Aging, Digitization, Automation, Migration, Trade Costs and Productivity

A US Case Study

Philip A. Luck

Economics Program Director and Scholl Chair in International Business at the Center for Strategic and International Studies; Former Deputy Chief Economist, US Department of State

Abstract

We examine how the United States, the largest APEC economy, is managing the intersection of demographic aging, automation, trade policy and immigration. Manufacturing labor productivity has been essentially flat since 2008, growing 3 percent cumulatively against 31 percent in the nonfarm business sector. Industrial robot density lags Korea's by more than a factor of three, tariffs at their highest level in at least 80 years raise costs on intermediate and capital goods, and the foreign-born workforce has contracted by roughly 1.1 million amid expanded immigration enforcement. Growth accounting shows that the labor contribution to US GDP growth has contracted by more than one percentage point per year relative to the prior decade. Capital deepening, at about 0.33 percentage points per year, runs at roughly one-quarter of Korea's pace and one-tenth of China's. Yet the United States retains genuine strength at the frontier: its private AI investment leads the world by a wide margin, so the binding constraint is diffusion to smaller firms. The United States appears unique among major APEC economies in having simultaneously constrained all three adjustment margins: trade openness, immigration and automation investment. Peer economies offer workable alternatives in each dimension.

1. Introduction

1.1 Context within APEC

This paper is an economy case study for the APEC series on structural reform and productivity growth, contributing to the evidence base established by the Enhanced APEC Agenda for Structural Reform (EAASR) and the Putrajaya Vision 2040. Because the reform agenda is comparative by design, we read the US experience against APEC peers that face the same aging pressures and have answered them differently.

1.2 Central Thesis

Since 2000, US manufacturing has shed more than four million jobs, one in four, even as real output held near its historical peak. Rising output per worker and a shift toward higher-value subsectors account for that divergence. Since 2008, however, manufacturing productivity growth has slowed to roughly one-tenth the economy-wide pace. The US economy faces exogenous challenges and self-imposed constraints that together suppress productivity growth. The exogenous challenges are shared across APEC economies: an aging population, sub-replacement fertility and declining research productivity. The self-imposed constraints are policy choices with identifiable costs and available alternatives: elevated tariffs, immigration restrictions and chronic under-investment in technology adoption.

These challenges interact. Tariffs raise the cost of imported automation equipment. Immigration enforcement shrinks the workforce. Firms that cannot automate and cannot hire see productivity growth weaken. Weak productivity growth erodes the fiscal base for public investments that could break the cycle.

We do not claim to identify causal effects through original econometric analysis. Our contribution is *synthetic*: we assemble descriptive evidence, cross-economy comparisons and estimates from empirical literature into an integrated framework. The causal estimates we cite are drawn from peer-reviewed studies employing their own identification strategies.

1.3 Relevance to Other APEC Economies

Japan and Korea face more acute aging but have responded with aggressive robotics strategies. China now installs more industrial robots each year than the rest of the world combined. Canada, Australia and Singapore are actively recruiting skilled immigrants while the United States deters them. What distinguishes the US case is that all adjustment margins — automation, immigration and trade openness — are being constrained simultaneously. This is not a failure of capability. The United States remains the frontier leader in AI and software; the challenge is spreading those gains beyond the largest firms.

In Section 2 we document the demographic headwinds: sub-replacement fertility and an aging manufacturing workforce. Section 3 quantifies the productivity slowdown and, through growth accounting, traces it to a sharply lower labor contribution and thin capital deepening. In Section 4 we show that the United States is falling behind its APEC peers in automation, a gap concentrated among smaller firms. Sections 5 and 6 examine the two policy margins, tariffs and immigration, that compound these structural challenges. Section 7 draws four recommendations from APEC peer experience, and Section 8 concludes.

2. Demographic Headwinds: An Aging Labor Force and Slowing Labor Supply

2.1 Declining Fertility and Natural Population Growth

The US total fertility rate now sits at approximately 1.6, well below the replacement rate of 2.1 and among the lowest in American history.[1] The decline has persisted since 2007, shifting long-run projections from gradual aging to outright natural population decline. Births minus deaths are projected to turn negative by 2038 under the Census Bureau's main-series projections,[2] making the United States entirely dependent on net immigration for population growth — a transition Japan crossed in the 2000s and that Korea and China crossed in 2020 and 2022, respectively.

2.2 Workforce Aging across Sectors

Manufacturing has one of the oldest workforce profiles of any major US industry. Deloitte and the Manufacturing Institute project that up to 3.8 million new manufacturing positions could be needed

[1] Anne K. Driscoll and Brady Hamilton, "Effects of Age-specific Fertility Trends on Overall Fertility Trends: United States, 1990–2023," *National Vital Statistics Reports* 74, no. 3 (March 2025), https://doi.org/10.15620/cdc/174576. For the 2024 final rate of 1.60, see Michelle J.K. Osterman et al., "Births: Final Data for 2024," *National Vital Statistics Reports* 75, no. 2 (2026), https://www.cdc.gov/nchs/data/nvsr/nvsr75/nvsr75-02.pdf.

[2] US Census Bureau, "U.S. Population Projected to Begin Declining in Second Half of Century," press release CB23-189, November 9, 2023, https://www.census.gov/newsroom/press-releases/2023/population-projections.html.

by 2033, with as many as half going unfilled.[3] A companion Deloitte analysis frames the labor shortage as the binding constraint on US manufacturing ambitions.[4]

Foreign-born workers are disproportionately concentrated in the sectors facing the most acute shortages: approximately 68 percent of hired crop farmworkers and roughly one-third of construction trades workers, along with large shares of manufacturing line workers.[5] Figure 1 displays this "demographic squeeze." The share of manufacturing workers aged 55 and over rose from 23.7 percent in 2010 to 27.4 percent by 2024, 4.0 percentage points above the all-industry average of 23.4 percent.[6] The foreign-born share of manufacturing employment rose from 17.2 to 20.1 percent over the same period, consistent with the Manufacturers Alliance estimate of approximately 20 percent.[7] BLS Current Population Survey data show a decline of approximately 1.1 million in the foreign-born workforce over the first eight months of 2025, coinciding with expanded enforcement actions (Section 6).[8]

2.3 Cross-APEC Demographic Comparison

Table 1 presents old-age dependency ratios for key APEC economies; Figure 2 charts the comparison.

Japan leads at 50.3 percent in 2023 and is projected to reach 64.5 percent by 2040. Korea's ratio is forecast to rise sharply from 25.9 to 57.6 percent, China's from 20.7 to 41.6 percent. The United States, at 26.8 percent (2023) and expected to climb to 35.5 percent (2040), occupies a middle

[3] Deloitte and the Manufacturing Institute, "Taking Charge: Manufacturers Support Growth with Active Workforce Strategies" (Washington, DC, April 2024), https://themanufacturinginstitute.org/wp-content/uploads/2024/04/Digital_Skills_Report_April_2024.pdf.

[4] Akrur Barua and Ruhika Agarwal, "A Shrinking Workforce May Thwart US Manufacturing Ambitions," *Deloitte Insights*, December 22, 2025, https://www.deloitte.com/us/en/insights/topics/economy/spotlight/us-manufacturing-labor-impact.html.

[5] US Department of Labor, "Findings from the National Agricultural Workers Survey (NAWS) 2017–2018: A Demographic and Employment Profile of United States Farmworkers," Research Report No. 14 (Washington, DC, March 2021), https://www.dol.gov/agencies/eta/research/publications/findings-national-agricultural-workers-survey-naws-2017-2018 (farmworkers); National Association of Home Builders, "Which States and Construction Trades Depend the Most on Immigrant Workers?," Eye on Housing, April 2026, analysis of 2024 American Community Survey data, https://eyeonhousing.org/2026/04/which-states-and-construction-trades-depend-the-most-on-immigrant-workers/ (construction trades).

[6] Manufacturing series: Sarah Flood et al., IPUMS CPS [dataset] (Minneapolis, MN: University of Minnesota), https://cps.ipums.org; author's calculations from Annual Social and Economic Supplement samples, 2010–2025, manufacturing defined as Census 2012 industry codes 1070–3990. The age series is ASECWT-weighted, with 2014 interpolated from 2013 and 2015 (supplement-weight anomaly) and 2025 scaled by the 2024 weighted-to-unweighted ratio (ASECWT not yet released). The foreign-born series uses unweighted counts, which match external benchmarks (18–20 percent) where ASECWT-weighted shares (14–16 percent) do not. The ASEC is fielded in March, so the 2025 observation precedes most of the decline discussed in Section 6.3. All-industry average: US Bureau of Labor Statistics, Current Population Survey, annual averages, series LNS12024230 and LNU02000000, https://www.bls.gov/cps/.

[7] Manufacturers Alliance, "Impact of Foreign-Born Workers on Manufacturing" (Arlington, VA, 2025), https://www.manufacturersalliance.org/research-insights/impact-foreign-born-workers-manufacturing, reporting foreign-born shares of 19.2 percent in durable goods and 22.3 percent in nondurable goods manufacturing in 2024.

[8] US Bureau of Labor Statistics, Current Population Survey, Table A-7, "Employment Status of the Civilian Population by Nativity and Sex, Not Seasonally Adjusted," foreign-born labor force, January–August 2025, https://www.bls.gov/news.release/empsit.t07.htm. Nativity is collected only in the CPS household survey, not the CES establishment survey.

position — aging faster than Southeast Asian economies such as Viet Nam (12.7 percent) and Indonesia (10.4 percent), but slower than Northeast Asia.

The United States is early enough in this transition to act, and aging slowly enough that its policy options remain open — options that narrow as aging advances. Japan and Korea have responded with economy-wide robotics strategies (Section 4.1). Canada, Australia and Singapore have prioritized skilled immigration. The United States is doing neither.

2.4 Implications for Labor Supply

BLS projects total employment to grow just 3.1 percent over 2024–2034, roughly 0.3 percent per year and less than a quarter of the pace recorded over the prior decade, a slowdown attributed to slower labor force growth and declining participation.[9] Immigration restriction acts directly on this margin, and Section 6.3 quantifies the contraction already recorded.

Table 1. Demographic trends and industrial robot density, 2023–2040

Economy	Old-age dependency, 2023 (%)	Old-age dependency, 2040 projected (%)	Robot density, 2023
Korea	25.9	57.6	1,012
Singapore	17.4	31.9	770
China	20.7	41.6	470
Germany*	36.0	51.1	429
Japan	50.3	64.5	419
United States	26.8	35.5	295
Canada	29.6	39.3	—
Australia	26.9	36.0	—
Thailand	21.0	40.7	—
Malaysia	10.6	17.5	—
Mexico	11.9	20.1	—
Viet Nam	12.7	23.6	—
Indonesia	10.4	18.0	—

*Notes: Old-age dependency ratio = population 65+ / population 15–64 × 100. Robot density = operational industrial robots per 10,000 manufacturing employees. — = no 2023 density published in openly accessible World Robotics 2024 materials. *Non-APEC comparator (major robotics producer).*

Sources: World Bank[10] and UN World Population Prospects 2024, medium variant[11] (dependency

[9] US Bureau of Labor Statistics, "Employment Projections: 2024–2034," news release USDL-25-1324, August 28, 2025, https://www.bls.gov/news.release/ecopro.nr0.htm; on the demographic drivers, see "Industry and Occupational Employment Projections Overview and Highlights, 2024–34," *Monthly Labor Review*, 2026, https://www.bls.gov/opub/mlr/2026/article/industry-and-occupational-employment-projections-overview.htm.

[10] World Bank, *World Development Indicators*, DataBank, https://databank.worldbank.org/source/world-development-indicators.

[11] United Nations, *World Population Prospects 2024* (New York: United Nations, 2024), https://www.un.org/development/desa/pd/world-population-prospects-2024.

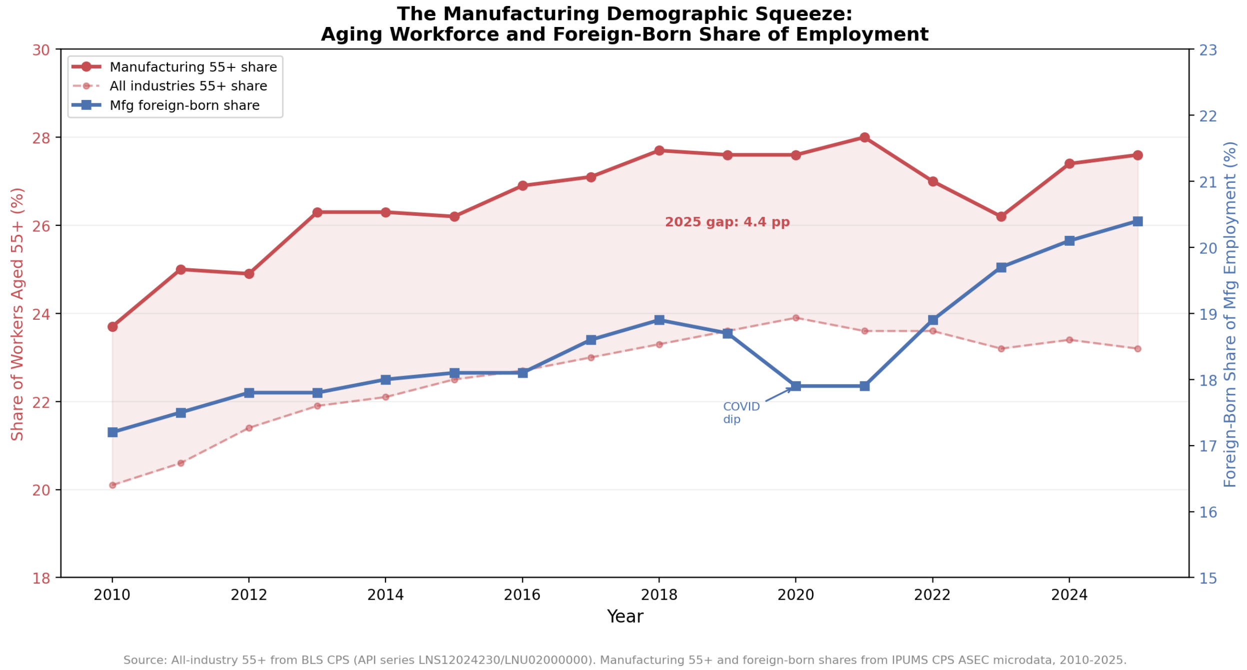

Figure 1. The manufacturing demographic squeeze: aging workforce and foreign-born share of employment, 2010–2025

ratios); IFR World Robotics 2024 (robot density). IFR revised its employment denominator in the 2025 edition, so the two editions are not comparable and are not mixed here.[12]

Sources: IPUMS CPS ASEC microdata (author's calculations); BLS CPS annual averages.

Sources: World Bank; UN World Population Prospects 2024.

3. Weak Productivity Growth in US Manufacturing

3.1 Falling Employment, Resilient Output

Manufacturing employment declined from roughly 17 million in 2000 to approximately 12.7 million by early 2025, before shedding an additional 82,000 jobs between April and December 2025 — a period coinciding with tariff escalation.[13] Yet real output has remained near its historical peak. That resilience masks a composition shift toward higher-value subsectors such as pharmaceuticals, aerospace and semiconductors. Output has also grown more concentrated among leading firms within industries over this period, a pattern Autor et al. document across the US economy.[14]

[12] International Federation of Robotics (IFR), *World Robotics 2024: Industrial Robots* (Frankfurt, 2024), https://ifr.org/img/worldrobotics/Contents_WR_2024_Industrial_Robots.pdf. On the revised methodology, see IFR, *World Robotics 2025: Industrial Robots* (Frankfurt, 2025), https://ifr.org/worldrobotics/report-2025.

[13] US Bureau of Labor Statistics, *Current Employment Statistics (CES)*, Series CES3000000001 (2025), https://www.bls.gov/ces/.

[14] David Autor et al., "The Fall of the Labor Share and the Rise of Superstar Firms," *Quarterly Journal of Economics* 135, no. 2 (2020): 645–709, https://doi.org/10.1093/qje/qjaa004.

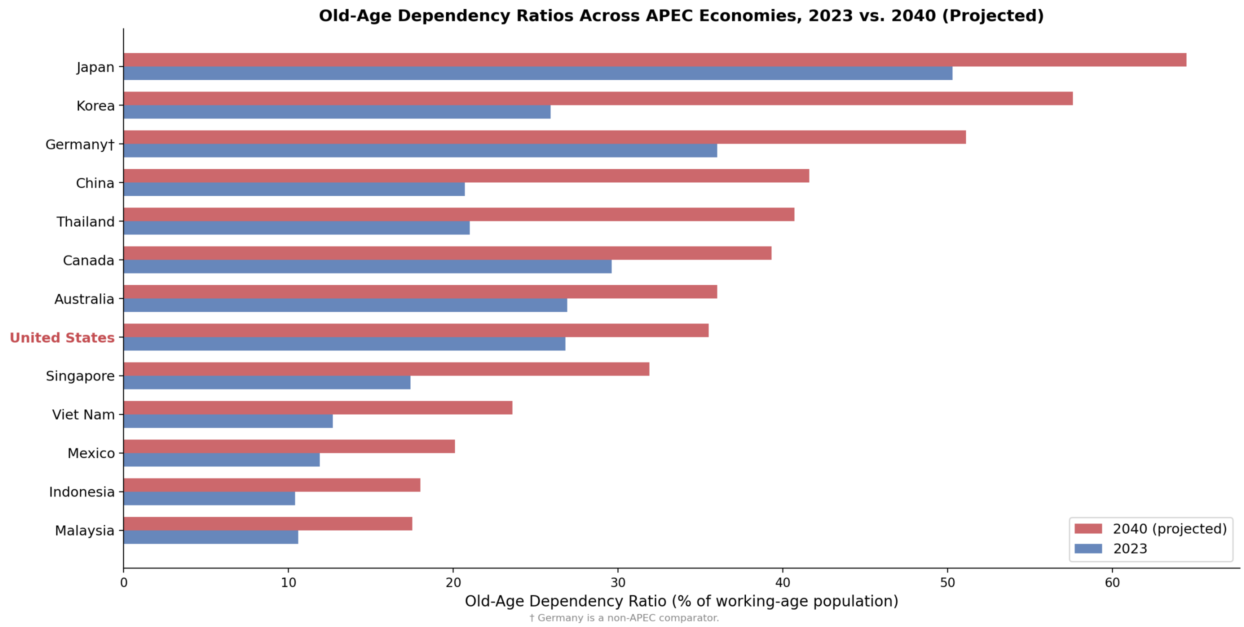

Figure 2. Cross-APEC old-age dependency ratios, 2023 and 2040 projected

3.2 The Productivity Gap

Between 2008 and 2024, nonfarm business labor productivity grew 31 percent cumulatively. Manufacturing managed just 3 percent, roughly one-tenth the economy-wide pace.[15] Figure 3 shows the divergence on a 2010 base, where nonfarm productivity grew 22 percent through 2024 while manufacturing output per hour fell 4 percent.[16] Lashkari and Pearce quantify the decline at approximately 0.5 percent per year from 2010 to 2022.[17]

Atalay et al. argue that part of the shortfall reflects mismeasurement stemming from a quality-adjustment bias in producer price indices.[18] Even under their more optimistic correction, manufacturing TFP grew at roughly 0.5 percent per year over 2009–2023, a sharp deterioration from the 2.0 percent pace their corrected series records over 1997–2009.[19]

3.3 The Adoption Gap

The declining productivity of research effort documented by Bloom et al. means new ideas are increasingly costly to produce, raising the return to diffusing the ones the economy already has,[20]

[15] US Bureau of Labor Statistics, *Major Sector Productivity and Costs*, Series PRS30006093 and PRS85006093 (2025), https://www.bls.gov/productivity/.
[16] US Bureau of Labor Statistics, Major Sector Productivity and Costs.
[17] Danial Lashkari and Jeremy Pearce, "The Mysterious Slowdown in U.S. Manufacturing Productivity," *Liberty Street Economics* (New York: Federal Reserve Bank of New York, July 2024), https://libertystreeteconomics.newyorkfed.org/2024/07/the-mysterious-slowdown-in-u-s-manufacturing-productivity/.
[18] Enghin Atalay et al., "Why Is Manufacturing Productivity Growth So Low?" Federal Reserve Bank of Philadelphia Working Paper 26-19 (April 2026), https://doi.org/10.21799/frbp.wp.2026.19.
[19] Atalay et al., "Why Is Manufacturing Productivity Growth So Low?"
[20] Nicholas Bloom et al., "Are Ideas Getting Harder to Find?" *American Economic Review* 110, no. 4 (2020): 1104–44, https://doi.org/10.1257/aer.20180338.

yet only 23 percent of US manufacturers report engaging in process innovation.[21] At the digital frontier the United States leads the world: private AI investment reached $109 billion in 2024, nearly twelve times China's and twenty-four times the United Kingdom's.[22] What lags is diffusion. In the most recent economy-wide census measure, from 2018, fewer than 6 percent of US firms used AI, while employment-weighted adoption was roughly three times higher because use concentrates in the largest firms; robot density, in turn, trails the APEC leaders (Sections 4.1 and 4.3).[23] The bottleneck, in other words, is adoption, not ideas. Luck finds that the industries most exposed to AI show no faster productivity gains or labor compression since 2022, consistent with a digitization gap that extends beyond factory automation to software and AI.[24] The United States generates the knowledge but fails to embed it in production processes.

3.4 Growth Accounting: Quantifying the Slowdown

A Solow growth decomposition using Penn World Table 11.0 ($\alpha = 0.33$) provides the quantitative spine. Table 2 presents the US results by decade.

Table 2. US growth accounting decomposition by decade (percentage points per year)

Decade	GDP growth	Capital deepening	Labor quantity	Human capital	TFP
1970s	3.16	0.78	1.42	0.63	0.33
1980s	3.05	0.67	1.70	0.21	0.47
1990s	3.17	0.73	1.31	0.27	0.86
2000s	1.88	1.17	−0.30	0.22	0.79
2010s	2.37	0.21	1.59	0.11	0.45
2020–23	2.25	0.63	0.44	0.36	0.83

Source: Penn World Table 11.0 (capital income share $\alpha = 0.33$).[25]

Labor's contribution to growth fell from 1.59 percentage points per year in the 2010s to 0.44 over 2020–23 (Table 2), a decline of 1.15 percentage points. Because the Penn World Table series ends in 2023, this reflects demographic aging and pandemic-era shifts in labor supply; the 2025 contraction of the foreign-born workforce documented in Section 6 postdates the data and would compound it.

[21] Robert D. Atkinson, "Don't Worry About Manufacturing Jobs. Worry About Manufacturing Productivity," Information Technology and Innovation Foundation (ITIF), November 4, 2024, https://itif.org/publications/2024/11/04/dont-worry-about-manufacturing-jobs-worry-about-manufacturing-productivity/.

[22] Nestor Maslej et al., *The 2025 AI Index Report* (Stanford, CA: Stanford Institute for Human-Centered Artificial Intelligence, 2025), "Economy," https://hai.stanford.edu/ai-index/2025-ai-index-report.

[23] Kristina McElheran et al., "AI Adoption in America: Who, What and Where," *Journal of Economics & Management Strategy* 33, no. 2 (2024): 375–415, https://doi.org/10.1111/jems.12576. The firm-weighted adoption rate is 5.9 percent and the employment-weighted rate about 18 percent, from the 2018 Annual Business Survey.

[24] Philip Luck, "America's Unproven Productivity Boom, and the Cost of Misreading the Data," Center for Strategic and International Studies, July 20, 2026, https://www.csis.org/analysis/americas-unproven-productivity-boom-and-cost-misreading-data. This commentary is by the present author.

[25] Robert C. Feenstra, Robert Inklaar, and Marcel P. Timmer, "The Next Generation of the Penn World Table," *American Economic Review* 105, no. 10 (2015): 3150–82; *Penn World Table version 11.0* (Groningen: Groningen Growth and Development Centre, October 2025), https://www.rug.nl/ggdc/productivity/pwt/.

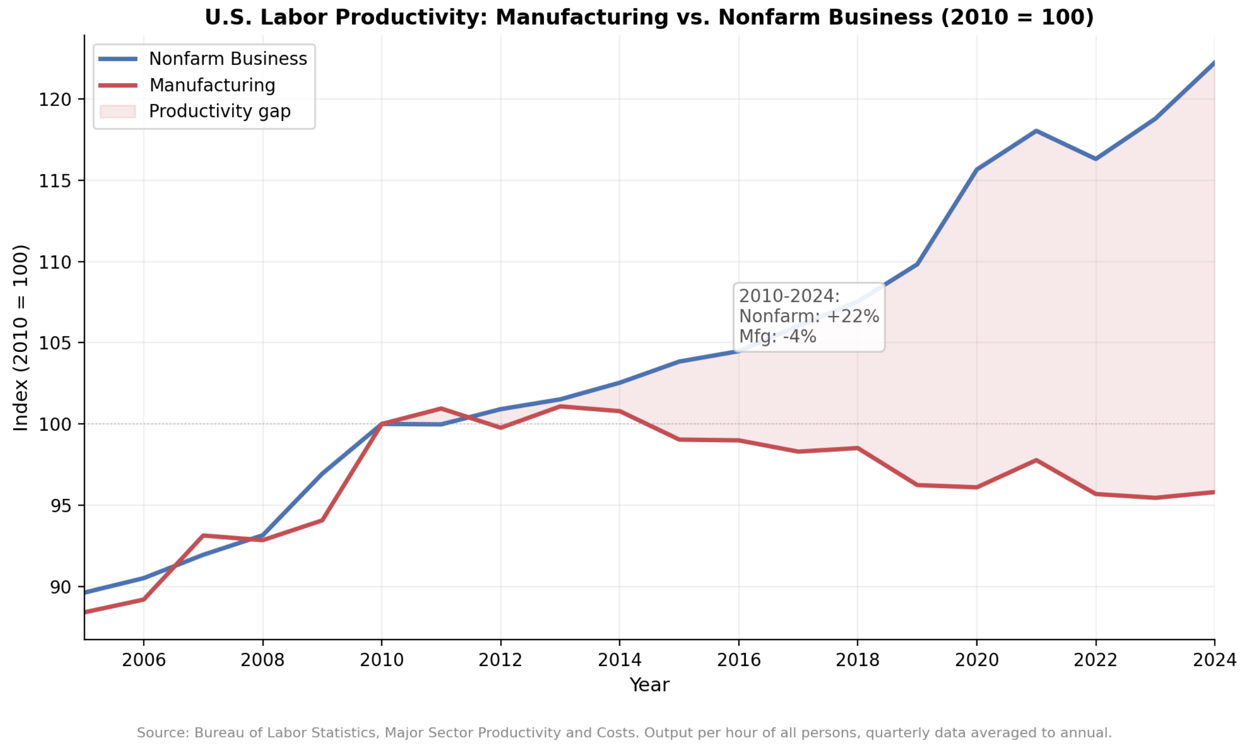

Figure 3. US manufacturing versus nonfarm business labor productivity, 2005–2024 (output per hour, indexed)

US capital deepening contributed just 0.33 pp/yr over 2010–2023, the year-weighted average spanning Table 2's last two rows, about one-quarter of Korea's 1.23 and one-tenth of China's 3.16 (Figure 4). That gap relative to Korea is consistent with the automation under-investment thesis in Section 4. The same PWT data show that this shortfall coexists with high capital efficiency. The United States has the lowest capital-output ratio in the comparison group — 3.4, versus 4.8 for Korea and 5.4 for Japan — implying a high average product of capital. Yet it also has the lowest investment rate among the APEC economies compared, at 22.7 percent of GDP, roughly two-thirds of Korea's and half of China's.[26]

While aggregate TFP appears strong (0.83 pp over 2020–23), this reflects gains concentrated outside manufacturing.[27] This aggregate strength may itself be overstated. Luck finds that utilization-adjusted total factor productivity, which strips out cyclical labor-hoarding effects, grew just 0.07 percent over the four quarters ending in the first quarter of 2026, against roughly 2.5 percent growth in measured labor productivity over the same period. The acceleration appears to reflect labor-market cycling more than a technology dividend.[28]

Source: BLS Major Sector Productivity and Costs.

Source: Penn World Table 11.0.

[26] Author's calculations from Penn World Table 11.0: capital-output ratio = rnna/rgdpna and investment rate = csh_i, averaged over 2010–2023 for the United States, Korea, Japan, China, and Germany.

[27] Lashkari and Pearce, "Mysterious Slowdown."

[28] Luck, "America's Unproven Productivity Boom."

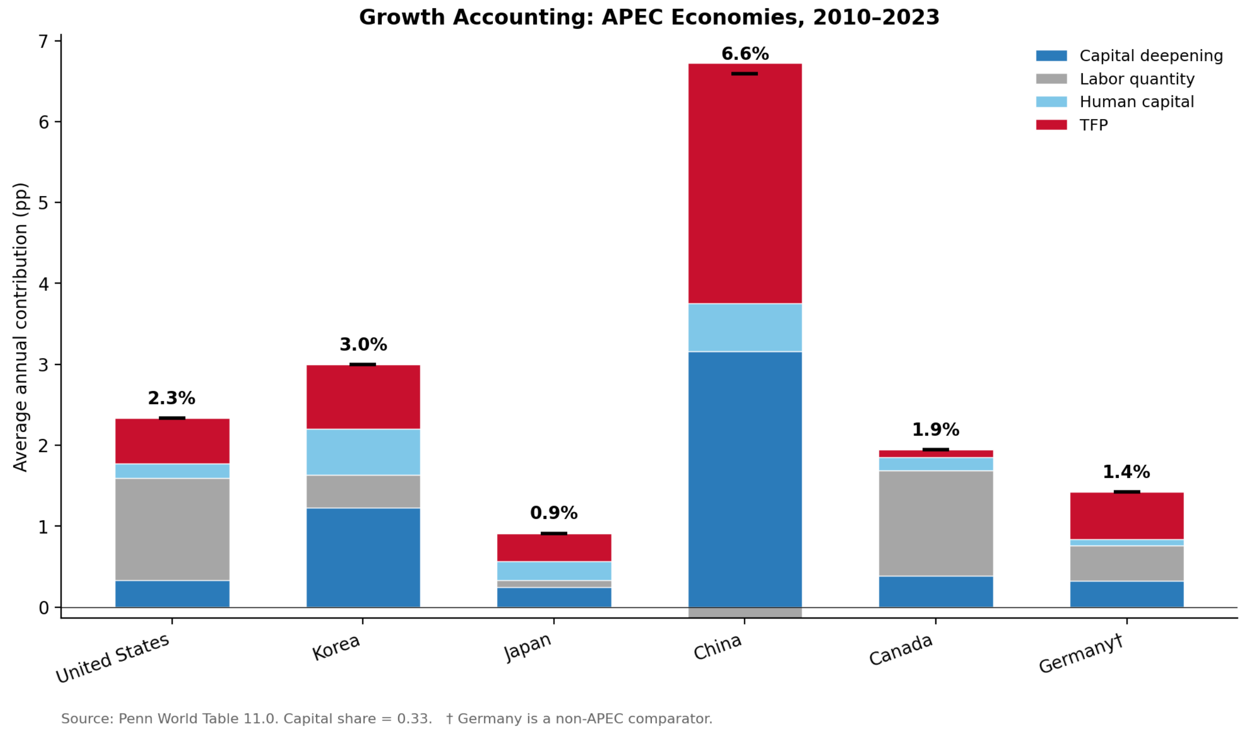

Figure 4. Cross-APEC growth accounting decomposition, 2010–2023 (percentage points per year)

4. The Automation and AI Adoption Gap

That weakness has a physical correlate: the United States is falling behind its APEC peers in deploying industrial robots. With labor force growth stalling (Section 2) and research productivity declining, automation is one of the few remaining margins for sustaining output growth.

4.1 Robotics Deployment

Robot density, the IFR's measure of operational industrial robots per 10,000 manufacturing employees, places the United States outside the top five globally at approximately 295 in 2023 (Figure 5). Korea leads at 1,012, followed by Singapore (770), China (470), Germany (429) and Japan (419).[29]

Trajectory matters more than the level. China's installations rose from 36,560 units in 2013 to 295,000 in 2024, more than an eightfold increase, accounting for more than half of all robots installed worldwide. US installations have hovered between roughly 27,000 and 40,000 per year for the past decade; in 2024 they fell 9 percent to 34,200 units. The US share of global installations has fallen from 13.3 percent in 2013 to 6.3 percent in 2024.[30]

[29] IFR, "Global Robot Density in Factories Doubled in Seven Years," press release (Frankfurt, 2024), https://ifr.org/ifr-press-releases/news/global-robot-density-in-factories-doubled-in-seven-years. Country-level densities appear here rather than in the World Robotics executive summary.

[30] IFR, "Global Robot Demand in Factories Doubles over 10 Years," press release (Frankfurt, September 25, 2025), https://ifr.org/ifr-press-releases/news/global-robot-demand-in-factories-doubles-over-10-years, reporting 542,000 industrial robots installed worldwide in 2024, of which 295,000 (54 percent) in China and 34,200 in the United States, down 9 percent on 2023. Installations for 2013 are from IFR, *World Robotics 2014: Industrial Robots* (Frankfurt, 2014). The employment-denominator revision described in the note to Table 1 applies to robot density only, not to installation counts. The 2025 release also reports that the

The United States has no major domestic producer of conventional articulated industrial robots. Japan (Fanuc, Yaskawa), Germany (KUKA, Chinese-owned), Switzerland (ABB) and increasingly China supply the critical hardware. American manufacturers seeking to automate generally purchase foreign equipment at prices inflated by trade policy.

Several APEC economies have adopted explicit robotics strategies that the United States lacks. Korea is investing roughly $2.2 billion in robotics under its Fourth Basic Plan on Intelligent Robots (2024–2028). Singapore has allocated $60 million to promote robotics adoption and allows first-year full expensing of automation equipment. China provides provincial purchase subsidies. Japan offers accelerated depreciation. The US flagship initiative, the ARM Institute, operates on approximately $30 million, a small fraction of Korea's five-year commitment.[31]

4.2 Robot Density, Productivity and the Korea Counterexample

Panel A of Figure 6 plots robot density against manufacturing value added per worker across the six economies with a 2023 density verifiable on the World Robotics 2024 basis; the level association is positive but modest (r = 0.33). Panel B shows that the same six, ranked by how fast they raised robot density over 2013–2023, also tended to record faster productivity growth (r = 0.57). Neither correlation is a causal estimate. The fitted line in Panel A omits China, whose productivity level reflects a different stage of development; excluding it moves the level correlation only to 0.35. The United States sits at the bottom of Panel B, pairing the second-smallest density gain with the slowest productivity growth.

Korea, the world's most robot-dense economy, faces a persistent productivity gap between chaebols and smaller firms, suggesting automation is necessary but not sufficient. Singapore's approach differs: its programs bundle equipment financing with consulting, process redesign and workforce training, addressing the full adjustment cost of technology integration. For SMEs, adjustment costs can exceed equipment costs.

Acemoglu and Restrepo model automation through displacement and productivity channels.[32] In a context of labor scarcity driven by demographic aging, under-automation means the United States is forgoing capital-for-labor substitution that could partially offset slowing labor supply.

4.3 The Small Firm Gap

Across every dimension of technology adoption, smaller firms lag, and planned AI investment points to a widening gap. CFO Survey evidence from the Federal Reserve Banks of Atlanta and Richmond quantifies the investment gap: approximately 30 percent of large firms plan to invest $1 million or more in AI in 2026, while roughly 60 percent of small firms plan less than $20,000.[33] The United

United States imports most of its robots from Japan and Europe and has few domestic suppliers.

[31] Robert D. Atkinson, Meghan Ostertag, and Trelysa Long, "A Time to Act: Policies to Strengthen the US Robotics Industry," Information Technology and Innovation Foundation, July 18, 2025, https://itif.org/publications/2025/07/18/time-to-act-policies-to-strengthen-us-robotics-industry/.

[32] Daron Acemoglu and Pascual Restrepo, "Automation and New Tasks: How Technology Displaces and Reinstates Labor," *Journal of Economic Perspectives* 33, no. 2 (2019): 3–30, https://doi.org/10.1257/jep.33.2.3. See also Acemoglu and Restrepo, "Robots and Jobs: Evidence from US Labor Markets," *Journal of Political Economy* 128, no. 6 (2020): 2188–2244, https://doi.org/10.1086/705716.

[33] Salomé Baslandze et al., "Artificial Intelligence, Productivity, and the Workforce: Evidence from Corporate Executives," Federal Reserve Bank of Atlanta Working Paper 2026-4 (March 2026); survey results summarized in "How Might AI Change the Workplace? Evidence from Corporate Executives," Atlanta Fed

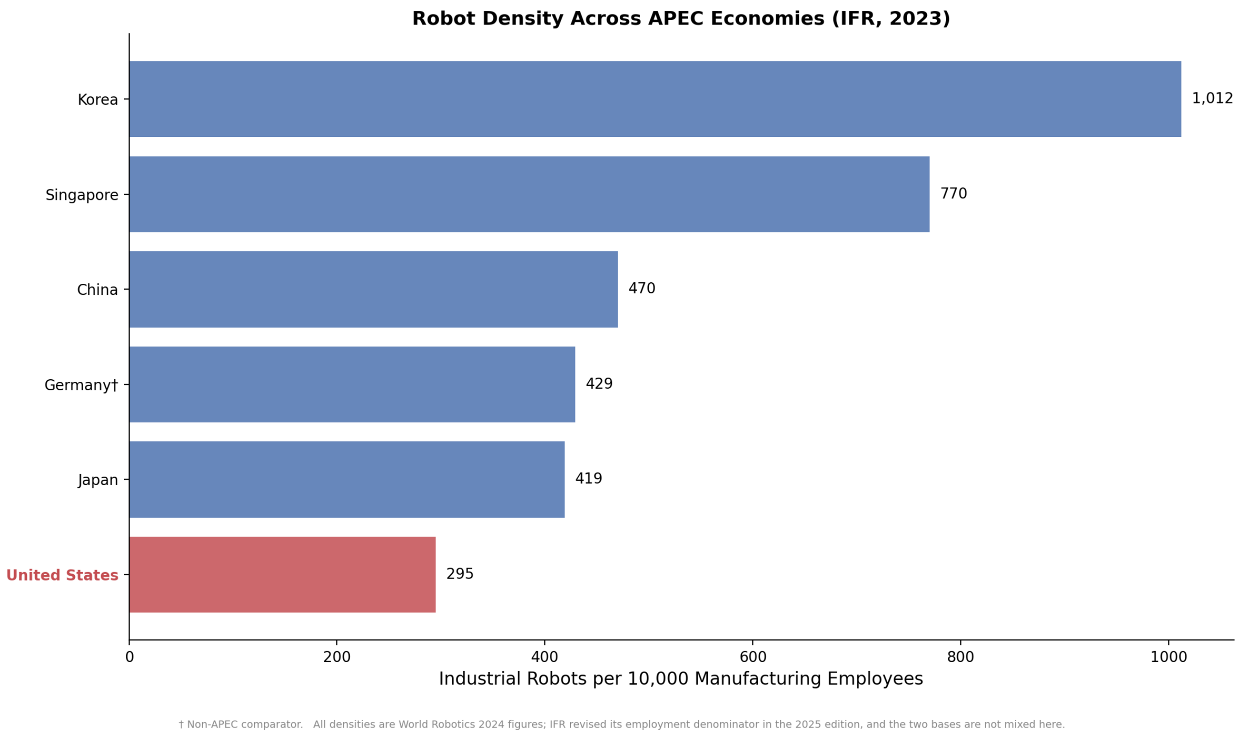

Figure 5. Robot density across APEC economies, 2023 (robots per 10,000 manufacturing employees)

States has roughly 285,000 manufacturing establishments.[34] Frontier performance among a few thousand, and weak productivity growth among the remaining 98-plus percent, are consistent with the aggregate pattern: rising R&D spending alongside flat manufacturing TFP.

Source: IFR World Robotics 2024.

Sources: IFR World Robotics 2024; World Bank; OECD STAN;[35] *Conference Board Total Economy Database.*[36]

macroblog, March 25, 2026, https://www.atlantafed.org/research-and-data/publications/policy-hub-macroblog/2026/03/25/how-might-ai-change-the-workplace-evidence-from-corporate-executives. See also Kristina McElheran et al., "AI Adoption in America: Who, What and Where," *Journal of Economics & Management Strategy* 33, no. 2 (2024): 375–415, https://doi.org/10.1111/jems.12576.

[34] US Census Bureau, County Business Patterns: 2023, NAICS sector 31-33 (manufacturing), https://www.census.gov/programs-surveys/cbp.html.

[35] OECD, *Structural Analysis (STAN) Database* (Paris: OECD, 2025). Manufacturing value added per worker in Figure 6 is compiled from published estimates in this source with World Bank and UNIDO series, not from a single harmonized extract; industry value added substitutes where the manufacturing-specific measure is unavailable. The levels reconcile to within roughly 4 percent for Japan, Germany, Canada and Korea against World Bank manufacturing value added per worker (constant 2015 US dollars).

[36] The Conference Board, *Total Economy Database* (New York, accessed April 2026), https://www.conference-board.org/data/economydatabase/, for manufacturing labor-productivity growth, 2013–2023, as published estimates rather than a direct extract. Figure 6's correlations are therefore illustrative.

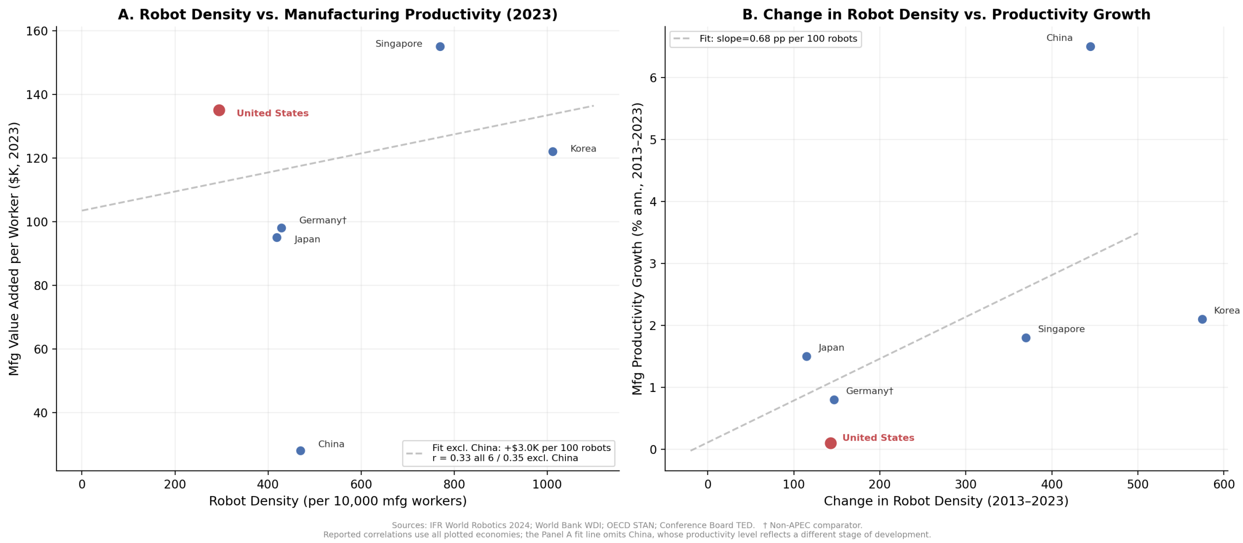

Figure 6. Robot density versus manufacturing labor productivity across APEC economies

5. Trade Costs and the 2025 Tariff Regime

The challenges traced so far (demographic aging, weak productivity growth and under-investment in automation) are primarily structural. They would exist regardless of trade policy. However, the tariff regime that took effect in 2025 has compounded each of them, raising costs on the intermediate inputs and capital goods manufacturers need to compete and automate.

5.1 Tariff Escalation

Fajgelbaum and Khandelwal estimate that the average effective US tariff duty rose from 2.4 percent in 2024 to 9.6 percent by the end of 2025 — the highest trade-weighted effective rate in at least 80 years and a fourfold increase in a single calendar year.[37] The Section 301 tariffs on Chinese goods initiated in 2018 were targeted by product and origin; the 2025 regime applies broadly across trading partners and product categories. Roughly 90 percent of tariff costs have been passed through to US importers rather than absorbed by foreign exporters, consistent with findings from the 2018–2019 rounds.[38]

Yale Budget Lab general equilibrium estimates project that long-run GDP contracts by 0.4 percent under the 2025 tariff regime. Manufacturing output as a whole expands by 2.5 percent, but that expansion is more than offset by losses elsewhere, with construction contracting by 3.8 percent. Its internal composition also runs the wrong way: nonadvanced durable manufacturing grows by 4.5 percent and nondurable manufacturing by 1.6 percent, while advanced manufacturing contracts by 3.3 percent.[39] The tariff regime may thus be shifting the composition of US manufacturing toward less sophisticated, lower-value-added production — precisely the opposite of what the productivity and automation challenges documented in Sections 3 and 4 require.

[37] Pablo Fajgelbaum and Amit Khandelwal, "Tariffs in 2025: Short-Run Impacts on the US Economy," National Bureau of Economic Research Working Paper 35064, April 2026, https://doi.org/10.3386/w35064.
[38] Fajgelbaum and Khandelwal, "Tariffs in 2025."
[39] The Budget Lab, "State of U.S. Tariffs: October 17, 2025" (New Haven, CT: Yale University), https://budgetlab.yale.edu/research/state-us-tariffs-october-17-2025.

Manufacturing employment losses (Section 3) coincided with the tariff escalation, complicating the protection rationale. Firms facing uncertainty about future trade policy defer capital expenditure, widening the automation gap traced in Section 4.[40] Because the United States imports virtually all of its industrial robots (Section 4.1), the tariffs function as a tax on the very capital deepening that Section 3 identified as essential.

5.2 Implications for the APEC Trade Agenda

The 2025 tariff escalation moves the United States further from the principles that have guided APEC trade policy for three decades. For APEC member economies that are both trading partners and suppliers of automation equipment — Japan, Korea and China, as well as non-APEC suppliers such as Germany — the tariffs create mutual costs. Japanese and Korean robotics manufacturers face reduced demand in a major export market. US manufacturers face higher costs for the equipment they need to remain competitive.

Lowering tariffs on automation inputs is a targeted productivity measure. Tariffs on equipment the United States does not produce generate no domestic production benefit, only cost.

6. Immigration Policy as a Productivity Variable

Section 2's demographic pressures have a straightforward policy remedy: immigration. That remedy is now being curtailed just as the demographic arithmetic turns against the United States.

6.1 The Skilled Immigration Bottleneck

The H-1B visa program is the primary channel for skilled foreign workers entering the US labor market. The statutory cap has remained essentially unchanged for two decades. A $100,000 fee on new petitions, imposed by proclamation in September 2025 and vacated by a federal court in June 2026 (the ruling is under appeal), would, if reinstated, function as a regressive tax falling hardest on startups and small firms. The National Foundation for American Policy reports that 61 percent of H-1B employers were approved for a single petition in FY 2025;[41] Luck and Denamiel note that the fee structure advantages large firms over smaller competitors.[42]

6.2 Immigration and Innovation

A large empirical literature links skilled immigration to innovation. Kerr and Lincoln find that higher H-1B admissions increase immigrant patenting without displacing native-born inventors;[43] immigrants produced 23 percent of US patents between 1990 and 2016 despite constituting 16

[40] Dario Caldara et al., "The Economic Effects of Trade Policy Uncertainty," *Journal of Monetary Economics* 109 (2020): 38–59, https://doi.org/10.1016/j.jmoneco.2019.11.002.

[41] National Foundation for American Policy, "H-1B Petitions and Denial Rates in FY 2025," NFAP Policy Brief, November 2025, https://nfap.com/wp-content/uploads/2025/11/H-1B-Petitions-and-Denial-Rates-For-FY-2025.NFAP-Policy-Brief.2025.pdf.

[42] Philip Luck and Thibault Denamiel, "Practical H-1B Reforms to Serve US Economic Interests," Center for Strategic and International Studies, February 2, 2026, https://www.csis.org/analysis/practical-h-1b-reforms-serve-us-economic-interests. The fee, imposed by proclamation on September 19, 2025, was vacated by the District of Massachusetts on June 8, 2026; the First Circuit declined to stay the vacatur on July 24, 2026.

[43] William R. Kerr and William F. Lincoln, "The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention," *Journal of Labor Economics* 28, no. 3 (2010): 473–508, https://doi.org/10.1086/651934.

percent of the inventor workforce;[44] and 46 percent of 2024 Fortune 500 companies were founded by immigrants or their children.[45] Dimmock, Huang, and Weisbenner show that startups with higher H-1B lottery win rates are more likely to secure venture capital and file patents.[46]

At the firm level, Doran, Gelber, and Isen find that the causal effect of an individual H-1B hire on firm-level patenting is small, and that a marginal H-1B hire crowds out roughly 1.5 other workers while lowering average employee wages and raising firm profits.[47] Those results cut against a purely complementary reading. The aggregate and firm-level findings are not contradictory, however: the system-wide contribution of skilled immigrants is large even if each marginal hire has a modest firm-level effect.

When restrictions bind, firms offshore. Glennon documents that firms with high H-1B dependency respond to visa cap reductions by increasing foreign affiliate employment.[48] The American Competitiveness in the 21st Century Act of 2000 temporarily raised the H-1B cap to 195,000, but the increase expired at the start of FY2004, reverting the cap to 65,000 — a change that accelerated offshoring of R&D-intensive jobs.[49]

6.3 Deportations, Labor Supply and Macroeconomic Effects

Immigration enforcement has escalated sharply. Figure 7 presents ICE's average daily detained population from TRAC data.[50] After declining from approximately 49,000 (September 2019) to roughly 15,000 during the pandemic, the detained population surged to over 67,000 by early 2026, more than a third above its pre-COVID level. Most of that increase came after January 2025, when the population stood at roughly 38,000.

East et al. provide causal microeconomic evidence: their estimates imply that for every one million deportations, native-born employment falls by approximately 88,000 in affected local economies, as higher labor costs reduce job creation and local consumption declines.[51] Multiple macroeconomic analyses estimate the GDP growth drag from immigration restriction at 0.1 to 1.0 percentage points annually.[52] The Penn Wharton estimate is a level effect: mass deportation would leave GDP 1.0 to

[44] Shai Bernstein et al., "The Contribution of High-Skilled Immigrants to Innovation in the United States," National Bureau of Economic Research Working Paper 30797, December 2022 (conditionally accepted, *American Economic Review*), https://doi.org/10.3386/w30797.

[45] American Immigration Council, "New American Fortune 500 in 2024," 2024, https://www.americanimmigrationcouncil.org/report/new-american-fortune-500-2024/.

[46] Stephen G. Dimmock, Jiekun Huang, and Scott J. Weisbenner, "Give Me Your Tired, Your Poor, Your High-Skilled Labor: H-1B Lottery Outcomes and Entrepreneurial Success," *Management Science* 68, no. 9 (2022): 6950–70. https://doi.org/10.1287/mnsc.2021.4152.

[47] Kirk Doran, Alexander Gelber, and Adam Isen, "The Effects of High-Skilled Immigration Policy on Firms: Evidence from Visa Lotteries," *Journal of Political Economy* 130, no. 10 (2022): 2501–33, https://doi.org/10.1086/720467.

[48] Britta Glennon, "How Do Restrictions on High-Skilled Immigration Affect Offshoring? Evidence from the H-1B Program," *Management Science* 70, no. 2 (2024): 907–30. https://doi.org/10.1287/mnsc.2023.4715.

[49] Glennon, "How Do Restrictions on High-Skilled Immigration Affect Offshoring?"

[50] TRAC Immigration, *Immigration Detention Statistics* (Syracuse, NY: Transactional Records Access Clearinghouse, 2026).

[51] Chloe N. East, Annie L. Hines, Philip Luck, Hani Mansour, and Andrea Velasquez, "The Labor Market Effects of Immigration Enforcement," *Journal of Labor Economics* 41, no. 4 (2023): 957–96, https://doi.org/10.1086/721152. The author of this case study is a coauthor; the per-deportation figure extrapolates from the article's estimates, not a reported coefficient.

[52] National Foundation for American Policy, "The Economic Impact of the Trump Administration's Immigration

3.3 percent smaller by 2034, depending on policy duration.

Deportation is not the only channel: withdrawing work authorization removes workers who were already legally employed. Ten Temporary Protected Status designations were terminated or allowed to expire during 2025, ending legal status for more than 700,000 people, roughly 550,000 of whom were authorized to work.[53] Several terminations were stayed in litigation until June 2026, when the Supreme Court held them largely unreviewable.[54] TPS holders participated in the labor force at 79.4 percent against 64.5 percent for the US-born population, and manufacturing was the largest single sector of their estimated output, so the loss falls on precisely the workforce Section 2 identified as scarce.

Foreign-born workers declined by approximately 1.1 million between January and August 2025.[55] Over the same months the native-born labor force grew by 2.3 million; in the same January-to-August window of 2023 and 2024, the foreign-born measure had grown by 1.6 million and 1.8 million. The decline is therefore not a seasonal artifact of the unadjusted series, nor does it reflect general labor-market weakness. The sectors that rely most on immigrant labor — agriculture, construction, hospitality and healthcare — are the most directly exposed.

Source: TRAC Immigration Detention Statistics.

7. Policy Recommendations and Lessons for APEC Economies

None of these challenges yields to action in a single policy domain. We offer four recommendations drawing on the experiences of APEC peer economies.

Policies," NFAP Policy Brief, October 2025, https://nfap.com/wp-content/uploads/2025/10/Economic-Impact-of-The-Trump-Administration-Immigration-Policies.NFAP-Policy-Brief.2025-1.pdf. See also Wendy Edelberg, Stan Veuger, and Tara Watson, "Macroeconomic Implications of Immigration Flows in 2025 and 2026: January 2026 Update," Brookings Institution, January 13, 2026, https://www.brookings.edu/articles/macroeconomic-implications-of-immigration-flows-in-2025-and-2026-january-2026-update/; Pia Orrenius et al., "Declining Immigration Weighs on GDP Growth, with Little Impact on Inflation," Dallas Fed Economics, July 8, 2025, https://www.dallasfed.org/research/economics/2025/0708; and Felipe Ruiz Mazin and Felix Reichling, "Mass Deportation of Unauthorized Immigrants: Fiscal and Economic Effects," Penn Wharton Budget Model, July 25, 2025, https://budgetmodel.wharton.upenn.edu/p/2025-07-25-mass-deportation-of-unauthorized-immigrants-fiscal-and-economic-effects/.

[53] Jesús Villero, Brendan Warshauer, and Youran Wu, "550,000 Workers Lose Status by End of 2025: Potential Impact by State and Industry," Penn Wharton Budget Model, November 19, 2025, https://budgetmodel.wharton.upenn.edu/issues/2025/11/19/demographic-and-labor-market-profile-of-tps-beneficiaries. Manufacturing accounted for $5.5 billion of TPS holders' estimated $35.9 billion annual contribution to GDP, ahead of construction ($5.0 billion).

[54] *Mullin v. Doe*, No. 25-1083 (US June 25, 2026), https://www.supremecourt.gov/opinions/25pdf/25-1083_f204.pdf; Congressional Research Service, "Mullin v. Doe: Supreme Court Allows Termination of Temporary Protected Status for Haiti and Syria," Legal Sidebar LSB11446, July 2, 2026.

[55] US Bureau of Labor Statistics, Current Population Survey, Table A-7 (foreign-born labor force, not seasonally adjusted). Author's calculations from series LNU01073395 (civilian labor force, foreign born) and LNU01073413 (native born): a fall of 1,068,000 from January to August 2025, against increases of 1,622,000 and 1,805,000 over the same months of 2023 and 2024, while the native-born series gained 2,289,000 in 2025. The 2025 fall is the largest over these months since at least 2019; the only other declines in that span were 533,000 in 2019 and 864,000 in 2020.

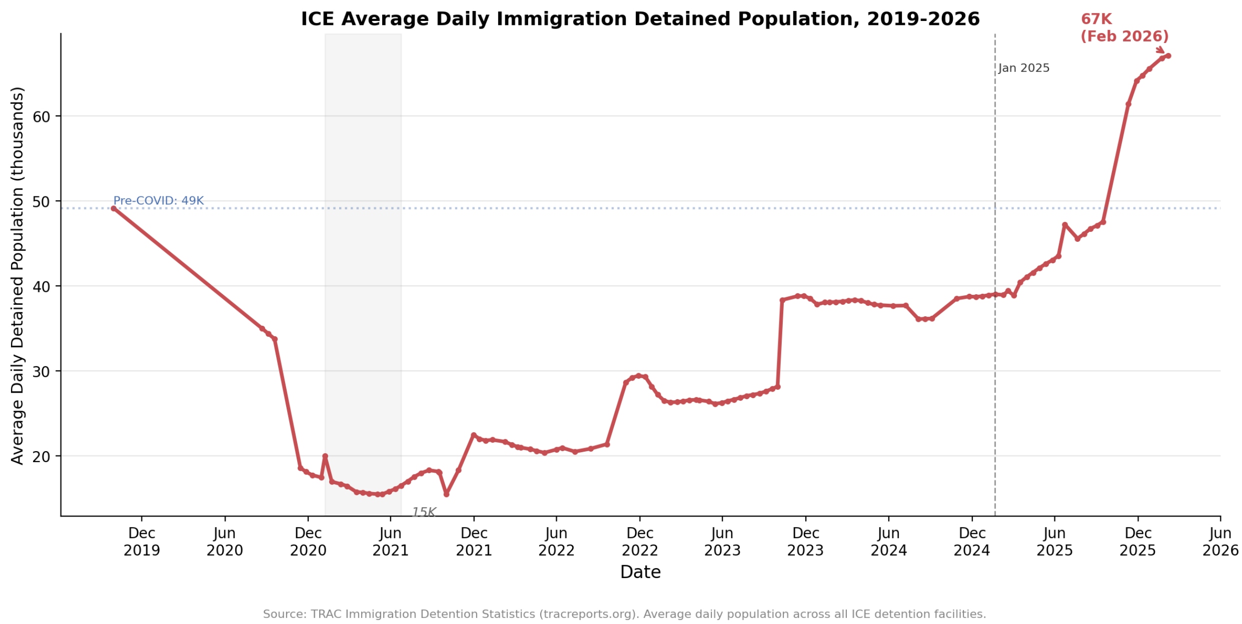

Figure 7. ICE average daily detained population, 2019–2026

7.1 Invest in Automation Adoption, with a Focus on SMEs

US manufacturing productivity growth is weak, robot density lags peer economies and the gap is concentrated among small and medium firms. The policy response should target adoption and diffusion. The APEC peer models — Korea's $2.2 billion robotics program, Singapore's bundled equipment-plus-consulting approach and Japan's depreciation incentives — offer proven alternatives. One approach would be to create an economy-wide network of automation institutes and provide accelerated depreciation for automation equipment purchases by firms below a size threshold.

7.2 Lower Trade Costs on Automation Inputs

Section 5 documented how tariffs function as a tax on automation investment. Because the United States does not manufacture industrial robots at scale, eliminating or substantially reducing tariffs on automation equipment would lower costs without sacrificing domestic production. The APEC FTAAP agenda offers a natural vehicle.

7.3 Reform Skilled Immigration Pathways

Three reforms merit consideration: (i) modernize the H-1B cap to reflect current demand; (ii) decline to reinstate the vacated $100,000 fee, which would function as a barrier to small firms; and (iii) streamline visa processing for documented shortage occupations. Canada, Australia and Singapore are actively recruiting the talent that US restrictions push away.

7.4 Align Industrial Policy with Trade and Immigration Policy

Industrial policy that contradicts trade and immigration policy defeats itself. The CHIPS Act and the Inflation Reduction Act subsidize advanced manufacturing; tariffs then tax the automation equipment those plants need, and visa policy narrows the skilled labor pipeline. The binding constraint is more often policy alignment than funding.

8. Conclusion

We began by asking how the world's largest APEC economy is navigating a demographic and policy squeeze on three fronts. The answer is that every adjustment margin is being constrained at once. Some constraints are exogenous — an aging population and declining research productivity — but the most consequential are self-imposed. Tariffs at their highest level in at least 80 years raise the cost of intermediate and capital goods. Immigration enforcement, with ICE's detained population reaching 67,000 by early 2026, has coincided with a shrinking foreign-born workforce just when demographics most demand expansion. The absence of an economy-wide technology adoption strategy leaves most manufacturers without the tools to close the productivity gap.

Growth accounting shows that the labor contribution to US GDP growth has contracted by more than one percentage point per year, while capital deepening lags Korea by nearly a factor of four and China by nearly ten.

For APEC, the cautionary message is that even the world's largest economy can hold back its own productivity growth through policies working at cross-purposes. The constructive message is that peer economies have demonstrated workable alternatives — from Korea's robotics investment to Singapore's immigration openness to Japan's automation incentives. The APEC cooperative framework provides a vehicle for collective action on these shared challenges. Whether the United States will use the policy options it still retains remains to be seen.

Works Cited

Acemoglu, Daron, and Pascual Restrepo. "Automation and New Tasks: How Technology Displaces and Reinstates Labor." *Journal of Economic Perspectives* 33, no. 2 (2019): 3–30. https://doi.org/10.1257/jep.33.2.3.

Acemoglu, Daron, and Pascual Restrepo. "Robots and Jobs: Evidence from US Labor Markets." *Journal of Political Economy* 128, no. 6 (2020): 2188–2244. https://doi.org/10.1086/705716.

American Immigration Council. "New American Fortune 500 in 2024." 2024. https://www.americanimmigrationcouncil.org/report/new-american-fortune-500-2024/.

Atalay, Enghin, et al. "Why Is Manufacturing Productivity Growth So Low?" Federal Reserve Bank of Philadelphia Working Paper 26-19, April 2026. https://doi.org/10.21799/frbp.wp.2026.19.

Atkinson, Robert D. "Don't Worry About Manufacturing Jobs. Worry About Manufacturing Productivity." Information Technology and Innovation Foundation, November 4, 2024. https://itif.org/publications/2024/11/04/dont-worry-about-manufacturing-jobs-worry-about-manufacturing-productivity/.

Atkinson, Robert D., Meghan Ostertag, and Trelysa Long. "A Time to Act: Policies to Strengthen the US Robotics Industry." Information Technology and Innovation Foundation, July 18, 2025. https://itif.org/publications/2025/07/18/time-to-act-policies-to-strengthen-us-robotics-industry/.

Autor, David, et al. "The Fall of the Labor Share and the Rise of Superstar Firms." *Quarterly Journal of Economics* 135, no. 2 (2020): 645–709. https://doi.org/10.1093/qje/qjaa004.

Barua, Akrur, and Ruhika Agarwal. "A Shrinking Workforce May Thwart US Manufacturing Ambitions." *Deloitte Insights*, December 22, 2025. https://www.deloitte.com/us/en/insights/topics/economy/spotlight/us-manufacturing-labor-impact.html.

Baslandze, Salomé, et al. "Artificial Intelligence, Productivity, and the Workforce: Evidence from Corporate Executives." Federal Reserve Bank of Atlanta Working Paper 2026-4, March 2026.

Bernstein, Shai, et al. "The Contribution of High-Skilled Immigrants to Innovation in the United States." National Bureau of Economic Research Working Paper 30797, December 2022. Conditionally accepted, *American Economic Review*. https://doi.org/10.3386/w30797.

Bloom, Nicholas, et al. "Are Ideas Getting Harder to Find?" *American Economic Review* 110, no. 4 (2020): 1104–44. https://doi.org/10.1257/aer.20180338.

The Budget Lab. "State of U.S. Tariffs: October 17, 2025." New Haven, CT: Yale University. https://budgetlab.yale.edu/research/state-us-tariffs-october-17-2025.

Caldara, Dario, et al. "The Economic Effects of Trade Policy Uncertainty." *Journal of Monetary Economics* 109 (2020): 38–59. https://doi.org/10.1016/j.jmoneco.2019.11.002.

The Conference Board. *Total Economy Database*. New York: The Conference Board. Accessed April 2026. https://www.conference-board.org/data/economydatabase/.

Congressional Research Service. "*Mullin v. Doe*: Supreme Court Allows Termination of Temporary Protected Status for Haiti and Syria." Legal Sidebar LSB11446, July 2, 2026.

Deloitte and the Manufacturing Institute. "Taking Charge: Manufacturers Support Growth with Active Workforce Strategies." Washington, DC: The Manufacturing Institute, April 2024. https://themanufacturinginstitute.org/wp-content/uploads/2024/04/Digital_Skills_Report_April_2024.pdf.

Dimmock, Stephen G., Jiekun Huang, and Scott J. Weisbenner. "Give Me Your Tired, Your Poor, Your High-Skilled Labor: H-1B Lottery Outcomes and Entrepreneurial Success." *Management Science* 68, no. 9 (2022): 6950–70. https://doi.org/10.1287/mnsc.2021.4152.

Doran, Kirk, Alexander Gelber, and Adam Isen. "The Effects of High-Skilled Immigration Policy on Firms: Evidence from Visa Lotteries." *Journal of Political Economy* 130, no. 10 (2022): 2501–33. https://doi.org/10.1086/720467.

Driscoll, Anne K., and Brady Hamilton. "Effects of Age-specific Fertility Trends on Overall Fertility Trends: United States, 1990–2023." *National Vital Statistics Reports* 74, no. 3 (March 2025). https://doi.org/10.15620/cdc/174576.

East, Chloe N., Annie L. Hines, Philip Luck, Hani Mansour, and Andrea Velasquez. "The Labor Market Effects of Immigration Enforcement." *Journal of Labor Economics* 41, no. 4 (2023): 957–96. https://doi.org/10.1086/721152.

Edelberg, Wendy, Stan Veuger, and Tara Watson. "Macroeconomic Implications of Immigration Flows in 2025 and 2026: January 2026 Update." Brookings Institution, January 13, 2026. https://www.brookings.edu/articles/macroeconomic-implications-of-immigration-flows-in-2025-and-2026-january-2026-update/.

Fajgelbaum, Pablo, and Amit Khandelwal. "Tariffs in 2025: Short-Run Impacts on the US Economy." National Bureau of Economic Research Working Paper 35064, April 2026. https://doi.org/10.3386/w35064.

Federal Reserve Bank of Atlanta. "How Might AI Change the Workplace? Evidence from Corporate Executives." *macroblog*, March 25, 2026. https://www.atlantafed.org/research-and-data/publications/policy-hub-macroblog/2026/03/25/how-might-ai-change-the-workplace-evidence-from-corporate-executives.

Feenstra, Robert C., Robert Inklaar, and Marcel P. Timmer. "The Next Generation of the Penn World Table." *American Economic Review* 105, no. 10 (2015): 3150–82.

Flood, Sarah, et al. *IPUMS CPS* [dataset]. Minneapolis, MN: IPUMS, University of Minnesota. https://cps.ipums.org.

Glennon, Britta. "How Do Restrictions on High-Skilled Immigration Affect Offshoring? Evidence from the H-1B Program." *Management Science* 70, no. 2 (2024): 907–30. https://doi.org/10.1287/mnsc.2023.4715.

International Federation of Robotics. "Global Robot Demand in Factories Doubles over 10 Years." Press release. Frankfurt: IFR Statistical Department, September 25, 2025. https://ifr.org/ifr-press-releases/news/global-robot-demand-in-factories-doubles-over-10-years.

International Federation of Robotics. "Global Robot Density in Factories Doubled in Seven Years." Press release. Frankfurt: IFR Statistical Department, 2024. https://ifr.org/ifr-press-releases/news/global-robot

-density-in-factories-doubled-in-seven-years.

International Federation of Robotics. *World Robotics 2024: Industrial Robots*. Frankfurt: IFR Statistical Department, 2024. https://ifr.org/img/worldrobotics/Contents_WR_2024_Industrial_Robots.pdf.

International Federation of Robotics. *World Robotics 2025: Industrial Robots*. Frankfurt: IFR Statistical Department, 2025. https://ifr.org/worldrobotics/report-2025.

Kerr, William R., and William F. Lincoln. "The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention." *Journal of Labor Economics* 28, no. 3 (2010): 473–508. https://doi.org/10.1086/651934.

Lashkari, Danial, and Jeremy Pearce. "The Mysterious Slowdown in U.S. Manufacturing Productivity." *Liberty Street Economics*. New York: Federal Reserve Bank of New York, July 2024. https://libertystreeteconomics.newyorkfed.org/2024/07/the-mysterious-slowdown-in-u-s-manufacturing-productivity/.

Luck, Philip. "America's Unproven Productivity Boom, and the Cost of Misreading the Data." Center for Strategic and International Studies, July 20, 2026. https://www.csis.org/analysis/americas-unproven-productivity-boom-and-cost-misreading-data.

Luck, Philip, and Thibault Denamiel. "Practical H-1B Reforms to Serve US Economic Interests." Center for Strategic and International Studies, February 2, 2026. https://www.csis.org/analysis/practical-h-1b-reforms-serve-us-economic-interests.

Manufacturers Alliance. "Impact of Foreign-Born Workers on Manufacturing." Arlington, VA: Manufacturers Alliance, 2025. https://www.manufacturersalliance.org/research-insights/impact-foreign-born-workers-manufacturing.

Maslej, Nestor, et al. *The 2025 AI Index Report*. Stanford, CA: Stanford Institute for Human-Centered Artificial Intelligence, 2025. https://hai.stanford.edu/ai-index/2025-ai-index-report.

McElheran, Kristina, et al. "AI Adoption in America: Who, What and Where." *Journal of Economics & Management Strategy* 33, no. 2 (2024): 375–415. https://doi.org/10.1111/jems.12576.

Mullin v. Doe, No. 25-1083 (US June 25, 2026). https://www.supremecourt.gov/opinions/25pdf/25-1083_f204.pdf.

National Association of Home Builders. "Which States and Construction Trades Depend the Most on Immigrant Workers?" *Eye on Housing*, April 2026. https://eyeonhousing.org/2026/04/which-states-and-construction-trades-depend-the-most-on-immigrant-workers/.

National Foundation for American Policy. "H-1B Petitions and Denial Rates in FY 2025." NFAP Policy Brief, November 2025. https://nfap.com/wp-content/uploads/2025/11/H-1B-Petitions-and-Denial-Rates-For-FY-2025.NFAP-Policy-Brief.2025.pdf.

National Foundation for American Policy. "The Economic Impact of the Trump Administration's Immigration Policies." NFAP Policy Brief, October 2025. https://nfap.com/wp-content/uploads/2025/10/Economic-Impact-of-The-Trump-Administration-Immigration-Policies.NFAP-Policy-Brief.2025-1.pdf.

OECD. *Structural Analysis (STAN) Database*. Paris: OECD, 2025.

Orrenius, Pia, et al. "Declining Immigration Weighs on GDP Growth, with Little Impact on Inflation." *Dallas Fed Economics*. Federal Reserve Bank of Dallas, July 8, 2025. https://www.dallasfed.org/research/economics/2025/0708.

Osterman, Michelle J.K., et al. "Births: Final Data for 2024." *National Vital Statistics Reports* 75, no. 2 (2026). https://www.cdc.gov/nchs/data/nvsr/nvsr75/nvsr75-02.pdf.

Penn World Table. Version 11.0. Groningen: Groningen Growth and Development Centre, University of Groningen, October 2025. https://www.rug.nl/ggdc/productivity/pwt/.

Ruiz Mazin, Felipe, and Felix Reichling. "Mass Deportation of Unauthorized Immigrants: Fiscal and Economic Effects." Penn Wharton Budget Model, July 25, 2025. https://budgetmodel.wharton.upenn.edu/p/2025-07-25-mass-deportation-of-unauthorized-immigrants-fiscal-and-economic-effects/.

TRAC Immigration. *Immigration Detention Statistics*. Syracuse, NY: Transactional Records Access Clearinghouse, Syracuse University, 2026.

United Nations. *World Population Prospects 2024*. New York: United Nations, 2024. https://www.un.org/development/desa/pd/world-population-prospects-2024.

US Bureau of Labor Statistics. *Current Employment Statistics*. US Department of Labor, series CES3000000001, 2025. https://www.bls.gov/ces/.

US Bureau of Labor Statistics. *Current Population Survey*. Table A-7, "Employment Status of the Civilian Population by Nativity and Sex, Not Seasonally Adjusted." https://www.bls.gov/news.release/empsit.t07.htm.

US Bureau of Labor Statistics. "Employment Projections: 2024–2034." News release USDL-25-1324, August 28, 2025. https://www.bls.gov/news.release/ecopro.nr0.htm.

US Bureau of Labor Statistics. "Industry and Occupational Employment Projections Overview and Highlights, 2024–34." *Monthly Labor Review*, 2026. https://www.bls.gov/opub/mlr/2026/article/industry-and-occupational-employment-projections-overview.htm.

US Bureau of Labor Statistics. *Major Sector Productivity and Costs*. US Department of Labor, series PRS30006093 and PRS85006093, 2025. https://www.bls.gov/productivity/.

US Census Bureau. *County Business Patterns: 2023*. NAICS sector 31-33 (manufacturing). https://www.census.gov/programs-surveys/cbp.html.

US Census Bureau. "U.S. Population Projected to Begin Declining in Second Half of Century." Press release CB23-189, November 9, 2023. https://www.census.gov/newsroom/press-releases/2023/population-projections.html.

US Department of Labor, Employment and Training Administration. *Findings from the National Agricultural Workers Survey (NAWS) 2017–2018: A Demographic and Employment Profile of United States Farmworkers*. Research Report No. 14. Washington, DC: US Department of Labor, March 2021. https://www.dol.gov/agencies/eta/research/publications/findings-national-agricultural-workers-survey-naws-2017-2018.

Villero, Jesús, Brendan Warshauer, and Youran Wu. "550,000 Workers Lose Status by End of 2025: Potential Impact by State and Industry." Penn Wharton Budget Model, November 19, 2025. https://budgetmodel.wharton.upenn.edu/issues/2025/11/19/demographic-and-labor-market-profile-of-tps-beneficiaries.

World Bank. *World Development Indicators*. DataBank. https://databank.worldbank.org/source/world-development-indicators.