How many (more) lost decades? The great productivity slowdown in Japan

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How many (more) lost decades?
The great productivity growth slowdown in Japan

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Abstract

I document that, relative to the period 1971 to 1990, Japan has suffered almost three complete "lost" decades of slower growth from 1991 through 2018. The average growth rate of output per working age person, and of labor productivity–measured by both output per hour worked and output per employed person–substantially declined in the 1990s and never returned to pre-1991 values. The average growth rate of output per working age person from 2011–2018 partially recovered, to just 56 percent of its 1980s value. I find this partial recovery was due solely to an increase in hours worked per working age person–labor input growth–which cannot support sustained growth in living standards. By contrast, labor productivity growth–which *can* support sustained growth in living standards–declined further in the 2010s and averaged just 20 percent of its 1980s value. Growth accounting shows that a large and persistent decline in total factor productivity (TFP) growth was the source of Japan's slowing labor productivity growth in the 1990s and 2000s, while a falling capital output ratio forced further slowing in the 2010s. Assuming a global trend growth rate of 2 percent per year, the average growth rate of output per working age person in the 20th century United States–commonly viewed as the technology-frontier country, I show that Japan's TFP collapsed relative to trend in 1992 and has deviated increasingly below it. By contrast, since 1991, US TFP has fallen relative to trend only since 2016. Among the twenty richest OECD countries, in the post-2000 era–widely argued to have witnessed a widespread advanced economy productivity growth slowdown–Japan's TFP factor was one of only seven to fall more than 15 percent below trend. Japan's TFP collapse in 1992, and that of several OECD countries after 2000, is due not to slower US-TFP trend growth but to domestic institutions, polices, and practices that have reduced the efficiency of frontier-technology use. Policy reforms that directly address productivity deficits are needed to support faster growth in living standards that is also sustainable.

JEL Classification: O41, O47, O50

Key words: Aggregate Productivity, Capital-Output Ratio, Economic Growth, Neoclassical Growth Model, Output Growth, Technological Change, Total Factor Productivity, Japan, United States, G-7, OECD.

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1. Introduction

Japan stopped "catching up" to advanced economy living standards after 1990. Japan's output per working age person among the richest twenty OECD countries ranked lower in 2018 (17th) than in 1990 (16th). The infamous slowing of Japan's economic growth during the "lost decade" of the 1990s and rather stagnant macroeconomic performance since, following several decades of rapid post-second world war development and "catch-up" growth, are often cited as the quintessential example of secular stagnation; Krugman (2014) and Summers (2014, 2915) are examples. On the other hand, some commentators dispute the comparative weakness of Japan's growth performance internationally, and especially the number of slower growth decades she has suffered relative to other advanced economies, in view of the 21st century "productivity slowdown" argued to have afflicted the richest countries in the world since 2000. For example, Ip (2019) argues that Japan's creative policy responses to a rapidly ageing population and shrinking working population, by increasing female labor force participation, delaying retirements, and immigration, have stimulated growth recently through increasing labor supply and employment rates. Posen (2020) maintains that adoption of corporate governance reforms and "Womenomics" since 2012 by prime minister Abe, among other "supply-side enhancing fiscal" policies, have generated output per capita and productivity growth rates in Japan higher than those of most G-7 countries. Japan's improved growth performance following policy reversals after 2002 and policy reforms instituted by Abe leads Posen to argue that the 1990s are the *only* "lost" growth decade for Japan and propose that other high-income countries suffering secular stagnation emulate Japan's policies. The goal of this paper is to clarify opposing views by presenting historically and internationally comparative, quantitative evidence on Japan's economic growth and productivity metrics, and framing its interpretation through the coherent lens of neoclassical growth theory. I show that at an increase in hours worked by employed persons and employment rates in Japan since 2011 has, indeed, facilitated moderately faster growth in living standards. However, this faster growth has been accompanied by no significant productivity growth improvement whatsoever and as a result–I argue–is unsustainable.

In the paper, I review and account for the economic growth and labor productivity performance of Japan since 1990 relative to i) her own history of strong growth in the 1970s and 1980s, ii) the performance of technology-frontier country, the United States, and iii) the twenty richest OECD countries, including the G-7. I show that a collapse in growth of total factor productivity (TFP), and hence labor productivity, which began in 1992 and persisted through 2018 is the origin of persistently slower growth in Japan's output per working age person relative to the 1970s and 1980s.

I argue that domestic institutions, practices, and policies are responsible for Japan's TFP collapse, reducing the efficiency with which globally available frontier technology is used, rather than any decline in the global trend growth rate of frontier technology in the United States. I also document that Japan's average output per working age person growth after 2010 partially recovered, although to only 56 percent of its 1980s value and, as Ip (2019) suggests, this modest recovery was entirely attributable to faster growth in hours per working age person–a rising labor input rate. The partial recovery occurred, however, *despite* labor productivity growth falling further to just 20 percent of its 1980s value after 2010, and despite continued anemic TFP growth from 2011 through 2018 at only 27 percent of its 1980s value. While the partial post-2010 recovery raised Japan's ranking of output per working age person growth among the twenty richest OECD economies, and especially the G-7 which contains some of the weakest economic and productivity growth rate performers among wealthy OECD countries, Japan's post-2000 productivity performance by any metric lay in the bottom half of the distribution.

Neoclassical growth theory tells us that sustained growth in output per working age person cannot be supported by labor input growth, but by labor productivity growth driven by faster TFP. Ultimately, the number of hours worked per working age person affects the level, but not the growth rate, of output per working age person. Increasing hours worked per working age person, as Japan has done in the 2000s and 2010s, cannot continue indefinitely or sustain faster growth in output per working age person. Emulating Japan's policies is unlikely to foster sustained growth in other rich countries suffering secular stagnation.

Specifically, I document that, relative to rapid economic and productivity growth years 1970 through 1990, from 1991 through 2018 Japan suffered almost three complete "lost" decades of slower annual average growth in output per working age person. Two common metrics of labor productivity, output per hour worked and output per employed person, exhibit quantitatively similar growth slowdowns to that in output per working age person in the 1990s, however, labor productivity shows no recovery in the 2010s in contrast to output per working age person. In fact, there has been a decline in Japan's average growth rate of output per employed person and output per hour worked in *every* decade since 1990. Differences in growth rate performance of output per working age person and labor productivity metrics suggest a decomposition of output per working age person into the product of two factors: 1) Output per hour worked, one measure of labor productivity, and 2) hours worked per working age person, a measure of the rate of labor input. I show the 1990s slowdown in output per working age person was attributable largely to slower labor productivity growth; declining labor input played a smaller role. In the 2000s, slower labor productivity growth was *solely* responsible for further decline in output per working age person growth as labor input stabilized, and even grew somewhat despite the great recession. From 2011–2018, Japan's partial recovery in output per working age person growth was due solely to increasing hours per working age person–labor input growth, which cannot support sustained growth in living standards. Labor productivity growth–which *can* support sustained growth in living standards–declined further after 2010, averaging less than 20 percent of its 1980s value.

To explore the sources of declining labor productivity I use a modified version of the growth accounting framework pioneered by Solow (1957) and Denison (1974) and adopted by Cole and Ohanian (1999) and Kehoe and Prescott (2002, 2007). Specifically, I decompose output per hour worked into two growth factors, due to 1) the capital-output ratio, measuring capital deepening, and 2) total factor productivity (TFP), measuring all factors affecting the efficiency with which the labor-capital input bundle produces output. I show that Japan's 1990s and 2000s slowing of labor productivity growth was due to a large decline in TFP growth, and somewhat attenuated by capital deepening. In the 2010s, a further decline in labor productivity growth was attributable to a falling capital-output ratio. Neither labor productivity growth nor TFP growth has ever recovered. I also derive the cumulative impact of slower growth for Japan's levels of output per working age person, output per hour, and TFP relative to their performance had they grown at global "trend" rates. I follow previous literatures in assuming that the United States is the global technology-leader country and that, ultimately, all other countries can access that technology so the trend growth rate in any country, including Japan, equals trend growth in the United States. I set this global trend growth rate equal to the average US output per working age person growth rate in the 20th century–2 percent–much slower than Japan's growth rate in the 1970s and 1980s. Japan's output per working age person has deviated increasingly below trend since 1990. Declining hours worked per working age person in the 1990s, and an ever-widening reduction in labor productivity relative to trend since 2000, are jointly responsible. I find that below trend growth in labor productivity since 2000 is driven by a large, increasing deviation of TFP below trend since 1992. Given Japan's TFP collapse relative to trend, were it not for capital deepening in the 1990s and 2000s labor productivity would have declined relative to trend earlier (in the 1990s), and output per working age person and labor productivity would have declined relative to trend by larger magnitudes.

The persistence of Japan's TFP collapse relative to trend raises the possibility that trend growth itself has declined. After all, the United States has suffered slower output per working age person growth since the great recession and slower labor productivity growth after 2010. I conduct the same growth accounting and de-trending exercises for the United States and show that, since 1991, US output per working age person, output per hour worked, and TFP have fallen significantly relative to a 2 percent trend only since 2007, 2012, and 2016, respectively. In particular, the decline in US output per working age person relative to trend in 2007, and throughout the great recession until 2012, was driven by declining hours per working age person–labor input–not by a decline in labor productivity or TFP growth relative to trend. These data indicate little evidence of a permanent decline in US, trend growth. At the very least, domestic institutions, practices, and policies are responsible for the collapse of Japan's TFP relative to trend from 1992 until after the great recession, reducing the efficiency with which she uses frontier technology.

Finally, I analyze Japan's experience since 1990 through the lens of the widespread "productivity slowdown" among advanced economies since 2000. I compare Japan's output per working age person, output per hour, and TFP factor data relative to analogous series that I calculate for the twenty richest OECD countries–measured by their 2018 GDP per capita. The comparison mirrors many features of that with the United States alone. While Japan's output per working age person growth has improved in ranking among these countries in the 2010s relative to the 2000s, her labor productivity growth ranking has declined, while her TFP factor growth ranking has risen marginally but not even into the top half of the distribution. Furthermore, Japan's faster growth rate of output per working age person in the 2010s has been insufficient to significantly improve Japan's ranking in levels of output per working age person among these twenty countries, given the sharp decline in its growth rate in the 1990s relative to the rest of the sample. Japan's output per working age person has improved in ranking among these twenty rich countries from 19th to just 17th since 1970. Japan is among just seven countries of the twenty to witness a decline of more than 15 percent below trend of her TFP factor since 2000. Relative to 1990, only the TFP of G-7 member Italy has declined by a larger factor relative to trend than Japan's–by 31 percent relative to Japan's 26 percent, and it merits mention that Italy's output per working age person performance since 2000 satisfies all three quantitative criteria established by Kehoe and Prescott (2002, 2007) for a "great depression". By contrast, I find that Ireland's TFP factor has risen by 30 percent relative to trend since 2000, and Iceland's by 16 percent, and both countries have exhibited remarkable growth rate and productivity recoveries after severe downturns during the great recession. Studying the policies pursued by Ireland

and Iceland and their role for productivity growth, rather than emulating those of Japan, might yield valuable insights for countries suffering secular stagnation.[1]

It is possible that Japan's inflexible labor market, and informal and formal employment and wage insurance policies have contributed to declining allocative efficiency, across sectors and firms, and innovation, thus depressing Japan's TFP growth. Long-held employment protection laws, customs, and practices have provided cyclical and secular employment security for a large portion of the labor force for decades, while recent policy initiatives have deliberately stimulated employment rates. Notice that growth in Japan's output per hour worked did not rise but fell during the 1990s, despite a sharp decline in average hours worked per employed person due to a mandated reduction in the length of the working week. Similarly, growth in output per employed person and output per hour worked in Japan both fell significantly during 2008-2009, when unemployment rose sharply in other rich countries supporting their measured labor productivity growth. Steinberg and Nakane (2011) discuss Japan's employers' propensity for labor hoarding during the great recession, while Dooley and Ueno (2020) document that the current COVID-19 crisis has also seen no notable increase in unemployment in Japan and continued stability of employment and wages. At best, there is no evidence that Japan's reforms have positively impacted productivity growth; at worst, Japan's labor market policies and practices may have contributed to the collapse of TFP growth relative to trend.

This paper contributes updated evidence to a large literature analyzing the origins and persistence of Japan's aggregate economic and productivity slowdown in the 1990s, and an entirely new assessment of the sources and sustainability of her growth rate recovery in the 2010s, prior to the COVID-19 crisis. Baily, Bosworth, and Doshi (2020), Fukao et al. (2004), Hayashi and Prescott (2002), Fukao (2013), and Fukao et al. (2015) are just a few precursors that have shown aggregate TFP growth slowing as the main source of Japan's economic growth slowdown. In these and many related research papers, TFP is measured using different data, and alternative growth and development accounting

[1] Notably, other than the United States which ranks 4th, the G-7 countries which constitute Posen's (2020) comparison group for Japan all lay in the bottom half of the twenty richest OECD countries by 2018 real GDP per working age person. Four of the G-7 ranked in the bottom half of the twenty richest OECD countries by average growth of real GDP per working age person in 2001-2010 and 2011-2018, five of the G-7 lay in the bottom half by 2001-2010 average labor productivity growth, and four lay in the bottom half by 2011-2018 average labor productivity growth. Although since 2000 Japan's productivity performance among G-7 countries generally ranks "mid-pack", in the broader comparison group of the twenty richest OECD countries Japan's productivity performance has been among the weakest.

models are utilized. The TFP slowdown finding is common, but other accounting results and their interpretations vary. My paper is closest in spirit to Hayashi and Prescott (2002), who utilized the same growth accounting framework to show that slower TFP growth was the largest source of Japan's 1990s slowdown, with a smaller role for declining average hours, and that the neoclassical growth model did a good job of accounting for the slowdown during the 1990s. Fukao et al. (2015), analyzing data to 2013, also reach the conclusion that Japan's slow economic growth relative to preceding post-war decades is the result of a long-term, structural slowdown in productivity growth. They use a different growth accounting framework than mine, however, which includes a labor "quality" measure and yields rather different implications for the evolution of labor productivity. Their sample period also prohibits the authors from addressing Japan's partial growth rate recovery in the 2010s. Nonetheless, they argue–as I do–that Japan cannot accomplish sustainable economic growth unless TFP growth accelerates. I reach similar conclusions to Baily, Bosworth, and Doshi (2020) regarding slower aggregate growth and productivity in Japan relative to the United States and other rich countries, although I construct my own measures of labor productivity and TFP, analyze a larger sample of comparison countries, and interpret my results through the lens of a neoclassical growth model. Jorgenson, Namura, and Samuels (2018) construct and study different productivity measures than I do, using PPP adjusted data, and focusing on the sectoral origins of productivity differences between Japan and the United States. The paper may also be viewed as an updated empirical investigation of the "near" great depression in Japan studied by Hayashi and Prescott (2002). In my data, Japan meets two of the three Kehoe and Prescott (2002, 2007) quantitative criteria for a great depression during the period 1990 through 2018; namely, a decline in output per working age person of at least 20 percent relative to trend (in 2009), and no significant recovery measured by a sub-period of a decade or longer in which the annual average growth rate of output per working age person is 2 percent or more. Japan falls short of a decline in de-trended output per working age person of 15 percent relative to trend in the first decade of the depression, as was true in Hayashi and Prescott's original analysis.

Section 2 records definitions and measurement of variables, and data sources. Sections 3, 4, and 5 document the performance of, and conduct a growth accounting for, Japan's output per working age person and labor productivity since 1970. Sections 6 and 7 compare Japan's output per working age person and labor productivity growth since 1970 to that in the United States, and the behavior of Japan and US output per working age person, output per hour worked, and TFP factors relative to trend, respectively. Section 8 compares Japan's output per working age person and productivity growth performance to that of the twenty richest OECD countries. Section 9 concludes.

2. Data

I measure all data at the annual frequency, over the period 1970 through 2018. I draw original series from the OECD national accounts and STAN data sets, the IMF investment and capital stock database, the Groningen Growth and Development Center's (GGDC) Penn World Tables, and the United Nations Population Dataset. As far as possible, I use consistent measures of variables, and use consistent data sources, for each of the twenty OECD countries included in my analysis.

2.1 Output per working age person

I follow an extensive modern growth accounting literature in focusing on output per working age person as a metric for macroeconomic growth performance in annual data (see Kehoe and Prescott (2002, 2007) for examples). I measure output in every country by real GDP in chained 2015 national currency, data drawn for 1970 through 2018 directly from the OECD's national account database, *except* in the ranking analysis of OECD country output per working age person in table 5. In table 5, to facilitate international comparisons of living standards, I measure output by real GDP in billions of 2011 international dollars for all countries, data drawn from the IMF's investment and capital stock dataset. The number of working age people in each year from 1970 through 2018 I compute as the sum of populations of people aged 15 years to 64 years from the United Nations Population Estimates database.[2] Output per working age person for each country is just the ratio of real GDP to the working age population of that country.

2.2 Labor productivity

Labor productivity is output per unit of labor input to production. I analyze data for two measures of labor productivity for Japan; output per employed person, and output per hour worked by employed persons. Results for output per employee are omitted for brevity but available upon request. In my decompositions and growth accounting exercises, output per hour worked is the crucial metric.

I measure output for both measures of labor productivity by real GDP, measured by real GDP in chained 2015 local currency units from the OECD. I measure the number of employed persons by

[2] This measure of the working age population differs from that used by Hayashi and Prescott (2002) in their analysis of Japan's 1990s lost growth decade. If I use their measure, namely, people in the population aged 20 to 69, my results for Japan are qualitatively identical and quantitatively similar. The main difference is that Japan's 1990s growth slowdown in output per working age person is more severe, and Japan's 2010s growth rate smaller, using their measure. This is because the population aged 20 to 69 grew more rapidly in the 1990s than the population aged 15 to 64, and declined more slowly in the 2010s, presumably due to a falling birth rate and migration concentrated in the 20 and over age-groups.

the GDDC's measure of employed persons, which is available from 1970 through 2017. I extrapolate the GDDC series to 2018, using the 2017-2018 growth rate of the sum of employed persons (all persons engaged) across all industries published in the OECD STAN database, wherever available. When OECD STAN employed persons data is unavailable, I extrapolate the GDDC series to 2018 using the growth rate of the sum of *employees* across all industries from the OECD STAN database. I prefer the GDCC to the OECD measure of all employed persons because it is consistent with the GDDC-published average hours worked by employed persons series that I use to construct total hours worked.

I measure the total number of hours worked by employed persons as follows. I first take directly average hours per employed person from the GDCC from 1970 to 2017. I compute the product of GDDC average hours worked and the number of employed persons to generate a series for total hours worked from 1970 through 2017. I extrapolate this total hours' series to 2018 using the 2017-2018 growth rate of total hours worked by employed persons (all persons engaged) across all industries from the OECD's STAN database. When this OECD series is not available for a country, I extrapolate total hours to 2018 using the OECD STAN measure of hours worked by employees.

Each labor productivity metric is calculated as output divided by labor input, where the latter is either employed persons, or total hours worked.

2.3 Average hours per employed person

I measure average hours worked per employed person for a country directly drawing average hours per employed person for that country from the GDCC from 1970 to 2017. I then extrapolate these series to 2018 using my estimates of 2018 employed persons and 2018 total hours worked by employed persons; average hours worked by employed persons in 2018 is the estimated 2018 number of employed persons divided by the estimated 2018 total hours worked by employed persons.

2.4 Capital-output ratios

To compute the capital-output ratio for a country, I divide the nominal value of the total capital stock by nominal GDP. For 1970 through 2017, both nominal GDP and the nominal gross capital stock series are drawn from the IMF's investment and capital stock dataset, measured in billions of local currency units. More specifically, the nominal capital stock for a country is the sum of private and government capital stocks from the IMF's dataset. I extrapolate to 2018 the total capital stock using the 2017-2018 growth rate of the OECD STAN dataset's total nominal gross capital stock across all industries. For some countries, the nominal gross capital stock in 2018 is unavailable and I am forced to use the nominal net capital stock series. The latter excludes inventory accumulation, and so provides an imperfect measure of the gross capital stock's growth. The results change little, however, if I estimate those countries' 2018 gross capital stocks using annual nominal gross investment data and a reasonable value for the annual depreciation rate.

2.5 Capital's share of income

I use 0.36 to measure the capital income share of all countries in the sample. Hayashi and Prescott (2002) estimated Japan's capital income share over an earlier period at 0.362. I compute an estimate for the United States using OECD industry input-output data on sources of value added over the period 1980 through 2018 which is essentially equal to 0.36. Japan's 1980 capital income share computed using sources of value added from OECD industry input-output tables is also 0.36. Gollin's (2002) results imply that, carefully measured, capital income shares are remarkably similar across time and countries with quite different real GDP per capita, and especially so among countries with similar GDP per capita. The countries studied in this paper are all members of the 2018 top twenty richest OECD country sample, and so I rely on Gollin's result and the common use of 0.36 as a metric for capital's income share in the macroeconomics literature.

3. Output per working age person and labor productivity in Japan

I first document the time-series behavior of output per working age person, and two metrics of labor productivity in Japan since 1970. Figures 1a through 1c show the growth rate of output per working age person, output per employed person, and output per hour worked employed persons, respectively. Figure 2a compares the time series behavior of the level of output per working age person, and the two labor productivity measures, output per employed person and output per hour worked, while Figure 2b compares the time series behavior of the associated three measures of labor. Table 1 documents the decennial growth rates of output per working age person, output per employed person, and output per hour worked in the first through third columns of numbers, respectively.

3.1 Output per working age person

Figure 1a and the first column of numbers in the table show a rapid growth rate of real GDP per working age person in the 1970s and 1980s, well above the 2 percent trend benchmark on average. In addition, table 6 shows that Japan's average growth rate from 1971 through 1990 was highest among the twenty richest OECD countries. It is well documented that Japan's post-war growth rate prior to 1970 and catch-up to the United States and other rich countries was extremely rapid. While Japan's 1970s and 1980s average growth rates were slower than that of the 1960s, they were nonetheless substantially higher than in other rich countries, implying a continuation of her "catch-up" to these countries as her living standard converged towards theirs.

Japan's growth rate did not gradually decline over the following decades, however, towards those of relatively rich OECD countries as neoclassical growth theory implies would be observed in a relatively poor country converging to the living-standard of the richest. Instead, Japan's growth rate fell sharply in the 1990s, following the collapse of commercial real estate prices in 1989–1992, and has never recovered to even 60 percent of its 1970s and 1980s average value. Table 1 shows a modest and unremarkable recovery in the period 2001–2007, prior to the great recession of 2008–2009. The average growth rate of output per working age person in Japan during these years was substantially lower than the 2 percent global trend and a full 1.83 percentage points lower than average growth in the 1980s. Even after the global great recession of 2008–2009, when Japan's growth performance was relatively strong compared to the 1990s and 2000s and among rich OECD countries, the average growth rate in Japan was more than 1.5 percentage points lower than during the 1980s, and barely equaled trend growth of 2 percent. As a result, far from catching up to the richest, as Japan's growth performance in the 1960s, 1970s, and 1980s implied, Japan's rank in output per working age person among the top twenty income per capita OECD countries has risen from 19th in 1970 to only 17th in 2018, as table 5 documents.

3.2 Labor productivity

Comparing figures 1b and 1c to figure 1a shows a larger and more persistent decline in the growth rate of both labor productivity metrics than in the growth rate of output per working age person since 1990 in Japan. In addition, figure 2a normalizes output per working age person, output per employed person, and output per hour worked to equal 100 in 1990. The figure shows that both labor productivity measures mirror the rapid growth of output per working age person in the 1970s and 1980s. Like output per working age person, both labor productivity metrics exhibit substantial slowing of growth rates in the 1990s, although they experienced different rates of decline. In the 1990s, output per hour worked exhibited relatively fast growth compared to output per working age person and output per employed person. By contrast, output per hour worked growth slowed relatively more than that of output per working age person and output per employed person between 2001 and 2010. Finally, figures 1 and 2a show clearly that growth in output per employed person and output per hour worked slowed further and was slower than that in output per working age person in the 2010s; output per working age person grew much more quickly than either labor productivity measure after 2010.

Comparing the second and third columns of numbers in table 1 to those in the first column confirm and quantify these observations. Japan has suffered almost three lost decades of labor productivity growth relative to the 1971-1990 period by both productivity metrics. Average labor productivity growth has declined in every subsequent decade since 1990, and neither labor productivity metric exhibited the significant, if partial, growth rate recovery after 2010 that output per working age person did. During 2011–2018, the average growth rate of output per working age person was 56 percent of its 1981–1990 value, and 58 percent of its 1971-1990 value. By contrast, the average growth rate of output per employed person was just 10.2 percent of its 1981–1990 value and 10.1 percent of its 1971–1990 value, and the average growth rate of output per hour worked was 19.8 percent of its 1981–1990 value and 19.5 percent of its 1971-1990 value.

Figure 2b shows the sources of growth performance differences in "output per labor unit" metrics. Again, each variable is normalized to 100 in 1990. The working age population began to systematically, but slowly, decline after 1995 until the end of the sample period. Hours worked declined relatively sharply from roughly 1991 until 2002, which is the origin of relatively fast growth in output per hour worked in the 1990s, fell briefly during the great recession, and then grew systematically from 2015 through the end of the sample. The number of employed persons grew, on average, throughout the sample period, exhibited transitory declines in the second half of the 1990s and during the great recession, but increased rapidly from 2012 through the end of the sample period. There was no uptick in the working age population as there was in both measures of labor input after the great recession. Faster recorded growth in output per working age person since 2000, and especially in the 2010s, *relative to labor productivity measures*, is attributable to the sustained decline in the working age population relative to labor input measures over this period.

4. Decomposing output and hours worked per working age person

To explore the sources of growth rate changes in output per working age person, I decompose the level of output per working age person into two factors; 1) output per hour worked, a labor productivity factor, and 2) hours worked per working age person, a labor input factor. I then explore further the sources of change in the labor input factor by decomposing it into two components; 1) hours worked per employed person, a measure of the intensity of labor effort, and 2) employed persons per working age person, the employment or utilization rate of the working age population.[3]

[3] In the output decomposition, I could alternatively use a narrower measure of hours, namely, hours worked by employees rather than by all employed persons. Then I would decompose the labor input factor into average hours per employee, and the number of employees per working age person. The number of employees, and the hours that they work, are narrower measures of labor input than employed persons and the number of hours that they work, however. The number of employed persons includes contract workers, sole proprietors and other self-employed workers, family business workers, and so on; namely, it is a more comprehensive measure of the number of workers in an economy. Furthermore, it is well-documented that contract work in Japan has increased significantly over the last three decades (see, for example, Steinberg and Nakane (2011)).

Specifically, in country *i*, $Y_{i,t}$ is aggregate output, $N_{i,t}$ denotes the working age population, $H_{i,t}$ denoted the number of hours worked by all employed persons, and $EP_{i,t}$ denotes the number of employed persons. Then, a two-factor decomposition of output per working age person in terms of labor productivity and labor input factor is:

$$\frac{Y_{i,t}}{N_{i,t}} = (Y_{i,t}/H_{i,t})(H_{i,t}/N_{i,t}). \tag{1a}$$

The labor input factor decomposition into average hours and the employment rate, yields

$$\frac{H_{i,t}}{N_{i,t}} = (H_{i,t}/EP_{i,t})(EP_{i,t}/N_{i,t}). \tag{1b}$$

Taking logs and log differences on both sides of (1*a*) and (1*b*) provides an approximate accounting of the growth rate of output per working age person and hours per working age person, respectively. The growth rate of output per working age person decomposes into the sum of growth rates of the labor productivity and labor input factors on the right-hand side of (1*a*), while growth in the labor input factor is the sum of growth rates of the average hours and employment rate factors on the right-hand side of (1*b*).

I present the decompositions represented by equations (1*a*) and (1*b*) in two ways. First, I plot the evolution of the right-hand side variables in (1*a*) and (1*b*) against that of output per working age person and hours per working age person, respectively, in figures 3a and 3b, setting all variables equal to 100 in 1990. Second, in tables 2a and 2b, I present a decennial accounting of the growth rate of output and hours per working age person in terms of the growth rates of the factors on the right-hand side of (1*a*) and (1*b*) respectively.

Figure 3a and table 2a show that rapid growth in output per working age person during the 1970 through 1990 period was entirely attributable to labor productivity growth. The labor input factor declined in both decades. In the 1990s, output per working age person growth declined markedly with a slowing of labor productivity growth, however, the labor input factor also exhibited a relatively sharp decline, so that output per working age person declined significantly relative to output per hour worked. In the 2000s, output per working age person and labor productivity grew steadily, if more slowly, until the great recession when both declined sharply, while the labor input factor was surprisingly stable during this decade and recession. In fact, a further substantial decline in average labor productivity growth in the 2000s was offset in its impact for output per working age person growth by slightly positive average growth in the labor input factor, relative to the 1990s. Finally, after the great recession, as we have seen, labor productivity grew even more slowly than observed prior to the great recession. In the 2011-2018 period, the observed recovery in output per working age person growth was entirely attributable to faster growth in the labor input factor and occurred *despite* the decline in labor productivity growth.

Figure 3b and table 2b show that the labor input factor's decline in the 1970s was attributable to a combination of falling average hours and a falling employment rate. In the late 1980s and 1990s, declining hours per working age person was entirely attributable to falling *average* hours; the employment rate stabilized and was almost constant in the 1980s and 1990s. By contrast, slightly increasing hours per working age person in the 2000s is accounted for by a rise in the employment rate, which more than offset another further decline in average hours worked. Similarly, the significant rise in the hours per working age person in the 2011-2018 period–the source of the partial recovery of output per working age person growth in the 2010s–is accounted for by a rapidly increasing employment rate, again, offsetting continued decline in average hours.

Japan's employment rate growth in the 2000s and 2010s prevented even slower output per working age person growth than was observed, offsetting small but sustained declines in average hours worked, and a substantial, persistent decline in the average growth rate of labor productivity which began in the 1990s.

5. Accounting for labor productivity in Japan

In this section, I decompose output per hour worked, the labor productivity factor on the right-hand side of (1*a*), to understand the sources of its declining growth which has been the source of Japan's secular slowdown in output per working age person growth after 1990. To understand the sources of labor productivity growth, I view the determination of output per working age person and output per hour worked through the lens of a neoclassical production function. This function has been used by economists to account empirically for the sources of long-run growth in output and output per unit of labor since, at least, Denison (1974) and Solow (1957).

5.1 Accounting framework

I assume that aggregate output in country *i* at time *t* is produced by the function

$$Y_{i,t} = A_{i,t} K_{i,t}^{\alpha_i} H_{i,t}^{1-\alpha_i}. \tag{2}$$

Here, as in equation (1*a*), $Y_{i,t}$ is aggregate output and $H_{i,t}$ denotes aggregate hours worked by employed persons, aggregate labor input. In addition, $K_{i,t}$ denotes the economy's physical capital stock, $A_{i,t}$ is total factor productivity (TFP), and α_i is capital's income share. A country's total factor productivity is the efficiency with which the input bundle $K_{i,t}^{\alpha_i} H_{i,t}^{1-\alpha_i}$ is used to produce output, $Y_{i,t}$.

As in section 4, I denote the number of working age people in country *i* by $N_{i,t}$. Then, algebraic manipulation of equation (2) yields a representation in which output per working age person can be written as the product of three growth factors: a TFP factor, $A_{i,t}{}^{\frac{1}{1-\alpha_i}}$, a capital factor, $\left(\frac{K_{i,t}}{Y_{i,t}}\right)^{\frac{\alpha_i}{1-\alpha_i}}$, and hours worked per working age person, $\left(\frac{H_{i,t}}{N_{i,t}}\right)$,

$$\left(\frac{Y_{i,t}}{N_{i,t}}\right) = A_{i,t}{}^{\frac{1}{1-\alpha_i}} \left(\frac{K_{i,t}}{Y_{i,t}}\right)^{\frac{\alpha_i}{1-\alpha_i}} \left(\frac{H_{i,t}}{N_{i,t}}\right). \tag{3}$$

The third term on the right-hand side of (3) is simply the labor-input factor in the decomposition of output per working age person in equation (1*a*). Combining (1*a*) and (3), it is immediate that labor productivity–output per hour worked by employed persons–is fully accounted for by the capital and TFP factors:

$$\left(\frac{Y_{i,t}}{H_{i,t}}\right) = A_{i,t}^{\frac{1}{1-\alpha_i}} \left(\frac{K_{i,t}}{Y_{i,t}}\right)^{\frac{\alpha_i}{1-\alpha_i}}. \tag{4}$$

I use equation (4) to account for the slowdown in Japan's labor productivity since the 1990s.

5.2 Observations about balanced growth

A useful feature of the accounting given by equations (3) and (4) is that, on the balanced growth path of a neoclassical growth model characterized by the production function (2), growth in output per working age person and growth in output per hour worked derive solely from growth in the TFP factor (see Kehoe and Prescott (2002, 2007) for an original exposition). In the model, on a balanced growth path both the capital factor and hours per working age person are constant. Specifically, when TFP and the working age population in country *i* both grow at a constant rate, $A_{i,t} = \Gamma_{i,0}(\gamma^t)^{1-\alpha_i}$ and $N_{i,t} = N_{i,0}g^t$, then there exists a balanced growth path of the neoclassical growth model on which the TFP factor, $A_{i,t}{}^{\frac{1}{1-\alpha_i}} = \Gamma_{i,0}{}^{\frac{1}{1-\alpha_i}}\gamma^t$, output per working age person, and capital per working age person all grow at the rate γ, while hours worked per working age person is constant. Since output and capital per working age person grow at the same constant rate, the capital-output ratio is constant on the balanced growth path. Thus "trend" growth in output per working age person and output per hour worked in equations (3) and (4) is solely driven by TFP factor growth, γ.

I have assumed that trend growth rate of the TFP factor is not country specific. This follows a literature which assumes that, ultimately, all countries can access the technology of the "innovation-technology leader" country, and hence exhibit trend TFP growth equal to that country. It is often argued that the leader country is the United States. Consequently, the globally accessible trend growth rate, γ, is assumed to equal 2 percent which is the average growth rate of US output per working age person over the 20th century. Kehoe and Prescott (2002, 2007) exposit this idea. Obviously, *levels* of TFP–even on a balanced growth path–can vary across countries through $\Gamma_{i,0}$, dictating different living standards at any date, given by (3), and labor productivity levels, given by (4). And, *off* a balanced growth path, any country's TFP growth rate can deviate substantially from the trend rate of the leader country. Assuming a general form for TFP of country *i*,

$$A_{i,t} = \Gamma_{i,t}(\gamma^t)^{1-\alpha_i},$$

one-time or persistent deviations of TFP growth from trend are possible through one-time or persistent changes in the time varying country level $\Gamma_{i,t}$; if persistent, very large level cross-country differences in living standards and productivity can cumulate. The country level $\Gamma_{i,t}$ reflects institutions, laws, policies, and practices that impact the efficiency with which capital and labor inputs are used in production relative to the leader country's trend TFP.

5.3 Additional data notes

The capital factor, as I note in section 2, is computed using the ratio of the nominal capital stock to nominal GDP. This ratio is raised to the exponent value dictated by the capital income share, $0.36/(1-0.36)$. The unobservable TFP factor is measured as the "Solow residual", by taking the ratio of observed real output per hour worked to the calculated capital factor.

5.4 Accounting for output per hour worked

Figure 3c decomposes labor productivity in Japan into the capital factor and TFP factors given by equation (4), setting all variables equal to 100 in 1990. Table 2c decomposes the decennial average growth rate of labor productivity into growth due to these two factors.

Figure 3c and table 2c show that TFP growth was not the only source of rapid growth in labor productivity in the 1970s, as Japan also experienced considerable capital deepening during this decade. However, in the 1980s, faster TFP growth was the sole source of rapid growth in output per working age person. Conversely, slower TFP growth was the sole source of slower labor productivity growth in the 1990s. Labor productivity growth was slower than TFP factor growth in the 1980s, because the capital factor declined on average, while labor productivity growth was faster than TFP factor growth in the 1970s and 1990s because the capital factor rose on average. Notably, TFP growth has never significantly recovered since its large decline in the 1990s. In the 2000s, until the great recession, labor productivity grew more quickly than the TFP factor, as the capital factor increased marginally. During the great recession, a sharp decline in the TFP factor was somewhat offset in its impact for labor productivity by a simultaneous sharp increase in the capital factor. Following the great recession, labor productivity growth was somewhat slower than TFP factor growth due to a modest decline in the capital factor on average. Note, however, from figure 3c that in 2018 Japan's TFP factor growth became negative, and the capital factor rose.

Although average TFP factor growth rose by 0.39 percentage points per year in the 2011-2018 period relative to 2001-2010, it was nowhere close to its 1980s rate and even a little slower than in the 2001-2007 pre-recession years. The TFP factor growth rate in 2011-2018 was barely 27 percent of its 1981-1990 value. Note that average labor productivity growth in the 1990s, although only 54 percent of its rate in the 1980s and 53 percent of its average value in 1971-1990, exceeded 2 percent–the growth rate that is associated with US trend growth. This was not the result of trend growth in Japan's TFP factor, however, which grew at just 0.96 percent per year on average during the 1990s, but of rapid capital deepening that offset the impact for labor productivity of the collapse in Japan's TFP growth.[4]

5.5 Summary

Evidently, systematically declining labor productivity growth in Japan since 1990 is the result of a massive decline in TFP factor growth in the 1990s, a smaller but significant decline in the 2000s, and a modest decline in the capital factor in the 2010s. While Japan has managed to boost output per working age person growth relative to the 1990s by increasing the labor input factor in the 2000s and, especially, 2010s, TFP and labor productivity growth have never recovered from their 1990s collapse. Neoclassical growth theory implies that TFP growth is the sole source of long-run growth in labor productivity, and in output per working age person. Increasing hours worked per working age person via rising employment rates is not sustainable, nor a source of sustainable growth in output per working age person. The improved growth performance of Japan's output per working age person will dissipate, unless TFP growth increases.

6. Japan's performance relative to the United States

How does Japan's output per working age person and productivity performance since 1990 compare

[4] The neoclassical growth model predicts that (expected) increases in TFP growth and capital deepening should be inversely related, through the inter-temporal consumption Euler equation. When growth in TFP and hence income and consumption is expected to decline, this is associated with a lower expected gross return to capital and hence a higher capital-output ratio. On a balanced growth path, both TFP growth and the capital-output ratio are constant, of course. Japan's decennial average growth rate data from 1971 through 2000 is broadly consistent with this prediction. More generally, there appears to be an inverse relation between the capital and TFP factors, as figure 3c illustrates.

to that of other high-income countries? Is it the case, as Posen argues, that the 1990s represent the only "lost decade" of growth for Japan among rich countries? In this section, I compare Japan's output per working age person and productivity growth to those of the United States, commonly regarded as the technology-frontier or technology-leader country.

The United States ranks 1st among the G-7 countries and 4th among OECD countries in 2018 GDP per working age person, much higher than Japan, ranking 5th and 17th, respectively. However, US growth and labor productivity performance since 2010 has been extraordinarily similar with that of Japan as tables 6 and 7 show. One motivation for singling the United States among OECD countries as a comparison country for Japan in this section is to assess whether Japan's slowdown can be attributed to a slowing of trend growth – output per working age person and TFP growth in the United States. Another, relatedly, is to understand whether the similar growth and labor productivity performances of the two countries since 2010 is attributable to common causes.

6.1 Output per working age person and labor productivity in the United States and Japan

The three panels of figure 4 compare the levels and growth rates of real GDP per working age person, real GDP per employed person, and real GDP per hour worked by employed persons in Japan and the United States since 1970. The figures show that the growth rate of output per working aged person and both labor productivity metrics in Japan was much faster than that of the United States in the 1970s and 1980s, as Japan exhibited rapid "catch-up" growth. Figure 4a shows that Japan's output per working age person growth slowed considerably relative to the United States in the early and late 1990s but appears to draw equal to the US growth rate after 2000. The growth rates tracked each other closely from 2001 until 2009, and after the great recession Japan's output per working age person grew marginally faster than that in the United States, at least until 2017. It is this evidence that supports Posen's argument that Japan has suffered a single lost decade of growth. In levels, Japan at least two decades of output per working age person relative to the United States since 1990; slower growth in the 1990s meant Japan was much poorer than the United States until at least 2010. However, in growth rates, she lost just one decade, the 1990s.

The first column of numbers in table 3 compares the decennial average annual growth rate of GDP per working age person in the United States with that of Japan since 1971. For brevity, I average growth rates from 1971 through 1990. All other decennial growth rates for Japan are replicated from the first column of numbers in table 1. The table confirms observations from figure 4a. Growth in Japan was much faster than that in the United States on average from 1971 through 1990. The US growth rate exceeded that of Japan during the 1990s. However, on average, US growth was significantly slower than that of Japan in the 2000s and slightly slower during the 2010s.

Figures 4b and 4c compare the evolution of the two labor productivity measures for Japan and the United States, from 1970 through 2018. Figures 5a through 5c compare the evolution of the working age population, employed persons, and hours worked in the two countries over the same period. While, as illustrated in figures 2a and 2b, there are large differences in the evolution of alternative measures of labor in Japan and, hence, in alternative measures of output per unit of labor, there are relatively small differences among labor and output per unit of labor measures in the United States. Thus, there are large differences in Japan's performance relative to the United States across measures of output per unit of labor.

Figure 4b shows that, *in levels*, Japan has suffered almost three full decades of substantially lower labor productivity measured by output per employed person since 1990, despite experiencing faster growth than the United States from 1971 through 1990. Labor productivity by this measure grew 30 percent less in Japan compared to the United States from 1990 to 2018. There is no evidence in the behavior of output per employed persons to suggest significant catchup by Japan since 2000, a period over which the United States is viewed to have suffered a significant productivity slowdown; in fact, the productivity gap has increased since 2000, including during the last several years of the sample. Figure 4c shows that output per hour worked in Japan grew slower than in the United States only from the *late* 1990s, thus increasing about 15 percent less in Japan than the United States over the 1990 to 2018 period. However, the productivity gap in output per hour worked also appears to widen in the last two years of the sample. In terms of levels, since 1990, Japan has suffered almost three full lost decades of output per employed person and two lost decades of output per hour; Japan is much less productive than the United States due to her productivity growth slowdown.

The second and third columns of numbers in table 3 compare the decennial growth rate of each measure of labor productivity in the United States with that in Japan. Again, most of Japan's numbers are replicated from table 1 for ease of comparison. Growth rates of each US labor productivity measure declined sharply in the 2010s after the great recession, however, they were remarkably stable, at roughly between 1.5 percent and 2 percent, in the 1970s, 1980s, 1990s, and 2000s. The changes in Japan's *relative* growth rate behavior during these decades were attributable largely to declining labor productivity growth in Japan rather than to any significant change in labor productivity growth rates in the United States. This contrasts with relative growth in output per working age person.

In the 2000s, relative growth in output per working age person declined sharply in the United States and recovered in the 2010s.

The differences in Japan's growth rate performance relative to the United States between output per working age person, output per employed person, and output per hour worked are attributable to relatively large differences in behavior among labor input measures in Japan, as figure 5 shows. The three panels of figure 5 compare the behavior of each labor measure in Japan and the United States. All measures of labor in Japan grew more slowly than their counterparts in the United States at some point after 1990, diverging downwards from the corresponding US labor input measure. None exhibits "catch-up" subsequently. All three measures of labor in the United States increased substantially, and by a quantitatively similar percentage between 1990 and the end of the sample period. From 1990 through 2018, the US working age population rose 29 percent, employed persons rose by 27 percent, and US hours worked increased by 25 percent. By contrast, in Japan, employed persons rose by 6.6 percent, hours *fell* by 9.3 percent, and the working age population *fell* by 12.4 percent. As a result, Japan's output per working age person performs relatively strongly compared to those in the United States after 2000 than do Japan's labor productivity metrics. To clarify this point, figure 6 shows the level of real GDP in the two countries. Output in Japan has on average grown much more slowly than in the United States since 1992, with the gap between real outputs increasing over time. To the extent that Japan's output per working age person and output per hour perform more strongly relative to the United States than does the level of her real GDP after 2000, it is due to negative growth in Japan's hours worked and working age population.

In summary, labor productivity measured by output per employed person in Japan has lost almost three complete decades of growth relative to the United States. Output per hour– like output per working age person–suffered just one decade of lost growth relative to the United States, although the lost growth decade is the 2000s. Nonetheless, US labor productivity metrics suffered substantial growth rate declines in the 2010s, converging towards the analogous growth rates in Japan.

6.3 Decomposition of US output per working age person

In tables 4a and 4b I present the same decomposition of average US real GDP per working age person and hours per working age person based on equations (1a) and (1b), as I presented for Japan in tables 2a and 2b. I reproduce Japan's numbers for the purposes of comparison. Again, I average growth rates over the first two decades of the sample.

By sharp contrast to Japan, the stability of the US growth rate in the 1990s relative to the 1970s and 1980s was accompanied by stable–in fact somewhat higher–labor productivity growth measured by output per hour worked. The average growth rate of hours per working age person was also stable. In the 2000s, the sharp reduction in the average growth rate of US output per working age person was not associated with any reduction in average labor productivity growth which, again, rose slightly, but to a decline in hours per working age person. Notably, the decline in hours began prior to the great recession. Faster US growth in the 2010s is due more to rising labor input than to increasing labor productivity growth.

Table 4b shows that the decline in US hours worked per working age person in the 2000s occurred via large declines in both the employment rate and average hours worked. The increase in hours per working age person in the 2010s was attributable more to a rise in the employment rate than to higher average hours. US labor productivity growth, as seen in table 4a and figure 4c, declined substantially in the 2010s. Indeed, the relatively sluggish US output per working age person growth rate recovery after the great recession (compare the magnitude of percentage point downturn in the 2000s to the uptick in the 2010s in table 4a) can be attributed to slower labor productivity growth; exactly as in Japan, only faster growth in labor utilization and effort intensity prevented an even slower US growth rate decade from 2011 through 2018.

6.4 Accounting for US output per hour worked

The decompositions of output per working age person for Japan and the United States exhibited very different roles for labor productivity, measured by output per hour worked. In Japan, labor productivity systematically declined; in the 1990s and 2000s, it was the most important source of slowing growth in output per working age person, although average hours reductions played a smaller role in the 1990s. In the 2010s, even slower labor productivity growth prevented a greater recovery in Japan's output per working age person, recovery which was driven by an increasing employment rate. In the United States, high labor productivity growth *sustained* relatively rapid growth of output per working age person in the 1971-1990 period and prevented even slower growth of output per working age person in the 2000s when hours per working age person fell sharply. However, in the 2010s, US labor productivity growth slowed to a rate much like that in Japan, similarly slowing output per working age person growth relative to the rapid increase in hours per working age person.

In Japan, declining labor productivity growth was driven by slower TFP growth in the 1990s and 2000s, although in the 1990s, dramatically slower TFP growth was somewhat offset by capital deepening. In the 2010s, a declining capital-output ratio was the source of even slower labor productivity growth. What accounts for the stability of US labor productivity growth until the 2010s, and why did US labor productivity growth then decline? I use equation (4) to decompose US output per hour worked. Table 4c decomposes the decennial growth rates of US labor productivity into growth in the capital and TFP factors. I reproduce the numbers for Japan for ease of comparison. The table shows that healthier TFP growth in the United States supported stable labor productivity growth in the 1990s relative to the 1960-1990 period, as the capital factor declined. Although there was a significant decline in US TFP growth in the 2000s, it remained much higher than that in Japan, and the impact for labor productivity growth of its decline was muted by capital deepening. In the 2010s, a further decline in US TFP growth was *exacerbated* by a decline in the capital factor; both the TFP and the capital factor contributed to the dramatic decline in US labor productivity growth in the 2010s. The table shows extraordinary convergence of not only labor productivity but also TFP growth rates and capital factor growth in the 2010s across Japan and the United States. In the 2010s, TFP growth in the two countries converged to a common rate that was roughly one third that of Japan's in the 1970s and 1980s, but two thirds that of the United States.

7. Has trend growth declined?

Combining the information in tables 4a, 4b, and 4c, evidently in the period 2011–2018 Japan and the United States exhibited close to convergence in the growth rates of output per working age person, the hours worked factor, capital factor, and TFP factor. Both countries suffered very low labor productivity growth, via slow TFP growth and declining capital-output ratios, however, the impact of slow productivity growth for output per working age person was offset by healthy growth in hours per working age person. Does the convergence of Japan and US growth and productivity performance in the 2010s imply that the two countries confront a common problem, of slower secular economic growth attributable to slower trend growth in the leader-country, the United States?

In this section, following the great depressions methodology of Cole and Ohanian (1999), and Kehoe and Prescott (2002, 2007), I document the magnitude and persistence of both countries' key macroeconomic variables deviations from a 2 percent trend. I depict output per working age person, output per hour worked, and the TFP factor of Japan and the United States "net" of the 2 percent growth rate that is typically thought of as the US-TFP determined global trend. I let the de-trended output per working age person, output per hour, and TFP factor series equal 100 in 1990 in figures 7a, 7b, and 7c. A value of 100 at every other date is the value that the variable would take had it grown at exactly two percent annually. If a variable in the figures increases at any date, it is growing faster than 2 percent, if it decreases, slower than 2 percent. The figures show Japan "catching up" to the United States prior to 1990 through faster than trend growth, but subsequently diverging below the corresponding US variable after 1990, without recovering. By sharp contrast, the corresponding US variables–at least output per working age person and the TFP factor–cyclically fluctuate around the 2 percent trend-line until late in the sample period, during and after the 2008-2009 great recession. This is how they should behave if indeed the United States is the source of global 2 percent trend growth. De-trended US labor productivity appears to exhibit gradual decline before 1990, which reflects the systematic decline over the period 1970-1990 in the US capital-output ratio shown in table 4c.

Specifically, figure 7a shows de-trended output per working age person in the two countries. Japan suffered below trend growth in output per working age person in most years from 1992 until 2009, resulting in substantial, increasing deviations from trend. In 2018, Japan's level of output per working age person lay about 18 percent below trend. The substantial deviation below trend observed for Japan starting in the early 1990s was not mirrored in the United States, which exhibited marginally below trend growth during the early 1980s, from 1991 until 1997, and in 2002 and 2003. However, by far the largest deviation from trend of output per working age person in the United States was initiated by the financial crisis and great recession onset in 2008. Notably, de-trended US output per working age person had not recovered through 2018; the United States has suffered a large, persistent, deviation below the output per working age person trend path since 2008. Furthermore, de-trended output per working age person in Japan and the US has behaved very similarly since the great recession.

Recall from the discussion of equation (4) and balanced growth paths in the neoclassical growth model that output per hour worked exhibits the same trend growth rate as output per working age person, that of the US TFP factor. Figure 7b shows that Japan's output per hour worked deviated below trend only after 2000, but then dropped off more steeply than did output per working age person. By contrast, since 1990 US output per hour worked has dropped below trend significantly only in 2012. Combining the information in figures 7a and 7b with equation (1a), the immediate post-1990 deviation below trend of Japan's output per working age person was attributable to a deviation below (the flat) trend in hours per working age person, but after 2000 to a substantial deviation below trend in output per hour worked. The US was insulated from substantial deviations from trend in output per working age person by offsetting deviations from trend in output per hour worked (positive) and hours per working age person (negative) from roughly 1970 until the great recession. De-trended output per hour in the two countries behaved very similarly after the great recession; not surprising, since output per hour exhibited a very similar growth rate in the two nations.

Figure 7c shows the de-trended TFP factors. To reiterate, the difference between de-trended TFP factors and de-trended labor productivity is simply due to changes in the capital-output ratio. The figure shows a large and sustained deviation from trend growth in Japan's TFP factor since 1993.

Only capital deepening, that the neoclassical growth model predicts should be associated with slowing TFP growth, prevented an even poorer labor productivity performance relative to trend after 1990 in Japan. Specifically, capital deepening delayed a deviation below trend of Japan's output per hour worked until the 2000s while the TFP factor crashed below trend from 1992. By contrast, while the US TFP factor growth rate approximated that of Japan after the great recession, for the entire period since 1991 the US TFP factor itself deviated below trend only during the last three years of the sample: 2016, 2017, and 2018. Notice how mild the decline in de-trended US TFP since the great recession appears relative to that experienced during the 1970s.

Based on these data, it is hard to argue that the US TFP trend growth rate has permanently declined since the great recession, and impossible to argue that Japan's TFP collapse in the 1990s and 2000s was associated with any change in trend growth. Assuming that the United States is the technology-frontier country, it is Japan's domestic institutions, practices, and policies that substantially and persistently reduced the level and growth rate of her TFP factor below trend since 1993.

8. How does Japan compare to other rich countries?

Posen argues that Japan's productivity growth performance since 2002, and especially 2012, has been quite strong relative to other rich G-7 countries. While a broader comparison set than that of the industrial leader, the United States, the G-7 also comprises several very slow growing OECD countries. In this section, I compare Japan's growth and productivity performance to those of a twenty-country sample of the richest OECD countries. Specifically, I compare Japan's output per working age person, labor productivity, and TFP growth performance relative to all OECD countries with a 2018 per capita real GDP at least as great as the OECD average. Twenty of thirty-seven OECD countries satisfy this criterion. I list them in the first column of table 5.[5]

Table 5 shows the ranking of the twenty rich OECD countries by the average *level* of output per working age person in each of six years in the sample period; 1970, 1980, 1990, 2000, 2010, and 2018. Japan and the United States are highlighted in yellow. The data show remarkable stability in Japan's ranking over this period. While Japan's rank improved by three places between 1970 and 1990, from 19th of twenty to 16th during a relatively fast growth period, it deteriorated by two places to 18th by 2000, and picked up only one place to 17th in 2018 despite Japan exhibiting 2 percent, "trend"

[5] Of these twenty, sixteen were among the founding members in 1961. Australia, Finland, Japan, and New Zealand joined in 1971, 1969, 1964, and 1973, respectively. The remaining four founding members–Greece, Portugal, Spain, and Turkey–were not among the richest twenty in 2018 (nor were they when Japan joined).

growth on average during the 2010s. Contrast Japan's experience to that of Ireland, a country which improved from a rank of 20th in 1970 to a rank of 1st in 2018; Australia which improved from 16th to 5th; Iceland which moved from 17th to 7th; and Luxembourg which improved from 13th to 6th. Japan's output per working age person growth has been insufficiently strong since 2010 to converge more rapidly towards the richest OECD countries' living standards.

Table 6 shows the growth rates of output per working age person by sub-period for the same set of rich countries, table 7 the growth rates of labor productivity measured by output per hour, and table 8 the growth rates of the TFP factors. TFP factors were derived for each country in the table using the same growth accounting exercise as those I derived for Japan and the United States in previous sections. I highlight in green the growth rates of countries that are greater than those of Japan in the 2000s and 2010s, the period over which the productivity slowdown is frequently argued to have occurred.

A comparison of the three tables shows that Japan's output per working age person growth compares relatively favorably among the twenty sample countries in the 2000s and 2010s to that of output per hour worked and the TFP factor, as is true of her output per working age person and productivity growth since 2000 relative to those of the United States. In the 1990s, the output per working age person of nineteen of twenty rich OECD countries grew more quickly than that of Japan; only that of Switzerland grew more slowly, a country argued by Kehoe and Ruhl (2003) to have suffered a great depression from 1974 through 2000. In the 2000s, however, only six grew more quickly, and just three in the 2010s. Japan's output per working age person growth ranking improved dramatically in the 2000s and 2010s in this country-sample, as did her output per working age person growth performance relative to the United States. This improvement in relative output per working age person growth performance, however, did not reflect comparable improvement in her labor or total factor productivity growth performance among rich OECD countries.

Table 7 shows that, in the 1990s, eight of the twenty rich OECD countries experienced more rapid output per hour growth than Japan, twelve in the 2000s, and eleven in the 2010s, eleven. Table 8 shows that Japan's TFP factor growth in the 1990s was unambiguously the slowest among all twenty countries, and her ranking improved in the 2000s and 2010s, however, this ranking improvement barely elevated Japan into the top half of all twenty OECD countries in the sample. In the 2000s, fourteen of the twenty richest OECD countries exhibited faster TFP factor growth than Japan, and in the 2010s nine. Note that, despite the evident widespread TFP growth slowdown in the 2000s among this subset of twenty OECD countries, Japan was one of nine countries to experience higher

TFP growth in the 2011-2018 period than in the 2000s, although by no measure was Japan's the most impressive TFP growth improvement. Look, for example, at the large TFP growth rate improvements between the 2000s and 2010s of Denmark, Iceland, and Ireland, each of which attained faster than trend growth in the 2010s.

Japan's relatively strong output per working age person growth performance in the 2000s and 2010s among rich OECD countries compared to her productivity growth performance reflects the fact that the former is driven by relatively strong hours per working age person growth in Japan among the twenty OECD countries, as is true of her performance relative to the United States during the 2000s and 2010s. If rich countries are to design policies supporting faster TFP, labor productivity, and *sustainable* output per working age person growth, then Denmark, Iceland, and especially Ireland are evidently the rich OECD countries with policies to emulate–not Japan.

Finally, I examine de-trended TFP factors in two international comparisons. First, I assess the impact of Japan's slower TFP growth since 1991 for the *level* of her TFP factor, relative to trend, among rich OECD countries. For clarity, I divide the nineteen other countries in the sample into those exhibiting average TFP factor growth from 2001 through 2018 (or from 2001 through 2017, depending on data availability for that country's growth accounting) that is at least as great as Japan's, and those exhibiting average TFP factor growth from 2001 through 2018 (or 2017) less than Japan. The former countries are depicted in green, the latter in red. Figure 8a shows the results, normalizing TFP factors to equal 100 in 1990. By 2018, Japan's TFP factor has fallen farther below trend since 1990–26 percent–than that of any other rich OECD country in the sample except Italy (30 percent)– a country that, in my data, has suffered a great depression since 2000 according to all three quantitative criteria established by Kehoe and Prescott (2002, 2007). Furthermore, Japan's de-trended TFP factor is continuing to fall, while some other countries with TFP factors below trend are experiencing reversion to trend.

Second, I assess Japan's performance relative to trend among rich OECD countries since 2000, the period over which a widespread productivity slow-down is argued to have occurred. Figure 8b also depicts countries with faster average TFP growth for the period 2001 through 2018 (or 2017, depending on data availability) in green, and those with slower TFP growth in red. All TFP factors are normalized to equal 100 in 2000. The figure shows that Japan's TFP growth performance since 2000 has been far from stellar. She is among seven countries with TFP factors that have declined more than 15 percent below trend since 2000. Thus, even when I omit the 1990s, the lost decade when Japan's TFP factor growth was unambiguously the lowest in the sample, Japan exhibits the seventh lowest level of de-trended TFP factor in 2018 among the richest twenty OECD countries, and shows no sign of improving her rank significantly. In fact, Japan's negative TFP factor growth rate of -1.37 percent between 2017 and 2018 is the lowest of any country in the sample.

9. Conclusion

By any metric, Japan has been one of the weaker productivity growth performers among rich OECD countries since 1990, and even since 2000 after which the apparent widespread productivity slowdown began. The data and accounting results documented in this paper make it difficult to argue, as some have, that other rich countries suffering secular stagnation should emulate Japan's policies, as Japan's policies have had no discernible positive impact for Japan's TFP or labor productivity growth for the past three decades. If stagnating countries are to foster faster growth that is sustainable, research must identify the specific institutions, practices, and policies that resulted in a large and persistent TFP deviation below trend after 1990 in Japan, and after 2000 in several other rich OECD countries. If Japan is to sustain the faster output per working age person growth accomplished in the 2010s by growing the employment rate and hours per working age person, accelerating TFP growth will be necessary.

Jones (2017), studying the productivity slowdown of the United States and several mature European countries, shows that US government R&D spending as a share of GDP has been declining since the late 1960s while growth in R&D employment has significantly fallen since 2002 in the United States, E.U., and – especially – Japan. He argues that because new ideas are harder and harder to produce, they are more and more costly to produce; the data suggest that R&D expenditures and employment in advanced countries are not rising "fast enough" to permit the same *rate of growth* in ideas, and hence frontier technology. Jones conceives the technology frontier as internationally determined, rather than by a single leader country, such as the United States. His argument is that insufficiently rapid growth in the R&D inputs of advanced countries has reduced the global trend growth rate, and this is reflected in the broad slowdown of productivity growth. My calculation and de-trending of TFP factors for the United States, Japan, and other OECD countries suggest, however, that it may be too soon to argue that trend growth has slowed, wherever it originates. Table 8 shows that for nine of the twenty richest OECD countries the TFP factor growth rate has been faster since 2011 than in the decade before it. Similarly, figures 8a and 8b show that the TFP factors for some countries are reverting to a mean of two percent or stabilizing at two percent. Nevertheless, investigating possible relationships between declining R&D input and expenditure growth and total factor productivity growth among advanced countries is an interesting future avenue for additional research.

Relatedly, Fukao (2013) presents evidence that information and communications technology (ICT) and intangible investment in Japan has been slow, especially among smaller firms that, at the same time, have experienced relatively slow TFP growth. He also argues that R&D spillovers from large to small firms in Japan have declined as global supply chains of larger firms have expanded and diversified. Fukao et al. (2015) also present data suggesting that Japan's slow TFP growth relative to the United States in the 1990s and 2000s prior to the great recession was attributable to Japan's failure to invest as rapidly in ICT capital. Interestingly, the authors argue that ICT-using firms and industries in Japan were unable to economize on unskilled labor inputs, which ICT use should facilitate, because of the high job security afforded full-time workers in Japan. They note, also, that growth in contract and part-time employment (potentially to circumvent employment and wage guarantees afforded full-time and permanent workers) has resulted in declining job training expenditures, thus depressing intangible investments. The relationship of Japan's ICT and intangible investment with labor market rigidities, including current labor market policies, clearly warrants further research attention.

Jones also cites a growing body of evidence, in firm-level and sectoral data from multiple countries, that depression of *the level* of aggregate TFP is significant due to microeconomic misallocation of resources across firms and sectors. It is exactly such misallocation that would result from bailout, credit, industrial, and labor market policies that directly or indirectly subsidize inefficient firms and sectors. However, there is no consensus that misallocation has been increasing over time in a manner that would explain the productivity slowdowns observed in this paper's data. Bils, Klenow, and Ruane (2017) show that *mismeasurement* in US manufacturing data has been rising over time and, if not corrected using the method they develop, this fact produces an inaccurate inference that misallocation in US manufacturing is rising over time. Beyond the scope of this paper, I leave an investigation of resource misallocation as a source of TFP collapse in Japan to future work.

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Figure 1a Real GDP per working age person growth rate, Japan (percent per annum)

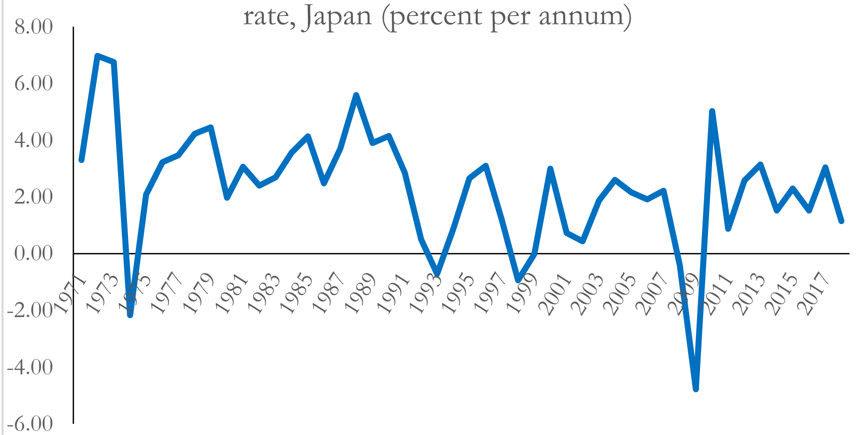


Figure 1b. Real GDP per employed person growth rate, Japan (percent per year)

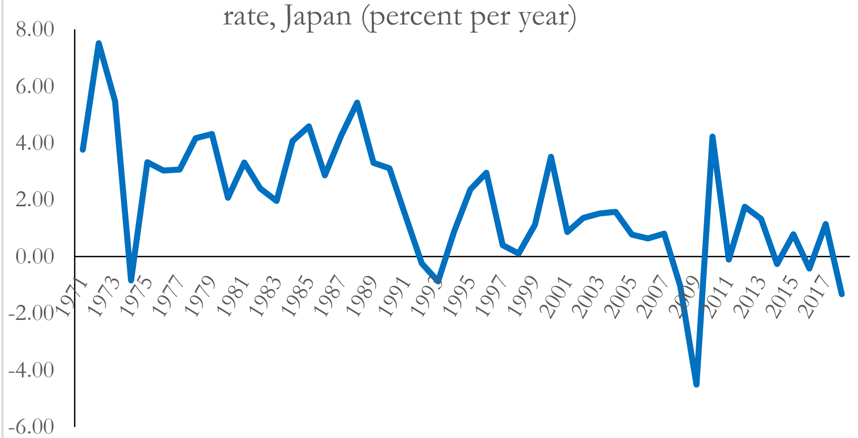
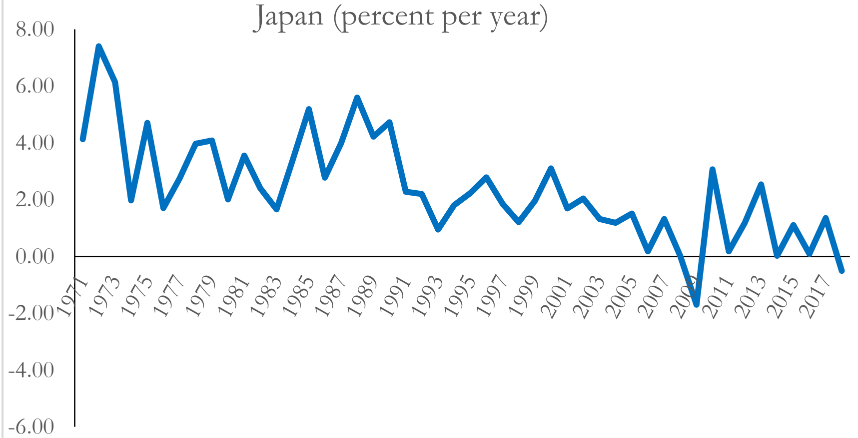


Figure 1c. Real GDP per hour worked growth rate, Japan (percent per year)



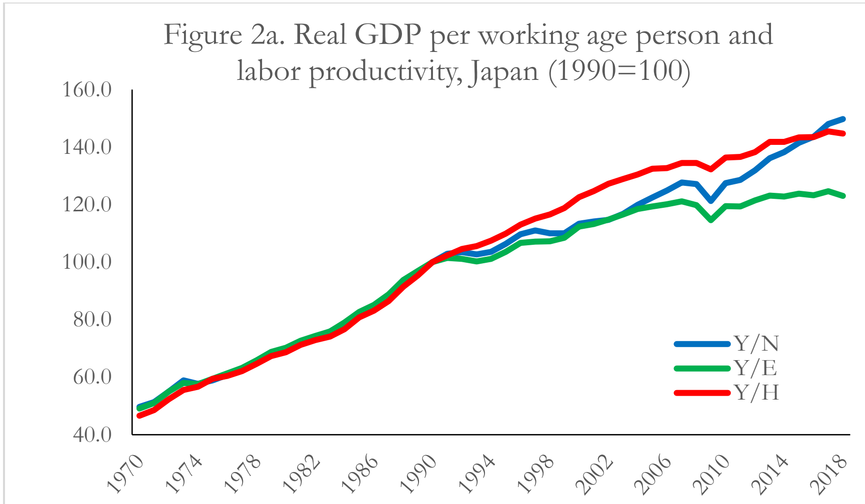


Figure 2a. Real GDP per working age person and labor productivity, Japan (1990=100)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
Y/N
Y/E
Y/H
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018

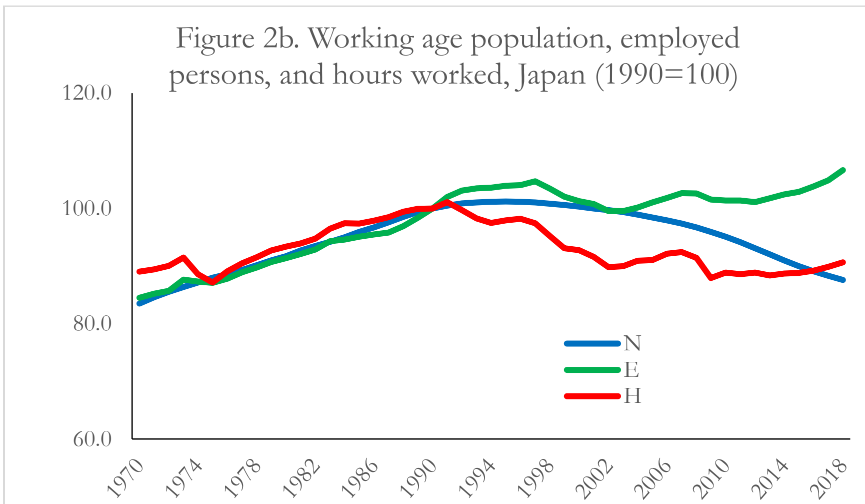


Figure 2b. Working age population, employed persons, and hours worked, Japan (1990=100)
120.0
100.0
80.0
60.0
N
E
H
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018

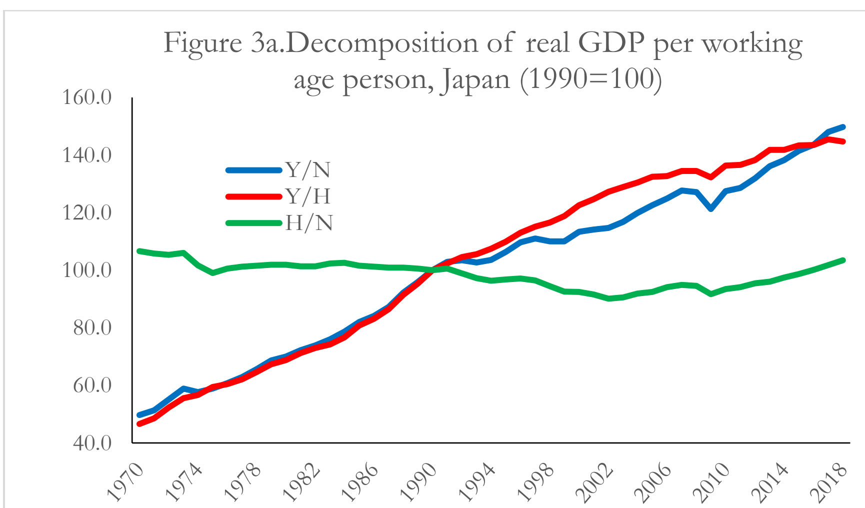


Figure 3a.Decomposition of real GDP per working age person, Japan (1990=100)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
Y/N
Y/H
H/N
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018

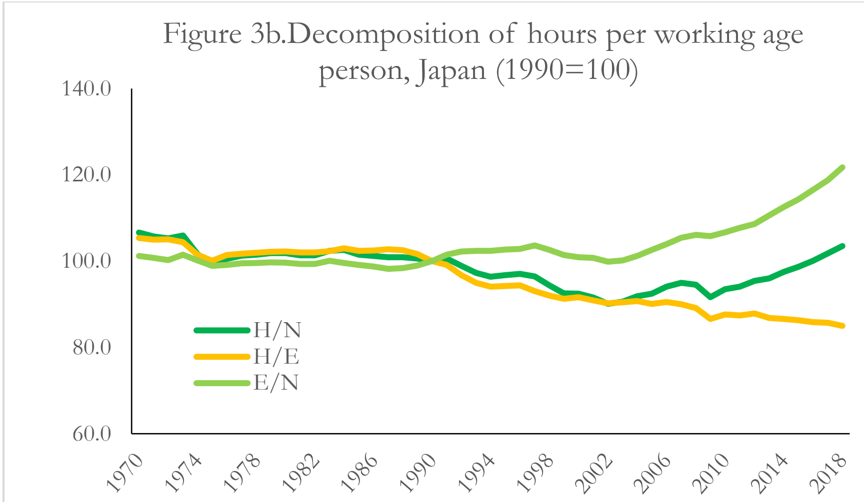


Figure 3b.Decomposition of hours per working age person, Japan (1990=100)

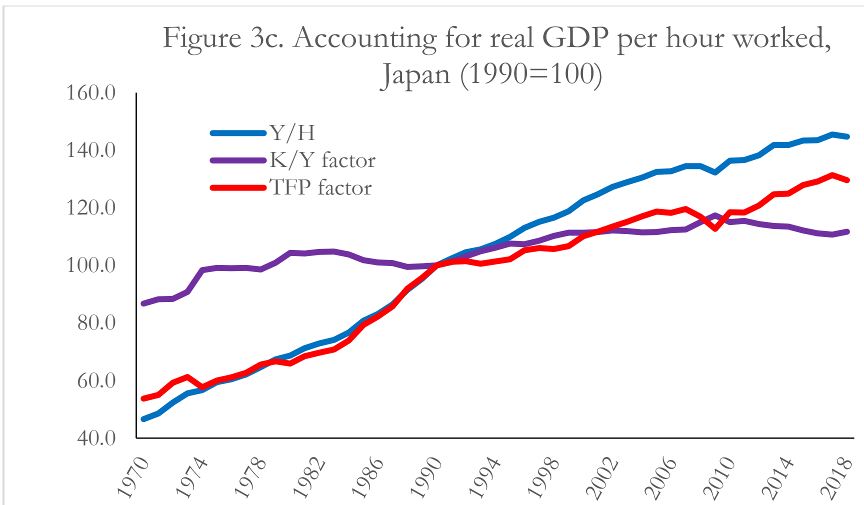


Figure 3c. Accounting for real GDP per hour worked, Japan (1990=100)

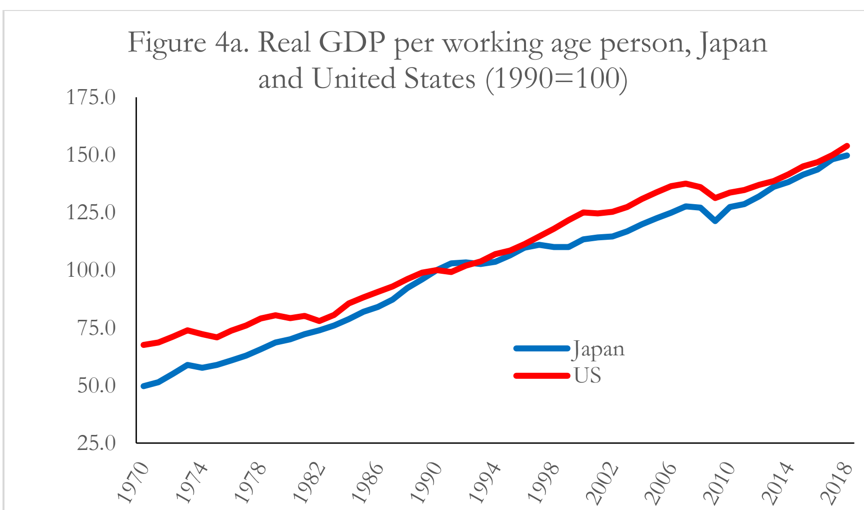


Figure 4a. Real GDP per working age person, Japan and United States (1990=100)

Figure 4b. Real GDP per employed person, Japan and United States (1990=100)

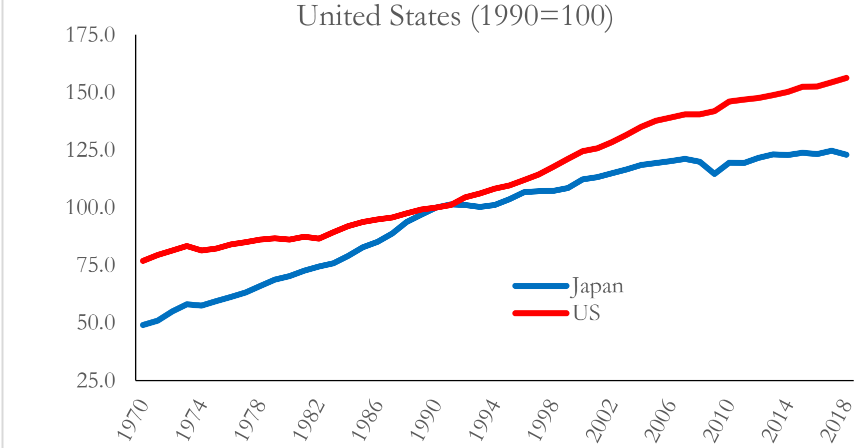


Figure 4c. Real GDP per hour worked, Japan and United States (1990=100)

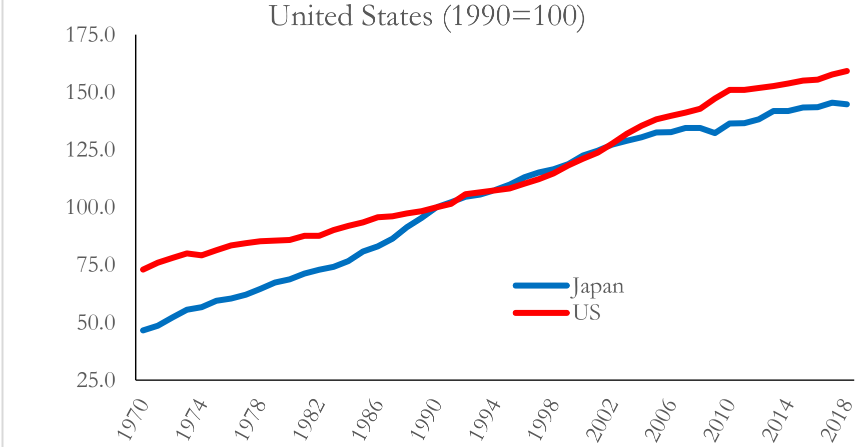


Figure 5a. Working age population, Japan and United States (1990=100)

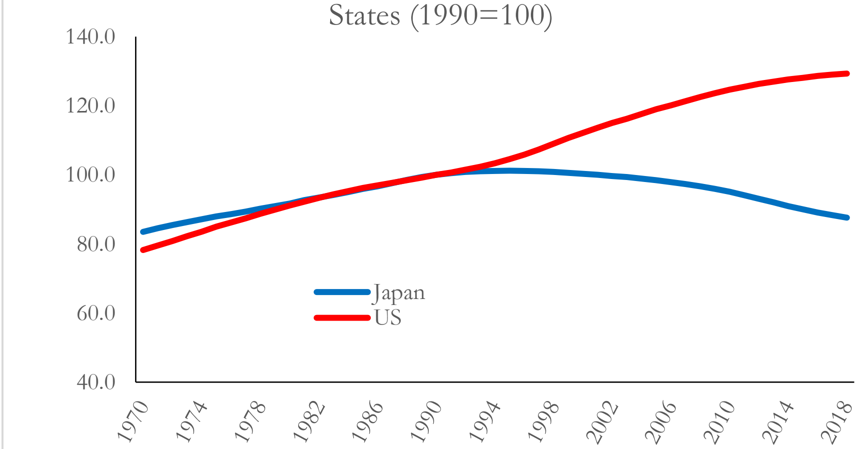


Figure 5b. Employed persons, Japan and United States (1990=100)

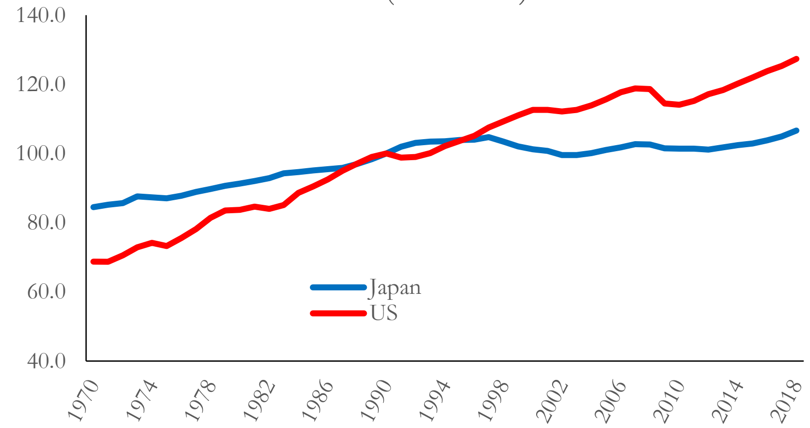


Figure 5c. Hours worked, Japan and United States (1990=100)

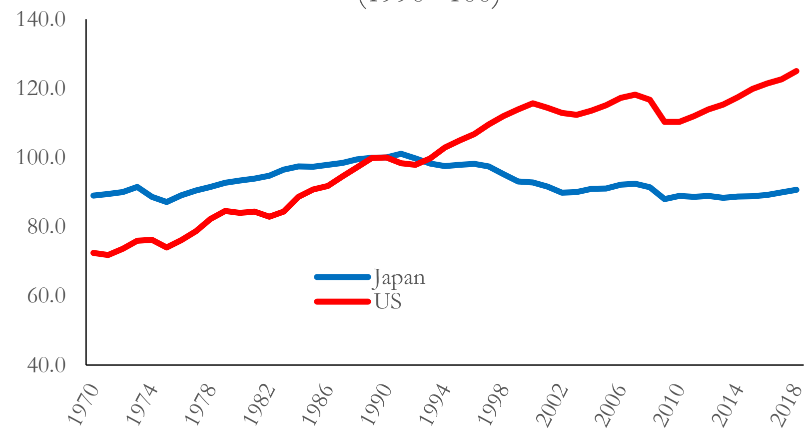
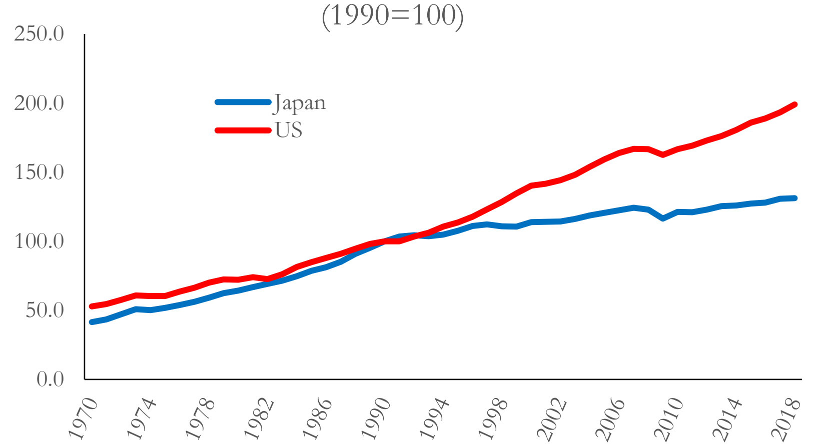


Figure 6. Real GDP in Japan and the United States (1990=100)



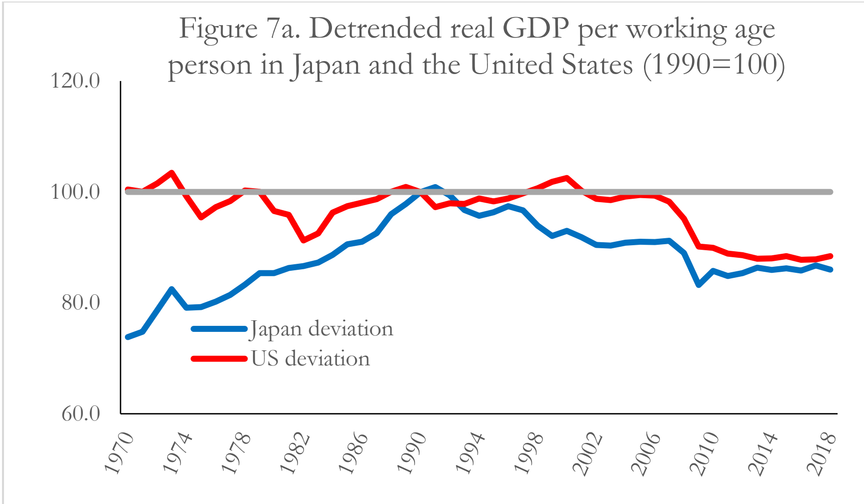


Figure 7a. Detrended real GDP per working age person in Japan and the United States (1990=100)
120.0
100.0
80.0
60.0
Japan deviation
US deviation
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018

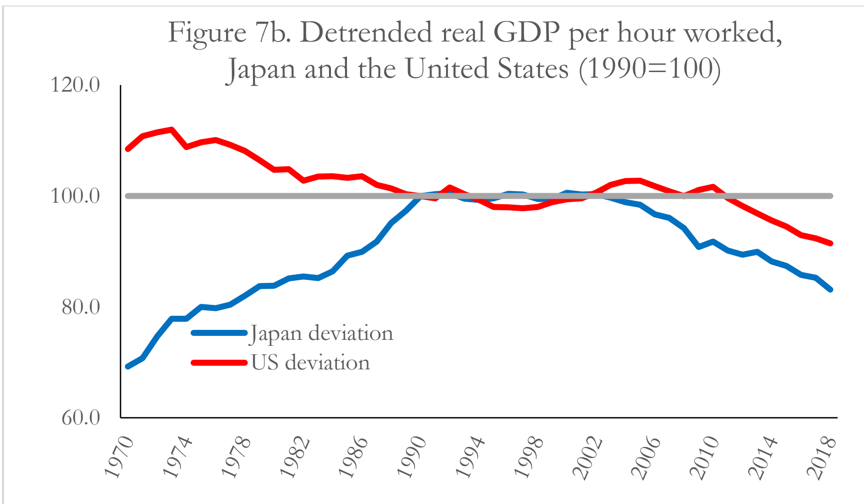


Figure 7b. Detrended real GDP per hour worked, Japan and the United States (1990=100)
120.0
100.0
80.0
60.0
Japan deviation
US deviation
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018

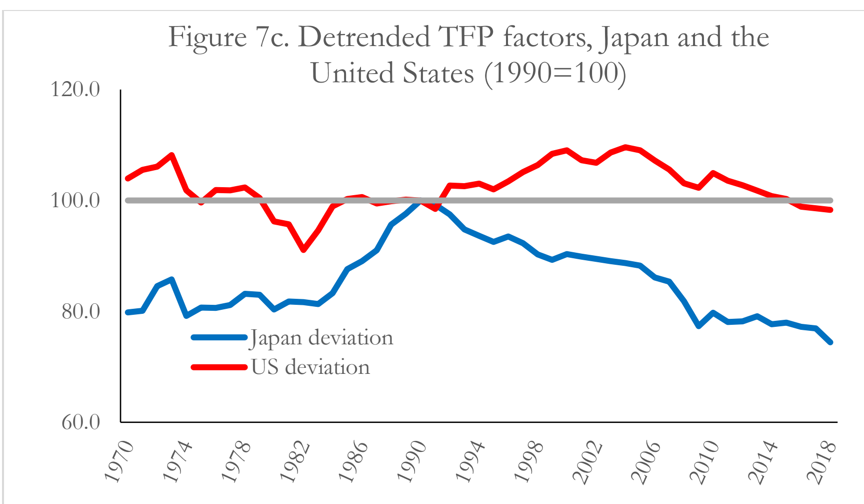


Figure 7c. Detrended TFP factors, Japan and the United States (1990=100)
120.0
100.0
80.0
60.0
Japan deviation
US deviation
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018

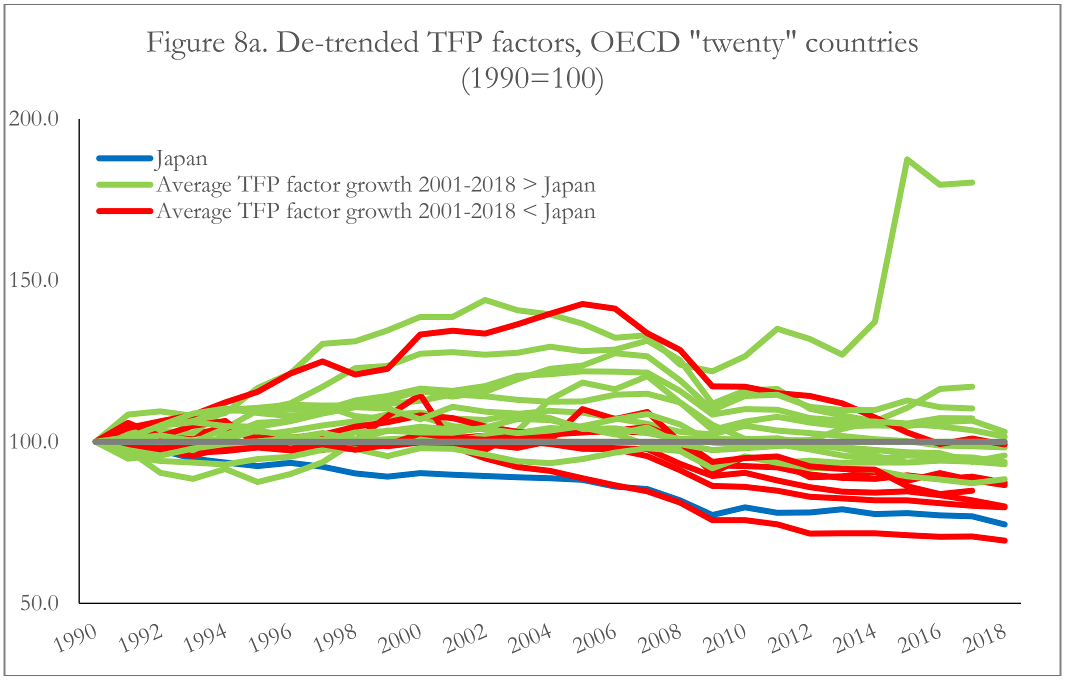


Figure 8a. De-trended TFP factors, OECD "twenty" countries
(1990=100)
200.0
150.0
100.0
50.0
Japan
Average TFP factor growth 2001-2018 > Japan
Average TFP factor growth 2001-2018 < Japan
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018

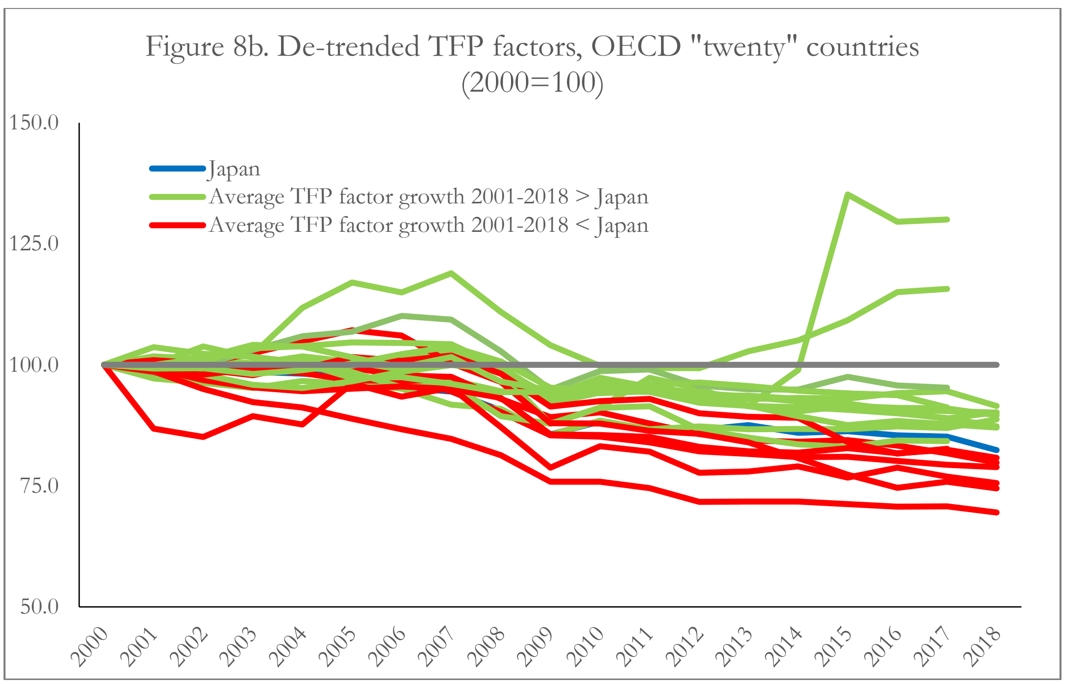


Figure 8b. De-trended TFP factors, OECD "twenty" countries
(2000=100)
150.0
125.0
100.0
75.0
50.0
Japan
Average TFP factor growth 2001-2018 > Japan
Average TFP factor growth 2001-2018 < Japan
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Table 1. Average GDP per working age person and labor productivity growth in Japan, 1971-2018 (percent per year)

	GDP/ working age person	GDP/ employed person	GDP/ hour worked by employed persons
1971-1980	3.43	3.59	3.89
1981–1990	3.57	3.53	3.75
1991–2000	1.25	1.16	2.04
2001–2010 **(2001-2007)**	1.17 (1.70)	0.62 (1.07)	1.06 (1.32)
2011–2018	2.01	0.36	0.75
1971-2018	**2.30**	**1.91**	**2.36**
1991-2018	**1.44**	**0.74**	**1.32**

Table 2a. Decomposition of average GDP per working age person growth in Japan, 1971-2018 (percent per year) *

	Y/N	Y/H	H/N
1971-1980	**3.43**	3.89	-0.46
1981–1990	**3.57**	3.75	-0.18
1991–2000	**1.25**	2.04	-0.78
2001–2010 **(2001-2007)**	**1.17** **(1.70)**	1.06 (1.32)	0.11 (0.38)
2011–2018	**2.01**	0.75	1.27
1971-2018	**2.30**	**2.36**	**-0.06**
1991-2018	**1.44**	**1.32**	**0.12**

*The second and third columns of numbers may not sum exactly to the first due (solely) to rounding errors.

Table 2b. Decomposition of average hours per working age person growth in Japan, 1971-2018 (percent per year) *

	H/N	H/EP	EP/N
1971-1980	**-0.46**	-0.30	-0.16
1981–1990	**-0.18**	-0.22	0.04
1991–2000	**-0.78**	-0.87	0.09
2001–2010 **(2001-2007)**	**0.11** **(0.38)**	-0.44 (-0.25)	0.55 (0.63)
2011–2018	**1.27**	-0.39	1.65
1961-2018	**-0.16**	**-0.45**	**0.38**
1991-2018	**0.12**	**-0.58**	**0.70**

*The second and third columns of numbers may not sum exactly to the first due (solely) to rounding errors.

Table 2c. Decomposition of average growth in GDP per hour worked in Japan, 1971–2018 (percent per year) *

	Y/H	$(K/Y)^{\frac{\alpha}{1-\alpha}}$	$A^{\frac{1}{1-\alpha}}$
1971-1980	**3.89**	1.85	2.04
1981–1990	**3.75**	-0.42	4.17
1991–2000	**2.04**	1.07	0.96
2001–2010 **(2001-2007)**	**1.06** **(1.32)**	0.33 (0.15)	0.73 (1.17)
2011–2018	**0.74**	-0.37	1.12
1971-2018	**2.36**	0.53	1.83
1991-2018	**1.32**	0.39	0.93

*The second and third columns of numbers may not sum exactly to the first due (solely) to rounding errors.

Table 3. Average GDP per working age person and labor productivity growth in Japan and the United States, 1961–2018 (percent per year)

	GDP/ working age person	GDP/ employed person	GDP/ hour
1971–1990			
Japan	3.50	3.56	3.82
United States	1.96	1.31	1.57
1991–2000			
Japan	1.25	1.16	2.04
United States	2.23	2.19	1.92
2001–2010 (2001-2007)			
Japan	1.17 (1.70)	0.62 (1.07)	1.06 (1.32)
United States	0.67 (1.37)	1.59 (1.72)	2.20 (2.18)
2011–2018			
Japan	2.01	0.36	0.74
United States	1.77	0.85	0.66

Table 4a. Decomposition of average GDP per working age person growth, Japan and the United States, 1971-2018 (percent per year) *

	Y/N	Y/H	H/N
1971–1990			
Japan	**3.50**	3.82	-0.32
United States	**1.96**	1.57	0.39
1991–2000			
Japan	**1.25**	2.04	-0.78
United States	**2.23**	1.92	0.31
2001–2010 (2001-2007)			
Japan	**1.17 (1.70)**	1.06 (1.32)	0.11 (0.38)
United States	**0.67 (1.37)**	2.20 (2.18)	-1.53 (-0.82)
2011–2018			
Japan	**2.01**	0.74	1.27
United States	**1.77**	0.66	1.11

*The second and third columns of numbers may not sum exactly to the first due (solely) to rounding errors.

Table 4b. Decomposition of hours per working age person growth, Japan and the United States, 1971-2018 (percent per year) *

	H/N	H/EP	EP/N
1971–1990			
Japan	**-0.32**	-0.26	-0.06
United States	**0.39**	-0.25	0.55
1991–2000			
Japan	**-0.78**	-0.87	0.09
United States	**0.31**	0.27	0.04
2001–2010 (2001-2007)			
Japan	**0.11 (0.38)**	-0.44 (-0.25)	0.55 (0.63)
United States	**-1.53 (-0.82)**	-0.61 (-0.46)	-0.92 (-0.35)
2011–2018			
Japan	**1.27**	-0.38	1.65
United States	**1.11**	0.19	0.92

*The second and third columns of numbers may not sum exactly to the first due (solely) to rounding errors.

Table 4c. Accounting for average GDP per hour worked growth, Japan and the United States, 1971–2018 (percent per year) *

Period	Y/H	$(K/Y)^{\frac{\alpha}{1-\alpha}}$	$A^{\frac{1}{1-\alpha}}$
1971–1990			
Japan	**3.82**	0.71	3.11
United States	**1.57**	-0.21	1.79
1991–2000			
Japan	**2.04**	1.07	0.96
United States	**1.92**	-0.92	2.85
2001–2010 (2001–2007)			
Japan	**1.06 (1.32)**	0.33 (0.15)	0.73 (1.17)
United States	**2.20 (2.18)**	0.60 (0.66)	1.60 (1.52)
2011–2018			
Japan	**0.74**	-0.37	1.12
United States	**0.66**	-0.50	1.16

*The second and third columns of numbers may not sum exactly to the first due (solely) to rounding errors.

Table 5. Rank of richest OECD countries by real GDP per working age person *

Country	1970	1980	1990	2000	2010	2018
Australia	16**	4	15	20	2	5
Austria	12	10	12	9	10	12
Belgium	11	13	13	10	12	13
Canada	6	8	8	12	16	14
Denmark	5	6	5	6	8	10
Finland	18	16	17	16	14	15
France	10	11	11	13	15	16
Germany	9	12	10	11	11	11
Iceland	17	7	9	14	13	7
Ireland	20	20	19	7	9	1
Italy	14	14	14	15	19	20
Japan	19	19	16	18	17	17
Luxembourg	13	15	4	3	4	6
Netherlands	4	5	7	5	6	8
New Zealand	8	18	20	19	20	19
Norway	3	2	2	1	1	2
Sweden	7	9	6	8	7	9
Switzerland	1	1	1	2	3	3
United Kingdom	15	17	18	17	18	18
United States	2	3	3	4	5	4

* Richest OECD countries are members having real GDP per capita at least equal to that of the OECD average in 2018.
** 1971 real GDP per working age person.

Table 6. Growth rates of output per working age person in richest OECD countries *

	1971-1990	1991-2000	2001-2010	2011-2018
Australia	1.19	2.37	1.39	1.64 8
Austria	2.23	2.19	1.15	0.97 17
Belgium	2.16	2.16	1.05	1.10 16
Canada	1.54	1.48	1.64	1.52 12
Denmark	1.67	2.36	0.57	1.70 7
Finland	2.93	1.97	1.51	1.39 14
France	2.18	1.81	0.67	1.39 14
Germany	2.09	1.81	1.22	1.63 9
Iceland	2.85	1.66	0.93	3.22 2
Ireland	2.90	4.96	0.92	6.40 1
Italy	2.40	1.92	0.14	0.09 20
Japan	3.50	1.25	1.17	2.01 4
Luxembourg	2.81	3.83	0.93	0.48 19
Netherlands	1.36	2.80	1.02	1.55 10
New Zealand	0.73	1.79	1.19	2.32 3
Norway	2.96	3.03	0.50	0.69 18
Sweden	1.84	1.73	1.47	1.99 5
Switzerland	1.08	0.65	0.88	1.14 15
United Kingdom	2.16	2.29	0.71	1.52 12
United States	1.96	2.23	0.67	1.77 6

*

*Richest OECD countries are members having real GDP per capita at least equal to that of the OECD average in 2018.

Table 7. Growth rates of output per hour worked in richest OECD countries *

	1971-1990	1991-2000	2001-2010	2011-2018
Australia	1.33	2.31	1.35	1.44
Austria	2.63	2.18	1.43	0.93
Belgium	3.12	1.95	1.14	0.48
Canada	1.18	1.49	1.92	1.06**
Denmark	2.90	2.01	0.94	1.56
Finland	3.54	3.20	1.43	0.74**
France	3.36	1.72	0.99	0.94
Germany	3.49	2.75	1.03	1.20
Iceland	3.09	1.26	3.19	1.48**
Ireland	4.10	4.20	2.43	5.39**
Italy	2.84	1.60	-0.03	0.51
Japan	3.82	2.04	1.06	0.74
Luxembourg	2.88	1.65	0.10	0.53
Netherlands	2.66	1.48	0.93	0.68
New Zealand	1.38	1.10	1.19	0.94**
Norway	3.43	2.73	0.69	0.49
Sweden	1.75	2.26	1.77	1.10**
Switzerland	1.51	0.98	1.31	0.71
United Kingdom	2.45	2.63	1.19	0.45
United States	1.57	1.92	2.20	0.66

*Richest OECD countries are members having real GDP per capita at least equal to that of the OECD average in 2018.
** 2011-2017 due to missing data.

Table 8. Growth rates of TFP factor in richest OECD countries*

	1971-1990	1991-2000	2001-2010	2011-2018
Australia	0.68	2.65	1.38	1.00
Austria	2.94	2.43	1.45	1.27
Belgium	3.41	2.00	0.95	0.45
Canada	1.24	2.24	1.20	0.36**
Denmark	3.18	2.74	0.76	2.01
Finland	3.34	4.39	1.05	0.87**
France	3.15	2.09	0.37	1.02
Germany	3.92	3.18	1.39	1.61
Iceland	3.91	2.10	1.96	4.10**
Ireland	3.66	5.25	1.06	7.05**
Italy	3.96	1.97	-0.78	0.89
Japan	3.11	0.96	0.73	1.12
Luxembourg	3.03	3.34	0.14	0.77
Netherlands	2.48	2.77	0.41	1.28
New Zealand	1.55	2.26	1.50	1.35**
Norway	3.10	4.85	0.69	-0.09
Sweden	1.63	3.44	1.85	1.48**
Switzerland	1.61	1.78	1.71	1.02
United Kingdom	2.34	3.50	1.42	0.98
United States	1.79	2.85	1.60	1.16

*Richest OECD countries are members having real GDP per capita at least equal to that of the OECD average in 2018.
** 2011-2017 due to missing data.