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Economic Tectonics: A Closer Look at Structural Changes and Productivity Trends in the U.S. Economy

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ABSTRACT: The U.S. economy has undergone profound structural transformations in recent decades. This descriptive study analyzes tradable and nontradable sectoral trends, with our findings demonstrating that the share of tradable sector employment and, within it, manufacturing employment, leveled off in the decade following the GFC after declining for several decades. Still, by 2023, the nontradable sector accounted for a large majority of employment and real value added. At the same time, the tradable sector exhibited robust productivity growth of nearly 3 percent, juxtaposed against far lower 0.7 percent growth in nontradable sectors. This marked divergence raises concerns regarding inequality and the sustainability of economic growth.

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Economic Tectonics: A Closer Look at Structural Changes and Productivity Trends in the U.S. Economy

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July 21, 2025

Abstract

The U.S. economy has undergone profound structural transformation in recent decades, predominantly influenced by the forces of globalization, rapid technological innovation, and the residual effects of the Global Financial Crisis (GFC). This descriptive study analyzes trends in U.S. employment, real value added, and labor productivity, highlighting a pronounced divergence between tradable and nontradable sectors. Our findings demonstrate that the share of tradable sector employment and, within it, manufacturing employment, leveled off in the decade following the GFC after declining for several decades. Still, by 2023, the nontradable sector continued to account for 77 percent of total employment while contributing 68 percent to real value added, a small decrease in its share of value added in prior decades. Based on average annual growth rates over 1998-2023, the tradable sector exhibited robust productivity growth of nearly 3 percent, juxtaposed against far lower 0.7 percent growth in nontradable sectors. This marked divergence raises critical concerns regarding income inequality and the long-term sustainability of economic growth.

Keywords: employment, productivity, tradable and nontradable sectors, structural change

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1 Introduction

The structural evolution of the U.S. economy during the two decades leading up to the Global Financial Crisis (GFC) was heavily affected by a period of rapid globalization, sometimes called the period of 'hyperglobalization' (Rodrik, 2019). Powerful deflationary forces and sometimes disruptive shifts in labor demand materialized globally as a result of improved technology and rapid growth in the productive capacity of large emerging economies–most prominently, China–that simultaneously increased trade in both intermediate and final products while also reducing labor share in the U.S. (Abdih and Danninger, 2017).

During that period, several prominent trends emerged. Almost all incremental employment in the U.S. economy occurred in the nontradable sector (i.e., the part of the U.S. economy that cannot be traded across borders; see Box 1), which accounted for almost two-thirds of total value added (i.e., output calculated in a manner that nets out intermediate inputs)[1] and over 75 percent of employment in the United States (Spence and Hlatshwayo, 2012). On the other side of the economy, the tradable sector has two parts: manufacturing and tradable, usually high value added, services. Employment in manufacturing declined steadily during those two decades, while employment in tradable services grew by about the same amount, resulting in only a small net addition to employment from the tradable side.

The decline in manufacturing employment can be linked to both factors briefly stated above. One was the proliferation and deepening of global value chains, where large and complex portions of manufacturing supply chains could be offshored to lower-cost and increasingly productive emerging economies. The second and likely more important factor was labor-saving technology in advanced manufacturing. In contrast, both factors had a positive effect on U.S. manufacturing value-added output, which continued to grow rapidly during this period, even as employment declined. The crosscurrents across sectors and shifting trends in employment versus value added generated a steady divergence in labor productivity between the tradable and nontradable sectors. Labor productivity grew at a reasonable pace in the tradable sectors, while it largely stagnated in the nontradable part of the economy. These cross-sectoral dynamics gave rise to a sustained divergence in labor productivity, with the tradable sector experiencing continued gains, while the nontradable sector stagnated.

The descriptive patterns raise deeper analytical questions about the structural mechanisms that shape sectoral employment and productivity trends. To guide our interpretation, we adopt a conceptual framework that draws from multisector models of structural trans-

[1] For our purposes, value-added data are preferred as they net out the costs of intermediate inputs to avoid double-counting and provide sectors' true contributions to gross domestic product.

formation, sectoral price dynamics, and capital-labor substitutability (Ngai and Pissarides, 2007; Acemoglu and Guerrieri, 2008; Herrendorf et al., 2015). Specifically, the observed reallocation of labor toward nontradable sectors, despite their slower productivity growth, can be explained by shifts in relative prices, capital intensity, and sector-specific technological adoption. Sectors with low price elasticity of demand and limited automation potential tend to absorb more labor but contribute less to aggregate productivity growth. Furthermore, relative price changes, especially declining nontradable prices, alter value-added shares and affect the weighting of sectoral productivity contributions of sectors to aggregate productivity when using Divisia decompositions (Diewert, 2010; Azenui and Rada, 2021).

This paper extends our previous work by covering more recent developments through 2023 and studies productivity dynamics in far more depth. Compared to the earlier work, there are some similarities but also some significant differences in the patterns detected earlier in the structure of the U.S. economy.

First, amongst the similarities, the nontradable part of the U.S. economy continues to account for most of the employment in the economy–at 77 percent in 2023. There is also still a widening divergence in labor productivity between the tradable and nontradable sectors and tradable sector productivity was close to one and half times that of the nontradable sector by 2023. There are two reasons to be concerned about this trend. Since the nontradable sectors employ almost 80 percent of workers, lagging productivity in that sector translates to lagging productivity growth in the economy as a whole. Second, while labor productivity and labor incomes are not perfectly correlated, they are closely related. Labor productivity tends to be an upper bound on labor income, therefore the widening productivity differential across the tradable and nontradable sectors is a factor in driving widening income inequality.

From the perspective of structural transformation, labor reallocation contributes positively to aggregate productivity only when it moves toward sectors with high or rising productivity (McMillan and Rodrik, 2011). When employment shifts toward sectors with lower productivity or stagnant relative prices, aggregate growth may slow despite technological progress elsewhere. These insights are operationalized through a Divisia index decomposition framework (Ang, 2004; Azenui and Rada, 2021), which allows us to disaggregate labor productivity growth into within-sector improvements, structural change effects, and terms-of-trade adjustments.

Amongst the differences, and reversing prior declines, tradable sector employment and, within it, manufacturing employment slowly grew in the decade following the GFC. A second and related distinguishing factor is that productivity growth, already modest after the surge in the late 1990s and early 2000s, declined further. The decline was large and widespread, occurring across a broad range of high and low productivity sectors.

These trends reflect shifting capital-labor ratios across sectors, changes in the tradability frontier, and the elasticity of substitution between tradable and nontradable goods. As in the multisector growth models of (Ngai and Pissarides, 2007), faster productivity growth in tradables can drive down their relative prices, inducing demand-driven expansion of nontradables. Yet when labor shifts into sectors that are less amenable to automation or scale economies–due to regulatory constraints, face-to-face service needs, or geographic dispersion–aggregate productivity suffers. Our analysis connects these structural dynamics to recent episodes of supply-side constraint, inequality, and post-pandemic labor market recovery.

Box 1: The Tradable and Nontradable Sectors of the U.S. Economy

Some sectors like finance and manufacturing are almost entirely tradable sectors while other sectors, such as hospitality, health care, and education, are almost entirely nontradable. Most sectors contain both tradable and nontradable subsectors, like retail which has tradable e-commerce vs. less tradable traditional big box stores.

In nontradable sectors, domestic demand and supply must coincide. That means that nontradable consumption and investment growth are constrained by the domestic supply side of the U.S. economy. Conversely, when domestic demand is weak, domestic nontradable output must fall in tandem since international trade is not feasible (i.e., a good or service must be provided in person or in close proximity given technological and regulatory constraints and/or the cost of moving such goods across borders).

The tradable part of the U.S. economy is strikingly different. In addition to domestic sources of demand and supply, there are external sources of both demand and supply. This means that demand is far less constrained on the tradable part of the U.S. economy since firms can sell to the 95 percent of the global population that resides outside U.S. borders. Tradability can shift over time due to changes in policies and/or technological improvements. For example, both regulations and technological advancements in telemedicine may increase the tradability of medical care going forward and the spread of e-commerce has increased the tradability of retail stores (e.g., Amazon, Alibaba, and Temu). However, these shifts in the tradable-nontradable boundaries tend to be slow moving trends–again, in large part due to regulation.

Several structural and macroeconomic factors help explain the new trends that have emerged following the GFC. With trade as a ratio to output stalling out globally, the powerful deflationary forces associated with emerging economy growth and advanced economy labor demand disruptions began to fade, and by the end of the decade, they were noticeably less powerful than in the past.[2] One of us has described this as the Lewis Turning Point in the global economy, an analogy with the early stage developing country growth model developed by Nobel Laureate Sir W. Arthur Lewis. The core of that model is the extraction of surplus labor from traditional sectors and their deployment in the higher productivity modernizing part of the urban economy. The Lewis turning point is the period in which most of the underutilized productive resources and labor in traditional sectors have been pulled into the modernizing industrial and growing part of the economy. The Lewis turning point corresponds to a major shift in the growth model and growth engines of emerging economies.[3] By analogy, the global economy has grown and, relative to its size, no longer has vast pools of low cost and underutilized labor that are easily accessible and connected to the global economy supply networks. There were other factors constraining the elasticity of supply-side responsiveness in recent years, and contributing to inflationary cost pressures. These include aging demographics, major changes in labor market behavior, and diversification in global supply networks in response to shocks from multiple sources (e.g., pandemics, wars, climate, and geopolitical tensions). Not all forces are pushing in the same direction; some technologies, like those that enable remote work in tradable services sectors, have been a source of resiliency and growth.[4]

On a net basis, these structural changes shifted the U.S. and much of the world into a supply-constrained pattern of growth with accompanying inflationary pressures that had not been present for several recent decades. The post-pandemic period is instructive but also unique. In 2021-23, the U.S. economy saw persistently high inflation for the first time

[2]Globally, the trend of global trade rising in relation to global output stopped and leveled off. Of course, in absolute terms, trade flows continued to grow, especially trade in services, but at roughly the rate of global GDP growth. What the GFC appears to have marked was the end of hyperglobalization, at least in goods trade but the world remains highly interconnected.

[3]The Lewis turning point is typically described as part of developing countries' growth process. Here, in a developed market context, we use the concept as an analogy. The global economy benefited on the supply side from large additions of productive capacity as emerging economies like China grew; that deflationary force is now fading and will fade further in the future (Spence, 2022).

[4]Many of these advancements have occurred in sectors that contribute to the knowledge economy, which Unger (2019) defines as "the accumulation of capital, technology, technology-relevant capabilities, and science in the conduct of productive activity." Given the breadth of its definition, there is no one measure that fully captures the extent of the knowledge economy. However, the share of high-tech industries' contribution to employment and output can be used as a lower bound estimate of its contribution. According to the BLS Roberts and Wolf (2018), high-tech industries contributed to around 10 percent of employment and almost 20 percent of output in 2016.

in several decades. This same pattern was experienced broadly in the global economy.[5] Much of the increase was ascribed to pandemic-induced supply-demand imbalances that were expected to be resolved by supply-side normalization of activity and by a gradual sunset of policy-induced high demand. However, the normalization of supply conditions did not restore supply elasticities to the point where the excess demand gap was closed. Part of the explanation is that the pandemic-induced recession was the opposite of a balance sheet recession. During the pandemic and in the recovery period, very large fiscal programs designed to limit balance sheet damage in the household and corporate sectors worked. Unlike the post-GFC period where household balance sheet damage was very large and took years to repair even with the support of zero interest rates and elevated risk asset prices, pandemic-era policies prevented the pandemic recession from becoming a balance sheet recession, and the recovery has been more rapid as a result, especially on the demand side, and resulting in large supply-demand imbalances. While there is exceptionally high uncertainty, some of the supply-side constraints in the U.S. may persist or emerge from new sources. In addition, the anticipated AI-fueled productivity boom may not come to pass or may be far more muted than current expectations.

Together with the structural factors that predated the pandemic, this leaves the primary gating factor with respect to U.S. growth largely on the supply side-—which is also why increased migration proved so beneficial to the U.S. economy in recent years. Beyond growth, U.S. policymakers are also making efforts to address important questions around how best to enhance the economy's resiliency and reduce inequality going forward. Having a clear understanding of how U.S. trends in employment, output, and productivity have developed in recent decades, how such trends have been impacted by recent shocks, and what the outlook might be is critical to answering these questions. This paper focuses on detailing such developments and differentiating between sectors based on their degree of tradability—or their potential to be traded in global markets.

Our research connects with several parts of the literature, particularly research that focuses on various structural classifications of economic activities and their implications for productivity and trade. The foundation of this approach can be traced back to the seminal work of Allan Fisher in the 1930s, who introduced the primary, secondary, and tertiary classifications of the economy, laying the groundwork for further analysis on the nature and evolution of economic sectors (Fisher, 1939). Building on this foundational concept, subse-

[5] China is a notable exception – due to domestic conditions and imbalances, China is currently in a demand constrained growth pattern of uncertain duration.

quent research has sought to delineate economic activities into tradable and non-tradable sectors, employing various methodologies to achieve this distinction. For instance, the use of export data as a means to identify tradable activities has been prevalent in the literature, as demonstrated by studies like De Gregorio and Wolf (1994) and Amador and Soares (2017). Additionally, occupation task-based approaches to classifying structural characteristics have also gained prominence with significant contributions from scholars like Blinder and Krueger (2013).

As a complement to these methodologies, our research adopts a geographic concentration approach, which has been effectively used in previous studies including those by Jensen and Kletzer (2005) and Gervais and Jensen (2019). This approach has not only facilitated a deeper understanding of the structural makeup of the U.S. economy but has also revealed consistent structural characteristics and trends across European economies, as seen in the work of Frocrain and Giraud (2019) for France and Eliasson and Hansson (2016) for Sweden. Furthermore, our findings intersect with the now extensive literature on the 'China shock,' particularly acknowledging the profound impacts of China's global integration in the 2000s on sectors and workers facing direct import competition (Autor et al., 2013; Autor and Hanson, 2021). In addition to these thematic areas, our paper contributes to the ongoing dialogue on productivity changes, drawing on analytical frameworks provided by Ang (2004) and Azenui and Rada (2021). By systematically analyzing the sectoral contributions to changes in U.S. labor productivity growth across tradable and non-tradable industries, our work adds a nuanced layer to the existing body of literature, offering fresh insights into the dynamic interplay between sectoral composition, trade, and productivity.

The remainder of this paper proceeds as follows. We outline our methodological approach in section 2, including our decomposition of labor productivity. Section 3 unpacks the previewed key findings, starting with overall employment and value added before turning to labor productivity, and ending the section with an analysis of digital technology and productivity. Finally, there are some concluding perspectives in section 4.

2 Methodology

2.1 Tradable versus Nontradable Economic Activity

There are several potential methods for separating the U.S. economy into its tradable and nontradable components, each with tradeoffs. One approach is to use the sector-specific share of exporting firms relative to the total number of firms. However, this would ignore firms within those sectors that, despite not exporting, still face global competition. A similarly coarse approach would be to allocate whole sectors as tradable or nontradable based on rough historical priors (e.g., manufacturing as a tradable sector and retail as nontradable). However, services have increasingly become tradable as digitization and connectivity have increased and become less costly–in tandem with changes in regulations and other trade barriers that may allow more trade in services. Finally, an approach that leverages information on occupational tasks to assess the offshorability (i.e., by considering the routine nature of some tasks and the ease of electronic delivery of outputs) can suffer from subjective biases associated with determining what tasks can be considered basic and/or whether electronic delivery would hinder their quality or not.

As in our 2014 paper, we opted to use the Jensen and Kletzer (2005) geographic concentration measure of tradability. The intuition of the geographic tradability index is that highly geographically concentrated industries are more tradable (e.g., mining) while industries that are geographically dispersed (e.g., healthcare and hospitality services) are less tradable as they have to be provided in a localized manner. While this approach is less coarse than some alternatives, the measure is a better proxy for domestic tradability rather than international tradability, although the two classifications often overlap. Therefore, we made some further adjustments to their measure, including by checking relevant trade statistics. The shares broadly fit with priors, including in reflecting the now-increased tradability of some historically nontradable service sectors (e.g., finance and insurance) (see Table 1 below).

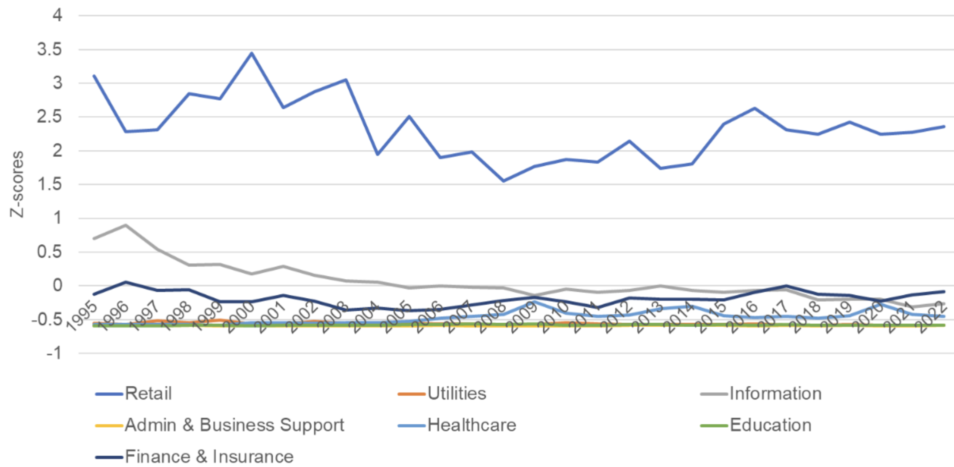
Table 1: Tradability Shares across Industries

Sector	Tradability Share
Agriculture	100
Mining	100
Utilities	19
Construction	0
Manufacturing	100
Wholesale	0
Retail	15
Transport & Warehousing	0
Information	66
Finance & Insurance	68
Real Estate	0
Legal	0
Computer Systems Design	100
Other Professional Services (incl. Consulting)	100
Management of Companies	0
Administrative and Support Services	19
Waste Management	0
Education	1
Health Care & Social Assistance	2
Arts and Entertainment	0
Accommodation & Food	0
Other Services	0
Government	0

The approach also does not account for dynamism over time. Therefore, as an additional robustness check on the static nature of geographic measures, we constructed measures of traditionally nontradable industries, tracking mentions of exports, imports, or cross-border activity in relation to these industries using news articles.[6] Dow Jones' Factiva database is a news aggregator covering over 850 million articles from over 36 thousand sources over the period from 1995 to 2022. To avoid false positives, there are a number of terms that exclude articles from the count of articles that match the algorithm, and overall counts are scaled by the total count of articles in a given period. We found that there is little variation in news chatter around industry tradability over time for largely nontradable industries, suggesting that our static approach is not fundamentally flawed for a first-order approximation of broad structural trends (see Figure 1). Moreover, most nontradable industries, using the geographic concentration measure, appear nontradable based on the news-based measures. Within the largely nontradable sectors, retail is amongst the most tradable, based on both the geographic and news-based index. While our approach is not without weaknesses, we view it as reasonable for assessing broad structural shifts in the U.S. economy over the period in question.

[6]The following Boolean algorithms were used: Retail: (shopping or commerce) near5 (export* or import* or cross-border) not (important or importance or importantly or company or department or administration or agency or ministry); Utilities: (USA or United States) near10 (electricity) near5 (export* or import* or cross-border) not (important or importance or importantly or company or gas or department or administration or agency); Information: (publishing or motion picture or film or broadcasting or data processing) near5 (export* or import* or cross-border) not (important or importance or importantly or company or gas or department or administration or agency or product or products or equipment or building or korea or gear); Admin & Business Support Services: (administrative service or business support) near5 (cross-border) not (important or importance or importantly or company or gas or department or administration or agency or arrest); Healthcare: (healthcare or health care) near5 (cross-border) not (important or importance or importantly or company or gas or department or administration or e-commerce); Education: (cross-border education) not (important or importance or importantly or company or gas or department or administration or e-commerce or cooperation or business); Finance/Insurance: (finance or insurance) near5 (cross-border) not (important or importance or importantly or company or gas or department or administration or agency).

Figure 1: News-based Measures of Tradability, 1995-2022 (z-scores)



Notwithstanding the lack of evidence of dramatic shifts in the tradable vs. nontradable boundaries, the high growth in services trade in the past decade suggests that there may be an expansion in services tradability. It could also be the result of the expansion of services' share in the global economy, a plausible trend because emerging economies' growth is generally accompanied by an expansion of the services share of those economies.

We use the industry-specific data from Bureau of Economic Analysis (BEA) for employment (full-time equivalent employees) and real value added, applying the tradability shares to both sets of indicators. For a company or sector, value added is sales minus purchased inputs. The idea is that value is created by the combined contributions of labor, capital, and technology. If you do not subtract purchased inputs from sales, you end up double counting the intermediate products. The data we use are in real terms, specifically 2017 chained dollars. By putting all years of the value-added data in 2017 prices, this allows us to make comparisons across time that are not muddled by the impact of changes in prices, including during the post-pandemic surge in inflation.

2.2 Labor Productivity and its Decomposition

Labor productivity is measured as value added per worker or full-time equivalent employed. Labor productivity is influenced by many factors, including human capital and skills that vary across sectors, the digital capital intensity or the digital footprint in a sector, and tangible capital intensity (e.g., mining and certain utilities have high measured labor productivity because they are capital intensive). More generally, labor productivity is affected by the state of technology in the sector.

To analyze changes in patterns of value-added (VA) per person employed in the U.S. across tradable and non-tradable industries, we employ the Divisia index decomposition method. This analysis breaks down overall productivity growth into components, including within-sector productivity growth and changes in sectoral employment shares. The approach enables us to pay particular attention to structural changes and the sectoral dynamics of labor productivity growth within and across sectors in the U.S. It also facilitates a better discussion of the potential factors and mechanisms associated with variations in labor productivity growth. Given that the U.S. lost manufacturing jobs in the 1990s, it raises the question of which sectors and activities have helped sustain aggregate output per worker. Furthermore, we can explore whether these dynamics will change in light of past and recent recessions.

We decompose aggregate value added per worker into three components: labor productivity growth contributions (1) from within sectors, (2) from redistribution of workers across sectors, and (3) from changes in sectoral terms-of-trade at the aggregate level for both tradable and non-tradable activities. We employ the methodology of Azenui and Rada (2021), which uses log mean Divisia index to analyze structural changes in industrial production because of its versatility. Also, because it is an additive and symmetric indicator of relative change, this Divisia decomposition technique does not produce a residual (Ang, 2004). The Divisia index methodology is described below and is similar to that described by Azenui and Rada (2021), but also accounting for variation in the tradability of sectors.

The aggregate labor productivity (E_t) in an economy with more than one economic activity can be defined as the sum of weighted averages of the labor productivities of each activity.

$$E_t = \frac{\sum_{i=1}^{n} P_{i,t} X_{i,t}}{P_t L_t} \tag{1}$$

Where $P_{i,t}$ is each activity's price level, $X_{i,t}$ is real value added in activity i, P_t and L_t is the gross domestic product (GDP) deflator and total employment respectively. Multiplying (1) by $L_{i,t}/L_t$, produces three components of labor productivity:

$$E_t = \sum_{i=1}^{n} \frac{P_{i,t} X_{i,t}}{P_t L_{i,t}} \frac{L_{i,t}}{L_t} = \sum_{i=1}^{n} \varepsilon_{i,t} \lambda_{i,t} p_{i,t} \tag{2}$$

Where $E_{i,t}$ is sectoral labor productivity in activity i $(X_{i,t}/L_{i,t})$, $\lambda_{i,t}$ is employment share of sector i $(L_{i,t}/L_t)$, and is sectoral terms of trade of sector i $(P_{i,t}/P_t)$. Aggregate labor productivity can now be decomposed into several contributing factors spanning from tradable and nontradable sectors and further into economic activities within these sectors in our analysis. From (2) we can deduce that changes in the sectoral output per worker results in the direct productivity effect, reallocation effect as measured by changes in employment shares, and changes in the market structure or terms of trade effects. Presuming continuity in the variables, we differentiate (2) with respect to time and divide both sides by E_t, which yields:

$$d\ln(E_t)/dt = \sum \theta_{i,t}[d\ln(\varepsilon_{i,t})/dt + d\ln(\lambda_{i,t})/dt + d\ln(p_{i,t})/dt] \tag{3}$$

Where theta represents the sectoral weights in nominal value added. Integrating (3) over the interval $[0, T]$ gives the Divisia decomposition of aggregate labor productivity growth rate.

$$\ln\frac{E_T}{E_0} = \int_0^T \sum \theta_{i,t}[d\ln(p_{i,t})/dt] + \int_0^T \sum \theta_{i,t}[d\ln(\varepsilon_{i,t})/dt] + \int_0^T \sum \theta_{i,t}[d\ln(\lambda_{i,t})/dt] \tag{4}$$

Applying exponents to (4) and matching the discrete format of the data, the decomposition components can be written in discrete expressions:

$$Direct - Productivity_{effect} = \exp[\sum(\theta_{i,0} + \theta_{i,T})/2\ln(\varepsilon_{i,t}/\varepsilon_{i,t-1})] \tag{5}$$

$$Reallocation_{effect} = \exp[\sum(\theta_{i,0} + \theta_{i,T})/2\ln(\lambda_{i,t}/\lambda_{i,t-1})] \tag{6}$$

$$Terms - of - trade_{effect} = \exp[\sum(\theta_{i,0} + \theta_{i,T})/2\ln(p_{i,t}/p_{i,t-1})] \tag{7}$$

All Divisia index decomposition expressions are weighted by the sector's share in nominal value added. The direct productivity effect in (5) measures the gain in aggregate value added per worker that is due to increases in workers output within sectors, mostly driven by technology and capital gains. In the results that follow, we find that the direct effect dominates contributions to overall labor productivity performance in the U.S. This is not surprising because the reallocation and terms of trade terms are weighted averages of growth rates of sectoral shares whose average is bound to be close to zero given that sectoral shares cannot all increase from one period to the next (Diewert, 2010). Because changes in employment shares sum up to one, the reallocation effect diminishes compared to the direct effect.

Variations in labor shares impact aggregate labor productivity growth as workers are allocated across sectors with different levels of productivity. This is captured by the reallocation term. At the aggregate level, a positive reallocation effect reflects redistribution of workers from lower-than-average activities to activities with relatively high labor productivity. However, a negative value for this component at the sectoral level only reflects the fact that the sector has lost employed workers relative to the rest of the economy, which can be a good thing provided the sectors shedding labor are also the sectors with lower relative value added per worker Azenui and Rada (2021).

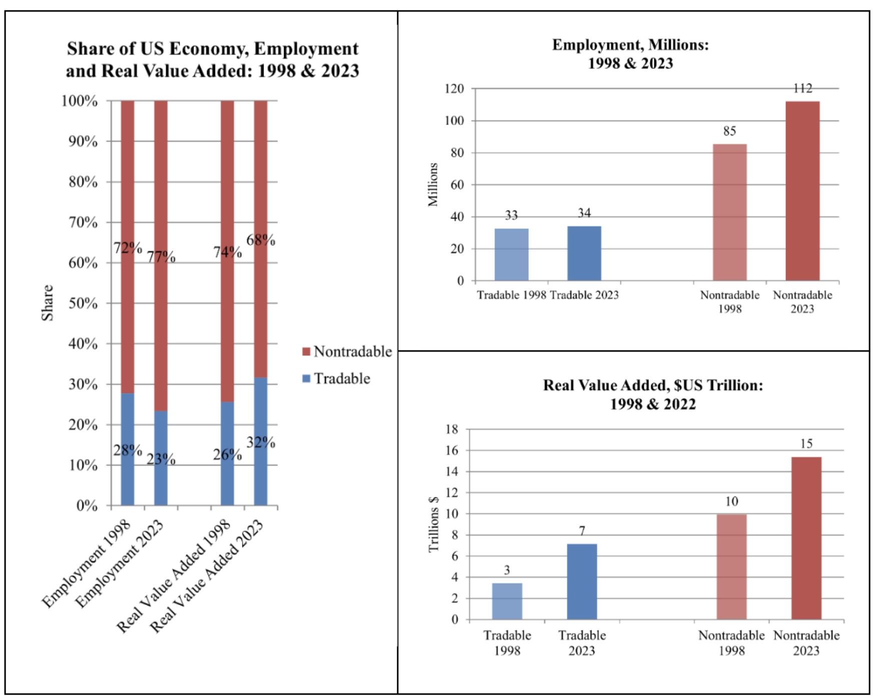
Changes in the weights of the decomposition values are reflected in changes in the market structure effect. The Divisia decomposition terms are weighted by sectoral nominal shares in value added because sectors do not produce the same output and therefore are valued at the applicable price. As some sectors become relatively more important and carry a larger weight in the economy, that shows up in the terms of trade effect (Diewert, 2010). Thus, changes in relative prices affect the weight of each industrial activity in the country. The transfer of workers to a sector with strong labor productivity gains raises the sector's contribution to aggregate productivity even higher, provided the sector's own price grows relatively faster than the general price level. This increases the sector's share in value added further. In other words, sectors with relatively high labor productivity that are also experiencing a rise in relative prices contribute to an increase in aggregate labor productivity and have positive market structure effects. A negative total terms of trade contribution to aggregate productivity growth indicates that prices of outputs in high productivity sectors rise more slowly than the overall price level while prices of lower-than-average productivity sectors rise relatively faster. The market structure component for the macroeconomy is expected to be relatively small and close to zero.

3 Results

3.1 Employment and Value Added

Overall Structure and Long Term Trends: The nontradable sector dominates the U.S. economy (see Figure 2), with its size and composition determined by a combination of technology and–more prominently–the composition of domestic demand. In 2023, the nontradable sector accounted for 77 percent of employment (112 million full time jobs) and 68 percent of real value added ($15 trillion). This is not new. In 1998, 72 percent of employment was nontradable, and 74 percent of real value added was nontradable. Of the total incremental increase of 28 million in jobs from 1998 to 2023, 95 percent or 27 million of it came from the nontradable sector with the tradable sector seeing a small increase in jobs since 1998 of 1 million. The change of $9 trillion in real value added between 1998 and 2023 was more evenly distributed between both the tradable and nontradable sector (although the nontradable sector still accounted for 60 percent of the increase over the period).

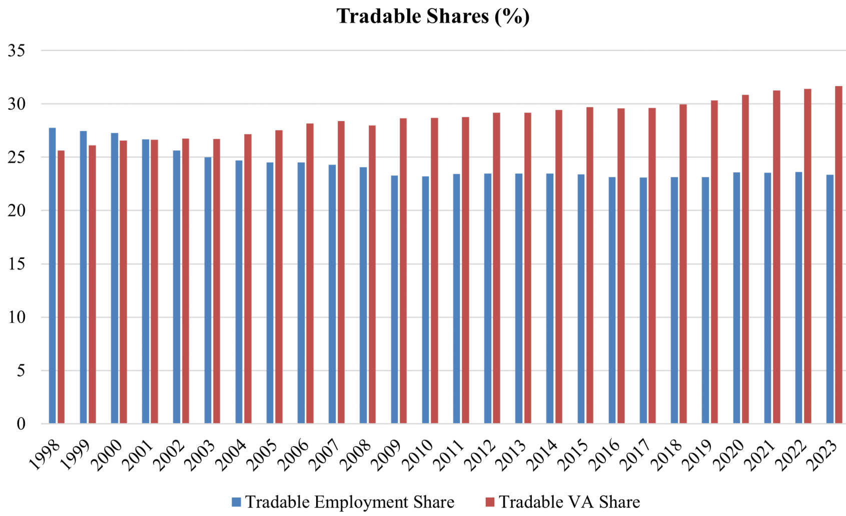
Figure 2: Structure of the US Economy in 1998 & 2023



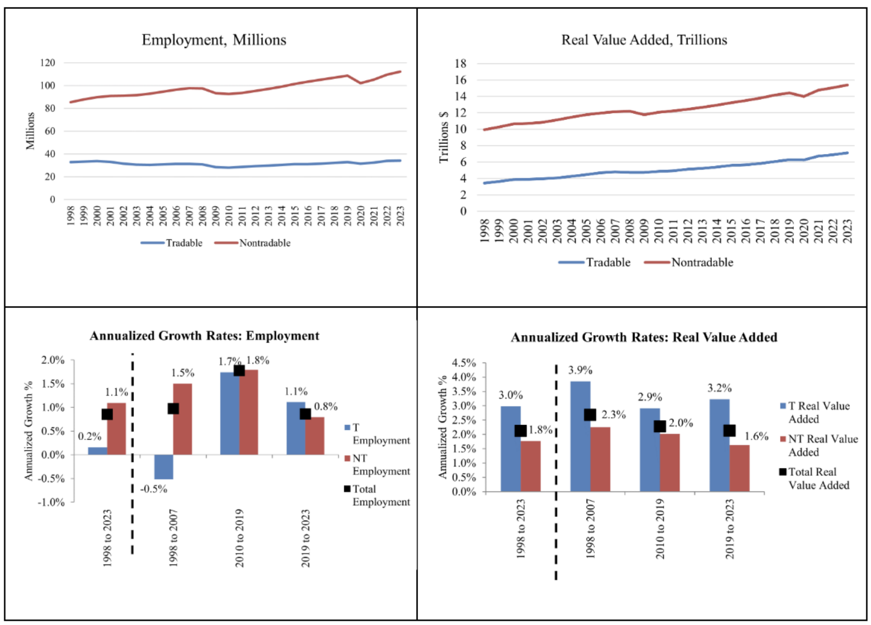
Looking more closely at developments during the two decade period, a prior trend of declining share of tradable employment ended in the decade after the GFC and leading up to the pandemic, when the tradable share of employment leveled out at around 23 percent (Figure 3a). Specifically, from 1998 to 2007, tradable employment fell on an annualized basis by 0.5 percent per year but rose by 1.7 percent per year from 2010 to 2019, similar to annualized trends for nontradable employment which grew steadily in both periods by over 1 percent per year on average (Figure 3b). The positive growth in tradable employment moderated but remained positive since 2019, outpacing growth in nontradable employment.

In contrast to the mid-point pivot in tradable employment trends, the tradable sector's real value-added share steadily increased over the entire period, with annualized tradable real value added growing by 3.9 percent from 1998 to 2007, by 2.9 percent from 2010 to 2019, and by 3.2 percent more recently. Tradable value-added has increased at a much faster pace than tradable employment—and at a faster pace than nontradable value-added, leading to persistent increases in tradable productivity. Stepping back, the improvement in employment growth rates juxtaposed against declines in real value added growth rates across recent decades creates a challenge for productivity, especially for the nontradable sector–as we will discuss below. All the series show declines as expected around the GFC and its immediate aftermath, as well as during the pandemic (see Box 1).

Figure 3: Trends in the US Structure of the Economy



(a) Share of Tradable Employment and Real VA, 1998-2023

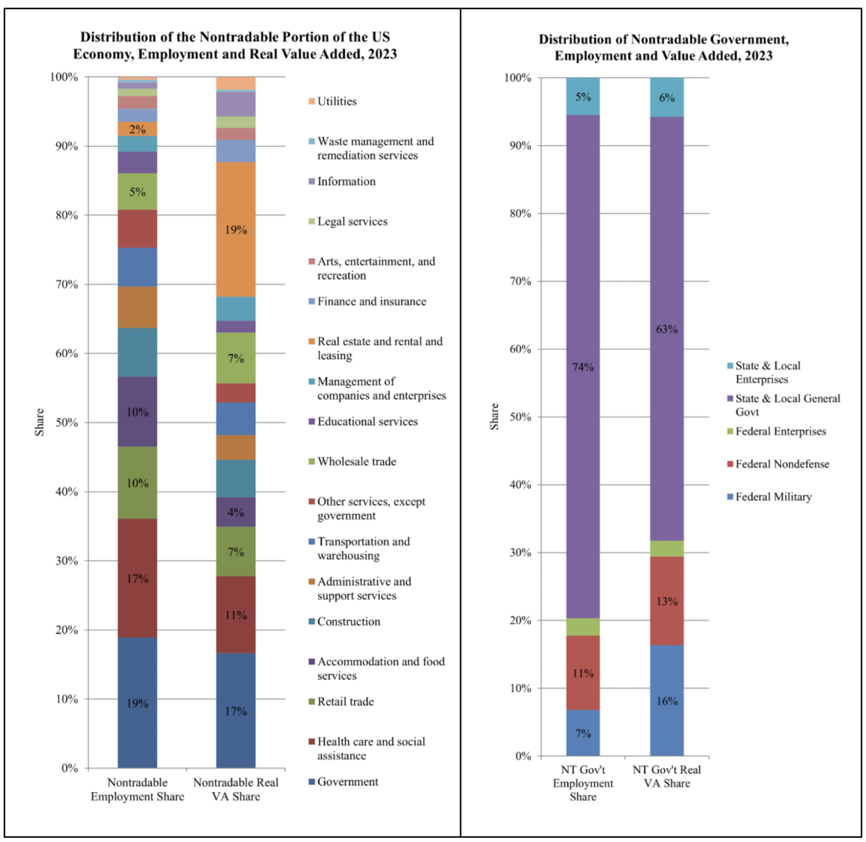


(b) Levels and Growth Rates, 1998-2023

3.1.1 Employment and Value Added within the Nontradable Sector

Looking across the nontradable sectors, the government is the largest nontradable employer followed by health care & social assistance (see Figure 4). Both also rank high amongst the value-added contributors, however real estate, rental, and leasing is the largest nontradable value-added sector. Government ranks second in terms of its value-add contribution; however, government's value-add estimates should be absorbed with some skepticism given that, for the most part, there are very few market indicators to value government services and so the cost of government services is often used as an imperfect proxy for its value-add. As mentioned above, the composition of domestic demand is a key determinant of the size of the relative nontradable sectors. For the top nontradable sectors, employment shares outweigh nontradable value added shares, but the real estate, rental, and leasing sector has an outsized value-added contribution compared to employment. Within government activity (right hand side of Figure 4), state & local governments account for a majority of both employment and value-added.

Figure 4: Structure of the Nontradable Sector in 2023



Looking at the nontradable sector's trends over time, healthcare, hospitality, and government employment drove longer-term nontradable employment growth (Figure 5). However, government's contribution to nontradable employment growth fell dramatically in the decade leading up to the pandemic compared to 1998 to 2007. Historically larger than real estate, government real value added has similarly stagnated since 2010 and the real estate has displaced it as the largest nontradable sector from a value-added perspective. Health care & social assistance's real value added has steadily grown, broadly in line with its employment growth trends in the decade leading up to the pandemic and since then (Figure 6).

Figure 5: Nontradable Employment, Millions

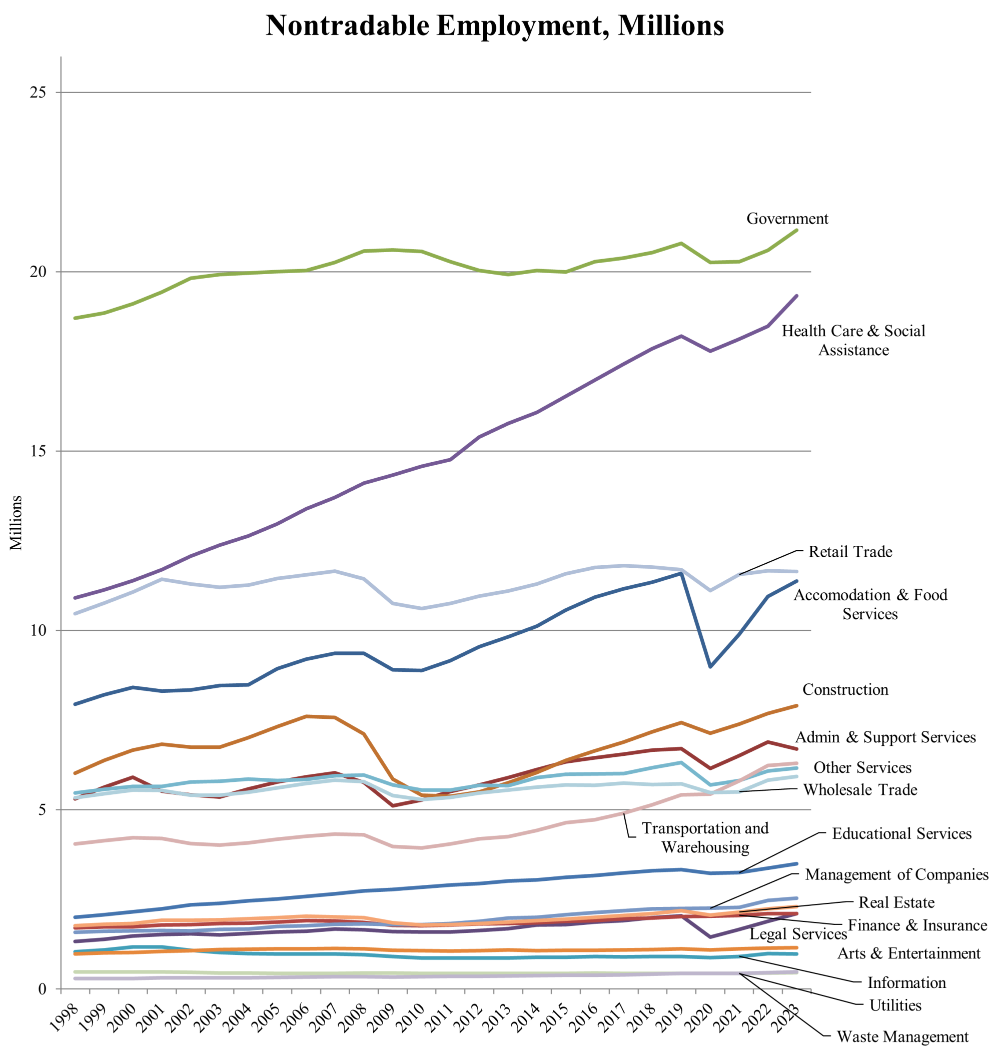


Figure 6: Nontradable Real Value Added, Trillions

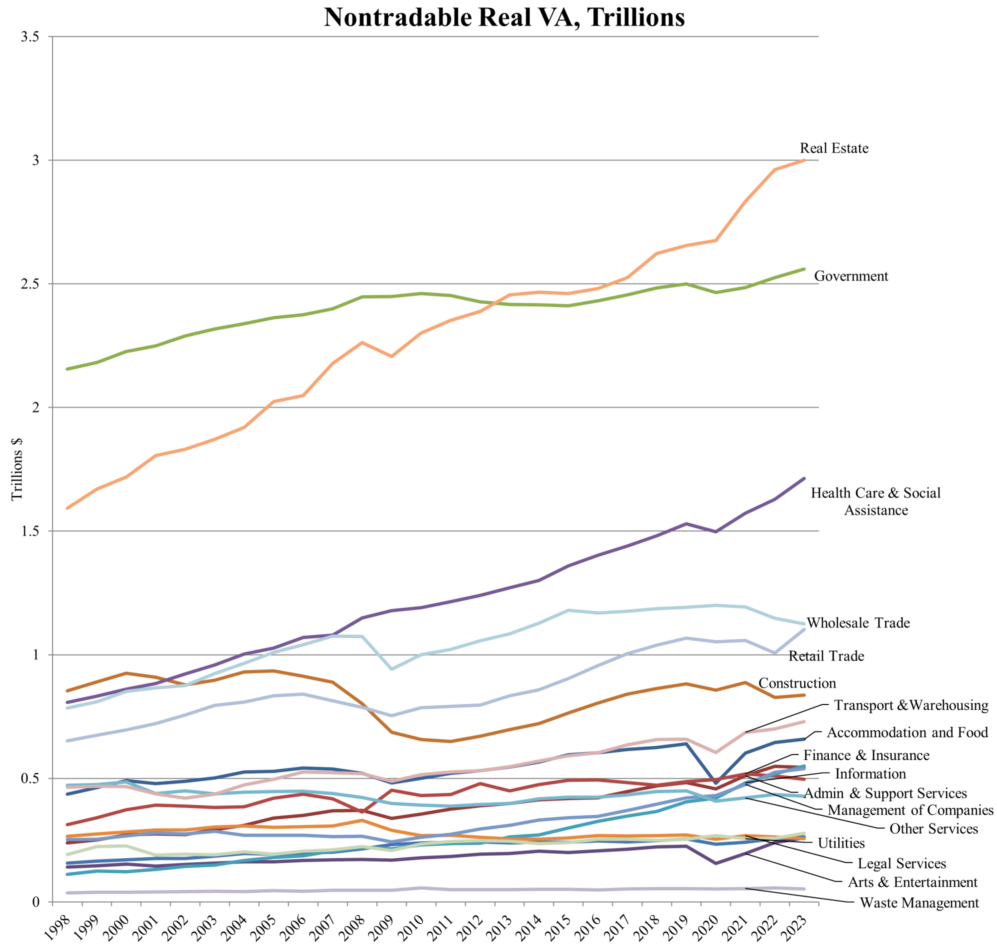
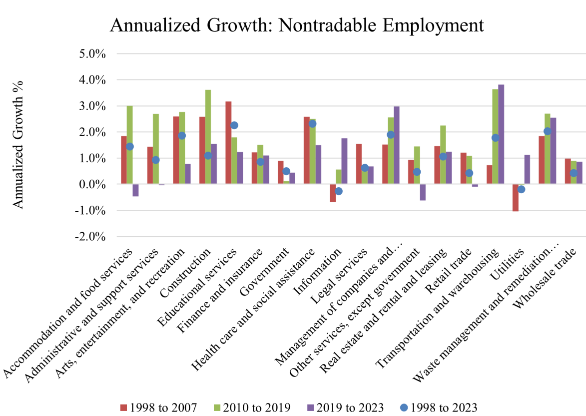
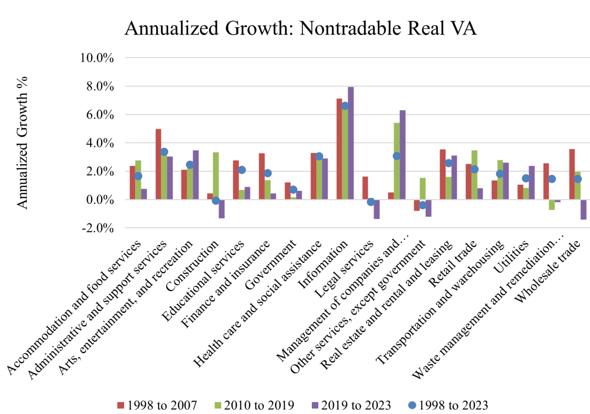


Figure 7: Nontradable Annualized Growth

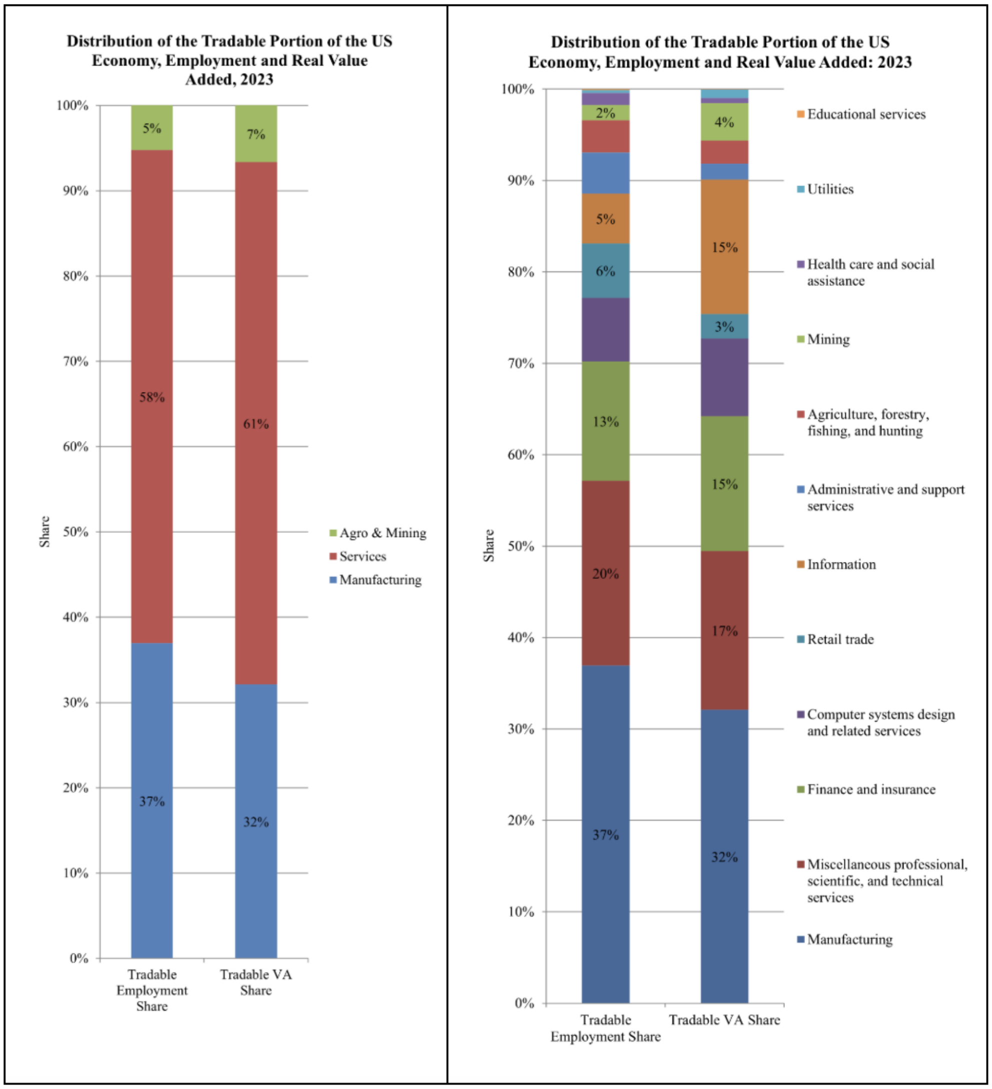




3.1.2 Employment and Value Added within the Tradable Sector

There are two parts of the tradable part of the economy. Goods-producing sectors are one part and correspond to the manufacturing sectors plus agriculture and mining. By 2023, goods-producing sectors accounted for 42 percent of tradable employment and 39 percent of tradable value added (Figure 8). The remainder, and bulk of the tradable sector, consists of different varieties of services: much of consulting, R&D, software, management of multinational enterprises outside of manufacturing, and a set of financial services. Tradable services account for 58 percent of tradable employment and 61 percent of real value added in 2023. The large services sectors include professional, scientific, and technical services, and finance and insurance. Similar to the nontradable part, for the largest tradable sectors, employment shares are larger than value-added shares. However, for information services and mining, their real value added shares are more than double their shares of tradable employment. Within the manufacturing sector, food, beverages, and tobacco and metal products are sizable employment sectors, while chemical products, computer and electronics, and food, beverages, and tobacco account for sizable value-added sources.

Figure 8: Structure of the Tradable Sector in 2023



Looking at trends over time, tradable sector employment growth more recently came from manufacturing, computers systems & design, and professional services like finance and insurance (Figure 9 & 10). Since 2010, both manufacturing value-added and employment have trended upwards. This finding is particularly striking on the employment side, where a multi-decade pattern of declining manufacturing employment stopped and began to increase in the decade leading up to the pandemic. The post-pandemic period is also the first recovery in recent history from a recession where there has been a complete recovery to pre-crisis levels in manufacturing employment, in part due to the outsized shift in relative demand towards goods and away from services that took place during the pandemic and because of policy interventions meant to give direct support to U.S. manufacturing. Strong tradable value-added growth also came from industries like information and computer systems & design (Figure 11 & 12).

Figure 9: Trends in the Tradable Structure of the US Economy

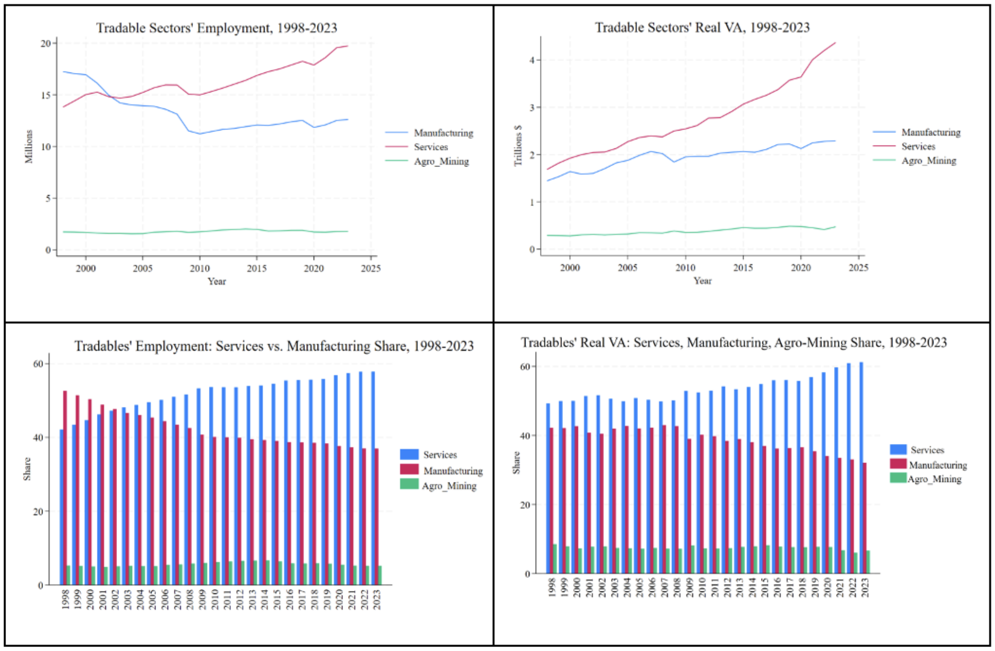


Figure 10: Tradable Employment, Millions

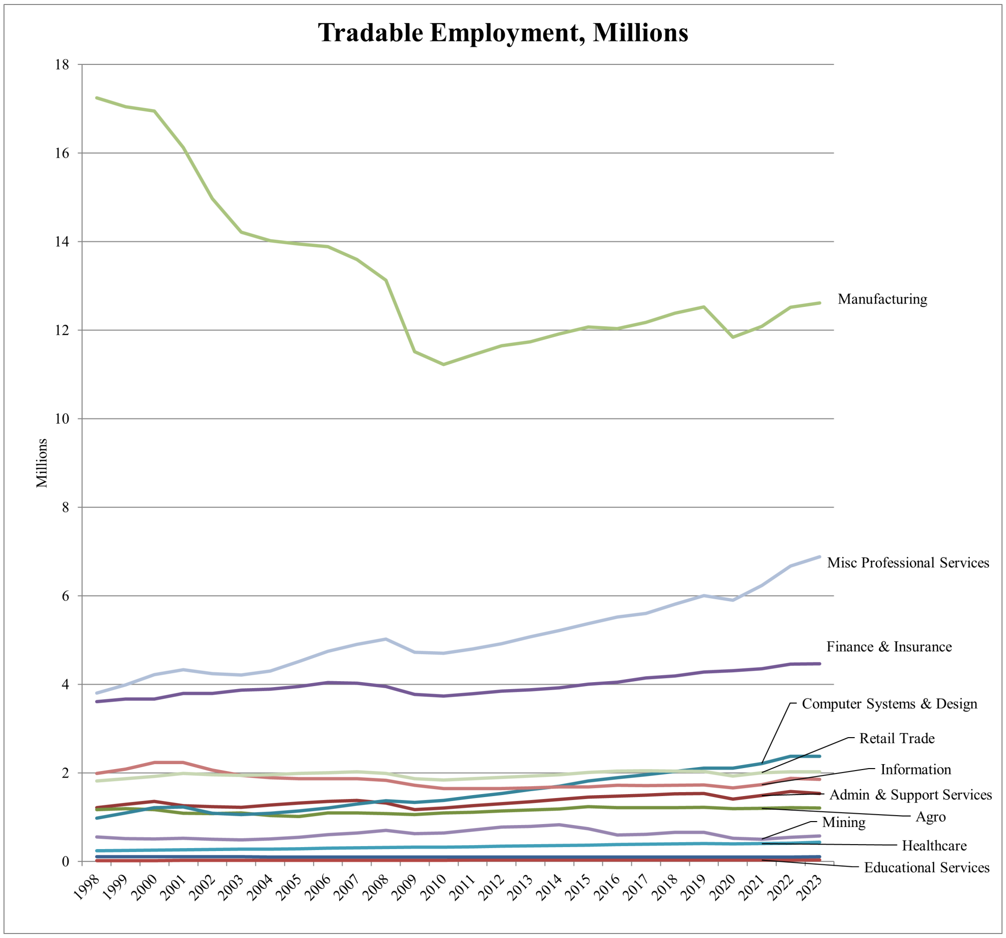


Figure 11: Tradable Real Value Added, Trillions

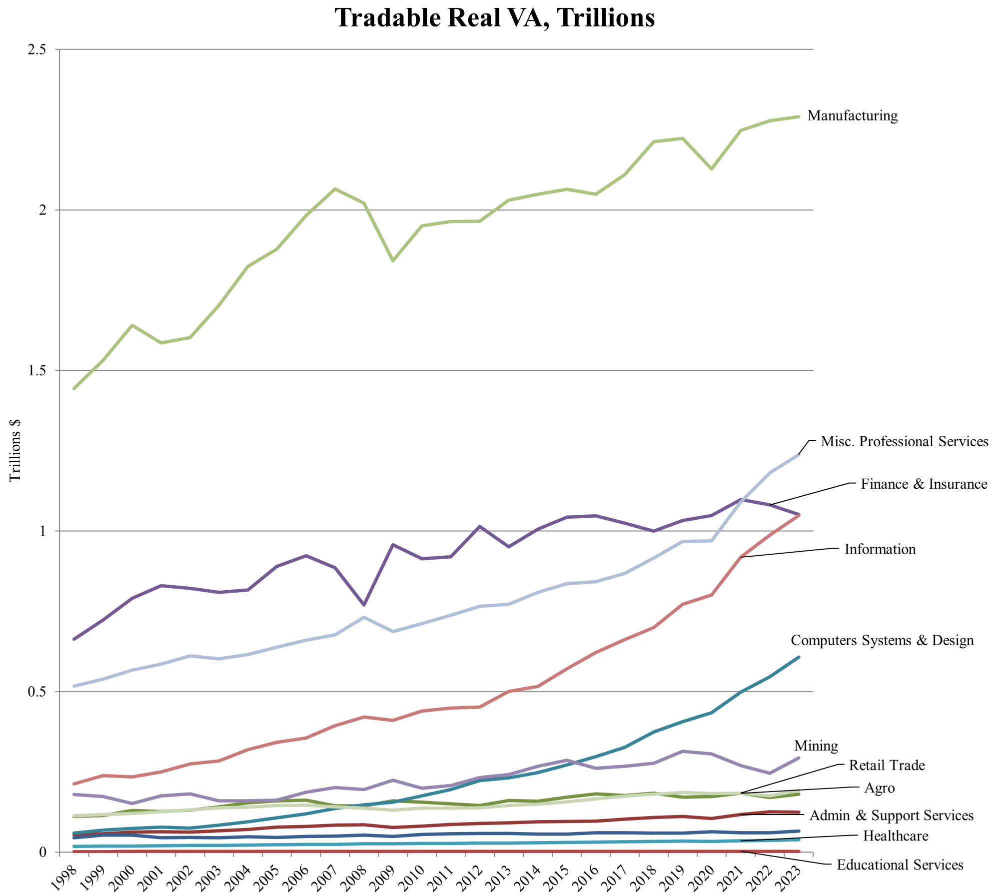
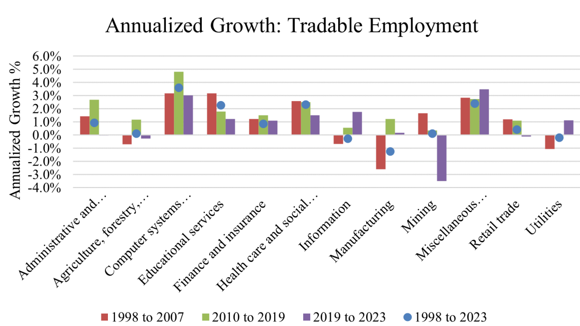
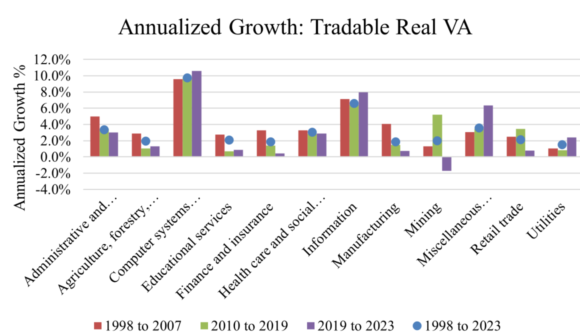


Figure 12: Tradable Annualized Growth





Box 2: Tradable and Nontradable Employment & Value-Added During the Pandemic

The pandemic dealt a larger blow to nontradable employment relative to tradable employment; the former dropped by 7 percent in 2020 while tradable employment fell by 4 percent. Comparing 2023 levels vs. 2019, nontradable employment was only 3 percent above 2019 levels while tradable employment was 5 percent above its 2019 levels. Within the nontradable sectors, healthcare and hospitality employment both experienced a large negative hit, especially the hospitality industry. Notably, nontradable retail employment had already begun to decline prior to the pandemic and further fell during the pandemic, likely reflecting a rise in e-commerce that is still small but growing quickly. Similar to the employment outcomes, the pandemic hit to nontradable value added was larger than the hit to tradable value added (-3 percent vs. -2 percent from 2019 to 2020). Both nontradable and tradable value added have bounced back, with 2023 tradable value added up 14 percent vs. 2019 and nontradable value added up 7 percent vs. 2019.

Looking across tradable sectors, professional services (including finance & insurance) employment and value added did not see a large decline during the pandemic. However, the pandemic halted manufacturing's progress temporarily. Manufacturing value added recovered faster than employment and was above pre-pandemic levels by 2021; by 2022, manufacturing employment had recovered close to its 2019 levels. Initially, manufacturing employment's weak recovery was driven by soft recoveries in fabricated metals, machinery, and computers & electronic products—likely weighed down by supply chain and labor supply pressures that have since dissipated. As others have documented, some of the supply-side constraints contributed to the run-up in inflation seen during 2022-23 (Shapiro, 2022).

Together, the aggregated employment and value added results suggest that tradable industries helped buoy the U.S. economy from a larger hit during the pandemic, even more so than during the GFC (i.e., tradable employment fell 10 percent from 2007 to 2010, while nontradable employment fell only 4 percent). As the next section will document, we ascribe this to the resiliency of the knowledge economy and its ability to function remotely despite the pandemic shock.

3.1.3 Tradability, Teleworkability, and Resiliency

The above findings suggest that the tradable sector is a core driver of the U.S. economy's overall resiliency, which is especially true of tradable services during the pandemic. At the same time, research has shown that teleworkable industries experienced less unemployment relative to non-teleworkable industries during the recent crisis (Shibata, 2021). To explore the intersection of these two findings, we examined correlations between teleworkability and sectoral industry-specific changes in employment and value added across both the tradable and nontradable sectors. To measure teleworkability, we use the U.S. Bureau of Labor Statistics' 2021 Business Response Survey to the Coronavirus Pandemic and subtract the percentage of jobs that "rarely or never" involve teleworking from 100 as the index (see Figure 13).[7] To capture industry-specific, pandemic-related "resiliency," we look at the change in employment and value added between 2019 and 2023 where industries that have higher employment and/or value added vs. their pre-pandemic levels are viewed as more 'resilient' than their peers (Table 2 & 3).

Figure 13: Telework Patterns by Industry (BLS)

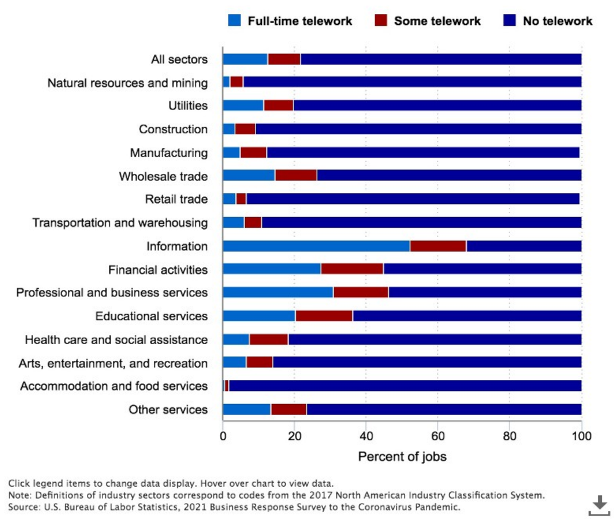


Figure 14 shows simple correlations between our selected measures of resiliency and tele-

[7]The survey covered a nationally representative group of private firms and was collected between July and September 2021. Some industries were not explicitly covered by the survey. We applied the information industry's tradability to computer system design, legal services, and management of companies and enterprises. We applied "other services" tradability to waste management and remediation services, administrative and support services, and government. For agriculture's tradability, we used natural resources and mining sector tradability. For more information, see here: https://www.bls.gov/opub/mlr/2022/article/telework-during-the-covid-19-pandemic.htm

Table 2: Tradable Resiliency: Employment and Real Value Added

	T % Change in Employment: 2023 vs. 2019	T % Change in VA: 2023 vs. 2019
Administrative and support services	-0.1	12.7
Agriculture, forestry, fishing, and hunting	-1.1	5.3
Computer systems design and related services	12.7	49.5
Educational services	5.0	3.6
Finance and insurance	4.5	1.7
Health care and social assistance	6.1	12.1
Information	7.2	35.8
Manufacturing	0.7	3.0
Mining	-13.3	-6.7
Miscellaneous professional, scientific, and technical services	14.7	28.0
Retail trade	-0.4	3.2
Utilities	4.6	9.9

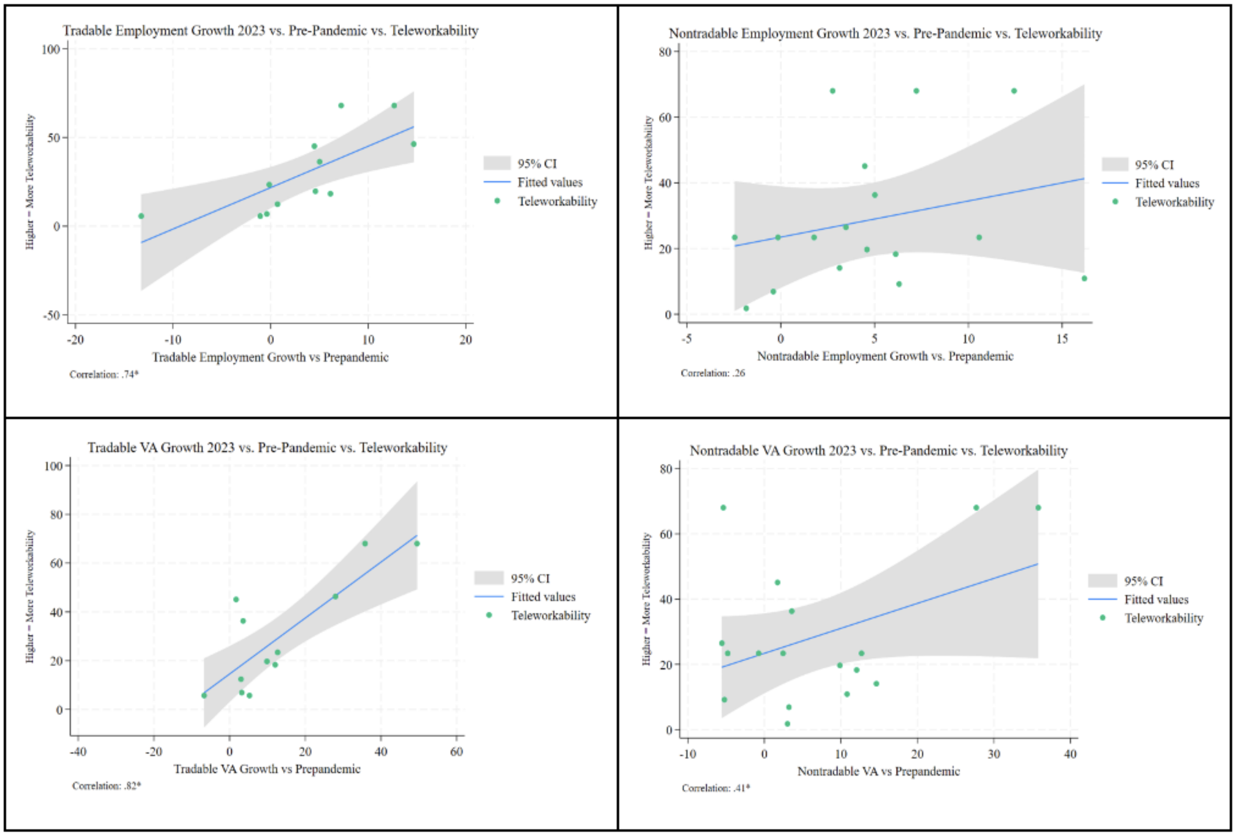
Table 3: Nontradable Resiliency: Employment and Real Value Added

	NT % Change in Employment: 2023 vs. 2019	NT % Change in VA: 2023 vs. 2019
Accommodation and food services	-1.8	3.0
Administrative and support services	-0.1	12.7
Arts, entertainment, and recreation	3.1	14.6
Construction	6.3	-5.2
Educational services	5.0	3.6
Finance and insurance	4.5	1.7
Government	1.8	2.4
Health care and social assistance	6.1	12.1
Information	7.2	35.8
Legal services	2.8	-5.4
Management of companies and enterprises	12.4	27.7
Other services, except government	-2.5	-4.8
Real estate and rental and leasing	5.1	13.0
Retail trade	-0.4	3.2
Transportation and warehousing	16.2	10.8
Utilities	4.6	9.9
Waste management and remediation services	10.6	-0.7
Wholesale trade	3.5	-5.6

workability across the tradable and nontradable sectors, with 95 percent confidence intervals. Resiliency is positively and strongly correlated with teleworkability. The relationship is strongest between tradable value-added growth and teleworkability—and there is a similarly significant relationship between tradable employment growth and teleworkability. Examples of tradable industries with high resiliency and high teleworkability include many professional services, including computer systems design and related services. This result likely reflects at least two reinforcing channels. First, teleworkable industries employ higher-skill workers that have a more secure connection with their employment. Second, teleworkable industries within the tradable sector were not only able to maintain their operations, they also were able to rely on external, foreign markets to continue supporting demand—not just the domestic market. With that latter channel in mind, our prior was that the relationships between teleworkability and nontradable value added and employment growth would be insignificant or far weaker and this is the case for nontradable employment growth. However, for nontradable value added, there is also a positive and significant relationship. Examples of resilient and teleworkable nontradable industries include portions of the information sector, management of companies and enterprises, portions of the finance and insurance industry; an example of a less resilient and not teleworkable nontradable industry is arts, entertainment, and recreation.

As we will discuss in more detail below, one can also disaggregate the U.S. economy by sectors that heavily rely on knowledge and those that do not, with this distinction interacting with our prior tradable vs. nontradable framing. Teleworkability is highest in the knowledge economy because its main input is information. The knowledge economy is larger in the tradable sector, and it is a major driver of what makes the services like finance and computer systems design highly tradable. However, the knowledge economy also has a footprint in the nontradable sector (e.g., a fair amount of management, accounting, service delivery and customer interaction is in the knowledge economy). This helps explain why teleworkability also showed some resiliency on the value-added side in the nontradable sectors.

Figure 14: Tradability, Teleworkability, and Resiliency

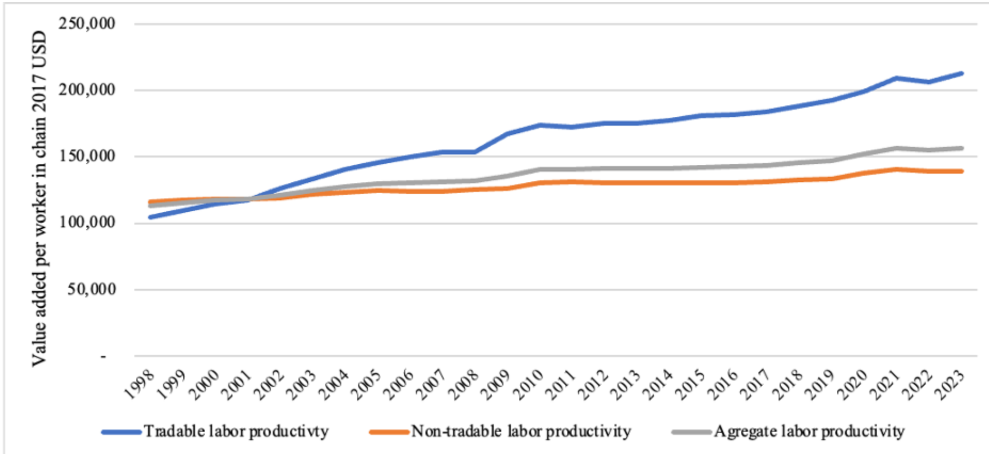


3.2 Labor Productivity Trends

After analyzing employment and value-added trends, we now bring these two measures together to examine U.S. labor productivity across the tradable and nontradable sectors. The distinction between tradable and nontradable industries helps explain changes in productivity patterns over time (e.g., Elsby and Sahin (2013)). Increases in mechanization, foreign competition, and subsequent offshoring of low value added, labor-intensive activities have catalyzed the decline of the tradable employment share in the U.S., with an outsized impact on manufacturing's productivity due to its exposure to both automation and foreign competition. On the other hand, services sectors have not seen as much drastic change due to the difficulty in robotizing/automating them and the nontradable nature of the sector's output, as shown by labor productivity trends in the U.S. since 1998 (Figure 15). However, with increasing tradability of certain services, especially high-tech sectors, this narrative will likely change. For instance, Taylor and Omer (2019) find that employment shares are falling sharply in service sectors, particularly in finance, wholesale trade, and information technology, while those of sectors such as health, education and entertainment are rising but with relatively low labor productivity. Also, some services sector jobs, such as file clerks and information systems, have been automated. In this era of advances in artificial intelligence, many cognitive service activities and jobs have the potential to be equipped with digital assistants and some degree of automation. In sum, the job and income polarization from the pre-AI period is attributable to both offshoring and digital technology automation in manufacturing and, to an extent, services.

Applying this conceptual framework, we now discuss labor productivity trends and the key drivers of changes in labor productivity growth based on results from the Divisia index decomposition. We begin by describing labor productivity levels and trends over the entire period (1998-2023). Based on average annual growth rates, tradable labor productivity grew at just under 3 percent while nontradable labor productivity grew at 0.7 percent as shown on Figure 18b. While the non-tradable sector accounts for close to 80 percent of employment, much of the increase in aggregate productivity was driven by the tradable sector. Figure 15 shows that the level of productivity in the two sectors was similar in 1998, though the nontradable sector had a slight lead. As a result of these trends, the divergence between the sectors grew dramatically over the 25-year period. By 2021, tradable labor productivity was nearly double that of nontradable. Also, the impact of the Covid pandemic on labor productivity is clear for both tradable and nontradable sectors. This downward trend in productivity levels due to the pandemic was driven by a fall in productivity growth within both tradable and nontradable sectors in the period 2021-2022 as seen in Figure 17. By 2023, productivity trends had recovered to prepandemic levels.

Figure 15: Labor Productivity Trends, 1998-2023



The tradable sector's measured labor productivity is affected by recessions, although recent recessions have had little impact. During the GFC, there was a small decline and then an increase in tradable labor productivity. During that period, the decline in tradable employment was less than 200,000 full-time equivalent jobs and returned to pre-recession levels by 2013, while real value added dropped in 2009 but quickly recovered above pre-recession levels. By the end of 2009, labor productivity growth had caught up to the long-term historical trend.

Conversely, labor productivity has been steadily increasing in the nontradable sector since 1998, and the effect of recessions was less pronounced as shown in Figure 15. In other words, the level of nontradable labor productivity is pretty much upward sloping and without sharp dips or spikes, which raises the question of why nontradable labor productivity was not affected by the global financial crisis (GFC) given that the housing market is a major nontradable sector. For real estate, both value added and employment fell. During the recession, construction of new homes was hard hit, and the value of homes declined concurrently with declining employment in those sectors, which resulted in labor productivity remaining almost unaffected. In fact, we observe from the decomposition that contributions to labor productivity growth from within the real estate sector have not returned to pre-recession levels although there have been some gains in employment and improved contributions from reallocation in real estate.

Rising real value added in other services has enabled strong resilience of nontradable labor productivity to shocks. The sustained increase in labor productivity could be the result of technological change and cyclical effects, particularly during the pandemic (Fernald and

Ochse, 2021). Capital per worker rose as employment fell due to the pandemic, increasing labor productivity in the short run; this is likely to unwind as the economy continues to normalize. In addition, Stewart (2022) found that increases in labor quality during the pandemic accounted for about two-thirds of labor productivity growth in the second quarter of 2020, and that 25 percent of the increase in labor quality was due to the change in the distribution of workers across sectors, mainly due to massive job losses in leisure, hospitality, tourism, and other low wage industries. Finally, labor supply shortages that were experienced during the pandemic helped catalyze the discovery of innovative ways to enhance productivity in nontradable sectors. For example, use of CLEAR Plus and Global Entry at airports scaled-up in response to preferences for no-touch solutions, and use of robots in low productivity sectors such as restaurants similarly helped reduce the need for as many workers in high-risk environments.

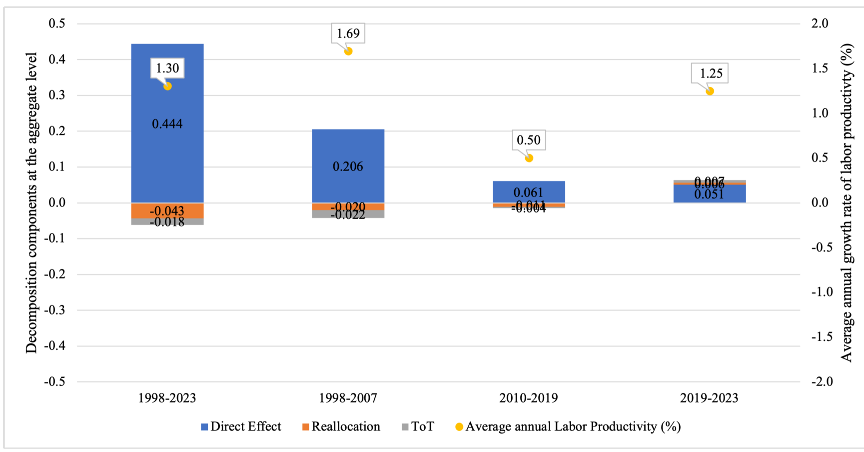
3.3 Labor Productivity Decomposition

The decomposition results show a breakdown of aggregate labor productivity growth into contributions from within sectors, across sectors, and sectoral terms of trade for both tradable and nontradable activities, which facilitates the analysis of changes in patterns and sectoral drivers of labor productivity growth. As described earlier in the methodology, the direct effect or within sector productivity growth is usually the result of technological improvements and capital investment within sectors while the reallocation effect captures productivity growth across sectors due to the transfer of labor from one sector to another. The terms of trade component reflect changes in relative prices across sectors.

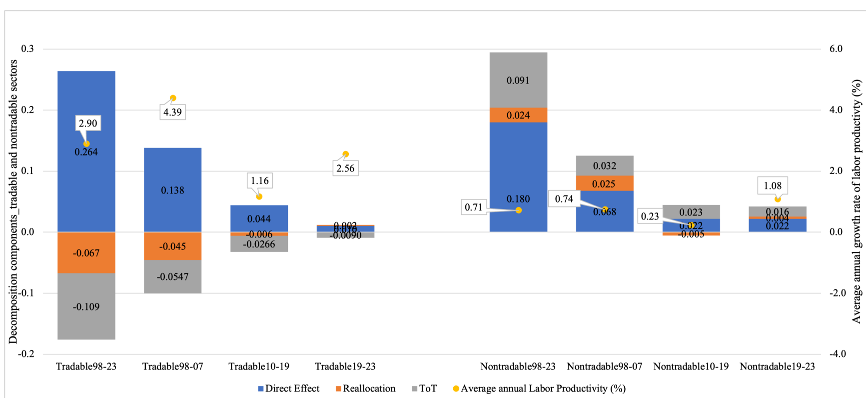
Figure 16a shows growth rate of labor productivity and its components across broad periods, beginning with the entire time frame from 1998-2023, followed by temporal breakdowns of 1998-2007, 2010-2019, and 2019-2023. We omit the GFC years that may bias results but include the recent pandemic to analyze how it affected sectoral drivers of labor productivity growth. Labor productivity growth (in bars) is plotted on the primary axis while average annual growth rate of labor productivity (dots) for each corresponding period is plotted on the secondary axis.

Figure 16b is a breakdown of Figure 16a by tradable and nontradable sectors. For example, the sum of the tradable 1998-2023 direct effect and nontradable 1998-2023 direct effect in 18b add up to the first blue bar in Figure 16a, which shows total direct effect for the entire economy between 1998 and 2023. It is worth noting that shorter periods have smaller growth compared to longer periods, which is the reason why the bars for the 2019-2023 period are smaller than bars in the 1998-2023 or 1998-2007 periods. As indicated from the figures, contributions from the direct effect dominate and are mostly driven by the tradable sector. The reallocation effect at the aggregate level is negative for the first three time periods, showing the movement of labor from high productivity to low productivity sectors. The tradable sector has shed workers while the nontradable sector has gained workers, reflecting a transition of the U.S. economy from manufacturing to services, with associated rising employment shares in the nontradable sector. This is indicated by the negative tradable reallocation effect and the positive reallocation effect in the nontradable sector.

Figure 16: Contributions to labor productivity & average annual labor productivity growth (%)



(a) Contributions to labor productivity by main effects



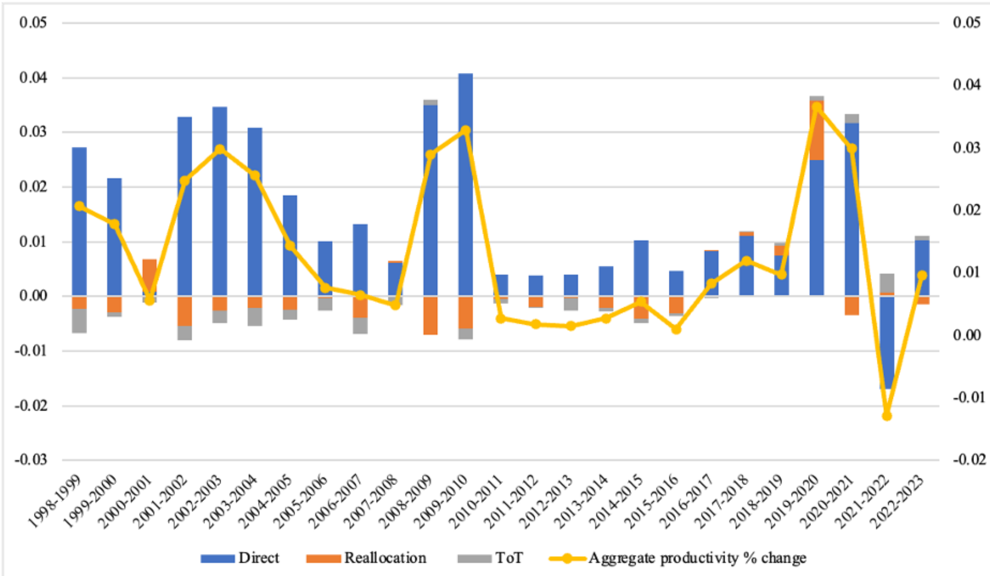
(b) Contributions to labor productivity by main effects: tradable and nontradable sectors

Figure 17 plots the annual growth rate of the direct, reallocation, and terms-of-trade decomposition components of labor productivity growth at the aggregate level from 1998 to 2023, with the breakdown across tradable vs. nontradable shown in Figure 18. The U.S. experienced a productivity growth surge in the late 1990s and early 2000s, with the exceptions of the internet bubble burst and 9/11. Productivity growth fell in the lead up to the GFC before spiking again during the GFC and dropping to nearly zero post-GFC. Before and during the pandemic, it spiked again. However, for the most part, the post-GFC period saw very muted productivity growth. There are several reasons that have been put forward to explain the slowdown in aggregate labor productivity growth post-GFC, including a reduction in investment due to risk aversion post-GFC and reduced business dynamism due to tighter lending conditions; lower marginal improvements in ICT technologies; an aging workforce; and potential measurement error due to the difficulty of capturing the value added from digital goods and services (Cardarelli and Lusinyan, 2015; Fernald and Ruzic, 2024). The slowdown in productivity growth can also be attributed to structural change towards low labor productivity sectors and technical change responding to lower pressures from wages.

The induced technical change hypothesis, which posits that firms will be incentivized to develop and adopt factor saving technologies when labor becomes scarce, may help explain the long-term downward trends in productivity growth observe in Figure 19 (Acemoglu, 2002). However, it is important to note that the expectation of higher productivity outcomes resulting from such technological adoption is contingent on labor actually being sufficiently scarce within sectors. In the post-GFC period, while labor shortages were evident in some sectors, labor remained relatively abundant in other lower-productivity sectors, especially in nontradable sectors like healthcare and education. This continued labor availability in these sectors likely mitigated the full potential for labor-saving technological adoption.

Additionally, the post-GFC period was characterized by several structural challenges, such as capital investment constraints, reduced business dynamism, and risk aversion, which may have limited firms' incentives to invest heavily in productivity-enhancing technologies despite labor shortages. Furthermore, advancements in digital technologies, while significant, may not have been fully captured in traditional productivity measures, potentially underrepresenting actual productivity growth in sectors like information technology and online retail. Therefore, while the induced technical change hypothesis theoretically suggests higher productivity outcomes due to labor scarcity, the broader economic conditions of the post-GFC era, including labor abundance in specific sectors and limitations on technological adoption, provide a more nuanced explanation for the observed productivity trends.

Figure 17: Aggregate labor productivity and its contributions by main effects (actual % points)



As shown in Figure 19, we see higher productivity growth in the high value-added sectors, especially tradable services, and low productivity growth in a significant number of high employment, lower value-added parts of the economy that are mostly in the nontradable part of the economy. Information, wholesale, and retail sectors maintained positive productivity growth even during the 2010-2019 period, probably driven by the rise in online retail.

Looking at the main contributors to changes in aggregate labor productivity growth, the direct effect dominates in Figure 17, which fits with priors and as explained in the methodology section. The scarring effects of recessions are also apparent, with almost zero labor productivity growth from 2010 to 2014 and a negative growth rate between 2012 and 2013. Productivity was also lower in the nontradable sector and almost all employment gains were in the sector (composition effect). Based on the compositional decomposition across tradable and nontradable sectors in Figures 18 & 19, the period between 2016-2020 exhibits strong learning-by-doing effects and technological innovation (significant positive direct labor productivity growth), accompanied by strong complementarities and spillovers across sectors that promote a shift of labor to sectors with relatively higher labor productivity as well as positive terms-of-trade effects (sectors with strong labor productivity gains experienced prices that rose faster than the general price level).

The aggregate reallocation effect is mostly negative, implying that labor has been moving from higher-than-average productivity sectors to lower-than-average productivity sectors.

On the one hand, our decomposition results indicate a negative reallocation effect in the tradable sector larger due to manufacturing shedding labor. On the other hand, Figure 18 shows a positive total reallocation effect for the nontradable sector in the late 1990s and early 2000s, partly due to the dot-com bubble and the associated rise in employment shares of higher productivity services such as information. Also, the labor share has declined in manufacturing while healthcare and government sectors have gained a larger share of workers.

Autor et al. (2013) provide an explanation for the declining manufacturing share of employment by analyzing international variation in industry-specific relative productivity. They find that increased Chinese import competition could account for up to one-quarter of the sharp decline in the U.S. manufacturing workforce between 1990 and 2007 and conclude from their model that trade flows can affect the allocation of labor between tradable and nontradable sectors if bilateral trade is imbalanced. Herrendorf et al. (2015) also draw attention to fast-growing trade in services, which is likely to have a significant impact on the nature and speed of labor reallocation in advanced countries. For example, the U.S. has a comparative advantage in certain tradable services like computer and systems design. Related to the increasing tradability of services, Mendieta-Muñoz et al. (2022) show falling employment shares in high productivity services such as finance, information and technology and wholesale trade but rising employment in health, education, and entertainment services characterized as low productivity services. Our results also show a negative reallocation effect in information and technology in recent years.

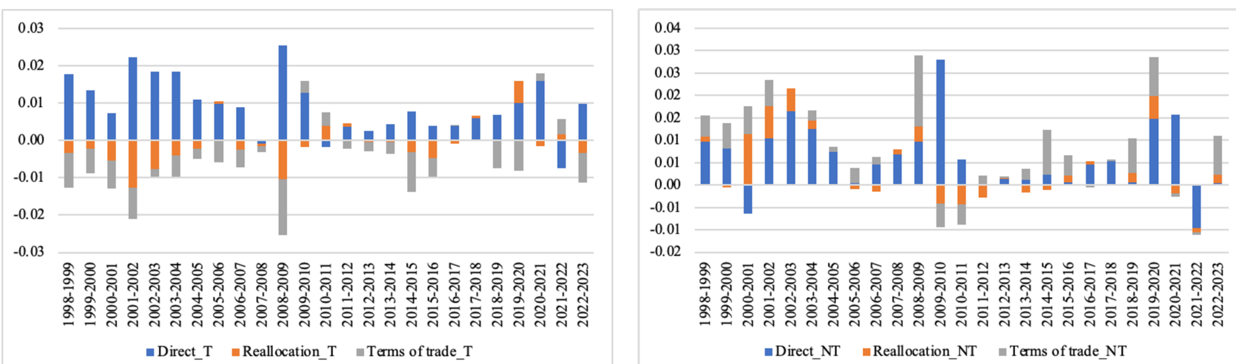
More recently, the U.S. has seen positive reallocation effects during the pandemic and during part of its recovery. Labor has shifted to sectors with relatively higher productivity. In particular, the decomposition shows a loss of jobs in hospitality, accommodation and food services, arts and entertainment, while finance and insurance, scientific and technical services, government, healthcare and social assistance, and transportation generated the most positive gains in reallocation effect during this period.

With regards to the terms-of-trade effect for the tradable sector, the Figure 18 indicates that the terms-of-trade component contributed negatively to aggregate labor productivity growth for most years, supported by the prices of manufacturing, information, and computer systems rising more slowly relative to the overall price level in the tradable sector. This implies that the nominal weights for the U.S. have increased for tradable sectors with relatively lower labor productivity. The patterns are not so clear in the nontradable sector, but the prices of education, government, other services, construction, and health care have been higher than average for most years when looking at annual growth rates. As the U.S.

recovered from the pandemic, the nontradable sector became relatively more important and carried a higher nominal weight in the economy, shown by the positive nontradable terms-of-trade effect in 2023. However, unlike the Baumol effect where relative prices of stagnant sectors rise in response to higher wages in high-productivity jobs, for the nontradable sectors mentioned above, it is more a matter of stagnant productivity in these stagnant sectors.

In general, the overall productivity performance of the U.S. economy in recent decades is noticeably different from the pre-GFC decade. The decompositions show that structural change in the U.S. since 1998 has been towards nontradable services sectors, which exhibit below average labor productivity, hence the negative aggregate reallocation effect. As explained earlier, given the imbalance between the limits on the change in the employment share (since sum of shares equals 1), the employment effect and the terms-of-trade effect are by construction diminished compared to direct effects. Information and computer systems have consistently contributed positively to labor growth within sectors. The trends in the tradable sector are for the most part driven by fluctuations in manufacturing, finance, and insurance (Figure 19).

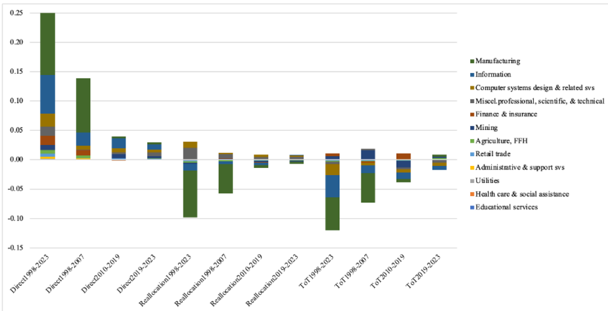
Figure 18: Actual contribution by main effect for tradable(T) and nontradable(NT) activities



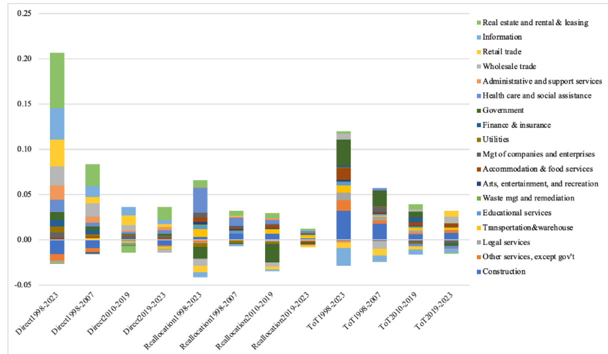
(a) Tradable sector

(b) Nontradable sector

Figure 19: Decomposition results: Tradable and Nontradable sectoral contributions



(a) Tradable sectors



(b) Nontradable sectors

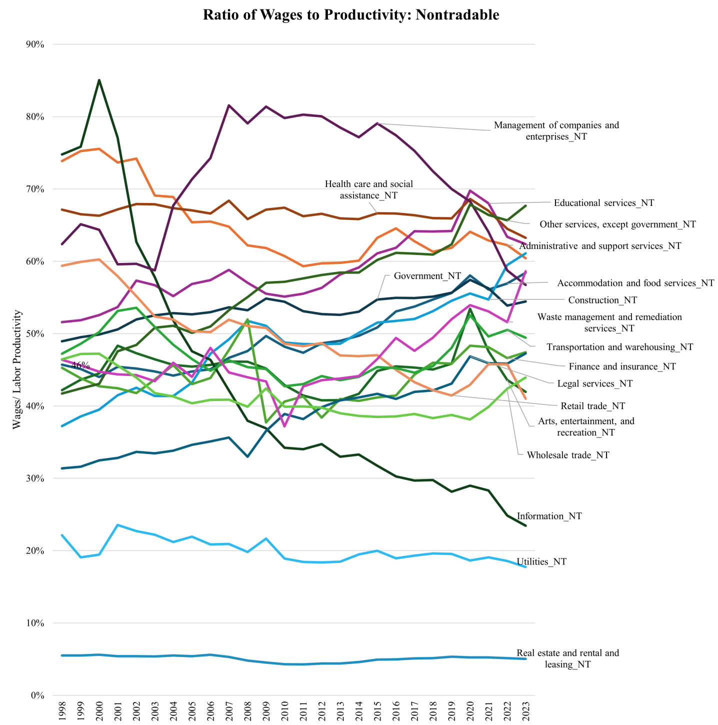
3.4 Labor Productivity and Wages

Historically, productivity has acted as an implicit upper bound on wages in most sectors. To the extent that wages are stagnating in certain sectors, such trends may be linked to their respective productivity. To explore this, we looked at the ratios of wages to labor productivity to get a sense of how wages converge (or not) with productivity over time and across industries. Figure 20, which shows a weighted average of these ratios across the nontradable and tradable sectors, shows that the nontradable sector has greater wage convergence with labor productivity. In 2023, the ratio was 11 percentage points higher than for the tradable sector. This is a reversal of the ratios at the start of the sample period in the late 1990s.

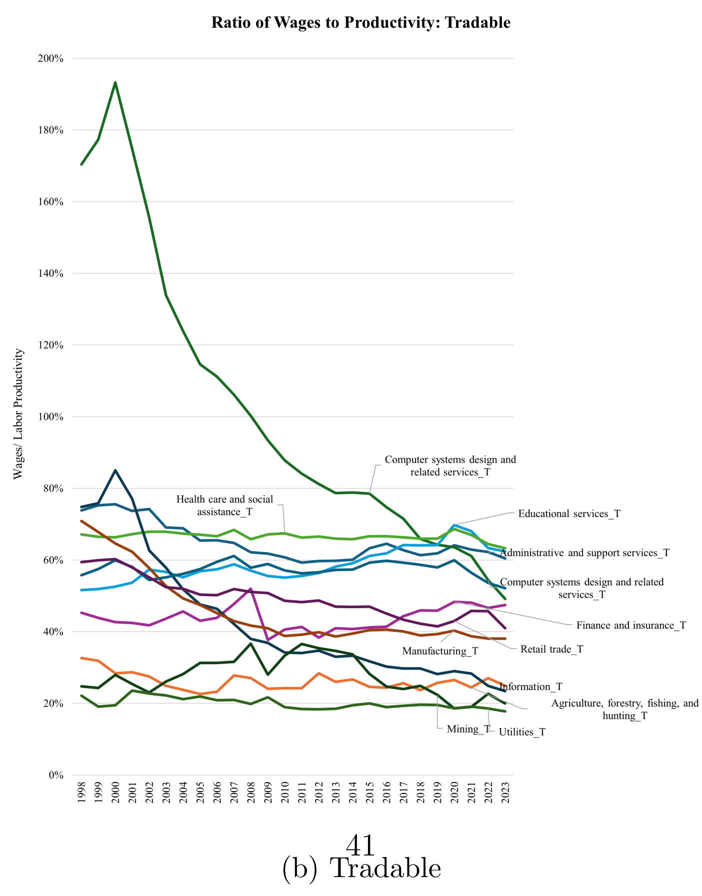
Figure 20: Ratio of Wages to Labor Productivity: Weighted Averages

Turning to an industry breakout in Figure 21, one of the drivers of the reversal and associated weakness in the tradable average ratio is the dramatic drop in wage convergence for tradable computer systems & design roles. From a peak of 193 percent in 2000, the ratio of wages to productivity in that sector fell as firms dramatically increased their productivity (e.g., via automation). By 2023, the wage ratio for workers in computer systems & design hit 49 percent—-far lower but still high relative to many other sectors. Manufacturing wage convergence has also declined over the period, from 71 percent in 1998 to 38 percent in 2023, stalling out since the end of the GFC. Looking at the nontradable sectors, some of the high convergence sectors include the most labor-intensive industries like education, construction, healthcare, and administrative services. However, the nontradable sector also has some of the lowest ratios–namely, real estate where workers make only 5 percent of their estimated labor productivity in 2023.

Figure 21: Ratio of Wages to Labor Productivity: Tradable and Nontradable Industries



(a) Nontradable



(b) Tradable

3.5 Digital Technology and Productivity

As noted earlier, the growing digital footprint in the knowledge economy contributes to the resiliency of the U.S. economy, supported by a variety of communication, collaboration, e-commerce, and financial services platforms. During the pandemic, this enabled a large and critical part of the economy to largely escape shutdowns while continuing to function, though not on all cylinders. There has also been a series of recent breakthroughs in AI, speech and handwriting recognition, image and object recognition, and most recently, reading comprehension and language understanding, where the latter includes large language models (LLMs) and related engines under the broad heading of generative AI. Strikingly, these models have improved so rapidly that some outperform average human performance for a range of tests including the SATs, GRE, and legal Bar exams. Previous generations of AI encountered significant limits–mainly the existence of many tasks humans perform that defy precise or simple codification. The advances described above break through these barriers by replacing codification with sophisticated, multi-layered pattern recognition capabilities. From an economic point of view, the range of human activities that machines can now perform (and in some cases outperform) has expanded dramatically.

The past few months alone have witnessed a flurry of activity, as people experiment with LLMs and potential applications. The LLMs have several striking features. One is that they are accessible; one does not need a mountain of training to create prompts or ask and refine questions. The barriers to adoption seem low and are consistent with the observation that ChatGPT had 100 million users after two months. The second is that the LLMs cover a huge number of domains, and unlike earlier AI technologies that worked well in defined and relatively narrow domains, they detect and switch domains relatively effortlessly in response to questions, requests, or prompts. Third, their performance keeps improving in part because the model sizes are increasing dramatically.

It is far too early to predict, with any precision, the ultimate results of this activity and related investment. We are in a period of intense experimentation and innovation. That said, it appears that a host of applications or use cases are set to be built on LLM platforms, training with additional specialized data to enhance performance in a wide variety of sectors, including creative sectors. The list is long and growing. The technology and product roadmap for Open AI includes licensing the LLM and providing an API that allows firms to build their particular applications on the LLM platform.

Because these models operate in the knowledge part of the economy, that is where the largest impact is likely to occur. While the LLMs, augmented by speech and image recognition may replace humans in certain tasks, the most likely immediate use is in creating powerful digital assistants. These models are prediction machines. They are not perfect and sometimes produce bad predictions. They are trained, using huge amounts of computing power (available to very few entities–mostly the large cloud computing companies) on internet data, hoovering it up at superhuman speeds. That means they are vulnerable to bias, prejudice, conspiracy theories and a host of other potential negative content. They also produce hallucinations, or in ordinary language, they make stuff up. In numerous applications (like legal briefs) where assertions masquerading as facts is a major problem, humans, search engines, and fact checking will need to remain part of the process of deploying the technology in the economy.

Despite these important caveats, there is a meaningful potential for a very large productivity surge across many sectors in the economy, especially knowledge-intensive ones (see Box 3 for an example). Using our sectoral lens with the tradable vs. nontradable overlay, this productivity surge could be broad-based and cross the tradable vs. nontradable divide. It may also have some positive distributional features if the leveling-up effect proves to be fairly generalized. In particular, manufacturing may also see benefits from the AI revolution given that an important part of digital technology in manufacturing is robotics and a major set of breakthroughs in robotics could contribute to productivity advances in a range of blue-collar occupations. Robots with embedded Gen AI could have a much larger presence in the economy than those without given that robots with LLMs can communicate, so that they do not have to function in fully autonomous mode. This facilitates machine-to-human collaboration and compensates for deficiencies that legacy robots still have with respect to spatial intelligence and limitations on their ability to navigate in complex physical environments. At the same time, in several sectors in the nontradable part of the economy where the majority of work is blue collar and requires an in-person presence, the current batch of AI-based digital technology may be somewhat less applicable than in the higher-productivity nontradable sectors where the existing knowledge economy overlay is large. Therefore, it is also possible that there are some potentially adverse distributional effects and the productivity surge may be less broad-based and more subdued than some anticipate.

Box 3: The Potential for Productivity Surges Associated with Digital Assistants

For customer service, digital assistants are one promising pathway for AI to boost productivity, as highlighted in work by Erik Brynjolfsson and co-authors for the technology sector (Brynjolfsson and Raymond, 2023). The AI was trained on a large collection of audio recordings of customer service personnel interacting with customers, along with performance measures where the problem was solved, how long it took, whether the customer was happy with the interaction, and so forth. The model was then tested by having it made available as an AI assistant to a set of customer service agents, with another set, similar in range of experience and past performance, not having access to the AI.

First, the authors found that the overall productivity increase, using several metrics, was about 14 percent and was achieved in a very short amount of time. The second, and even more interesting, finding was that the performance increment was noticeable at the high end of the experience spectrum, but very large at the lower end. In other words, the AI substantially reduced the performance differential across the spectrum of experience. One interpretation is that the AI either substitutes for or speeds up the learning process. One is reminded in a different context of London taxi drivers before and after Google Maps and Waze.

Both the productivity impact and leveling-up effects are potentially promising developments. It will take time for the use cases to be developed and tested but there is reason for optimism that productivity and other measures of performance in a wide range of sectors will materialize. If strong enough, they may reverse recent trends in productivity in parts of the economy.

4 Conclusions

While there are elements of continuity that remain in the U.S.'s economic structure relative to the pre-GFC period, notable changing patterns in employment and productivity trends are also evident. Nontradable service sectors continue to dominate employment in the U.S. economy, accounting for over 70 percent of jobs, with most absolute employment gains arising from these domestically-focused sectors. Another point of continuity is the higher rate of value-added growth in the tradable sector relative to the nontradable part of the economy. Combined with relatively modest employment growth in the tradables, this results in consistently higher labor productivity growth in the tradable sector, further widening the productivity gap with nontradables. Despite this divergence, the overall trend in productivity growth is distinctly negative. In the decade following the GFC and through the onset of the pandemic, productivity growth declined across nearly all sectors. Both high- and low-productivity sectors, with few exceptions, experienced a sharp drop in productivity growth. This broad-based decline in productivity growth is now reflected in the lower aggregate productivity growth across the economy.

Part of the drop in aggregate labor productivity is due to the composition effects, like the expansion of the share of labor in lower productivity sectors. But most of the drop is attributable to direct productivity declines within sectors. There is no single explanation for this pattern. Shortfalls in both public and private investment probably contributed to the decline. In addition, given the demand-constrained growth pattern that prevailed after the GFC and the widespread balance sheet damage especially in the household sector, the incentives to search for productivity enhancements were muted—recalling that household consumption is a very large fraction of aggregate demand in the U.S. economy (on the order of 68%). As a result of the suppressed consumption and demand, the supply-side constraints associated with low productivity growth that might have been binding actually were not, until the pandemic and the post pandemic period.

There have also been important changes in the structure of the U.S. economy. The long-term trend of declining manufacturing employment stopped, leveled out and then increased modestly in the decade after the GFC. More broadly, for the two decades prior to the GFC, the tradable sector did not contribute to employment growth. Manufacturing employment declined and tradable services employment grew, largely canceling each other out. In the past decade, this has changed. Tradable services employment growth is significant and, with positive manufacturing employment growth, the tradable part of the economy has once again begun to contribute to overall employment growth.

What can we expect going forward in terms of the structure of the U.S. economy? It is hard to make predictions with great confidence. However, geoeconomic tensions are unlikely to subside in the near term and the key elements of globalization (flows of goods and services, capital, technology, and people) are now subject to a growing set of restrictions and industrial policies that are very different from the period of hyperglobalization, resulting in higher costs, distortions, and inefficiencies. The response to these tensions, the growing power of China, and elevated polarization within countries are likely to result in a mix of some reshoring, due to national and economic security concerns, and a rewiring of globalization elsewhere in favor of blocs of trusted trading partners and to the detriment of others. There may be a slight acceleration in U.S. manufacturing employment growth in the near term as recent policies exert their influence but the long-term effect on U.S. manufacturing output and employment may be negative due to lower potential growth both in the U.S. and globally.

Looking forward, there is also a reasonable chance that the negative productivity trends that persisted in prior decades will shift course again. There are powerful technologies and tools (especially in the digital area, including those in biomedical science and energy) that have the potential to arrest the declining productivity trends and even produce, by the end of the decade, a surge in U.S. productivity. The critical question is whether these technologies spread and are effectively adopted by the large employment sectors in the nontradable part of the economy. The hope is that the answer is affirmative, but the ultimate outcome is unknown. The available data on postpandemic structural change are limited to a couple of years. Inflationary pressures have declined due to a combination of reduced supply-side disruptions, a global re-balancing of demand back towards services and away from goods, and as a natural result of higher interest rates and their effect on credit and aggregate demand. However, with persistent geopolitical tensions, fragmentation, diversification and national security policies overriding economic considerations, supply-side relief for inflation may be increasingly limited. But, over the longer term, new digital technologies have the potential to reverse negative productivity trends and increase the elasticity of supply, countering factors like trade restrictions, aging, and high debt ratios.

Future work should explore how these trends materialize and could also feature deeper empirical causal analysis around the role of policy in driving the sectoral shifts seen thus far, with an indication of how to reverse the productivity gap between the tradable and nontradable sectors. There is also scope for conducting further analyses on similarities and contrasts with other countries and regions around the world, building on the small but growing literature mentioned above. In the end, the key question is whether the secular headwinds to growth and inflation will prevail or eventually diminish, potentially offset by powerful productivity-enhancing technologies. Opinions on this fundamental issue vary significantly. Ultimately, only the future evolution of the global economy will provide a conclusive answer.

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