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CHAPTER 4 OF THE
CHAIRMAN'S VIEWS

Driving Production Through
Human Capital and Innovation



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CHAPTER 4: DRIVING PRODUCTION THROUGH HUMAN CAPITAL AND INNOVATION

To fulfill the promises the Federal government made to its aging population and preserve economic prosperity for its citizens, the United States must have strong economic growth. Growth plays a critical role in generating the tax receipts that fund senior benefits and help the country manage its growing Federal debt levels, which can raise financing costs for housing, cars, and business equipment. Key drivers of economic growth are the supply of labor and the productivity of industry. The supply of labor can increase through births. However, fertility rates have continuously failed to reach replacement level across the Western world, and interventions have thus far been ineffective. Productivity can increase through education, training, and, in particular, technological advancements.

Labor supply

Demographic challenges

The global population is expected to peak in 2084, and the Congressional Budget Office projects U.S. population growth will fall to 0.0 percent in 2048 and will not recover for the foreseeable future.²¹⁰ The composition of the U.S. population will also shift older. The median U.S. age is projected to rise from 39.4 years in 2025 to 45.5 years in 2056, with the percent of individuals aged 65 and over rising from 15 percent to 23 percent.²¹¹ As detailed in Chapter 1, Federal benefits for retirees are funded through

²¹⁰ Congressional Budget Office, *The Demographic Outlook: 2026 to 2056* (January 2026), <https://www.cbo.gov/publication/61994>; Monolo Corichi, Sofia Hernandez Ramones, and Skylar Thomas, “5 facts about how the world’s population is expected to change by 2100,” Pew Research Center, July 9, 2025, <https://www.pewresearch.org/short-reads/2025/07/09/5-facts-about-how-the-worlds-population-is-expected-to-change-by-2100/>.

²¹¹ Congressional Budget Office, *The Demographic Outlook: 2026 to 2056*.

intergenerational transfers; workers pay the taxes used to provide the benefits seniors use, such as Social Security and Medicare. The demographic challenges of a slowing workforce growth rate and a contracting ratio of workers to retirees are headwinds to economic growth and restraining fiscal deficits.

Theoretically, correcting the declining ratio of workers to retirees could occur through higher fertility rates. The total fertility rate (TFR) is the average number of children a woman would have by the end of her childbearing years assuming she experiences present age-specific fertility rates over that time.²¹² At 1.59,²¹³ the U.S. currently has a TFR well below the replacement rate,²¹⁴ a trend which is a significant contributor to the shrinking workforce. Unfortunately, interventions in other countries to increase birth rates have been ineffective and often expensive.²¹⁵ For example, South Korea saw its fertility rates drop to record lows even after spending 1.5 percent of GDP on pro-family policies.²¹⁶

Increased fertility as a solution also comes with near- and mid-term increases in government outlays (for example, public education, government-subsidized healthcare, and supplemental nutrition),²¹⁷ while the fiscal benefits arise in the long-term.

²¹² Organisation for Economic Co-operation and Development, “Fertility rates,” accessed April 17, 2026, <https://www.oecd.org/en/data/indicators/fertility-rates.html>.

²¹³ Congressional Budget Office, *The Demographic Outlook: 2026 to 2056*.

²¹⁴ Generally stated to be 2.1 live births per woman. J. Craig, “Replacement Level Fertility and Future Population Growth,” *Population Trends* no. 78 (1994): 20–22, <https://pubmed.ncbi.nlm.nih.gov/7834459/>.

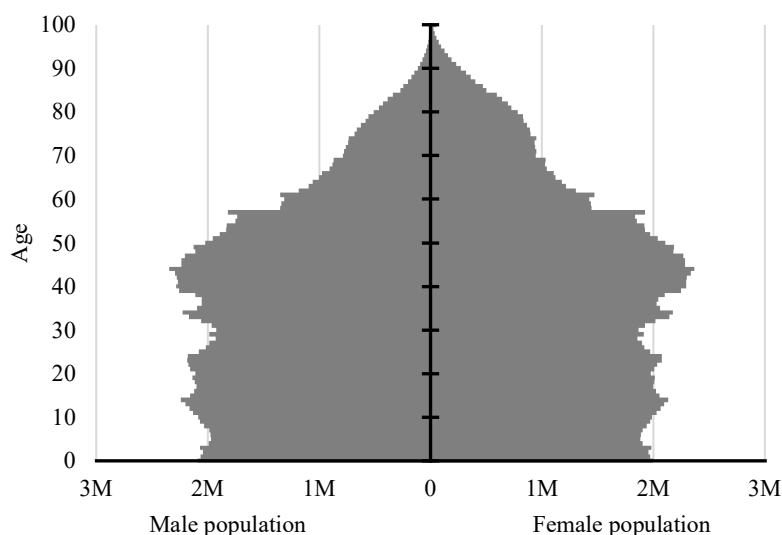
²¹⁵ Chelsea Follett, “The World Needs Children, Not Child Subsidies,” Cato Institute, February 22, 2025, <https://www.cato.org/commentary/world-needs-children-not-child-subsidies>.

²¹⁶ Michael Lokshin, “What’s needed to encourage larger families?” Brookings Institute, May 16, 2025, <https://www.brookings.edu/articles/whats-needed-to-encourage-larger-families/>.

²¹⁷ Per-capita early-life public spending is far outweighed by post-retirement public spending, with post-retirement spending consuming about five times the per-capita outlays for children in 2019, see Lisa Dettling and Luke Pardue, “Low Fertility and

Children born now will not be productive for at least 16 years and will consume a great magnitude of public benefits in their childhood and early adulthood.²¹⁸ Increased outlays on childhood investment resulting from a “baby boom” would occur concurrently with already increasing outlays on a growing senior population, with retirees consuming five times the benefits value that children consume per capita per year.²¹⁹ Thus, increasing fertility alone is insufficient to support an aging population and address the nation’s fiscal trajectory.

Figure 4-1: U.S. Population Pyramid, 2005



Source: U.S. Census Bureau²²⁰

Fiscal Sustainability: The Effects of Past and Future Fertility Rates on the US Federal Budget Outlook,” in *Demographic Headwinds: The Economic Consequences of Lower Birth Rates and Longer Lives*, ed. Milissa S. Kearney and Luke Pardue (Aspen Economic Strategy Group, 2026),

<https://www.economicstrategygroup.org/publication/demographic-headwinds/>.

²¹⁸ Dettling and Pardue, “Low Fertility and Fiscal Sustainability.”

²¹⁹ Dettling and Pardue, “Low Fertility and Fiscal Sustainability.”

²²⁰ U.S. Census Bureau, “Population and Housing Unit Estimates Datasets,” last modified January 13, 2026, <https://www.census.gov/programs-surveys/popest/data/data-sets.html>.

Figure 4-2: U.S. Population Pyramid, 2025

Source: U.S. Census Bureau²²¹

The problem of slowing birth rates, dwindling labor supply, and an aging population is global. This dynamic sets up a worldwide competition for individuals most likely to contribute to a country's success. China, India, and every OECD country except Israel also has a TFR under replacement.²²² Consequently, all these countries will likely suffer from a shortage of high-skilled labor in the next 20 years. Other nations have already initiated efforts to recruit high-skilled talent, such as the United Kingdom's Global Talent and High Potential Individual Visas,²²³ Canada's Tech Talent

²²¹ U.S. Census Bureau, "Population and Housing Unit Estimates Datasets."

²²² Organisation for Economic Co-operation and Development, *Society at a Glance 2024: OECD Social Indicators* (OECD Publishing, 2024), <https://doi.org/10.1787/918d8db3-en>.

²²³ GOV.UK, "Apply for the Global Talent Visa," accessed March 2, 2026, <https://www.gov.uk/global-talent>; GOV.UK, "High Potential Individual (HPI) visa," accessed March 2, 2026, <https://www.gov.uk/high-potential-individual-visa>.

Strategy (TTS),²²⁴ and China’s nonimmigrant K visa.²²⁵ Some programs have demonstrably siphoned talent away from the U.S. Canada was able to redirect 10,000 skilled immigrants from the U.S. within 24 hours of launching its TTS program,²²⁶ and it is likely that other wealthy, aging countries could accomplish the same with similar programs. The U.S. must position itself well in this contest for skills and talent.

Notwithstanding the imperative, attracting talent from other countries is an insufficient long-term solution to counter population decline. Of the ten countries that currently produce the most immigrants to the U.S.,²²⁷ eight are themselves below replacement.²²⁸ This suggests that in the long term (30 years or more in the future), if population growth, or even population stability, is to continue, domestic TFR must increase. To support family growth in the long term, policymakers should consider pro-family policies. This need not entail aggressively pro-natalist spending or regulation—some improvements in TFR can be attained simply by eliminating superfluous rules in zoning or

²²⁴ Government of Canada, “Minister Fraser launches Canada’s first-ever Tech Talent Strategy at Collision 2023,” last modified June 27, 2023, <https://www.canada.ca/en/immigration-refugees-citizenship/news/2023/06/minister-fraser-launches-canadas-first-ever-tech-talent-strategy-at-collision-2023.html>.

²²⁵ Eduardo Baptista, “China’s new K visa beckons foreign tech talent as US hikes H-1B fee,” *Reuters*, September 29, 2025, <https://www.reuters.com/sustainability/sustainable-finance-reporting/chinas-new-k-visa-beckons-foreign-tech-talent-us-hikes-h-1b-fee-2025-09-29/>.

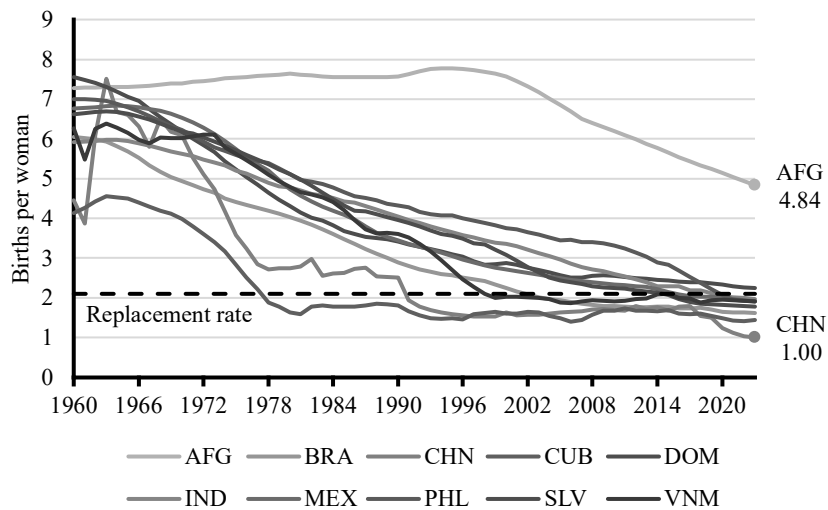
²²⁶ Government of Canada, “H-1B visa holder work permit,” last modified October 23, 2025, <https://www.canada.ca/en/immigration-refugees-citizenship/services/work-canada/special-instructions/h1b.html>.

²²⁷ World Population Review, “US Immigration by Country 2026,” accessed March 2, 2026, <https://worldpopulationreview.com/country-rankings/us-immigration-by-country>.

²²⁸ Exceptions are the Dominican Republic and Afghanistan. World Bank, “Fertility rate, total (births per woman).”

parenting.²²⁹ Further improvements likely require cultural changes.

Figure 4-3: Total Fertility Rate in Top 10 Countries of Origin for Immigration to U.S.



Source: World Bank;²³⁰ World Population Review²³¹

Reforming immigration to a merit-based, demand-dependent system

Recognizing that (1) population growth is slowing against a backdrop of below-replacement fertility rates; (2) labor force growth drives economic growth; (3) labor force growth increases receipts that pay for government spending, particularly for the senior population; and (4) other nations are actively seeking skilled labor for themselves to address their population trajectory,

²²⁹ U.S. Congress Joint Economic Committee, “Cars, Kids, and Unintended Costs,” October 5, 2020, <https://www.jec.senate.gov/public/index.cfm/republicans/2020/10/cars-kids-and-unintended-costs>.

²³⁰ World Bank, “Fertility rate, total (births per woman).”

²³¹ World Population Review, “US Immigration by Country 2026.”

U.S. policy should modernize to meet near-term fiscal and economic needs. Making each unit of labor more productive through technological innovations such as artificial intelligence (AI) and other technologies is part of the solution (and is discussed later in this chapter) but is insufficient on its own.²³² The U.S. should also reform its immigration system to ensure every migrant it admits fulfills the needs of the country and optimally contributes to its economic and fiscal strength.

Any reforms should account for the opportunity costs of admitting one migrant over another, as well as fiscal and social costs of each migrant and in the aggregate. In a quota-limited immigration system, any immigrant outside of the most qualified applicant in their field will have an opportunity cost greater than their own contribution. Any system that is either effectively lottery-based (like the Diversity Immigrant Visa Program) or “first-come, first-served” (such as the current employment-based (EB) system) will almost certainly result in high opportunity cost, even though they generally recruit immigrants with an aggregate positive fiscal impact.

The H-1B program should be replaced due to the opportunity cost arising from its lottery structure and its observed propensity to displace workers, effective limitations on labor mobility, and demonstrated history of fraud. H-1B visas facilitate a supply of high-skilled talent on a temporary basis; however, they are sub-optimally distributed through a lottery rather than a meritocratic process. Furthermore, H-1B workers are often preferred to native-born workers due to their captive status, making the program unpopular with displaced domestic workers, especially during difficult job markets. While workers on these visas are not legally

²³² Other technologies include automation, industrial robotics, synthetic biology, and advancements in agriculture.

required to remain with their initial sponsor employer,²³³ there are practical problems that prevent portability. The greatest of these is that in the current first-come, first-served visa system, re-filing a green card application with a new employer can add a lengthy delay to an already cumbersome process. In a situation where backlogs can be decades long, this is untenable.

Abuse of the H-1B program is well documented. A September 2008 report from the Department of Homeland Security (DHS) that sampled 246 H-1B petitions found at least one disqualifying violation in 20.7 percent of cases, consisting of fraud in 13.4 percent of cases and technical violations in 7.3 percent.²³⁴ Examples of fraud included the use of forged or falsified documents, the use of illegitimate shell companies that did not extend legitimate job offers to candidates, misrepresentation of job roles or a petitioner's H-1B status, and cases where petitioners or beneficiaries were currently under investigation by Immigration and Customs Enforcement (ICE), among others.²³⁵ Accounting, human resources, sales, and advertising had the highest fraud rate of 42 percent, and managerial, art, and computer professional jobs also had high rates between 27 and 33 percent.²³⁶

Some immigrants have a net-negative Federal fiscal impact beyond opportunity cost. In particular, family reunification visas for older relatives of U.S. citizens or green card holders result in a

²³³ In fact, there are several clauses intended to make job-changing easier to facilitate. Immigration and Nationality Act, 8 U.S.C. § 1184.

²³⁴ U.S. Citizenship and Immigration Services, "H-1B Benefit Fraud & Compliance Assessment," September 2008, <https://lawandborder.com/wp-content/uploads/2008/10/h-1b-benefit-fraud-assessment.pdf>.

²³⁵ U.S. Citizenship and Immigration Services, "H-1B Benefit Fraud & Compliance Assessment," pp. 9–11.

²³⁶ U.S. Citizenship and Immigration Services, "H-1B Benefit Fraud & Compliance Assessment," p. 13.

net-negative impact on average.²³⁷ They typically never generate returns that allow the government to offset their fiscal costs. Therefore, they should be de-emphasized and reduced in quantity.

While certain forms of immigration have net costs, immigration also brings benefits. High-skilled employment-based immigration in particular has produced a great quantity of jobs, fostered innovation,²³⁸ and bolstered entrepreneurship.²³⁹ Employment-based immigration can alleviate contemporary labor shortages, growing the economy and buttressing American benefits programs. Immigrants also tend to be highly entrepreneurial. At least one study indicates that foreign-born aliens selected for admission to the U.S. are more likely to file and receive patents on innovations than native-born entrepreneurs are.²⁴⁰ Innovation and entrepreneurship contribute to U.S. economic strength.

Some immigrants bring greater value than others, and the mosaic of non-meritocratic pathways to migrate to the U.S. should be replaced with a system that limits admissions to applicants expected to provide the greatest economic value. An ordinal points system provides a convenient proxy variable for this future value. Such a system identifies the most qualified visa applicants, based on factors such as age, education, and English fluency. The characteristics of potential admittees can then be analyzed with

²³⁷ Daniel Di Martino, *The Fiscal Impact of Immigration (2025 Update)*, Manhattan Institute (October 23, 2025), <https://manhattan.institute/article/the-fiscal-impact-of-immigration-2025-update>; JEC calculations.

²³⁸ Shai Bernstein et al., “The Contribution of High-Skilled Immigrants to Innovation in the United States,” NBER Working Paper no. 30797 (December 2022), <https://doi.org/10.3386/w30797>.

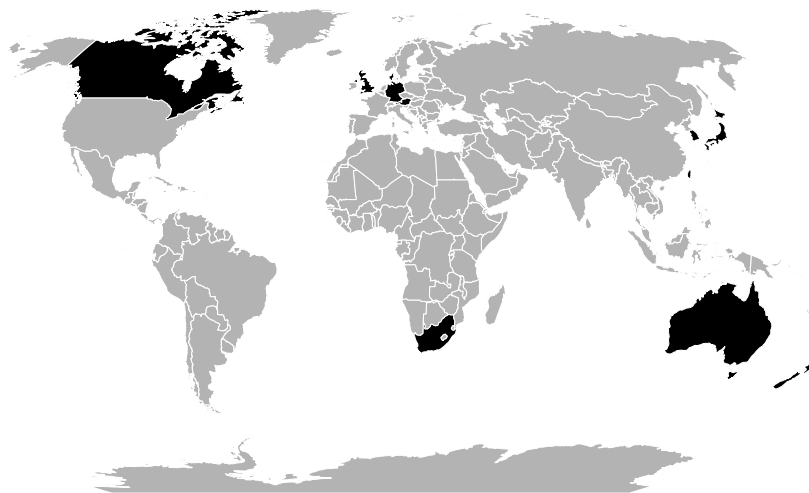
²³⁹ Pierre Azoulay et al., “Immigration and Entrepreneurship in the United States,” NBER Working Paper no. 27778 (September 2020), <https://doi.org/10.3386/w27778>.

²⁴⁰ Saheel A. Chodavadia et al., “Immigrant Entrepreneurship: New Estimates and a Research Agenda,” NBER Working Paper no. 32400 (May 2024), <https://doi.org/10.3386/w32400>.

government economic data, including labor supply and demand, to determine which applicants should receive visas.

While Canada, Australia, and several other countries already have points-based systems which assign visa quotas based on industrial need, industrial need in those countries is determined subjectively by political operatives rather than by an expert-monitored, data-driven process. In doing away with first-come, first-served and lottery processes and purposefully selecting individuals that meet the country's needs through a points-based system, the U.S. can better position itself for the global competition for talent and address its fiscal challenges.

Figure 4-4: Countries with Points-Based Immigration Systems



Source: various national government sources²⁴¹

²⁴¹ Global Legal Research Directorate, *Points-Based Immigration Systems* (LL File no. 2013-009046, The Law Library of Congress, 2013), <https://tile.loc.gov/storage-services/service/l1/lglrd/2013404868/2013404868.pdf>; Immigration New Zealand, "Skilled Migrant Category to Open on 9 October 2023," October 2, 2023,

Box 4-1: Millionaires and Gold Cards

It is imperative to amend the structure of “millionaire” visas like the EB-5 investor visa to prevent fraud and to generate capital for the U.S. Treasury. This visa as currently written allows foreigners and their families to immigrate to the U.S. if they:

1. Make a recoverable investment of \$1,050,000 into an American business (this amount decreases to \$800,000 if the investment is made in a targeted employment area²⁴²).
2. Create or preserve ten jobs for American citizens.²⁴³

This allows the immigration of many economically helpful aliens, but it also can enable bad actor individuals and organizations to prey on would-be immigrants. These bad actors attract international millionaires with the promise of low-risk returns on investments and easy acquisition of a green card. However, once funds are sent, the individual or organization can vanish, leaving

<https://www.immigration.govt.nz/about-us/news-centre/skilled-migrant-category-to-open-on-9-october-2023/>; Migration and Home Affairs, European Commission, “Highly-Qualified Worker in Austria,” April 1, 2025, https://home-affairs.ec.europa.eu/policies/migration-and-asylum/eu-immigration-portal/highly-qualified-worker-austria_en; South African Government, Immigration Act, 2002: Points-Based System, GN 5448 of GG 51416 (October 18, 2024); Federal Ministry of the Interior of Germany, “Opportunity Card (‘Chancenkarte’) Introduced,” May 31, 2024, <https://www.bmi.bund.de/SharedDocs/kurzmeldungen/EN/2024/05/chancenkarte.html>; Korea Immigration Service, “Skilled Worker Points System Visa,” accessed April 2, 2026, https://www.immigration.go.kr/immigration_eng/1852/subview.do.

²⁴² These are rural areas and areas that have experienced significantly higher-than-average unemployment; U.S. Citizenship and Immigration Services, “About the EB-5 Visa Classification,” last updated November 18, 2025, <https://www.uscis.gov/working-in-the-united-states/permanent-workers/employment-based-immigration-fifth-preference-eb-5/about-the-eb-5-visa-classification>.

²⁴³ U.S. Citizenship and Immigration Services, “EB-5 Immigrant Investor Program,” last updated March 1, 2023, <https://www.uscis.gov/working-in-the-united-states/permanent-workers/eb-5-immigrant-investor-program>.

their victim without either a green card or their money.²⁴⁴ This fraud is harmful to the would-be immigrant, the government, and the community that the alien intended to join.

The “gold card” instituted by President Trump’s Executive Order 14351 solves part of this problem by tightly regulating payments made for millionaire visas and ensuring that money spent on these ends up in the hands of the American people, not fraudsters and other criminals.²⁴⁵ It further ensures that aliens petitioning for a visa receive the ability to come to the U.S. and are not cheated out of this privilege.

Macroeconomic model

Immigration supports economic growth, which, in turn, helps to lower the U.S.’s debt-to-GDP ratio and support an aging population. A larger economy can stem from a larger supply of labor, an increased output per unit of labor as a result of innovation and productivity-enhancing technologies, or a combination of both. The direct positive economic effect of immigration comes from augmenting higher- and lower-skilled labor stocks. Below this paragraph, there is a Cobb-Douglas production function for U.S. GDP (Y_t) that has three primary inputs:

- Capital, K_t (which largely is immutable through workforce or productivity changes)

²⁴⁴ Office of U.S. Senator Chuck Grassley, “Newly-Discovered EB-5 Scam Highlights Fraud, National Security Weaknesses, Need for Long-Term Reform,” April 21, 2017, <https://www.grassley.senate.gov/news/news-releases/newly-discovered-eb-5-scam-highlights-fraud-national-security-weaknesses-need>; U.S. Citizenship and Immigration Services, “Combating Fraud and Abuse in the EB-5 Visa Program,” last updated March 18, 2019, <https://www.uscis.gov/scams-fraud-and-misconduct/report-fraud/combating-fraud-and-abuse-in-the-eb-5-visa-program>.

²⁴⁵ Executive Order 14351 of September 19, 2025, “The Gold Card,” *Federal Register* 90 (September 24, 2025): 46031–33, <https://www.govinfo.gov/content/pkg/FR-2025-09-24/pdf/2025-18602.pdf>.

- Unskilled labor, L_t
- Skilled labor, S_t

$$Y_t = K_t^{\beta_k} L_t^{\beta_l} S_t^{\beta_s} e^{\omega_t + \varepsilon_t}$$

The labor variables L_t and S_t are notable here, as those are the variables which may be directly influenced through immigration and immigration policy. L_t may trivially be boosted through most immigration schemes, while raising S_t requires the targeting and design described in earlier sections.

The Cobb-Douglas model is appropriate for conceptual illustration because in log form,²⁴⁶ all the inputs are additively separable and easy to comprehend (for small values, logs may be interpreted as “percent changes”. For example, log capital k_t can be thought of as “percent change in level value K_t ”).²⁴⁷ Ergo:

$$y_t = \beta_k k_t + \beta_l l_t + \beta_s s_t + \omega_t + \varepsilon_t$$

Thus, there is a simple and intuitive equation by which one can understand effects of labor changes on output. A 1 percent increase in stock of skilled labor is associated on average with a β_s percent

²⁴⁶ Eric Miller, “An Assessment of CES and Cobb-Douglas Production Functions,” Congressional Budget Office Working Paper 2008-05 (June 2008), <https://www.govinfo.gov/app/details/GOVPUB-Y10-PURL-LPS121761>; David Baqaee and Emmanuel Farhi, “The Microeconomic Foundations of Aggregate Production Functions,” NBER Working Paper no. 25293 (November 2018), <https://doi.org/10.3386/w25293>; Werner Roeger, “The Production Function Approach to Calculating Potential Growth and Output Gaps: Estimates for EU Member States and the US,” paper prepared for a workshop organized by Banque de France and the Bank of Canada, April 24–25, 2006, <https://www.banqueducanada.ca/wp-content/uploads/2010/08/roeger.pdf>.

²⁴⁷ While the Cobb-Douglas model suffers some problems, such as its inability to model capacity constraints or nonlinear interactions between inputs, it is generally sufficient for illustrating macroeconomic effects. The more flexible constant-elasticity-of-substitution (CES) model is less accessible to lay observers and will simplify to the Cobb-Douglas model under some conditions.

increase in GDP, while a 1 percent increase in stock of unskilled labor is associated on average with a β_l percent increase in GDP. Both increases can have a pronounced impact on the Federal deficit, spending, and support for senior benefits.

Increasing fertility rates and implementing selective immigration policies each offer partial solutions to demographic and fiscal challenges. To sustainably restore fiscal stability and rein in debt, it is also critical to more efficiently provide benefits and services to retirees as well as produce more output per worker to fund these provisions. Policymakers should evaluate how technology can facilitate such critical reforms.

Productivity

As identified earlier, the U.S. can increase labor quantity through immigration, population growth, and upskilling. One can observe which variables of production can be shifted by growing the workforce in the Cobb-Douglas function described earlier:

$$y_t = \beta_k k_t + \beta_l l_t + \beta_s s_t + \omega_t + \varepsilon_t$$

The U.S. can also improve total productivity through technology. By implementing mechanized or automated tools, better legal and professional services software, or quantum computing, output can be increased without adding new workers or facilities. This change in output comes from *total factor productivity* (ω_t).

$$y_t = \beta_k k_t + \beta_l l_t + \beta_s s_t + \omega_t + \varepsilon_t$$

Total factor productivity (TFP) is often cited in technological progress literature.²⁴⁸ The difference between labor productivity and TFP can be explained thus: increased labor productivity means more output per unit of labor supplied, while increased TFP indicates increased output unrelated and independent of changes in capital or labor.²⁴⁹ The two are difficult to separately identify,²⁵⁰ so analysis of productivity change generally only explores one or the other. For ease of illustration, this section focuses on TFP.

Artificial intelligence

Improvements to productivity can be made through a variety of technologies, but investment and public interest are currently heavily focused on artificial intelligence (AI). AI is a branch of computer science that simulates human intelligence with machines, thereby increasing productivity and growth. Capital expenditures on AI have recently represented 0.8 percent of GDP and are expected to grow.²⁵¹

AI has been successfully deployed to improve performance across the economy, including in customer service, professional services, and product design. Econometric research indicates that in call

²⁴⁸ Chen Fan, Xuehui Liao, and Xin Yang, “Artificial intelligence and enterprise total factor productivity: A human capital requirement perspective,” *International Review of Economics & Finance* 104 (2025): 104661, <https://doi.org/10.1016/j.iref.2025.104661>; Alexander Arnon, “The Projected Impact of Generative AI on Future Productivity Growth,” Penn Wharton Budget Model, September 8, 2025, <https://budgetmodel.wharton.upenn.edu/p/2025-09-08-the-projected-impact-of-generative-ai-on-future-productivity-growth/>; Christoph Görtz, Christopher Gunn, and Thomas A. Lubik, “What Can News Shocks Tell Us About the Effects of AI?,” Economic Brief No. 25-16, Federal Reserve Bank of Richmond, April 2025, https://www.richmondfed.org/publications/research/economic_brief/2025/eb_25-16.

²⁴⁹ Ulrich Doraszelski and Jordi Jaumandreu, “Measuring the Bias of Technological Change,” *Journal of Political Economy* 126, no. 3 (2018), <https://doi.org/10.1086/697204>.

²⁵⁰ Doraszelski and Jaumandreu, “Measuring the Bias of Technological Change.”

²⁵¹ “Why AI Companies May Invest More than \$500 Billion in 2026,” Goldman Sachs, December 18, 2025, <https://www.goldmansachs.com/insights/articles/why-ai-companies-may-invest-more-than-500-billion-in-2026>.

centers, AI-assisted providers can perform more efficiently and resolve more issues per hour than their unassisted counterparts (by a full 15 percent, on average). Moreover, this appears to have an equalizing effect, with the largest gains in both speed and quality observed for the workers that initially were the least productive (up to 31 percent). There was also a lower failure rate among AI-assisted agents in this study; customers asked for a manager less frequently and reportedly behaved qualitatively more politely when interacting with augmented assistance.²⁵² This equalizing effect has also been observed in professional services, where generative AI can decrease the time required per writing task by 40 percent while increasing output quality and reducing the productivity gap between least- and most-productive workers.²⁵³ In materials science, generative AI can be used to create ultra-reflective surfaces through design of novel thermal meta-emitters, allowing construction of passively-cooled structures in desert or tropical climates.²⁵⁴

AI can be taxonomized into two nested categories, generative and agentic. Generative AI can inform a user how to complete a task in theory, while agentic AI (a subset of generative) can complete the task in practice. It can book a flight, send an email, compile code, or ship a product with minimal human interface.²⁵⁵ Provision for physical applications of artificial intelligence will likely come

²⁵² Erik Brynjolfsson, Danielle Li, and Lindsey Raymond, “Generative AI at Work,” *The Quarterly Journal of Economics* 140, no. 2 (2025): 889–942, <https://doi.org/10.1093/qje/qjae044>.

²⁵³ Shakked Noy and Whitney Zhang, “Experimental Evidence on the Productivity Effects of Generative Artificial Intelligence,” *Science* 381, no. 6654 (2023): 187–92, <https://doi.org/10.1126/science.adh2586>.

²⁵⁴ Chengyu Xiao et al., “Ultrabroadband and band-selective thermal meta-emitters by machine learning,” *Nature* 643 (2025): 80–88, <https://doi.org/10.1038/s41586-025-09102-y>.

²⁵⁵ Deepak Bhaskar Acharya, Karthigeyan Kuppan, and B. Divya, “Agentic AI: Autonomous Intelligence for Complex Goals—A Comprehensive Survey,” *IEEE Access* 13 (2025): 18912–36, <https://doi.org/10.1109/ACCESS.2025.3532853>.

from agentic rather than purely generative AI. This will provide a leap from using AI predominantly for research and miscellaneous knowledge to ubiquitous enterprise applications, particularly in robotics and licensed digital services like law, arbitration, and accounting.

Agentic AI will cause disruption in the physical commerce space, particularly in transportation and shipping. Self-driving cars are spreading across the U.S., reducing accidents and precipitating new questions and decisions in liability law.²⁵⁶ Similarly, automated shipping will impact interstate trucking. When drivers' home preferences are nullified, prices in driver-rich areas increase disproportionately.²⁵⁷ Maritime transportation systems will also be impacted. Seaports around the world have become more automated, and this has produced a dramatic competitive advantage over those which have not updated their technology.²⁵⁸

Outside of physical labor, agentic AI can also be expected to revolutionize licensed white-collar work. While it continues to suffer some hiccups and drawbacks such as repeated hallucination,²⁵⁹ legal-specific LLMs today are used by over 500 legal firms and continue to proliferate.²⁶⁰ In the field of

²⁵⁶ Jonathan Slotkin, "The Data on Self-Driving Cars Is Clear. We Have to Change Course," *The New York Times*, December 2, 2025, <https://www.nytimes.com/2025/12/02/opinion/self-driving-cars.html>.

²⁵⁷ Ron Yang, "(Don't) Take Me Home: Home Preference and the Effect of Self-Driving Trucks on Interstate Trade," paper presented at NBER Economics of Artificial Intelligence Conference, September 22, 2022, https://conference.nber.org/conf_papers/fl73721.pdf.

²⁵⁸ World Bank, *The Container Port Performance Index 2020 to 2024: Trends and Lessons Learned* (2025), <https://doi.org/10.1596/43744>.

²⁵⁹ Varun Magesh et al., "Hallucination-Free? Assessing the Reliability of Leading AI Legal Research Tools," *Journal of Empirical Legal Studies* 22, no. 2, (2025): 216–42, <https://doi.org/10.1111/jels.12413>.

²⁶⁰ Suzi Ring, "How a former junior lawyer created a \$5bn AI legal start-up," *Financial Times*, September 14, 2025, <https://www.ft.com/content/49d00498-9a15-4d26-b10c-938bd7e893c6>.

commodities trading, AI commodities traders can often outperform human traders because of their superior speed and, interestingly, their tendency to collude with one another unprompted, leading to greater profits.²⁶¹

Quantum computing, a technology that harnesses the principles of quantum mechanics to solve complex problems, can accelerate improvements already made by AI. By evaluating immense matrices using quantum superpositions, quantum computers can solve problems many orders of magnitude faster than conventional computers can. Current quantum computers can also operate orders of magnitude faster than past generations. Specifically, fifth-generation quantum computers are estimated to be 260,000,000 times more powerful than the fourth generation.²⁶² However, quantum computing continues to suffer from practical issues, such as consistently high error rates and drawbacks in each type of qubit.²⁶³ Despite this concern, quantum computing has myriad applications in various subfields of AI, particularly in optimization, machine learning, and cryptography.²⁶⁴ While quantum computing can accelerate the advances made in AI, positive influence can also work in the other direction: data-driven

²⁶¹ Winston Wei Dou, Itay Goldstein, and Yan Ji, “AI-Powered Trading, Algorithmic Collusion, and Price Efficiency,” NBER Working Paper no. 34054 (July 2025), <https://doi.org/10.3386/w34054>.

²⁶² *Frontier Technologies, Industrial Efficiency, and Pro-Innovation Policies, Before the U.S. Congress Joint Economic Committee*, 119th Cong. (2025) (response of Niccolo de Masi, CEO of IonQ, to questions).

²⁶³ National Institute of Standards and Technology, “Quantum Computing Explained,” last updated March 30, 2026, <https://www.nist.gov/quantum-information-science/quantum-computing-explained>.

²⁶⁴ Vanessa García Pineda et al., “Integrating artificial intelligence and quantum computing: A systematic literature review of features and applications,” *International Journal of Cognitive Computing in Engineering* 7 (2026): 26–39, <https://doi.org/10.1016/j.ijcce.2025.08.002>.

techniques pioneered in AI are ideal for the high-dimensional problems that quantum computing presents.²⁶⁵

Macroeconomic effect of AI and policy implications

Given sector-by-sector uncertainties around the direction of AI's future development, it is difficult to identify how much macroeconomic growth AI can provide. Deutsche Bank's Research Institute compiled a short list of estimates,²⁶⁶ which range from Daron Acemoglu's 0.0 to 0.1 percent to Aghion and Bunel's more optimistic 1.3 percentage points.²⁶⁷ The Yale Budget Lab and Penn Wharton Budget Model have similarly divergent conclusions.²⁶⁸ Yale suggests the difference in the national occupational mix before and after AI adoption is not large or necessarily induced by AI, while Penn claims that "40 percent of current GDP could be substantially affected by generative AI." AI implementation will affect every sector and industry differently. A model that accommodates the input-output relationships between each industry and considers sectoral effects could replicate network interactions more accurately than one that

²⁶⁵ Yuri Alexeev et al., "Artificial intelligence for quantum computing," *Nature Communications* 16 (2025): 10829, <https://doi.org/10.1038/s41467-025-65836-3>.

²⁶⁶ Matthew Luzzetti et al., "Omni debita solventur?," Deutsche Bank Research Institute, October 22, 2025, <https://www.dbresearch.com/PROD/IE-PROD/PDFVIEWER.calias?pdfViewerPdfUrl=PROD000000000606735&rwnode=REPORT>.

²⁶⁷ Daron Acemoglu, "The Simple Macroeconomics of AI," NBER Working Paper no. 32487 (May 2024), <https://doi.org/10.3386/w32487>; Philippe Aghion and Simon Bunel, "AI and Growth: Where Do We Stand?" Federal Reserve Bank of San Francisco (June 2024), <https://www.frbsf.org/wp-content/uploads/AI-and-Growth-Aghion-Bunel.pdf>.

²⁶⁸ The Budget Lab at Yale, "Evaluating the Impact of AI on the Labor Market: November/December CPS Update," January 28, 2026, https://budgetlab.yale.edu/sites/default/files/page_to_pdf/1334/publication_1334.pdf; Alexander Arnon, "The Projected Impact of Generative AI on Future Productivity Growth," Penn Wharton Budget Model, September 8, 2025, <https://budgetmodel.wharton.upenn.edu/p/2025-09-08-the-projected-impact-of-generative-ai-on-future-productivity-growth/>.

instead treats the economy monolithically, and a sectoral model may project larger impacts to growth than others.²⁶⁹

Synthetic biology and anti-obesity medications

While AI has received much attention, advancements in other sciences also have the potential to increase productivity and generate growth and savings. As this and past *Joint Economic Reports* highlight, healthcare costs are a significant driver of Federal outlays. Advancements in healthcare, such as synthetic biology, could therefore materially affect U.S. fiscal health.

Synthetic biology involves redesigning organisms to have new abilities.²⁷⁰ Lab-created organic compounds, viruses, and cells can affect productivity, sometimes in tandem with AI. For example, artificially designed bacteriophages may be leveraged to combat antibiotic-resistant bacteria such as MRSA or certain strains of *E. coli*.²⁷¹ The combined use of these technologies can thus increase the speed and output of national research and reduce development costs of medicine. In turn, the resulting treatments can decrease temporary or permanent worker loss from antibiotic-resistant microbes.

In addition to synthetic biology, anti-obesity medications such as GLP-1 drugs are also useful for improving productivity and eliminating absenteeism or presenteeism losses brought about by

²⁶⁹ Vasco M. Carvalho et al., “Supply Chain Disruptions: Evidence from the Great East Japan Earthquake,” *The Quarterly Journal of Economics* 136, no. 2 (2021): 1255–1321, <https://doi.org/10.1093/qje/qjaa044>.

²⁷⁰ National Human Genome Research Institute, “Synthetic Biology,” last updated August 14, 2019, <https://www.genome.gov/about-genomics/policy-issues/Synthetic-Biology>.

²⁷¹ Katie Kavanagh, “World’s first AI-designed viruses a step towards AI-generated life,” *Nature* 646, no. 16 (2025), <https://doi.org/10.1038/d41586-025-03055-y>.

obesity.²⁷² As obesity also negatively impacts reproductive health in both men and women,²⁷³ weight reduction through GLP-1 drugs could also positively affect birth rates.

Policy implications of technology

Technology provides a tailwind for economic growth and another lever to address the nation's precarious fiscal picture, and Federal policies can hinder or incent their development and adoption. Policymakers must not unduly restrict the advancement of promising technologies with burdensome laws. In particular, they should scrutinize efforts by organized labor and incumbent businesses to preserve their business models through demands for innovation-stifling, unnecessary regulatory barriers that rob the public of cost savings. Past legislation has restricted Federal funds from being allocated to port development projects that would result in a net loss of jobs.²⁷⁴ Other legislation has restricted Federal funding to fund the purchase of only "human-operated equipment or human-maintained technology."²⁷⁵ These actions induce asymmetries with higher-efficiency international competitors.

Policymakers should ensure that innovation is not made illegal and reject the imposition of high barriers to entry for startups. They should also pursue regulatory sandboxes, legal frameworks that

²⁷² U.S. Congress Joint Economic Committee, *The 2025 Joint Economic Report*, H. Rep. 119-9 (2025), p. 94, <https://www.govinfo.gov/app/details/CRPT-119hrpt9/CRPT-119hrpt9-pt1>.

²⁷³ Konstantina Barbouni et al., "When Weight Matters: How Obesity Impacts Reproductive Health and Pregnancy-A Systematic Review," *Current Obesity Reports* 14, no. 1 (2025): 37, <https://doi.org/10.1007/s13679-025-00629-9>.

²⁷⁴ *National Defense Authorization Act for Fiscal Year 2022*, Pub. L. No. 117-81 § 3501(a)(12), 135 Stat. 2237 (December 26, 2021), <https://www.govinfo.gov/app/details/PLAW-117publ81>; World Bank, *The Container Port Performance Index 2020 to 2024*.

²⁷⁵ *An act to provide for reconciliation pursuant to title II of S. Con. Res. 14*, Pub. L. No. 117-169 § 60102(d)(4), 136 Stat. 2065 (August 15, 2022), <https://www.govinfo.gov/app/details/PLAW-117publ169>.

encourage innovators to test new technologies by reducing the legal risk and uncertainty associated with novel approaches. Any policy enacted by Congress should be flexible enough to allow innovation, entrepreneurship, and growth.

Conclusion

Consider once more the production function described in this chapter,

$$y_t = \beta_K k_t + \beta_L l_t + \beta_S s_t + \omega_t + \varepsilon_t$$

There are many ways to increase national GDP. Policymakers can directly increase the supply of labor through education and training and selective immigration. Development and implementation of novel technologies can increase TFP. These include generative and agentic artificial intelligence, automation, quantum computing, and synthetic biology. By increasing productivity and output, the U.S. can address its debt-to-GDP ratio, which would help hold down interest rates, facilitating future growth and preserving fiscal flexibility.²⁷⁶

Ultimately, policymakers must prioritize legislation that quickly and reliably induces positive feedback loops at the observable microeconomic level. Well-executed STEM education raises human capital and increases the size of the workforce. Research and development produces novel technologies which make the workforce more productive even if no new workers are added. Frivolous spending must be reined in, but targeted policies that

²⁷⁶ Jack Salmon and Veronique de Rugy, “Debt and Growth: A Decade of Studies,” Mercatus Center Research (April 2020), <http://doi.org/10.2139/ssrn.3690510>; Tobias Adrian, Vitor Gaspar, and Pierre-Olivier Gourinchas, “The Fiscal and Financial Risks of a High-Debt, Slow-Growth World,” *IMF Blog*, March 28, 2024, <https://www.imf.org/en/blogs/articles/2024/03/28/the-fiscal-and-financial-risks-of-a-high-debt-slow-growth-world>.

precipitate growth should be encouraged, celebrated, examined, and potentially repeated. The next chapter examines how tax policy can help achieve these goals.