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Loukas Karabarbounis
University of Minnesota and Federal Reserve Bank of Minneapolis

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Perspectives on the Labor Share*

Loukas Karabarbounis
University of Minnesota and FRB of Minneapolis

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Abstract

As of 2022, the share of U.S. income accruing to labor is at its lowest level since the Great Depression. Updating previous studies with more recent observations, I document the continuing decline of the labor share for the United States, other countries, and various industries. I discuss how changes in technology and product, labor, and capital markets affect the trend of the labor share. I also examine its relationship with other macroeconomic trends, such as rising markups, higher concentration of economic activity, and globalization. I conclude by offering some perspectives on the economic and policy implications of the labor share decline.

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*The views in this paper do not necessarily reflect the views of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

1 Introduction

The "labor share" refers to the fraction of an economy's income that accrues to workers in exchange for their labor services. The evolution of the labor share has always fascinated, and often puzzled, economists, partly because it seems central to the question of how an economy is benefiting those who receive their income from working as opposed to those who receive it from owning capital. Ricardo (1817) famously argued that the distribution of income between labor and capital is the principal problem of political economy. Keynes (1939) noticed the United Kingdom and the United States had a stable labor share between the 1910s and the 1930s and claimed this was "a bit of a miracle." Kaldor (1957) argued that the stability of the labor share is an important stylized fact of economic growth, which implied that an economy's aggregate production could be written as a function of labor and capital in a convenient way. However, Solow (1958) was skeptical, arguing that this constancy "may be an optical illusion" and that we should not view the labor share as a fundamental constant of nature.

In 2022, the labor share in the United States was at its lowest level since the Great Depression. The headline estimate for the United States is a roughly 5 percentage points decline of the labor share between 1929 and 2022. The decline after World War II is even larger, at around 7 percentage points. The great majority of U.S. industries exhibited labor share declines in recent decades. The United States is not unique, as we observe labor share declines in most countries of Europe and Asia and in emerging markets. The headline estimate for the world is a decline of roughly 6 percentage points since 1980.

Conceptually, it may seem easy to divide income produced by an economy into labor compensation for providing labor services to production, and capital compensation for providing capital services to production. However, the measurement of the labor share is contentious because statistical agencies do not necessarily report the division of income between factors as economists conceptualize it. I lay out key issues in measuring the labor share, present various alternatives, and clarify some pitfalls in measuring practices.

In explaining why the labor share declined, I find it useful to consider five categories: technology, product markets, labor markets, capital markets, and globalization. The factors that have contributed to the labor share decline are intertwined, so no neat decomposition is possible without further analyses. My view is that the most plausible causes have technological origin. Developments such as the information age and automation, manifesting through changes in the cost of capital and the structure of product markets, caused the labor share to decline. However, this view is not necessarily dominant among economists, so I explain the mechanisms and evaluate the plausibility of each factor in light of available observations. I also highlight how the trend of the labor share relates to other macroeconomic trends and the implications that these trends have for economics research.

I conclude by discussing welfare, distributional, and policy implications of the labor share

Table 1: The Distribution of Income in National Income and Product Accounts

NIPA Item	Variable	Value (billions)
1.12 – 1	Net National Income	18,281
1.10 – 21	Consumption of Fixed Capital	3,480
equals	Gross National Income	21,761
1.1.5 – 1	Gross Domestic Product	21,521
1.12 – 1	Net National Income	18,281
1.12 – 2	Compensation to Employees	11,448
1.12 – 9	Proprietors' Income	1,554
1.12 – 12	Rental Income	685
1.12 – 13	Corporate Profits	2,470
1.12 – 18	Interest	515
1.12 – 19	Taxes on Production and Imports	1,553
1.12 – 20	Less: Subsidies	73
1.12 – 21	Business Current Transfer Payments	161
1.12 – 25	Surplus of Government Enterprises	−12

decline. Here, the discussion is necessarily more speculative, because the consequences of the labor share decline partly depend on whether it will continue.

2 Measuring the Labor Share

The measurement of the labor share is complicated by ambiguities about what constitutes labor versus capital income in the reports prepared by statistical agencies.[1] Should national or domestic income be used in the denominator of the labor share? How should we treat taxes? How to split proprietors' income between labor and capital? Should we include the government in our measurement of the labor share and what is capital income in the government sector? Should we include the imputed income that homeowners receive from living rent-free in their houses as capital income? How should we treat the depreciation of physical capital? Should income be netted out of measured investment expenditures? Or, should income be augmented to include some of the expenses that are currently missing from measured income but generate future returns?

2.1 Allocating Income between Labor and Capital

To illustrate the implications of these kinds of questions, Table 1 presents an example from the National Income and Product Accounts (NIPA) published by the U.S. Bureau of Economic

[1] Influential predecessors for some of the issues that I discuss include Cooley and Prescott (1995), Gollin (2002), and Gomme, Ravikumar, and Rupert (2011).

Analysis (BEA) for 2019.

The top part of the table concerns the denominator of the labor share calculation. National income net of depreciation is roughly 18 trillion dollars. Adding depreciation, which includes the consumption of both private and government fixed assets, yields a gross national income of close to 22 trillion dollars. The fourth line presents gross domestic product (GDP). Products and incomes are conceptually the same objects, with differences arising because products are measured from the market value of new goods and services, while incomes are measured from compensations to factors and taxes on production. On the other hand, the distinction between national and domestic concepts is not merely statistical. "Domestic" refers to the income produced within a country using both domestic and foreign factors of production. "National" refers to the income produced by citizens of a country, irrespective of whether the income is produced domestically or abroad.

The second part of the table decomposes net national income into its components. The largest component is compensation to employees, which unambiguously belongs to labor income. The measure of compensation used by the BEA includes wages and salaries, commissions, bonuses, tips, severance payments, supplements, in-kind benefits, employer contributions to pensions and social insurance, and exercised "non-qualified" stock options (that is, options on which a taxpayer pays ordinary income taxes on the gain between their grant price and exercise price). Corporate profits, rentals, interest income, business transfers, and the surplus of government enterprises unambiguously are compensation to capital.[2]

This leaves us with the choice of how to allocate taxes (less subsidies) on production and the income of proprietors. Taxes on production include indirect taxes such as sales and excise taxes, property taxes, motor vehicle licensing fees, and import duties. They do not include direct income taxes, which are included either in corporate profits or in compensation to employees. Examples of subsidies are those that accrue to farmers and local governments. A reasonable approach is to allocate taxes less subsidies proportionally between labor and capital. This avoids tilting the balance between unambiguous labor and capital income.[3]

Proprietors' income includes both labor and capital components. As an example, consider an Uber driver. The Internal Revenue Service observes only gross receipts less expenses occurred while driving, not the split of income between labor and capital. The driver earns labor income in compensation for time spent driving passengers to destinations. However, the driver also earns capital income, because they operate their car to earn income. Thus, part of the total

[2]Appendix A discusses measurement difficulties for compensation of employees arising from equity-based compensation (Eisfeldt, Falato, and Xiaolan, 2023), for corporate profits arising from profit shifting (Guvenen, Mataloni, Rassier, and Ruhl, 2022), and for rentals arising from imputations of owner-occupied housing services. It also discusses how tax incentives may shift reported labor and capital income within the corporate sector and the treatment of corporate housing. Finally, it documents differences between my measures and the labor share measure produced by the U.S. Bureau of Labor Statistics.

[3]Allocating ambiguous income proportionally between labor and capital is equivalent to excluding it from the denominator: Labor Share = Labor Income/(Total Income − Ambiguous Income).

income of the Uber driver includes the depreciation cost of using their car and the opportunity cost of using their car instead of earning rent from leasing it to another driver or interest from investing in a financial asset.

There are several ways to handle proprietors' income. The most unsatisfactory way is to exclude it from the numerator of the labor share, because this amounts to treating proprietors' income entirely as capital income. A more satisfactory alternative is to impute the labor income of proprietors by multiplying employees' average wage with proprietors' hours worked. Another satisfactory alternative is to assume that proprietors use labor as intensively as the rest of the economy does. Considered in terms of our Uber driver example, the first alternative assumes that the hourly wage of an Uber driver equals the wage of drivers employed by driving companies in the rest of the economy, whereas the second alternative assumes that the share of labor income of the Uber driver is equal to the labor share of driving companies who employ drivers.

For my analysis of the United States, I construct three measures of the labor share. The first, called "Total: Proprietors Same Share," covers the entire economy and allocates taxes on production and proprietors' income proportionally between labor and capital. It equals compensation to employees divided by GDP less taxes on production and proprietors' income. The second measure, called "Total: Proprietors Same Wage," continues to allocate taxes on production proportionally between labor and capital but assumes equal earnings between proprietors and employees for imputing the labor income of proprietors. It equals compensation to employees divided by GDP less taxes on production, scaled by a time-varying factor that equals one plus the ratio of proprietors' to employees' labor input.[4]

The third measure is the corporate labor share, defined as compensation to employees in the corporate sector divided by corporate value added less corporate taxes on production. For the United States, the benefit of focusing on the corporate sector is that proprietors are not incorporated, and thus there is no ambiguity about how to split their income. The corporate sector accounts for roughly 50 to 60 percent of GDP. It excludes housing, government, and unincorporated businesses.

For analyses of international data, the System of National Accounts (SNA) does not have a separate entry for proprietors' income. The closest alternative is to proxy for proprietors' income with the operating surplus of private unincorporated businesses (mixed income). The caveat is that some private businesses may be paying wages to their owners, and some proprietors may be legally incorporated. I believe the corporate labor share offers a balanced alternative in terms of availability, comparability, and measurement concerns. In terms of availability,

[4] To calculate this labor share, define Total Income as Capital Income + Compensation of Employees + Proprietors' Income. Assuming that w is the return to labor for both the employees and the proprietors, we impute Proprietors' Labor Income $=$ $w \times$ Proprietors' Labor Input. Then, Labor Share $=$ (Compensation of Employees/Total Income) $\times$ (1 + Proprietors' Labor Input/Employees' Labor Input).

Karabarbounis and Neiman (2014b) compiled data for a large cross section of countries from the SNA. Focusing on the corporate sector has the advantage of holding the sectoral composition of economic activity relatively constant across countries, as the cross-country variation in industry and sectoral shares is much larger than the variation observed within a country.

2.2 The Official BLS Measure of the Labor Share

The U.S. Bureau of Labor Statistics (BLS) produces the official measure of the labor share in the United States (see `https://rb.gy/fud0l`). The BLS measure is most similar to "Total: Proprietors Same Wage," because it adjusts for proprietors' income assuming the same wage between employees and proprietors. One difference of the BLS measure is that it only covers the non-farm business sector, which accounts for roughly three-quarters of GDP as it excludes government and owner-occupied housing services.

The labor share "Total: Proprietors Same Share" is preferred to "Total: Proprietors Same Wage," because I view the assumption of equal factor shares across businesses' and proprietors' technologies as more natural than the assumption that proprietors earn the same hourly wage as employees. In fact, Hurst and Pugsley (2011) document significant non-pecuniary benefits from self-employment, so assuming equal wages has the unappealing implication that proprietors are better off than employees. By contrast, I do not see why production technologies should change upon crossing the legal boundaries that separate organized businesses from proprietorships.

There are two arguments why one might want to exclude housing from the labor share. First, owner-occupied rental income may be imputed with significant measurement error (Rognlie, 2015). Second, housing is a broadly held asset whose returns accrue also to workers, and thus the split between capital and labor commonly associated with the distribution of income does not apply to owner-occupied housing. I do not view this as a problem, because there is no presumption that laborers and capitalists are two mutually exclusive groups of households. Rather, the labor share may be a poor proxy for inequality, given that dividends and interest income may also accrue to workers. Almost all of the value added of the housing sector is capital income, so including it in the measurement decreases the labor share relative to what it would be if the housing sector were excluded.

The most common argument for excluding government is that including it biases the labor share upward, since households do not consume capital income generated from government's production. I do not find this argument compelling, because even if the government does not produce direct payments of capital income, government's compensation to employees is still informative about distribution. Further, because the government is the largest industry by value added, shifts in its size could affect the aggregate labor share. The most compelling argument for excluding government from the labor share calculation, at least for certain research purposes, is that its optimization decision is quite different from the optimization decision of the private sector. If one uses the labor share to learn about production technologies that are outcomes of private decisions, then it might be reasonable to exclude government from the measurement of the labor share.

2.3 Additional Measurement Issues

The appropriateness of any measure of the labor share will ultimately depend on the application for which it is being used. Robust scientific practice is to examine the sensitivity of the conclusions to alternative measurements and to understand where differences might arise. The discussion has already mentioned a number of different ways of measuring the labor share, such as excluding the government sector or owner-occupied housing, or different ways of dividing the proprietor's income between labor and capital. Here, I list some other choices that can arise in calculating the labor share.

National or domestic product in the denominator of the labor share? For analysis of the distribution of income across citizens of a country, the appropriate concept of income is the national one, because some citizens work or invest abroad. For analysis of production, factor supply and demand, and productivity of a country, the appropriate concept of income is the domestic one, because domestic technologies and institutions affect them. For the measurement of the U.S. labor share, this distinction is not important, as the ratio of national to domestic income is quite stable around one. I have used domestic product concepts, because they more closely correspond to industry value added concepts and are more readily available for foreign countries.

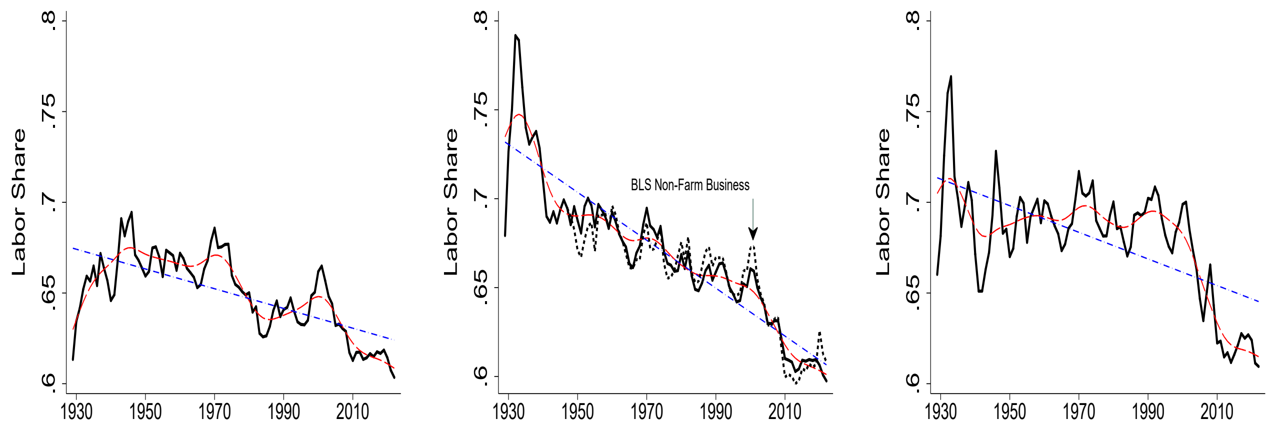
Treatment of depreciation. All measures of the labor share have gross output in the denominator, and thus include the depreciation of capital goods arising from wear, tear, and obsolescence. Aggregate depreciation rates have been increasing over time, as economies have shifted their composition of fixed assets toward higher-depreciating assets such as software and computers. Mechanically, this compositional change tends to lower the labor share.

Some research that emphasizes the distributional role of the labor share chooses to exclude depreciation from the measure of income in the denominator, because it does not represent consumption by households. From a production perspective, gross product is the more appropriate notion of income, because depreciation absorbs resources. However, depreciation is imputed by statistical agencies, and thus net product is subject to larger measurement errors than gross product. Additionally, the labor share of income net of depreciation measures the net income of capital owners relative to that of workers at a point in time. Net incomes at a point in time are not very informative about inequality outside of steady state, because capital owners' welfare is the present discounted value of consumption flows and not current consumption. For perspectives on depreciation and the labor share, useful starting points are Karabarbounis and Neiman (2014a), Piketty (2014), and Rognlie (2015).

Treatment of investments. Some measures of the labor share exclude part of or the entire investment expenditure of an economy from GDP in the denominator when calculating the labor share. There are two ways to rationalize this practice. First, investment expenditures are not consumed, and therefore this alternative measure is more directly related to inequality between owners of labor and owners of capital. Second, this alternative measure is more robust to measurement error in investments when evaluating the drivers of the labor share.

This practice causes confusion, so let me discuss with an example. The economy produces 100 dollars of output. On the expenditure side, households purchase and consume 80 dollars of goods and services, and corporations purchase 20 dollars of capital goods to use in future production. On the income side, corporations pay 60 dollars to workers and earn 40 dollars of (accounting) profits. Out of these 40 dollars, 20 are paid to households in the form of dividends, and 20 are used to purchase capital goods. The standard measure of the labor share is 0.6. An argument for excluding investment from income, thus increasing the labor share to 0.75, is that we allocate the remaining 80 dollars between labor income (the "laborers") and dividends (the "capitalists"), which are both are consumed. I do not find this argument persuasive. The 20 dollars of investment produce future returns to owners of capital. It is not economically reasonable to assume that changes in corporate valuations do not matter for welfare. For example, capitalists optimally postpone consumption when the productivity of investment or the demand for goods from the rest of the world is higher today relative to the future. Capitalists' welfare is the present discounted value of consumption flows, not consumption in current period.

I recognize the difficulty of measuring some forms of investments, such as intellectual property products, especially in the early years of the NIPA. But there are measurement difficulties with other NIPA items, such as proprietors' labor input and income. Further, the labor share that excludes investment is not informative about aggregate production, unless one thinks that corporate financial and payout policies have much to do with production. Returning to our example, if corporations increased their dividend payout to 30 dollars and reduced investment to 10 dollars, the labor share excluding investment would increase, but production would not change. Taking measurement at face value, the BEA appropriately treats expenses on intellectual property products as part of output to the extent that these expenses are not consumed within a period and produce future returns to their owners. To the extent that these investments augment capital owned by businesses, the BEA appropriately treats the income generated by this capital stock as capital income. For alternative views on these issues, useful starting points include Atkeson (2020), Koh, Santaeulalia-Llopis, and Zheng (2020), and Barro (2021). Appendix A discusses how unmeasured intangibles and durable services affect the measurement of the labor share.



(a) Total: Proprietors Same Share (b) Total: Proprietors Same Wage (c) Corporate

Figure 1: Labor Share in the United States, 1929–2022

Notes: Solid black line is the labor share measure, dotted blue line is the linear trend of each measure, and red long-dashed line is the Hodrick-Prescott trend of each measure with a smoothing parameter of 100. The short-dashed black line is the BLS measure of the labor share for the non-farm business sector, scaled to equal "Total: Proprietors Same Wage" in the first year of its observation.

3 Observations on the Labor Share Decline

This section begins with analyses of the U.S. labor share and then proceeds with analyses for a large cross section of other countries.

3.1 United States

Aggregate labor shares. Figure 1 presents the evolution of the three labor share series in the United States between 1929 and 2022.[5] For each labor share series, I plot the linear trend with the dotted blue line and, to visualize nonlinearities, the Hodrick-Prescott trend with the red long-dashed line. Common issues in the labor share literature are that starting and ending points matter quite a bit for estimating trends and trends appear to be nonlinear, especially in samples that extend to years before World War II. For these reasons, the upper panel of Table 2 presents summary statistics during four different subperiods, a subperiod that covers the years before World War II and three subperiods after World War II, all of which are roughly the same length.

Beginning with the left panel of Figure 1, I notice that the labor share measure "Total: Proprietors Same Share" increases during roughly the first 15 years of the sample and then declines between the end of World War II and the end of the sample. Table 2 shows that the labor share increases by 3 percentage points per decade between 1929 and 1945 and then

[5]Appendix B presents three additional measures of the labor share, that either exclude housing, or exclude the government, or add government's imputed capital income to GDP.

Table 2: Trends of the U.S. Labor Share

		Total: Same Share	Total: Same Wage	Corporate
Subperiod	1929-1945	3.0	−3.9	−3.2
(percentage points	1946-1970	−0.2	−0.9	−0.1
per decade)	1971-1995	−1.6	−1.1	−0.1
	1996-2022	−1.8	−2.3	−3.3
Period: 1929-2022	Linear Trend	−5.1	−12.5	−6.8
(percentage points)	HP(100) Trend	−2.1	−13.4	−9.0
	MA(5) Trend	−2.1	−11.7	−7.4
Period: 1946-2022	Linear Trend	−6.3	−9.4	−7.4
(percentage points)	HP(100) Trend	−6.6	−9.1	−7.0
	MA(5) Trend	−7.3	−9.0	−8.2

Notes: In the first panel, entries are percentage points changes per decade in different measures of the labor share. The estimates are from separate regressions of labor share measures on a linear trend within each subperiod. In the second panel for the period between 1929 and 2022, entries are estimates of the trend of each labor share measure using a linear trend, a Hodrick-Prescott trend with a smoothing parameter of 100, and a 5-year moving average. The third panel repeats these estimates for the period between 1946 and 2022.

declines by 0.2 percentage point per decade between 1946 and 1970, by 1.6 percentage points per decade between 1971 and 1995, and by 1.8 percentage points per decade between 1996 and 2022.

The second panel of Figure 1 plots my series "Total: Proprietors Same Wage" alongside the BLS official series. My series tracks the BLS series extremely well, with a correlation of 0.96. The labor share "Total: Proprietors Same Wage" exhibits the largest decline among all measures. The upper panel of Table 2 shows that the main difference with the other measures is in the first subperiod, when the labor share declines by 3.9 percentage points. I discuss measurement difficulties with proprietors' labor input in Appendix A, because they might be partly responsible for the large decline in the first subperiod.

In the third panel of Figure 1, we see that the corporate labor share behaves quite differently than the other two measures. As the upper panel of Table 2 shows, the corporate labor share declines substantially before World War II. Further, the corporate labor share is more stable than the other measures in the first decades after the World War II and declines by more than the other measures during the last subperiod of the sample.

The lower two panels of Table 2 summarize trends of the labor share for the whole sample (1929 to 2022) and the sample after World War II (1946 to 2022). I use three different ways to estimate the trend: a linear trend, a Hodrick-Prescott trend with a smoothing parameter of 100, and a 5-year moving average. For "Total: Proprietors Same Share," the linear trend shows a decline of 5.1 percentage points in the whole sample. The nonlinear trends display a smaller decline at 2.1 percentage points. The sensitivity to applying a linear trend disappears in the sample after World War II, with the labor share declining between 6 and 7 percentage points. The "Total: Proprietors Same Wage" measure exhibits the largest changes among all measures, declining by roughly 12 percentage points in the whole sample and by 9 percentage points in the sample after the World War II. The corporate labor share declines by roughly 8 percentage points beginning in both samples.

In sum, all labor share series experience declines, although to a varying degree and sometimes at different times. A baseline estimate averages the trends from the "Total: Proprietors Same Share" and the corporate labor share measure, which are my preferred measures, to conclude that the labor share declined by 5.4 percentage points when starting in 1929 and by 7.1 percentage points when starting in 1946. However, the two measures behave quite differently. Most of the difference is compositional, because the corporate sector has a higher labor share and its contribution to GDP increased by almost 10 percentage points between the beginning of the sample and 1970. The recent decline of the labor share is more similar between these two measures.

Industry labor shares. The integrated BLS-BEA industry production accounts (U.S. KLEMS) combine output and intermediate input data from the BEA industry accounts with measures of factor inputs and compensations from the BLS productivity program. Compensation to employees in the integrated accounts adjusts the original BEA compensation to employees data in order to account for proprietors' labor income (Fleck, Rosenthal, Russell, Strassner, and Usher, 2014). Following the BLS practice, the adjustment assumes equal wages among employees and proprietors conditional on demographics.

Value added at the industry level from the BLS-BEA integrated accounts differs significantly from value added in the BEA's industry accounts, with gaps ranging from roughly -20 to 40 percent. Given these differences, I consider two labor share measures at the industry level. Both use compensation from the integrated BEA-BLS accounts in the numerator, because it adds proprietors' labor income. The first one, which I call "BLS Industry," divides compensation to employees by value added for each industry from the BEA-BLS integrated accounts. The second measure, which I call "BEA Industry," instead uses the levels of value added and taxes on production from the BEA industry accounts to impute value added net of taxes on production in the integrated accounts.

Table 3 presents summary statistics across U.S. industries for the two measures of the labor share. BLS Industry is used in the first three columns, and BEA Industry is used in the remaining three columns. The first and fourth columns show the value added share of each industry in total value added, averaged over the entire sample. The value added shares are very similar across the two measures.

The second and fifth columns present the average labor share of each industry over the entire sample. The BEA Industry labor share allocates taxes on production proportionally between

Table 3: Statistics of U.S. Industries, 1987-2021

	BLS Industry			BEA Industry		
	Value Added	Labor Share		Value Added	Labor Share	
Industry	Share	Level	Trend	Share	Level	Trend
Agriculture	1.2	63.8	2.2	1.3	66.5	5.8
Mining, oil	1.4	33.5	−13.9	1.4	36.7	−15.1
Utilities	1.7	28.6	1.1	1.6	32.2	1.5
Construction	4.1	83.2	−8.7	4.4	84.8	−9.1
Manufacturing	13.8	55.9	−11.6	14.5	57.2	−11.6
Wholesale	4.7	65.9	−14.3	5.0	67.2	−16.7
Retail	5.1	78.2	−7.1	5.4	79.4	−5.1
Transportation	2.9	70.6	−8.4	3.0	72.6	−9.1
Information	4.6	42.8	−7.3	4.9	43.7	−8.3
Finance	6.8	58.6	−3.1	7.2	59.9	−3.1
Real estate	12.5	7.8	−1.0	11.9	8.9	−1.1
Professional, business	6.4	81.7	−6.1	6.8	82.5	−6.5
Management	1.6	87.4	−1.0	1.7	89.8	−1.6
Administrative	2.6	83.0	−5.2	2.8	83.7	−5.5
Education	1.0	85.1	−6.4	1.1	88.3	−7.1
Health	6.5	89.2	−5.1	6.9	90.6	−5.6
Arts, entertainment	0.9	81.3	1.4	0.9	83.6	1.8
Accommodation, food	2.4	74.6	−3.6	2.6	75.6	−3.6
Other services	2.3	82.0	8.0	2.5	83.7	8.5
Government	17.3	61.4	−7.1	14.1	81.2	−9.4
Median	3.5	72.6	−5.7	3.7	77.5	−5.6
Average	5.0	65.7	−4.9	5.0	68.4	−5.0
Weighted Average		59.4	−6.1		64.2	−6.6

Notes: Value added share and labor share level are averages by industry between 1987 and 2021. Labor share trend is the change of the average labor share in the period between 1987 and 2003 and the average labor share in the period between 2005 and 2021. For methodology, details, and additional discussion, see Appendix A.

labor and capital income, and so it is higher than the BLS Industry labor share. Industries with low labor share include mining and oil, utilities, and real estate. High labor share industries are construction and services such as management, health, and education. The patterns are very similar across measures, with the main exception being the government. The value added share of the government under the BLS measure is significantly larger than the value added share under the BEA measure, because the integrated accounts impute capital income for the government that exceeds depreciation. For the same reason, the labor share of the government under the BLS measure is significantly lower than the labor share under the BEA measure.

The third and sixth columns present the trend of the labor share by industry. Given the relatively short sample, and the fact that choice of endpoints can clearly make a difference, as demonstrated in the earlier discussion, I calculate the trend as the difference in the average labor share between the second half and the first half of the sample. The trends are similar between the two labor share measures. Out of 20 industries, only agriculture, utilities, arts and entertainment, and other services exhibit increases in their labor shares, whereas the remaining 16 industries exhibit declines of their labor shares. The median decline is around 5 percentage points, and the average decline weighted by industry share in value added is around 6 percentage points. The magnitude of these declines matches well with the 5.5 percentage points decline after 1987 in the measure "Total: Proprietors Same Wage" for the aggregate economy, which is closest to the official BLS measure of the labor share and thus the most comparable measure to the averaged industry measure.

Given the significant labor share declines observed for the great majority of industries, it is not surprising that the decline of the aggregate labor share reflects within-industry declines, rather than a reallocation of economic activity from high to low labor share industries. A formal shift-share decomposition shows that roughly 100 percent of the decline of the aggregate labor share is because of the within-industry component, and not because of shifts between industries.[6]

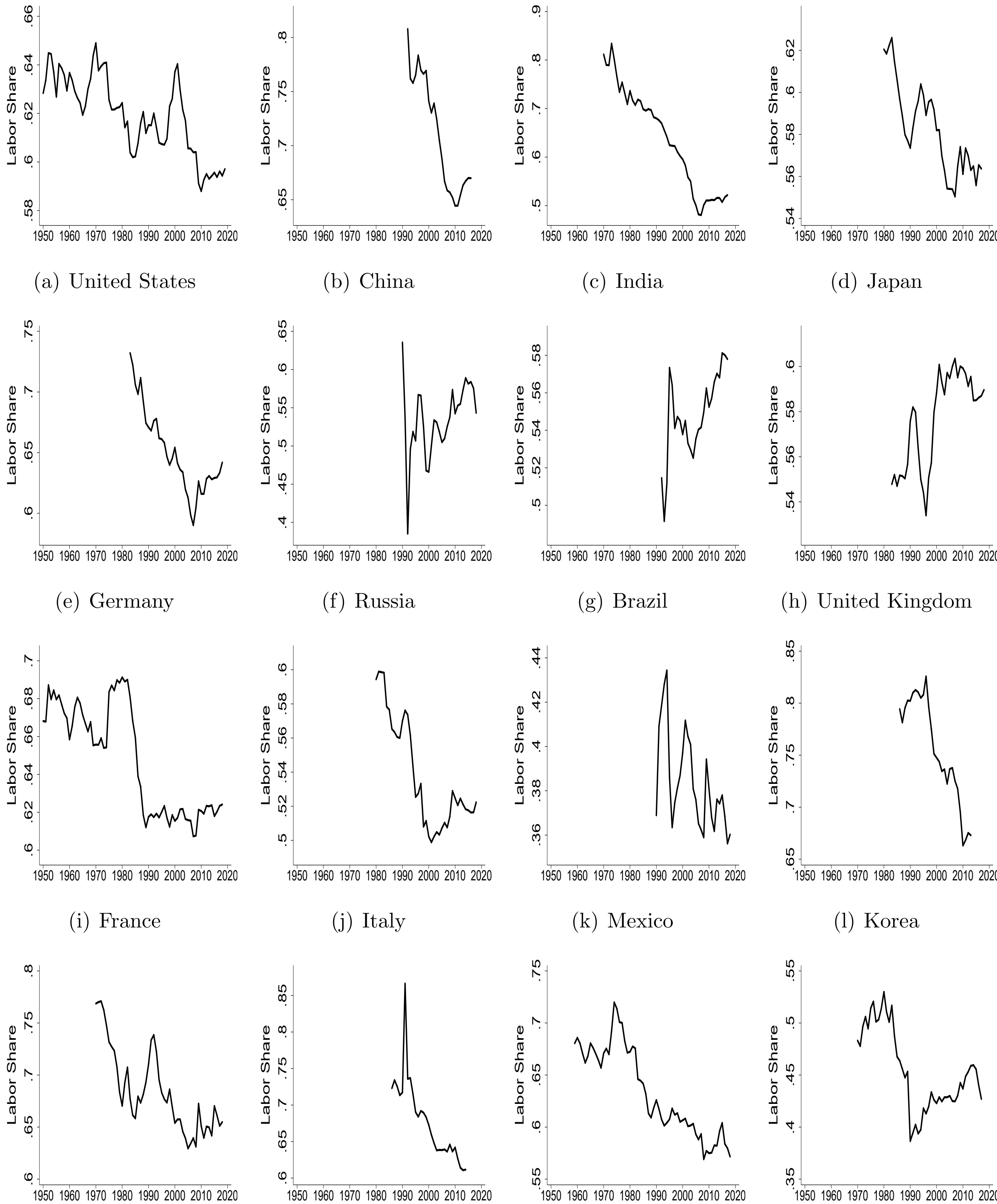
3.2 World

To calculate the labor share for a range of countries, I use data from the Penn World Tables (Feenstra, Inklaar, and Timmer, 2015, PWT version 10.01). This database is compiled from national accounts from 1950 onward with information on output, inputs, productivity, and labor shares. My main series is the labor share that allocates mixed income and taxes on production proportionally between labor and capital, thus resembling the "Total: Proprietors Same Share" measure (see Appendix A for more details).

Figure 2 presents the labor share of the 16 largest economies of the world based on 2015 GDP. Out of these, we can see 13 economies whose labor share has declined. The pattern of these declines is not related in any obvious way to geography, level of the labor share, or level of development. We observe labor share declines in advanced Anglo-Saxon economies (Australia, Canada, and United States), advanced European economies (France, Germany, Italy, and Spain), advanced Asian economies (Japan and Korea), and emerging markets (China, India, Mexico, and Thailand). The only countries with increases are Brazil, the United Kingdom, and Russia.

Table 4 presents the global patterns of the labor share decline more systematically. For each country and subperiod, I estimate the trend of the labor share using a linear trend, the change in the Hodrick-Prescott trend, and the changes in 5-year moving averages. Each row of the table presents statistics of the distribution of trends using the various methods.

[6] This result qualitatively confirms previous analyses at the industry level such as Elsby, Hobijn, and Sahin (2013) for the United States and Karabarbounis and Neiman (2014b) for the world. I discuss quantitative differences in Appendix A.



(a) United States (b) China (c) India (d) Japan

(e) Germany (f) Russia (g) Brazil (h) United Kingdom

(i) France (j) Italy (k) Mexico (l) Korea

(m) Canada (n) Spain (o) Australia (p) Thailand

Figure 2: Labor Share around the World

Table 4: Trends of the World Labor Share

Period: 1970-2019	Linear Trend	HP(100) Trend	MA(5) Trend	Countries	% GDP
25 percentile	−14.1	−13.7	−13.0		
Median	−10.5	−8.2	−8.9		
75 percentile	−7.3	−4.1	−4.5		
Average	−15.1	−13.2	−12.6		
Weighted Average	−8.7	−7.8	−7.7	16	39
Period: 1980-2019	**Linear Trend**	**HP(100) Trend**	**MA(5) Trend**	**Countries**	**% GDP**
25 percentile	−11.5	−9.6	−9.8		
Median	−5.9	−6.8	−7.1		
75 percentile	−2.2	−2.4	−2.4		
Average	−7.4	−7.3	−7.2		
Weighted Average	−6.2	−5.9	−5.9	27	52
Period: 1995-2019	**Linear Trend**	**HP(100) Trend**	**MA(5) Trend**	**Countries**	**% GDP**
25 percentile	−6.0	−4.8	−4.9		
Median	−2.4	−2.6	−2.6		
75 percentile	1.6	0.8	0.9		
Average	−3.7	−3.6	−3.5		
Weighted Average	−3.2	−2.6	−2.4	57	85

Notes: Entries are the trend of the labor share using a linear trend, a Hodrick-Prescott trend with a smoothing parameter of 100, and a 5-year moving average. The last two columns present the number of countries and their share of world GDP in each sample period.

In the top panel, the sample between 1970 and 2019 covers 16 countries, which account for 39 percent of world GDP. Across the various detrending methods, I find that the median country experienced a decline of roughly 8 to 11 percentage points since 1970, with an interquartile range between 4 and 13 percentage points. Weighted by GDP, the average decline is around 8 percentage points.

For the middle panel, the period covering 1980 to 2019 has 27 countries, which account for roughly half of world's GDP. The median country experienced a decline between 6 and 7 percentage points. Weighted by GDP, the average decline is 5.9 percentage points. For the period between 1995 and 2019, we have 57 countries, which account for 85 percent of world GDP. In this shorter sample, both the median and the average country (weighted by GDP) country experienced a decline of around 2 to 3 percentage points.

4 Causes of the Labor Share Decline

While the decline in the labor share varies in magnitude and timing across countries and industries, the systematic pattern of a decline suggests that common factors may underlie the decline. This often overlooked observation restricts significantly the freedom of researchers to propose theories that account for the decline of the labor share. It may well be that idiosyncratic factors have higher explanatory power than common factors in some countries or industries. Nonetheless, it is unlikely that countries as different as India and the United States or as Korea and France all experienced changes in the labor share for unrelated reasons. Similarly, the systematic pattern of a decline across industries also argues against explanations based on compositional factors.

I discuss the factors that might have caused the decline of the labor share using the profit maximization problem of a firm that operates in partial equilibrium and chooses prices and quantities of output and inputs. The production function describes how output y is produced with physical capital k and labor ℓ. It features constant returns to scale, a constant elasticity of substitution, σ, between the two inputs and a distribution factor, α, which weights the importance of capital in production. It also features technology A_k, which augments capital, and technology A_ℓ, which augments labor. The firm faces product demand $p(y)$ and labor supply $\ell(w)$, and internalizes that its price p and its wage w depend on output and labor. The firm takes as given the (user) cost of capital R.

This leads to the following solution for the labor share of income:

$$s_\ell = \frac{w\ell}{py} = \left(\frac{1}{\mu\theta}\right)\left(1 - \alpha^\sigma \left(\frac{A_k}{\mu R}\right)^{\sigma-1}\right),$$

where $\mu \geq 1$ is the markup of price over marginal cost of production, which distorts all input choices, and $\theta \geq 1$ is the markup of the marginal revenue product of labor over the wage, which distorts only labor. Given an elasticity of substitution σ and a distribution factor α, the labor share depends on four factors: (i) capital-augmenting technology A_k; (ii) cost of capital R; (iii) product market markup μ; and (iv) labor market markup θ. The labor share does not depend on labor-augmenting technology A_ℓ and the wage w. Appendix C explains the reasoning, provides the derivations, considers the case without constant returns to scale, and discusses how this solution might also apply in general equilibrium.

4.1 Technology

Perhaps the most intuitive explanation for the decline of the labor share is that capital-augmenting technology has increased over time. Using our labor share solution, we see that this requires an increase in A_k and $\sigma > 1$. The economics of why parameter σ affects the relationship between the labor share and capital-augmenting technology are fairly straightforward. Factors are substitutes when $\sigma > 1$, and thus, following an increase in capital-augmenting technology, production requires more capital relative to labor to accomplish the same level of output. In this case, the labor share decreases.[7]

Despite the appealing economics of how capital-augmenting technology might have affected the labor share, this is also the most irrefutable explanation of the labor share decline. In order to rationalize the decline of the labor share, one could claim that A_k decreases over time and factors are complements, $\sigma < 1$. While this case is nonintuitive because we suspect that technology is improving over time, there is little hope to differentiate between these two explanations. The fundamental problem is that factor-augmenting technologies are not easy to conceptualize and measure. For example, are robots physical capital, or do they augment high-skilled labor's technology? Do improvements in an organization's management increase or decrease the productivity of capital relative to labor?

The development of task-based models of the labor market has allowed economists to think more concretely about the role of technology for factor shares. These models emphasize the conceptual difference between tasks, which produce services of output, and skills, which are workers' capabilities for performing tasks. The key assumption is that some types of services can be produced with either capital or labor, whereas other services are produced only with labor. Automation decreases the number of tasks which are produced only with labor, enabling capital to substitute for labor in a larger share of tasks.

The economics of automation are similar to an increase in the distribution parameter α in the production function of the firm. As our labor share solution shows, the increase in α unambiguously reduces the labor share, for any value of σ. In fact, some researchers use the labor share as a proxy for the displacement of tasks due to automation (Acemoglu and Restrepo, 2022). While the economics are similar, task-based frameworks are empirically more appealing than frameworks with factor-augmenting technologies because they are easier to refute using proxies for automation, such as the adoption of robots and the share of routine jobs. One difference between factor-augmenting technology and task-based frameworks is that in the former capital-augmenting technology increases wages, whereas in the latter automation could displace labor demand and lower wages (Acemolgu and Autor, 2011).

4.2 Cost of Capital

A closely related explanation for the decline of the labor share is that the cost of capital R has decreased over time and $\sigma > 1$. A decrease in the cost of capital relative to that of labor unambiguously increases demand for capital relative to that of labor. If the increase in the demand for capital is sufficiently strong to offset the decline in its cost, that is when $\sigma > 1$, payments to capital Rk increase relative to payments to labor $w\ell$, and the labor share declines.

[7] The elasticity of substitution is the percent increase in the capital-labor ratio k/ℓ in response to a one percent increase in relative prices w/R (Robinson, 1933). To give an example, if $\sigma = 0$ (Leontief production), then $A_k k = A_\ell \ell$, so an increase in A_k necessitates a decrease in k/ℓ and, for given R/w, generates an increase in the labor share.

Thus, the economics of a decrease in the cost of capital are similar to the economics of capital-augmenting technology. Despite this similarity, explanations of the decline of the labor share based on a falling cost of capital are more empirically appealing. Unlike capital-augmenting technology which is difficult to conceptualize and measure, we have a fairly good understanding of the determinants of the cost of capital and an easier time measuring its components.

What determines the cost of capital? Although a few firms rent their physical capital, most firms own their physical capital, and so by "cost of capital" economists mean the opportunity cost of using capital in the production process. To measure opportunity cost in this situation, it is useful to think about how a firm uses a unit of capital in production and, had it not used this unit, what it would have done with the freed-up resources (Hall and Jorgenson, 1967). First, the firm could sell physical capital and invest in financial assets. Second, the firm incurs the cost of physical damage to capital and gains or losses from changes in the price of capital. Third, the firm pays sales taxes to purchase capital and further taxes on the income generated by capital. Fourth, the price of capital goods that the firm purchases may change over time, relative to price of its output. Fifth, the firm may be uncertain about its demand and productivity, and so it needs to be compensated for using physical capital instead of investing in safe assets. Finally, the firm may incur costs of adjusting its capital stock and of raising financing to purchase capital.

Several components of the cost of capital have exhibited secular declines over time. The price of capital goods has declined relative to the price of consumption goods both in the United States (Greenwood, Hercowitz, and Krusell, 1997) and for various other countries (Karabarbounis and Neiman, 2014b). For example, according to the BEA industry accounts, the (quality-adjusted) nominal price of computers and electronics declined by 52 percent between 2001 and 2021, and the price of motor vehicles increased by only 15 percent. By contrast, the price of food products increased by 59 percent, the price of housing services by 72 percent, and the price of educational services by 75 percent. The decline of the relative price of capital goods reflects technological factors that favor faster productivity growth in investment- than in consumption-producing sectors and globalization, which decreased the cost of importing capital goods.

Up through 2021, real interest rates also generally declined in the past 40 years around the world. This decline reflects factors such as low aggregate productivity growth, the aging of the population, and credit market liberalization, as discussed by Henry (2003), Bernanke (2005), Eggertsson, Mehrotra, and Robbins (2019), and Mian, Straub, and Sufi (2021). Corporate income taxes also decreased for several countries. Kaymak and Schott (2023) connect the decline of corporate income taxes to the falling labor share.

The argument that the fall in the cost of capital caused a decline of the labor share requires an elasticity of substitution between capital and labor that is higher than one. It is fair to say that this elasticity is one of the most controversial parameters in economics. Earlier research concluded mostly that the elasticity of substitution is lower than one (Chirinko, 2008), but some recent research has argued that it is higher than one (Karabarbounis and Neiman, 2014b; Hubmer, 2023).

There are two reasons to favor a high estimate of the elasticity of substitution. First, methodologies estimating low elasticities typically use wage data as an independent variable and omit variables correlated with wages in the residual of their regressions (as explored at greater length in Appendix D). Second, low elasticities of substitution at the establishment level are not very informative about the aggregate elasticity of substitution in the long run. When the cost of capital decreases, new firms may enter with technologies that are more capital intensive than the technologies used by incumbents. Or, among incumbents, a larger share of economic activity may be concentrated at firms with relatively high capital shares. Such substitution patterns may cross local, industry, or even national boundaries, and thus it is not feasible to estimate the aggregate elasticity of substitution using micro-level data alone or variation within an industry or geographic area. To draw a parallel with the labor supply literature, aggregation theory demonstrates that individual-level estimates of the elasticity of labor supply may not be very informative about the economy's labor response to changes in productivity and taxes.

This is an often misunderstood point, so consider a concrete example that illustrates why firm-level technologies may not be useful in understanding the aggregate labor share. Consider an industry populated by two perfectly competitive firms. The labor-intensive firm produces one unit of output with one unit of labor. The capital-intensive firm produces A_k units of output with one unit of capital. By construction, neither firm can substitute between capital and labor. However, to the extent that consumers perceive the two firms as substitutes, the aggregate labor share decreases when the technology A_k of the capital-intensive firm increases because this firm gains market share. Thus, the economy aggregates *as if* the elasticity of substitution in production is higher than one.

4.3 Product Markets

Changes in product market structure are captured by the markup μ in our labor share solution. An increase in the markup of price over marginal cost causes a decline of the labor share. The economics are that firms exploit an increase in product market power by increasing their prices and lowering their demand for inputs, thus leaving labor with a lower share of total income.

Before discussing the evidence for changes in product market markups, it is useful to clarify some terminology on income shares in relation to the measurements discussed earlier. In a perfectly competitive economy with constant returns to scale, labor and capital exhaust all income. With product and labor market imperfections or with decreasing returns to scale, firms make economic profits. In these cases, income is split into three components: the labor share, the capital share, and the profit share. What I called "compensation to capital" in the earlier discussion consists of both opportunity costs of using capital in production and economic profits. To be clear, the line labeled "Corporate Profits" in Table 1 is accounting profits and should not be confused with economic profits, a term that refers to revenues that exceed the sum of explicit and implicit costs of production.

What evidence do we have that markups have increased? De Loecker, Eeckhout, and Unger (2020) observe that the cost of goods sold has fallen dramatically relative to revenues during the past 40 years, and thus conclude that markups increased from roughly 20 percent to 60 percent. The increase in markups is driven by the small subset of firms at the top of the markup distribution and by a reallocation of economic activity toward high markup firms. How compelling is their evidence? My personal view is that product market markups have indeed increased over time, and this increase has had important consequences for the labor share and other macroeconomic outcomes. However, the magnitude of rising markups in this particular study seems overstated.[8]

Other evidence for increasing aggregate markups comes from the observation that aggregate investment rates and capital-to-output ratios are stable despite a decline of the labor share. If the decline of the labor share is not offset by an equal increase in the capital share, then economic profits must have risen.[9] Conversely, if increasing markups are the sole determinant of the labor share decline, then we would observe a decline of the capital share that is proportional to the decline of the labor share. Karabarbounis and Neiman (2014b) use this logic to attribute around half of the decline of the labor share to increasing markups, with the other half attributed to the decline of the relative price of capital goods. They calculate that markups increased by roughly 6 percentage points at the global level during the last four decades. Barkai (2020) also used estimates of the capital share to infer markups and finds that markups increased by roughly 17 percentage points in the United States. While these methods appear intuitive, calculating capital shares is complicated by factors such as unmeasured investments, adjustment costs to changing capital, and risk in capital accumulation (Karabarbounis and Neiman, 2019).

Another piece of evidence concerns the role of "superstar" firms (Autor, Dorn, Katz, Patterson, and Van Reenen, 2020; Kehrig and Vincent, 2021). The evidence shows that an increasing share of economic activity has been concentrated at larger firms with lower labor shares. This compositional effect generates a decline of the aggregate labor share. While it is tempting to do so, we should not use this evidence to conclude that product markets are becoming more

[8]For a critical evaluation of the evidence on product-market markups in this journal, see Basu (2019). Appendix D in this paper summarizes my critique of De Loecker, Eeckhout, and Unger (2020). For example, the Compustat data used in their study cover only about 30 percent of economic activity. Also, those data include only firm sales, not prices and quantities of goods, and do not allow for a clean separation of fixed from variable costs.

[9]We should not necessarily equate economic profits to markups, because economic profits also increase when returns to scale decrease. A stable profit share is consistent with increasing markups if returns to scale also increase (for example, because of increasing fixed costs). As I show in Appendix C, the distinction between profits and markups is important for evaluating the dynamic efficiency of an economy's capital accumulation.

imperfect over time. Industry concentration is an outcome and not a primitive cause. In fact, in the simple example of the two firms, which I sketched before, markets are perfectly competitive, yet a technological change that favors larger and capital-intensive firms increases product market concentration and reduces the labor share. The industrial organization literature has identified several channels by which concentration and market power may be either positively or negatively correlated (Syverson, 2019).

4.4 Labor Markets

Changes in labor market structure are captured by the markup θ in our labor share solution. An increase in the labor market markup causes a decline of the labor share. The economics are that firms exploit an increase in their labor market power by lowering their wages and demand for labor, thus leaving labor with a lower share of total income.

How should we think about the labor market markup? I note that the framework applies to any distortion on the labor side as long it augments the perceived cost of labor, which equals $(1+\theta)w\ell$, but it does not accrue to labor in the form of compensation, which is $w\ell$. Examples of labor distortions that affect the division of income are monopsony in which firms internalize workers' labor supply, oligopsony in which firms strategically interact in local labor markets, and wage bargaining between firms and workers. Some of these factors may also indirectly affect the labor share by limiting technology adoption and automation. Payroll taxes are an example of a distortion that does not affect the measured division of income, because they are included in compensation to employees. Another example is the monopoly union model, in which firms are price takers in labor markets but workers charge a markup that increases the wage above the opportunity cost of working. These distortions or rents are isomorphic to a change in the preference of workers to supply labor, in the sense that they affect the levels of compensation to employees and output, but not the ratio of compensation to employees to output.

What evidence do we have that labor market markups have contributed to the decline of the labor share? One good example is the New Deal policies during the Great Depression, which increased the bargaining power of workers and, as some series in Figure 1 show, coincided with an increase in the labor share. A second example is the Hartz reforms in Germany during the 2000s, which reduced the bargaining power of workers and accelerated the decline of the labor share before the Great Recession, as Figure 2 shows. A third example is the worldwide decline of the share of employees with the right to bargain, which has declined by roughly 7 percentage points for the average country since the early 2000s (according to OECD data). While it seems plausible to attribute the decline of the labor share to changes in collective bargaining institutions, the evidence is inconclusive. The labor share has also declined in regions with high and relatively stable share of employees with the right to bargain, such as Austria, Belgium, countries in southern Europe, and countries in Scandinavia. For some other evidence on worker's bargaining power and the labor share, see Blanchard and Giavazzi (2003) and Elsby, Hobijn, and Sahin (2013).

In terms of labor market policies, it might be tempting to attribute the decline of the labor share to declines of the minimum wage, because a higher minimum wage removes labor market power from firms if markets are monopsonistic. A first read of the evidence is also inconclusive. According to OECD data, in the past two decades, Australia, France, and the United States have experienced declines of their minimum wage relative to their median or average wage. However, Canada, Korea, and Spain have experienced increases. Yet, as shown in Figure 2, all six countries experienced declines of the labor share, although to varying degrees and at different times.

Recent work uses administrative datasets at the establishment level to infer labor market power and concludes that labor market power is decreasing over time. Examples include Berger, Herkenhoff, and Mongey (2022) for the U.S. non-farm business sector, Yeh, Macaluso, and Hershbein (2022) for the U.S. manufacturing sector, and Brooks, Kaboski, Li, and Qian (2021) for the manufacturing sector in China and India. This evidence is more compelling in my opinion, as one would reasonably expect labor to become increasingly mobile over time for various reasons. Increased labor mobility can be attributed to technological changes such as the internet, which decreased the cost of searching for jobs, to socio-economic changes such as the decline of marriage and fertility rates, or, more recently, to work from home arrangements.

4.5 Globalization

Globalization refers to the increase in the flow of goods, services, and financial assets across national borders during the last half-century or so. It is a multidimensional process and thus might affect the labor share in a number of ways.

Globalization, outsourcing, and financial integration cannot have contributed to the decline of the labor share through changes in the distribution of economic activity across countries. After all, many different countries, ranging from advanced economies to emerging markets, and many different industries, ranging from manufacturing to non-traded sectors, have experienced declines of their labor share. If we think of emerging markets as relatively labor-abundant economies opening up to trade, one might predict a decline of the labor share in advanced economies due to a reallocation of economic activity away from labor-intensive sectors in advanced economies. However, this mechanism would counterfactually predict an increase in the labor share of emerging markets. Similarly, as the world removes restrictions on capital mobility, we expect the cost of capital to converge across countries. While this mechanism rationalizes the decrease in the labor share of emerging markets, it also counterfactually predicts an increase in the labor share of advanced economies.

Globalization might affect the labor share in other ways. In capital markets, globalization lowers transaction costs on financial assets and trade costs on imported capital goods, contributing to declines of the cost of capital for all countries. In production, globalization lowers trade costs of imported intermediate inputs for all countries. Standard economic models predict that lower prices of imported intermediate inputs cause a decline of the labor share if labor is more substitutable to these inputs than capital is (see Appendix C). But many imported goods are capital goods, so it is not obvious if labor is more substitutable than domestic capital goods to imported capital goods. Globalization affects the structure of product markets, because it allows consumers to access a larger variety of imported goods and it pressures less productive domestic firms to exit. Globalization also affects technology adoption through foreign direct investments.

Overall, my view is that the role of globalization with regard to the falling labor share remains an open question, as we do not yet have a framework that allows us to discriminate between all these possibilities while accounting for the observed patterns of the labor share across different countries and industries.

5 Implications of the Labor Share Decline

While some explanations, such as technological change and changes in product markets, appear more promising than others, it is fair to say that there is no strong consensus yet about the deeper causes of the labor share decline. With this caveat in mind, I organize the discussion of the implications of the labor share decline in three themes: what we learn about economic models, what we learn about aggregate welfare, and what the distributional consequences are.

5.1 Economic Models

For a long time, economists have resisted giving up on models that generate constant macroeconomic ratios along the "balanced growth" path. Balanced growth is a property of a dynamic economic model in which variables eventually grow at a constant rate. For example, in a standard neoclassical growth model with exogenous growth of technology and population, output, capital, consumption, and investment grow at the exogenous growth rate of technology and population, labor grows at the population growth rate, and hours per worker are constant. Thus, the labor share is constant.

The decline of the labor share poses a challenge to models designed to be consistent with constant macroeconomic ratios along the balanced growth path. There are three ways to proceed. First, in certain settings it may be reasonable to ignore the problem, if the structural factors causing the decline of the labor share have nothing to do with the research question. This option is attractive, because models with non-balanced growth are complicated and sometimes nonintuitive. Second, a researcher might maintain key assumptions that allow the model to be consistent with constant ratios and balanced growth in the long run, but allow the economy to deviate from this path at times because of transitory changes. The third option is to stop resisting and give up the assumptions that generate constant ratios and balanced growth in the long run. For example, a researcher could relax the assumption of an aggregate production function with unitary elasticity of substitution between capital and labor and allow for continuing capital-augmenting or investment-specific technological progress that leads the labor share to approach either zero or one in the long run.[10]

The findings that I discussed about product and labor market power have spurred further interest in developing economic and quantitative tools for studying models with imperfect competition. A key limitation of many of these models is that their predictions are sensitive to arbitrary definitions of what constitutes a market. For example, most economists would agree that not all manufacturing firms belong to one product market and that not all college-educated workers compete in one labor market. Conceptually, one could argue that every product or worker in the world constitutes a separate market because it is not strictly identical to any other product or worker. But this is not a useful disaggregation of economic activity. So, where do we draw the line? One promising alternative is to think about competition in the space of characteristics that define products, as in Pellegrino (2023).

Finally, models in corporate finance are often based on the idea that firms need to access external capital markets for financing. Such models may postulate some form of financial friction that restricts firms from accessing capital. But the decline of the labor share has been associated with changes in the distribution of available resources between households and corporations. Companies as a group have not distributed a significant fraction of their additional resources as payouts to households but instead have retained them in the corporate sector in the form of holding cash, accumulating other assets, and paying back debt (Chen, Karabarbounis, and Neiman, 2017). In fact, retained earnings have increased to such an extent that the corporate sector as a whole can finance its entire investments using retained earnings. Retention of earnings is likely to be heterogeneous across firms and countries, but the fact that many large companies need not rely on external capital markets calls for some rethinking of models that rely on frictions to generate interesting corporate financing and investment decisions.

5.2 Aggregate Welfare and Policy Implications

The welfare implications of the labor share decline depend on which factors are primarily contributing to its decline. Suppose, first, that the decline reflects technological factors that allow economies to substitute away from labor toward tangible capital, intangible capital, and

[10]A parallel is with the labor supply literature, in which economists postulate preferences so that income and substitution effects of wage changes cancel out in the long run. Thus, hours per worker remain constant despite the continuing improvement of technology. Boppart and Krusell (2020) develop a preference specification so that hours decline at a constant rate over time, as roughly observed in several countries.

automation. Since economies choose a different mix of inputs when the old mix of inputs is available, aggregate welfare must increase. In this case, the decline of the labor share is a symptom of a more efficient aggregate technology of production.[11]

Alternatively, suppose that the decline of the labor share partly reflects changes in product or labor markets. It is fair to say that we do not yet have a complete understanding of changes in product and labor markets. Are barriers to entering product markets increasing over time? Are barriers to accessing particular occupations increasing over time? Are markups increasing because consumers are becoming less price sensitive, or are deregulation and merger policies to blame? To the extent that lower price sensitivity and deregulation allow firms to increase their margins without fostering innovation, one would expect aggregate welfare losses. There are several sources of efficiency losses arising from product and labor market markups. The textbook example of inefficiency is the deadweight loss that arises from distorting the marginal revenue product of factors relative to their price. Another example is the inefficiency in production if firms with market power have higher costs than if they operated in competitive markets. A final source of inefficiency arises from the misallocation of inputs when firms have different markups. Useful starting points are Atkeson and Burstein (2008), Peters (2020), and Edmond, Midrigan, and Xu (2023).

If the decline of the labor share is a symptom of an efficient change in aggregate technology, then there is nothing to do from the point of view of a policy maker who is interested in efficiency. However, if the labor share decline reflects changes in market power over time, policy makers should be concerned about the ability of markets to achieve efficient production and input levels. Policies that remove barriers to entry, foster competition, and subsidize production, potentially as a function of the scale of production, may help restore efficiency.

However, the welfare implications of the labor share decline are subtle if technological progress is changing both the nature of production and the structure of product markets. For example, increased fixed costs in intangibles necessitate higher markups for firms to recuperate their investments. If intangibles spill over across firms, then markups act as a subsidy to innovation. It is difficult to discriminate between the roles of technology and product market structure for the decline of the labor share, because technological changes affect product markups, product market structure may itself affect the direction of technical change, and policies and demographic trends may affect both of them at the same time. Further, one could be conflating the roles of technology and product market structure because some intangible investments are not measured in GDP but affect corporate valuations and welfare. Research aiming to separate these factors is extremely valuable.[12]

[11] A caveat is that the lower cost of capital may have induced economies to accumulate more capital than is socially efficient. Following Abel, Mankiw, Summers, and Zeckhauser (1989), my preliminary tests show that this is not the case for many countries, as measured investment rates have not generally exceeded measured capital shares (see Appendix B).

[12] An example is Aghion, Bergeaud, Boppart, Klenow, and Li (2023), which shows how an improvement of

5.3 Distributional Effects and Policy Implications

The decline of the labor share has important distributional consequences. Irrespective of what is causing the labor share to decline, a larger portion of income is absorbed by the capital factor that is more dispersed across households. We thus expect the decline of the labor share to be associated with more income inequality. Even if we accept that technological progress has increased standards of living on average, we must recognize that the benefits of technological progress are distributed unevenly across households. For example, the reduction in the price of capital goods increases the labor income gap between skilled and unskilled labor, because skilled labor is more complementary to capital than unskilled labor is (Krusell, Ohanian, Rios-Rull, and Violante, 2000). Advances in information and communication technologies have reduced the share of income accruing to routine labor (Eden and Gaggl, 2018). In addition to disproportionately benefiting high-skilled labor, automation increases the return to wealth for capital owners (Moll, Rachel, and Restrepo, 2022).

From a redistributive perspective, the policy implications of the decline of the labor share decline depend on whether it is transitory or will continue in the future. If it is transitory, insurance mechanisms that operate, explicitly, through asset markets and the usual government tax and transfer policies or, implicitly, through intra-family transfers and substitution across firms, occupations, and industries will carry most of the adjustment. Acemoglu and Restrepo (2018) show that, if labor has a comparative advantage in creating new and more complex ideas, then the labor share need not decrease forever even if older tasks performed by labor are continuously automated. The authors use an interesting example from the technologies of the early 20th century that made horses redundant after the introduction of machines: unlike horses, humans will not become redundant to machines because they have a comparative advantage in creating more complex tasks.

I am not as optimistic as Acemoglu and Restrepo (2018). Brynjolfsson and McAfee (2014) argue that the second machine age involves the automation of cognitive tasks that make humans and software-driven machines substitutes, rather than complements. Artificial intelligence may soon have a comparative advantage in producing new ideas and replace human labor even in complex tasks, as machines replaced horses a century ago. If technological advancements continue to favor capital indefinitely, the natural outcome is a transition to a world in which capital on its own produces the entire global income. Perhaps then, a natural policy response will be to institutionalize a national dividend, or even a global dividend, which guarantees a reasonable minimum standard of living to every person in the world. I call this policy a dividend

best firms' productivity is associated with lower long-run innovation and welfare losses. Other examples include Hopenhayn, Neira, and Singhania (2022), who argue that the welfare effects are not obvious if the decline in labor share reflects a decline of population growth, and Covarrubias, Gutierrez, and Philippon (2020), who, in light of stable investment rates, interpret increasing concentration as reducing welfare. Crouzet and Eberly (2023) argue that opportunity costs and rents that accrue to unmeasured intangible investments help to reconcile stable physical investment rates with increasing corporate valuations.

as opposed to universal basic income for two reasons. The first is semantics, as output is entirely produced by capital. The second is more substantial. Universal basic income is financed by taxes which distort incentives to produce. However, one could hypothesize that artificial intelligence does not suffer disutility from producing and that humans maintain command of output. In that case, complete redistribution is feasible as there is no distortion from taxing production.

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Perspectives on the Labor Share

Online Appendix

Loukas Karabarbounis

Appendix A provides details for the measurement of the labor share. Appendix B presents some additional empirical results for the labor share of the United States and other countries. Appendix C provides algebraic derivations for various models of the labor share and for tests of dynamic inefficiency. Finally, Appendix D discusses in more detail some work cited in the main text.

A Details on Measurement

Compensation of employees. The primary data source is the Quarterly Census of Employment and Wages (QCEW) of the Bureau of Labor Statistics (BLS), which covers roughly 97 percent of non-farm payroll. The BEA adjusts these data to account for misreporting and compensation not covered by unemployment insurance. The BEA aggregates industry-level estimates using industry payroll data from the U.S. Census Bureau.

Equity pay is included in the national accounts under compensation to employees when it is taxed as ordinary income (that is, reported under a W-2 form). Compensation to employees does not include incentive stock options, which are deferred and taxed as capital gains when exercised, and includes equity pay only when it is reported as taxable income and not when it is granted. Eisfeldt, Falato, and Xiaolan (2023) document that between one-third and one-half of stock options are taxed as capital gains. They argue that total compensation should equal the wage component plus the value of all newly granted equity compensation, which alters the dynamics of the labor share if newly granted equity compensation increases over time as a fraction of measured compensation.

Types of unambiguous capital income. In the NIPA accounts, corporate profits refer to the profits from the current production of U.S. corporations. This item includes profits reported by both C and S corporations. Corporate profits are inclusive of corporate income taxes. They exclude dividend income and capital gains and losses. The primary data source for the BEA, when available, is data collected on a tax-accounting basis from corporate income tax returns filed to the IRS. The NIPA measure of corporate profits includes adjustments for inventories and capital consumption. Guvenen, Mataloni, Rassier, and Ruhl (2022) argue that U.S. multinationals book profits in low tax foreign countries by transferring ownership of their intangible assets to foreign affiliates. If these intangibles were developed in the United States, then the income they generate should be attributed to the U.S. and not to foreign GDP. The authors reattribute income generated abroad to U.S. corporate profits and find that the U.S. labor share declined by almost an additional percentage point between 1987 and 2008.

Rental income is net of depreciation and includes tenant- and owner-occupied housing, non-residential properties, royalties, and an adjustment for capital consumption, which converts tax-based depreciation to economic depreciation. The source data for housing rentals is the American Community Survey of the Census Bureau, with an imputation by the BEA of the service flow to owner-occupied housing. Business current transfer payments are payments or transfers to persons, governments, or the rest of the world when no service is provided. Examples include insurance payouts, scholarships, and debt write-offs. The surplus of government enterprises is the revenues minus expenses of government agencies net of any subsidies. Examples include utilities, housing, and transportation agencies. The difference with the government sector is that these enterprises are charging prices so that revenues exceed 50 percent of costs. The System of National Accounts (SNA) calls these enterprises quasi-corporations.

Proprietors' labor input. My labor share measure "Total: Proprietors Same Wage" uses people working in each sector and not hours to scale the labor share. This amounts to assuming that employees and proprietors have the same earnings instead of the same wage. I believe both are equally defensible choices, so I opt for the measure with the lower data requirement. I call this measure "Same Wage" for comparability with previous literature.

Mechanically, in Figure 1, the labor share measure "Total: Proprietors Same Wage" is declining before World War II because the share of proprietors' labor input in total labor input is declining without a corresponding decline of the compensation share. I investigated this more, and I am not convinced that proprietors' labor input is well measured in the period before World War II. The raw data for proprietors' labor input come from the NIPA, Table 6.7. I compared the NIPA estimates with those presented by Margo (1998) for the non-agricultural sector. The self-employment rate reported by the NIPA is 13.2 percent in 1930 for the non-agricultural sector, which matches closely with the 13.4 percent estimate reported by Margo. However, the self-employment rate in the NIPA increases to 15.7 percent in 1932. The change is so large because the NIPA report an increase in the number of self-employed workers relative to its level in 1929, whereas the number of employed fell by roughly 25 percent. I use the self-employment rate reported by Margo to correct the NIPA measure until 1940. The adjustment is significant between 1931 and 1933 and becomes negligible by 1940 because the self-employment rates in the NIPA and in Margo converge. The labor share measure "Total: Proprietors Same Wage" in Figure 1 spikes even after this adjustment, and without this adjustment it would increase significantly more in the early 1930s. I suspect but cannot confirm that the NIPA also underestimate the decline of the number of proprietors during the Great Recession in agriculture, so an adjustment of agricultural proprietors would also be reasonable.

Labor share measure that excludes housing. For the labor share excluding housing, I subtract compensation of employees in the housing sector from aggregate compensation in the numerator of the labor share. In the denominator, I subtract housing value added from GDP, subtract proprietors' income in the housing sector from total proprietors' income, and net out taxes on production and imports less subsidies from the corresponding taxes recorded in the housing sector.

Labor share measure that excludes the government. For the labor share excluding government, I subtract compensation of employees in the government sector from aggregate compensation in the numerator of the labor share and government's gross value added from GDP in the denominator of the labor share. The government does not have proprietors' income and taxes on production, so no other adjustment is necessary.

Labor share measure that imputes capital income to the government. Government's gross value added equals compensation of employees and depreciation, because national accounts treat government as making zero net capital income from its operations. To impute net capital income produced by government's assets to GDP and to capital income, I multiply government fixed assets by the return net of depreciation that accrues to private non-residential fixed assets. The return is calculated as total capital income excluding the income from government and housing divided by private non-residential fixed assets plus inventories.

BLS labor share measure. There are three differences between the BLS measure and "Total Proprietors: Same Wage." First, my series is more comprehensive in terms of coverage, as it includes the entire economy. Second, I have used the assumption of equal earnings to impute proprietors' labor income, whereas the BLS uses the assumption of equal wages. Third, the BLS allocates a fraction of taxes on production to capital. In Figure 1, I scale the BLS series to have the same value as my series in 1947.

The BLS approach is to allocate a fraction of taxes on production, namely the taxes that concern property and motor vehicles, to capital income. Taxes on property and motor vehicles are subcategories of "other taxes on production," separate from "taxes on products," which mainly concern sales and excise taxes. I do not find this practice persuasive, because changes in these taxes may also affect the cost of labor. As an example, consider a restaurant earning 100 dollars of income net of intermediate inputs. The restaurant pays 50 dollars in wages to its employees and 10 dollars in production taxes for its structure, which produces food, and its vehicles, which deliver food. The remaining 40 dollars accrue to its owner. Allocating one-half of property and vehicle taxes to labor income and one-half to capital income implies that the effective labor cost scales with these production taxes. This is a more appealing assumption than entirely allocating production taxes to capital income, because doing so does not take into account that the size of the structure and the number of vehicles likely scale with the size of the workforce.

Corporate sector. In the United States, both C and S corporations belong to the corporate sector, whereas partnerships and sole proprietorships do not. An important difference between C and S corporations is that the latter do not pay corporate income taxes but pass through their income to the owners. Smith, Yagan, Zidar, and Zwick (2022) argue that after the Tax Reform Act of 1986, the share of the corporate sector organized as S rose over time, and owners of S corporations started to prefer recording their income as profits instead of labor income for preferential tax treatment. Therefore, the tax reform caused some of the decline of the corporate labor share (around 1 percentage point).

The NIPA measure of corporate profits is closely related to the measures for corporations in the SNA. However, the strict exclusion of housing from the corporate sector applies only to the United States. For other countries, the SNA categorizes cooperatives, limited liability partnerships, and quasi-corporations as part of the corporate sector, and these legal forms may own some housing. However, I argued that excluding the housing sector from capital income may not be desirable, and thus it is not obvious if the corporate labor share is a better proxy for the labor share in the United States relative to other countries. In addition, the corporate sector in the SNA includes quasi-corporations such as government enterprises and limited liability partnerships, which are excluded under the NIPA measures.

Some researchers also look at the corporate non-financial labor share, which excludes financial firms' contributions to corporate compensation of employees, gross value added, and taxes on production. I find that this measure behaves quite similarly to the one for the entire corporate sector, and thus my analysis focuses on the measure that represents the larger share of the economy.

Unmeasured investments. Expenses accruing on brand equity, customer capital, firm-specific worker training, advertising, and marketing are not counted in GDP, because statistical agencies treat them as intermediate inputs (Corrado, Hulten, and Sichel, 2009). However, to the extent that these outlays are expected to generate returns in the future, economically they should be treated as investment flows. If statistical agencies decide to recognize these expenses as investments, then measured GDP will increase. Whether this income accrues to labor or capital depends on the ownership of the accumulated factors. If the ownership stays with the firm, or spills over to other firms because of the non-exclusive nature of intangibles, then the income generated by the stock of intangibles is capital income. It is appropriate to allocate part of the intangibles' income to labor if this income is paid to skilled workers in the form of equity-based compensation, which is not recorded in compensation of employees.

The effect of recognizing these expenses as investments on the trend of the labor share depends on the trend of these expenses relative to measured output and on the fraction of expenses that accrues to labor compensation. Expenses on unmeasured intangibles are increasing over time as a share of output and tangible investments. It also seems plausible that these expenses do not affect labor income much. Thus, if statistical agencies recognize these expenses as investments, the decline of the labor share is going to be even more pronounced.

Treatment of non-market output. Services provided by durable goods are not included in GDP and capital income. This contrasts with services provided by owner-occupied housing, which are included in GDP and capital income through imputed rent. The logic for this difference is that the durables are part of non-market production. In a broader measure of output that includes non-market production, the service flow of durables should be added to GDP and capital income. But if one adopts such a measure, consistency requires imputing the labor compensation generated in the home sector in the form of non-market time spent on activities such as cooking, cleaning, child care, and home and personal maintenance.

Differences between value added and compensation concepts in BLS-BEA integrated accounts and BEA industry accounts. Both labor share measures that I construct at the industry level use compensation from the integrated BEA-BLS accounts, which adds proprietors' labor income. The "BLS Industry" measure divides compensation to employees by value added for each industry from the BEA-BLS integrated accounts. The "BEA Industry" measure scales value added of each industry from the BEA-BLS integrated accounts by a constant ratio, calculated as the industry's average valued added in BEA industry accounts to its value added in BLS-BEA integrated accounts, and then subtracts taxes on production available only from the BEA industry accounts. For years before 1998, I impute taxes on production using the mean ratio of taxes on production from the BEA industry accounts to value added in the BLS-BEA integrated accounts. The fourth column of Table 3 shows industry shares of valued added less taxes on production, because the aggregate labor share in the BEA measure has value added less taxes on production in the denominator.

The two projects have different scopes. The BEA industry accounts are designed so that value added of industries adds up to GDP in the NIPA. Value added is organized similarly to the aggregate accounts and equals the sum of compensation to employees, gross operating surplus, and taxes on production less subsidies. Depreciation expenses and proprietors' income are included in the gross operating surplus of each industry. By contrast, the integrated BEA-BLS accounts are designed to estimate productivity and costs by industry. Value added equals the sum of compensation to workers, adjusted for proprietors' income, and various types of fixed assets. In contrast to the BEA industry accounts, compensation to capital in the integrated accounts follows the BLS practice of including imputed capital income to the government and part of taxes on production.

To confirm that proprietors' income is included in the integrated accounts, I compared compensation in the BLS-BEA integrated accounts to compensation produced by the BEA in its industry accounts, which does not include proprietors' income. I find that compensation in the integrated accounts significantly exceeds compensation in the industry accounts in industries for which we expect a large share of proprietors, such as agriculture, construction, real estate, professional and business services, arts and entertainment, and other services. I also find that compensation is roughly equal between the two data sources in industries without a significant share of proprietors, such as oil and mining, utilities, manufacturing, wholesale, and government.

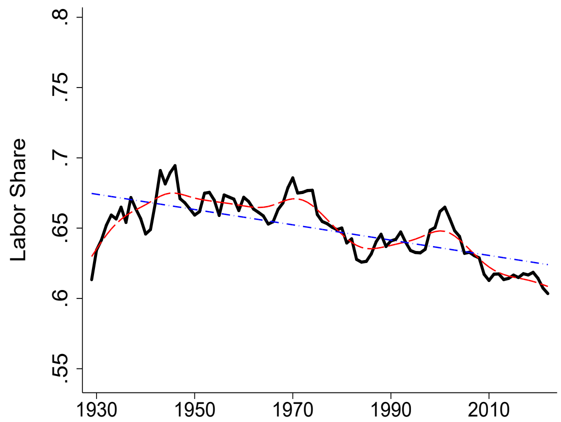
Differences between industry labor shares and those in Elsby, Hobijn, and Sahin (2013). My estimated declines of the labor share at the industry level are generally larger than those reported by Elsby, Hobijn, and Sahin (2013). An important difference with their measurement is that they use the BEA industry accounts, which do not allocate any of proprietors' income into labor compensation. Instead, I use the BEA-BLS integrated product accounts, which allocate part of proprietors' income to labor compensation. For example, the average labor share of agriculture in the BEA industry accounts is below 30 percent, compared with more than 60 percent in my measures.

Labor shares from the Penn World Table. Similar to my U.S. measures, all measures subtract taxes on products from the denominator of the labor share. The labor share resembling the "Total: Proprietors Same Share" for the United States is called "lab_sh2" in the PWT. The measures are not, however, strictly comparable, because some private businesses may be paying wages to their owners and some proprietors may be legally incorporated. The labor share that adjusts for the ratio of labor inputs between the self-employed and employees is called "lab_sh3" in the PWT (similar to "Total: Proprietors Same Wage" measure for the United States). The measure "lab_sh4" adds all value added of agriculture to compensation of employees, and the measure "lab_sh1" allocates all mixed income to compensation of employees.

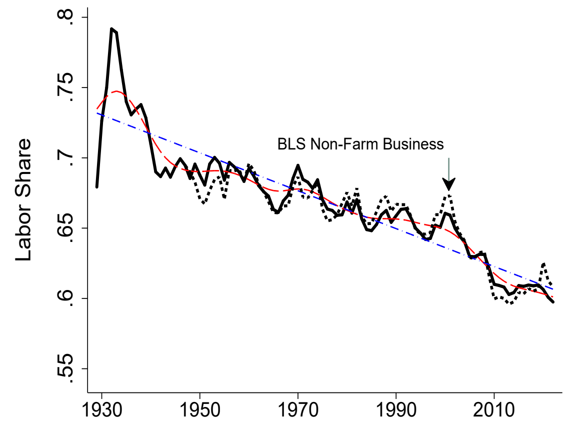
I restrict the sample to countries with at least 25 years of data. My preferred labor share series is "lab_sh2." I impute missing values for "lab_sh2" using the slope of the regression of "lab_sh2" on "lab_sh3," which is the most comparable measure to "lab_sh2." This allows me to expand the sample for a few countries (for example, Germany and the United Kingdom) by a few more years. When the "lab_sh2" series augmented with the imputation is unavailable for at least 25 years, I use, in order, "lab_sh3," "lab_sh4," and "lab_sh1."

B Additional Results

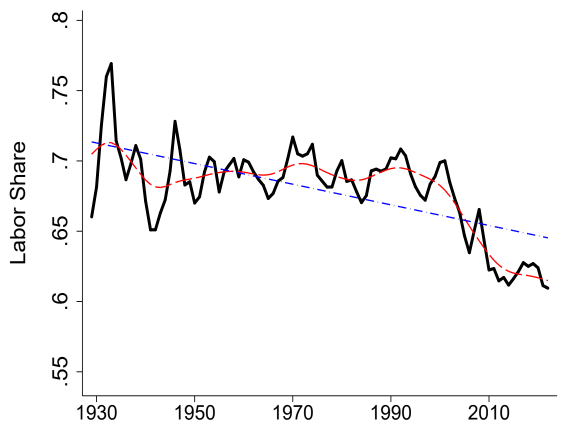
Additional labor share measures in the United States. Figure A.1 presents three additional measures of the labor share, in addition to "Total: Proprietors Same Share," "Total: Proprietors



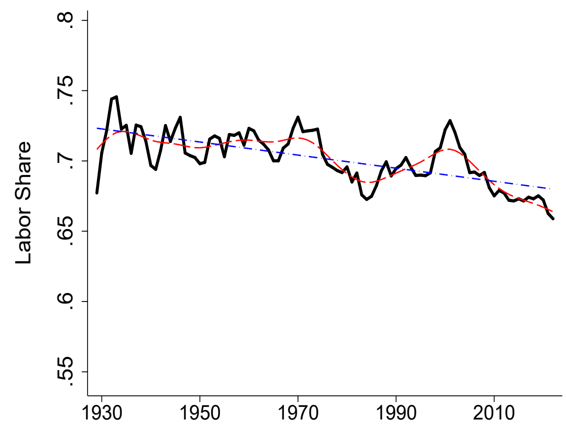
(a) Total: Proprietors Same Share



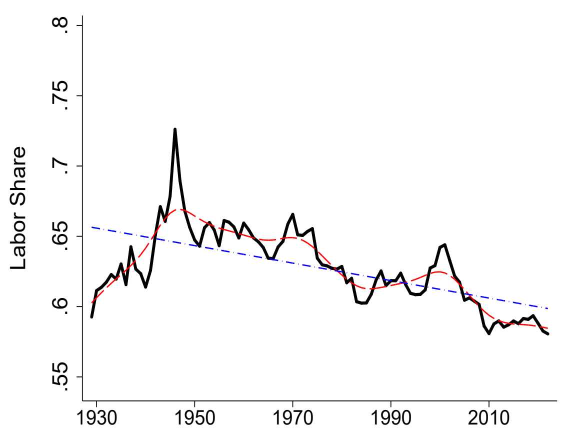
(b) Total: Proprietors Same Wage



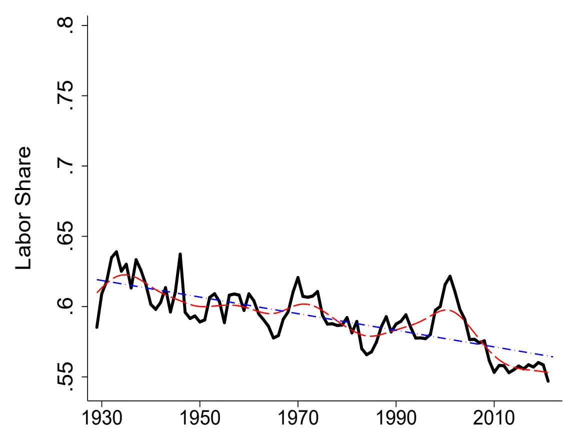
(c) Corporate



(d) Excluding Housing



(e) Excluding Government



(f) Government Capital Income

Figure A.1: Labor Share in the United States, 1929–2022

Notes: Solid black line is the labor share measure, dotted blue line is the linear trend of each measure, and red long-dashed line is the Hodrick-Prescott trend of each measure with a smoothing parameter of 100. The short-dashed black line is the BLS measure of the labor share for the non-farm business sector, scaled to equal "Total: Proprietors Same Wage" in the first year of its observation.

Same Wage," and the corporate labor share discussed previously in the text. The first measure is based on "Total: Proprietors Same Share," but excludes the housing sector by removing its contribution to compensation of employees, GDP, proprietors' income, and taxes on production. The second measure is also based on "Total: Proprietors Same Share," but excludes the government sector by removing its contribution to compensation of employees and GDP. Government's gross value added equals compensation of employees and depreciation, because national accounts treat government as making zero net capital income from its operations. The last measure imputes to capital income and to GDP the net capital income produced by government's assets.

Excluding the housing and the government sectors matters quite a bit for the estimated trends of the labor share in the early years of the sample. Estimates become more robust after World War II and are robust in the last subperiods, which include the decline of the labor share in the 2000s. Excluding government generates a dramatic increase in the labor share around the end of World War II, because government's labor share decreased substantially during this period and the government accounted for roughly 20 percent of GDP. The measure of the labor share that imputes government's capital income to output exhibits behavior similar to the other measures, except again in the early years of the sample. Notably, this measure does not display the spike of "Total: Proprietors Same Share" in the aftermath of World War II, because wartime fixed assets substantially increased imputed capital income.

Table A.1 presents the estimated trends in the additional measures of the labor share and for additional subsamples. Relative to the results reported in Table 2 in the main text, the labor share decreases by more in the first subperiod, remains roughly constant until the end of the 20th century, and declines by less in the last subperiod. Table A.2 presents estimates of the trend of each labor share measure using a linear trend, a Hodrick-Prescott trend, and a 5-year moving average, separately for the whole sample between 1929 and 2022 and the sample after World War II between 1946 and 2022.

Labor shares and collective bargaining. Figure A.2 shows the evolution of the labor share for countries in which the share of employees with the right to bargain exceeds 50 percent but remains relatively stable between the early 2000s and the late 2010s. The labor share data are from the PWT, and the data on the share of employees with the right to bargain are from the OECD. As the figure shows, most countries experienced declines of their labor shares, including three of the four Scandinavian countries.

Tests of dynamic inefficiency. An economy is dynamically inefficient if it can increase its consumption per capita forever by reducing its capital per capita in a balanced growth path. The economy is dynamically inefficient if, in a balanced growth path, the marginal product of capital is lower than the growth rate of aggregate output. In competitive economies, this is

Table A.1: Changes of the U.S. Labor Share by Subperiod

(percentage points change per decade)	1929-1945	1946-1970	1971-1995	1996-2022
Total: Proprietors Same Share	3.0	−0.2	−1.6	−1.8
	(0.6)	(0.4)	(0.3)	(0.3)
Total: Proprietors Same Wage	−3.9	−0.9	−1.1	−2.3
	(1.9)	(0.3)	(0.2)	(0.2)
Corporate	−3.2	−0.1	−0.1	−3.3
	(1.8)	(0.5)	(0.3)	(0.3)
Excluding Housing	−0.1	0.3	−1.0	−2.0
	(1.0)	(0.3)	(0.3)	(0.3)
Excluding Government	3.8	−1.3	−1.6	−2.0
	(0.6)	(0.7)	(0.3)	(0.3)
Government Capital Income	−0.8	−0.3	−0.9	−2.3
	(0.9)	(0.5)	(0.2)	(0.4)
Median	−0.5	−0.3	−1.1	−2.2
(percentage points change per decade)	1929-1951	1952-1975	1976-1999	2000-2022
Total: Proprietors Same Share	1.7	0.1	−0.3	−2.3
	(0.5)	(0.4)	(0.3)	(0.3)
Total: Proprietors Same Wage	−3.4	−0.8	−0.7	−2.6
	(1.1)	(0.2)	(0.2)	(0.2)
Corporate	−1.6	0.4	0.1	−3.6
	(1.0)	(0.3)	(0.3)	(0.5)
Excluding Housing	−0.6	0.1	0.4	−2.6
	(0.6)	(0.2)	(0.3)	(0.3)
Excluding Government	3.3	−0.4	−0.3	−2.3
	(0.7)	(0.2)	(0.3)	(0.3)
Government Capital Income	−1.2	0.0	0.2	−2.9
	(0.6)	(0.3)	(0.3)	(0.4)
Median	−0.9	0.1	−0.1	−2.6

Notes: Entries are percentage points changes per decade in different measures of the labor share. The estimates are from separate regressions of labor share measures on a linear trend within each subperiod. Robust standard errors are in parentheses.

equivalent to the criterion that the (net) rate of return on capital is lower than the growth rate. Such a case can arise in overlapping generations economies in which the conditions of the first welfare theorem do not apply because there is an infinite number of generations.

The problem with the criterion that compares the rate of return with the growth rate is that it is not obvious which rate of return to use. Abel, Mankiw, Summers, and Zeckhauser (1989) suggest an alternative criterion, which says that the economy is dynamically inefficient if its investment rate always exceeds its capital share of income. Intuitively, the economy is producing a dividend when capital income exceeds investment, whereas the economy is losing resources if it invests more than it is earning from its capital. The logic of why this criterion

Table A.2: Trends of the U.S. Labor Share

Period: 1929-2022	Raw	Linear Trend	HP(100) Trend	MA(5) Trend
Total: Proprietors Same Share	−1.0	−5.1	−2.1	−2.1
Total: Proprietors Same Wage	−8.2	−12.5	−13.4	−11.7
Corporate	−5.1	−6.8	−9.0	−7.4
Excluding Housing	−1.8	−4.3	−4.4	−3.7
Excluding Government	−1.2	−5.8	−1.8	−2.2
Government Capital Income	−3.8	−5.4	−5.7	−4.9
Period: 1946-2022	**Raw**	**Linear Trend**	**HP(100) Trend**	**MA(5) Trend**
Total: Proprietors Same Share	−9.1	−6.3	−6.6	−7.3
Total: Proprietors Same Wage	−10.2	−9.4	−9.1	−9.0
Corporate	−11.9	−7.4	−7.0	−8.2
Excluding Housing	−7.2	−4.1	−4.8	−5.1
Excluding Government	−14.6	−8.4	−8.4	−10.1
Government Capital Income	−9.0	−4.4	−5.1	−5.1

Notes: "Raw" is the change between the value in 2022 and the value in either 1929 or 1946. The other entries are estimates of the trend of the labor share using a linear trend, a Hodrick-Prescott trend with a smoothing parameter of 100, a 5-year moving average, and a 20-year moving average.

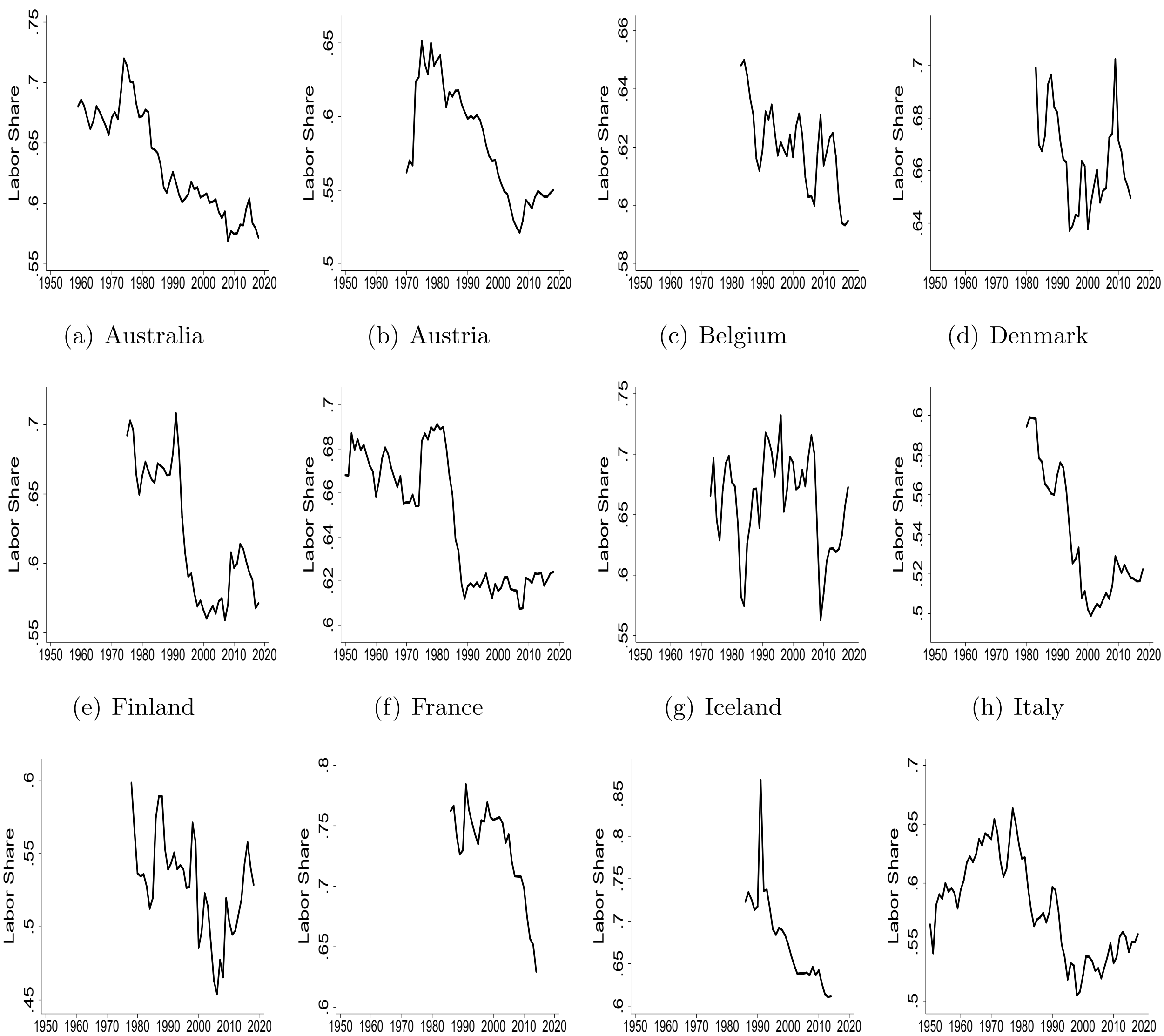
does not explicitly require measurement of the return to capital is that the capital share of income implicitly embeds the appropriate rate of return earned by an economy's capital.

Figure A.3 reports the share of capital income and the share of investment in GDP for the 16 largest economies of the world by GDP in 2015. The data come from the PWT. The capital share is defined as one minus the labor share. We observe that in most countries the capital share exceeds the investment rate, and thus most countries are not dynamically inefficient.

In assessing dynamic inefficiency, the comparison of one minus the labor share to the investment rate is appropriate when there are no economic profits. However, if some of the residual payments accrue to profits instead of capital, this comparison is no longer appropriate. I adjust the criterion in Section C to take into account markups and fixed costs. The adjustment shows that economic profits need to increase significantly for economies to become dynamically inefficient. To be clear, by "economic profits" I mean the gap between revenues and costs, irrespective of whether the gap derives from markups or returns to scale that are not constant.

C Models of the Labor Share

Labor share solution. Consider a firm that operates in partial equilibrium and chooses prices and quantities of output and inputs. Output y is produced with capital k and labor ℓ according



(a) Australia (b) Austria (c) Belgium (d) Denmark

(e) Finland (f) France (g) Iceland (h) Italy

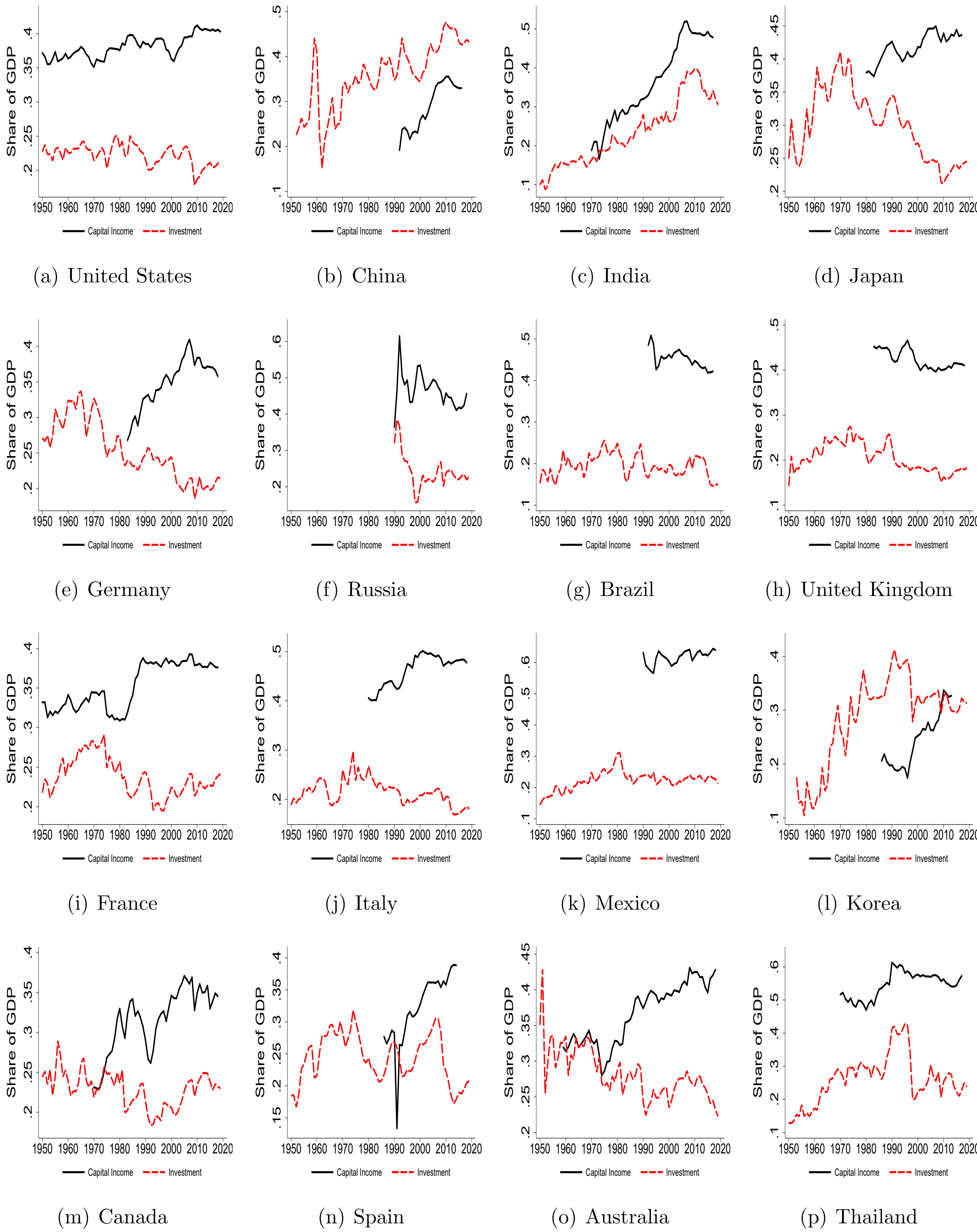
(i) Norway (j) Portugal (k) Spain (l) Sweden

Figure A.2: Labor Share with High and Stable Share of Right-to-Bargain Employees

to the production function

$$y = F(k,\ell) - f = \left(\alpha(A_k k)^{\frac{\sigma-1}{\sigma}} + (1-\alpha)(A_\ell \ell)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} - f, \tag{A.1}$$

where $\sigma \geq 0$ is the constant elasticity of substitution between capital k and labor ℓ , $A_k \geq 0$ is capital-augmenting technology, and $A_\ell \geq 0$ is labor-augmenting technology. The distribution factor α is between 0 and 1. Parameter f subtracts output for given capital and labor. The firm faces increasing returns to scale when $f > 0$, constant returns to scale when $f = 0$, and decreasing returns to scale when $f < 0$. Denote by λ the solution of the following equation: $\lambda y = F = F_k k + F_\ell \ell \Longrightarrow \lambda = 1 + \frac{f}{F(k,\ell)-f}$. I call λ returns to scale, and note that returns to



(a) United States (b) China (c) India (d) Japan

(e) Germany (f) Russia (g) Brazil (h) United Kingdom

(i) France (j) Italy (k) Mexico (l) Korea

(m) Canada (n) Spain (o) Australia (p) Thailand

Figure A.3: Tests of Dynamic Inefficiency scale generally vary with the optimal choices of inputs.

The firm faces product demand $p(y)$ and labor supply $\ell(w)$. The firm takes as given the user cost of capital R. The profit maximization problem of the firm is

$$\max_{k,\ell} \pi = p(y) \cdot y(k,\ell) - w(\ell) \cdot \ell - R \cdot k, \tag{A.2}$$

subject to the production technology $y = F(k,\ell) - f$, the product demand $p(y)$ and the labor supply $\ell(w)$. In the profit maximization problem, the firm internalizes that its price p varies with output y and that its wage w varies with labor ℓ. The first-order conditions with respect to capital and labor are

$$pF_k = p\alpha A_k^{\frac{\sigma-1}{\sigma}} \left(\frac{\lambda y}{k}\right)^{\frac{1}{\sigma}} = \mu R, \tag{A.3}$$

$$pF_\ell = p(1-\alpha) A_\ell^{\frac{\sigma-1}{\sigma}} \left(\frac{\lambda y}{\ell}\right)^{\frac{1}{\sigma}} = \mu\theta w, \tag{A.4}$$

where the expressions for the two markups are given by $\mu = (-y'(p)p/y)/(-y'(p)p/y - 1) \geq 1$ and $\theta = (\ell'(w)w/\ell + 1)/(\ell'(w)w/\ell) \geq 1$, where $y'(p)$ is the slope of product demand and $\ell'(w)$ is the slope of labor supply. Dividing the two first-order conditions, I get that the optimal capital-to-labor ratio is

$$\frac{k}{\ell} = \left(\frac{\alpha}{1-\alpha}\frac{\theta w}{R}\right)^{\sigma} \left(\frac{A_k}{A_\ell}\right)^{\sigma-1}. \tag{A.5}$$

The capital-to-labor ratio does not depend on product market markups μ, because μ distorts capital and labor proportionally, and on fixed costs f, because fixed costs do not affect marginal products.

Income shares are defined as

$$s_\ell = \frac{w\ell}{py}, \quad s_k = \frac{Rk}{py}, \quad s_\pi = \frac{\pi}{py}. \tag{A.6}$$

I note that fixed costs f affect output directly and do not reflect demand for labor or capital inputs. Thus, compensation to labor and compensation to capital do not include f. To express income shares in terms of markups, returns to scale, and payments to factors, we use the definition of returns to scale λ (evaluated at the optimal choices) and the first-order conditions to derive profits as

$$\pi = py - w\ell - Rk = \left(\frac{pF_k}{\lambda} - R\right)k + \left(\frac{pF_\ell}{\lambda} - w\right)\ell = \left(\frac{\mu}{\lambda} - 1\right)Rk + \left(\frac{\mu\theta}{\lambda} - 1\right)w\ell. \tag{A.7}$$

Therefore, income shares are

$$s_\ell = \frac{\lambda}{\mu}\left(\frac{w\ell}{\theta w\ell + Rk}\right), \quad s_k = \frac{\lambda}{\mu}\left(\frac{Rk}{\theta w\ell + Rk}\right), \quad s_\pi = 1 - \frac{\lambda}{\mu}\left(\frac{w\ell + Rk}{\theta w\ell + Rk}\right). \tag{A.8}$$

One expression for the labor share is obtained by applying the income shares in equation (A.8) to the capital-to-labor ratio in equation (A.5):

$$s_\ell = \frac{\lambda}{\mu\theta}\left(\frac{1}{1 + \left(\frac{\alpha}{1-\alpha}\right)^\sigma \left(\frac{A_k \theta w}{A_\ell R}\right)^{\sigma-1}}\right). \tag{A.9}$$

The expression that appears in the main text derives from applying the income shares in equation (A.8) to the first-order condition with respect to capital in equation (A.3):

$$s_\ell = \frac{\lambda}{\mu\theta}\left(1 - \alpha^\sigma \left(\frac{A_k}{\mu R}\right)^{\sigma-1}\right), \tag{A.10}$$

where I normalize the product price to one at the optimal choices, so R represents the cost of capital relative to the product price. The solution for the labor share shown in the main text is equation (A.10) for the case of constant returns to scale, $\lambda = 1$.

The misleading equation (A.9). A difference between equations (A.9) and (A.10) is that labor-augmenting technology A_ℓ and the wage w appear only in the former. Here, I want to draw a distinction between partial and general equilibrium. If all firms experience a change in labor-augmenting technology, we expect the equilibrium wage to grow proportionally to technology. Thus, keeping the wage constant in equation (A.9) is misleading for thinking about changes in labor-augmenting technology at the aggregate level. It is also confusing to think how the wage affects the aggregate labor share, because the wage is typically determined in general equilibrium as a function of labor-augmenting technology and potentially other primitives. So, it makes little sense to do comparative statics with respect to the wage.

The more useful equation (A.10). Using equation (A.10) avoids some of the pitfalls from changing one determinant of the labor share in partial equilibrium without thinking about how this determinant is determined in general equilibrium. Mechanically, A_ℓ and w do not appear in equation (A.10), because I used the capital's first-order condition for profit maximization to derive the labor share. Equation (A.10) may not be misleading for thinking about the effects of capital-augmenting technology A_k on the labor share, to the extent that the cost of capital R and markups μ, θ do not respond to A_k. Similarly, it may not be misleading to think about the effects of the cost of capital on the labor share, to the extent that the cost of capital is pinned down in equilibrium independently of A_k, μ, and θ.[1] Several economic models share these

[1]With fixed costs, $f > 0$, returns to scale λ decline with a higher A_k or a lower R because production

properties under infinitely elastic supply of capital in the long run, isoelastic preferences, and monopolistic or monopsonistic markets. However, the same caveats about partial equilibrium versus general equilibrium reasoning apply in models that relax these assumptions.

Industry equilibrium with two types of firms. Consider an industry populated by two types of firms. The labor-intensive firm produces with technology $y_\ell = \ell$. The capital-intensive firm produces with technology $y_k = A_k k$. The output prices of the firms are given by p_ℓ and p_k. With linear production we obtain $p_\ell = w$ and $p_k = R/A_k$, where w is the wage and R is the cost of capital.

Consumers have CES preferences over the output of the two firms, with an elasticity ε. Demand functions are given by $y_\ell = (p_\ell/p)^{-\epsilon}E$ and $y_k = (p_k/p)^{-\epsilon}E$, where E is the aggregate expenditure of consumers across all industries and p is the industry price index.

The labor share of income for the industry equals the share of output produced by the labor-intensive firm:

$$s_\ell = \frac{w\ell}{w\ell + Rk} = \frac{p_\ell y_\ell}{p_\ell y_\ell + p_k y_k} = \frac{p_\ell^{1-\varepsilon}}{p_\ell^{1-\varepsilon} + p_k^{1-\varepsilon}} = \frac{1}{1 + \left(\frac{w}{A_k R}\right)^{\varepsilon-1}}. \tag{A.11}$$

Consider an increase in A_k, holding constant w and R. Equation (A.11) shows that the labor share of the industry declines if consumers perceive the two goods as substitutes, $\varepsilon > 1$. The HHI of sales concentration for the industry is given by $s_\ell^2 + (1 - s_\ell)^2$, which declines with s_ℓ if $s_\ell < 1/2$. The 1/2 threshold can be relaxed by introducing more parameters or in a richer environment in which firms are not as striking.

The point is that we have constructed an economy in which, if $\varepsilon > 1$ and $s_\ell < 1/2$: larger firms have a lower labor share; no firm substitutes between labor and capital; capital-augmenting technical change leads to a decline of the labor share; and capital-augmenting technical change leads to an increase in sales concentration without changing employment or capital concentration.

Here, again, we need to be cautious about general equilibrium effects as we have not allowed w/R to respond to A_k. The relative input price w/R is unresponsive to A_k if the change in A_k is at the industry level and the industry is small enough relative to the rest of the economy. Alternatively, if all industries experience the same change in A_k, the assumption is satisfied in a small open economy with perfectly elastic capital supply and labor mobility. Relaxing the labor mobility assumption and assuming that labor is completely inelastic in the aggregate, in the symmetric-industry equilibrium the wage satisfies $w^{1-\varepsilon} = \mathbb{C} - (R/A_k)^{1-\varepsilon}$ for a constant $\mathbb{C}$. In this case, the solution for the labor share in general equilibrium becomes $s_\ell = 1 - 1/(\mathbb{C}(R/A_k)^{\varepsilon-1})$, which again is decreasing in R/A_k if $\varepsilon > 1$.

expands.

Labor share with imported intermediate inputs: Model I. I consider the problem of a firm in partial equilibrium. The firm produces gross output with technology

$$g = \left((1-\omega)\ell^{\frac{\sigma-1}{\sigma}} + \omega y(k,m)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{A.12}$$

$$y = \left(\alpha(A_k k)^{\frac{\phi-1}{\phi}} + (1-\alpha)(A_m m)^{\frac{\phi-1}{\phi}}\right)^{\frac{\phi}{\phi-1}}. \tag{A.13}$$

Labor ℓ and the composite good y nest in gross output g with an elasticity of substitution σ. Capital k and imported intermediate inputs m nest in the composite good y with an elasticity of substitution ϕ. The price of g is p, the price of ℓ is w, the price of k is R, and the price of m is q. Domestic product equals $pg - qm$.

We can split the problem of the firm in two steps. In the first step, we obtain the price of the composite good y from minimizing the cost $v = qm + Rk$ of producing one unit of the composite good,

$$v = \left(\alpha^{\phi} A_k^{\phi-1} R^{1-\phi} + (1-\alpha)^{\phi} A_m^{\phi-1} q^{1-\phi}\right)^{\frac{1}{1-\phi}}. \tag{A.14}$$

Given v, the firm maximizes its profits $\pi = p(g)g - vy - w\ell$, internalizing that it faces an isoelastic demand for its product $p(g)$.

Denoting the income shares of gross output by θ and the income shares of the composite good by χ, we obtain

$$\theta_\ell = \frac{w\ell}{pg} = \left(\frac{1}{\mu}\right)\left(\frac{1}{1+\left(\frac{\omega}{1-\omega}\right)^{\sigma}\left(\frac{w}{v}\right)^{\sigma-1}}\right), \tag{A.15}$$

$$\chi_m = \frac{qm}{vy} = \frac{1}{1+\left(\frac{\alpha}{1-\alpha}\right)^{\phi}\left(\frac{qA_k}{RA_m}\right)^{\phi-1}}. \tag{A.16}$$

The labor share of domestic income is

$$s_\ell = \frac{w\ell}{pg-qm} = \frac{w\ell}{pg}\frac{pg}{pg-qm} = \frac{\theta_\ell}{1-\chi_m(1/\mu-\theta_\ell)}. \tag{A.17}$$

The labor share of income is increasing in θ_ℓ because labor absorbs a larger part of gross output and some of gross output represents domestic income. The labor share of income is increasing in χ_m because χ_m increases the gap between gross output and domestic income and labor is paid from gross output.

For the comparative statics with respect to q, I impose the assumption that w and R do not respond in equilibrium. Thus, the comparative statics are subject to the same caveats I discussed above. The comparative statics of s_ℓ with respect to q depend on the relative values of σ and ϕ. If $\sigma > \phi$, then s_ℓ is an increasing function of q. The logic is that when imported intermediate inputs become cheaper, firms substitute more between labor and the composite good when σ is high, and firms substitute more between materials and capital when ϕ is high. The first effect tends to lower the labor share of gross output for high values of σ, whereas the second effect tends to close the gap between gross output and domestic income for high values of ϕ. When $\sigma > \phi$, the first effect dominates, and the labor share falls when the price of intermediate inputs decreases.

I do not find this to be a very intuitive way to think about the decline of the labor share. First, even if one accepts that globalization has caused a decline of q, commodity prices tend to be more volatile than domestic input prices, and so one would need to consider other forces that impact q relative to w and R. Second, for the theory that declines of q cause a decline of s_ℓ, we need labor to be more substitutable with imported intermediate inputs than capital is. But many imported goods are capital goods, so for these goods, a better description of technology is that imported goods are more substitutable to domestic capital than to labor, $\phi > \sigma$.

Labor share with imported intermediate inputs: Model II. The same prediction arises if we change the way the three inputs are nested in the production function. Technology is

$$g = \left((1-\omega)k^{\frac{\sigma-1}{\sigma}} + \omega y(\ell, m)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{A.18}$$

$$y = \left(\alpha(A_\ell \ell)^{\frac{\phi-1}{\phi}} + (1-\alpha)(A_m m)^{\frac{\phi-1}{\phi}}\right)^{\frac{\phi}{\phi-1}}. \tag{A.19}$$

Capital k and the composite good y nest in gross output g with an elasticity of substitution σ. Labor ℓ and imported intermediate inputs m nest in the composite good y with an elasticity of substitution ϕ. The price of g is p, the price of ℓ is w, the price of k is R, and the price of m is q. Domestic product equals $pg - qm$.

As was the case before, we can split the problem of the firm in two steps. In the first step, we obtain the price of the composite good y from minimizing the cost $v = qm + w\ell$ of producing one unit of the composite good,

$$v = \left(\alpha^\phi A_\ell^{\phi-1} w^{1-\phi} + (1-\alpha)^\phi A_m^{\phi-1} q^{1-\phi}\right)^{\frac{1}{1-\phi}}. \tag{A.20}$$

Given v, the firm maximizes its profits $\pi = p(g)g - vy - Rk$, internalizing that it faces an isoelastic demand for its product $p(g)$.

Denoting the income shares of gross output by θ and the income shares of the composite good by χ, we obtain

$$\theta_y = \frac{vy}{pg} = \left(\frac{1}{\mu}\right)\left(\frac{1}{1+\left(\frac{1-\omega}{\omega}\right)^{\sigma}\left(\frac{v}{R}\right)^{\sigma-1}}\right), \tag{A.21}$$

$$\chi_\ell = \frac{w\ell}{vy} = \frac{1}{1+\left(\frac{1-\alpha}{\alpha}\right)^{\phi}\left(\frac{wA_m}{qA_\ell}\right)^{\phi-1}}. \tag{A.22}$$

The labor share of domestic income is

$$s_\ell = \frac{w\ell}{pg-qm} = \frac{w\ell}{vy}\frac{vy}{pg}\frac{pg}{pg-qm} = \frac{\chi_\ell\theta_y}{1-\theta_y(1-\chi_\ell)}. \tag{A.23}$$

The labor share of income is increasing in χ_ℓ because labor absorbs a larger part of the composite good. The labor share of income is increasing in θ_y because θ_y increases the gap between the composite good and domestic income and labor is paid from the composite good.

For the comparative statics with respect to q, I again impose the assumption that w and R do not respond in equilibrium. The comparative statics of s_ℓ with respect to q depend on the relative values of σ and ϕ. If $\phi > \sigma$, then s_ℓ is an increasing function of q. The logic is that when imported intermediate inputs become cheaper, firms substitute more between capital and the composite good when σ is high, and firms substitute more between materials and labor when ϕ is high. The first effect tends to close the gap between the composite good and domestic income for high values of σ, whereas the second effect tends to increase the labor share of the composite good for high values of ϕ. When $\phi > \sigma$, the second effect dominates, and the labor share falls when the price of intermediate inputs decreases. Thus, for the theory that declines of q cause a decline of s_ℓ, we again need labor to be more substitutable with imported intermediate inputs than capital is.

Dynamic inefficiency with economic profits. Denote the capital stock per capita that maximizes consumption per capita in balanced growth by k^* and the equilibrium capital stock per capita by $\hat{k}$. In the neoclassical models with market power considered by Ball and Mankiw (2023), the capital stock that maximizes consumption satisfies

$$F_k(k^*) = n + \delta + g, \tag{A.24}$$

where F_k is the marginal product of capital, n is population growth, δ is the depreciation rate, and g is the growth rate of output per capita. The equilibrium capital stock satisfies

$$F_k(\hat{k}) = \mu(r+\delta), \tag{A.25}$$

Table A.3: Illustrations of Condition for Dynamic Inefficiency

s_ℓ	μ	λ	s_π	Naive $1 - s_\ell$	Adjusted $\lambda - \mu s_\ell$
0.60	1.00	1.00	0.00	0.40	0.40
0.60	1.10	1.00	0.09	0.40	0.34
0.60	1.20	1.00	0.17	0.40	0.28
0.60	1.30	1.00	0.23	0.40	0.22
0.60	1.40	1.00	0.29	0.40	0.16
0.60	1.20	1.08	0.10	0.40	0.36
0.60	1.30	1.17	0.10	0.40	0.39
0.60	1.40	1.26	0.10	0.40	0.42
0.60	1.50	1.35	0.10	0.40	0.45
0.60	1.20	1.10	0.08	0.40	0.38
0.60	1.30	1.15	0.12	0.40	0.37
0.60	1.40	1.20	0.14	0.40	0.36
0.60	1.50	1.25	0.17	0.40	0.35

where μ is the markup of prices over marginal cost.

Dynamic inefficiency arises if $n + \delta + g > \mu(r + \delta)$. By multiplying both sides by k/y and using the fact that the balanced growth investment rate is $i/y = (n + g + \delta)k/y$, we obtain $i/y > \mu s_k$, where $s_k = (r+\delta)k/y$ is the capital share of income. For the case of no labor market power, this criterion simplifies to

$$\frac{i}{y} > \lambda - \mu s_\ell, \tag{A.26}$$

where s_ℓ is the labor share of income and λ is returns to scale. The profit share in the case of no labor market power is $s_\pi = 1 - \lambda/\mu$. My analysis differs from Ball and Mankiw (2023) in that I express the criterion for dynamic inefficiency in terms of the labor share.

How does product market power change the calculus underlying the tests of dynamic inefficiency in Figure A.3? Table A.3 provides some illustrative calculations. The labor share is fixed at 0.6 in the first column, and each row of the table varies the markup μ and returns to scale λ in the next two columns. The fourth column shows the profit share s_π, the fifth column shows the naive criterion used in Figure A.3 that equates the capital share with one minus the labor share, and the sixth column shows the right-hand side of the criterion in equation (A.26), $\lambda - \mu s_\ell$, for the model with product market power. In the first panel, keeping returns to scale λ constant, we see that a significant increase in markups μ results in a significant decrease of the right-hand side of equation (A.26). In the second panel, returns to scale instead adjust to keep the profit rate constant as μ increases. In this case, the right-hand side of equation (A.26) increases with μ. Finally, the last panel adjusts λ less than in the second panel so that profits rise. But as the table shows the right-hand side of equation (A.26) does not decline significantly, because the rise in λ tends to offset the rise in μ.

In sum, increasing market power can lead to dynamic inefficiency only if it is associated with a significant increase in the economic profit share. If the rise of market power is accompanied with rising fixed costs, so that economic profits do not change much, then the analysis in Figure A.3 does not need to be modified significantly.

D Further Discussions

Discussion of the elasticity of substitution between capital and labor. Strategies to estimating the elasticity of substitution σ usually involve variants of our labor share solution (A.9) to project relative inputs or factor shares on input costs such as the wage and the cost of capital. Earlier, I explained the conceptual problems of using this equation for comparative statics. The same problems arise from an econometric perspective.

Chirinko (2008) summarizes the earlier estimates, which suggest an elasticity of substitution around 0.5. Several of these estimates appeal to within-country or within-industry variation in factor shares, relative inputs, and relative costs. These estimation techniques tend to identify short-term elasticities, which are expected to be lower than long-run elasticities once adjustments in output and input markets take place. They are prone to measurement errors, which attenuate the elasticity of substitution, because it is difficult to measure the marginal cost of labor and capital at high frequencies. Additionally, these techniques are plagued by endogeneity concerns and require strong assumptions about the time series behavior of markups μ, θ and factor-augmenting technologies A_k, A_ℓ.

At the micro level, Oberfield and Raval (2021) examine how establishments' wage bill to capital ratio varies with local wages to estimate micro-level elasticities between 0.3 and 0.7. The authors estimate an equation similar to (A.9), by projecting $w\ell/k$ on w. This approach amounts to delegating A_k, A_ℓ, θ, μ, and R into the error term. Another alternative is to use the capital-to-output ratio that I solved for in equation (A.5), which again requires assumptions about labor market markups and factor-augmenting technologies. The problem of using wages as the right-hand side variable is that we expect them to comove closely with labor-augmenting technology. Thus, using variation in wages to estimate the elasticity of substitution is not a credible strategy.

More recent estimates sidestep some of these problems by looking at long-term and cross-sectional variation in factor shares and the cost of capital. Karabarbounis and Neiman (2014b) estimate an elasticity of substitution of around 1.3 using an equation similar to (A.10) to project a function of the long-run change in labor share on the change in the relative price of investment, which does not require assumptions or measurements of wages and labor market markups. Further, we expect the cost of capital to move one to one with the relative price of investment in the long run, which makes the use of the relative price of investment a good proxy of the cost of capital. Hubmer (2023) exploits differential exposure across U.S. goods to the secular decline of the relative price of investment and estimates an elasticity of substitution of around 1.4. These approaches, however, still require assumptions on capital-augmenting technology and product market markups.

The impossibility of separating σ from A_k, A_ℓ without further structure is stressed by Diamond, McFadden, and Rodriguez (1978). Leon-Ledesma, McAdam, and Willman (2010) show that joint estimation using both the production function and the first-order conditions provides a useful alternative.

Houthakker (1955) famously demonstrated that the aggregation of micro-level Leontief technologies with independently distributed Pareto productivities leads to an aggregate Cobb-Douglas production function with a unitary elasticity of substitution. See Growiec (2013) for a microfoundation of aggregate production functions with an elasticity of substitution higher than one and Kaymak and Schott (2023) for industry elasticities higher than one despite unitary elasticities at the establishment level. Kehrig and Vincent (2021) document that within-establishment labor shares do not change much over time, which is consistent with unitary elasticities at the establishment level.

Discussion of the rise of markups. De Loecker, Eeckhout, and Unger (2020) apply the production approach pioneered by Hall (1988) to Compustat financial data. They infer markups as the ratio of the revenue elasticity of cost of goods sold to the revenue share of cost of goods sold (COGS). There are several concerns about their methodology, which infers an extremely large increase in markups.

1. Compustat represents only 30 percent of economic activity, and it is a selected sample of firms. So, it is not obvious how to generalize their results to the rest of the economy.

2. In Compustat, it is impossible to separate payments to flexible inputs from payments to inputs which require costs to adjust. The accounting item COGS does not reflect only payments to flexible inputs such as materials, as it also includes production and overhead labor costs. Conversely, as pointed out by Traina (2018), labor payments to non-production workers and some variable inputs are also included in the accounting item selling, general, and administrative (SG&A). There has been a shift of reported expenses over time away from COGS toward SG&A, because the ratio of sales to the sum of COGS and SG&A has been relatively constant over time. It is not obvious if this shift represents changes in market structure, changing interpretations of what financial accountants mean by production, an economic substitution of production activities performed by labor toward production activities performed by capital, or a rise in outsourcing, which could

cause a reclassification of otherwise economically similar expenses. The shift away from COGS toward SG&A is observed in many other countries (Karabarbounis and Neiman, 2019).

3. The authors do not aggregate firm-level markups appropriately. To be precise, if one is interested in the aggregate markup and the aggregate labor share, then the weights that need to be applied are cost weights, and not revenue weights, for the case in which cost elasticities are equalized across firms (Edmond, Midrigan, and Xu, 2023). If cost elasticities are not equalized, one needs to use harmonic revenue-weighted markups (Hasenzagl and Perez, 2023). Applying either of these alternative weighting schemes changes dramatically the magnitude of the increase of markups.

4. Compustat does not include prices and quantities of goods, only firm sales. In a static profit maximization problem, the ratio of revenue elasticities to revenue costs for a flexible input, which is what De Loecker, Eeckhout, and Unger (2020) calculate, is identically equal to one and thus uninformative about markups (Bond, Hashemi, Kaplan, and Zoch, 2021). If inputs are distorted, as is likely with inputs included in COGS, then the ratio identifies distortions between the input price and the cost of hiring the input. To see this point, consider the cost minimization problem of a firm that uses a flexible input m and a distorted input ℓ: $\min_{m,\ell} C = qm + (1+\tau)w\ell$ subject to $y(m,\ell) < \bar{y}$. The notion of distortion here is that τ drives a wedge between the cost of hiring ℓ and the observed price of ℓ, which is just w. From the first-order conditions for cost minimization and the revenue function py, we obtain that $1+\tau = [(\partial(py)/\partial\ell)/(py/\ell)]/[(w\ell)/(py)]$, which is the ratio of revenue elasticity to revenue share. If instead we use the flexible input, the ratio is identically one: $1 = [(\partial(py)/\partial m)/(py/m)]/[(qm)/(py)]$.

5. Echoing the arguments of Basu (2019), with constant returns to scale, moving from 20 percent to 60 percent markups implies an increase in the profit share from 17 percent to 38 percent for a representative firm. This is because, in the absence of labor market distortions, the profit share is equal to $s_\pi = 1 - \lambda/\mu$, where λ are returns to scale. Since the labor share is around 60 percent, opportunity costs must absorb almost none of income. To partly avoid this absurd prediction, one must argue that fixed costs have increased over time. While rising fixed costs are consistent with a reallocation of economic activity from low fixed cost and high marginal cost industries to high fixed cost and low marginal cost industries, the measured decreases in the labor share and rise of markups are mostly within-industry phenomena. Arguments that rely on fixed costs being large are inconsistent with research that indicates that the typical industry has constant or decreasing returns to scale (Basu and Fernald, 1997), and it is unclear what economic forces have caused fixed costs to increase by so much over time within industry or within

firm.

Appendix References

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