Trade Effects of Immigration Enforcement in Labor-Intensive Agriculture*

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Abstract

This paper examines how interior immigration enforcement, which reduces the supply of immigrant farm labor, affects domestic and international trade in the U.S. specialty crop sector. Using variation in enforcement intensity within and across states between 1997 and 2012, I find that stricter enforcement is associated with declines in the number and share of immigrant farmworkers and in the production of labor-intensive specialty crops. I then estimate reduced-form gravity models and find that increased enforcement lowered both interstate and international exports while increasing imports from U.S. states with lower enforcement intensity. In contrast, I find no direct effect on international imports. These results suggest that short-run adjustments to labor supply shocks occur primarily through domestic reallocation of specialty crop production and reduced exports rather than increased reliance on foreign imports.

Keywords: Immigration enforcement, agricultural labor, agricultural trade

JEL Codes: J43, F14, F16, K37, Q17

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1 Introduction

Labor expenses account for roughly 30-40 percent of variable production costs in U.S. fruit, vegetable, and other specialty crop industries (Martin and Calvin, 2011; Castillo et al., 2021; Calvin et al., 2022), making these sectors particularly sensitive to labor market shocks.[1] Because production of these labor-intensive crops is geographically concentrated while consumption is nationwide, disruptions to farm labor supply in major producing regions have the potential to reshape both interstate and international trade flows. Over the last few decades, the U.S. farm labor market has tightened as the supply of seasonal farm workers has declined, and farmers have increasingly reported labor shortages and upward pressure on real farmworker wages (Charlton et al., 2019). Yet little is known about how such labor supply shocks translate into changes in where specialty crops are produced and how they move across regions and borders.

One of the largest and most salient negative shocks to low-skill farm labor supply in recent decades has been the expansion of interior immigration enforcement within the United States. Beginning in the 2000s, federal, state, and local authorities intensified enforcement through local cooperation with federal immigration authorities, employment verification requirements, and restrictions on access to public services such as driver's licenses, education, and public benefits. A growing body of work shows that these policies reduce the undocumented immigrant population in implementing jurisdictions (Bohn et al., 2014; East et al., 2023). The U.S. fruit and vegetable sector is especially vulnerable to such policies, as it relies heavily on immigrant labor: approximately 75 percent of hired crop workers are foreign-born, largely from rural Mexico, and roughly 40 percent of all hired crop workers lack legal work authorization.[2]

[1]Throughout the paper, I use the terms specialty crops, fruits and vegetables, and labor-intensive crops interchangeably to refer to the same group of commodities.

[2]The 2022 National Agricultural Workers Survey (NAWS), administered by the U.S. Department of Labor, reports that about 70 percent of U.S. hired crop workers are foreign-born and 68 percent of them (and, thus, 48 percent of all hired crop workers) lack legal work authorization. However, the NAWS sample excludes H-2A workers, who account for roughly 15 percent of all hired crop workers (Castillo et al., 2024). A back-of-the-envelope calculation yields the adjusted figures reported above. Between 1997 and 2012, the

These enforcement-driven labor market disruptions coincide with major changes in U.S. agricultural trade patterns. Over the past three decades, imports of fruits and vegetables have risen sharply while exports have remained relatively stable, generating a persistent trade deficit (Figure 1). Imported produce now supplies roughly 60 percent of fresh fruit and 40 percent of fresh vegetable consumption in the United States (Figure 2). At the same time, the production of specialty crops remains regionally concentrated, primarily in the Sunbelt and the Pacific Northwest, while consumption is nationwide. This geographic mismatch makes interstate trade networks essential for linking producing and consuming regions. Domestic shipments of agricultural commodities across states far exceed exports abroad, reflecting the deep integration of agricultural markets within the United States (Finner, 1959; Hillberry and Hummels, 2008; Anderson and Yotov, 2010, 2016). As a result, labor market shocks in major producing states can ripple through domestic supply chains, altering trade flows, sourcing patterns, and regional interdependence.[3]

This paper examines how interior immigration enforcement, as a negative shock to farm labor supply, affects domestic and international trade in fruits, vegetables, and other specialty crops. To investigate this question, I exploit spatial and temporal variation in the intensity of enforcement programs across 48 contiguous U.S. states. I construct a state-by-year enforcement index aggregating five major interior immigration enforcement policies. I link this index to USDA Census of Agriculture data to study farm labor expenditures and production outcomes. I then combine it with bilateral trade flows from the Freight Analysis Framework (FAF-5), which reports origin-destination shipments of agricultural commodities across U.S. states and between states and foreign markets. The analysis covers the period from 1997 to 2012, ending before major nationwide restructuring of enforcement policy.

The results show that higher enforcement intensity is associated with lower farm labor

study period, the shares of foreign-born and undocumented non-H-2A farm workers were even higher, around 75 percent and 50 percent, respectively. This period preceded the sharp increase in the number of H-2A workers that began in 2011.

[3]For instance, during the 2012 Midwest drought, Nebraska's interstate exports collapsed while its imports surged (Dall'Erba et al., 2021).

expenditures at the state level and a decline in labor's share of operating costs, and is accompanied by a reduction in the number and share of immigrant workers employed in agriculture. Total sales of fruits, nuts, and vegetables decline, consistent with both reduced total production and increased harvest losses that lower marketed volumes. Using a Poisson Pseudo Maximum Likelihood gravity framework, I find that domestically, stricter immigration enforcement reduces exports of fruits and vegetables to other states while increasing imports from states with below-median enforcement intensity. Internationally, stricter enforcement leads to a significant decline in state-level international exports of specialty crops. Despite the secular growth in fruit and vegetable imports in recent decades, I find no statistically significant relationship between enforcement intensity and international imports, either in aggregate or with respect to Mexico, the United States' largest fruit and vegetable import partner.

A substantial literature examines the effects of immigration enforcement on U.S. agriculture, focusing primarily on labor market outcomes such as employment, wages, and labor supply, as well as farm-level responses including mechanization, crop mix, and profitability (Kostandini et al., 2014; Charlton and Kostandini, 2021; Ifft and Jodlowski, 2022; Luo and Kostandini, 2022). These studies document sizable, first-order effects of enforcement-induced contractions in farm labor supply and corresponding on-farm adjustments, but largely abstract from how these shocks propagate through trade. Separately, research on agricultural trade and domestic supply chains emphasizes the importance of interstate trade in reallocating production across regions and buffering local shocks (Finner, 1959; Hillberry and Hummels, 2008; Anderson and Yotov, 2010, 2016). More recent work highlights how climate shocks and drought affect interstate trade and supply chain resilience (Dall'Erba et al., 2021; Nava et al., 2023). Earlier studies examine the effects of immigration policy on agricultural trade (Devadoss and Luckstead, 2011; Zahniser et al., 2012), but focus on aggregate or international trade responses and abstract from state-level heterogeneity and domestic interstate trade adjustments within the United States. As a result, little is known about how enforcement-induced labor shortages are transmitted through domestic supply chains and interact with international trade in labor-intensive agriculture.

This paper contributes to several strands of economic literature. First, it contributes to the agricultural labor literature by linking immigration enforcement to trade outcomes in labor-intensive agriculture, showing how farm labor shortages reshape interstate supply chains, alter sourcing patterns across states, and affect international export and import flows. Second, it contributes to the wider literature on immigration shocks and trade by documenting how restrictive immigration policies and adverse labor supply shocks erode comparative advantage and reduce exports, complementing work that has largely focused on positive immigration shocks and export expansion (Pennerstorfer, 2016; Cohen et al., 2017; Mitaritonna et al., 2017; Lombardo and Peñaloza-Pacheco, 2021; Akgündüz et al., 2023, 2024; Orefice et al., 2025). Third, it contributes to broader work on how labor market policies shape comparative advantage and trade specialization (Askenazy, 2003; Helpman and Itskhoki, 2010; Cunat and Melitz, 2012; Gan et al., 2016; Roy, 2021; Muñoz, 2023), as well as to research emphasizing the role of institutions and endowments in shaping trade patterns (Costinot, 2009; Svaleryd and Vlachos, 2005; Nunn, 2007; Levchenko, 2007; Nunn and Trefler, 2014; Santeramo and Lamonaca, 2019; Tong et al., 2019; Santacreu, 2015). Finally, the paper offers new insights into the resilience of domestic food systems by highlighting a source of vulnerability arising from policy-driven labor market shocks rather than natural or climatic disruptions.

The remainder of the paper is organized as follows. Section 2 provides institutional context on U.S. interior immigration enforcement programs. Section 3 describes the data. Section 4 explains the empirical framework. Section 5 presents the findings, and Section 6 reports robustness checks. Section 7 concludes.

2 Institutional Context

Modern interior immigration enforcement evolved following the passage of the Illegal Immigration Reform and Immigrant Responsibility Act (IIRIRA) of 1996, which laid the foundation for local-federal cooperation and employment verification. Enforcement expanded rapidly after the 9/11 attacks, as immigration control became increasingly framed as a national security issue. Subsequent years saw programs designed to identify, detain, and remove unauthorized immigrants through both police-based and employment-based mechanisms. These programs were implemented at varying times and intensities across jurisdictions, creating rich spatial and temporal variation that I exploit empirically. To capture this variation, I construct an enforcement intensity index that quantifies the adoption of major interior enforcement policies across county and state jurisdictions beginning in the early 2000s. I discuss the main enforcement policies below, and provide a concise summary in Table A1.

287(g) agreements (police-based, local or state level). Beginning in the early 2000s, the Department of Homeland Security (DHS) authorized state and local law enforcement officers, under Section 287(g) of the Immigration and Nationality Act, to perform immigration enforcement functions under federal supervision. These agreements operate in two forms: task-force models, which allow local officers to identify and detain suspected unauthorized immigrants encountered during regular policing, and jail-enforcement models, which screen individuals booked into local jails for their immigration status. Agreements are signed either with state-level agencies, such as departments of corrections or public safety, or with local law enforcement bodies, including county sheriff's offices and municipal police departments.

One of the earliest police-based immigration enforcement programs, 287(g) implementation began in 2002, and its expansion accelerated after 2007, producing substantial within-state heterogeneity in participation. By enabling local law enforcement to act as extensions of Immigration and Customs Enforcement (ICE), 287(g) effectively decentralized immigration enforcement to the county level. From 2006 through the first two months of fiscal year

2009, about 900 local officers were trained under 287(g) agreements, resulting in over 80,000 arrests (Vaughan and Edwards, 2009). Figures A4 and A5 show the spatiotemporal variation in 287(g) implementation across counties and states.

Secure Communities (SC) (police-based, local-national data linkage). Launched in 2008 and expanded nationwide by 2013, SC established an automated fingerprint-sharing system that linked local arrest records to federal immigration databases maintained by the FBI and DHS. When an arrestee's fingerprints match immigration records, ICE is notified, potentially leading to detainer requests or removal proceedings. Unlike 287(g), which requires local agreements, SC is implemented unilaterally by DHS, making participation effectively mandatory. Although the program was designed to prioritize the removal of serious criminal offenders, data show that many individuals deported under SC had committed minor offenses or had no criminal convictions (East et al., 2023). SC resulted in about 454,000 deportations (and a comparable number of arrests/detainers) between 2008 and 2014 (East et al., 2023). After being discontinued in 2014 and replaced by the narrower Priority Enforcement Program, SC was reinstated in 2017. Figure A6 shows the rollout timeline across states.

E-Verify mandates (employment-based, state level). E-Verify is an online system administered jointly by DHS and the Social Security Administration that allows employers to confirm the legal work authorization of new hires by cross-checking information from Form I-9 against federal records. Originating as a pilot under the 1986 IIRCA and expanded nationally in 2003, E-Verify became a key tool for employment-based immigration control. States began mandating its use during the mid-2000s, first for public agencies and later for private employers. These mandates were intended to deter the hiring of unauthorized workers and to shift enforcement from the workplace to the point of hire. However, compliance and accuracy issues limited its reach, and employers often used the system selectively. Figure A7 shows the timing of state-level E-Verify adoption.

Omnibus immigration laws (primarily police-based, state level). Beginning around 2010, several states enacted broad, multi-provision immigration laws modeled after Arizona's SB 1070. These omnibus laws combine multiple enforcement measures into single legislative packages, typically including "show me your papers" provisions requiring police to verify immigration status during lawful stops, E-Verify mandates for employers, and restrictions on access to driver's licenses, education, and public benefits for unauthorized immigrants. While their scope extends to both policing and service provision, the enforcement emphasis is overwhelmingly police-based, reflecting an effort to create comprehensive state-level enforcement regimes. Figure A8 illustrates the variation in their implementation across states.

Collectively, these programs reflect a shift from a largely federal, border-centered system to a decentralized, interior enforcement regime. By the early 2010s, much of the enforcement activity had moved inside U.S. borders, involving local law enforcement, state legislatures, and employers. Existing evidence indicates that immigration enforcement policies are primarily shaped by political and institutional forces rather than by local economic conditions (Bohn and Pugatch, 2015; Ifft and Jodlowski, 2022; East et al., 2023). The timing of enforcement policies reflects legislative calendars and partisan control, rather than contemporaneous economic or export conditions. These programs target undocumented populations broadly across sectors, making it unlikely that their design or intensity responded to the performance of the agricultural sector.

Existing literature shows that intensified interior enforcement reduce the local presence of undocumented immigrants through several channels: direct removals via deportations (East et al., 2023), out-migration to jurisdictions with less stringent enforcement (commonly described as the 'chilling effect' in the immigration enforcement literature) (Bohn et al., 2014; Amuedo-Dorantes et al., 2019), and a decline in new migration to areas adopting stricter enforcement policies (Smith, 2023). Agriculture-specific studies show that enforcement reduces farm labor supply (Ifft and Jodlowski, 2022; Luo and Kostandini, 2022; Luo et al., 2023), affects crop choices and profitability (Kostandini et al., 2014; Cruz et al., 2022), and accelerates mechanization (Charlton and Kostandini, 2021). This paper adds to this literature by estimating the effects of immigration enforcement on domestic and international flows of specialty crops.

I limit the sample period to years up to 2012, as the 287(g) agreements were substantially restructured that year following the nationwide roll-out of the SC program. In 2014, SC was replaced by the Priority Enforcement Program, which focused on individuals convicted of serious crimes or deemed threats to public safety.

3 Data

3.1 Data on Immigration Enforcement

I assemble data on the implementation of immigration enforcement policies for 1997-2012 from several sources: the year of 287(g) program implementation at the county and state levels from Kostandini et al. (2014), Secure Communities implementation at the county level from East et al. (2023), E-Verify from Orrenius and Zavodny (2015), and the Omnibus Immigration Bill implementation at the state level from Allen and McNeely (2017) and Luo and Kostandini (2023).[4]

Similar to the approaches in Amuedo-Dorantes et al. (2018) and East et al. (2023), I create the treatment variable, ENF_{it}^k, which denotes the intensity of immigration enforcement for program k in state i and year t as:

$$ENF_{it}^k = \frac{1}{A_{i,0}} \sum_{c \in i} \frac{1}{12} \sum_{m=1}^{12} \mathbb{1}(E_{mtc}^k) A_{c,0} \tag{1}$$

In the equation, $\mathbb{1}(E_{mc}^k)$ is an indicator function that is equal to 1 if an immigration enforcement policy k, is active in county c in state i during month m of year t.[5] $A_{c,0}$ and A_0 represent total agricultural employment for county c and state i, respectively, for the baseline year, 1997. The data for the number of agricultural workers comes from the Quarterly Census

[4] Whenever possible, I double-check the data using official sources from ICE and DHS.

[5] I consider a month as treated if a county implemented the policy on or before the 15th of the month.

of Employment and Wages (QCEW). I construct the weights using the number of workers employed in industries classified under NAICS code 11, which covers the broad agriculture, forestry, fishing, and hunting sectors. The variable ENF_{it}^{k} is therefore a weighted measure of the share of state i's agricultural employment sector that was affected by policy k in year t, and takes continuous values between 0 and 1. I separately calculate ENF_{it}^{k} for five immigration policies: the Immigration and National Act 287(g) agreements at the state and county levels, the Secure Communities program, the E-Verify, and the Omnibus Bill.

Following the approach of Amuedo-Dorantes et al. (2018), I create a single aggregate index by summing the weighted shares of the policies.[6]

$$ENF_{it} = \sum_{k \in K} ENF_{it}^{k} \tag{2}$$

Figure 3 shows the spatiotemporal variation in the immigration enforcement intensity over time. Figure A9 shows the average enforcement intensity for 48 contiguous U.S. states from 2001-14 using this index. For a better interpretation of coefficients, I use the normalized version of this index. A one-standard-deviation increase in the index is roughly twice the average level of enforcement during the sample period.[7]

3.2 Data on Agricultural Production and Labor Costs

To analyze how immigration enforcement affects the production of fruit and vegetable crops and labor costs, I use data from the U.S. Census of Agriculture (CoA) administered by the

[6]The index assigns equal weights to the five disparate policies, where equal weights assume that all policies contribute equally to the enforcement, which may not be true. The policies differ significantly in their nature, with some focusing on stopping public services to undocumented immigrants, others on stopping and verifying the legality of immigrants, and others disincentivizing employers from hiring undocumented immigrants. Given these differences, determining appropriate weights for their effects on the presence of undocumented immigrants is not feasible. The effects on their presence in a jurisdiction could result from direct deportations, out-migration to other U.S. states, or a decrease in in-migration from Mexico or other U.S. states.

[7]Most existing work examining immigration enforcement (Kostandini et al., 2014; Charlton and Kostandini, 2021; Luo and Kostandini, 2022; Ifft and Jodlowski, 2022) has focused on the effects of a single policy at a time. The aggregate consequences of simultaneous policies can differ markedly from those of individual measures. Interacting policies may generate complementarities or nonlinearities, producing combined effects that are qualitatively different than the sum of their parts.

U.S. Department of Agriculture's National Agricultural Statistics Service (USDA NASS). The CoA is the most comprehensive source of information on U.S. farm operations and outcomes, covering all agricultural producers in the country every five years. It provides detailed state- and county-level information on farm production, land use, input expenditures, labor use, and farm finances.

I use the 1997, 2002, 2007, and 2012 survey rounds. For each state and year, I use variables on labor expenses (total value and a share of total operating costs) and the total value of fruit, nut, and vegetable sales.[8] These outcomes capture the effects of immigration enforcement intensity on the scale of fruit and vegetable production and changes in labor inputs.[9]

3.3 Data on Interstate and International Trade

For the trade analysis, I use the Freight Analysis Framework version 5 (FAF-5) created by the Oak Ridge National Laboratory with the support of the Bureau of Transportation Statistics and the Federal Highway Administration. FAF-5 relies on various sources, such as the agricultural census and the merchandise trade statistics, to produce origin-destination quantity of trade measures (both in monetary value and physical quantity measured in weight) across the U.S. states, metropolitan areas, and foreign continents. Disaggregation by commodity in the FAF-5 uses a two-digit sectoral classification of transported goods (SCTG).

FAF-5 extends the Commodity Flow Survey (CFS), which is limited to sampled establishments, by incorporating customs records, the CoA, and other administrative sources to create a comprehensive origin-destination-commodity-mode database. Each shipment is

[8]Production data are not directly available in the NASS Census of Agriculture. I use total sales as a proxy for production, which effectively represents the total amount produced minus the quantity that remained unsold or unharvested. This measure is more appropriate for my analysis because sales outcomes are directly shaped by labor constraints that determine how much output can be harvested and marketed.

[9]Vegetable sales for 1997 are not available in NASS QuickStats. For consistency, I use fruit, nut, and vegetable sales for all years from the replication files of Lacy et al. (2023), which compile them directly from the Census of Agriculture.

identified by its origin, destination, commodity classification at the 2-digit SCTG level, and mode of transportation, with flows reported in both monetary value and physical tonnage.[10]

FAF-5 is uniquely suited for this analysis because it provides consistent measures of both interstate and international trade flows. Unlike most trade datasets that capture only international shipments between countries or domestic shipments within countries, FAF-5 integrates both in a comparable format. Flows are available for states, 132 domestic FAF regions (metropolitan areas and state remainders), and eight foreign regions. For domestic trade, FAF-5 reports the value and tonnage of shipments between every pair of U.S. states. For international trade, it provides flows between each U.S. state and either major world regions or Canada and Mexico.[11] Similar to the CoA, the FAF-5 data are available from 1997 in five year intervals. I use the 1997, 2002, 2007, and 2012 data.

I use the SCTG product code of 03, which includes fruits, vegetables, horticulture, seeds, and other specialty crops.[12] I also use the SCTG product codes for cereal grain crops, animal feed, and milled grain products, and other prepared food products, for falsification tests, as they are highly capital-intensive and less labor-intensive, and thus, immigration policy should not affect the production and trade of cereal crops.

The FAF-5 dataset has several limitations. First, international flows are reported for broad foreign regions rather than individual countries (except for Mexico and Canada), which limits the ability to distinguish bilateral patterns of trade and may attenuate heterogeneous effects across individual trading partners. Second, although FAF-5 aims to allocate shipments to their ultimate origins and destinations, some flows may still appear concentrated in port states that serve as initial entry or exit points. I address the entry point effects through robustness checks in Section 6.1 by distinguishing logistical port activity from local demand.

[10] In this analysis, I focus on monetary values, which provide a consistent measure of economic activity across commodities and states.

[11] FAF-5 aggregates foreign origins and destinations into eight regions: Canada, Mexico, Rest of the Americas, Europe, Africa, Southwest and Central Asia, Eastern Asia, and Southeast Asia and Oceania.

[12] The SCTG code 03 includes fruit and nuts (edible, fresh, chilled, or dried), vegetables (edible, fresh, chilled, or dried), fruits and juices, nuts, tobacco (not steamed or stripped), live plants or parts of plants, and oil seeds. More information: https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/surveys/commodity-flow-survey/210866/2017-cfs-commodity-code-sctg-manual.pdf

Finally, the dataset aggregates commodity codes, grouping fruits and vegetables with soybeans. Because soybeans are highly mechanized and far less labor-intensive, this aggregation could attenuate the estimated effects if enforcement primarily affects labor-intensive crops. I address this concern through robustness checks reported in Section 6.2.

4 Empirical Methods

4.1 Effects on Farm Labor Expenses and Crop Production

The analysis of the trade effects of immigration enforcement policy is based on the premise that immigration enforcement reduces the availability of farm workers or raises labor costs in the implementing jurisdiction, thereby decreasing the production of labor-intensive commodities such as fruits and vegetables. More broadly, immigration enforcement can be seen as a labor market distortion that alters the relative supply of inputs across states. By constraining labor availability, these policies can shift the production possibility frontier for agriculture and change the pattern of regional production. Therefore, before discussing the trade effects of immigration enforcement intensity, it is essential to establish the relationship between immigration enforcement, farm worker employment, and labor-intensive specialty crop production.

Studies have shown that immigration enforcement negatively impacts farm labor supply (Kostandini et al., 2014; Ifft and Jodlowski, 2022; Luo and Kostandini, 2022). They primarily focus on the effects of a singular policy at a time. I use the aggregated immigration enforcement index created in Section 3.1 to analyze these effects. I estimate impacts using equation (3).

$$y_{it} = \alpha ENF_{it} + X'_{it}\beta + \Omega_i + \Lambda_t + \varepsilon_{it} \tag{3}$$

The term y_{it} is the outcome variable in the state, i, and year, t, which includes total labor expenses (hired and contract) as a percentage of the total operating costs, total agricultural labor expenses (hired and contract), and total sales of fruits, nuts, and vegetables. The terms Ω_i and Λ_t denote the state and year fixed effects, respectively to control for unobserved heterogeneity that may vary across states but are constant over time, and unobserved heterogeneity that may vary over time but are constant across states.

X_{it} is a vector of time-variant state-level covariates, including a control for local labor demand shocks and weather variables, including weighted state-level average temperature and precipitation. The sources and creation of these variables are explained in Section 4.3. Finally, ε_{it} represents the idiosyncratic error term, with standard errors clustered at the state level, the level at which the enforcement index varies in the estimation. All regressions are weighted by the baseline state-level value of fruit and vegetable sales, so estimates reflect the economic importance of larger producing states.

4.2 Effects on Trade

4.2.1 Effects on Exports

To analyze the effects of intensified immigration policy on labor-intensive agricultural commodity trade, I estimate the Poisson Pseudo-Maximum Likelihood (PPML) estimator illustrated in equation (4), which is loosely derived from the structural gravity model by Anderson and Van Wincoop (2003) and closely follows Tong et al. (2019). PPML addresses heteroskedasticity biases of log-linear gravity models and accommodates zero trade flows (Silva and Tenreyro, 2006; Shepherd et al., 2013).

$$EX_{ijt} = \exp\Big[\alpha ENF_{it} + \Gamma_{jt} + \Psi_{ij} + X'_{it}\beta\Big] \times \varepsilon_{ijt} \tag{4}$$

where i, j, and t index exporter, importer, and year, respectively. EX_{ijtj} denotes the total value of shipments in a given SCTG commodity category exported from U.S. state i to state, country, or region j in year t.[13] The primary explanatory variable is ENF_{it}, which measures immigration enforcement intensity in exporter state i in year t. I describe the creation of this variable in Section 3.1. The term Γ_{jt} denotes importer-year fixed effects, which absorb all time-varying importer-specific factors that shape trade costs and demand, including economic size and growth (GDP and population), macroeconomic conditions (exchange rates, inflation, and demand shocks) (Bacchetta and Van Wincoop, 2000), and trade policy measures such as tariffs, quotas, subsidies, and preferential agreements (Anderson and Van Wincoop, 2003; Yotov et al., 2016; Auboin and Ruta, 2013). These effects also capture importer-side infrastructure, regulatory environments, and non-tariff barriers that influence the degree of multilateral resistance to trade (Yotov et al., 2016).

The importer-year fixed effects treat the trade policies and demand conditions of a given importer, j, as constant across all of its U.S. export partners in year t. This means that any time-varying importer-specific factors such as tariffs, non-tariff barriers, or macroeconomic shocks are absorbed by Γ_{jt}. Because all exporters in this study are U.S. states, and importers typically apply uniform trade policies toward all U.S. origins,[14] this assumption is unlikely to bias the estimates. One potential limitation is that importer–year fixed effects average across all goods imported from the United States. Because U.S. states specialize in different agricultural commodities, differential trade policies across product categories could, in principle, remain unobserved. In practice, however, this concern is mitigated by the structure of agricultural trade policy: tariffs and related measures applied to U.S. specialty crops are typically set at relatively broad product classifications rather than at narrowly disaggregated commodity levels. As a result, within-year differential treatment across specialty crop categories is limited, reducing the scope for bias arising from unobserved product-specific policies.

The term Ψ_{ij} denotes the dyadic importer-exporter pair fixed effects, which control for

[13] For the entire analysis, I use the monetary value of exports and imports, expressed in 2023 million U.S. dollars.

[14] For example, if a country adjusts tariffs on U.S. products, the new rates apply uniformly to all U.S. states rather than differentially across them.

time-invariant pair characteristics like whether they share a border and the distance between each other. The term also encompasses state fixed effects (origin fixed effects and destination fixed effects separately). The inclusion of Γ_{jt} and Ψ_{ij} collectively also accounts for state-level factors that are more likely constant over time at the state level but which may have experienced slight changes over the sample years, including the transportation costs (Geraci and Prewo, 1977; Hummels, 2007) and relative factor price differentials (Hilton, 1984).

To predict the total trade volume between two trading partners, empirical analyses follow the gravity model by Anderson and Van Wincoop (2003) that includes importer-year fixed effects and exporter-year fixed effects to control for importer-specific and exporter-specific time-variant shocks respectively. I omit the exporter-year fixed effects since the primary explanatory variable is exporter immigration policy intensity. However, I control for several exporter-specific time-varying variables affecting agricultural production and trade, denoted in the equation as vector X_{it}, including a measure for local labor demand shocks, weather variables, weighted average trade partner enforcement intensity, and soybean production levels. These variables are explained in Section 4.3.

The term ε_{ijt} denotes the error term, with standard errors clustered at the origin-destination level to account for serial correlation arising from persistent, unobserved bilateral trade relationships between exporter-importer pairs over time. The primary coefficient of interest, α, captures the marginal effect of within-exporter-importer-pair variation in immigration enforcement intensity over time. Identification relies on variation in enforcement within the same exporter-importer pair across years, conditional on fixed effects and covariates, rather than on a parallel trends assumption as in difference-in-differences or event-study designs. The key identifying assumption is strict exogeneity of the enforcement index with respect to contemporaneous shocks to trade flows. As discussed in Section 2, this assumption is supported by the institutional features of interior immigration enforcement, which is largely determined by political and administrative processes, such as federal mandates, intergovernmental agreements, and enforcement priorities, rather than by short-run fluctuations in state-level agricultural production or trade. I further assess the validity of this assumption in Section 6.4.

4.2.2 Extensions for Import Analysis

To analyze the effects of immigration enforcement intensity on imports, I estimate equation (5), which is identical to equation (4) except that the outcome variable is IM_{ijt}, which denotes the total imports to j from state i in year t, and I replace origin-level enforcement index and covariates with destination-level enforcement index, ENF_{jt}, and covariates. I also replace destination-by-year fixed effects with origin-by-year fixed effects, Γ_{it}, which control for time-varying exporter-specific trade-promoting and trade-restricting components, and factors determining the exporter's ease of market access.

$$IM_{ijt} = \exp\Big[\alpha ENF_{jt} + \Gamma_{it} + \Psi_{ij} + X'_{jt}\beta\Big] \times \varepsilon_{ijt} \tag{5}$$

This specification estimates the effects of the destination-specific enforcement intensity on trade, controlling for destination-specific variables that may affect their agricultural production and exporter-specific trade-regulating components.

4.3 Covariates

The regressions described above include a set of time-varying covariates under vector X_{it} to absorb alternative channels through which local economic and climatic conditions may affect agricultural production and trade.

4.3.1 Labor Demand Shocks

Local economic conditions can influence agricultural production and trade through shifts in labor demand. In particular, employment shocks associated with national business cycles, such as those occurring around the Great Recession, may affect the availability and cost of labor in labor-intensive agricultural sectors. To account for these demand-side fluctuations, I include a shift-share measure of local labor demand following Bartik (1992) and Goldsmith-Pinkham et al. (2020). The shift-share control captures the component of local labor demand changes that arise from national industry-specific employment trends interacting with each state's baseline industrial composition.

Formally, the shift-share measure is given by:

$$\sum_{m}(s_{im0} \times g_{mt}), \tag{6}$$

where s_{im0} is the share of employment in industry m and state i in the baseline year, 1997, and g_{mt} is the national growth rate of industry m in year t with respect to the baseline year. The growth variable, g_{mt}, is equal to $\frac{Emp_{mt}}{Emp_{m0}}$, where Emp_{mt} and Emp_{m0} denote the total employment in industry m in year t and the total employment in industry m in the baseline year, respectively. I construct this variable using the Quarterly Census of Employment and Wages (QCEW) from the U.S. Bureau of Labor Statistics (BLS). Because this measure is constructed from national growth rates rather than local outcomes, it provides an exogenous source of variation that helps isolate the effects of other factors, such as immigration enforcement or trade policy, on agricultural outcomes.

4.3.2 Weather

Weather conditions are a key determinant of agricultural production and yields and may independently affect trade flows through their impact on output and prices. Accordingly, I control for agricultural-acreage-weighted state-level precipitation and temperature, using the Parameter-Elevation Regressions on Independent Slopes Model (PRISM) data from the PRISM Climate Group at Oregon State University.[15] I use county-level annual precipitation

[15] Regarded as one of the most reliable interpolation procedures for climatic data on a small scale, the model is used by NASA, the Weather Channel, and various professional weather services (Deschênes and Greenstone, 2007). PRISM generates precipitation and temperature at 4×4 kilometer grid cells for the entire U.S. For precipitation, it considers the orographic effect, where mountains influence precipitation patterns, by modeling how air masses interact with terrain. For temperature, it uses observations from weather stations,

and temperature from PRISM and aggregate them to the state level by weighting counties according to their 1997 agricultural acreages from the Census of Agriculture, yielding agricultural-acreage-weighted state-level averages.

4.3.3 Trade Partner Enforcement

When analyzing the effects of immigration enforcement in a given U.S. state i on its exports to state j, a key concern is that enforcement policies in other U.S. states that also import from i may indirectly affect this bilateral trade flow. Specifically, if state i exports to multiple domestic destinations, and some of those partner states $g \neq i$ intensify immigration enforcement, the resulting labor shortages may lower their in-state production and increase their reliance on imports from state i. This shift in demand may inflate observed exports from i to j, even if enforcement in i itself had no direct effect.

For instance, consider California, a major exporter of fruits and vegetables to both domestic and international markets. If neighboring states such as Arizona or Oregon intensify immigration enforcement, a reduction in farm labor supply in those states may reduce local production of labor-intensive crops, leading those states to import more from California. This additional domestic demand could raise California's domestic supply, while leaving less product available for international markets. In this case, the observed decline in California's international exports might partly reflect enforcement in its domestic trading partners rather than enforcement within California itself.

Failing to account for these spillover effects can bias estimates by overstating the role of i's enforcement in driving exports to j. Such spillover effects raise the possibility of violating the Stable Unit Treatment Value Assumption (SUTVA), which requires that the treatment in one unit not affect outcomes in another. To address this concern, I construct a weighted immigration enforcement index for state i's domestic export partners, denoted ENF_{it}^{P}, which captures enforcement levels in other U.S. states that import from i. The

considering factors such as elevation, aspect, and coastal proximity to model temperature distributions (Daly et al., 2008). PRISM data is available in the following link: https://prism.oregonstate.edu/

weights ω_{ig} are based on the share of i's total domestic exports sent to each partner state $g \neq i$ in a baseline year. Mathematically,

$$ENF_{it}^{P} = \sum_{g \neq i} \omega_{ig} \cdot ENF_{gt} \tag{7}$$

where ENF_{gt} is the enforcement intensity in state g at time t.

For the import specification, a similar concern arises if immigration enforcement in other U.S. states that also export to i shifts their production capacity and trade orientation. To address this, I construct an analogous weighted domestic trade partner index for i's import origins, ensuring that enforcement-induced supply shocks in origin states are not conflated with the effects of i's own enforcement.

4.3.4 Soybean Production

Finally, as noted in Section 3.3, FAF-5 groups several crops into broad categories. For this analysis, I use SCTG 03, which covers fruits and vegetables but also includes soybeans, a major capital-intensive crop. To address this issue, I control for state-level soybean production in the regressions. Although this aggregation could bias the estimated coefficients toward zero, as I discuss in Section 5, the results remain largely statistically and economically significant. This concern is less relevant for the international import analysis, since the United States does not import soybeans in large quantities. As a robustness check, I also re-estimate the international export regressions both excluding and restricting the sample to the top soybean-producing states.

5 Results

5.1 Effects on Farm Labor Expenses and Crop Production

Before discussing the trade effects of immigration enforcement, I discuss the results of the regressions analyzing the relationship between enforcement and farm-level outcomes. Table 1 shows the effects of immigration enforcement on farm labor expenses and production from estimating equation (3).

Results in columns (1) and (2) show that a one-standard-deviation increase in immigration enforcement intensity leads to a 3.9 percent decline in the labor share of operating costs and a 4.2 percent decline in total labor expenses. Despite potential upward pressure on wages in tighter labor markets (Kostandini et al., 2014), these declines indicate a contraction in effective labor input rather than simple substitution along the wage margin. Column (3) shows that the same increase in enforcement reduces fruit, nut, and vegetable sales by 3.9 percent, significant at the 5 percent level, consistent with reduced production capacity in labor-intensive agriculture.

Evidence on the composition and size of the agricultural workforce, presented in Appendix Section C, further clarifies the mechanism underlying these effects. Enforcement intensity is associated with a decline in the number of farm workers and a reduction in the share of immigrant labor employed in agriculture, indicating that enforcement operates as a negative labor supply shock rather than merely altering labor costs or farm accounting practices. These results show that stricter immigration enforcement reduces the effective availability of farm labor, leading to lower marketed output of labor-intensive crops.

In perishable horticultural production, where harvesting and marketing are tightly constrained by labor availability, such reductions in effective labor input are likely to propagate downstream through supply chains. As local production contracts, buyers reallocate sourcing toward lower-enforcement states that retain a comparative advantage in labor availability and, when domestic substitution is insufficient, toward foreign suppliers. This mechanism motivates the trade analysis that follows.

5.2 Effects on Domestic Trade Flows

I begin the discussion of the trade effects of immigration enforcement with an analysis of domestic trade flows. Table 2 shows the effects of immigration enforcement on the interstate export of fruits and vegetables. All regressions use the reduced-form gravity model with the PPML estimator illustrated in equation (4) and the FAF-5 dataset from 1997, 2002, 2007, and 2012. The outcome variable is the total trade flows measured in monetary value (in million U.S. dollars, adjusted to 2012 values). Each regression is shown in three versions: starting with only fixed effects and no covariates, then adding state-level covariates, and finally including both state-level covariates and domestic trading partners' enforcement intensity.

For all PPML estimates, I compute and discuss percentage changes using the transformation $(e^{\hat{\beta}} - 1) \times 100$. Panel A shows results for domestic (interstate) exports, while Panel B shows results for domestic (interstate) imports. Both panels use the normalized version of the enforcement index.

Panel A, column (3), results using the preferred specification, show that a one-standard-deviation increase in enforcement intensity is associated with a 13.60 percent decrease in the outflow of fruits and vegetables to other U.S. states in terms of monetary value, which is statistically significant at 1 percent level. Panels B uses equation (5) to analyze the effects of enforcement intensity on fruit, vegetable, and specialty crop imports from other U.S. states. Column (3) shows the results from the preferred specification, which shows that a one-standard-deviation increase in enforcement intensity is associated with a 13.43 percent increase in the value of fruit, vegetable, and specialty crop inflows from other U.S. states in terms of monetary value, which is statistically significant at the 1 percent level. This indicates that immigration enforcement affects not only local production but also the spatial organization of U.S. agricultural trade. States with higher enforcement export less and import more.

5.2.1 Accounting for Trade Partner's Enforcement Intensity

In the domestic import analysis, exporter-state-by-year fixed effects absorb variation in enforcement at the origin. As a result, the baseline model does not identify the direct effects of the origin state enforcement on imports. To explore how enforcement at both ends jointly shapes trade flows, I interact destination-state enforcement with a binary indicator for high-enforcement origins. The indicator equals 1 if the origin state's enforcement intensity exceeds the median and 0 otherwise.[16] This approach isolates whether the relationship between destination-state enforcement and import volumes differs when trading with origins that themselves face higher enforcement intensity.

Table A2 presents the results of this analysis. Column (3), which shows results from the preferred approach, shows that a one standard deviation increase in enforcement intensity leads to a 29.73 percent increase in imports from states with below-median enforcement, while the difference in imports from above-median enforcement states is a 19.91 percent reduction. Both of these coefficients are significant at a 1 percent level. On net, the overall effect remains positive, indicating that total interstate imports still rise as destination-state enforcement tightens.

These results indicate strong interdependence across state enforcement environments in shaping domestic trade. Both origin- and destination-state policies matter: when enforcement tightens in one state, that state increasingly sources products from other states with less restrictive enforcement. In turn, low-enforcement states expand exports, temporarily gaining a comparative advantage and becoming key suppliers that sustain the domestic flow of labor-intensive crops.

[16]Specifically, I take the maximum enforcement intensity observed in each state over the four survey years and calculate the median value across states.

5.3 Effects on International Trade

Unlike domestic interstate flows, which capture the reallocation of fruits and vegetables across U.S. states in response to labor supply shocks, international flows depend on how these shocks interact with broader patterns of comparative advantage, foreign supply capacity, and import infrastructure. In this context, immigration enforcement may influence not only the competitiveness of U.S. producers in foreign markets but also the extent to which domestic shortages are offset by imports from abroad. The international trade margin, therefore, provides a complementary perspective: whereas domestic trade reallocates production within the country, international trade outcomes reveal whether foreign partners step in to fill gaps created by enforcement-induced reductions in local labor supply.

Table 3 presents the results of the analysis of the effects of state-level immigration enforcement on international exports and imports, using equations (4) and (5), respectively. Panel A, column (3) shows that a one-standard-deviation increase in enforcement intensity is associated with a 19.40 percent decrease in the outflow of fruits and vegetables to foreign export partner countries in terms of monetary value. It is weakly statistically significant at 10 percent level. These results are consistent with earlier work documenting the role of immigration enforcement in reducing U.S. agricultural exports (Devadoss and Luckstead, 2011; Zahniser et al., 2012).

Similarly, Panel B, column (3) shows results from the preferred specification for international imports in terms of monetary value. The results show that a one-standard-deviation increase in enforcement intensity is associated with a 0.070 percent decrease in imports of specialty crops. However, the coefficient is not statistically significant at 10 percent level.

The FAF-5 dataset is at the level of U.S.-state-by-foreign-continents, unless it is either Mexico or Canada, in which case, it is U.S.-state-by-country level. Mexico and Canada are the largest importers of the U.S., comprising 58.5 percent and 8.9 percent of fruit and vegetable imports, respectively, in 2022. Therefore, alongside the effects on imports in aggregate, I also look at the effects on imports specifically from Mexico and Canada, which are shown in Table A3.

Panel A uses equation (5) to show the effects of enforcement intensity on fruit and vegetable imports from Mexico. Panel A, column (2) shows that a one-standard-deviation increase in enforcement intensity is associated with a 4.97 percent decrease in fruit and vegetable imports from Mexico, which is statistically significant at the 1 percent level. However, once I control for the weighted-average enforcement of domestic import partner states, column (3) shows that both the magnitude and statistical significance of the coefficient decline substantially. This suggests that part of the observed relationship between immigration enforcement and international imports reflects adjustments in domestic trade patterns, highlighting the importance of accounting for domestic reallocation when evaluating the effects of immigration policy on international trade flows. Panel B reports the effects on imports from Canada. Across specifications, I do not find any statistically or economically significant effects of state-level enforcement intensity on imports from Canada.

6 Robustness Checks

6.1 Entry Point Effects: Evidence from Port States

Although the FAF-5 data aim to allocate imports to their true destinations, in practice some goods may still be recorded in port states that serve as the point of entry and redistribution. In such cases, the port itself may appear as the destination even though the imported products are subsequently supplied to other U.S. states. The relatively small and imprecise effects found earlier for international imports may partly reflect this data limitation: if imports are recorded at ports rather than at their true consuming states, the measured trade response to immigration enforcement could be understated.

To capture this, I interact the weighted enforcement intensity of a state's domestic export partners with an indicator for being a major fruit and vegetable port state. To ensure that the results are not conflated with the fact that some of the largest port states are also the largest producers of fruits and vegetables, I exclude those states and focus on ports where local production is relatively limited.[17]

Table A4 presents the results of this exercise. The direct effect of a state's own enforcement on foreign imports is positive but statistically not significant at 10 percent level (t-stat of 1.36, p-value of 0.17), consistent with a modest shift toward foreign imports following immigration enforcement intensification. The coefficient on partners' enforcement is also positive, though imprecisely estimated, suggesting that tighter enforcement in domestic supplier states may raise overall import demand. Importantly, the interaction between partners' enforcement and the indicator for being a prominent fruit and vegetable port state is positive (0.324) but statistically insignificant. Although the estimate is imprecise, its direction and magnitude are consistent with the main specification, suggesting that the results are robust to potential data allocation issues in FAF-5. This supports the interpretation that the observed patterns are not driven by how imports are recorded in port states.

6.2 Controlling for Soybean Production

I run a set of robustness checks to assess whether the international export results are affected by the inclusion of soybeans, a crop that is capital- rather than labor-intensive but aggregated into the same SCTG category as fruits, vegetables, and other specialty crops. In Table A5, Panels A, I re-estimate the regression, analyzing the effects of state-level enforcement intensity on the international export value of specialty crops, excluding the top soybean-producing states as origins.[18] The coefficient on enforcement remains negative and statistically significant at the 10 percent significance level, consistent with the expectation that enforcement should reduce exports of labor-intensive crops rather than soybeans. In

[17] Port states in the specification include California, New York, New Jersey, Georgia, Texas, Louisiana, South Carolina, Washington, Alabama, and Florida, the largest international entry points for fruits and vegetables. However, California, Florida, Georgia, Texas, and Washington are excluded from the analysis because they are both major states for fruits and vegetable production as well as states with major ports for their import, making it difficult to disentangle real import effects from domestic production or re-export activity.

[18] The top soybean-producing states that I include (or exclude, depending on the regression type) are Illinois, Iowa, Minnesota, Indiana, Nebraska, Ohio, Missouri, and South Dakota.

Table A5, Panels B, I restrict the sample to these soybean-heavy states and find null effects, with coefficients close to zero and statistically insignificant. Together, these patterns indicate that the main findings are not driven by soybean exporters and that the negative relationship between enforcement and exports is concentrated in crops with greater labor intensity.

6.3 Falsification Tests

In the primary analysis of the effects of immigration enforcement, I used the FAF-5 data, precisely the sample of product code 03 which includes labor-intensive commodities like fruits and vegetables. In this section, I run regressions and show results for the trade flows of agricultural commodities that are not highly labor-intensive. For this, I use the sample of cereal grain crops, animal feed, milled grain products, and other prepared food (product codes 02, 04, 06, and 07 respectively) from the FAF-5 data. Although I call it falsification tests, it should be noted that the production of these crops may still require some labor, so they cannot be taken as pure placebo commodities.

Appendix Table A6 and Table A7 report the effects of immigration enforcement on interstate and international trade in less labor-intensive agricultural commodities. Column (3) in both tables presents results from the preferred specification with fixed effects and control variables. Across all regressions, the estimated effects of enforcement intensity are not statistically significant and are also economically small. The implied percentage changes associated with a one-standard-deviation increase in enforcement range from -2.2 to 3.2 percent for international flows and are close to zero for interstate trade, in sharp contrast to the 13-14 percent changes in interstate trade and the roughly 19 percent decline in international exports observed for fruits and vegetables. These findings suggest that the trade effects of immigration enforcement are not a general feature of agricultural trade but are instead concentrated in labor-intensive production.

6.4 Addressing the Potential Endogeneity of Enforcement

A key concern is that the adoption and intensity of state-level immigration enforcement policies may not be random but correlated with contemporaneous or anticipated changes in agricultural or trade conditions. While state fixed effects absorb time-invariant differences in agricultural structure or trade dependence, bias could still arise if states implemented tougher enforcement in response to evolving conditions such as declining agricultural employment, shifts in crop composition, or changing trade patterns that also influence fruit and vegetable trade. However, as discussed in Section 2, there is substantial evidence that immigration enforcement policies are driven primarily by political and institutional factors rather than by short-run economic or trade dynamics, making the exogeneity assumption plausible in this context. To further support this assumption, I conduct a series of tests to address potential endogeneity concerns.

First, I follow a strategy similar to Ferrara et al. (2012) and Amuedo-Dorantes et al. (2018) by examining the relationship between various pre-treatment characteristics and the adoption of immigration policies at the state level. Specifically, I construct a variable that identifies the year each state's enforcement index first became positive and regress this measure on a set of state-level characteristics measured in 2002, prior to the adoption of stricter policies. This exercise helps assess whether states that adopted enforcement earlier were systematically different in observable ways, such as in their demographic composition, labor market structure, or political climate, relative to those that adopted later, which would suggest endogenous timing. In addition, I examine whether pre-treatment state-level characteristics can predict the maximum measure of enforcement intensity in 2012, providing a complementary check on whether the eventual strength of enforcement is systematically related to initial conditions. Finally, as an additional robustness exercise, I re-estimate these regressions using the percentage changes in key characteristics between 1997 and 2002 as regressors, to test whether pre-trends rather than levels predict enforcement adoption and intensity.

The results, reported in Appendix Table A8, indicate that the unemployment rate, the population of likely undocumented immigrants, and agricultural and trade flows in the baseline period, as well as their pre-treatment trends, do not systematically predict the timing or maximum intensity of enforcement adoption. Instead, the clearest patterns come from geography and politics: states located closer to Mexico adopt enforcement earlier and at higher intensity, while Republican vote share shows statistically significant effects in the change regressions. Interestingly, however, after controlling for other variables, the direction of the relationship between Republican share and the outcome variables does not align with the conventional narrative. Increases in Republican support between 1997 and 2002 are associated with later adoption and lower maximum intensity. This counterintuitive result suggests that partisan alignment alone does not explain policy roll-out.

Second, I perform a Granger-type analysis by including future policy variables in the model (Granger, 1969; Amuedo-Dorantes et al., 2022). If current enforcement levels drive changes in agricultural outcomes, then future levels of interior immigration enforcement should not be related to current outcomes (Angrist and Pischke, 2009). I run a set of regressions specified in equation (4), where, along with the contemporaneous enforcement variable, I also include a term that averages state-level enforcement over the three subsequent years. Using an average rather than three separate lead indicators reduces noise and multicollinearity, providing a more parsimonious falsification test while still capturing the possibility of systematic pre-trends in enforcement.

Appendix Table A9 shows no evidence of pre-trends: across both interstate and international trade specifications, the coefficients on the lead enforcement terms are consistently small and statistically insignificant. This indicates that future changes in immigration enforcement are not systematically related to current trade outcomes, reducing concerns that anticipatory behavior drives the main results.

7 Conclusion

This paper shows that U.S. interior immigration enforcement leads to readjustments in domestic and international trade flows for specialty crops. Using variation in enforcement intensity across states between 1997 and 2012, I find that stricter enforcement reduces the sales of labor-intensive crops, lowers interstate exports, and increases interstate imports, while also reducing international exports.

The effects on international imports are weak and statistically insignificant, indicating no clear evidence of short-run substitution toward foreign suppliers following immigration enforcement. This suggests that immigration enforcement primarily constrains local production and domestic trade capacity rather than immediately altering international import patterns. Limited short-run substitutability between domestic and foreign produce, due to quality differentiation, transportation constraints, and consumer preferences for locally or nationally grown products, may explain this muted response. In the longer term, however, sustained import growth from Mexico and other Latin American suppliers likely reflects structural factors such as rising U.S. demand for year-round produce and comparative advantage abroad, rather than short-term labor supply shocks. Assessing these longer-run dynamics lies beyond the scope of this analysis.

Overall, while prior work emphasizes technology, finance, or regulation as drivers of comparative advantage, this study demonstrates that shocks to factor endowments alone can alter trade outcomes. More broadly, the findings show that labor-market institutions can influence competitiveness in tradable sectors. Although centered on U.S. horticulture, similar mechanisms might apply for other labor-intensive industries, such as apparel, meatpacking, or food processing, where competitiveness depends on access to flexible, low-skilled labor.

For policymakers, these results highlight that interior immigration enforcement can have unintended consequences for agricultural trade, food security, and supply-chain resilience, highlighting the close link between labor policy and comparative advantage in labor-intensive agriculture. In settings characterized by persistent farm labor scarcity, policy design may have differential implications across crops depending on labor intensity and perishability. In particular, labor constraints are likely to be more costly for highly perishable specialty crops, where short-run substitution through imports is limited, than for less perishable or more easily tradable commodities. From this perspective, enforcement and labor policies that fail to account for such heterogeneity may disproportionately affect segments of agriculture where domestic production is most difficult to replace. Complementary responses, including better alignment of the H-2A program with peak labor demand, support for mechanization where feasible, and improved coordination across immigration, labor, and trade policy, may help mitigate these tradeoffs while preserving the stability of U.S. food supply chains.

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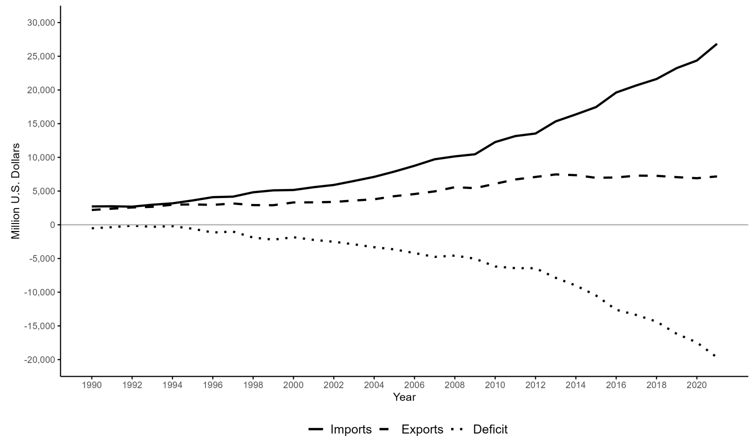
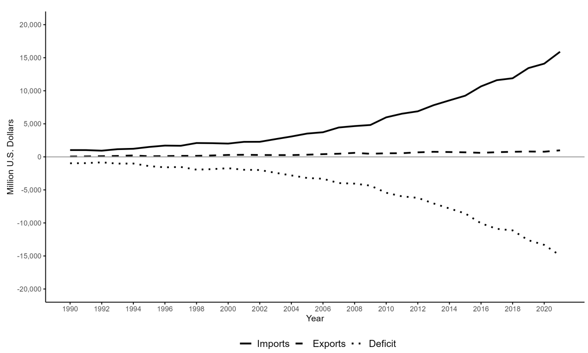
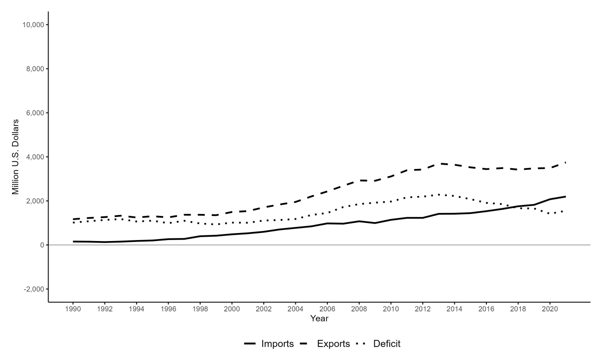
Figures



(a) Total fresh fruit and vegetable trade with foreign partners, 1990-2021



(b) Fresh fruit and vegetable trade with Mexico, 1990-2021

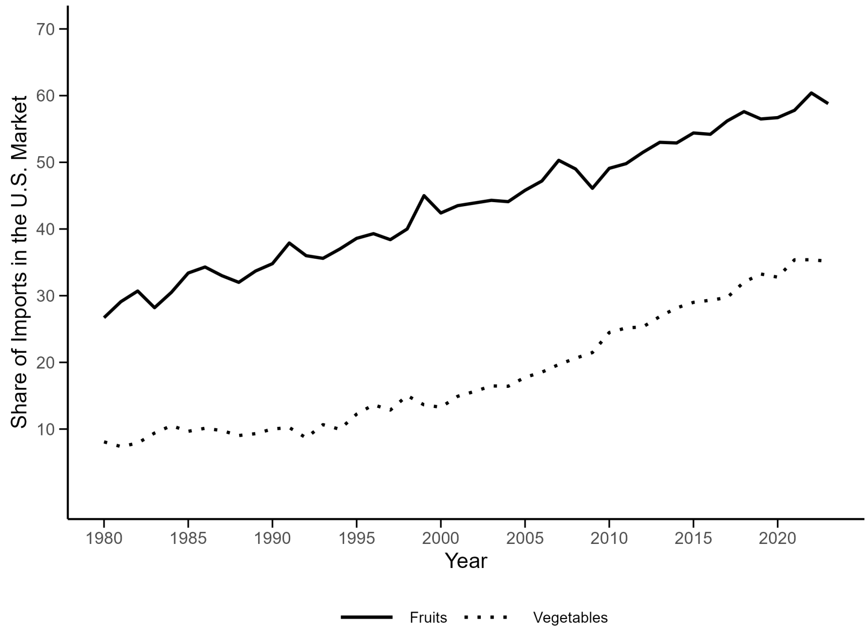


(c) Fresh fruit and vegetable trade with Canada, 1990-2021

Figure 1: Trends in U.S. Fruit and Vegetable Exports and Imports

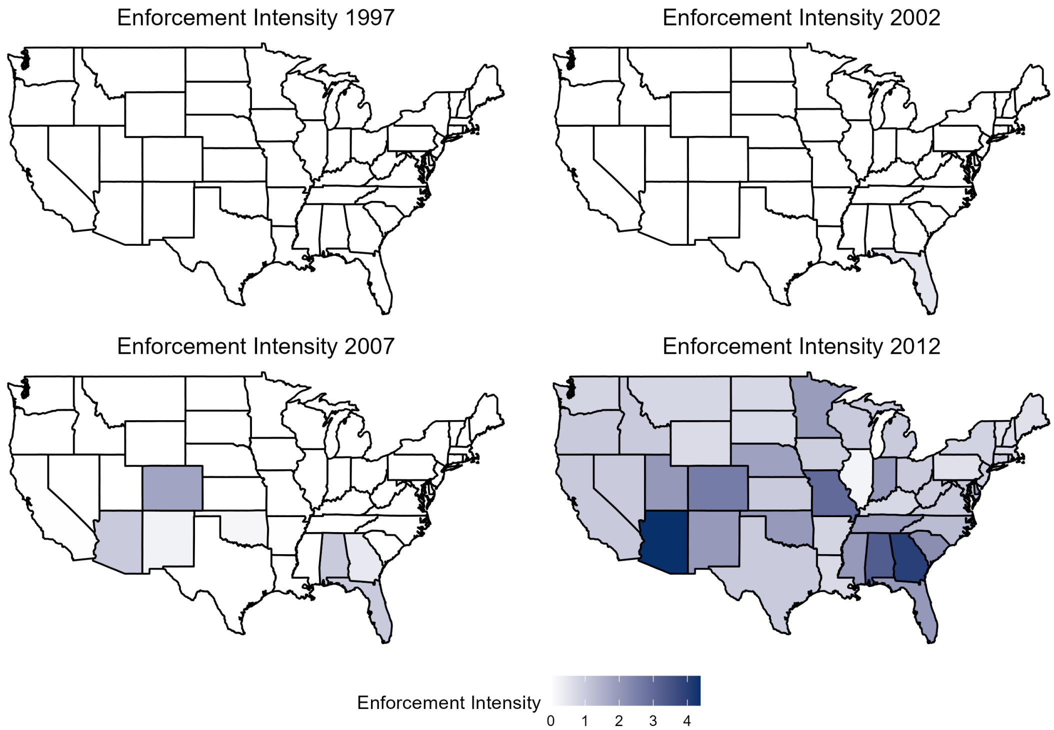
Notes: Created using the data from the USDA. The values are in 2022 US Dollars.

Figure 2: Imports as a share of U.S. fresh fruit and vegetable availability, 1981-23



Note: Created using the data from the USDA.

Figure 3: Spatiotemporal Variations in Enforcement intensity



Note: This figure shows the enforcement intensity across 48 contiguous U.S. states for 1997, 2002, and 2007, and 2012. The enforcement intensity variable is created using equations (1) and (2).

Tables

Table 1: Effects on Labor Expenses and Agricultural Production

	Labor Exp (% of Operating Costs)	Total Labor Expenses	FV Sales
	(1)	(2)	(3)
Enforcement	-0.039**	-0.042**	-0.039**
	(0.016)	(0.016)	(0.016)
Control variables	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	192	192	192

Notes: In column (1), the dependent variable is the log of total labor expenses (hired and contract) as a share of total operating costs. In column (2), the dependent variable is the log of total agricultural labor expenses (hired and contract), measured in 2012 dollars. In column (3), the dependent variable is the log of total fruit, nut, and vegetable sales, measured in 2012 dollars. All values are taken from the Census of Agriculture from USDA National Agricultural Statistical Service (NASS). The primary explanatory variable is the normalized version of the enforcement index created in equation (2). Each regression is weighted by the baseline state-level value of fruit and vegetable sales. For all regressions, standard errors are clustered at the state level. *** 0.01, ** 0.05, * 0.1.

Table 2: Effects on Domestic (Interstate) Trade

	Trade (Monetary Value)		
	(1)	(2)	(3)
Panel A: Domestic Exports			
Enforcement	-0.144***	-0.152***	-0.146***
	(0.048)	(0.048)	(0.047)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Destination-Year Fixed Effects	Yes	Yes	Yes
N	8,392	8,392	8,392
Panel B: Domestic Imports			
Enforcement	0.081*	0.126***	0.126***
	(0.041)	(0.044)	(0.044)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Origin-Year Fixed Effects	Yes	Yes	Yes
N	8,392	8,392	8,392

Notes: The outcome variables are bilateral exports from a U.S. state to other U.S. states, measured as the total value of fruits, vegetables, and other specialty crops in millions of 2023 U.S. dollars from the Freight Analysis Framework (FAF-5). The primary explanatory variable is the normalized version of the enforcement index created in equation (2). All regressions estimate a reduced-form gravity model via PPML. Export regressions in Panel A include destination-year fixed effects; import regressions in Panel B include origin-year fixed effects. All specifications include origin-destination (dyad) fixed effects. Column (2) adds controls for local labor-demand shocks, weighted state-level weather variables, and soybean production. Column (3) additionally includes other states' enforcement intensity weighted by baseline trade flows. Robust standard errors are clustered at the origin-by-destination (dyad) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 3: Effects on International Trade

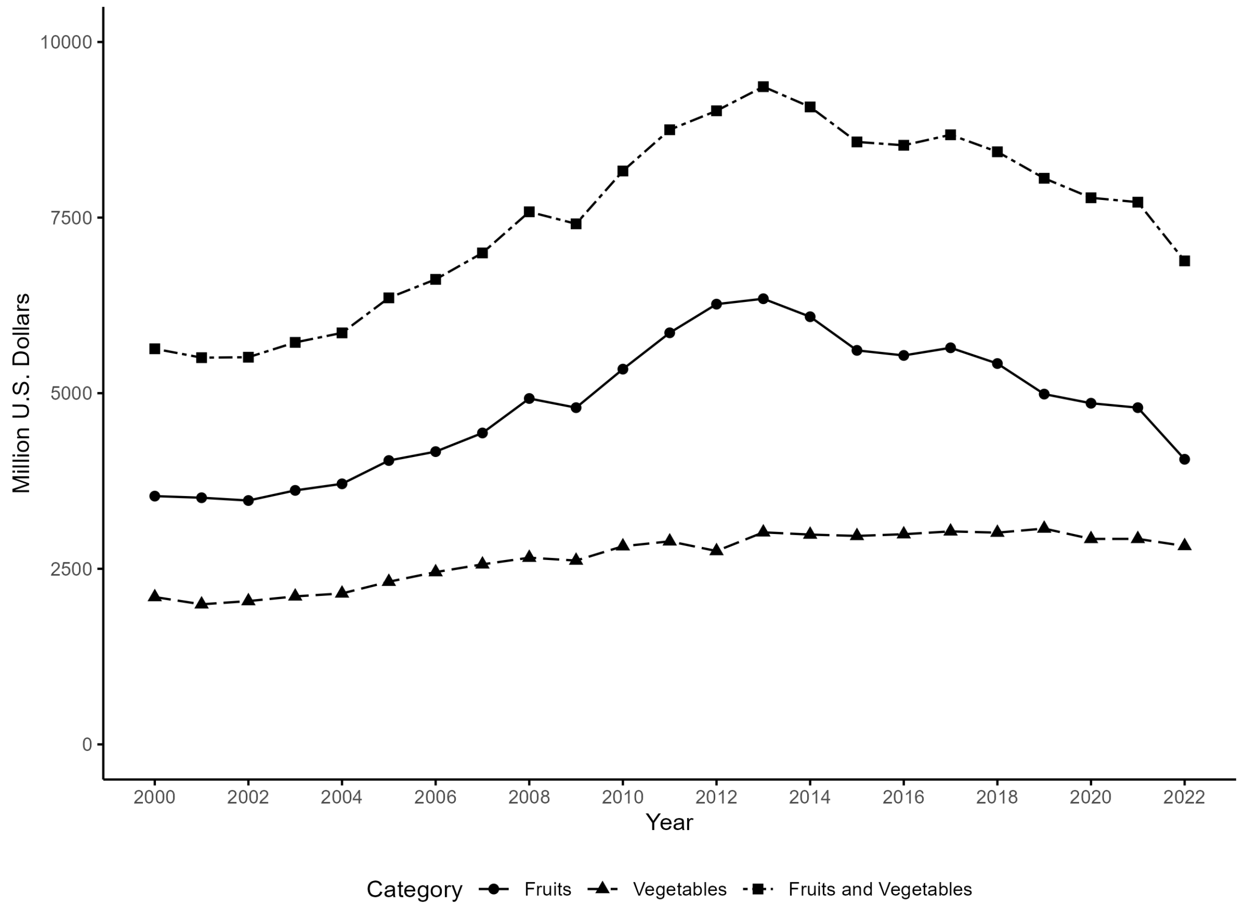
	Trade (Monetary Value)		
	(1)	(2)	(3)
Panel A: Foreign Exports			
Enforcement	-0.263*	-0.210*	-0.216*
	(0.147)	(0.119)	(0.119)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Destination-Year Fixed Effects	Yes	Yes	Yes
N	1,524	1,524	1,524
Panel B: Foreign Imports			
Enforcement	-0.010	-0.029	-0.007
	(0.028)	(0.029)	(0.041)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Origin-Year Fixed Effects	Yes	Yes	Yes
N	1,536	1,536	1,536

Notes: The outcome variables are bilateral exports from a U.S. state to foreign regions, measured as the total value of fruits, vegetables, and other specialty crops in millions of 2023 U.S. dollars from the Freight Analysis Framework (FAF-5). The primary explanatory variable is the normalized version of the enforcement index created in equation (2). All regressions estimate a reduced-form gravity model via PPML. Export regressions in Panel A include destination-year fixed effects; import regressions in Panel B include origin-year fixed effects. All specifications include origin-destination (dyad) fixed effects. Column (2) adds controls for local labor-demand shocks, weighted state-level weather variables, and soybean production. Column (3) additionally includes other states' enforcement intensity weighted by baseline trade flows. Robust standard errors are clustered at the origin-by-destination (dyad) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

APPENDICES

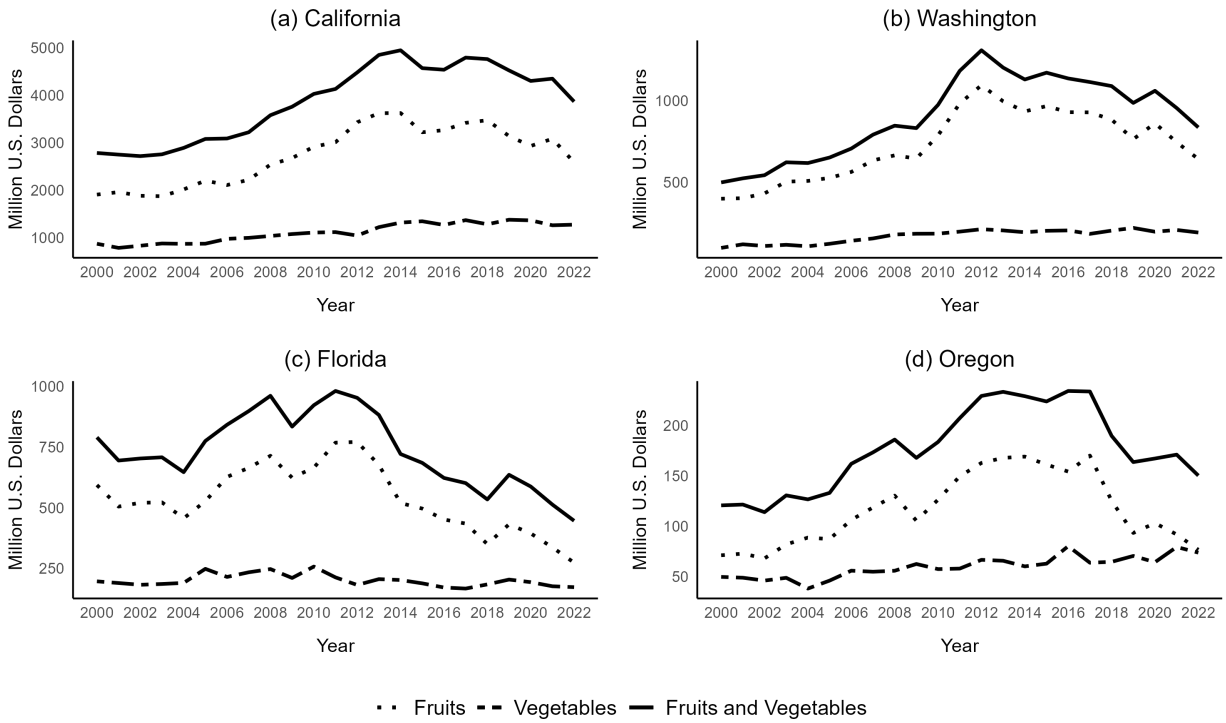
A Other Figures

Figure A1: Fresh fruit and vegetable trade with Canada, 1990-2021



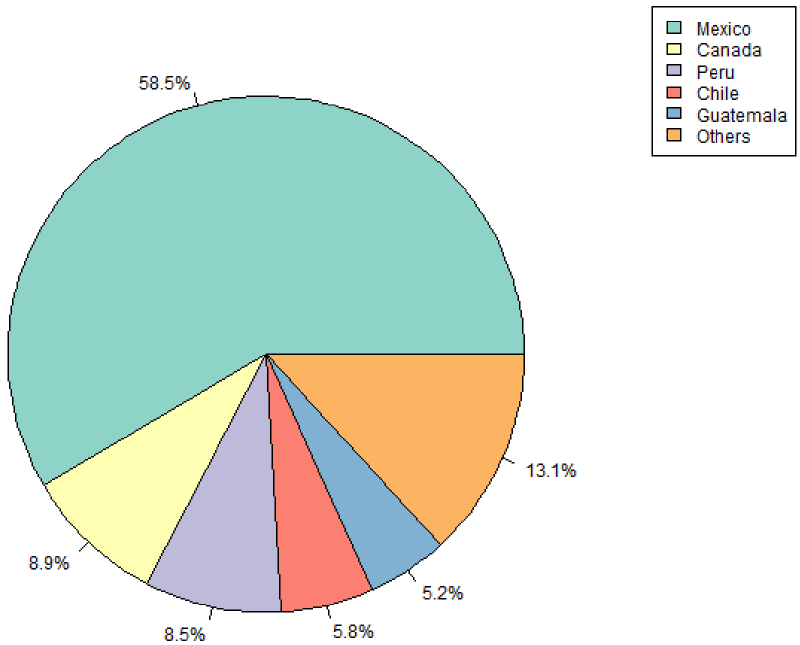
Note: Created using the data from the USDA. The values are in 2022 US Dollars.

Figure A2: Fresh fruit and vegetable exports, Four Largest Exporters, 2000-2022



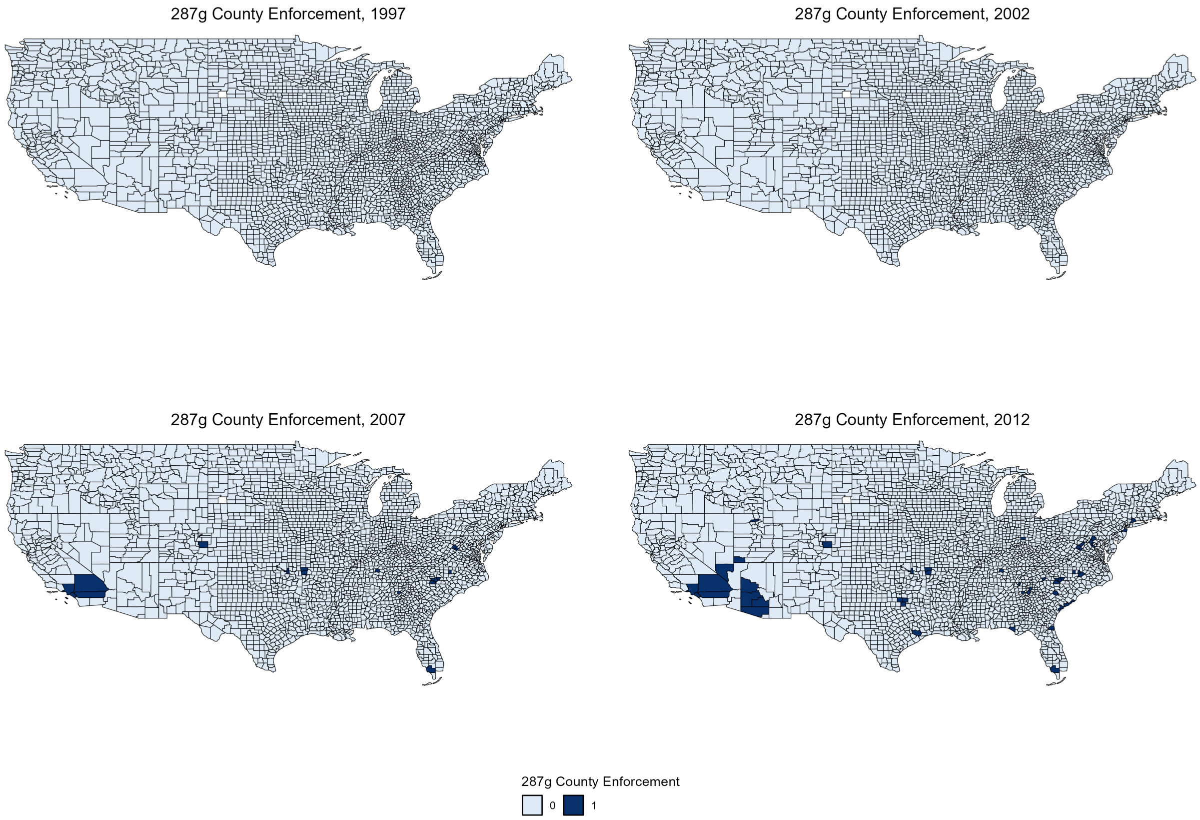
Note: Created using the data from the USDA. The values are in 2022 US Dollars.

Figure A3: Import partners for fresh fruits and vegetables for the United States, 2022



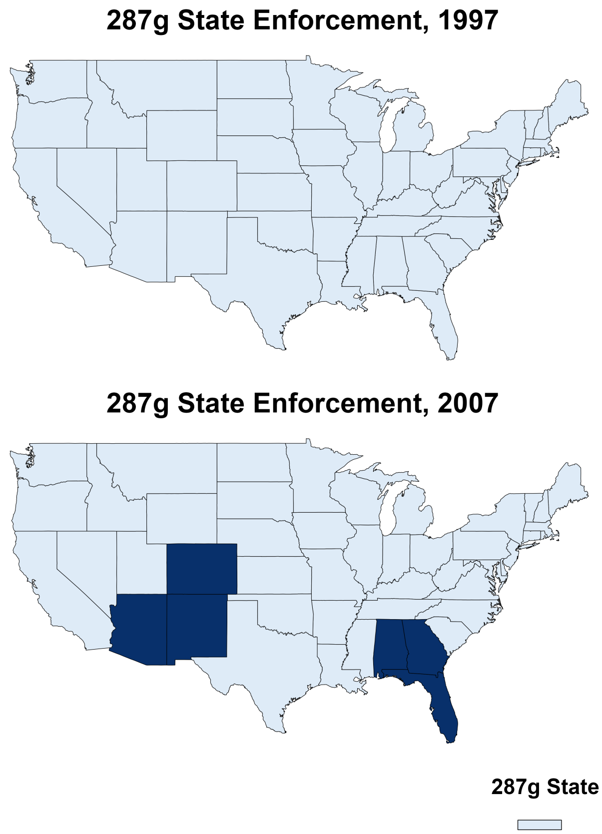
Note: Data comes from the USDA FSA.

Figure A4: Spatiotemporal Variations in 287(g) County Enforcement



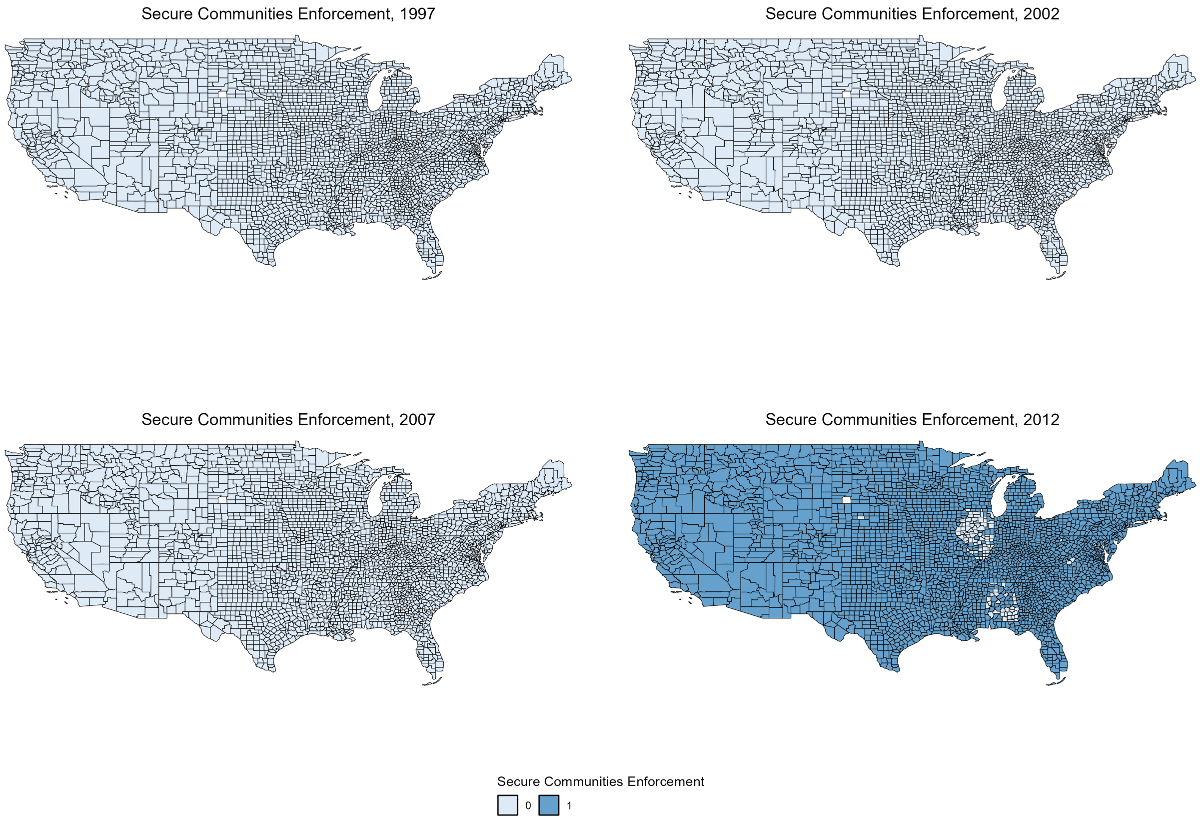
Note: This figure shows counties with active Immigration and National Act 287(g) county-level policy across 50 U.S. states for 1997, 2002, and 2007, and 2012.

Figure A5: Spatiotemporal Variations in 287(g) State Enforcement



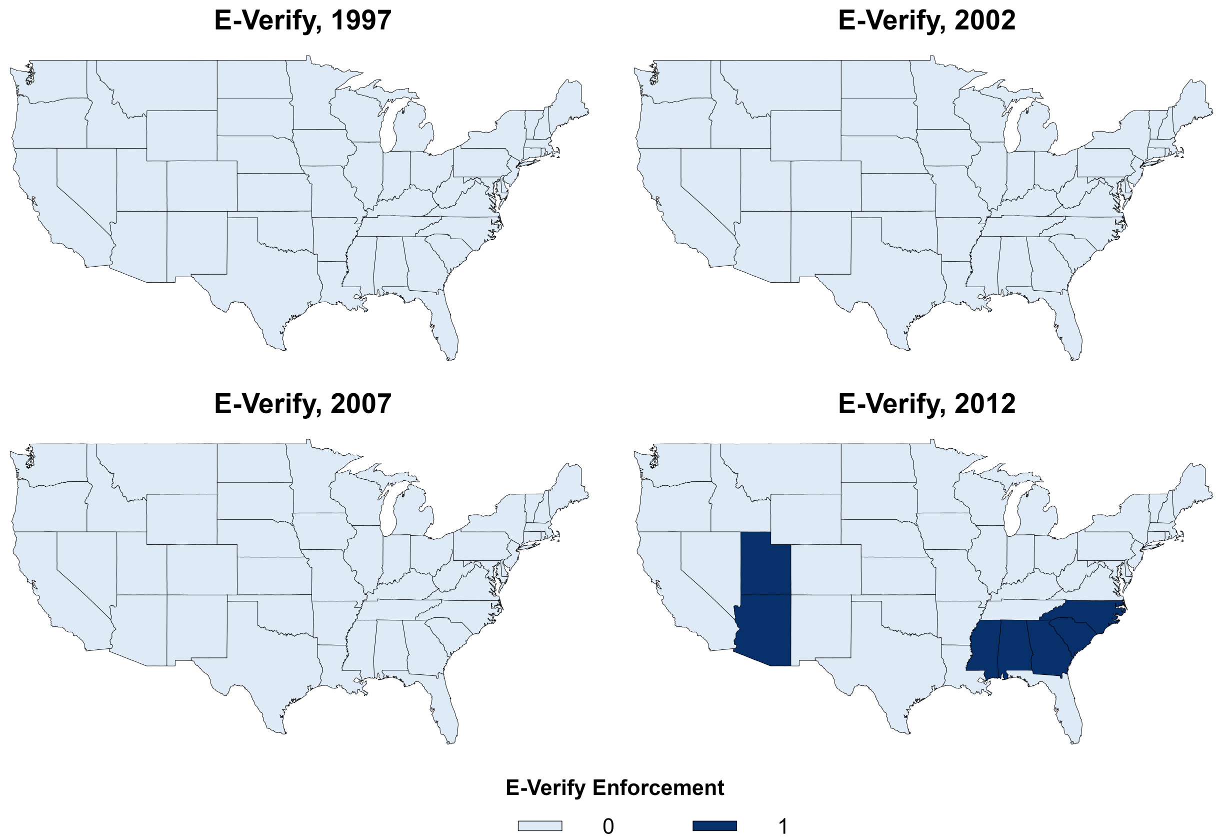
Note: This figure shows counties with active state-level 287(g) policy across 50 U.S. states for 1997, 2002, and 2007, and 2012.

Figure A6: Spatiotemporal Variations in Secure Communities Enforcement



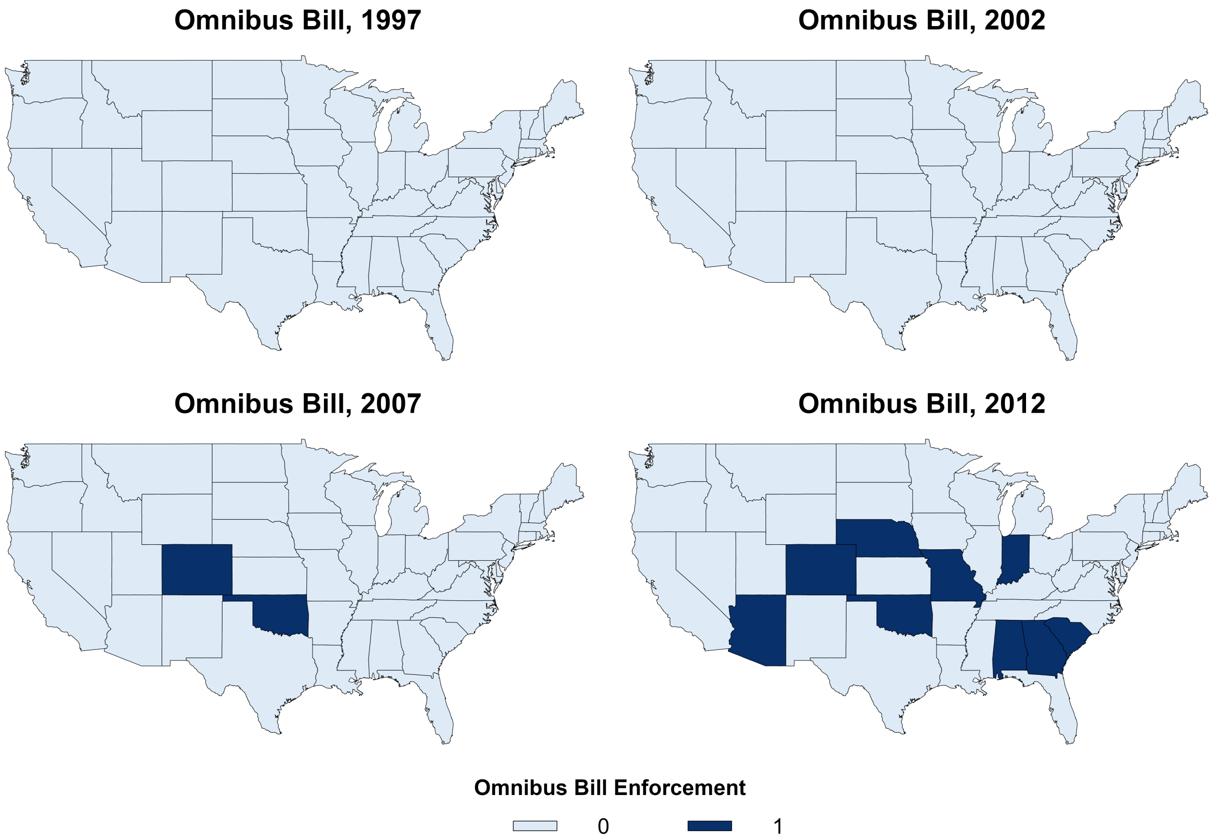
Note: This figure shows counties with active Secure Communities policy across 50 U.S. states for 1997, 2002, and 2007, and 2012.

Figure A7: Spatiotemporal Variations in E-Verify Enforcement



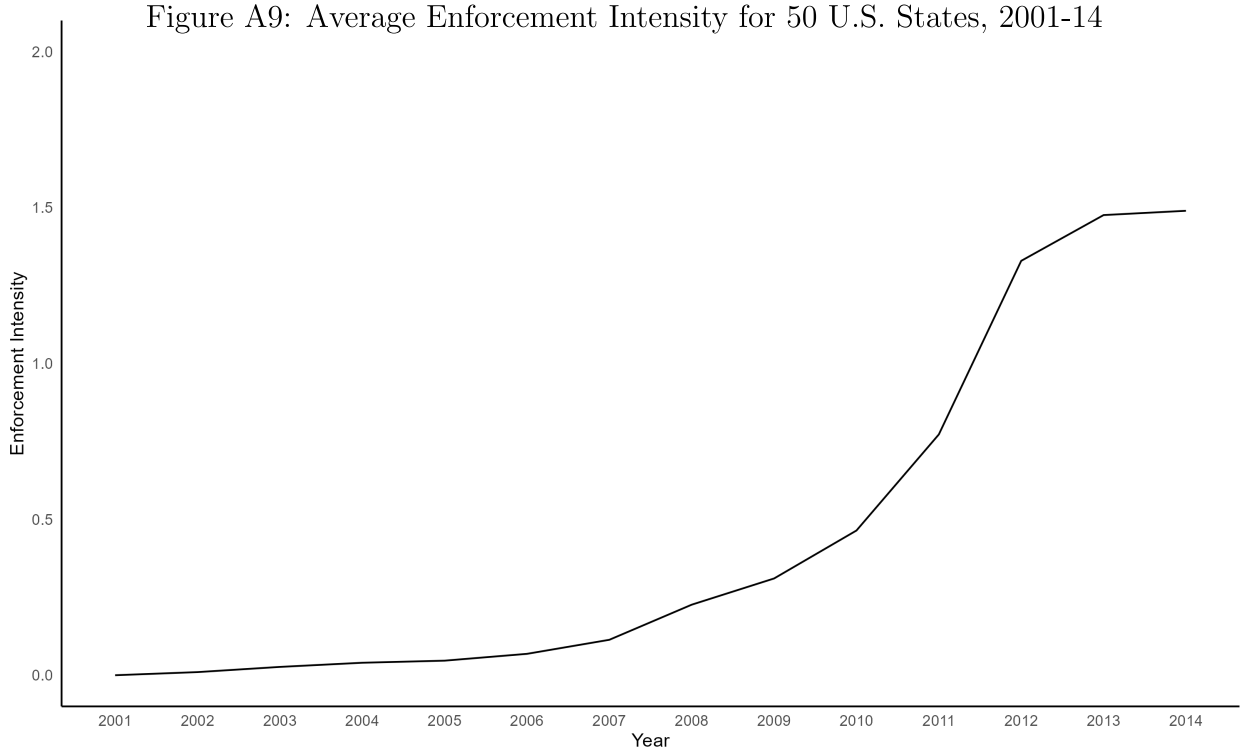
Note: This figure shows counties with active E-Verify policy across 50 U.S. states for 1997, 2002, and 2007, and 2012.

Figure A8: Spatiotemporal Variations in Omnibus Bill Enforcement

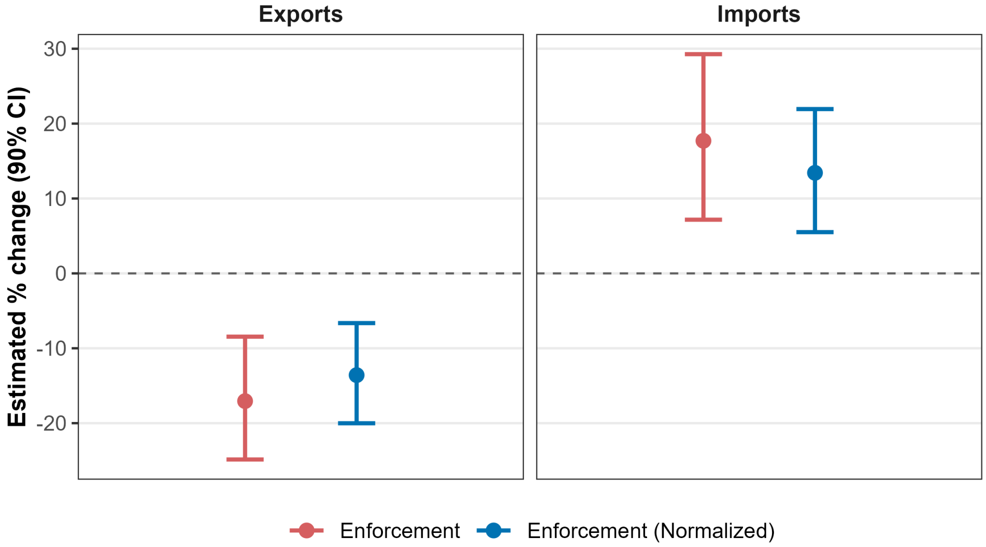


Note: This figure shows counties with active Omnibus Bill across 50 U.S. states for 1997, 2002, and 2007, and 2012.

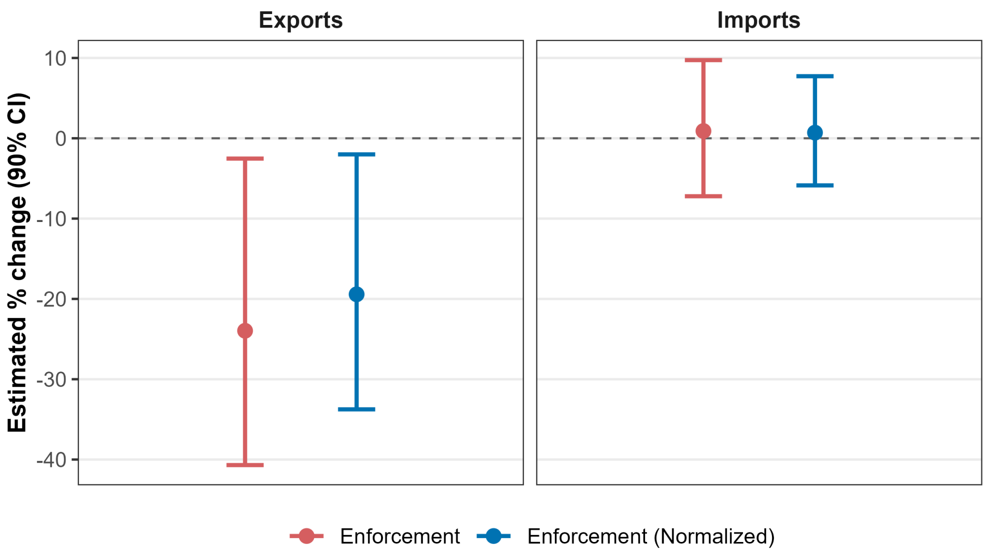
Figure A9: Average Enforcement Intensity for 50 U.S. States, 2001-14



Note: This figure shows the average enforcement intensity across 50 U.S. states from 2001 to 2014. The enforcement intensity variable is created using equations (1) and (2).



(a) Interstate Trade



(b) International Trade

Figure A10: Effects of Immigration Enforcement on Interstate and International Trade Flows

Note: Points show percent effects that are equivalent to the PPML estimates shown in Tables 3 and 2, and computed as $100[\exp(\hat{\beta}) - 1]$. Whiskers show 95% confidence intervals computed as $100[\exp(\hat{\beta} \pm 1.96\,\widehat{se}) - 1]$. "Enforcement" is a one standard deviation change in the index.

B Other Tables

Table A1: Interior Immigration Enforcement Policies: Key Features

	287(g) – State MOA	287(g) – County/City MOA	Secure Communities	E-Verify	Omnibus Laws
Policy type	Police-based (state agency with ICE)	Police-based (local MOA with ICE)	Police-based biometric checks at booking	Employer-based work verification	Mixed (police + admin)
Implementing authority	DHS/ICE + state police or DOC	DHS/ICE + sheriff or city police	DHS/ICE + FBI databases	USCIS (DHS) + SSA; employers	State legislatures
Jurisdiction level	State agency facilities	County/city jails or field ops	Nationwide jails (by county rollout)	Nationwide; state/federal mandates	Statewide (varies by law)
Implementation period	2000s onward; renew/terminate	2002–2010 main wave	2008–2013 rollout; later changes	Pilot 1990s; internet-based mid-2000s	Mid-2000s–2010s
Coverage	Few states; scope varies	Hundreds of local MOAs at peak	Nearly all counties by 2013	All states; federal contractors required; some state mandates	Subset of states; provisions differ
Mechanism	Trained state officers detain/screen	Local officers screen, warrants, detainers	Fingerprints shared with DHS; ICE notified	I-9 data checked vs. SSA/DHS online	Police checks; limits on benefits, licenses
Targets	Arrestees in state custody	Arrestees in local custody	All arrestees booked in jails	All new hires (where required)	Undocumented residents statewide
Mandate status	Voluntary MOA with ICE	Voluntary MOA with ICE	Federal program; local discretion limited	Voluntary unless mandated; federal contractors must comply	Mandatory within adopting states
Measurement in research	Indicator of MOA start; scope by bookings covered	Indicator of MOA start; jail population share	County-by-date adoption; coverage by pop	State mandate timing; contractor mandate	State-by-date omnibus index
Design caveats	Heterogeneous MOA terms; selective adoption	Jail vs. field models differ; political endogeneity	Staggered rollout; admin changes	Non-random employer use; compliance gaps	Multi-provision; hard to isolate effects

Notes: MOA = Memorandum of Agreement under INA 287(g). DOC = Department of Corrections. Text shortened for compact presentation.

Table A2: Effects on Domestic (Interstate) Imports

	Trade (Monetary Value)		
	(1)	(2)	(3)
Enforcement	0.212***	0.260***	0.260***
	(0.082)	(0.080)	(0.080)
Enforcement × High Exporter Enforcement	-0.216**	-0.223***	-0.222***
	(0.091)	(0.085)	(0.085)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Origin-Year Fixed Effects	Yes	Yes	Yes
N	8,392	8,392	8,392

Notes: The outcome variables are bilateral imports from a U.S. state to other U.S. states, measured as the total value of fruits, vegetables, and other specialty crops in millions of 2023 U.S. dollars from the Freight Analysis Framework (FAF-5). The primary explanatory variable is the normalized version of the enforcement index created in equation (2). High Export Enforcement equals 1 if the state's maximum enforcement intensity (in 2012) is above the median value. The regressions include origin-year and origin–destination (dyad) fixed effects. Column (2) adds controls for local labor-demand shocks, weighted state-level weather variables, and soybean production. Column (3) additionally includes other states' enforcement intensity weighted by baseline trade flows. Robust standard errors are clustered at the origin–destination (dyad) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A3: Effects on International Imports from Mexico and Canada

	Trade (Monetary Value)		
	(1)	(2)	(3)
Panel A: Imports from Mexico			
Enforcement	-0.022	-0.051***	-0.012
	(0.023)	(0.019)	(0.059)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Origin-Year Fixed Effects	Yes	Yes	Yes
N	192	192	192
Panel B: Imports from Canada			
Enforcement	-0.003	0.004	-0.001
	(0.072)	(0.070)	(0.074)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Origin-Year Fixed Effects	Yes	Yes	Yes
N	192	192	192

Notes: The outcome variables are bilateral imports into U.S. states from Mexico or Canada, measured as the total value of fruits, vegetables, and other specialty crops in millions of 2023 U.S. dollars from the Freight Analysis Framework (FAF-5). The primary explanatory variable is the normalized version of the enforcement index created in equation (2). The dependent variable for regressions in Panel A is imports from Mexico; the dependent variable for regressions in Panel B is imports from Canada. All regressions estimate a reduced-form gravity model via PPML. All specifications include origin-year and origin–destination (dyad) fixed effects and controls for local labor-demand shocks, weighted state-level weather variables, and soybean production. Column (3) additionally includes other states' enforcement intensity weighted by baseline trade flows. Robust standard errors are clustered at the origin–destination (dyad) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A4: Effects on International Imports

	Monetary Value	
	(1)	(2)
Enforcement	0.087	0.104
	(0.064)	(0.065)
Domestic Export Partners' Enforcement		0.306
		(0.393)
Domestic Export Partners' Enforcement		0.324
$\times$ State with Prominent Port for FVs		(0.218)
Control Variables	Yes	Yes
Partners' Enforcement Control	Yes	Yes
Dyadic Fixed Effects	Yes	Yes
Origin-Year Fixed Effects	Yes	Yes
N	1,344	1,344

Notes: The outcome variables are bilateral imports from a U.S. state to foreign regions, measured as the total value of fruits, vegetables, and other specialty crops in millions of 2023 U.S. dollars from the Freight Analysis Framework (FAF-5). The primary explanatory variable is the normalized version of the enforcement index created in equation (2). Both regressions estimate a reduced-form gravity model via PPML. Both specifications include origin-destination (dyad) fixed effects, origin-year fixed effects, and control variables, including a measure of local labor-demand shocks, weighted state-level weather variables, soybean production, and partner states' enforcement intensity weighted by baseline trade flows. Robust standard errors are clustered at the origin-by-destination (dyad) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A5: Effects on International Exports: Excluding and Only Including Top 10 Soybean Producing States

	Trade (Monetary Value)		
	(1)	(2)	(3)
Panel A: Excluding top soybean producing states			
Enforcement	-0.301*	-0.204*	-0.226*
	(0.160)	(0.118)	(0.132)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Destination-Year Fixed Effects	Yes	Yes	Yes
N	1,236	1,236	1,236
Panel B: Only including top soybean producing states			
Enforcement	-0.282**	-0.044	0.005
	(0.119)	(0.122)	(0.095)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Destination-Year Fixed Effects	Yes	Yes	Yes
N	256	256	256

Notes: The outcome variables are bilateral exports from a U.S. state to foreign destinations, measured as the total value of fruits, vegetables, and other specialty crops in millions of 2023 U.S. dollars from the Freight Analysis Framework (FAF-5). The primary explanatory variable is the normalized version of the enforcement index created in equation (2). All regressions estimate a reduced-form gravity model via PPML. Regressions in Panel A exclude the top 10 soybean-producing states; Regressions in Panel B include only the top 10 soybean-producing states. All specifications include destination-year and origin–destination (dyad) fixed effects. Column (2) adds controls for local labor-demand shocks, weighted state-level weather variables, and soybean production. Column (3) additionally includes other states' enforcement intensity weighted by baseline trade flows. Robust standard errors are clustered at the origin–destination (dyad) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A6: Effects on Domestic (Interstate) Trade: Falsification Test

	Trade (Monetary Value)		
	(1)	(2)	(3)
Panel A: Domestic Exports			
Enforcement	0.019	0.010	0.009
	(0.018)	(0.018)	(0.018)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Destination-Year Fixed Effects	Yes	Yes	Yes
N	31,608	31,608	31,608
Panel B: Domestic Imports			
Enforcement	0.017	0.002	0.002
	(0.015)	(0.017)	(0.017)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Origin-Year Fixed Effects	Yes	Yes	Yes
N	31,608	31,608	31,608

Notes: The outcome variables are bilateral exports from a U.S. state to other U.S. states, measured as the total value of placebo crops in millions of 2023 U.S. dollars from the Freight Analysis Framework (FAF-5). The placebo crops include cereal grain crops, animal feed, milled grain products, and other prepared food. The primary explanatory variable is the normalized version of the enforcement index created in equation (2). All regressions estimate a reduced-form gravity model via PPML. Export regressions in Panel A include destination-year fixed effects; import regressions in Panel B include origin-year fixed effects. All specifications include origin–destination (dyad) fixed effects and product code fixed effects. Column (2) adds controls for local labor-demand shocks, weighted state-level weather variables, and soybean production. Column (3) additionally includes partner states' enforcement intensity weighted by baseline trade flows. Robust standard errors are clustered at the origin-by-destination (dyad) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A7: Effects on Domestic (International) Trade: Falsification Test

	Monetary Value		
	(1)	(2)	(3)
Panel A: Domestic Exports			
Enforcement	-0.075	-0.040	-0.022
	(0.082)	(0.077)	(0.071)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Destination-Year Fixed Effects	Yes	Yes	Yes
N	5,960	5,960	5,960
Panel B: Domestic Imports			
Enforcement	0.039	0.039	0.032
	(0.045)	(0.044)	(0.045)
Control Variables	No	Yes	Yes
Partners' Enforcement Control	No	No	Yes
Dyadic Fixed Effects	Yes	Yes	Yes
Origin-Year Fixed Effects	Yes	Yes	Yes
N	5,952	5,952	5,952

Notes: The outcome variables are bilateral exports from a U.S. state to foreign regions, measured as the total value of placebo crops in *millions of 2023 U.S. dollars* from the Freight Analysis Framework (FAF-5). The placebo crops include cereal grain crops, animal feed, milled grain products, and other prepared food. The primary explanatory variable is the normalized version of the enforcement index created in equation (2). All regressions estimate a reduced-form gravity model via PPML. Export regressions in Panel A include destination-year fixed effects; import regressions in Panel B include origin-year fixed effects. All specifications include origin–destination (dyad) fixed effects and product code fixed effects. Column (2) adds controls for local labor-demand shocks, weighted state-level weather variables, and soybean production. Column (3) additionally includes partner states' enforcement intensity weighted by baseline trade flows. Robust standard errors are clustered at the origin-by-destination (dyad) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A8: Effects on Interstate Export of Fruits and Vegetables

	2002 Values		1997–2002 Change	
	First Adoption	Max Enforcement	First Adoption	Max Enforcement
	(1)	(2)	(3)	(4)
Unemployment rate	45.933	-2.661	22.765	30.434
	(42.697)	(21.735)	(62.812)	(27.813)
Likely-undocumented population	-16.449	14.785	-91.146	-17.297
	(33.777)	(17.560)	(78.511)	(46.653)
Agricultural worker population	-0.000**	0.000	-0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Total agricultural/crop sales	0.000	-0.000	-0.000**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Agricultural wage	0.004	-0.001	0.001	-0.001
	(0.004)	(0.001)	(0.002)	(0.001)
International FV exports	0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
International FV imports	0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)
Interstate FV exports	-0.000	0.000*	-0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Interstate FV imports	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Republican share	0.034	0.005	0.291**	-0.084*
	(0.046)	(0.022)	(0.108)	(0.044)
Distance to Mexico	0.002***	-0.001*	0.003***	-0.001***
	(0.001)	(0.000)	(0.001)	(0.000)
Borders Mexico	1.629	0.381	1.635	0.360
	(2.040)	(1.262)	(1.254)	(0.902)
N	48	48	48	48

Notes: The outcome variable in columns (1) and (3) is the first year in which a state's immigration enforcement intensity becomes positive from zero. The outcome variable in columns (2) and (4) is the peak enforcement intensity, measured by its 2012 level (the sample's peak enforcement year). Descriptions and sources for all explanatory variables appear in Appendix Section D. All specifications are estimated by ordinary least squares (OLS). Heteroskedasticity-robust standard errors are reported. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A9: Effects on Fruit and Vegetable Trade

	Export		Import	
	(1)	(2)	(3)	(4)
Panel A: Interstate Trade Flows				
Enforcement	-0.187***	-0.073	0.163***	0.184*
	(0.060)	(0.115)	(0.057)	(0.104)
Lead Enforcement (3-year average)		-0.141		-0.026
		(0.111)		(0.102)
Control Variables	Yes	Yes	Yes	Yes
Dyadic Fixed Effects	Yes	Yes	Yes	Yes
Destination-Year Fixed Effects	Yes	Yes	No	No
Origin-Year Fixed Effects	No	No	Yes	Yes
N	8,392	8,392	8,392	8,392
Panel B: International Trade Flows				
Enforcement	-0.274*	-0.432*	-0.015	-0.030
	(0.151)	(0.240)	(0.037)	(0.057)
Lead Enforcement (3-year average)		0.199		0.026
		(0.150)		(0.066)
Control Variables	Yes	Yes	Yes	Yes
Dyadic Fixed Effects	Yes	Yes	Yes	Yes
Destination-Year Fixed Effects	Yes	Yes	No	No
Origin-Year Fixed Effects	No	No	Yes	Yes
N	1,492	1,492	1,536	1,536

Notes: The outcome variables are bilateral exports in columns (1) and (2), and bilateral imports in columns (3) and (4), measured as the total value of fruits and vegetables in millions of 2023 U.S. dollars from the Freight Analysis Framework (FAF-5). Panel A reports interstate trade flows; Panel B reports international trade flows. The primary explanatory variable is the normalized version of the enforcement index created in equation (2). Lead enforcement (3-year average) is the mean of a state's enforcement intensity over the three years following year t (i.e., $t+1$ to $t+3$). All regressions estimate a reduced-form gravity model using PPML. All specifications include fixed effects and controls, including local labor-demand shocks, weighted state-level weather variables, soybean production, and partner states' enforcement intensity weighted by baseline trade flows. Standard errors are heteroskedasticity-robust and clustered at the origin–destination (dyad) level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

C Effects on Farm Worker Count and Composition

In this section, I provide corroborative evidence on the mechanism through which interior immigration enforcement affects agricultural production and trade. Specifically, I examine whether stricter enforcement alters the composition of labor employed in agriculture.

Using microdata from the American Community Survey (ACS) over the period 2000-2012, I construct state-year measures of the composition of the farm labor force by nativity and citizenship status. Farm employment is defined using harmonized occupation classifications, focusing on field-based agricultural workers and graders and sorters of agricultural products. These occupations capture core on-farm tasks that are closely tied to specialty crop production and rely heavily on manual labor. The analysis focuses on employed, working-age individuals (ages 18-64) and restricts the sample to wage and salary workers, excluding the self-employed. All measures are constructed using person weights provided by the ACS.[19]

Appendix Table A10 reports estimates from state- and year-fixed-effects regressions examining how immigration enforcement affects the composition of the farm labor force. Columns (1) and (2) use $\log(y+1)$ transformations of the number of foreign-born, non-citizen and Mexican/Central American–born, non-citizen farmworkers. A one-standard-deviation increase in immigration enforcement reduces the number of foreign-born, non-citizen farmworkers by approximately 30 percent and the number of Mexican/Central American–born, non-citizen farmworkers by about 28 percent. Columns (3) and (4) use the corresponding shares of farmworker occupations and yield comparable results: enforcement lowers the share of foreign-born, non-citizen farmworkers by 3.2 percentage points and the share of Mexican/Central American–born, non-citizen farmworkers by 3.0 percentage points. All estimates are statistically significant at the 1 percent level.

[19] According to the ACS, during 2001-2003, approximately 45 percent of field-based agricultural workers were foreign-born, Mexican or Central American-born, and non-citizen, and about 85 percent had a high school education or less. For graders and sorters of agricultural products, the corresponding shares were approximately 48 percent and 94 percent, respectively. These figures are lower than commonly cited estimates of the foreign-born share of the U.S. agricultural workforce, which likely reflects underreporting of undocumented status in household survey data such as the ACS.

Importantly, these results indicate that immigration enforcement reduces labor supply to specialty crop production by lowering the availability of non-citizen immigrant farmworkers. This pattern is consistent with the production and trade results in the main text, which show reduced specialty crop output and increased domestic reallocation following enforcement-induced labor supply shocks.

Table A10: The Effects of Immigration Enforcement on the Number and Composition of Foreign-Born, Non-Citizen Farmworkers

	Count [log(y+1)]		Share	
	Foreign-born Non-citizen	Mexican / Central American–born Non-citizen	Foreign-born Non-citizen	Mexican / Central American–born Non-citizen
Enforcement	-0.305^{***}	-0.278^{**}	-0.032^{***}	-0.030^{***}
	(0.103)	(0.106)	(0.009)	(0.011)
State fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
N	564	564	562	562

Notes: In Columns (1)-(2), the dependent variables are the $\log(y+1)$ transformations of the number of farmworkers who are foreign-born and non-citizen or Mexican/Central American-born and non-citizen, where farmworker occupations are defined using IPUMS harmonized occupation codes. In Columns (3)-(4), the dependent variables are the shares of farmworkers from the respective demographic groups. All regressions include state and year fixed effects. The enforcement index is standardized to have mean zero and unit variance. Standard errors are clustered at the state level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

D Creation of Variables for the Exogeneity Test

In Section 6.4, I test exogeneity of state-level immigration enforcement by examining how pre-treatment characteristics predict the subsequent adoption of state-level immigration policies. Table 6 reports the results. In this section, I document the variables I use. Throughout, I use either (i) the 2002 level or (ii) the percentage change from 1997 to 2002.

Unemployment rate. I construct state-level unemployment rates using the decennial Census and the American Community Survey (ACS). Because the ACS replaces the Census long form after 2000, I linearly interpolate the 1997 value from the 1990 and 2000 Censuses, and I take the 2002 value from the 2002 ACS. I define an unemployment indicator equal to one for civilian unemployed persons, excluding armed forces, and restricting to ages ≥ 16. The weighted unemployment rate is

$$\frac{\sum_i perwt_i \, \mathbf{1}\{\mathrm{ESR}_i = 3,\ \mathrm{age}_i \geq 16\}}{\sum_i perwt_i \, \mathbf{1}\{\mathrm{ESR}_i \in \{1,2,3\},\ \mathrm{age}_i \geq 16\}},$$

where *perwt* is the ACS person weight.

Likely-undocumented population. The ACS does not report legal status. I therefore construct a proxy for likely undocumented immigrants using a residual-style approach [see Borjas and Cassidy (2019)]. Among the foreign-born, I exclude individuals with clear signals of legal status, and treat the remainder as likely undocumented. Specifically, I retain foreign-born individuals who (i) arrived after 1980, (ii) were not born in Cuba, (iii) are not veterans, (iv) report no public-assistance receipt in the past year,[20] and (v) have less than a high-school education. This measure is a proxy and should be interpreted with caution.

Agricultural worker population. I proxy the agricultural workforce using the Quarterly Census of Employment and Wages (QCEW). I aggregate county employment in agriculture-

[20]Specifically, I exclude those reporting Medicaid and Supplemental Security Income receipt.

related industries (NAICS 11) to the state level.

Total agricultural/crop sales. I take state-level agricultural and crop sales from the Census of Agriculture.

Agricultural wage. I compute the average wage in agriculture from QCEW earnings and employment at the state-year level.

Trade variables. I obtain bilateral state-to-state fruit and vegetable trade flows from the Freight Analysis Framework (FAF-5).

Republican vote share. I measure the state-level Republican share using Dave Leip's Atlas of U.S. Presidential Elections.

Distance to Mexico. I measure the great-circle distance from each state's population-weighted centroid to the nearest point on the Mexico land border (state-year invariant).