Prices and Immigration: Firm-level Evidence

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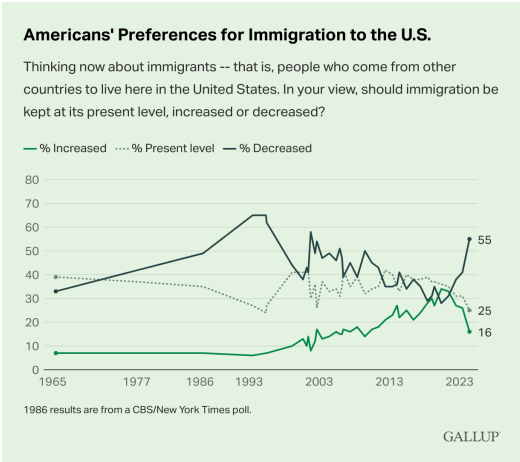
May 20, 2026
ABFER

Motivation

Two top policy topics these days

(1) immigration



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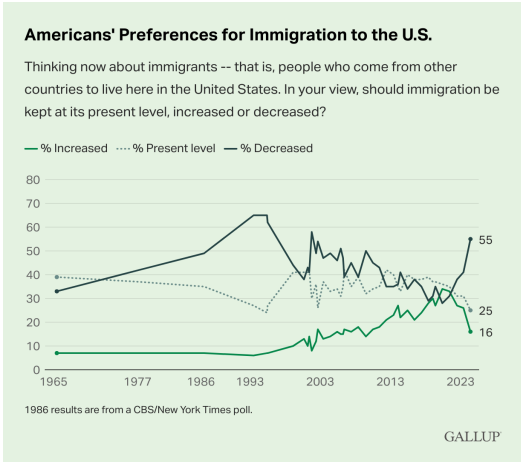
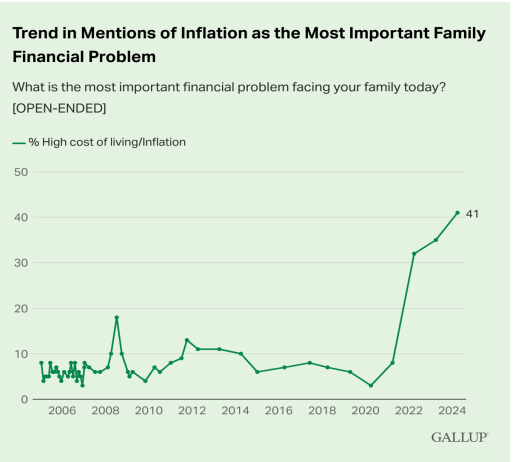


(2) inflation



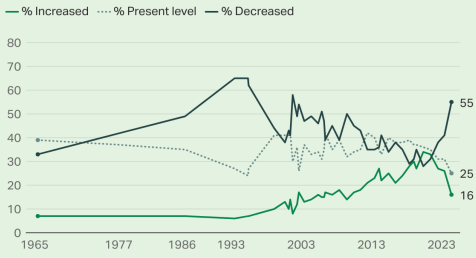
Motivation

Two top policy topics these days

(1) immigration $\overset{?}{\Longleftrightarrow}$ (2) inflation

Americans' Preferences for Immigration to the U.S.

Thinking now about immigrants -- that is, people who come from other countries to live here in the United States. In your view, should immigration be kept at its present level, increased or decreased?

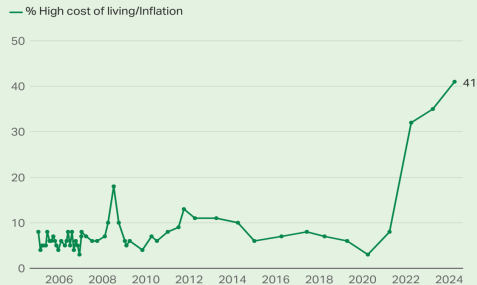


1986 results are from a CBS/New York Times poll.

GALLUP

Trend in Mentions of Inflation as the Most Important Family Financial Problem

What is the most important financial problem facing your family today? [OPEN-ENDED]



GALLUP

A Question

How does immigration inflow affect output prices?

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A politically sensitive question

1. Immigration opponents: **higher product demand,** higher prices

Demand at Denver food banks is higher than ever

Emergency services change amid migrants' influx, inflation

People line up outside the Metro Caring Food Bank in Denver on Thursday, Feb. 15, 2024. The pantry has had to suspend its emergency food bags in the face of increased demand. (Photo by Andy Cross/The Denver Post)

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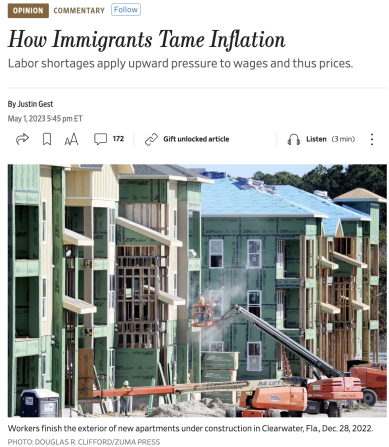
1. Immigration opponents: **higher product demand,** higher prices

2. Immigration proponents: **higher labor supply,** lower wages, lower prices



OPINION COMMENTARY Follow

How Immigrants Tame Inflation

Labor shortages apply upward pressure to wages and thus prices.

By Justin Gest

May 1, 2023 5:45 pm ET

172 Gift unlocked article Listen (3 min)

Workers finish the exterior of new apartments under construction in Clearwater, Fla., Dec. 28, 2022.

PHOTO: DOUGLAS R. CLIFFORD/ZUMA PRESS

A Question

How does immigration inflow affect output prices?

A theoretically ambiguous question with many countervailing forces

Product demand channel:

- P $\Uparrow$: More people, higher aggregate product demand

Labor supply channel:

- P $\Downarrow$: More people, higher aggregate labor supply, lower wages

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- P $\Uparrow$: Different people complementing natives,
  producing more appealing, higher-priced products

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+ many others: skill composition, higher productivity, more intense competition, etc.

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- Establish a causal effect of immigration inflow on output prices
- Investigate the underlying mechanism: demand vs. supply, shift vs. composition
- Formalize the mechanism

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Empirical analyses with detailed scanner price + firm establishment location data

- Establish a causal effect of immigration inflow on output prices
  - by using county-level immigration shock ("ancestry" IV) (Terry et al. 24)
- Investigate the underlying mechanism: demand vs. supply, shift vs. composition
  - by separately observing firms' product sales and production locations
  - by analyzing how purchasers search, pay, and choose products
- Formalize the mechanism
  - by estimating elasticity and quality (appeal) with a nested demand (Hottman et al. 16)
  - by rationalizing the results with the heterogeneous demand elasticity

Preview of the Results

- At the county level, immigration inflows reduce the price index
  - arising from low-income, low-education immigrants
  - among non-durables only, mostly muted for the other sectors (e.g., services)

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  - increase prices via **supply effect** as immigrants make products more appealing
  - The demand effect dominates the supply effect
  - Structural estimation confirms: immigration raises demand elasticity and lowers product appeal — rationalized by more elastic, search-intensive immigrants

Related Literature

- Potential channels connecting immigration and prices

Primary Channel		Price	Description	Source
Labor Supply	Lower Wages	Fall	Increased labor supply reduces wages and production costs.	Borjas 03, Cortes 08
	Productivity		Task specialization increases productivity, lowering unit costs.	Peri Sparber 09
	Entrepreneurship		Immigrant entrepreneurs increase firm entry and competition.	Olney 13, Mahajan 24
	Skill Upgrading	Rise	Natives shift to higher-skilled tasks, raising their wages.	Kerr et al. 15
	Innovation		Increased innovation and capital investment raise costs.	Kerr Lincoln 10, Burchardi et al. 19, Terry et al. 24
Product Demand	Demand Pull	Rise	Larger population increases overall demand.	Saiz 07
	Price Sensitivity	Fall	Search-intensive immigrants increase price competition.	Lach 07

- Utility-based firm price index
  - Hottman et al. 16, Redding and Weinstein 20, Lenzu et al. 22, Eslava et al. 23
- Consumer Heterogeneity
  - Jaravel 19; Stroebel and Vavra 19; Handbury 21; Faber and Fally 22; Mongey and Waugh 25

Outline

Data

- **Barcode-County-level P & Q**: NielsenIQ Retail Scanner (RS) & Homescan Panel (HP)
  - RS: $\approx$ 2.6 million product prices and quantities in 2006-2018
    from $\approx$ 35,000 (balanced) retail stores, $\approx$ 2,500 counties (about 83% of U.S. counties)

    e.g: cherry-flavored 500ml diet coke in New York county in 2010
  - HP: $\approx$ 55,000 households every year with demographic variables
    # of trips, # of days shopping, # of visits to retail stores, store brand shares

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  - producer name, plant location, employment, industry code in 2006-2018
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- **County-level Information**: Census, ACS, QCEW, BLS, BEA, USDA, Corelogic, Zillow
  - Census/ACS: immigration, birthplace, ancestry in 1880, 1900-1930, 1970-2000, 2010, 2014, 2018
  - QCEW: annual wages, total employment, # of establishments
  - BLS: city-level price index by durable, non-durable, services, and rent (also in ACS)
  - BEA & USDA: initial county GDP, urban indicator
  - Corelogic/Zillow: county-level house price index

County-level Regression Specification

$$\Delta \ln P_{c,t} = \delta_{s(c)} + \delta_t + \gamma_1 \mathrm{I}_{c,t} + \varepsilon_{c,t}$$

Price Index

c: county, s: state, t: time; δ: fixed effects; Δ: 4-year first-difference (stacked) or 12-year difference

- $\mathrm{I}_{c,t}$: immigration inflow in county c in time t, likely endogenous
  - e.g., immigrants select into booming areas

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- Follow Terry et al. 24: Card-type shift-share instrument: Detail

$$\mathrm{I}_{c,t} = \sum_o A_{o,c,t-1} \times \mathrm{I}_{o,t}$$

o: a country of origin

  - $A_{o,c,t-1}$: social pull factor, immigrants (ancestry) from origin o to county c in time t-1

  - $\mathrm{I}_{o,t}$: push factor, total immigrants from origin o

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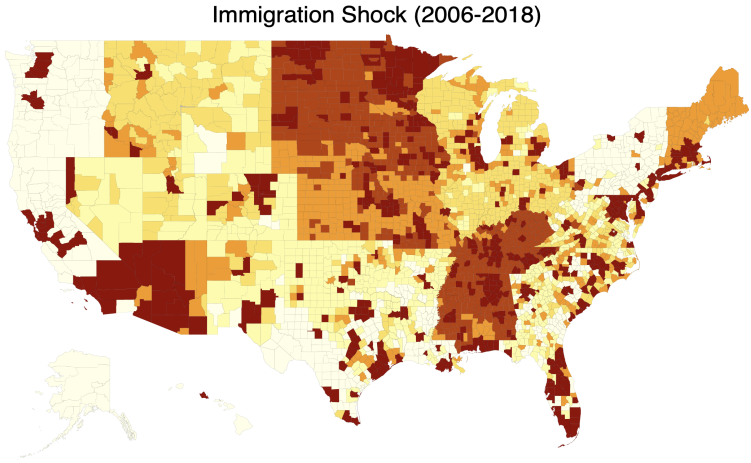
o: a country of origin

  - $A_{o,c,t-1}$: social pull factor, immigrants (ancestry) from origin o to county c in time t-1
    Historical data: predict $A_{o,c,t-1}$ with the historical pull and push factors
  - $\mathrm{I}_{o,t}$: push factor, total immigrants from origin o
    Leave-one-out: excluding the county of interest c

Outline

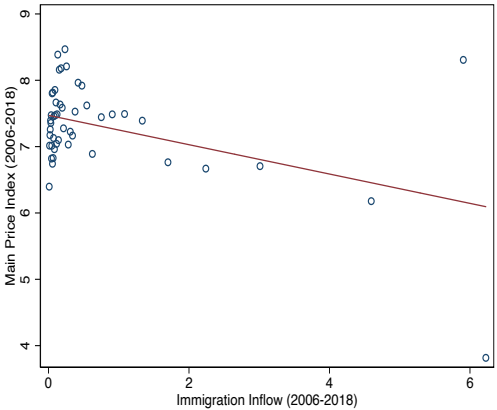
County-level Analyses: Immigration

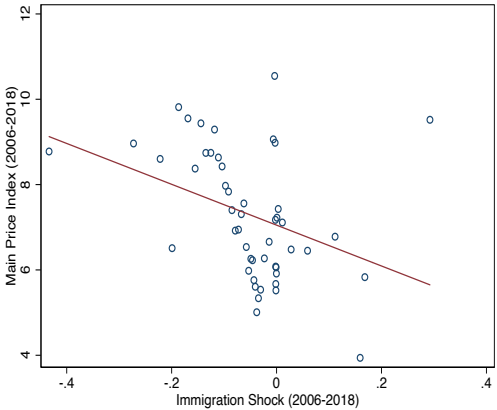


Darker colors signify larger immigration shocks

County-level Analyses: Price Results

Output prices fall in counties with larger immigration inflow





Reduced-form. 12-year difference without weighting and controls. Winsorize top and bottom 5% outliers of the immigration shock

County-level Analyses: Price Results

Output prices fall in counties with more immigration inflow

- 12.5K additional immigrants ($\approx$ 1 SD) reduce the Δ price by 0.73 pp in 4 years ($\approx$ 12% of the mean price change, similar to the absolute wage effect in Terry et al. 24)
- Underestimation with the OLS: immigrants likely move to the booming areas

	Δ $P^{SV,Stacked}$ (2006-2018)					
	(1)	(2)	(3)	(4)	(5)	(6)
$Immigr_{d,t}$	-0.038***	-0.026***	-0.021***	-0.068***	-0.065***	-0.058***
	(0.008)	(0.004)	(0.004)	(0.013)	(0.012)	(0.013)
Obs.	6,339	6,339	6,249	6,339	6,339	6,249
First-Stage F-stat				254.4	94.4	85.5
Fixed Effects	Time	State, Time	State, Time	Time	State, Time	State, Time
Method	OLS	OLS	OLS	IV	IV	IV
Controls			Yes			Yes

Standard errors are clustered by state. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

County-level Analyses: Price Results

Output prices fall in counties with more immigration inflow

	Δ P$^{\text{Sato-Vartia,Stacked}}$ (2006-2018)			
	(1)	(2)	(3)	(4)
$\text{Immigr}_{d,t}$ (over25)	-0.101***	-0.202***		
	(0.024)	(0.073)		
$\text{Immigr}_{d,t} \times \text{EducYears}_{d,t}$		0.088*		
		(0.051)		
$\text{Immigr}_{d,t}$ (No HS Degree)			-0.059**	
			(0.025)	
$\text{Immigr}_{d,t}$ (Some College)			0.019	
			(0.014)	
$\text{Immigr}_{d,t}$ (Low Inc. Occ.)				-0.045
				(0.028)
$\text{Immigr}_{d,t}$ (High Inc. Occ.)				0.055
				(0.053)
Obs.	6,249	6,245	6,249	6,249
First-Stage F-stat	85.5	1.8	59.3	19.3
Fixed Effects	State, Time	State, Time	State, Time	State, Time

IV specification. Standard errors are clustered by state. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

County-level Analyses: Price Results

Output prices fall more in counties with more low-skilled immigration inflow

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County-level Analyses: Price Results

Output prices fall more in products with higher low-income and immigrant intensity

Heterogeneity in Product Basket (by Consumer Income and Predicted Immigration)	Low-Inc Goods	High-Inc Goods	High-Immigrant	Low Immigrant
	(1)	(2)	(3)	(4)
$Immigr_{d,t}$ (over25)	-0.127***	-0.077***	-0.133**	-0.103***
	(0.033)	(0.022)	(0.055)	(0.024)
Obs.	6,249	6,249	4,524	4,524
First-Stage F-stat	85.5	85.5	84.9	84.9
Fixed Effects	State, Time	State, Time	State, Time	State, Time

IV specification. Standard errors are clustered by state. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

County-level Analyses: Other Results

- Increase # of establishments and employment
  - More people ⇒ more entry and employment

	# Establ.	Emp.	Wages			Wages (Retail)
	(1)	(2)	(3)	(4)	(5)	(6)
$Immigr_{d,t}$	0.012**	0.746***	0.391**			0.001
	(0.005)	(0.247)	(0.147)			(0.141)
$Immigr_{d,t}$ (over25)				0.588**	-1.838*	
				(0.227)	(0.959)	
$Immigr_{d,t} \times EducYears_{d,t}$					2.828**	
					(1.156)	
Obs.	6,249	6,249	6,249	6,249	6,245	6,249
First-Stage F-stat	45.9	45.9	45.9	41.2	4.0	45.9
Fixed Effects	State, Time	State, Time	State, Time	State, Time	State, Time	State, Time
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors are clustered by state. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

County-level Analyses: Other Results

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- Wage: Positive, but negative effect with more low-skilled immigrants

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County Level Analyses: External Validity

- The effect on price is negative and is stat. significant for non-durables only
  - non-durables: consistent with our main results using mostly non-durables
  - durables: the search intensity is probably similar across natives & immigrants,
    services & housing: local, larger labor supply effect,
    rent: mixed results, but $< 8\%$ of CPI basket and cannot overturn the negative effect

	$\Delta \ln P^{\text{Dur}}$	$\Delta \ln P^{\text{Non-dur}}$	$\Delta \ln P^{\text{Svc}}$	$\Delta \ln P^{\text{Rent,BLS}}$	$\Delta \ln P^{\text{Rent,ACS}}$		$\Delta \ln HP^{\text{CL}}$	$\Delta \ln HP^{\text{Z}}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{Immigr}_{d,t}$	-0.017	-0.070***	-0.015	-0.015	0.075**	0.020	-0.103	-0.090
	(0.020)	(0.020)	(0.023)	(0.042)	(0.030)	(0.042)	(0.124)	(0.108)
Obs.	741	741	741	741	6,246	669	2,406	4,710
First-Stage F-stat	99.1	99.1	99.1	99.1	84.6	83.8	91.8	81.7
Fixed Effects	State, Time	State, Time	State, Time	State, Time	State, Time	State, Time	State, Time	State, Time
Method	IV	IV	IV	IV	IV	IV	IV	IV
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample						Cities		

BLS price indexes are based on cities, and we match them to counties. Robust standard errors are reported. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

County-level Analyses: Robustness and Sanity Checks

- Robustness
  - Different Price indexes: Jevons, Laspyres, Passche, Tornqvist ◂ Price Indexes
  - 2006-2018 Long-Difference Specification ◂ Long-Difference
  - More Sample ◂ 6-Year Sample
  - Others ◂ Others
    - Illegal Immigrants: Mexican border, ICE arrests controls
    - More Fixed Effects: State x Time FE, County FE & Time FE
    - Different Regressor: Immigration to population, Non-winsorized variables

- Sanity Checks
  - Scanner Price Index vs. BLS Price Index
  - Comparison with Terry et al: $>.99$ correlation, the same wage results before 2010

Outline

Firm-level Analyses

Objective: Investigate the underlying mechanism

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- Many potential channels in county-level analyses
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- Many potential channels in county-level analyses
  - product demand vs. labor supply (smaller for tradable goods)
  - Other GE channels: firm entry and exit, people move in and out

- At the firm level, disentangle product demand vs. labor supply channels
  - Firms exposed via demand when immigrants arrive in their sales locations
  - Firms exposed via supply when immigrants arrive in their production locations
  - A median firm produces in 1 plant but sells in 155 counties (Hyun & Kim 23)

Firm-level Analyses: Regression Specification

$$\Delta \ln P_{ft} = \beta_1 \mathrm{I}_{ft}^{\text{demand}} + \beta_2 \mathrm{I}_{ft}^{\text{supply}} + \mathbf{X}_f' \gamma + \delta_t + \varepsilon_{ft}$$

f: firm; $\mathbf{X}_f'$: a vector of firm-specific controls; δ: fixed effect; Δ: 4-year first-difference (stacked) or 12-year difference

- $\Delta \ln P_{ft}$: Sato-Vartia index aggregated across (i) products, (ii) groups, (iii) counties

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- $\Delta \ln P_{ft}$: Sato-Vartia index aggregated across (i) products, (ii) groups, (iii) counties
- Two different immigration shifters with different exposure weights:

$$\mathrm{I}_{ft}^{\text{demand}} = \sum_d w_{fdt_0}^{\text{demand}} \mathrm{I}_{dt}$$

$w_{fdt_0}^{\text{demand}}$: f's sales share in county d in t_0

Firm-level Analyses: Regression Specification

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- $\Delta \ln P_{ft}$: Sato-Vartia index aggregated across (i) products, (ii) groups, (iii) counties
- Two different immigration shifters with different exposure weights:

$$\mathrm{I}_{ft}^{\text{demand}} = \sum_d w_{fdt_0}^{\text{demand}} \mathrm{I}_{dt} \qquad \mathrm{I}_{ft}^{\text{supply}} = \sum_s w_{fst_0}^{\text{supply}} \mathrm{I}_{st}$$

$w_{fdt_0}^{\text{demand}}$: f's sales share in county d in t_0 $\quad$ $w_{fst_0}^{\text{supply}}$: f's emp. share in county s in t_0

Firm-Level Analyses: Price Results

- Immigration inflows (i) decrease prices via demand, (ii) increase prices via supply

	Δ lnP^{SV,Stack} (2006-2018)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Immigration$_{f,d,t}$ (D)	-0.071***	-0.057***		-0.061***	-0.066***	-0.055***		-0.051***
	(0.020)	(0.021)		(0.020)	(0.020)	(0.021)		(0.019)
Immigration$_{f,d,t}$ (S)	0.016***		0.007	0.019***	0.014***		0.005	0.016***
	(0.005)		(0.005)	(0.005)	(0.005)		(0.005)	(0.005)
Δ lnW (Retail, D)				0.031				0.048
				(0.220)				(0.220)
Δ lnP (Rent, D)				0.220				0.178
				(0.184)				(0.176)
Δ lnW (Retail, S)				0.094				0.092
				(0.065)				(0.065)
Δ lnP (Rent, S)				-0.044				-0.033
				(0.065)				(0.066)
Obs.	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037
First-Stage F-stat	3,743.4	4,896.3	4,908.1	3,977.9				
Fixed Effects	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time
Method	IV	IV	IV	IV	OLS	OLS	OLS	OLS
Controls	Yes			Yes	Yes			Yes

The regression is weighted by the initial sales. Missing shares are controlled. Standard errors are clustered by the industry; the industry is the initial 3-digit SIC code. Controls: 2006 county GDP per capita and urban indicator, each weighted by either initial sales share or employment share across counties within firm, and interacted with the year indicators.

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$Immigration_{f,d,t}$ (S)	0.016***		0.007	0.019***	0.014***		0.005	0.016***
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Fixed Effects	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time
Method	IV	IV	IV	IV	OLS	OLS	OLS	OLS
Controls	Yes			Yes	Yes			Yes

The regression is weighted by the initial sales. Missing shares are controlled. Standard errors are clustered by the industry; the industry is the initial 3-digit SIC code. Controls: 2006 county GDP per capita and urban indicator, each weighted by either initial sales share or employment share across counties within firm, and interacted with the year indicators.

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	(0.020)	(0.021)		(0.020)	(0.020)	(0.021)		(0.019)
Immigration$_{f,d,t}$ (S)	0.016***		0.007	0.019***	0.014***		0.005	0.016***
	(0.005)		(0.005)	(0.005)	(0.005)		(0.005)	(0.005)
Δ lnW (Retail, D)				0.031				0.048
				(0.220)				(0.220)
Δ lnP (Rent, D)				0.220				0.178
				(0.184)				(0.176)
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				(0.065)				(0.065)
Δ lnP (Rent, S)				-0.044				-0.033
				(0.065)				(0.066)
Obs.	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037
First-Stage F-stat	3,743.4	4,896.3	4,908.1	3,977.9				
Fixed Effects	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time
Method	IV	IV	IV	IV	OLS	OLS	OLS	OLS
Controls	Yes			Yes	Yes			Yes

The regression is weighted by the initial sales. Missing shares are controlled. Standard errors are clustered by the industry; the industry is the initial 3-digit SIC code. Controls: 2006 county GDP per capita and urban indicator, each weighted by either initial sales share or employment share across counties within firm, and interacted with the year indicators.

Firm-Level Analyses: Price Results

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	Δ $\ln P^{SV,Stack}$ (2006-2018)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Immigration_{f,d,t}$ (D)	-0.071***	-0.057***		-0.061***	-0.066***	-0.055***		-0.051***
	(0.020)	(0.021)		(0.020)	(0.020)	(0.021)		(0.019)
$Immigration_{f,d,t}$ (S)	0.016***		0.007	0.019***	0.014***		0.005	0.016***
	(0.005)		(0.005)	(0.005)	(0.005)		(0.005)	(0.005)
Δ lnW (Retail, D)				0.031				0.048
				(0.220)				(0.220)
Δ lnP (Rent, D)				0.220				0.178
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Δ lnW (Retail, S)				0.094				0.092
				(0.065)				(0.065)
Δ lnP (Rent, S)				-0.044				-0.033
				(0.065)				(0.066)
Obs.	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037
First-Stage F-stat	3,743.4	4,896.3	4,908.1	3,977.9				
Fixed Effects	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time
Method	IV	IV	IV	IV	OLS	OLS	OLS	OLS
Controls	Yes			Yes	Yes			Yes

The regression is weighted by the initial sales. Missing shares are controlled. Standard errors are clustered by the industry; the industry is the initial 3-digit SIC code. Controls: 2006 county GDP per capita and urban indicator, each weighted by either initial sales share or employment share across counties within firm, and interacted with the year indicators.

Firm-Level Analyses: Search Intensity

- Immigration inflows increase search intensity via demand effect
  - firm-level measure: sales-weighted average across purchaser characteristics
    - Rel. Price: Aguiar and Hurst (2007)

	Δ lnPurChar^{SV,Stack} (2006-2018)					
	(1) N. Trips	(2) N. Days	(3) N. Chains	(4) N. Products	(5) % Store Brand	(6) Rel. Price
Immigration$_{f,d,t}$ (D)	0.012**	0.010**	0.008	-0.002	0.008*	-0.002***
	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)	(0.001)
Immigration$_{f,d,t}$ (S)	-0.000	0.001	0.000	0.001	0.002	0.000
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.000)
Obs.	10,325	10,325	10,325	10,325	10,325	10,317
First-Stage F-stat	3,736.5	3,736.5	3,736.5	3,736.5	3,736.5	3,735.9
Fixed Effects	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time	Industry, Time
Method	IV	IV	IV	IV	IV	IV
Controls						

The regression is weighted by the initial sales. Missing shares are controlled. Standard errors are clustered by the industry; the industry is the initial 3-digit SIC code.

Outline

Structural Estimation: Setup

Objective: estimate structural demand parameters to verify the price mechanism

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- Nested demand by location c (upper-tier Cobb-Douglas, nested CES below it):

$$\ln U_{ct} = \int_{g \in \Omega_{ct}} \phi^C_{gct} \ln C_{gct} dg$$

$$C_{gct} = \left[\sum_{f \in \Omega_{gct}} \left(\phi^F_{fgct} C^F_{fgct} \right)^{\frac{\sigma^F_{sgt}-1}{\sigma^F_{sgt}}} df \right]^{\frac{\sigma^F_{sgt}}{\sigma^F_{sgt}-1}}, \quad C_{fgct} = \left[\sum_{u \in \Omega_{fgct}} \left(\phi^U_{uct} C^U_{uct} \right)^{\frac{\sigma^U_{sgt}-1}{\sigma^U_{sgt}}} df \right]^{\frac{\sigma^U_{sgt}}{\sigma^U_{sgt}-1}}$$

ϕ: appeal/quality (structural residual),
σ_{sgt}: state-group-period-specific elasticities, estimated by applying HRW to each state & period

▸ HRW Estimation Details

County/State-Level Analyses: Demand Elasticity

- Immigration inflows increase the estimated demand elasticity
  - consistent with the increase in search intensity
  - County-group-period-level analyses or state-group-period-level analyses, with state-group-period-specific σ_{sgt}

	Demand Elast. (σ)			
	(1) σ^F	(2) σ^U	(3) σ^F	(4) σ^U
Immigration (100K)	0.040**	0.062**	0.052***	0.082***
	(0.017)	(0.025)	(0.006)	(0.012)
Obs.	465,736	465,736	11,033	11,033
First-Stage F-stat	2,189	2,189	154	154
Fixed Effects	County-Group, Time-Group	County-Group, Time-Group	State-Group, Time-Group	State-Group, Time-Group
Aggregation	County-Level	County-Level	State-Level	State-Level

The regression is weighted by the initial sales. Missing shares are controlled. Standard errors are clustered by the industry; the industry is the initial 3-digit SIC code.

Structural Decomposition

- Fixing variety: Price Index

$$\frac{P_{fgct}}{P_{fgc,t-1}} = \Phi^{SV}_{fgct}$$

  - Φ^{SV}_{fgct}: SV Price index, weighted mean of relative prices of continuing varieties

Structural Decomposition

- Changing variety: Price Index

$$\frac{P_{fgct}}{P_{fgc,t-1}} = \Phi^{SV}_{fgct} \cdot \Phi^{Variety}_{fgct}$$

  - Φ^{SV}_{fgct}: SV Price index, weighted mean of relative prices of continuing varieties
  - $\Phi^{Variety}_{fgct}$: Feenstra variety index: more variety $\Rightarrow$ lower price index

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  - Φ^{SV}_{fgct}: SV Price index, weighted mean of relative prices of continuing varieties
  - $\Phi^{Variety}_{fgct}$: Feenstra variety index: more variety $\Rightarrow$ lower price index

- Appeal (quality) Index

$$\Phi^{Appeal}_{fgct} \equiv \frac{\phi_{fgct}}{\phi_{fgc,t-1}} = \frac{P_{fgct}/P_{fgc,t-1}}{P^G_{gct}/P^G_{gc,t-1}} \left(\frac{S_{fgct}}{S_{fgc,t-1}} \right)^{\frac{1}{\sigma^F_\ell - 1}}$$

  - Φ^{Appeal}_{fgct}: Higher appeal $\Rightarrow$ higher market share conditional on price

Decomposition of CES Price Index and Appeal: Firm-Level Analyses

- Similar effect on variety-adjusted output price index

	Δ lnP^{Stack} (2006-2018), Decomposition			Quality
	(1)	(2)	(3)	(4)
	Price+Variety	SV-Price	Variety Corr.	Appeal
$Immigration_{f,d,t}$ (D)	-0.051**	-0.057***	-0.005	-0.119***
	(0.020)	(0.020)	(0.005)	(0.019)
$Immigration_{f,d,t}$ (S)	0.014***	0.018***	0.004***	0.025***
	(0.004)	(0.004)	(0.001)	(0.009)
Obs.	10,333	11,037	10,333	10,333
First-Stage F-stat	3,779.3	3,733.5	3,779.3	3,779.3
Fixed Effects	Industry, Time	Industry, Time	Industry, Time	Industry, Time
Method	IV	IV	IV	IV
Controls	Yes	Yes	Yes	Yes

The regression is weighted by the initial sales. Standard errors are clustered by state.

Decomposition of CES Price Index and Appeal: Firm-Level Analyses

- Similar effect on variety-adjusted output price index
  - D: decrease in product appeal as low-income immigrants prefer less appealing products

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	(0.004)	(0.004)	(0.001)	(0.009)
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Fixed Effects	Industry, Time	Industry, Time	Industry, Time	Industry, Time
Method	IV	IV	IV	IV
Controls	Yes	Yes	Yes	Yes

The regression is weighted by the initial sales. Standard errors are clustered by state.

Decomposition of CES Price Index and Appeal: Firm-Level Analyses

- Similar effect on variety-adjusted output price index
  - D: decrease in product appeal as low-income immigrants prefer less appealing products
  - S: increase in product appeal and variety as firms innovate more with immigrants

	Δ $\ln P^{Stack}$ (2006-2018), Decomposition			Quality
	(1)	(2)	(3)	(4)
	Price+Variety	SV-Price	Variety Corr.	Appeal
$Immigration_{f,d,t}$ (D)	-0.051**	-0.057***	-0.005	-0.119***
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Fixed Effects	Industry, Time	Industry, Time	Industry, Time	Industry, Time
Method	IV	IV	IV	IV
Controls	Yes	Yes	Yes	Yes

The regression is weighted by the initial sales. Standard errors are clustered by state.

Outline

Theoretical Framework: Setup

Goal: Rationalize the structural estimation results with a single primitive

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Environment:

- **Demand:** CES preferences, two household types (natives n, immigrants i)
  - Key assumption: $\sigma_i > \sigma_n$ (immigrants are more price-sensitive)
- **Supply:** Monopolistic competition, $p_u = \mu_u \cdot MC(q_u)$
  - Increasing marginal cost: $MC_u = a_u q_u^{\delta}$, $\delta > 0$
  - Firms cannot price discriminate across household types
- **Fixed variety and quality:** disciplined by the data
  - Feenstra variety corrections ≈ 0; barcode characteristics do not change

◂ Detail

Theoretical Framework: Two Channels

From $\sigma_i > \sigma_n$, immigration affects prices through:

Price channel: $p_u = \underbrace{\mu_u(\sigma_{\text{eff}})}_{\text{markup}} \cdot \underbrace{a_u \cdot q_u^{\delta}}_{\text{MC}}$

- Markup compression (P ↓): $\sigma_{\text{eff}} = \sum_h \omega_{uh}\sigma_h \uparrow \quad \Rightarrow \quad \mu_u \downarrow$
- Scale effect (P ↑): $q_u \uparrow \quad \Rightarrow \quad MC_u \uparrow$

Theoretical Framework: Two Channels

From $\sigma_i > \sigma_n$, immigration affects prices through:

Price channel: $p_u = \underbrace{\mu_u(\sigma_{\text{eff}})}_{\text{markup}} \cdot \underbrace{a_u \cdot q_u^{\delta}}_{\text{MC}}$

- Markup compression (P $\downarrow$): $\sigma_{\text{eff}} = \sum_h \omega_{uh}\sigma_h \uparrow \quad \Rightarrow \quad \mu_u \downarrow$
- Scale effect (P $\uparrow$): $q_u \uparrow \quad \Rightarrow \quad MC_u \uparrow$

Net effect: Markup compression dominates scale $\Rightarrow$ prices fall, as in data

Theoretical Framework: Two Channels

From $\sigma_i > \sigma_n$, immigration affects prices through:

Price channel: $p_u = \underbrace{\mu_u(\sigma_{\text{eff}})}_{\text{markup}} \cdot \underbrace{a_u \cdot q_u^{\delta}}_{\text{MC}}$

- Markup compression (P $\downarrow$): $\sigma_{\text{eff}} = \sum_h \omega_{uh}\sigma_h \uparrow \quad \Rightarrow \quad \mu_u \downarrow$
- Scale effect (P $\uparrow$): $q_u \uparrow \quad \Rightarrow \quad MC_u \uparrow$

Net effect: Markup compression dominates scale $\Rightarrow$ prices fall, as in data

Quality composition: $\bar{\phi}_f = \sum_u s_u \cdot \phi_u$

- More elastic consumers spend more on cheaper, lower-quality products
- Expenditure shares s_u shift toward low-ϕ_u products $\quad \Rightarrow \quad \bar{\phi}_f \downarrow$, as in data

Conclusion

- At the county level, immigration inflows reduce the price index

- At the firm level, immigration inflows
  - decrease prices via demand effect as immigrants search more to purchase products
  - increase prices via supply effect as immigrants make products more appealing
  - The demand effect dominates the supply effect
  - Structural estimation confirms: immigration raises demand elasticity and lowers product appeal — rationalized by more elastic, search-intensive immigrants

Appendix

County-level Price Index

Construct a chain-weighted change in the county-level price index

County-level Price Index

Construct a chain-weighted change in the county-level price index

Step 1: UPC-county-time to Firm-group-county-time

$$\frac{P_{fgct}}{P_{fgc,t-1}} = \prod_{k \in \Omega_{fgct,t-1}} \left(\frac{P_{kct}}{P_{kc,t-1}} \right)^{w_{kct}}$$

k: UPC, f: firm, g: product group, c: county, t: year; $\Omega_{fgct,t-1}$: set of products k sold in county c in both t and t-1

- Baseline weight (w_{kct}): Sato-Vartia (logarithmic mean, exact for the CES utility)
  - Robustness: Tornqvist, Laspyres, Passche, Jevons

◂ Weight

County-level Price Index

Construct a chain-weighted change in the county-level price index

Step 2: Firm-group-county-time to county-group-time, and then to county-time

$$\frac{P_{gct}}{P_{gc,t-1}} = \prod_{f \in \Omega_{gct,t-1}} \left(\frac{P_{fgct}}{P_{fgc,t-1}} \right)^{w_{fgct}}, \qquad \frac{P_{ct}}{P_{c,t-1}} = \prod_{g \in \Omega_{ct,t-1}} \left(\frac{P_{gct}}{P_{gc,t-1}} \right)^{w_{gct}}$$

f: firm, g: product group, c: county, t: year; $\Omega_{gct,t-1}$: set of firms f sold in county c in both t and t-1, $\Omega_{ct,t-1}$: set of groups sold in county c in both t and t-1

- w_{fgct}: Sato-Vartia, consistent with the CES utility across firms
- w_{gct}: Tornqvist, approximation for the Cobb-Douglas utility across groups

Back

Immigration Shock Instrument: Terry et al. 24

- Predict the ancestry with the historical pull and push factors:

$$A_{o,c,t} = \sum_{\tau=1880}^{t} a_{r(c),\tau} \underbrace{\left[I_{o,-r(c),\tau}\right]}_{push} \underbrace{\left[I_{Europe,c\tau}/I_{Europe,\tau}\right]}_{pull} + \delta_{o,r(c),t} + \delta_{i(o),c,t} + X'_{o,c}\zeta + \nu_{o,c,t}$$

o: origin, c: county, i: country, d: destination, r: region, t: time; δ: fixed effects, $X'_{o,d}$: a vector of controls; estimate for non-Europeans

Immigration Shock Instrument: Terry et al. 24

- Predict the ancestry with the historical pull and push factors:

$$A_{o,c,t} = \sum_{\tau=1880}^{t} a_{r(c),\tau} \underbrace{\left[I_{o,-r(c),\tau}\right]}_{push} \underbrace{\left[I_{Europe,c\tau}/I_{Europe,\tau}\right]}_{pull} + \delta_{o,r(c),t} + \delta_{i(o),c,t} + X'_{o,c}\zeta + \nu_{o,c,t}$$

o: origin, c: county, i: country, d: destination, r: region, t: time; δ: fixed effects, $X'_{o,d}$: a vector of controls; estimate for non-Europeans

- First-stage regression:

$$I_{o,c,t} = b_t \left[\hat{A}_{o,c,t-1} \times \mathrm{I}_{o,-r(c),t}\right] + \delta_{o,r(c)} + \delta_{i(o),c} + \delta_t + X'_{o,c}\theta + u_{o,c,t}$$

And

- $\hat{I}_{c,t} = \sum_o \hat{b}_t \left[\hat{A}_{o,c,t-1} \times \mathrm{I}_{o,-r(c),t}\right]$

Back

County-level Analyses: Wage Effects

	Δ lnWages^{Stacked} (2006-2018)			Δ lnWages^{LongDiff} (2006-2018)	
	(1)	(2)	(3)	(4)	(5)
$Immigr_{d,t}$	0.015				
	(0.023)				
$Immigr_{d,t}$ (over25)		0.027	-0.310*	0.029	-0.548*
		(0.039)	(0.183)	(0.031)	(0.324)
$Immigr_{d,t} \times EducYears_{d,t}$			0.392*		0.633*
			(0.201)		(0.335)
Obs.	6,249	6,249	6,245	2,082	2,082
First-Stage F-stat	45.9	41.2		41.3	
Fixed Effects	State, Time	State, Time	State, Time	State	State
Method	IV	IV	IV	IV	IV
Controls	Yes	Yes	Yes	Yes	Yes

Standard errors are clustered by state. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

Go Back

Robustness: Alternative Rent Prices from ACS

	Δ $P^{SV,Stacked}$ (2006-2018)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Immigr_{d,t}$	0.070***	0.075***	0.083***	0.065***	0.078**	0.100***	0.014
	(0.019)	(0.020)	(0.017)	(0.023)	(0.033)	(0.036)	(0.035)
Obs.	6,336	6,336	6,246	6,336	6,336	6,246	669
First-Stage F-stat				23.7	49.8	45.8	157.7
Fixed Effects	Time	State, Time	State, Time	Time	State, Time	State, Time	State, Time
Method	OLS	OLS	OLS	IV	IV	IV	IV
Controls			Yes			Yes	Yes
Sample							Cities

Standard errors are clustered by state except the last column, where the robust standard errors are reported. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

Go Back

Robustness: Alternative Price Indexes

	Δ P^{Jevons} (2006-2018)		Δ P^{Laspyres} (2006-2018)		Δ P^{Passche} (2006-2018)		Δ P^{Tornqvist} (2006-2018)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Immigr_{d,t}$	-0.021**	-0.014**	-0.069***	-0.067***	-0.067***	-0.063***	-0.068***	-0.065***
	(0.008)	(0.006)	(0.012)	(0.011)	(0.014)	(0.012)	(0.013)	(0.012)
Obs.	6,339	6,339	6,339	6,339	6,339	6,339	6,339	6,339
First-Stage F-stat	254.4	94.4	254.4	94.4	254.4	94.4	254.4	94.4
Fixed Effects	Time	State, Time	Time	State, Time	Time	State, Time	Time	State, Time
Method	IV	IV	IV	IV	IV	IV	IV	IV

Standard errors are clustered by state. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

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Robustness: Long-Difference

	Δ $P^{SV,LongDiff}$ (2006-2018)					
	(1)	(2)	(3)	(4)	(5)	(6)
$Immigr_{d,t}$	-0.041***	-0.029***	-0.024***	-0.054***	-0.035***	-0.031***
	(0.009)	(0.004)	(0.004)	(0.011)	(0.006)	(0.008)
Obs.	2,113	2,112	2,082	2,113	2,112	2,082
First-Stage F-stat				273.5	92.4	89.4
Fixed Effects	None	State	State	None	State	State
Method	OLS	OLS	OLS	IV	IV	IV
Controls			Yes			Yes

Standard errors are clustered by state. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

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Robustness: 6-Year Continuous Product Sample

	Δ $P^{SV,Stacked}$ (2006-2018)					
	(1)	(2)	(3)	(4)	(5)	(6)
$Immigr_{d,t}$	-0.034***	-0.028***	-0.023***	-0.062***	-0.064***	-0.056***
	(0.008)	(0.004)	(0.005)	(0.011)	(0.013)	(0.014)
Obs.	6,339	6,339	6,249	6,339	6,339	6,249
First-Stage F-stat				267.7	95.6	86.3
Fixed Effects	Time	State, Time	State, Time	Time	State, Time	State, Time
Method	OLS	OLS	OLS	IV	IV	IV
Controls			Yes			Yes

Standard errors are clustered by state. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

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Robustness: Others

	Δ P$^{\text{Sato-Vartia,Stacked}}$ (2006-2018)					
	(1)	(2)	(3)	(4)	(5)	(6)
Immigr$_{d,t}$ / Pop'l$_{d,t}$	-1.106***					
	(0.249)					
Immigr$_{d,t}$		-0.058***	-0.058***	-0.038***	-0.005***	-0.026***
		(0.013)	(0.012)	(0.009)	(0.001)	(0.008)
Mexico Border		-0.334***				
		(0.111)				
total ICE Arrests			0.046***			
			(0.012)			
Obs.	6,339	6,249	6,249	6,246	6,249	6,249
First-Stage F-stat	9.3	86.4	101.5	77.7	861.0	2,217.9
Fixed Effects	State, Time	State, Time	State, Time	State-Time	State, Time	County, Time
Baseline +	Imm / Popl	Border	ICE Arrests	State-Year FE	Non-Winsorized	County FE

Standard errors are clustered by state. Both immigration shock and immigration are winsorized by top and bottom 1%. Controls: 2006 county GDP per capita and urban indicator, each interacted with the year indicators.

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Chain-weighted Price Index: Firm-Group-County-Time-level

- Sato-Vartia:

$$w_{kct}^{SV} = \frac{\frac{s_{kct}^* - s_{kc,t-1}^*}{\ln s_{kct}^* - \ln s_{kc,t-1}^*}}{\sum_{k \in \Omega_{fgct,t-1}} \frac{s_{kct}^* - s_{kc,t-1}^*}{\ln s_{kct}^* - \ln s_{kc,t-1}^*}}$$

  - s_{kct}^*: market share of products k in county c at time t among $k \in \Omega_{fgct,t-1}$

- Tornqvist, Laspyres, Passche, Jevons:

$$w_{kct}^T = \frac{s_{kct}^* + s_{kc,t-1}^*}{2}, \quad w_{kct}^L = \frac{s_{kc,t-1}^*}{2}, \quad w_{kct}^P = \frac{s_{kct}^*}{2}, \quad w_{kct}^J = \frac{1}{|\Omega_{fgct,t-1}|}$$

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Structural Decomposition: Price Index Detail

$$\frac{P_{fgct}}{P_{fgc,t-1}} = \prod_{k \in \Omega_{fgct,t-1}} \left(\frac{P_{kt}}{P_{k,t-1}} \right)^{w_{kt}} \left(\frac{\sum_{k \in \Omega_{fgct,t-1}} S_{kt}}{\sum_{k \in \Omega_{fgct,t-1}} S_{k,t-1}} \right)^{\frac{1}{\sigma_g^U - 1}} = \Phi_{fgct}^{SV} \Phi_{fgct}^{F}$$

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Theoretical Framework (1/3): Setup

Demand: CES preferences, two household types ($h \in \{n, i\}$)

$$c_{uh} = \phi_u \left(\frac{p_u}{P_h} \right)^{-\sigma_h} \frac{E_h}{P_h}$$

Key Assumption: $\sigma_i > \sigma_n$ (immigrants are more price-sensitive)

Supply: Monopolistic competition, uniform pricing

$$p_u = \mu_u(\sigma_{\text{eff}}) \cdot MC(q_u), \quad MC_u = a_u \cdot q_u^{\delta}, \quad q_u = \sum_h L_h c_{uh}$$

Effective elasticity: $\sigma_{\text{eff}} = \sum_h \omega_{uh} \sigma_h, \quad \omega_{uh} = \frac{L_h c_{uh}}{\sum_{h'} L_{h'} c_{uh'}}$

Fixed variety and quality: Ω_f and $\{\phi_u\}_{u \in \Omega_f}$ are fixed (disciplined by data)

Theoretical Framework (2/3): Two Channels

Channel 1: Markup compression (P ↓)

$$\frac{\partial \sigma_{\text{eff}}}{\partial L_i} > 0 \quad \Rightarrow \quad \frac{\partial \mu_u}{\partial \sigma_{\text{eff}}} < 0 \quad \Rightarrow \quad p_u \downarrow$$

Immigration increases immigrant quantity share ω_{ui}, raising effective elasticity

Channel 2: Scale effect (P ↑)

$$\frac{\partial q_u}{\partial L_i} > 0 \quad \Rightarrow \quad \frac{\partial MC(q_u)}{\partial q_u} > 0 \quad \Rightarrow \quad p_u \uparrow$$

Larger population increases quantities, pushing up marginal costs

Quality composition:

- More elastic consumers ($\sigma_i > \sigma_n$) spend more on cheaper, lower-ϕ_u products
- Expenditure shares shift: $\bar{\phi}_f = \sum_u s_u \phi_u \downarrow$

Theoretical Framework (3/3): Decomposition

Firm-level price decomposition:

$$\frac{d \ln P_f}{dL_i} = \underbrace{\sum_u s_u \frac{d \ln p_u}{dL_i}}_{\substack{\text{Price Effect} \\ \text{Ch.1 (-), Ch.2 (+)}}} + \underbrace{\sum_u s_u \frac{d \ln \phi_u}{dL_i}}_{\substack{\text{Quality Composition} \\ \text{(-)}}}$$

Mapping to data:

Price Effect (Ch.1 dominates Ch.2)	$\Rightarrow$	SV-Price falls ✓
Quality Composition	$\Rightarrow$	Appeal falls ✓
Variety		Fixed by assumption (Feenstra ≈ 0) ✓

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HRW Demand Estimation (1): Product-Level Elasticity

- **Product-level (within-firm) elasticity** σ_{sg}^{U}:

$$\Delta^{\underline{u},t} \ln S_{ugt}^{U} = (1 - \sigma_{sg}^{U}) \Delta^{\underline{u},t} \ln P_{ugt}^{U} + \omega_{ugt}$$

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- **Supply moment** (relative UPC supply):

$$\Delta^{\underline{u},t} \ln P_{ugt}^{U} = \frac{\delta_{sg}}{1 + \delta_{sg}} \Delta^{\underline{u},t} \ln S_{ugt}^{U} + \kappa_{ugt}$$

  - Derived from multi-product firm's profit maximization under Bertrand competition
  - δ_{sg}: MC curvature parameter where $MC(q) = a \cdot q^{\delta}$

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  - Derived from multi-product firm's profit maximization under Bertrand competition
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- **Estimation**: GMM using moment conditions $\mathbb{E}[\nu_{ugt}] = 0$ where $\nu_{ugt} = \omega_{ugt}\kappa_{ugt}$
  - Identification through heteroskedasticity: variance of demand shocks varies across u
  - Estimate separately for each state s and product group g

HRW Demand Estimation (2): Firm-Level Elasticity

- **Firm-level (across-firm) elasticity** σ_{sg}^F:

$$\Delta^{\underline{f},t} \ln S_{fgt}^F = (1 - \sigma_{sg}^F) \Delta^{\underline{f},t} \ln P_{fgt}^F + \omega_{fgt}$$

- **IV**: Within-firm share dispersion addresses the simultaneity problem
  - Valid instrument from nested demand structure (variety chosen before the shock)
  - Estimate separately for each state s and product group g

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