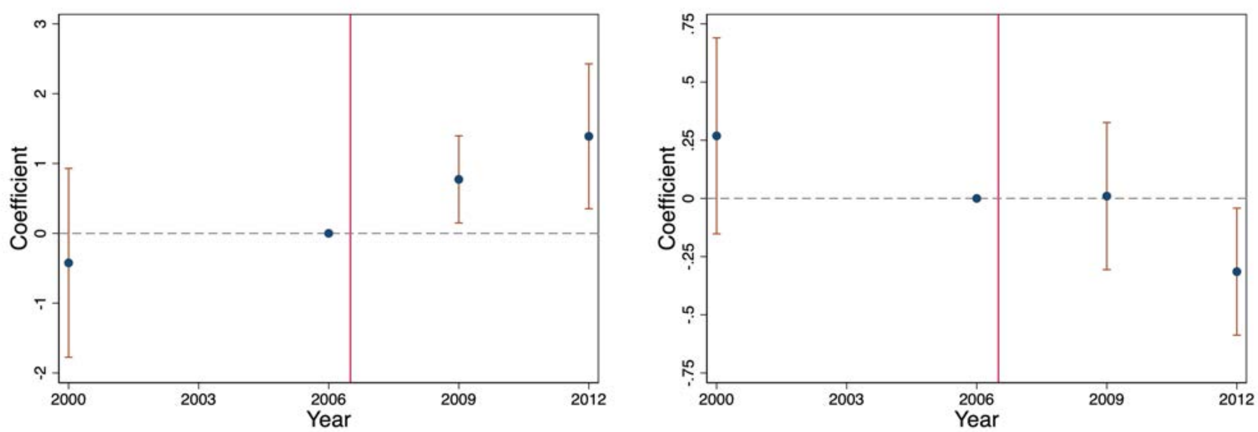

(c) Deterrence effect (stop migrating)




*Notes*: This figure depicts two-way fixed effect event study estimates of the detour, diversion, and deterrence effects of the border wall expansion. In panel (a), we use EMIF data on border crossing choices and the timing of the border wall expansion to estimate the extent to which migrants from a given origin to a given destination take a different route to avoid a border wall.The regression is weighted by the number of migrants. Standard errors are clustered by crossing point. In panel (b), we use the 2006–2014 matrícula consular database on bilateral migration flows to estimate the extent to which the recentered border wall expansion led to migrants choosing a different destination within the U.S. Regressions are weighted by the number of matrícula cards. Standard errors are two-way clustered by origin bin (1 degree x 1 degree) and destination bin (1 degree x 1 degree). In panel (c), we use the numer of matrícula cards issued for each Mexican municipality to estimate the extent to which the recentered border wall expansion reduced the total number of migrants. Regressions are weighted by the total number of matrícula cards issued for the origin. Standard errors are clustered at the Mexican state. In panel (a), exposure to the wall is staggered, hence we follow Borusyak, Jaravel, and Spiess (2024) and include never-treated units in the estimation; panels (b) and (c) are conventional event studies; details in the main text.

Figure 4: Effect of the border wall expansion on local labor markets: Event studies

(a) Population ratio of Mexican / U.S. low skill workers (b) Wage ratio of Mexican / U.S. low skill workers

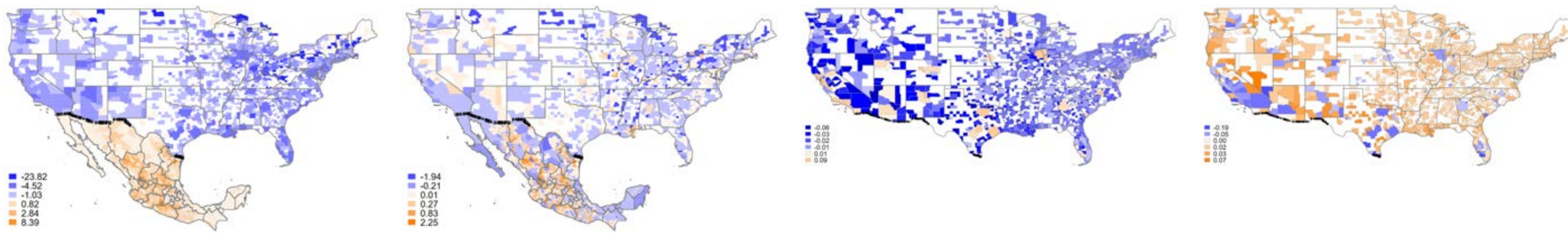



*Notes*: Data source: 2000 Census and 3-year ACS sample for 2006, 2009 and 2012. Panel (a) shows the log of the population ratio of low-skill (high school education or less) Mexican-born to US-born against the recentered destination exposure measure. Panel (b) shows the log of the wage ratio of low-skill (high school education or less) Mexican-born to US-born. Both regressions are weighted by the inverse sampling weight defined in Borjas, Grogger, and Hanson (2012). Standard errors are clustered by US state by year.

Figure 5: Effect of the border wall expansion

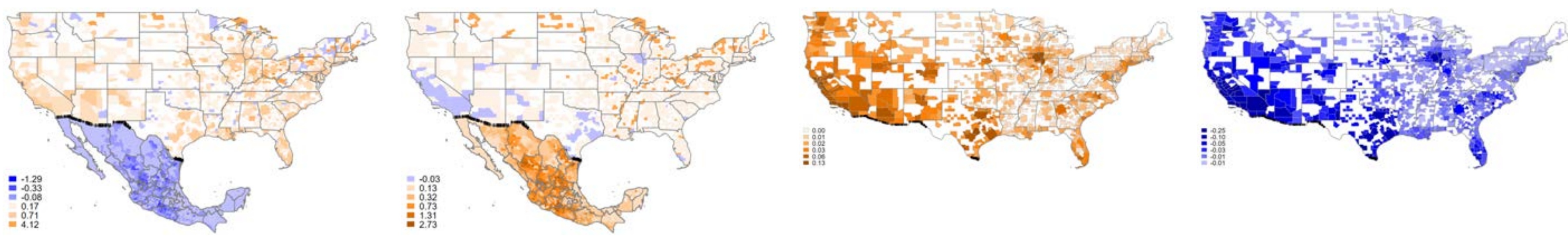
Panel (a): Population

(a) Mex. low-skill (b) Mex. high-skill (c) U.S. low-skill (d) U.S. high-skill



Panel (b): Income

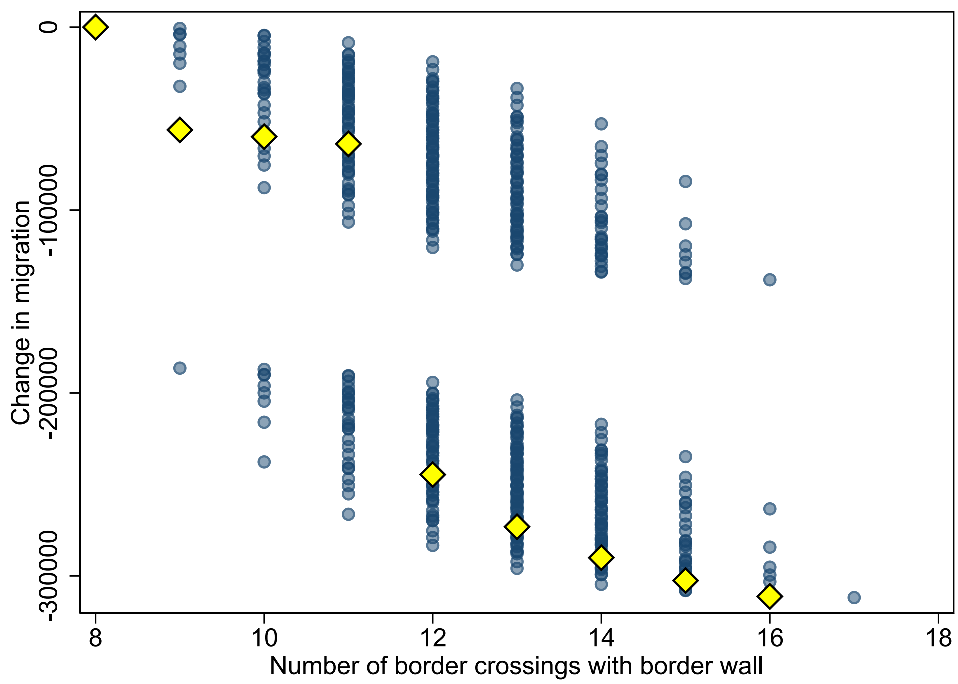
(e) Mex. low-skill (f) Mex. high-skill (g) U.S. low-skill (h) U.S. high-skill



*Notes*: The numbers reported are percent changes from simulations of the model using the parameter values described in the text. These figures show the effect of the border wall expansion on the spatial distribution of population of each labor type (top panel) and the per capita annual income impact of each labor type (bottom panel) in our preferred specification and accounting for the impact of changing wages on migration patterns.

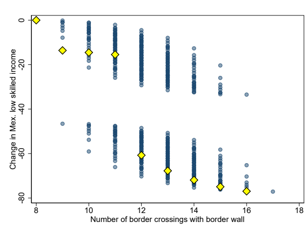
Figure 6: Actual vs. optimal border wall expansion

Panel (a): Effect on migration

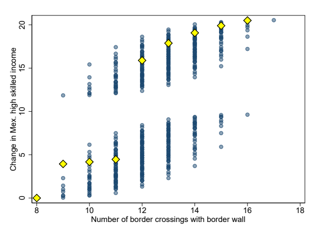



Panel (b): Effect on income

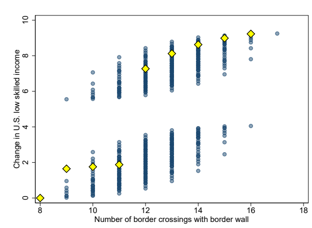
(b) Mex. low-skill



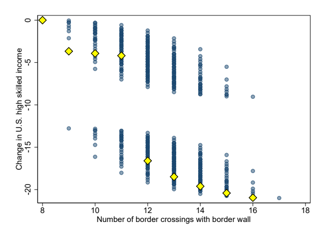
(c) Mex. high-skill



(d) U.S. low-skill



(e) U.S. high-skill



*Notes*: These figures compare the actual border wall expansion to all possible border wall expansions. Each blue dot indicates the impact of a particular set of border crossings with a border wall; the yellow diamond indicates the actual border wall expansion. Panel (a) reports the effect on migration flows from Mexico to the United States; panel (b) reports the effect on the per capital annual income of each labor type. Income is measured in 2000 U.S.D.

Table 1: The detour effect: estimating the elasticity of route choice to route cost

| | OLS | | | Poisson | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Dep var: share migrants (EMIF) | | | | | | |
| *Panel (a): Log distance* | | | | | | |
| Log distance | -3.304 | -3.745 | | -11.668 | -11.669 | |
| | 0.797*** | 0.745*** | | 1.350*** | 1.351*** | |
| Has any barrier | -1.145 | -1.352 | -1.907 | -0.564 | -0.565 | -1.311 |
| | 0.242*** | 0.265*** | 0.169*** | 0.234** | 0.234** | 0.164*** |
| | [0.007] | [0.004] | [0.046] | [0.192] | [0.192] | [0.064] |
| *Panel (b): Log cost-weighted distance* | | | | | | |
| Log cost-weighted distance | -5.731 | -6.629 | | -19.747 | -19.748 | |
| | 1.474*** | 1.365*** | | 2.385*** | 2.385*** | |
| Has any barrier | -1.143 | -1.349 | -1.907 | -0.548 | -0.549 | -1.311 |
| | 0.239*** | 0.262*** | 0.169*** | 0.227** | 0.227** | 0.164*** |
| | [0.007] | [0.004] | [0.046] | [0.192] | [0.192] | [0.064] |
| Obs | 13344 | 5221 | 2244 | 428043 | 428043 | 27300 |
| $R^2$ | 0.56 | 0.48 | 0.82 | 0.41 | 0.41 | 0.24 |
| CrossingPoint FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Orig-Dest FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Orig-Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Dest-Year | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Orig-Dest-Year FE | | ✓ | ✓ | | ✓ | ✓ |
| Orig-CrossingPoint-Dest FE | | | ✓ | | | ✓ |
| Sample | share>0 | share>0 | share>0 | Full | Full | Full |

*Notes:* This table reports estimates the elasticity of route choice to route cost using the EMIF dataset. The dependent variable is the share of migrants from origin $o$ going to destination $d$ that cross the border through point $b$. The dependent variable is log(share). Has any barrier measures whether the crossing border had any wall within a 1 mile radius. Distance is the distance from $o$ to $d$, going through $b$ and cost-weighted distance is the same, but accounting for both natural (e.g. deserts and mountains) and man-made geographic features (such as roads). The sample includes data from 2004 (pre border wall expansion) to 2012 (post expansion). The regressions are weighted by the total number of migrants from origin $o$ going to destination $d$. Standard errors are reported directly below the point estimate and are clustered at the crossing point level. Stars indicate statistical significance: *p<0.10 **p<0.05 ***p<0.01. Standard errors in brackets are permutation p-values computed from all 280 possible permutations of wall construction resulting in the same number of border crossings walled each year as in the data.

Table 2: The diversion effect: elasticity of destination choice to border wall exposure

| | Baseline | | Recentered | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Dep var: log migrants (matrícula) | OLS | Poisson | OLS | Poisson |
| Migration Costs $(\delta_{odt})$ | -0.651 | -0.540 | | |
| | 0.223*** | 0.201*** | | |
| Migration Costs $(\delta_{odt})$ – Recentered | | | -0.591 | -0.468 |
| | | | 0.286** | 0.240* |
| | | | [0.048] | [0.038] |
| Obs | 106286 | 267164 | 106286 | 267164 |
| $R^2$ | .96 | .35 | .96 | .35 |
| Pair FE | ✓ | ✓ | ✓ | ✓ |
| Orig-Year FE | ✓ | ✓ | ✓ | ✓ |
| Dest-Year FE | ✓ | ✓ | ✓ | ✓ |

*Notes:* This table estimates the effects of the changes in migration cost caused by the border fence expasion on migration flows. Migration cost $(\delta_{odt})$ is defined as in the paper and estimated as the origin-destination-year fixed effects in the regression reported in Table 1. Each observation is a origin-destination-year and the dependent variable is log number of migrants in 2006 and 2010 in the matricula data. To ensure statistical separation (necessary for the Poisson estimation), the sample is restricted to pairs that have at least one migrant in at least one year, and to origins and destinations that have at least five migrants every year. Regression is weighted by the contemporanous number of migrants. Standard errors are two-way clustered by origin bin (1 degree x 1 degree) and destination bin (1 degree x 1 degree). Stars indicate statistical significance: *p<0.10 **p<0.05 ***p<0.01. Standard errors in brackets under the recentered values are permutation p-values computed from 500 permutations of wall construction that matches the actual number of border crossings walled each year, allowing initial conditions to change.

Table 3: The deterrent effect: elasticity of migration to value of migrating

| Dep. var: Log change share US - log change share MX | (1)<br>Baseline | (2)<br>Distance trends | (3)<br>Sectoral trends | (4)<br>Push factors | (5)<br>All |
|---|---|---|---|---|---|
| Value US − value MX (Recentered) | 3.741 | 3.179 | 3.725 | 3.533 | 2.974 |
| | 0.784*** | 1.054*** | 0.773*** | 0.789*** | 1.053*** |
| | [0.006] | [0.004] | [0.006] | [0.006] | [0.004] |
| Log distance border × post | | -0.184 | | | -0.184 |
| | | 0.154 | | | 0.149 |
| Share in ag/mining × post | | | 0.503 | | 0.430 |
| | | | 0.626 | | 0.614 |
| Share in services × post | | | 0.482 | | 0.401 |
| | | | 0.797 | | 0.767 |
| Homicide rate | | | | 13.533 | 11.993 |
| | | | | 15.235 | 14.457 |
| Drought | | | | 0.056 | 0.058 |
| | | | | 0.025** | 0.025** |
| N | 4236 | 4236 | 4234 | 4236 | 4234 |
| $R^2$ | 0.994 | 0.994 | 0.994 | 0.994 | 0.994 |
| Origin FE | ✓ | ✓ | ✓ | ✓ | ✓ |
| State-Year FE | ✓ | ✓ | ✓ | ✓ | ✓ |

*Notes:* Data source: values computed from the 2005 and 2010 Mexican Census and 2006 and 2010 Matrícula database. The unit of observation is a Mexican municipality. The dependent variable is the log share migrating to the U.S. minus the log share staying in Mexico, using a conversion rate between a Matrícula and a Census observation of 1. The value of being in the U.S. is the origin-year fixed effect from the Matrícula gravity equation. The value of being in Mexico is the origin-year fixed effect from the within-Mexico gravity equation. Regression is weighted by total population. Standard errors are clustered at origin bin (1 degree x 1 degree). Stars indicate statistical significance: *p<0.10 **p<0.05 ***p<0.01. Standard errors in brackets under the recentered values are permutation p-values computed from 500 permutations of wall construction that matches the actual number of border crossings walled each year, allowing initial conditions to change.

Table 4: Elasticity of substitution between low-skill US-born and Mexican-born workers

| | Baseline | | Recession | |
|---|---|---|---|---|
| | (1) First Stage | (2) Second Stage | (3) First Stage | (4) Second Stage |
| Instrument (recentered) | 1.611 | | 1.808 | |
| | 0.482*** | | 0.515*** | |
| | [0.024] | | [0.024] | |
| log MX/US low-skill pop ratio | | -0.196 | | -0.146 |
| | | 0.076** | | 0.075* |
| Housing Shock × post | | | 0.428 | 0.174 |
| | | | 0.327 | 0.064*** |
| Implied elasticity ($\rho$) | . | 5.1 | . | 6.8 |
| | | $(2.0)^{***}$ | | $(3.5)^{*}$ |
| N | 1642 | 1642 | 1642 | 1642 |
| $R^2$ | 0.985 | | 0.985 | |
| Destination FE | ✓ | ✓ | ✓ | ✓ |
| State-Year FE | ✓ | ✓ | ✓ | ✓ |
| First stage F value | . | 11.2 | . | 12.3 |

*Notes:* An observation is an USA CBSA. The dependent variable is the ratio of log wages of Mexican-born workers to US-born workers. Data: 2006 and 2012 3-year ACS. Instrument (recentered) is the recentered exposure of the scaled-destination shock as described in the text. The low-skill pop ratio is the ratio of log low-skill Mexican workers to US workers. Regression is estimated by 2SLS. Regression is weighted by the inverse weight recommended by Borjas, Grogger, and Hanson (2012). Implied elasticity is calculated as the inverse of the estimated elasticity on the population ratio. Standard errors are clustered by state. Stars indicate statistical significance: *p<0.10 **p<.05 ***p<0.01. Standard errors in brackets under the recentered values are permutation p-values computed from 500 permutations of wall construction that matches the actual number of border crossings walled each year, allowing initial conditions to change.

## Table 5: Structural parameters

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Parameter | Description | Estimate | Bootstrap CI | Source | Robustness |
| $\widehat{C}_{od,r}^{-\theta^R}$ | Effect of wall on migration costs | 0.58 | [0.49,0.72] | Column (5) of Table 1 | Appendix Table A17 |
| $\frac{\theta^D}{\theta^R}$ | Ratio of divert to detour | 0.47 | [0.25,0.86] | Column (4) of Table 2 | Column (4) of Table 7 |
| $\frac{\theta^C}{\theta^D}$ | Ratio of deter to divert | 3.74 | [3.20,4.33] | Column (1) of Table 3 | Column (5) of Table 7 |
| $\rho$ | EoS between low-skill Mexican-born and US-born | 6.8 | [3.4,25.3] | Column (4) of Table 4 | Appendix Table A19 |
| $\lambda$ | EoS between low-skill and high-skill workers | 2 | N/A | Calibrated from Piyapromdee (2021) | Columns (2) and (3) of Appendix Table A20 |
| $\theta^D$ | Elasticity of migration | 3 | N/A | Calibrated from Bryan and Morten (2019) | Columns (4) and (5) of Appendix Table A20 |

*Notes:* Table shows value of parameters used for counterfactuals. Parameters are either estimated as described in the text or calibrated as described in the text. Robustness refers to tables showing how the counterfactuals results change under alternative values of a given parameter.

Table 6: Aggregate impacts of a border wall expansion

| | Actual Wall Expansion | | Complete Wall Expansion | |
|---|---|---|---|---|
| | Baseline (1) | Wage Feedback Loop (2) | Baseline (3) | Wage Feedback Loop (4) |
| *Change in Migration (persons per year)* | | | | |
| Change in routes | 89250 | 89250 | 85934 | 85934 |
| | [60843,112897] | [60843,112897] | [58404,108973] | [58404,108973] |
| Change in destination (within U.S.) | 14261 | 13980 | 14679 | 14417 |
| | [8327,19649] | [8085,19211] | [8570,20234] | [8325,19874] |
| Change in migration from Mexico to U.S. | -311205 | -282480 | -330233 | -300618 |
| | [-377763,-218578] | [-346652,-193168] | [-399133,-232698] | [-367547,-206081] |
| *Change in Income (per year per person)* | | | | |
| Mexican low skill | $-77 | $-70 | $-82 | $-75 |
| | [-96,-51] | [-90,-44] | [-101,-54] | [-95,-47] |
| Mexican high skill | $21 | $18 | $22 | $19 |
| | [14,25] | [12,22] | [15,26] | [13,24] |
| U.S. low skill | $9 | $9 | $10 | $9 |
| | [3,14] | [2,14] | [3,15] | [2,14] |
| U.S. high skill | $-21 | $-19 | $-22 | $-21 |
| | [-25,-15] | [-24,-13] | [-27,-16] | [-25,-14] |

*Notes:* This table reports the aggregate impact of both the actual 2007-2010 border wall expansion on migration patterns and incomes (in columns 1 and 2) and a counter-factual border wall that affects all routes (in columns 3 and 4). The baseline results consider the direct change in route-specific costs of migration; the wage feedback loop also incorporates how changes in destination wages affect migration decisions. 5%/95% Bootstrapped confidence intervals are reported in brackets.

Table 7: Aggregate impacts of a border wall expansion: Mechanisms

| | | Reducing margins of adjustment | | Imposing IIA | |
|---|---|---|---|---|---|
| | Baseline | Fixed route | Fixed destination | Across routes/destinations | Across destinations/country |
| | (1) | (2) | (3) | (4) | (5) |
| *Change in Migration (persons per year)* | | | | | |
| Change in routes | 89250 | 0 | 89250 | 89250 | 89250 |
| | [60843,112897] | [0,0] | [60843,112897] | [60843,112897] | [60843,112897] |
| Change in destination (within U.S.) | 14261 | 13878 | 0 | 30332 | 14261 |
| | [8327,19649] | [8103,19175] | [0,0] | [20611,38431] | [8327,19649] |
| Change in migration from Mexico to U.S. | -311205 | -336531 | -312791 | -515360 | -99041 |
| | [-377763,-218578] | [-403190,-236855] | [-380136,-219251] | [-586644,-399872] | [-131436,-59701] |
| *Change in Income (per year per person)* | | | | | |
| Mexican low skill | $-77 | $-83 | $-77 | $-128 | $-24 |
| | [-96,-51] | [-103,-56] | [-96,-51] | [-151,-95] | [-34,-14] |
| Mexican high skill | $21 | $22 | $20 | $33 | $7 |
| | [14,25] | [16,26] | [14,25] | [26,38] | [4,9] |
| U.S. low skill | $9 | $10 | $9 | $15 | $3 |
| | [3,14] | [3,15] | [3,14] | [5,23] | [1,5] |
| U.S. high skill | $-21 | $-23 | $-21 | $-35 | $-7 |
| | [-25,-15] | [-27,-16] | [-26,-15] | [-40,-27] | [-9,-4] |

*Notes:* This table reports how the aggregate results are affected by the various mechanisms in the model. Column 1 reports the baseline effects. Column 2 removes the detour effect by holding the route choice of migrants fixed. Column 3 removes both the detour and diversion effects by holding both the route choice and within-country destination of migrants fixed. Column 4 equates the route choice and within-country destination elasticities, imposing the independence of irrelevant alternatives assumption across routes within country. Column 5 equates within- and across-country destination elasticities, imposing the independence of irrelevant alternatives assumption across all destinations. 5%/95% Bootstrapped confidence intervals are reported in brackets.

# Online Appendix (not for publication)

## A The debate surrounding the Secure Fence Act of 2006

Since the passage of the Immigration Reform and Control Act in 1986, the United States has followed a policy of increased border enforcement on the U.S.-Mexico border. While prior to the adoption of the Secure Fence Act in 2006, only 110 of the 1954-mile U.S.-Mexico border had any sort of physical barrier, between 2000 and 2005 the Border Patrol employed 10,000 agents on the southern border and apprehended an average 1.1 million people each year. Sociologists and historians argue that rather than reducing unauthorized migration, the increased focus on enforcement since 1986 changed migration patterns from being circular and short-term in nature (primarily following the agricultural season) to being permanent, as a result increasing the number of unauthorized migrants in the U.S (Massey, Durand, and Malone (2003); Minian (2018)). Indeed, the Pew Research Center estimated that 11.1 million unauthorized migrants were living in the United States in 2005 (of which, 6.3 million were born in Mexico), up from 3.5 million in 1990. Data from the Mexican Migration Project between 2000 and 2005 shows that 95% of migrants hired a *coyote* to help them cross the border (at an average cost of $2000 in 2013 dollars). Using retrospective migration data, Massey, Durand, and Pren (2016) estimate that the apprehension probability during this period for a single attempt was 35%, but as migrants made multiple attempts to enter the United States, over 95% who attempted to enter the United States did so eventually.

In response to the growing consensus that something needed to be done about the growth in unauthorized migration, in 2006 the U.S. Senate passed a comprehensive immigration reform bill, which included the expansion of a guest worker program, a path toward citizenship, and additional fencing along the U.S.-Mexico border. The U.S. House objected to all components of the bill that could be interpreted as offering amnesty, and the resulting compromise was the Secure Fence Act (SFA) – which provided only for the construction of 700 miles of additional fencing along the U.S.-Mexico border – was signed into law on October 26, 2006 by President George W. Bush.[31] Proponents of the SFA contended that the barriers were a proven deterrent and the border wall expansion was necessary to reduce unauthorized immigration; as Alabama Senator Jeff Sessions argued, "We know that fencing works. It's time to make it a reality."[32] Opponents contended that the proposed expansion would simply cause individuals to substitute toward migrating elsewhere; as Illinois Senator Richard Durbin argued, "You don't have to be a law enforcement or engineering expert to know that a 700-mile fence on a 2,000-mile border makes no sense."[33]

The extent to which the SFA succeeded in reducing unauthorized immigration remains highly contested. Proponents of the border wall pointing to declines in apprehension rates in areas with border walls, whereas opponents note that the border wall itself

[31] "Bush Signs Bill Ordering Fence on Mexican Border." *New York Times*. October 26, 2006.
[32] "Senate Moves Toward Action on Border Fence." *New York Times*. September 26, 2006.
[33] "Senate Passes Bill on Building Border Fence." *New York Times.* September 30, 2006.

was surmountable (there have been 9,200 documented breaches between 2010 and 2015) and that the fencing has shifted migrants to alternative routes where no wall exists.[34] A 2017 report by the U.S. Government Accountability Office ultimately concluded the impact of border walls on "border security operations have not been assessed." (United States Government Accountability Office, 2017b)

# B Data appendix

## B.1 Border Wall Data

To study the border wall expansion, we use GIS shape files generously shared with us by Guerrero and Castañeda (2017), which provide the year of construction for each border wall segment. We use these data to measure how the border wall affects each of the EMIF crossing points the following way.

First, we split the US-Mexico border into 1001 equidistant border points, approximately 2 miles from each other. We classify each of border point as "walled" if there is any wall within 2.5 miles. This buffer is necessary because most pieces of the wall are build 1 or 2 miles into the US territory. Then, we match each EMIF crossing point to the closest border points. The number of border points matched to each crossing point depends on the specification: 1 point (baseline), 3 points (3-mile radius robustness), 11 points (10-mile radius robustness), or 21 points (3-mile radius robustness). Finally, we define the exposure of a crossing point to the wall in a given year as the share of its border points that is walled in that year. Note that this definition implies that, in our baseline specification, exposure is discrete, since each crossing point is matched with only one border point.

## B.2 United States Data

We follow the replication files provided by Ottaviano and Peri (2012) and Borjas, Grogger, and Hanson (2012) and define our sample variables in the same way:

- Our primary sample is all individuals aged 18-64 (inclusive).
- We drop people in group quarters (**inlist(gq,0,3,4)**).
- We define education as low education if the person has complete high school or less (educ variable less than or equal to category 6). We define education as high education if the person has completed some college (educ variable greater than or equal to category 7).
- We define experience as age minus first time worked, where we assume first time worked is 17 for workers with no HS degree, 19 for HS graduates, 21 for workers with some college, and 23 for college graduates. We then drop if **experience <1 | experience > 40**.

[34] See, e.g., Congressional Research Service (2009) and "Border Wall Breached 9,000 times. Does it even work?" CNN. February 16, 2017.

- We use the CPI - U variable to deflate the wage variables into constant year 2000 dollars.

- We calculate the usual hours of work per week. Before 1980 and from 2008, we use the midpoint of the aggregated variable wkswork2. For the other years, we use the value reported in the variable hrswork2.

- We sum the variable PERWT to get the total counts of individuals.

Further sample selection rules

- We include both males and females in the analysis. Ottaviano and Peri (2012)and Borjas, Grogger, and Hanson (2012) consider only males

- For computing population counts, we drop self-employed people (**classwkrd<20 | classwkrd>28**). We keep people who did not work the last week (this is in contrast to B/OP who drop this. We are interested in employment as an outcome)

- For computing average wages, we drop self-employed people, those with zero wage income, and those who with 0 hours of regular work. Average income is weighted by the number of hours worked.

## B.3 Mexican data

We follow the same definitions as above as closely as possible to define analgous variables in the Mexican Census.

## B.4 Geographic concordances

We are restricted to using geographical variables that are available in the public use files. The primary variable is the CBSA.

## B.5 Survey of Migration at Mexico's Northern Border (EMIF) data

The Survey of Migration at Mexico's Northern Border (EMIF) is a survey conducted in locations along the U.S.-Mexico border traditionally used as crossing points both by authorized and unauthorized migrants. The study is run by the Mexican government, in partnership with a local university (El Colegio de la Frontera Norte), and its target population is adult Mexican residents who do not live in the city where the interview takes place who are planning to migrate to the United States. The survey is designed to capture both the volume and characteristics of migration flows. We observe the place of birth, planned crossing point, and planned destination in the United States.

Appendix Table A3 presents descriptive statistics of the EMIF dataset. We see that the survey is geographically comprehensive: respondents come from 1406 different municipalities distributed accross all Mexican states; their planned destinations span 171 CBSAs in 40 American states; and, as we see in Figure 2, the 17 survey locations are spread across all the U.S.-Mexico border. Moreover, only 11% of the respondents hold a high-school diploma, fewer than 1% are college educated, and 87% are migrating to the United States for work-related reasons. This indicates that a large share of them are undocumented migrants, which are the focus of our study.

**Verification**

To verify the EMIF data, we validate the EMIF data against two sources: border apprehension data and the matrícula consular data. The results are in Online Appendix Table A4. We start by regressing the (log) flow of migrants from origin $o$ to destination $d$ through crossing point $r$ against the (log) apprehensions in the border sector $r$ is in, controlling for origin-year, destination-year, border-sector, and origin-destination fixed effects. We find that an increase in apprehensions of 10% is correlated with an increase in EMIF-measured migration of 7%. The coefficient is 0.81 if we consider a Poisson regression in levels. Second, we run a regresion of the (log) flow of migrants from origin $o$ to destination $d$ through crossing point $r$ against the (log) number of migrants from location $o$ in destination $d$from the matrícula data. Column 5 shows that the elasticity is 0.542.

## B.6 Computation of $\delta^R_{odt}$ and $\delta^D_{oct}$

### B.6.1 $\delta^R_{odt}$

Note that $\delta^R_{odt}$ is given by:

$$\ln \delta^R_{odt} \equiv -\ln \sum_{r' \in \mathcal{R}} \exp \left[ \left( \theta^R \beta_W Wall_{rt} + \theta^R \beta_d \log dist_{odr} - \theta^R \ln \delta^R_r - \theta^R \ln \xi^R_{odr't} \right) \right].$$

However, as shown in Dingel and Tintelnot (2023) directly using the above formula has bad small sample properties and would result in biased estimates when $\delta^R_{odt}$ is used as a regressor. Hence, we follow Dingel and Tintelnot (2023), fix the error term at its mean $\left(\xi^R_{odr't} = 1\right)$ and compute $\delta^R_{odt}$ as:

$$\ln \delta^R_{odt} \approx -\ln \sum_{r' \in \mathcal{R}} \exp \left[ \left( \theta^R \beta_W Wall_{rt} + \theta^R \beta_d \log dist_{odr} - \theta^R \ln \delta^R_r \right) \right],$$

where $\beta_W$, $\beta_d$, $\delta^R_r$, and $\theta^R$are estimated in Regression (11).

### B.6.2 $\delta^D_{oct}$

Note that $\delta^R_{odt}$ is given by:

$$\ln \delta^D_{oct} \approx -\ln \sum_{d' \in \mathcal{D}_c} \exp \left( -\theta^D \log \mathcal{C}^R - \frac{\theta^D}{\theta^R} \ln \delta^R_{odt} + \ln \delta^D_{dt} + \ln \delta^D_{od} + \theta^D \ln \xi^D_{odt} \right),$$

To minimize estimation error, we again follow Dingel and Tintelnot (2023) and do not use the high-dimensional fixed effects when computing $\delta^D_{oct}$. Here there are two such objects, the error term $(\xi_{odt})$ and the origin-destination fixed effect $\left(\ln \delta^D_{od}\right)$. For the error term, we keep simply keep it at its mean $(\xi_{odt} = 1)$, resulting it:

$$\ln \delta^D_{oct} \approx -\ln \sum_{d' \in \mathcal{D}_c} \exp\left(-\theta^D \log \mathcal{C}^R - \frac{\theta^D}{\theta^R} \ln \delta^R_{odt} + \ln \delta^D_{dt} + \ln \delta^D_{od}\right),$$

To reduce the dimensionality of $\ln \delta_{od}$, we project it linearly on origin fixed effects, destination fixed effects, and log distance between $o$ and $d$. Finally, we take the projection $\widehat{\ln \delta}_{od}$ and compute $\delta^D_{oct}$ as:

$$\ln \delta^D_{oct} \approx -\ln \sum_{d' \in \mathcal{D}_c} \exp\left(-\theta^D \log \mathcal{C}^R - \frac{\theta^D}{\theta^R} \ln \delta^R_{odt} + \ln \delta^D_{dt} + \widehat{\ln \delta}_{od}\right).$$

Where $\theta^D \log \mathcal{C}^R$, $\frac{\theta^D}{\theta^R} \ln \delta^R_{odt}$, $\ln \delta^D_{dt}$, and $\ln \delta^D_{od}$ are estimated in Regression 13. For $c = US$, the outcome, $\left(\pi_{d|o,US,t}\right)$ is taken from the matrícula data. For $c = MEX$, $\pi_{d|o,MEX,t}$ is taken from the Mexican census.

## B.7 Matrícula Database

One of the datasets used in this study was constructed from the administrative records of the Mexican matrícular consular. The original source did not provide numeric identifiers for place of birth or residency, but did provide the names of these locations. In this appendix we describe how we constructed our dataset from this records. We will do so in two parts: first merging places of residency to CBSAs in the United States and then merging place of birth to GEOLEV2 locations in Mexico[35]

**Place of residency in the United States**

The raw data gives us two pieces of information regarding place of residency, "Current State" and "Current Municipality." The field "Current Municipality" is vague and was interpreted by applicants in different ways, some providing a county, others a city. Furthermore, it is common to use unofficial names, e.g., "LA" for "Los Angeles". To match theses localities to CBSAs, we made use of a crosswalk provided by the Missouri Census Data Center.[36] It contains the names of all counties, minor civil divisions, cities, villages, towns, etc. in the United States We matched these with the matrícula consular dataset using the Stata function *reclink*. After this, we hand-coded the unmatched localities with the highest numbers of matrícula cards. One example of such location is "LA", which the algorithm could not recognize as being "Los Angeles". This procedure yields the following results: 92% of the matrículas consulares were matched to a CBSA, 7% did not have

[35]CBSAs and GEOLEV2 are time-invariant geographical divisions provided by IPUMS, which are comparable to counties, but usually larger. More details in https://usa.ipums.org/usa/

[36]`http://matrículacarddc.missouri.edu/websas/geocorr2k.html`

place of residency in the raw data and 1% were not matched.

### Place of birth in Mexico

The raw data gives us two pieces of information regarding place of birth, "State of Birth" and "Municipality of Birth". Again, the field "Municipality of Birth" was interpreted by applicants in different ways. To match these to the municipality codes, we used a list of all geographical divisions of Mexico provided by the *Instituto Nacional de Estadistica y Geografia*[37] and the Stata function *reclink*. As above, we hand-coded the unmatched localities with the highest numbers of matrícula cards. Finally we used the dictionaries provided by IPUMS to aggregate municipalities to GEOLEV2 areas. This procedure yields the following results: 86% of the matrículas consulares were matched to a GEOLEV2, 7% did not have place of birth in the data and 7% were not matched.

### Verification

We undertake several exercises to show that matrícula cards correlate with measures of migration from both U.S. and Mexican datasets.

Appendix Table A5 summarizes the sample size of the variables. On average, 810,732 matrícula cards are issued each year. We identify a first-time card as the first time we see a card issued to an individual. Once issued, a card is valid for five years. Appendix Figure A2 plots the hazard rate of renewal. As expected, we see a spike immediately when the card expires, and people continue renewing cards in the following years. For the cohort of individuals who were issued a card in 2006, 67% have renewed the card in 2015, nine years later. Column 4 gives the counts of migrants in the United States. Over the period 2006 through 2015, we see an average of 5.7 million Mexican-born adults in the United States. Of these, approximately 10% (686,000) have been in the country for less than five years.

Our first exercise correlates the number of matrículas with the number of migrants. Column 1 of Panel (a) of Appendix Table A6 shows that, within CBSA, a 10% increase in the number of matrícula cards is associated with a 0.6% increase in the number of Mexican migrants in a CBSA. Panel (b) shows that each matrícula card is correlated with an increase of 1.3 migrants on average. These results exploit only variation within CBSA. Column 2 shows that, on average, an additional matrícula card is associated with an extra 1.2 low-educated migrants in the CBSA. The population-pass through for each matrícula card for recently-arrived migrants (Columns 3 and 4) are 0.51 (all recently arrived migrants) and 0.47 (low-skill recently arrived migrants). Columns 5 through 8 repeat the exercise, dropping renewed cards. We find very strong correlations and population pass-throughs close to 1 for all migrants and for recently arrived migrants.[38]

Appendix Table A7 repeat the same exercise for the Mexican population census. The Mexican population census is conducted every five years, so we create comparable mea-

[37]See "Catálogo de Claves de Entidades Federativas y Municipios" in http://www.inegi.org.mx/default.aspx.

[38]Demographers estimate that the ACS and the Census under-count unauthorized migration by 8–13% Passel and Cohn (2016), and so a number less than one may represent some undercounting in the ACS.

sures of flows between the population counts and the matrícula consular database by constructing the change in the Mexican population between each census and then summing all matrículas issued for the five years between censuses. We expect to see a negative coefficient if a matrícula card is associated with a migrant leaving the municipality. Columns 1 and 2 show the population pass-through per matrícula for all Mexican adults. We find a small negative, but insignificant, pass-through for the whole population and a positive but insignificant pass-through for low-skill adults. We then do the same exercise considering a fixed cohort of individuals, born between 1940 and 1987, to adjust for the fact that population growth in Mexico will change both the number of adults as well as the number of matrículas. Columns 3 finds that each additional matrícula card issued is associated with a reduction of 0.24 adults in an origin municipality, and Column 4 finds a matrícula card is associated with a reduction of 0.6 low-skill adults. Columns 5-8 repeat the exercise using first-time matrícula cards only. We estimate a pass-through of between 0.11 and 0.19 per matrícula card.

The next exercise is to estimate the takeup of matrícula cards separately by recent and established migrants. Here, we separate explicitly between first-time cards and renewed cards. Appendix Table A9 estimates that the take-up rate of the matrícula card for recently arrived migrants was 26% in the pre-wall period and 56% in the post-wall period.[39]

We also verify that the geographical patterns in the matrícula database mirror those of migrants in the ACS as well as data from the Mexican demographic survey (ENADID)[40] Appendix Table A10 shows that all three datasets agree with the broad shift away from California and Arizona and into Texas over the study period.

Finally, a drawback of the matrícula consular dataset is the absence of certain covariates, such as income and time in the United States. The Pew Reseach Center surveyed a sample of individuals applying for a matrícula card in six different states and we compare this database to the sample of Mexican-born individuals in the 2005 ACS. Appendix Table A8 shows that the matrícula applicants are on average slightly younger (31 vs 37 years); slightly less educated (94% of the sample has high school or less as their highest level of completed education, compared with 86% in the ACS); earn slightly less ($334/week, compared with $451/week); and have spent less time in the United States.

# C Theoretical Framework

In this appendix, we describe in more detail the general equilibrium framework presented in section 5. The framework embeds the labor market structure featuring imperfectly substitutable labor types differing in skill and nativity developed in the immigration litera-

[39]We estimate that the annual takeup rate of matrícula cards for established migrants was 12.5% in the pre-period. In the post-period, we estimate that 4% of established migrants take up a matrícula card for the first time, and 11.6% of established migrants renew their card.

[40]The ENADID surveys households in Mexico and asks about household members who have left the household within the last five years. We use the surveys collected in 2009 and 2014. The ENADID is designed to be nationally representative of households within Mexico but by design will not include migrants who live in a household where the entire household has moved to the United States.

ture[41] into a general equilibrium "quantitative" spatial framework[42] where outcomes are intertwined across labor markets through the costly movement of people (i.e., migration). The framework serves three purposes: first, it allows us to quantify the indirect economic impacts of the Secure Fence Act; second, it allows us to assess the welfare effects of the wall expansion on different types of labor in different locations; and third, it allows us to compare the Secure Fence Act to other large-scale counterfactual policies.

## C.1 Setup

Consider a world comprising $i \in \{1, ..., N\} \equiv \mathcal{N}$ locations and inhabited by workers of two different skills $s$ (high-skill $h$ and low-skill $l$) and two different nationalities $n$ (Mexican $M$ and United States $U$), each endowed with a unit of labor which they supply inelastically. In each location $i \in \mathcal{N}$, the four types of workers combine their labor to produce a homogeneous good using a nested constant elasticity of substitution (CES) production function:

$$Q_i = \left( \sum_{s \in \{h,l\}} \left( \left( \sum_{n \in \{M,U\}} A_i^{n,s} \left( L_i^{n,s} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}} \right)^{\frac{\lambda}{\lambda-1}}, \tag{16}$$

where $A_i^{n,s} > 0$ is the productivity of a worker of nationality $n$ and skill $s$ in location $i$, $\rho \geq 1$ is the elasticity of substitution across the nationalities of workers, and $\lambda \geq 1$ is the elasticity of substitution across high-skill and low-skill workers.[43]

Production occurs under perfect competition and a worker in location $i$ of nationality $n$ and skill $s$ is paid a wage $w_i^{n,s}$ equal to her marginal product:

$$w_i^{n,s} = Q_i^{\frac{1}{\rho}} \times \left( \left( \sum_{n \in \{M,U\}} A_i^{n,s} \left( L_i^{n,s} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1} \frac{\lambda-1}{\lambda}} \right)^{\left( \frac{1}{\rho} - \frac{1}{\lambda} \right)} \times A_i^{n,s} \times \left( L_i^{n,s} \right)^{-\frac{1}{\rho}}. \tag{17}$$

[41]See, for example, the works of Katz and Murphy (1992); Card (2001); Borjas (2003); Borjas and Katz (2007); Ottaviano and Peri (2012) and the excellent review article of Dustmann, Schönberg, and Stuhler (2016).

[42]See, for example, the works of Allen and Arkolakis (2014); Tombe and Zhu (2019); Burstein, Hanson, Tian, and Vogel (2020); Monte, Redding, and Rossi-Hansberg (2018); Redding (2016) and the excellent review article of Redding and Rossi-Hansberg (2017).

[43]While our framework abstracts from capital, it is formally isomorphic to a setting where capital is perfectly mobile across locations and hence rent is equalized, see Allen and Arkolakis (2014). The model can be extended to incorporate immobile capital (i.e., a fixed factor of production) by assuming that the productivity of workers is a function of the number of workers within a labor market, thereby creating diseconomies of scale. Note, however, that even with a constant returns to scale production function in labor, because there are many labor markets varying in their levels of productivity, a reallocation of labor across labor markets can have impact aggregate output – something that is not true in frameworks that assume a single national production function (see e.g., Ottaviano and Peri (2012)).

The movement of people across locations is subject to "iceberg" frictions. For simplicity, we take the initial distribution of different types of labor across locations $\left\{L_{i,0}^{n,s}\right\}$ as exogenous and treat the migration decision as static. In particular, we suppose that for each type of labor in each initial location, there is a continuum of heterogeneous workers $\nu \in \left[0, L_{i,0}^{n,s}\right]$ who chooses where to live in order to maximize her welfare:

$$U_i^{n,s}(\nu) = \max_{j \in \mathcal{N}} \frac{w_j^{n,s}}{\mu_{ij}^{n,s}} \varepsilon_{ij}^{n,s}(\nu), \tag{18}$$

where , $\mu_{ij}^{n,s} \geq 1$ is a migration friction common to all workers moving from $i \in \mathcal{N}$ to $j \in \mathcal{N}$ of type $\{n, s\}$, and $\varepsilon_{ij}^{n,s}(\nu)$ is an migration friction idiosyncratic to worker $\nu$ drawn from an extreme value (Fréchet) distribution with shape parameter $\theta^{n,s} \geq 0$.

## C.2 Calculating the general equilibrium effects of any police

Suppose there is any policy shock that changes any combination of migration costs, productivities, and/or amenities from $\left\{\mu_{od}^{n,s}, A_d^{n,s}, u_d^{n,s}\right\}$ to $\left\{\widetilde{\mu_{od}^{n,s}}, \widetilde{A_d^{n,s}}, \widetilde{u_d^{n,s}}\right\}$; what are the economic effects of this shock?

For any variable $x$, define $\hat{x} \equiv \frac{\tilde{x}}{x}$. From equations 17, we have that:

$$
\begin{aligned}
\hat{w}_d^{n,s} =& \hat{Q}_d^{\frac{1}{\lambda}} \times \left( \left( \frac{\sum_{n\in\{M,U\}} \widetilde{A_d^{n,s}} \left(\widetilde{L_d^{n,s}}\right)^{\frac{\rho-1}{\rho}}}{\sum_{n\in\{M,U\}} A_d^{n,s} \left(L_d^{n,s}\right)^{\frac{\rho-1}{\rho}}} \right)^{\frac{\rho}{\rho-1}} \right)^{\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)} \times \hat{A}_d^{n,s} \times \left(\hat{L}_d^{n,s}\right)^{-\frac{1}{\rho}} \\
=& \hat{Q}_d^{\frac{1}{\rho}} \times \left( \left( \sum_{n\in\{M,U\}} \frac{A_d^{n,s} \left(L_d^{n,s}\right)^{\frac{\rho-1}{\rho}}}{\sum_{n\in\{M,U\}} A_d^{n,s} \left(L_d^{n,s}\right)^{\frac{\rho-1}{\rho}}} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)} \times \hat{A}_d^{n,s} \times \left(\hat{L}_d^{n,s}\right)^{-\frac{1}{\rho}} \\
=& \hat{Q}_d^{\frac{1}{\rho}} \times \\
& \times \left( \left( \sum_{\substack{n\in \\ \{M,U\}}} \frac{Q_d \left( \sum_{\substack{n\in \\ \{M,U\}}} A_d^{n,s} \left(L_d^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)} A \left(L_d^{n,s}\right)^{\frac{\rho-1}{\rho}}}{\sum_{\substack{n\in \\ \{M,U\}}} Q_d \left( \sum_{\substack{n\in \\ \{M,U\}}} A_d^{n,s} \left(L_d^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)} A_d^{n,s} \left(L_d^{n,s}\right)^{\frac{\rho-1}{\rho}}} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)} \times \\
& \times \hat{A}_d^{n,s} \times \left(\hat{L}_d^{n,s}\right)^{-\frac{1}{\rho}} \\
=& \hat{Q}_d^{\frac{1}{\lambda}} \times \\
& \times \left( \left( \sum_{n\in\{M,U\}} \left( \frac{w_d^{n,s} L_d^{n,s}}{w_d^{MEX,s} L_d^{MEX,s} + w_d^{US,s} L_d^{US,s}} \right) \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)} \times \\
& \times \hat{A}_d^{n,s} \times \left(\hat{L}_d^{n,s}\right)^{-\frac{1}{\rho}} \\
=& \hat{Q}_d^{\frac{1}{\rho}} \times \left( \left( \sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)} \times \hat{A}_d^{n,s} \times \left(\hat{L}_d^{n,s}\right)^{-\frac{1}{\rho}}, \qquad (19)
\end{aligned}
$$

where $y_d^{n,s} \equiv \frac{w_d^{n,s} L_d^{n,s}}{w_d^{MEX,s} L_d^{MEX,s} + w_d^{US,s} L_d^{US,s}}$ is the share of income earned by workers of skill $s$ that is paid to workers of nativity $n$ in location $d$.

Moreover, notice that:

$$
w_i^{n,s} = Q_i^{\frac{1}{\rho}} \times \left( \left( \sum_{n\in\{M,U\}} A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)} \times A_i^{n,s} \times \left(L_i^{n,s}\right)^{-\frac{1}{\rho}}
$$

Therefore:

$$w_i^{n,s} L_i^{n,s} = Q_i^{\frac{1}{\lambda}} \times \left( \left( \sum_{n \in \{M,U\}} A_i^{n,s} \left( L_i^{n,s} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\left( \frac{1}{\rho} - \frac{1}{\lambda} \right)} \times A_i^{n,s} \times \left( L_i^{n,s} \right)^{\frac{\rho-1}{\rho}}$$

Therefore:

$$\begin{aligned}
\sum_n w_i^{n,s} L_i^{n,s} &= Q_i^{\frac{1}{\lambda}} \times \left( \left( \sum_{n \in \{M,U\}} A_i^{n,s} \left( L_i^{n,s} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\left( \frac{1}{\rho} - \frac{1}{\lambda} \right)} \sum_n \left( A_i^{n,s} \left( L_i^{n,s} \right)^{\frac{\rho-1}{\rho}} \right) \\
&= Q_i^{\frac{1}{\lambda}} \times \left( \sum_{n \in \{M,U\}} A_i^{n,s} \left( L_i^{n,s} \right)^{\frac{\rho-1}{\rho}} \right)^{\left( \frac{\rho}{\rho-1} \right) \left( \frac{1}{\rho} - \frac{1}{\lambda} \right) + 1} \\
&= Q_i^{\frac{1}{\lambda}} \times \left( \sum_{n \in \{M,U\}} A_i^{n,s} \left( L_i^{n,s} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1} \left( \frac{\lambda-1}{\lambda} \right)} \qquad (20)
\end{aligned}$$

Using equations 18 and 20, we have that:

$$
\begin{aligned}
\hat{Q}_d =& \frac{Q'_d}{Q_d} \\
=& \frac{\left( \sum_{s\in\{h,l\}} \left( \left( \sum_{n\in\{M,U\}} \widetilde{A_i^{n,s}} \left(\widetilde{L_i^{n,s}}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}} \right)^{\frac{\lambda}{\lambda-1}}}{\left( \sum_{s\in\{h,l\}} \left( \left( \sum_{n\in\{M,U\}} A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}} \right)^{\frac{\lambda}{\lambda-1}}} \\
=& \left[ \sum_{s\in\{h,l\}} \frac{1}{\sum_{s\in\{h,l\}} \left( \left( \sum_{n\in\{M,U\}} A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}}} \times \right. \\
& \left. \times \left( \left( \sum_{n\in\{M,U\}} \widetilde{A_i^{n,s}} \left(\widetilde{L_i^{n,s}}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right) \right]^{\frac{\lambda}{\lambda-1}} \\
=& \left[ \sum_{s\in\{h,l\}} \frac{\left( \left( \sum_{n\in\{M,U\}} A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}}}{\sum_{s\in\{h,l\}} \left( \left( \sum_{n\in\{M,U\}} A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}}} \times \right. \\
& \left. \times \left( \left( \frac{\sum_{n\in\{M,U\}} \widetilde{A_i^{n,s}} \left(\widetilde{L_i^{n,s}}\right)^{\frac{\rho-1}{\rho}}}{\sum_{n\in\{M,U\}} A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}} \\
=& \left[ \sum_{s\in\{h,l\}} \left( \frac{\left( \left( \sum_{n\in\{M,U\}} A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}}}{\sum_{s\in\{h,l\}} \left( \left( \sum_{n\in\{M,U\}} A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}}} \right) \times \right. \\
& \left. \times \left( \left( \sum_{n\in\{M,U\}} \left( \frac{A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}}}{\sum_{n\in\{M,U\}} A_i^{n,s} \left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}}} \right) \hat{A}_i^{n,s} \left(\hat{L}_i^{n,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right)^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}}
\end{aligned}
$$

$$=\left[\sum_{s\in\{h,l\}}\left(\frac{\left(\left(\sum_{n\in\{M,U\}}A_i^{n,s}\left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}}\right)^{\frac{\lambda-1}{\lambda}}}{\sum_{s\in\{h,l\}}\left(\left(\sum_{n\in\{M,U\}}A_i^{n,s}\left(L_i^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}}\right)^{\frac{\lambda-1}{\lambda}}}\right)\times\right.$$

$$\left.\times\left(\sum_{n\in\{M,U\}}y_d^{n,s}\hat{A}_d^{n,s}\left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\left(\frac{\rho}{\rho-1}\right)\left(\frac{\lambda-1}{\lambda}\right)}\right]^{\frac{\lambda}{\lambda-1}}$$

$$=\left(\sum_{s\in\{h,l\}}\left(\frac{\sum_{n\in\{M,U\}}w_i^{n,s}L_i^{n,s}}{\sum_{s\in\{h,l\}}\sum_{n\in\{M,U\}}w_i^{n,s}L_i^{n,s}}\right)\left(\sum_{n\in\{M,U\}}y_d^{n,s}\hat{A}_d^{n,s}\left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\left(\frac{\rho}{\rho-1}\right)\left(\frac{\lambda-1}{\lambda}\right)}\right)^{\frac{\lambda}{\lambda-1}}$$

$$=\left(\sum_{s\in\{h,l\}}\eta_d^s\left(\sum_{n\in\{M,U\}}y_d^{n,s}\hat{A}_d^{n,s}\left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\left(\frac{\rho}{\rho-1}\right)\left(\frac{\lambda-1}{\lambda}\right)}\right)^{\frac{\lambda}{\lambda-1}}, \tag{21}$$

where $\eta_d^s \equiv \frac{\sum_{n\in\{M,U\}}w_i^{n,s}L_i^{n,s}}{\sum_{s\in\{h,l\}}\sum_{n\in\{M,U\}}w_i^{n,s}L_i^{n,s}}$ is the fraction of labor income in location $d$ paid to workers of skill $s$.

Now combining equations 19 and 21:

$$\hat{w}_d^{n,s}=\left(\sum_{s\in\{h,l\}}\eta_d^s\left(\sum_{n\in\{M,U\}}y_d^{n,s}\hat{A}_d^{n,s}\left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\left(\frac{\rho}{\rho-1}\right)\left(\frac{\lambda-1}{\lambda}\right)}\right)^{\frac{1}{\lambda-1}}\times \tag{22}$$

$$\times\left(\left(\sum_{n\in\{M,U\}}y_d^{n,s}\hat{A}_d^{n,s}\left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}}\right)^{\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)}\times\hat{A}_d^{n,s}\times\left(\hat{L}_d^{n,s}\right)^{-\frac{1}{\rho}},$$

Notice that

$$\left(\left(\sum_{n\in\{M,U\}}y_d^{n,s}\hat{A}_d^{n,s}\left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}}\right)^{\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)}=\left(\left(\sum_{n\in\{M,U\}}y_d^{n,s}\hat{A}_d^{n,s}\left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}\left(\frac{\lambda-1}{\lambda}\right)}\right)^{\frac{\lambda}{\lambda-1}\left(\frac{1}{\rho}-\frac{1}{\lambda}\right)}$$

$$=\left(\left(\sum_{n\in\{M,U\}}y_d^{n,s}\hat{A}_d^{n,s}\left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}\left(\frac{\lambda-1}{\lambda}\right)}\right)^{\left(\frac{\lambda}{\rho}-1\right)\frac{1}{\lambda-1}}$$

Therefore, equation 22 simplifies to:

$$
\begin{aligned}
\hat{w}_d^{n,s} = &\left(\sum_{s\in\{h,l\}} \eta_d^s \left(\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\left(\frac{\rho}{\rho-1}\right)\left(\frac{\lambda-1}{\lambda}\right)}\right)^{\frac{1}{\lambda-1}} \times \\
&\times \left(\left(\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}\left(\frac{\lambda-1}{\lambda}\right)}\right)^{\left(\frac{\lambda}{\rho}-1\right)\frac{1}{\lambda-1}} \times \hat{A}_d^{n,s} \times \left(\hat{L}_d^{n,s}\right)^{-\frac{1}{\rho}} \\
= &\left(\frac{\left(\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}\left(\frac{\lambda-1}{\lambda}\right)}}{\sum_{s\in\{h,l\}} \eta_d^s \left(\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\left(\frac{\rho}{\rho-1}\right)\left(\frac{\rho-1}{\rho}\right)}}\right)^{-\frac{1}{\lambda-1}} \times \\
&\times \left(\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{1}{\rho-1}} \times \hat{A}_d^{n,s} \times \left(\hat{L}_d^{n,s}\right)^{-\frac{1}{\rho}} \\
= &\left(\frac{\left(\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}\left(\frac{\lambda-1}{\lambda}\right)}}{\sum_{s\in\{h,l\}} \eta_d^s \left(\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\left(\frac{\rho}{\rho-1}\right)\left(\frac{\lambda-1}{\lambda}\right)}}\right)^{-\frac{1}{\lambda-1}} \times \\
&\times \left(\frac{\hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}}{\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}}\right)^{-\frac{1}{\rho-1}} \left(\hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{1}{\rho-1}} \times \hat{A}_d^{n,s} \times \left(\hat{L}_d^{n,s}\right)^{-\frac{1}{\rho}} \\
= &\left(\frac{\left(\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}\left(\frac{\lambda-1}{\lambda}\right)}}{\sum_{s\in\{h,l\}} \eta_d^s \left(\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}\right)^{\left(\frac{\rho}{\rho-1}\right)\left(\frac{\lambda-1}{\lambda}\right)}}\right)^{-\frac{1}{\lambda-1}} \times \\
&\times \left(\frac{\hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}}{\sum_{n\in\{M,U\}} y_d^{n,s} \hat{A}_d^{n,s} \left(\hat{L}_d^{n,s}\right)^{\frac{\rho-1}{\rho}}}\right)^{-\frac{1}{\rho-1}} \times \left(\hat{A}_d^{n,s}\right)^{\frac{\rho}{\rho-1}},
\end{aligned}
$$

which is the decomposition presented in equation (10) of the main text.

## C.3 Equivalence of a model with correlated draws

This appendix shows that the above model with sequentiality and independence of Frechet draws is isomorphic to an alternative model where an individual receives correlated draws.

Consider the three-nested model from the paper. An individual first chooses a country. The shock across countries is correlated with disimilarity parameter $\rho_c$. The individual then chooses a destination. The shock across destinations is correlated with disimilarity parameter $\rho_d$. Finally, the individual chooses a route. The shock across routes is correlated with disimilarity parameter $\rho_r$. The nested Frechet model is:

$$\pi_{rdc} = \pi_{r|dc} \times \pi_{d|c} \times \pi_c$$

$$\pi_{r|dc} = \frac{V_{rdc}^{\frac{\theta}{\rho_r}}}{\sum_{r'} V_{r'dc}^{\frac{\theta}{\rho_r}}} = \frac{V_{rdc}^{\frac{\theta}{\rho_r}}}{\Phi_d}$$

$$\pi_{d|c} = \frac{\Phi_d^{\frac{\rho_r}{\rho_d}}}{\sum_{d'} \Phi_{d'}^{\frac{\rho_r}{\rho_d}}} = \frac{\Phi_d^{\frac{\rho_r}{\rho_d}}}{\Phi_c}$$

$$\pi_c = \frac{\Phi_c^{\frac{\rho_d}{\rho_c}}}{\sum_{c'} \Phi_{c'}^{\frac{\rho_d}{\rho_c}}}$$

$$\pi_{rdc} = \frac{V_{rdc}^{\frac{\theta}{\rho_r}}}{\Phi_d} \times \frac{\Phi_d^{\frac{\rho_r}{\rho_d}}}{\Phi_c} \times \frac{\Phi_c^{\frac{\rho_d}{\rho_c}}}{\sum_{c'} \Phi_{c'}^{\frac{\rho_d}{\rho_c}}}$$

The model with three independent Frechet shocks is:

$$\pi_{rdc} = \pi_{r|dc} \times \pi_{d|c} \times \pi_c$$

$$\pi_{r|dc} = \frac{V_{rdc}^{\theta_r}}{\sum_{r'} V_{r'dc}^{\theta_r}} = \frac{V_{rdc}^{\theta_r}}{\Phi_d}$$

$$\pi_{d|c} = \frac{\Phi_d^{\frac{\theta_d}{\theta_r}}}{\sum_{d'} \Phi_{d'}^{\frac{\theta_r}{\theta_d}}} = \frac{\Phi_d^{\frac{\theta_d}{\theta_r}}}{\Phi_c}$$

$$\pi_c = \frac{\Phi_c^{\frac{\theta_c}{\theta_d}}}{\sum_{c'} \Phi_c^{\frac{\theta_c}{\theta_d}}}$$

$$\pi_{rdc} = \frac{V_{rdc}^{\theta_r}}{\Phi_d} \times \frac{\Phi_d^{\frac{\theta_d}{\theta_r}}}{\Phi_c} \times \frac{\Phi_c^{\frac{\theta_c}{\theta_d}}}{\sum_{c'} \Phi_{c'}^{\frac{\theta_c}{\theta_d}}}$$

The two models are isomorphic, with

$$\frac{\theta}{\rho_r} = \theta_r$$

$$\frac{\rho_r}{\rho_d} = \frac{\theta_d}{\theta_r}$$

$$\frac{\rho_d}{\rho_c} = \frac{\theta_c}{\theta_d}$$

which implies:

$$\theta_r = \frac{\theta}{\rho_r}$$

$$\theta_d = \frac{\theta}{\rho_d}$$

$$\theta_c = \frac{\theta}{\rho_c}$$

# D Counterfactual Appendix

This section provides additional details on the counterfactual procedure presented in Section 5.

## D.1 Construction of the data-set used in the counterfactuals

To compute our counterfactuals, we need data on wages and migration flows. We build this data for two periods, pre-fence and post-fence. We restrict our sample to Mexicans living in Mexico or in the US, and Americans living in the US. We do not allow Americans to migrate to Mexico in our model since only 0.5% of the working-age population living in Mexico was not born in Mexico (as a comparison, in the US, this number is 14.5%, in our sample period).

The wage data is the average wage of each location in our sample, in each year and each skill group. The procedure to calculate these averages is described in Appendices B.2 and B.3 for locations in the United States and Mexico, respectively. The post-fence data is the 2010 Mexican census and the 2010 ACS; the pre-fence data is the 2005 Mexican Census and the 2006 ACS (the earliest available).

To build migration flows we need to know, for each location, in each period: the number of individuals living there, how many are recent migrants, where they migrated from, and the route they took. This last point is only relevant for migrants crossing the border, i.e., migrating from Mexico to the U.S.

For locations in Mexico, we take the number of residents from the 2005 and 2010 Mexican censuses. The census asks where individuals were living 5 years before, which we use to build migration flows within Mexico.

For locations in the US, we take the number of residents from the 2006 and 2010 ACS.

The ACS asks where individuals where living 1 year before, which we use to build migration flows within the US. We multiply this by 5 to make it comparable with within-Mexico flows, which measure 5-year migration.

To compute the number of migrants from each origin in Mexico to each destination in the US, we use the matrícula dataset from 2006 (pre) and 2010 (post). We consider "origin" to the be individuals' birth municipality and "destination" their place of residency reported in the matrícula card. Note that, as shown in Column (8) of Appendix Table A6, the number of matrícula cards issued each year, in each destination, correlates well with the number of low-ed Mexicans living there who arrived in the US less than 5 years before. Hence, the flows computed using the matrícula data are comparable to the ones using the ACS and the Mexican census.

Finally, we construct migration routes using the MMP and EMIF datasets. Migrants can choose between 18 routes: the 17 border-crossing locations surveyed by the EMIF or the outside option. According to the MMP data, 3.9% of migrants use a route not included in the EMIF. Hence, we assume that 3.9% of the flows in each origin-destination pair goes through the outside option. For routes included in the EMIF, we compute the share of migrants going from origin $o$ to destination $d$ who use route $r$ as:

$$\pi_{r|odt} = \frac{\exp\left(-\theta^R \beta_W Wall_{rt} - \theta^R \beta_d \log dist_{od,r} - \theta^R \ln \delta_r^R\right)}{\sum_{r'} \exp\left(-\theta^R \beta_W Wall_{r't} - \theta^R \beta_d \log dist_{od,r'} - \theta^R \ln \delta_{r'}^R\right)} \cdot (1 - 0.039)$$

Where $\theta^R \beta_W$, $\theta^R \beta_d$ and $\theta^R \ln \delta_r^R$ are estimated from Regression 11 using the EMIF data. Note that, in the equation above, there is no error term $\left(\xi_{odr't}^R\right)$ because we follow Dingel and Tintelnot (2023) and keep the error term at its mean $\left(\xi_{odr't}^R = 1\right)$.

## D.2 Construction of the bootstrapped confidence intervals reported in the counterfactuals

We construct standard errors for the structural estimates by bootstrap. We create 500 bootstrap samples. Each sample is created by drawing destinations in the US, with replacement. We weight destinations by the number of matrícula cards issued there in the first year of our sample; that is, destinations with more matrícula cards are more likely to be sampled. In order to cluster standard errors at the destination level, each time a destination is drawn, all migration flows to this destination are included in the sample. For each sample, we re-estimate all parameters, starting from route choice and building up from there. Following Fox (2015), regressions are weighted by the inverse of the bootstrap sampling weights. Finally, we compute counterfactuals using each of the 500 resulting sets of parameters. We build confidence intervals by taking quantiles from these counterfactuals.

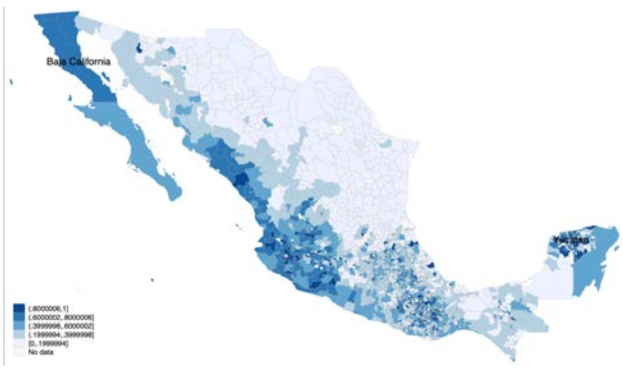
Notice that the counterfactual estimates confidence intervals will be clustered only at the destination level. As shown in Menzel (2021), there is no bootstrap procedure with multi-way clustering that achieves uniform consistency. Hence, we decided to cluster only at the destination level because correlated errors are likely to be more problematic at the destination level, in particular for the wage regressions.

Another limitation of bootstrap-based inference in this context is that we are not recentering wall exposure because it would be computationally infeasible. Hence, the median of the bootstrap estimates does not match exactly the baseline parameters, which are based on recentered regressions. We then shift the bootstrap estimates so that the median of the bootstrap estimates matches our baseline parameters.

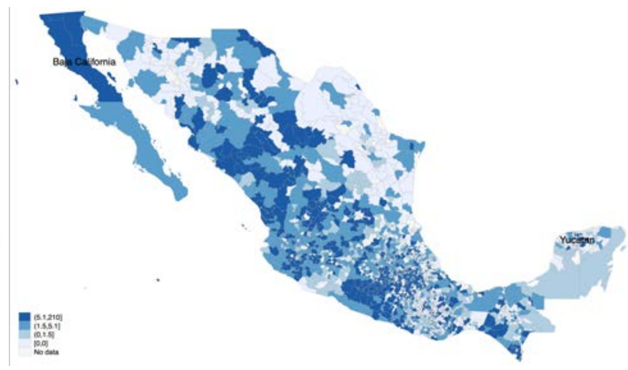
# E Additional Figures and Tables

Appendix Figure A1: Examples of migration patterns

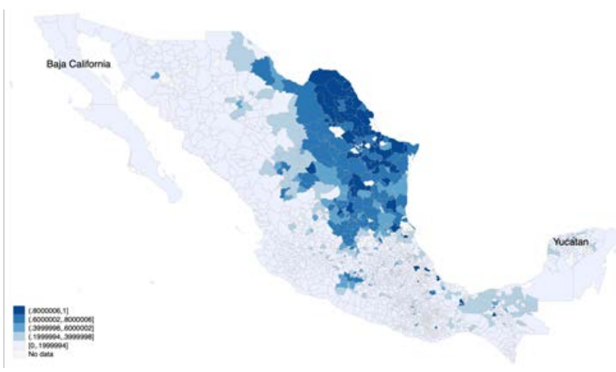
(a) Destination: California



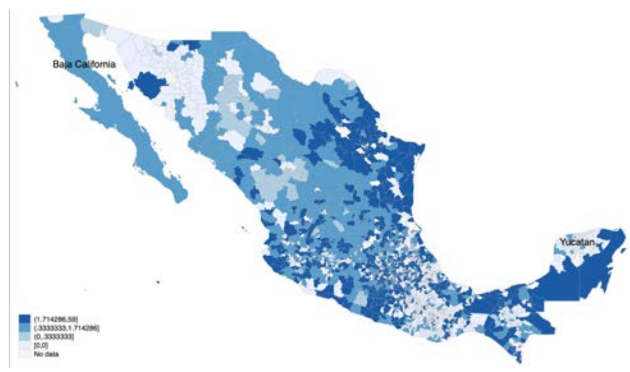

(b) Relative share: LA compared with Bay Area (conditional on migrating to California)




(c) Destination: Texas

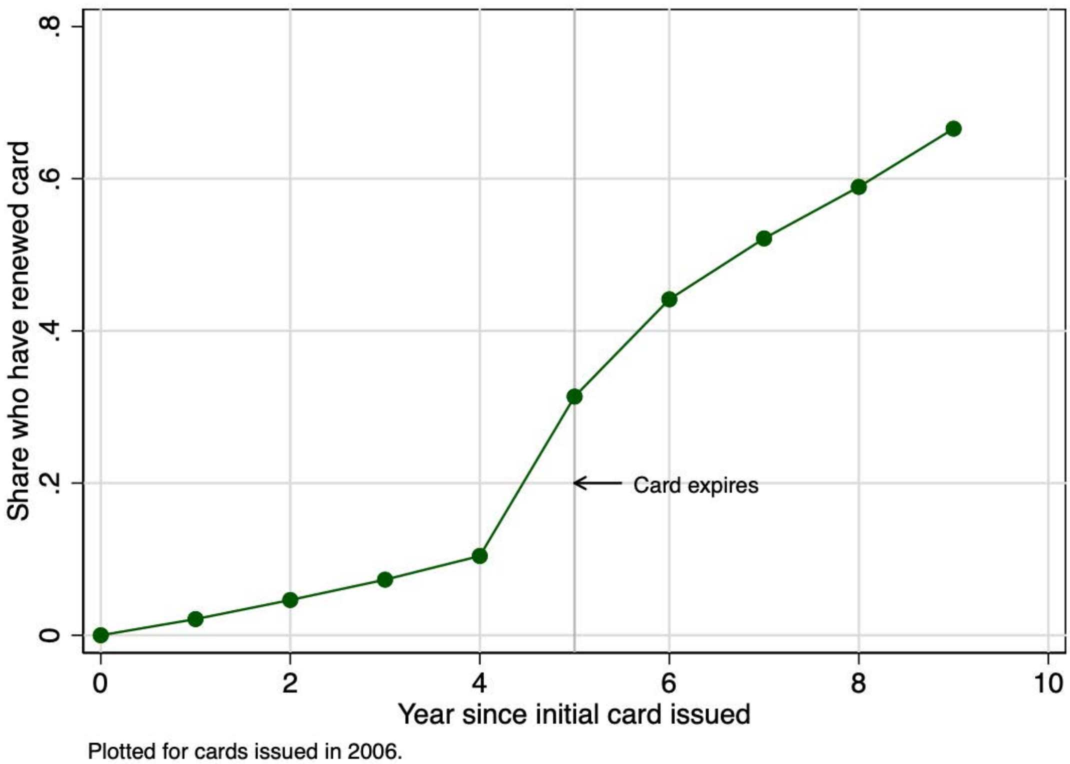



(d) Relative share: Houston compared with Dallas (conditional on migrating to Texas)




*Notes*: This figure shows probability of migrating to California (panel a), the relative probability of migrating to different cities within California, conditional on migrating to California (panel b), the probability of migrating to Texas (panel c), and the relative probability of migrating to different cities within Texas, conditional on migrating to Texas (panel d). Source: 2006 matrícula consular database.

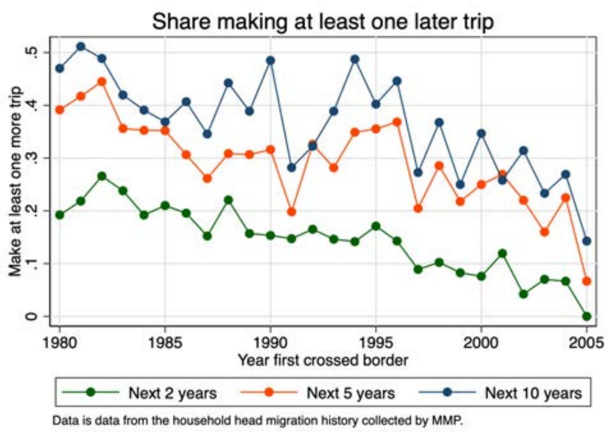
Appendix Figure A2: Renewal probability of matrícula cards



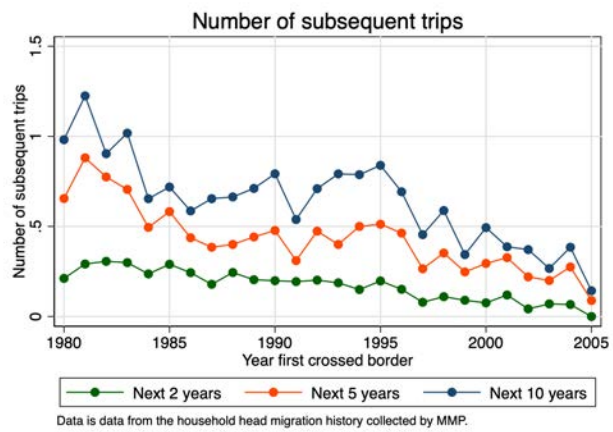

*Notes*: Data source: 2006–2015 matrícula consular database. Matrícula cards expire after five years. The figure shows when an individual is noted as renewing their matrícula card.

Appendix Figure A3: Repeat migration patterns over time

(a) Share making at least one later trip

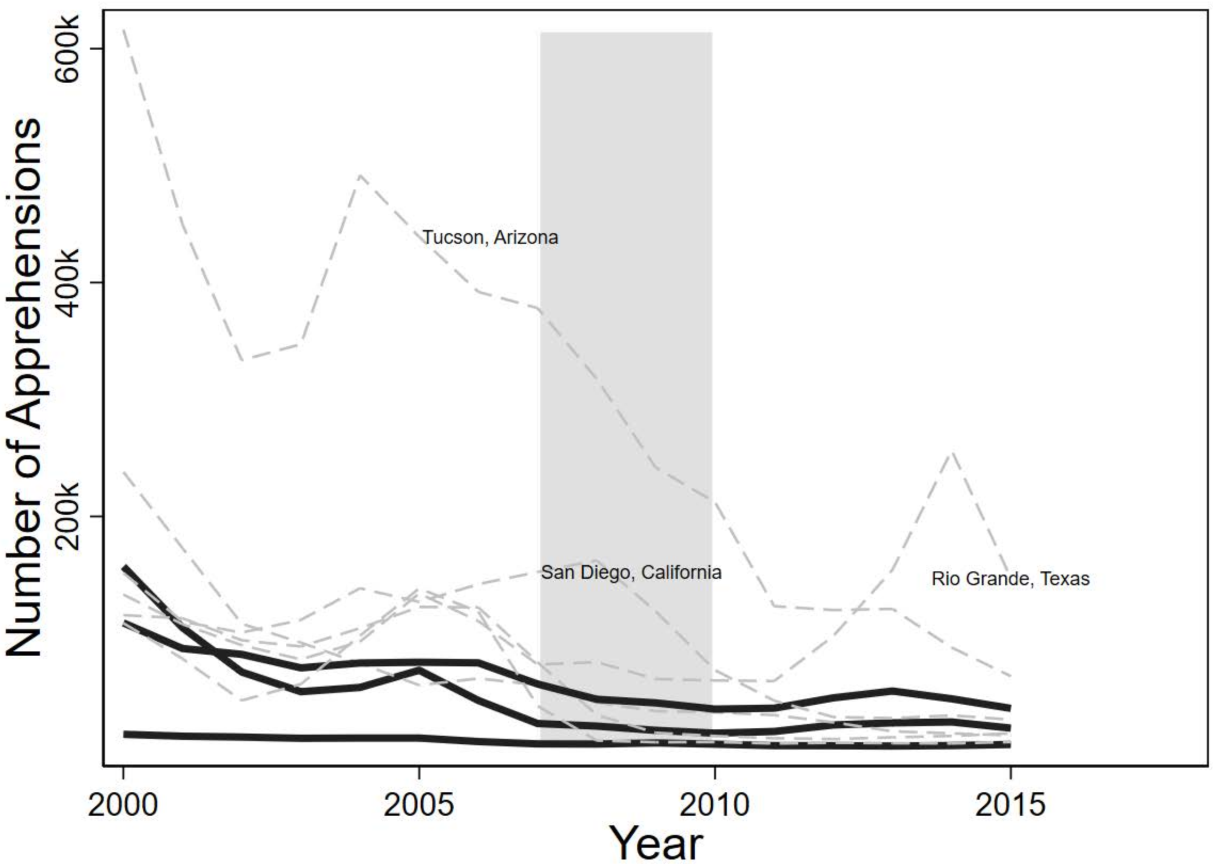



(b) Number of subsequent trips



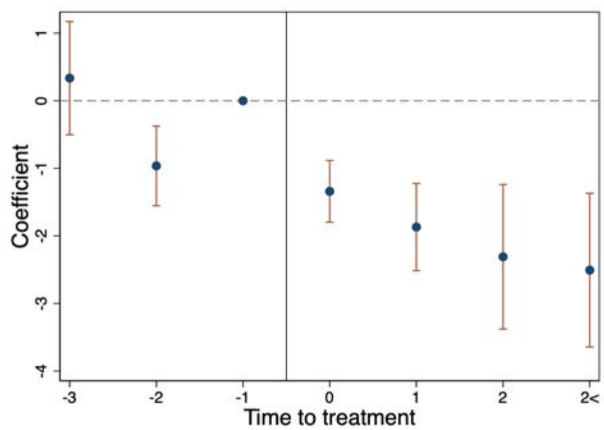

*Notes*: Data source: 1980-2015 Mexican Migration Project. Data source is the migration history of household head. X axis shows the year the individual first crossed the border. Panel (a) shows the share of migrants who make at least one additional trip after their first trip. Panel (b) shows the average number of additional trips a migrant made after their first trip.

Appendix Figure A4: Apprehensions by border sector




*Notes*: This figure shows the number of unauthorized migrants apprehended in the Mexican-U.S. border per year in each of the border sectors. The bold lines are sectors that were unaffected by the wall expansion (all in Texas). The shaded area shows the period when the fence expansion occurred. The data is from the United States Border Patrol official reports.

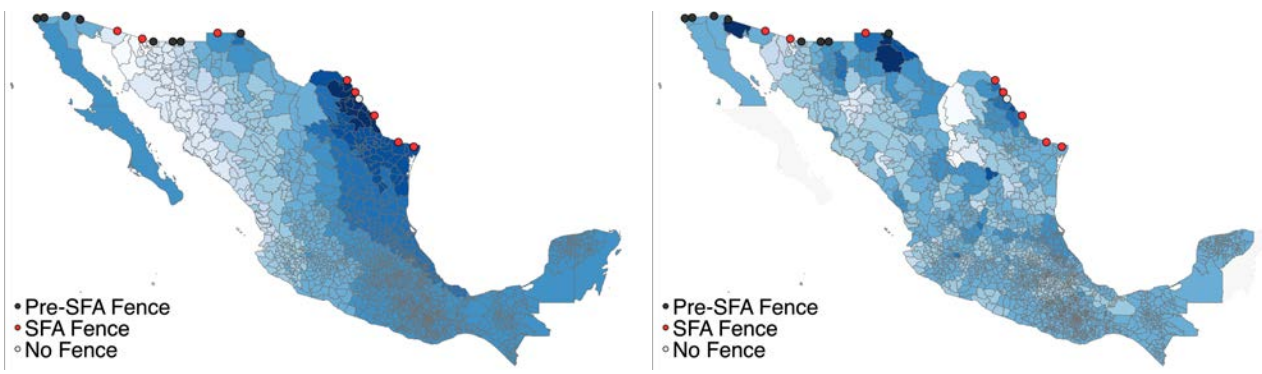
Appendix Figure A5: Effect of the border wall expansion on migration flows: Event studies (Robustness)




*Notes*: This figure depicts event study estimates of the detour effects of the border wall expansion using a conventional event study design. That is, we estimate $\ln \pi_{r|odt} = \sum_{\tau=-4}^{-1} \beta_\tau Wall_{rt+\tau} + \gamma_{odt} + \gamma_r + \varepsilon_{odtr}$ only including border points that receive a wall at some point. We use EMIF data on border crossing choices and the timing of the border wall expansion to estimate the extent to which migrants from a given origin to a given destination take a different route to avoid a border wall. The regression is weighted by the total number of migrants from each origin to each destination. Standard errors are clustered by crossing point.

Appendix Figure A6: Geographic variation in exposure to the wall expansion

(a) Baseline (b) Residualized by state fixed effects

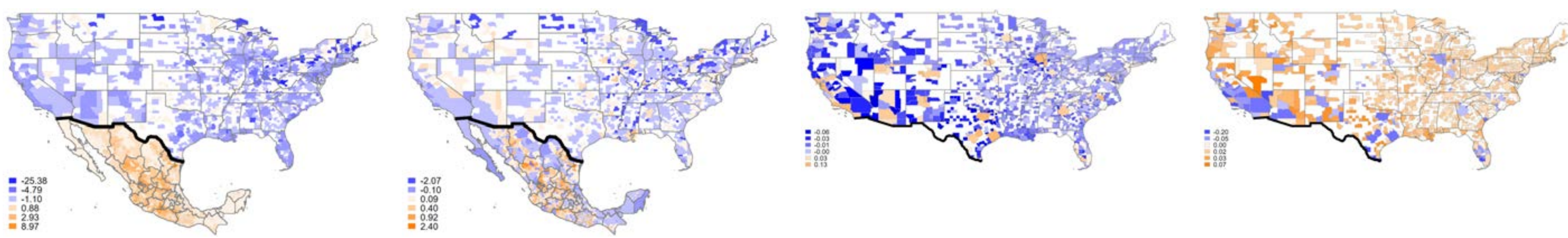



*Notes*: This figure shows the geographic variation in exposure to the wall expansion, as measured by change over time between the relative value of going to the U.S. versus staying in Mexico after the fence expansion, i.e., $\widehat{\delta}_o^{US-MX} \equiv \left(\ln \delta^D_{o,US,t_1} - \ln \delta^D_{o,MX,t_1}\right) - \left(\ln \delta^D_{o,US,t_0} - \ln \delta^D_{o,MX,t_0}\right)$. In both panels, we recenter $\widehat{\delta}_o^{US-MX}$ by the expected wall exposure of each location (see Section 4.3 for details). Darker colors indicate greater declines in the relative value of going to the U.S. versus staying in Mexico.

Appendix Figure A7: Effect of a complete border wall

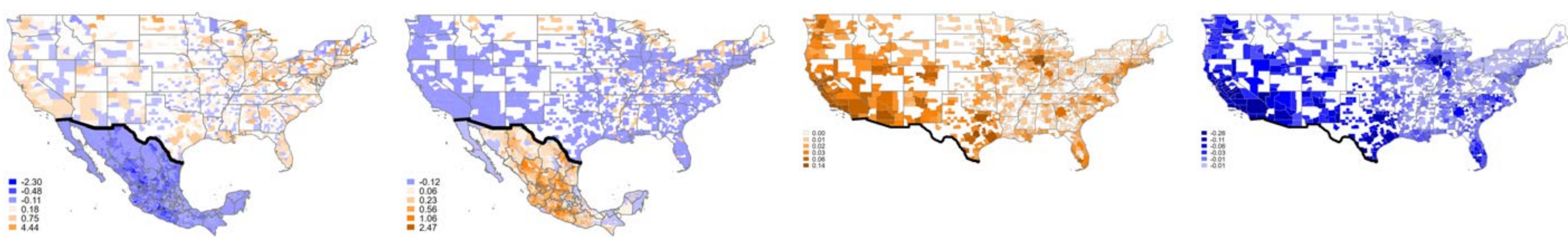
Panel (a): Population

(a) Mex. low-skill (b) Mex. high-skill (c) U.S. low-skill (d) U.S. high-skill



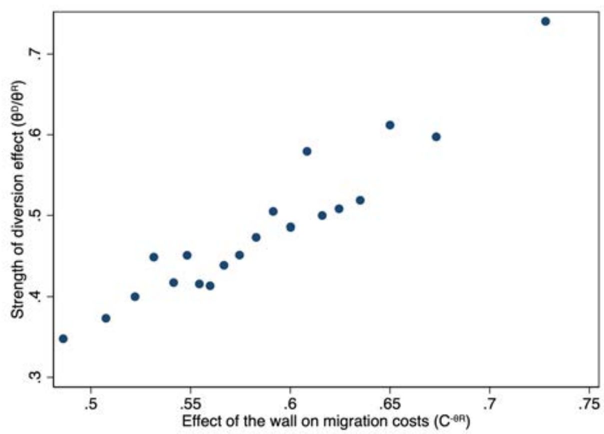

Panel (b): Income

(e) Mex. low-skill (f) Mex. high-skill (g) U.S. low-skill (h) U.S. high-skill




*Notes*: These figures show estimated effect of a counterfactual pedestrian border wall spanning the entire U.S.-Mexico border on the spatial distribution of population of each labor type (top panel) and the per capita annual income impact of each labor type (bottom panel) relative to the pre-period. Income is measured in 2000 U.S.D.

Appendix Figure A8: Positive correlation between estimated effect of wall on migrations cost $\left(\widehat{C}_{od,r}^{-\theta^R}\right)$ and strength of diversion effect $\left(\frac{\theta^D}{\theta^R}\right)$




*Notes*: This figures shows a binscatter plot of the estimated strength of diversion effect $\left(\frac{\theta^D}{\theta^R}\right)$ against the estimated effect of the wall on migration costs $\left(\widehat{C}_{od,r}^{-\theta^R}\right)$ for 500 bootstrap replications.

Appendix Table A1: Method of traveling to the border/US

| | Return to Mx by land | Return to Mx by air |
|---|---|---|
| Car | 3.67 | 5.29 |
| Bus | 84.34 | 27.90 |
| Train | 0.84 | 0.17 |
| Plane to border | 5.65 | 15.60 |
| Foot | 5.23 | 50.95 |
| Other | 0.27 | 0.09 |
| N | 2618 | 1154 |

*Notes:* Data is the 2010 EMIF survey of migrants returning to Mexico by air/land. Question asks the method of transportation used to arrive in the US from Mexico the more recent time the migrant crossed the border. Table shows percent of people choosing each method. The sample is restricted to people who crossed the border without any documents border between 2005 and 2010.

Appendix Table A2: Where did the wall expansion occur?

| | Entire border | | EMIF locations | | |
|---|---|---|---|---|---|
| | (1) Had fence before 2004 | (2) Fence built 2005-2009 | (3) Is EMIF point | (4) Had fence pre 2004 | (5) Year fence built 2005-2009 |
| Temperature | -0.050 | -0.045 | -0.002 | -0.034 | -0.184 |
| | 0.004*** | 0.008*** | 0.002 | 0.024 | 0.237 |
| Populated location | 0.234 | 0.149 | 0.045 | 0.318 | -0.713 |
| | 0.032*** | 0.047** | 0.016** | 0.272 | 0.968 |
| TX | -0.021 | -0.454 | -0.006 | -0.335 | 0.975 |
| | 0.023 | 0.028*** | 0.009 | 0.276 | 1.247 |
| CA | 0.523 | 0.649 | 0.020 | 0.227 | 0.000 |
| | 0.041*** | 0.051*** | 0.018 | 0.287 | . |
| Mean dep. var | 0.206 | 0.397 | | 0.588 | |
| N | 1001 | 795 | 1001 | 17 | 6 |
| r2 | 0.304 | 0.277 | 0.025 | 0.374 | 0.369 |

*Notes:* The table shows OLS regressions. Columns (1) and (2) study the entire border. An observation is one of 1001 2-mile long grid points on the border. Column (1) shows which locations had a wall before 2004. Column (2) shows which locations had a wall built between 2005-2009. Columns (3)-(5) focus on the 17 EMIF locations. Column (3) shows which points are contained in the EMIF database. Column (4) shows which of these locations had a wall before 2004. Column (5) regresses the year the wall was built. Robust standard errors in parentheses. Stars indicate statistical significance: *p<0.10 **p<0.05 ***p<0.01.

Appendix Table A3: Summary statistics: EMIF

| | |
|---|---|
| Migrants | 3817588 |
| Observations | 52336 |
| Origin states | 32 |
| Origin municipalities | 2103 |
| Destination states | 44 |
| Destination CBSAs | 214 |
| Crossing points | 17 |
| Crossing points with border pre-SFA | 8 |
| Crossing points with border post-SFA | 16 |
| Share with high school education or higher | 0 |
| Share with college education | 0.01 |
| Share migrating for work | 0.68 |
| Share using coyote/guide | 0.14 |

*Notes:* This table presents summary statistics of the EMIF dataset. Data is from 2004 to 2012. 'Observations' denotes the number of interviews conducted by the EMIF. 'Migrants' denotes the estimated number of migrants computed using survey weights. All shares are computed using survey weights.

Appendix Table A4: Validating the EMIF data

| **Panel A:** EMIF Data vs Border Apprehensions | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Dep var: # Migrants (EMIF) | | | | |
| # Apprehensions | 0.66 | 0.56 | 0.74 | 0.71 |
| | 0.06*** | 0.05*** | 0.08*** | 0.15*** |
| Observations | 71 | 71 | 71 | 71 |
| R2 (within) | 0.65 | 0.66 | 0.60 | 0.30 |
| Year FE | | ✓ | | ✓ |
| Border Fector FE | | | ✓ | ✓ |

| **Panel B:** EMIF Data vs Matricula Data | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Dep var: # Migrants (EMIF) | | | | |
| # Migrants (Matricula) | 0.98 | 0.95 | 0.78 | 0.75 |
| | 0.01*** | 0.01*** | 0.01*** | 0.01*** |
| Observations | 28267 | 28267 | 27880 | 27880 |
| R2 (within) | 0.33 | 0.33 | 0.21 | 0.20 |
| Year FE | | ✓ | | ✓ |
| Origin FE | | | ✓ | ✓ |
| Destination FE | | | ✓ | ✓ |

*Notes:* This table compare the migration flows in the EMIF against other datasets. Panel A uses border apprehensions by the U.S. border security. The data is at the border crossing sector-year level. The sample goes from 2004 to 2012. The independent variable is the number of apprehensions in each year in each border sector. Panel B uses the matricula consular dataset. The data is at the origin-destination-year level. The sample goes from 2006 to 2014. The independent variable is the number of matricula cards issues at each destinations to migrations from each origin, in each year. Stars indicate statistical significance: *p<0.10 **p<0.05 ***p<0.01.

Appendix Table A5: Counts: Matrícula and ACS

| | Matricula | | | Migrants in ACS | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | | | | | Recent | Established |
| | All cards | First-time | Renewed cards | All | In US less than 5 years | In US more than 5 years |
| 2006 | 799,260 | 790,556 | 8,704 | 6,042,228 | 1,180,518 | 4,861,710 |
| 2008 | 801,248 | 754,397 | 46,850 | 5,765,247 | 896,718 | 4,868,529 |
| 2010 | 724,100 | 561,062 | 163,038 | 5,716,321 | 656,509 | 5,059,812 |
| 2012 | 822,401 | 398,110 | 424,292 | 5,464,329 | 383,014 | 5,081,315 |
| 2014 | 907,668 | 326,332 | 581,336 | 5,407,318 | 311,890 | 5,095,428 |
| Average | 810,936 | 566,091 | 244,844 | 5,679,089 | 685,730 | 4,993,359 |
| Share low-skill | 0.96 | 0.96 | 0.96 | 1.00 | 1.00 | 1.00 |
| Share women | 0.42 | 0.41 | 0.45 | 0.35 | 0.28 | 0.36 |

*Notes:* Data source: 2006-2015 Matrícula database and 2005-2015 ACS. ACS is restricted to low-skill migrants only. Data is averaged across two years. An observation is a cbsa/two-year pair. A new card is defined as the first time an individual is in the database. A renewed card is a subsequent card issued to the same individual.

Appendix Table A6: Comparing Matrículas and ACS Mexican-born

| | All cards | | | | First-time cards | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Dep var: (log) Mx. pop | All | Low-ed | All<br>Arrived < 5 years | Low-ed<br>Arrived < 5 years | All | Low-ed | All<br>Arrived < 5 years | Low-ed<br>Arrived < 5 years |
| *Panel (a): Log-Log* | | | | | | | | |
| Log matrícula | 0.107 | 0.098 | 0.085 | 0.118 | 0.104 | 0.109 | 0.119 | 0.159 |
| | 0.027*** | 0.029*** | 0.053 | 0.057* | 0.023*** | 0.025*** | 0.046** | 0.050** |
| N | 4452 | 4375 | 3402 | 3224 | 4434 | 4358 | 3397 | 3223 |
| N region | 977 | 977 | 977 | 977 | 977 | 977 | 977 | 977 |
| *Panel (a): Level-Level* | | | | | | | | |
| Matrícula | 1.131 | 1.249 | 0.506 | 0.466 | 1.308 | 1.530 | 0.994 | 0.925 |
| | 0.049*** | 0.053*** | 0.036*** | 0.033*** | 0.015*** | 0.013*** | 0.009*** | 0.008*** |
| N | 4885 | 4885 | 4885 | 4885 | 4885 | 4885 | 4885 | 4885 |
| N region | 977 | 977 | 977 | 977 | 977 | 977 | 977 | 977 |
| cbsaFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| yearFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

*Notes:* Data source: 2006-2015 ACS; 2006-2015 Matrícula database. Data is averaged across two years. An observation is a cbsa/two-year pair. A new card is defined as the first time an individual is in the database.

Appendix Table A7: Comparing Matrículas and Mexican census

| | All cards | | | | First-time cards | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | | | All | Low-ed | | | All | Low-ed |
| Dep var: ΔMx. pop | All | Low-ed | Born 1940-1987 | Born 1940-1987 | All | Low-ed | Born 1940-1987 | Born 1940-1987 |
| Five-year sum of matriculas | -0.053 | 0.173 | -0.238 | -0.601 | -0.146 | -0.155 | -0.106 | -0.189 |
| | 0.133 | 0.138 | 0.043*** | 0.040*** | 0.040*** | 0.042*** | 0.009*** | 0.008*** |
| N | 4662 | 4644 | 4636 | 4614 | 4662 | 4644 | 4636 | 4614 |
| No. municipalities | 2331 | 2331 | 2331 | 2331 | 2331 | 2331 | 2331 | 2331 |
| Municipality FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

*Notes:* Data source: 2005, 2010, 2015 Mexican Census. 2006-2015 Matrícula database. In order to match the 2005 census to the Matrícula database we duplicate the observations for 2006 and merge to 2005. The Mexican census is only collected every five years. We therefore look at the change in population in a five year period in Mexico and compare to the sum of matrícula cards issued in the U.S. over the same five year period. An observation is an municipality/year. A new card is defined as the first time an individual is in the database.

Appendix Table A8: Comparison: Pew Matrícula applicants vs ACS Mexican-born

| | (1)<br>2006 Matr. (all) | (2)<br>2006 Matr. (6 states) | (3)<br>Pew | (4)<br>2005 ACS (all) | (5)<br>2005 ACS (6 states) |
|---|---|---|---|---|---|
| Share male | 0.60 | 0.59 | 0.59 | 0.54 | 0.53 |
| Age | 31.68 | 32.36 | 31.29 | 36.18 | 36.93 |
| High school educ or less | 0.97 | 0.97 | 0.94 | 0.88 | 0.87 |
| Married | | | 0.46 | | |
| Avg weekly earnings | | | 334.51 | 427.80 | 440.43 |
| In U.S. for less than 5 years | | | 0.39 | 0.21 | 0.17 |
| In U.S. for less than 2 years | | | 0.12 | 0.09 | 0.07 |
| In U.S. for less than 1 years | | | 0.12 | 0.05 | 0.04 |
| No. obs (unweighted) | 821241 | 577472 | 4836 | 79216 | 53567 |

*Notes:* Data source: Pew Matrícula survey. Pew survey conducted in CA, NY, IL, GA, TX, NC, between July 2004-Jan 2005 and 2006 Matrícula database.

Appendix Table A9: Estimating takeup rate of Matrícula

| | Recent = 1 yr in US | | Recent = 2 years in US | | Recent = 5 years in US | |
|---|---|---|---|---|---|---|
| | (1)<br>2006-2011 | (2)<br>2012-2015 | (3)<br>2006-2011 | (4)<br>2012-2015 | (5)<br>2006-2011 | (6)<br>2012-2015 |
| *All cards* | | | | | | |
| Recent migrants | 0.509 | | 0.509 | | 0.257 | |
| | 0.031*** | | 0.031*** | | 0.008*** | |
| Established migrants | 0.133 | | 0.133 | | 0.125 | |
| | 0.001*** | | 0.001*** | | 0.001*** | |
| *Renewed cards only* | | | | | | |
| Established migrants | | 0.112 | | 0.112 | | 0.116 |
| | | 0.001*** | | 0.001*** | | 0.001*** |
| *New cards only* | | | | | | |
| Recent migrants | | 1.702 | | 1.702 | | 0.561 |
| | | 0.061*** | | 0.061*** | | 0.013*** |
| Established migrants | | 0.046 | | 0.046 | | 0.038 |
| | | 0.001*** | | 0.001*** | | 0.001*** |
| Implied recent migrant share | 0.090 | 0.259 | 0.090 | 0.259 | 0.252 | 0.529 |

*Notes:* Data source: 2006-2015 Matrícula database and 2005-2015 ACS. Data is averaged across two years. An observation is a cbsa/two-year pair. A new card is defined as the first time an individual is in the database. A renewed card is a subsequent card issued to the same individual. Matrícula cards are valid for five years so the earliest we can reliably identify renewals is five years after 2006 (i.e., 2011).

Appendix Table A10: Spatial distribution of Mexican migrants: ACS, Matrícula and ENADID

| | Stocks | | Flows | | | |
|---|---|---|---|---|---|---|
| | (1)<br>Matrícula<br>All active cards | (2)<br>ACS<br>All Mexican-born | (3)<br>Matrícula<br>Annual (all) | (4)<br>Matrícula<br>Annual (first-time) | (5)<br>ACS<br>Arrived U.S. last two years | (6)<br>ENADID<br>Left Mexico last five years |
| *Pre-wall (2006-2007)* | | | | | | |
| Arizona | | 0.051 | 0.041 | | 0.072 | 0.068 |
| Texas | | 0.185 | 0.164 | | 0.165 | 0.170 |
| California | | 0.373 | 0.406 | | 0.243 | 0.298 |
| Illinois | | 0.068 | 0.082 | | 0.044 | 0.036 |
| *Post-wall (2010-2012)* | | | | | | |
| Arizona | 0.039 | 0.039 | 0.018 | 0.020 | 0.031 | 0.039 |
| Texas | 0.175 | 0.194 | 0.216 | 0.229 | 0.251 | 0.228 |
| California | 0.356 | 0.358 | 0.339 | 0.308 | 0.200 | 0.250 |
| Illinois | 0.081 | 0.068 | 0.072 | 0.060 | 0.042 | 0.040 |
| *Post-wall (2013-2015)* | | | | | | |
| Arizona | 0.012 | 0.039 | 0.011 | 0.012 | 0.052 | |
| Texas | 0.241 | 0.196 | 0.214 | 0.249 | 0.270 | |
| California | 0.290 | 0.356 | 0.326 | 0.273 | 0.195 | |
| Illinois | 0.051 | 0.066 | 0.081 | 0.049 | 0.051 | |

*Notes:* Table shows share of migrants in each state. Data source: Matrícula Consular database and ACS. Only migrants with high-school education or lower included from ACS. A first-time matrícula card is a card issued to an individual that has not appeared in the database since 2006. Data for pre-wall (2006-2007) comes from the 2006 and 2007 ACS, 2006 and 2007 Matrícula database, and 2009 ENADID. Data for post-wall (2010-2012) comes from 2010-2012 ACS and Matrícula, and 2014 ENADID. Data from post-wall (2013-2015) comes from the 2012-2015 ACS and Matrícula.

Appendix Table A11: The detour effect: Other time-varying migration costs

| | Poisson | | | |
|---|---|---|---|---|
| | Baseline | Time-varying costs | | Pre-SFA Fence |
| | (1) | (2) | (3) | (4) |
| Dep var: share migrants | | Border Patrol | Homicides | |
| Log cost-weighted distance | -19.748 | -19.379 | -19.815 | -19.739 |
| | 2.385*** | 2.203*** | 2.401*** | 2.355*** |
| Has any barrier | -0.549 | -0.569 | -0.568 | -0.546 |
| | 0.227** | 0.229** | 0.222** | 0.241** |
| staffSize | | 0.001 | | |
| | | 0.000 | | |
| homicideRate | | | 37.536 | |
| | | | 18.912** | |
| Obs | 428043 | 428043 | 408813 | 428043 |
| $R^2$ | 0.41 | 0.41 | 0.40 | 0.41 |
| CrossingPoint FE | ✓ | ✓ | ✓ | ✓ |
| Orig-Dest-Year FE | ✓ | ✓ | ✓ | ✓ |
| Nuevo Laredo-Year FE | | | | ✓ |

*Notes:* This table reports estimates the elasticity of route choice to route cost using the EMIF dataset. The dependent variable is the share of migrants from origin $o$ going to destination $d$ that cross the border through point $b$. The regressions are weighted by the total numbers of migrants from origin $o$ going to destination $d$. Cost-weighted distance is the distance from $o$ to $d$, going through $b$, accounting for both natural (e.g. deserts and mountains) and man-made geographic features (such as roads). Border patrol is the size of the patrol staff and homicide is the homicide rate in the Mexican side of the border. Both these variables are at the border crossing-year level. The sample includes data from 2004 (pre border wall expansion) to 2012 (post expansion). Standard errors (in parentheses) are clustered at the crossing point level. Stars indicate statistical significance: *p<0.10 **p<0.05 ***p<0.01.

Appendix Table A12: The detour effect: estimating the elasticity of route choice to route cost (robustness to wall definition)

| | OLS | | | Poisson | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Dep var: share migrants (EMIF) | | | | | | |
| *Panel (a): Baseline, 1 mile radius (discrete)* | | | | | | |
| Log cost-weighted distance | -5.731 | -6.629 | | -19.747 | -19.748 | |
| | 1.474*** | 1.365*** | | 2.385*** | 2.385*** | |
| Fence exposure | -1.143 | -1.349 | -1.796 | -0.548 | -0.549 | -1.311 |
| | 0.239*** | 0.262*** | 0.182*** | 0.227** | 0.227** | 0.164*** |
| *Panel (b): 3 mile radius (continuous)* | | | | | | |
| Log cost-weighted distance | -5.696 | -6.574 | | -19.787 | -19.789 | |
| | 1.496*** | 1.400*** | | 2.392*** | 2.393*** | |
| Fence exposure | -1.271 | -1.499 | -1.905 | -0.725 | -0.726 | -1.235 |
| | 0.286*** | 0.314*** | 0.232*** | 0.235*** | 0.235*** | 0.141*** |
| *Panel (c): 10 mile radius (continuous)* | | | | | | |
| Log cost-weighted distance | -5.746 | -6.631 | | -19.916 | -19.918 | |
| | 1.514*** | 1.426*** | | 2.423*** | 2.423*** | |
| Fence exposure | -1.564 | -1.873 | -2.354 | -0.846 | -0.847 | -1.377 |
| | 0.349*** | 0.373*** | 0.267*** | 0.202*** | 0.202*** | 0.129*** |
| *Panel (d): 20 mile radius (continuous)* | | | | | | |
| Log cost-weighted distance | -5.758 | -6.663 | | -19.983 | -19.984 | |
| | 1.477*** | 1.358*** | | 2.450*** | 2.450*** | |
| Fence exposure | -1.828 | -2.220 | -2.618 | -0.654 | -0.654 | -1.322 |
| | 0.410*** | 0.417*** | 0.290*** | 0.224*** | 0.224*** | 0.158*** |
| Obs | 13344 | 5221 | 2244 | 428043 | 428043 | 27300 |
| CrossingPoint FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Orig-Dest FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Orig-Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Dest-Year | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Orig-Dest-Year FE | | ✓ | ✓ | | ✓ | ✓ |
| Orig-CrossingPoint-Dest FE | | | ✓ | | | ✓ |
| Sample | share>0 | share>0 | share>0 | Full | Full | Full |

*Notes:* This table reports estimates the elasticity of route choice to route cost using the EMIF dataset. The dependent variable is the share of migrants from origin $o$ going to destination $d$ that cross the border through point $b$. The dependent variable is log(share). The measure of wall exposure in panel (a) is whether the crossing border had any wall within a 1 mile radius. The measure of wall exposure in panels (b) through (d) is a measure of the share of the border covered by wall for different radii. Distance is the distance from $o$ to $d$, going through $b$ and cost-weighted distance is the same, but accounting for both natural (e.g. deserts and mountains) and man-made geographic features (such as roads). The sample includes data from 2004 (pre border wall expansion) to 2012 (post expansion). The regressions are weighted by the total number of migrants from origin $o$ going to destination $d$. Standard errors are reported directly below the point estimate and are clustered at the crossing point level. Stars indicate statistical significance: *p<0.10 **p<0.05 ***p<0.01.

Appendix Table A13: The detour effect: estimating the elasticity of route choice to route cost (treatment heterogeneity)

| | OLS | | | |
|---|---|---|---|---|
| Dep var: share migrants (EMIF) | (1) Baseline | (2) Rel. Time | (3) Cross. Point | (4) Year |
| *Panel (a): Log distance* | | | | |
| Has any barrier | -1.352 | -1.693 | -1.140 | -1.371 |
| | 0.265*** | 0.365*** | 0.168*** | 0.158*** |
| *Panel (b): Log cost-weighted distance* | | | | |
| Has any barrier | -1.349 | -1.703 | -1.137 | -1.292 |
| | 0.262*** | 0.359*** | 0.170*** | 0.159*** |
| Obs | 5221 | 5221 | 5221 | 5221 |
| CrossingPoint FE | ✓ | ✓ | ✓ | ✓ |
| Orig-Dest-Year FE | ✓ | ✓ | ✓ | ✓ |
| Sample | | | | |

*Notes:* This table reports estimates the elasticity of route choice to route cost using the EMIF dataset. The dependent variable is the share of migrants from origin $o$ going to destination $d$ that cross the border through point $b$. The dependent variable is log(share). Has any barrier measures whether the crossing border had any wall within a 1 mile radius. The table presents the average treatment effect after allowing for treatment effect heterogeneity in the dimension labeled by the column, following Borusyak, Jaravel, and Spiess (2024). Column (1) presents the baseline results with no heterogeneity. Column (2) allows for heterogeneous effects of the wall based on time relative to treatment. Column (3) allows for heterogenous effects of the wall by crossing point. Column (4) allows for heterogenous effects of the wall by year. The sample includes data from 2004 (pre border wall expansion) to 2012 (post expansion). The regressions are weighted by the total number of migrants from origin $o$ going to destination $d$. Standard errors are reported directly below the point estimate and are clustered at the crossing point level. Stars indicate statistical significance: *p<0.10 **p<0.05 ***p<0.01.

Appendix Table A14: The diversion effect: robustness

| | Baseline | Time-varying costs | | Sample choice | | Time-varying shocks | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Dep. var: log num matr | | Border patrol | Homicides | Consul states | Drop outliers | Recession | Industry |
| Migration Costs $(\delta_{odt})$ – Recentered | -0.468 | -1.418 | -0.417 | -0.436 | -0.149 | -0.502 | -0.468 |
| | 0.240* | 0.435*** | 0.194** | 0.236* | 0.265 | 0.252** | 0.240* |
| Border patrol staff | | -0.596 | | | | | |
| | | 0.204*** | | | | | |
| Homicide rate | | | 0.049 | | | | |
| | | | 0.017*** | | | | |
| construction × housing shock | | | | | | 1.251 | |
| | | | | | | 0.818 | |
| orig ag × dest ag | | | | | | | 2.860 |
| | | | | | | | 4.485 |
| orig services × dest services | | | | | | | 2.595 |
| | | | | | | | 3.099 |
| N | 267164 | 267164 | 267164 | 205514 | 256446 | 228238 | 267164 |
| Origin-Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Dest-Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Pair FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

*Notes:* Data: 2006 (pre border wall expansion) and 2010 (post expansion) Matrícula database. Each observation is an origin (Mexican municipality) - destination (U.S. CBSA statistical area) -year. $\delta_{odt}$ is an estimate of the cost of going from a given origin to a given destination that takes into account the cost of crossing a wall, as well as the substitutability between different routes. Border patrol is the size of the patrol staff and homicide is the homicide rate in the Mexican side of the border. Both these variables are at the border crossing-year level. They are converted to the origin-destination-year level by taking a weighted average where the weights are the probability a migrant of this pair will cross at each of the border crossing points. Services, ag and const are, respectively, the share of migrants from a given origin or at a given destination that work in services, agriculture or construction, according to the Matrícula database. Housing shock measures how much each destination was affected by the 2008 housing crisis (as in Mian and Sufi (2014)). Standard errors are reported in parentheses. Spatial cluster is origin-cluster (1 degree x 1 degree) x destination cluster (1 degree x 1 degree). Regressions weighted by total migration in each origin. Stars indicate statistical significance: *p<0.10 **p<0.05 ***p<0.01.

Appendix Table A15: Elasticity of substitution between low-skill US-born and Mexican-born workers: Additional controls

| log MX/US low-skill wage ratio | (1) Baseline | (2) Recession | (3) Consul States | (4) Distance trends | (5) Sectoral trends | (6) All |
|---|---|---|---|---|---|---|
| log MX/US low-skill pop ratio | -0.196 | -0.146 | -0.200 | -0.245 | -0.344 | -0.288 |
| | 0.084** | 0.072** | 0.079** | 0.149* | 0.144** | 0.168* |
| Housing Shock × post | | 0.174 | | | | 0.200 |
| | | 0.052*** | | | | 0.071*** |
| Log distance border × post | | | | 0.056 | | 0.032 |
| | | | | 0.093 | | 0.090 |
| Share in ag/mining × post | | | | | 0.686 | 0.553 |
| | | | | | 0.317** | 0.278** |
| Share in services × post | | | | | 0.342 | 0.253 |
| | | | | | 0.261 | 0.255 |
| N | 1642 | 1642 | 1008 | 1642 | 1642 | 1642 |
| Destination FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| State-Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| First Stg F | 18.2 | 17.9 | 20.8 | 7.9 | 8.2 | 5.1 |
| Implied elasticity ($\rho$) | 5.10 | 6.83 | 4.99 | 4.09 | 2.91 | 3.47 |

*Notes:* An observation is an USA CBSA. The dependent variable is the ratio of log wages of Mexican-born workers to US-born workers. Data: 2006 and 2012 3-year ACS. Instrument (recentered) is the recentered exposure of the scaled-destination shock as described in the text. The low-skill pop ratio is the ratio of log low-skill Mexican workers to US workers. Regression is estimated by 2SLS. Regression is weighted by the inverse weight recommended by Borjas, Grogger, and Hanson (2012). Implied elasticity is calculated as the inverse of the estimated elasticity on the population ratio. Standard errors are clustered by state. Stars indicate statistical significance: *p<0.10 **p<.05 ***p<0.01. Standard errors in brackets under the recentered values are permutation p-values computed from 500 permutations of wall construction that matches the actual number of border crossings walled each year, allowing initial conditions to change.

Appendix Table A16: Elasticity of substitution between low-skill US-born and Mexican-born workers, robustness to alternative samples

| | Baseline | | Labor supply only workers | | Drop women | |
|---|---|---|---|---|---|---|
| | (1) First Stage | (2) Second Stage | (3) First Stage | (4) Second Stage | (5) First Stage | (6) Second Stage |
| Instrument (recentered) | 1.808 | | 1.822 | | 2.018 | |
| | 0.515*** | | 0.518*** | | 0.624*** | |
| Housing Shock × post | 0.428 | 0.174 | 0.426 | 0.171 | 0.513 | 0.103 |
| | 0.327 | 0.064*** | 0.330 | 0.063*** | 0.438 | 0.085 |
| log MX/US low-skill pop ratio | | -0.146 | | -0.140 | | -0.082 |
| | | 0.075* | | 0.070** | | 0.110 |
| N | 1642 | 1642 | 1642 | 1642 | 1606 | 1606 |
| $R^2$ | 0.985 | | 0.985 | | 0.983 | |
| Destination FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| State-Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| First stage F value | . | 12.3 | . | 12.4 | . | 10.5 |
| Implied elasticity ($\rho$) | . | 6.8 | . | 7.1 | . | 12.2 |

*Notes:* An observation is an USA CBSA. The dependent variable is the ratio of log wages of Mexican-born workers to US-born workers. Data: 2006 and 2012 3-year ACS. Instrument (recentered) is the recentered exposure of the scaled-destination shock as described in the text. The low-skill pop ratio is the ratio of log low-skill Mexican workers to US workers. Regression is estimated by 2SLS. Regression is weighted by the inverse weight recommended by Borjas, Grogger, and Hanson (2012). Implied elasticity is calculated as the inverse of the estimated elasticity on the population ratio. Standard errors are clustered by state. Stars indicate statistical significance: *p<0.10 **p<.05 ***p<0.01. Standard errors in brackets under the recentered values are permutation p-values computed from 500 permutations of wall construction that matches the actual number of border crossings walled each year, allowing initial conditions to change. The baseline labor supply sample composes male and female workers who are not self employed, including those who do not work. The baseline wage sample composes male and female workers who are not self employed, dropping those who do not work. Columns (3) and (4) composes the baseline sample but drops people who do not work from labor supply. Colums (5) and (6) composes the baseline sample, dropping women from both the labor supply and wage sample.

Appendix Table A17: Aggregate impacts of a border wall expansion: Alternative measures

| | | Continuous measure of fence exposure | | |
|---|---|---|---|---|
| | Baseline | 3 mile radius | 10 mile radius | 20 mile radius |
| | (1) | (2) | (3) | (4) |
| *Change in Migration (persons per year)* | | | | |
| Change in routes | 89250 | 104594 | 102774 | 71000 |
| | [60843,112897] | [60843,112897] | [51887,95817] | [50989,93146] |
| Change in destination (within U.S.) | 14261 | 16739 | 16580 | 8688 |
| | [8327,19649] | [8327,19649] | [6996,16422] | [5341,12454] |
| Change in migration from Mexico to U.S. | -311205 | -345668 | -383738 | -289141 |
| | [-377763,-218578] | [-377763,-218578] | [-380563,-218360] | [-365179,-207095] |
| *Change in Income (per year per person)* | | | | |
| Mexican low skill | $-77 | $-86 | $-95 | $-72 |
| | [-96,-51] | [-96,-51] | [-97,-51] | [-93,-49] |
| Mexican high skill | $21 | $23 | $25 | $19 |
| | [14,25] | [14,25] | [14,25] | [14,24] |
| U.S. low skill | $9 | $10 | $11 | $9 |
| | [3,14] | [3,14] | [3,14] | [2,14] |
| U.S. high skill | $-21 | $-23 | $-26 | $-20 |
| | [-25,-15] | [-25,-15] | [-26,-15] | [-25,-14] |

*Notes:* This table reports the aggregate impact of the actual 2007-2010 border wall expansion on migration patterns and incomes using different measures of exposure. Column 1 is the baseline result which considers a crossing location as being exposed to a wall if there is barrier constructed. Columns 2-4 consider a continuous measure of exposure equal to the fraction of the border within a given radius of the crossing point that is covered by a barrier. 5%/95% Bootstrapped confidence intervals are reported in brackets.

Appendix Table A18: Robustness of Aggregate Impacts: Alternative assumptions regarding skill

| | Baseline | Border wall affects high-skill too | High-skill become low skill after migrating |
|---|---|---|---|
| | (1) | (2) | (3) |
| *Change in Migration (persons per year)* | | | |
| Change in routes | 89250 | 78540 | 89250 |
| | [60843,112897] | [53542,99349] | [60843,112897] |
| Change in destination (within U.S.) | 14261 | 18895 | 14261 |
| | [8327,19649] | [10931,26185] | [8327,19649] |
| Change in migration from Mexico to U.S. | -311205 | -306174 | -311205 |
| | [-377763,-218578] | [-371682,-215033] | [-377763,-218578] |
| *Change in Income (per year per person)* | | | |
| Mexican low skill | $-77 | $-66 | $-82 |
| | [-96,-51] | [-82,-43] | [-102,-54] |
| Mexican high skill | $21 | $-38 | $37 |
| | [14,25] | [-52,-20] | [26,45] |
| U.S. low skill | $9 | $7 | $10 |
| | [3,14] | [1,11] | [2,15] |
| U.S. high skill | $-21 | $-18 | $-23 |
| | [-25,-15] | [-22,-13] | [-28,-16] |

*Notes:* This table reports how the aggregate impacts of the border wall expansion with the wage feedback loop change with different assumptions regarding the high skilled Mexican workers. Column 1 are the baseline results. Column 2 apportions the matricula consular bilateral flows into both high skilled and low skilled workers based on aggregate shares of Mexican migrants in the U.S. ACS and assumes that both groups are affected by the border wall expansion. Column 3 assumes that high skilled Mexican workers become low skilled upon migrating to the United States. 5%/95% Bootstrapped confidence intervals are reported in brackets.

Appendix Table A19: Robustness of Aggregate Impacts: Alternative elasticities of substitution ($\rho$)

| | Estimated $\rho = 7.2$ | | Alternative $\rho = 10$ | | Alternative $\rho = 20$ | | Alternative $\rho = 30$ | |
|---|---|---|---|---|---|---|---|---|
| | Baseline (1) | Wage Feedback Loop (2) | Baseline (3) | Wage Feedback Loop (4) | Baseline (5) | Wage Feedback Loop (6) | Baseline (7) | Wage Feedback Loop (8) |
| *Change in Migration (persons per year)* | | | | | | | | |
| Change in routes | 89250 | 89250 | 89250 | 89250 | 89250 | 89250 | 89250 | 89250 |
| | [60843,112897] | [60843,112897] | [60843,112897] | [60843,112897] | [60843,112897] | [60843,112897] | [60843,112897] | [60843,112897] |
| Change in destination (within U.S.) | 14261 | 13980 | 14261 | 14145 | 14261 | 14336 | 14261 | 14404 |
| | [8327,19649] | [8085,19211] | [8327,19649] | [8236,19528] | [8327,19649] | [8370,19760] | [8327,19649] | [8418,19843] |
| Change in migration from Mexico to U.S. | -311205 | -282480 | -311205 | -286942 | -311205 | -291876 | -311205 | -293579 |
| | [-377763,-218578] | [-346652,-193168] | [-377763,-218578] | [-351866,-198454] | [-377763,-218578] | [-357279,-202466] | [-377763,-218578] | [-359094,-203848] |
| *Change in Income (per year per person)* | | | | | | | | |
| Mexican low skill | $-77 | $-70 | $-81 | $-76 | $-86 | $-82 | $-88 | $-84 |
| | [-96,-51] | [-90,-44] | [-99,-57] | [-93,-52] | [-105,-61] | [-100,-56] | [-107,-62] | [-102,-58] |
| Mexican high skill | $21 | $18 | $21 | $19 | $21 | $19 | $21 | $19 |
| | [14,25] | [12,22] | [14,25] | [13,23] | [14,25] | [13,23] | [14,25] | [13,23] |
| U.S. low skill | $9 | $9 | $12 | $11 | $14 | $14 | $15 | $15 |
| | [3,14] | [2,14] | [8,14] | [8,14] | [10,17] | [10,17] | [11,19] | [10,18] |
| U.S. high skill | $-21 | $-19 | $-21 | $-20 | $-21 | $-20 | $-21 | $-20 |
| | [-25,-15] | [-24,-13] | [-25,-15] | [-24,-14] | [-25,-15] | [-24,-14] | [-25,-15] | [-24,-14] |

*Notes:* This table reports how the aggregate impacts of the border wall expansion change under different assumptions regarding the elasticity of substitution between Mexican-born and U.S.-born workers ($\rho$). Columns (1) and (2) replicate the main results. Columns (3)-(8) consider alternative values of $\rho$. 5%/95% Bootstrapped confidence intervals holding $\rho$ constant but allowing all other estimated parameters to change are reported in brackets.

Appendix Table A20: Robustness of Aggregate Impacts: Alternative parameters for wage feedback loop

| | | Skill elasticity | | Migration elasticity | |
|---|---|---|---|---|---|
| | Preferred parameters (1) | High (2) | Low (3) | High (4) | Low (5) |
| *Change in Migration (persons per year)* | | | | | |
| Change in routes | 89250 | 89250 | 89250 | 81301 | 81301 |
| | [60843,112897] | [60843,112897] | [60843,112897] | [60843,112897] | [60843,112897] |
| Change in destination (within U.S.) | 13980 | 13828 | 14172 | 15957 | 16500 |
| | [8085,19211] | [7986,19023] | [8210,19459] | [7825,18991] | [8179,19417] |
| Change in migration from Mexico to U.S. | -282480 | -290181 | -272239 | -249467 | -285682 |
| | [-346652,-193168] | [-354698,-199264] | [-335725,-185012] | [-317048,-164055] | [-360142,-205989] |
| *Change in Income (per year per person)* | | | | | |
| Mexican low skill | $-70 | $-74 | $-66 | $-63 | $-71 |
| | [-90,-44] | [-94,-47] | [-85,-41] | [-82,-37] | [-92,-47] |
| Mexican high skill | $18 | $7 | $36 | $15 | $19 |
| | [12,22] | [5,9] | [24,44] | [10,19] | [13,23] |
| U.S. low skill | $9 | $-1 | $23 | $8 | $9 |
| | [2,14] | [-7,3] | [13,31] | [2,13] | [2,14] |
| U.S. high skill | $-19 | $-8 | $-36 | $-17 | $-19 |
| | [-24,-13] | [-10,-6] | [-44,-24] | [-22,-11] | [-25,-14] |

*Notes:* This table reports how the aggregate impacts of the border wall expansion with the wage feedback loop depend on the two calibrated elasticities: the elasticity of substitution between high and low skill labor and the elasticity of migration flows to changes in wages. Column 1 reports the preferred estimates, with both elasticities calibrated to have a value of two, as is consistent with the existing literature. Column 2 considers a higher skill elasticity of five. Column 3 considers a lower skill elasticity of one. Column 4 considers a higher migration elasticity of five. Column 5 considers a lower migration elasticity of 1. 5%/95% Bootstrapped confidence intervals are reported in brackets.