Labor Share Decline and Intellectual Property Products Capital*

Dongya Koh
University of Arkansas

Raül Santaeulàlia-Llopis
MOVE-UAB and Barcelona GSE

Yu Zheng
Queen Mary University of London and CEPR

July 9, 2019

Abstract

We study the behavior of the US labor share over the past 70 years. We find that the observed decline of the US labor share is entirely explained by the capitalization of intellectual property products in the national income and product accounts. We assess the implications of this result for the US macroeconomic model and discuss the way forward.

Keywords: Labor Share, Intellectual Property Products, Capital, 1999- and 2013-BEA Revisions
JEL Classification: E01, E22, E25

*A first draft of this work was available as a working paper in the Fall of 2013 right after the Bureau of Economic Analysis (BEA) revision that capitalized R&D in national accouns. Since then, the paper has grown with comments and suggestions from discussants and seminar participants at many venues that we have visited and that we would like to thank. Special thanks go to Michele Boldrin and Ellen McGrattan for their comments at the earliest stages of this project. We would also like to thank Jennifer Lee, Lisa Mataloni, Edward Morgan, Gregory J. Punchak, and Dylan Rassier at the BEA and Monica Asselin and Christopher M. Russell for their insights on the vintage data from the St. Louis FED ALFRED database. Raül Santaeulàlia-Llopis thanks the Social Sciences grant by the Fundación Ramón Areces, the ERC AdG-GA324048, "Asset Prices and Macro Policy when Agents Learn (APMPAL)", and the Spanish Ministry of Economy and Competitiveness through the Severo Ochoa Programme for Centers of Excellence in R&D (SEV-2015-0563) for financial support.

1 Introduction

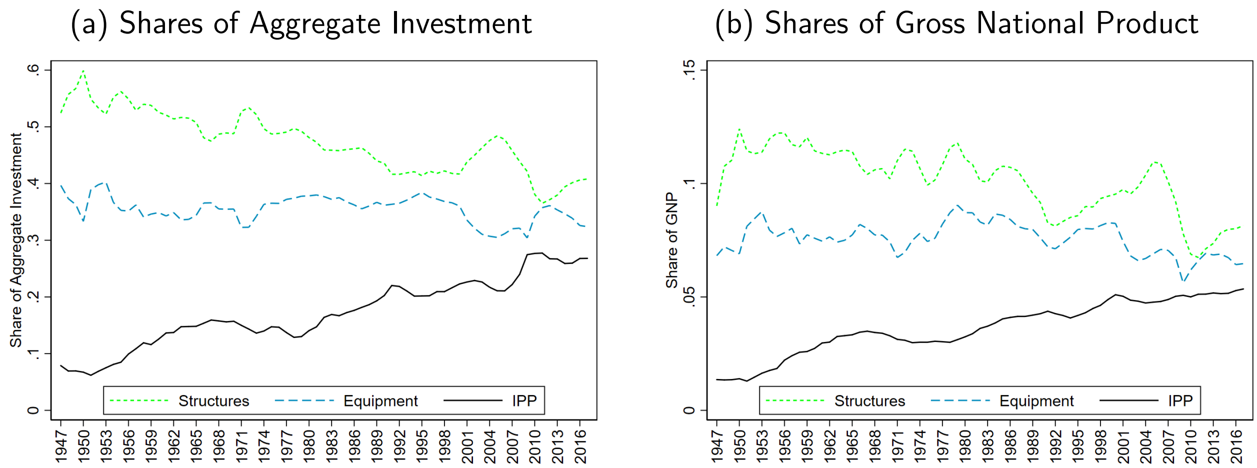
After carefully analyzing the most recent national income and fixed assets data, we show that the secular decline of the accounting labor share (LS), the observation that motivates a growing body of research on factor income shares (Elsby, Hobijn, and Sahin, 2013, Karabarbounis and Neiman, 2014), is entirely driven by the recent capitalization of intellectual property products (IPP) in the national income and product accounts (NIPA). The capitalization of IPP—previously treated as intermediate nondurable consumption in the business sector and final consumption in nonprofit institutions serving households (NPISH) and general government—is a major accounting change in the NIPA.

The capitalization of IPP has been gradually introduced by the Bureau of Economic Analysis (BEA) through two comprehensive revisions of the NIPA. In 1999, the 11th BEA revision capitalized software expenditures by business, NPISH, and government. Prior to this revision, software expenditure was considered intermediate nondurable consumption in the business sector and final consumption in NPISH and general government. Analogously, after the 14th revision in 2013, the BEA treats the expenditures by businesses, NPISH, and the government for R&D and those by private enterprises for the creation of entertainment, literary and artistic originals (henceforth, artistic originals) as investments in the form of durable capital, that is, no longer as business expenditures in intermediate nondurable goods or as NPISH and government final consumption. These newly recognized forms of investment (i.e., software, R&D, and artistic originals) constitute the set of intangible assets currently measured by the BEA, the so-called IPP. These revisions aim to capture the increasingly important role of IPP in the US economy (Corrado, Haltiwanger, and Sichel, 2005, McGrattan and Prescott, 2010, 2014, Akcigit, Celik, and Greenwood, 2016). Notably, the share of IPP in aggregate investment secularly increases from 8% in 1947 to 27% in 2017 in the NIPA (see Figure 1). This structural shift toward a more IPP–intensive economy measured by the BEA is large and does not show signs of deceleration.[1]

What are the effects of the capitalization of IPP on the LS? These effects strictly depend on how the newly recognized income (or rents) generated from IPP is distributed across capital and labor. We find that the capitalization of IPP unambiguously lowers the level of the LS in a purely accounting sense. The reason is simple. The BEA attributes the entire rents generated from IPP to capital income. First, in terms of the business sector, the capitalization of IPP revises up the value added (VA) of businesses by an amount equal to the gross investment in business IPP—which is equal to the sum of own-account IPP and purchased IPP in the business

[1] Excluding residential investment accentuates this shift: IPP investment increases from 11.0% of nonresidential aggregate investment in 1947 to 33.2% in 2017. In the corporate sector, the shares increase from 8% in 1947 to 33.6% in 2017. See the *Online Appendix*.

Figure 1: Investment Shares, BEA 1947–2017



Notes: All data were retrieved from the BEA in March 25, 2019. Our data and results are available in this permanent link: US Factor Shares.

sector.[2] To restore the accounting identity between the product side and the income side of the national accounts, the BEA must attribute the increase in the product to the factors' income. The current accounting assumption is to attribute the entire gross investment in business IPP to gross operating surplus (GOS), i.e., to capital income. This attribution automatically lowers the LS, which is one minus the ratio of the GOS to the VA. That is, an increase in IPP investment on the product side of the accounts translates into an equal increase of capital income on the income side of the accounts and, hence, on a lower LS constructed from national accounts. Second, since the NPISH and government expenditure in the IPP was previously treated as part of the final consumption and hence already in the value added, the capitalization increases the NPISH and government product by an amount equal to the depreciation of their respective IPP capital. From the income side of the accounts, the NPISH and government IPP depreciation is allocated to GOS, which further lowers the level of the accounting LS.

In this context, the fact that IPP investment is increasing over time at a faster rate than output implies that the capitalization of IPP can affect not only the level of the LS but also the trend of the LS. Our question is: Could the rise in IPP investment over time explain the secular decline of the accounting LS? We find that it entirely does. To measure the effects of the capitalization of IPP on the secular behavior of the LS, we compare our benchmark LS, which is constructed using current post-2013 BEA revision data, with a counterfactual accounting LS in which we decapitalize IPP from national accounts. The counterfactual accounting LS is constructed by undoing the capitalization of IPP, that is, removing gross business investment in IPP and NPISH and government IPP depreciation from both GOS and VA. This counterfactual accounting LS is consistent with the accounting rule in which all IPP is considered as an expense, as was the

[2]We describe the separate details of the effects of own-account IPP and purchased IPP in Section 2.

procedure before the revisions that capitalize IPP. The comparison between the benchmark LS and this counterfactual accounting LS yields the main result of our paper: In sharp contrast to the benchmark LS which exhibits a prolonged secular decline, the counterfactual LS in which IPP is expensed (not capitalized) is absolutely trendless. That is, the capitalization of IPP explains the entire secular decline of the accounting LS.[3]

The rest of this paper is organized as follows. We describe the BEA revisions that capitalize IPP in Section 2. We show the effects of the IPP capitalization on the decline of the accounting LS in Section 3. We examine the BEA assumptions behind the capitalization of IPP, discuss issues related to the unobservability of a broader set of intangibles, and discuss the implications of our results for the US model in Section 4. Section 5 concludes.

2 The Capitalization of IPP in the National Accounts

Under the current system of national accounts used by the BEA, the expenditure on IPP (i.e., software, R&D, and artistic originals) is treated as part of aggregate investment in NIPA. This treatment is the result of two recent comprehensive BEA revisions that gradually and retrospectively capitalized IPP items—software in the 1999 revision and R&D and artistic originals in the 2013 revision. Prior to these revisions, IPP was treated as expenditure in intermediate nondurable goods for businesses and as final consumption for NPISH and the government. Because the accounting changes associated with the capitalization of software, R&D and artistic originals are analogous, we place the two recent revisions into one illustrative IPP revision. We describe the impact of the capitalization of IPP on the business accounts in Section 2.1, on the entire economy including NPISH and government accounts in Section 2.2, and on the accounting LS in Section 2.3.

2.1 Effects of IPP Capitalization on the Business Accounts

Denote the pre-revision gross output in the business sector with Q (line 1, Table 1). Businesses engage in both in-house production of IPP and purchases of IPP. The capitalization of IPP implies that the business expenditure in own-account IPP, I_o, becomes part of gross output.[4] That is,

[3]Notably, the BEA is always trying to improve the measurement of national accounts and frequently updating the accounts. For example, as part of these ongoing revisions, the BEA is aiming to reclassify software R&D from software investment to R&D investment and incorporating capital services into the estimates of own-account investment in software and R&D. Part of these changes were introduced in the 2018 comprehensive revision of NIPA. All our data was retrieved from the BEA in March 25, 2019 and we find that our results are not altered by this most recent revision.

[4]Software and R&D purchases are captured with receipts from sales data from the Census Bureau. However, a large part of IPP is produced in-house and not sold in the market. Because own-account software and R&D is not sold in the market, the BEA estimates the own-account production of software and R&D as the sum of costs

Table 1: Effects of IPP Capitalization on the Business Sector: Value Added and Income Accounts

	Notation	USD Bill. 1947	2017
1. Gross output, pre-revision	Q	430.3	30,079.6
2. Plus own-account IPP	I_o	1.5	615.7
3. *Equals*: Gross output, post-revision:	$Q + I_o$	431.8	30,695.3
4. Intermediate expenditure, pre-revision	$M + I_p$	216.0	13,877.0
5. Less purchased IPP	I_p	0.5	213.4
6. *Equals*: Intermediate expenditure, post-revision	M	215.5	13,663.6
7. Value added, pre-revision (L. 1−4):	$Q - (M + I_p)$	214.2	16,202.6
8. Plus own-account and purchased IPP (I_b)	$I_o + I_p$	2.0	829.1
9. *Equals*: Value added, post-revision (L. 3−6)	$(Q + I_o) - M$	216.2	17,031.7
10. Compensation of Employees	W	110.4	8,478.3
11. Gross operating surplus (GOS), pre-revision (L. 7−10)	$Q - (M+I_p) - W$	103.9	7,724.3
12. Plus own-account and purchased IPP (I_b)	$I_o + I_p$	2.0	829.1
13. *Equals*: GOS, post-revision (L. 9−10)	$(Q + I_o) - M - W$	105.9	8,553.4
14. Depreciation, pre-revision	D	16.4	1,860.2
15. Plus depreciation of business IPP	D_{I_b}	1.3	714.4
16. *Equals*: Depreciation, post-revision	$D + D_{I_b}$	17.7	2,574.6
17. Net operating surplus (NOS), pre-revision (L. 11−14):	$Q - (M+I_p) - W - D$	87.5	5,864.1
18. Plus own-account and purchased IPP (I_b)	$I_o + I_p$	2.0	829.1
19. Less depreciation of IPP	D_{I_b}	1.3	714.4
20. *Equals*: NOS, post-revision (L. 13−16)	$(Q + I_o) - M - W - (D + D_{I_b})$	88.2	5,978.8

Notes: All data were retrieved from the BEA in March 25, 2019. Gross output, intermediate input expenditure, and value added refer to all private industries obtained from the BEA Industry Accounts. The compensation of employees for all private industries is obtained from the BEA NIPA Table 6.2. The depreciation for the business sector is obtained from Table 2.4 in the BEA Fixed Asset Tables (FAT). Own account Investment is obtained from the BEA R&D Satellite Account and the authors calculation.

the revised gross output increases by an amount equal to the expenditure on own-account IPP and becomes $Q + I_o$ (line 3, Table 1).

In terms of intermediate expenditure, the pre-revision accounting has two components: The expenditure on intermediate inputs in the production of non-IPP and own-account IPP (e.g., cost of energy for in-house R&D labs), M, plus the business expenditure on purchased IPP, I_p (line 4, Table 1). The capitalization of IPP implies that business expenditure on purchased IPP is no longer considered an intermediate expenditure in the post-revision accounting (line 6, Table 1).

(i.e., wages, nonwages, and intermediates) plus a markup based on the net operating surplus of the miscellaneous professional, scientific, and technical services industry (Crawford et al., 2014). Investment in artistic originals is measured using net present valuation.

Subtracting the intermediate expenditure from the gross output, we obtain the value added. The value added is consequently revised up by an amount equal to the gross investment in IPP in the business sector, that is, the sum of business expenditure in own-account IPP and purchased IPP, or $I_b = I_o + I_p$ (lines 7 to 9, Table 1). This revision increases the value added in the business sector by 2.0 billion in 1947 and by 829.1 billion in 2017. Since the gross investment in the IPP as a share of the value added increases from 1% in 1947 to 5% in 2017, the effect of the revision on the value added also increases over time. The value added is revised up by 0.93% in 1947, whereas this percentage is 5.12% in 2017.

On the income side of the business accounts, the BEA increases income by the same amount as the gross IPP investment in the business sector. This preserves the balance of the product and income accounts in the business sector. The BEA must also decide to which income accounts to attribute the rents from IPP investment. Let's denote with $\chi \in [0, 1]$ the proportion of IPP rents attributed to capital income accounts, and $1 - \chi$ the proportion attributed to labor income accounts. The choice of χ will turn out to be a critical decision for the secular behavior of the LS. We denote the compensation of employees by W and obtain the GOS as the value added minus W. The current accounting assumption implemented by the BEA regarding the split of IPP between capital and labor is to allocate the entire IPP investment rents to GOS. That is, the BEA assumes that the income rents from IPP investment are entirely attributed to capital income accounts, i.e., $\chi = 1$. This implies that GOS is revised up by exactly the gross investment in IPP in the business sector, $I_o + I_p$ (lines 11 to 13, Table 1). Precisely, GOS is revised up by 1.93% in 1947 and by 10.73% in 2017.

It is relevant to notice that this direct connection between investment in the product side of the accounts and GOS in the income side of the accounts that the BEA applies to the capitalization of IPP does not exist for other forms of investment. Indeed, the measurement of investment in structures and equipment on the product side of the accounts is independent from the measurement of the rents generated from those forms of investment on the income side of the accounts which are filtered through all components of income (e.g., profits, net interest and rental income); see NIPA Handbook (2017). That is, prior to the capitalization of IPP there is not direct accounting movement from aggregate investment on the product side of the accounts to GOS on the income side of the accounts. This direct link implemented by the BEA between investment (product) and the rents that it generates (income) is unique to IPP.

Lastly, we divide the GOS into its two components: the depreciation and the net operating surplus (NOS). The capitalization of IPP naturally generates depreciation for the IPP capital, D_{I_b}, which must be added to the pre-revision depreciation (lines 14 to 16, Table 1). Consequently, the NOS is increased by the net investment in business IPP, that is, $I_b - D_{I_b}$ (lines 17 to 20,

Table 1). Further breakdown along the finer categories of the business income account shows that the boost in NOS increases corporate profits and proprietors' income (McCulla et al., 2013). Due to the increase in depreciation, the revision increases NOS less than it increases GOS. More specifically, NOS is revised up by 0.8% in 1947 and by 1.96% in 2017.

2.2 Effects of IPP Capitalization on Private and Government Accounts

We now discuss the NPISH and government sector. The business and NPISH together form the private sector and the government sector includes all federal, state, and local governments, and completes the effects of the capitalization of IPP on the national accounts.

The capitalization of IPP affects the NPISH accounts and the government accounts in a similar manner. The IPP expenditure by the NPISH, I_{np}, (or the government, I_g) was treated as personal consumption expenditure (or government final consumption) before the revision as opposed to investment expenditure after the revision. For this reason, the pre-revision accounting did not include the depreciation of NPISH IPP capital, $D_{I_{np}}$, (or the depreciation of government IPP capital, D_{I_g}), in the product accounts and this changes with the capitalization of IPP. The revision moves NPISH (or government) net investment in IPP out of personal (or government) consumption (lines 1 to 3 and 7 to 9 in Table 2). Upon revision, private (or government) gross investment increases by the gross investment in business and NPISH (or government) IPP (lines 4 to 6 and 10 to 12 in Table 2).

The total effects on the private sector, which is the sum of the businesses and NPISH, are that personal consumption is revised down by the net investment in IPP by the NPISH, $I_{np} - D_{I_{np}}$, and the gross private investment is revised up by the sum of the business and NPISH gross investment in IPP, $I_b + I_{np}$. These results imply that private product is revised up by gross business investment in IPP, I_b, plus the depreciation of NPISH IPP capital, $D_{I_{np}}$. The total effect on the government expenditure, which is the sum of the government consumption and gross government investment, is that it is revised up by the depreciation of the government IPP capital, D_{I_g} (lines 13 to 15, Table 2).[5]

Piecing together the private and the government sectors, the revised gross domestic product, GDP, inherits all these effects from private consumption, private gross investment, and govern-

[5] McCulla et al. (2013) document that there were two additional changes introduced in reclassifying government IPP from consumption to investment. First, there was a change in the ownership of IPP assets from state and local governments to federal government. Second, BEA started using National Science Foundation (NSF) surveys of R&D instead of federal budget data. Those two changes make government R&D investment slightly larger than government R&D consumption. We do not incorporate these additional accounting changes in the pre-revision accounting counterfactuals that we describe in Section 3. However, note that removing this additional government R&D investment to construct the pre-revision accounting LS would simply strengthen our results in Section 3.

Table 2: Effects of IPP Capitalization on the Private and Government Product Accounts

	Notation	USD Bill. 1947	2017
Private sector:			
1. Personal consumption expenditure, pre-revision	C	161.9	13,324.2
2. Less: NPISH net investment in IPP	$I_{np} - D_{I_{np}}$	-0.1	2.8
3. *Equals*: Personal consumption expenditure, post-revision	$C - (I_{np} - D_{I_{np}})$	162.0	13,321.4
4. Gross private investment, pre-revision	X	35.1	2,514.7
5. Plus: Gross private investment in IPP	$I_b + I_{np}$	2.0	853.3
6. *Equals*: Gross private investment, post-revision	$X + I_b + I_{np}$	37.1	3,368.0
Government sector:			
7. Government consumption, pre-revision	C_g	34.7	2,742.6
8. Less: Government net investment in IPP	$I_g - D_{I_g}$	0.4	11.3
9. *Equals*: Government consumption, post-revision	$C_g - (I_g - D_{I_g})$	34.3	2,731.3
10. Gross government investment, pre-revision	X_g	4.3	440.6
11. Plus: Gross government investment in IPP	I_g	1.4	202.6
12. *Equals*: Gross government investment, post-revision	$X_g + I_g$	5.7	643.2
13. Government expenditure, pre-revision (L. 7+10)	G	39.0	3,183.1
14. Plus: Government depreciation in IPP	D_{I_g}	1.0	191.3
15. *Equals*: Government expenditure, post-revision (L. 9+12)	$G + D_{I_g}$	40.0	3,374.4
Gross domestic product, GDP:			
16. GDP, pre-revision (L. 1+4+13)	$C + X + G$	236.0	18,443.6
17. Plus: Business investment in IPP	I_b	2.0	829.1
18. Plus: NPISH depreciation in IPP	$D_{I_{np}}$	0.1	21.4
19. Plus: Government depreciation in IPP	D_{I_g}	1.0	191.3
20. *Equals*: GDP, post-revision (L. 3+6+15)	$C + (X + I_b + D_{I_{np}}) + (G + D_{I_g})$	239.1	19,485.4

Notes: All data were retrieved from the BEA in March 25, 2019. Personal consumption expenditure, C, gross private domestic investment X, government expenditure (including consumption and gross investment), G, and GDP come from NIPA Table 1.1.5 and 3.9.5. We ignore net exports of goods and services from GDP in this illustrative Table because these are unaffected by IPP capitalization. Our quantitative analysis in Section 3 incorporates net exports. Business, NPISH, and government's gross investment in IPP come from the Fixed Asset Tables 2.7 and 7.5, and their depreciation from the Fixed Asset Tables 2.4 and 7.3.

ment expenditure. Therefore, the revised GDP is increased by an amount equal to the increase in the business investment in IPP, I_b, plus the depreciation of NPISH IPP capital, $D_{I_{np}}$, and the depreciation of government IPP capital, D_{I_g} (lines 16 to 20, Table 2). In summary, this revision results in an increase of 1,041.8 billion in the GDP in 2017, that is, an increase of 5.65% with respect to its pre-revision counterpart. The effect is much lower in 1947, with an increase of 3.1 billion, that is, an increase of 1.3% of its pre-revision counterpart.

On the income side of the accounts, the capitalization of IPP increases gross domestic income

(GDI) by the same amount as GDP, that is, by the sum of the gross investment in business IPP and the depreciation of NPISH and government IPP capital, $I_b + D_{I_g} + D_{I_{np}}$. As was the case for the business sector, for the entire economy, the BEA also assumes that all the increase in GDI that results from the capitalization of IPP is attributed to GOS and, hence, to capital income. In other words, GOS and GDI are increased by exactly the same amount. Notably, we can decompose the increase in GOS as the net investment in business IPP (i.e., $I_b - D_{I_b}$) plus the total depreciation of IPP summing over all sectors (i.e., $D_{I_b} + D_{I_g} + D_{I_{np}}$). Consequently, the net operating surplus (NOS) is increased by the net investment in business IPP, which increases corporate profits and proprietors' income.

2.3 Qualitative Implications for the LS

It should be clear by now that the addition to the product account of the amount of IPP investment is balanced by an equal addition to the GOS on the income account. This particular accounting procedure chosen by the BEA allows us to undo the capitalization of IPP in a straightforward way and assess its implications for the accounting LS.[6] Clearly, if IPP investment is strictly positive, then the capitalization of IPP unambiguously decreases the accounting LS. To observe this decrease, define the LS as,

$$LS = 1 - \frac{GOS}{Y},$$

where Y is GDP and the ratio of GOS to Y is the capital share of income.[7] Then, the difference between the post-revision accounting LS, LS_{Post}, and the pre-revision accounting LS, LS_{Pre}, is as follows:

$$LS_{\text{Post}} - LS_{\text{Pre}} = \left(1 - \frac{GOS_{\text{Post}}}{Y_{\text{Post}}}\right) - \left(1 - \frac{GOS_{\text{Pre}}}{Y_{\text{Pre}}}\right) = \frac{(GOS_{\text{Post}} - Y_{\text{Post}})\Delta}{(Y_{\text{Post}} - \Delta)Y_{\text{Post}}} < 0$$

where $\Delta = I_b + D_{I_g} + D_{I_{np}} = GOS_{\text{Post}} - GOS_{\text{Pre}} = Y_{\text{Post}} - Y_{\text{Pre}} > 0$. The negative sign in the last inequality is explained by Y being larger than its components: $Y > GOS$, and $Y > \Delta$.

Thus, under the accounting assumption on the factor income distribution of IPP rents—that attributes all these rents to GOS, the effects of the capitalization of IPP on the secular behavior

[6] The same cannot be said about other types of capital. We would not be able to undo the capitalization of structures and equipment in a purely accounting sense because the income rents generated by these forms of capital filter through all components of the income accounts. See our discussion in Section 2.1.

[7] Here we use GOS interchangeably with capital income, although part of GOS can not be unambiguously attributed to capital (e.g., proprietor's income). While this is innocuous for the qualitative argument of this Section, we carefully correct for this ambiguous income in our quantitative analysis in Section 3.

of the accounting LS depend solely on the rise of IPP investment, in particular,

$$\frac{\partial\left(LS_{\text{Post}} - LS_{\text{Pre}}\right)}{\partial \Delta} = -\frac{Y_{\text{Post}} - GOS_{\text{Post}}}{\left(Y_{\text{Post}}\right)^2} < 0.$$

This opens the question of whether the capitalization of IPP can explain the decline of the accounting LS. This is the quantitative question that we explore next.

3 The Effects of IPP Capitalization on the LS

We construct our benchmark accounting LS using an economy-wide definition standard in the business cycle literature (Cooley and Prescott, 1995). Following this approach, we split the components of national income that cannot be unambiguously attributed to capital or labor (mainly proprietors' income) by using the factor shares of the unambiguous income of the economy:

1. Unambiguous Capital Income (UCI) = Rental Income + Corporate Profits + Net Interest + Current Surplus Government Enterprises + Taxes on Production − Subsidies − (Sales & Excise Taxes) + Business Current Transfers Payments + Statistical Discrepancy
2. Unambiguous Income (UI) = UCI + Depreciation (DEP) + Compensation of Employees (CE)
3. Proportion of Unambiguous Capital Income to Unambiguous Income: $\theta = \frac{\text{UCI+DEP}}{\text{UI}}$.
4. Ambiguous Income (AI) = Proprietors' Income + Sales & Excise Taxes
5. Ambiguous Capital Income (ACI) = $\theta \times$ AI.

Then, capital income (or GOS adjusted for ambiguous income) is computed as

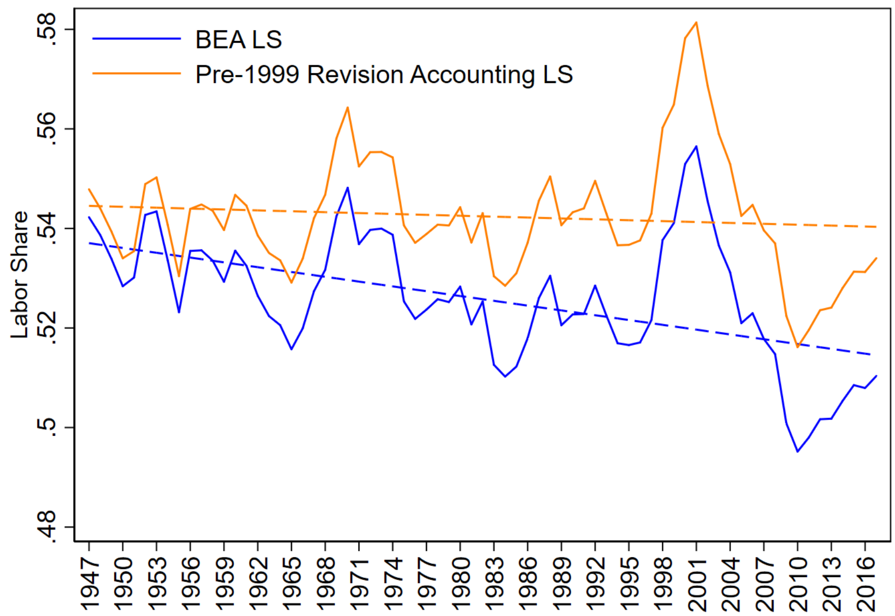
$$GOS = \text{UCI} + \text{DEP} + \text{ACI}, \tag{1}$$

and our benchmark accounting LS is

$$LS = 1 - \text{Capital Share} = 1 - \frac{GOS}{Y}, \tag{2}$$

where Y is the gross national product (GNP), that is, the sum of ambiguous and unambiguous income and depreciation. Because the IPP reclassification does not affect net foreign factor

Figure 2: Economy-Wide US Labor Share, BEA 1947–2017: Pre- Vs. Post-Revision Accounting



Notes: All the time series are computed using current BEA data retrieved on March 25, 2019, see *Online Appendix* A. The BEA LS (blue line) is constructed based on the economy-wide definition described in Section 3 by using the current post-2013 revision BEA data from 1947 to 2017, the latest available year. The pre-1999 revision accounting LS uses equation (3) to replicate the accounting rule in which IPP is expensed. Dotted lines show linear trends from 1947 to 2017. Our data and results are available in this permanent link: US Factor Shares.

income, which is trendless, our results are almost identical using either GNP or GDP.[8] Finally, as is standard in the business cycle literature, we also add, to GOS and Y, the capital income rents from consumer durable goods and government capital which are not incorporated in NIPA (Cooley and Prescott, 1995). See our *Online Appendix* for details.[9]

Figure 2 shows the time series of the benchmark accounting LS (i.e., the economy-wide BEA LS labeled "BEA LS"). Clearly, the accounting LS exhibits a relentless secular decline starting in the late 1940s. The LS begins at 54.2% in 1947 and reaches a value of roughly 51.0% in 2017 with a historical low at 49.5% in 2010, that is, a decline of 4 LS points, or approximately 8.7 percentage points.[10]

[8]In our permanent data link, US Factor Shares, we report our results using GDP. The difference between GNP and GDP, that is, net foreign factor income, averages 0.7% of GNP from 1947 to 2017 without any discernible long-run trends. See NIPA Table 1.7.5.

[9]As in Cooley and Prescott (1995), we add capital income from consumer durables and government capital to both GOS and Y, by using the net rate of return of the rest of the economy and the respective depreciation rates for consumer durables and government capital from the Fixed Assets Tables (FAT). This is consistent with the definitions of the LS in the business cycle literature (Gomme and Rupert, 2004, 2007, Ríos-Rull and Santaeulàlia-Llopis, 2010, McGrattan and Prescott, 2014, Koh and Santaeulàlia-Llopis, 2017). The results of our exercise remain to hold in the absence of this addition, see our discussion on the corporate sector LS using BEA data or the economy-wide "asset-basis" LS using data from the Bureau of Labor Statistics in *Online Appendix*.

[10]Notice that the average level of our economy-wide accounting LS is lower than the value of two thirds usually

To assess the effects of IPP capitalization on the accounting LS, we compare our benchmark LS with a counterfactual accounting LS consistent with the accounting treatment of IPP before the 1999 BEA revision. That is, in the counterfactual we entirely decapitalize IPP from national accounts by undoing the accounting changes described in Section 2. Specifically, we subtract the gross investment in business IPP (I_b), the NPISH IPP capital depreciation ($D_{I_{np}}$), and the government software and R&D capital depreciation (D_{I_g}) from GOS and Y. In this way, the counterfactual accounting LS that follows the pre-1999 accounting rule is as follows:

$$LS_{Pre\text{-}1999} = 1 - \frac{GOS - (I_b + D_{I_{np}} + D_{I_g})}{Y - (I_b + D_{I_{np}} + D_{I_g})}. \tag{3}$$

The comparison between our benchmark LS (blue line, Figure 2) and the pre-1999 revision counterfactual LS (orange line, Figure 2) delivers the main result of our paper: In sharp contrast to the decline of the benchmark LS, the pre-1999 revision counterfactual LS is absolutely trendless, with an average value of 54.2%.[11] That is, the decline of the accounting LS is entirely explained by the capitalization of IPP in national accounts. Had the BEA kept the pre-1999 treatment of IPP (as an expense), the LS would display no secular trend.[12]

The rising role of software after the 1970s. Our analysis has focused on the counterfactual accounting LS consistent with pre-1999 treatment of IPP, that is, before the capitalization of both software and R&D.[13] This implies that our examination considers the joint effects of capitalizing all IPP items rather than investigating software and R&D separately. We now decompose the effects of software capitalization and R&D capitalization. To do so, we provide a second counterfactual accounting LS consistent with the accounting rule directly before the 2013 BEA revision, that is, we decapitalize only R&D from the national accounts. Specifically, we subtract the gross investment in business R&D ($I_{b,R\&D}$), the NPISH R&D capital depreciation ($D_{I_{np,R\&D}}$), and the government R&D capital depreciation ($D_{I_{g,R\&D}}$) from both GOS and Y. This counterfactual LS

attained for the business sector. This is due to the fact that we extend national income using measures of consumer durables and government capital (see *Online Appendix*). Our results do not depend on the inclusion of consumer durables and government capital in national income. To corroborate this, see our study of the corporate sector below.

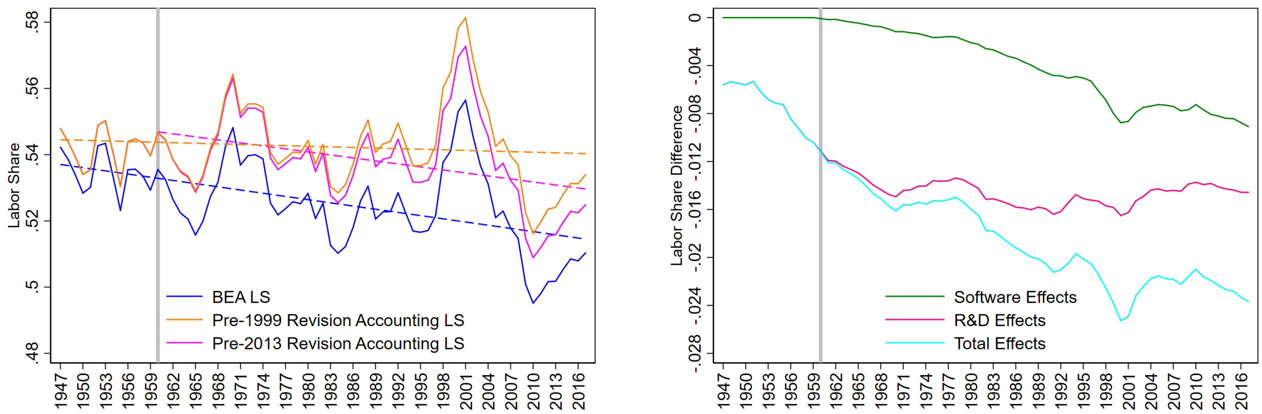
[11]Precisely, from 1947 to 2017, the linear trend of the benchmark LS is significantly negative, -0.0228, and that of the pre-1999 revision counterfactual LS is not statistically significantly different from zero.

[12]Our results are also externally validated using vintage data; see our *Online Appendix*. Lastly, the extension of our analysis to a larger sample period from 1929 to 2017 does not change our results either; see also our *Online Appendix*.

[13]For ease of reference, we subsume artistic originals to the R&D; thus, in the notation that follows, the R&D and artistic originals are simply referred to as R&D.

Figure 3: The Effects of Software and R&D Capitalization Revisions on the Accounting LS

(a) The Pre-2013 Revision Accounting LS (b) Decomposition of the Accounting LS Decline



Notes: All data were retrieved from the BEA on March 25, 2019. In panel (a), the pre-2013 revision accounting LS uses equation (4) to replicate the accounting rule in which software is capitalized and R&D (and artistic originals) are expensed. The BEA LS [equation (2)] and the pre-1999 revision accounting LS [equation (3)] reproduce Figure 2. Dotted lines show linear trends from 1947 to 2017 for the BEA LS and pre-1999 revision accounting LS, and from 1960 to 2017 for the pre-2013 revision accounting LS. The vertical gray line in 1960 indicates the first year with nonzero software investment in NIPA. In panel (b), we compute the total labor share decline as the difference between the BEA LS and the pre-1999 revision accounting LS. The effects of R&D capitalization on the LS decline is computed as the difference between the BEA LS and the pre-2013 revision accounting LS. The effects of software capitalization on the LS decline is computed as the difference between the pre-2013 revision accounting LS and the pre-1999 revision accounting LS. Our data and results are available in this permanent link: US Factor Shares.

consistent with the pre-2013 accounting rule is as follows:

$$LS_{Pre\text{-}2013} = 1 - \frac{GOS - (I_{b,R\&D} + D_{I_{np,R\&D}} + D_{I_{g,R\&D}})}{Y - (I_{b,R\&D} + D_{I_{np,R\&D}} + D_{I_{g,R\&D}})}. \tag{4}$$

Compared with the benchmark LS, the pre-2013 revision counterfactual LS displays a milder decline that starts in the mid-1970s and is approximately half of that of the benchmark LS in 2017 (panel (a), Figure 3). This suggests a quantitatively similar role for the software and R&D in explaining the decline of the accounting LS.

A simple decomposition quantifies the effects of R&D and software capitalization separately. First, we measure the effects of R&D capitalization on the LS decline as the difference between the BEA LS [equation (2)] and the pre-2013 revision accounting counterfactual LS [equation (4)]. Second, the effects of software capitalization on the LS decline can be computed as the difference between the pre-2013 revision accounting counterfactual LS [equation (4)] and the pre-1999 revision accounting counterfctual LS [equation (3)]. The total decline of the LS is the sum of these two effects, that is, the difference between the BEA LS [equation (2)] and the pre-1999 revision accounting LS [equation (3)]. Our results are in panel (b) in Figure 3. Clearly, it is the capitalization of software what solely drives the declining trend of the accounting LS after 1980s,

Figure 4: Gross Vs. Net LS

(a) Pre-1999 Revision Accounting LS [IPP Expensed]

(b) BEA LS [IPP Capitalized]

Notes: All data were retrieved from the BEA on March 25, 2019. Net LS is constructed by subtracting depreciation from our measure of GOS [see equation (1)] and using net national product (NNP) instead of GNP. Under both the pre-1999 and the post-2013 revision accounting rules we find that the net LS has positive, although small and nonsignificant, linear trends with, respectively, values of 0.0066 and 0.0055. Our data and results are available in this permanent link: US Factor Shares.

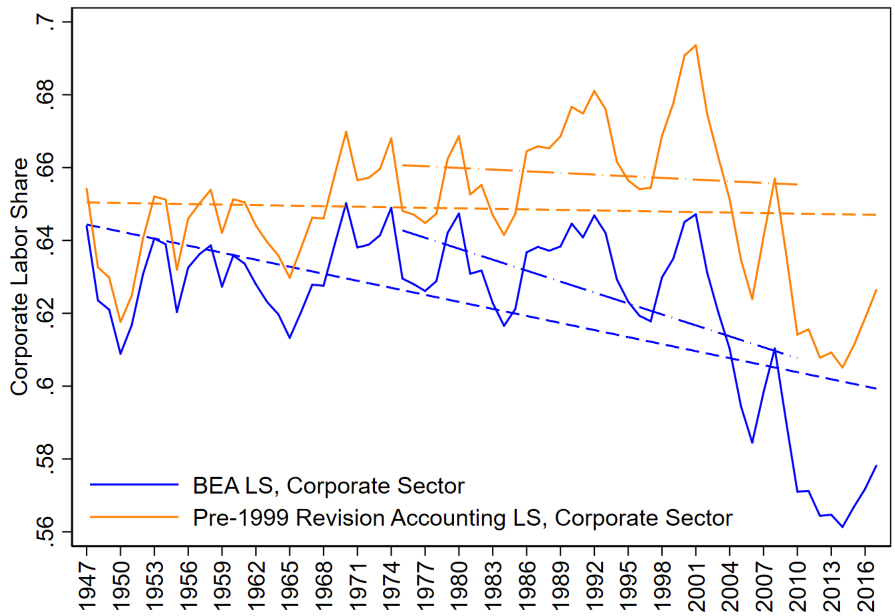
while the capitalization of R&D generates the decline of the LS before the 1980s. This simply reflects the growing relative importance of software in IPP investment.

This result directly speaks to earlier work on the decline of the LS that strictly relied on evidence from the pre-2013 revision data (Elsby et al., 2013, Karabarbounis and Neiman, 2014). Our result implies that the decline of the LS observed in that earlier work—that uses data for which software is capitalized but not R&D—is explained by the capitalization of software. To see this, simply compare the declining pre-2013 revision accounting LS in which software is capitalized (pink line, panel (a) in Figure 3) with the trendless pre-1999 revision accounting LS in which software is not capitalized (orange line, panel (a) in Figure 3).

Gross versus net. Thus far, we have focused on the gross LS. Part of the macro literature emphasizes that the decline in net LS is less pronounced than that of the gross LS, suggesting that the increased depreciation explains the decline of the LS (Bridgman, 2017).[14] We show that this phenomenon is also the result of IPP capitalization. In Figure 4 we plot the gross LS and the net LS separately for the pre-1999 accounting (i.e., when only structures and equipment are part of BEA capital) and for the post-2013 accounting (i.e., when IPP is capitalized). The result is clear. Gross and net LS are equally trendless in the pre-1999 accounting (panel (a), Figure 4). That is, the depreciation in structures and equipment has no implications for the trend of the

[14] Kravis (1959) uses national income, that is, net national product, to construct the LS.

Figure 5: Corporate Labor Share, BEA 1947–2017



Notes: All data were retrieved from the BEA on March 25, 2019. The BEA LS for the corporate sector is calculated as the share of the compensation of employees to the gross value added in the corporate sector. To back out the pre-1999 revision accounting LS for the corporate sector, we subtract gross corporate IPP investment from both the capital income and gross value added in the corporate sector. The short-dashed line corresponds to the linear trend computed using the entire sample period 1947-2017. The long-dashed line corresponds to the linear trend for the subperiod 1975-2010. Our data and results are available in this permanent link: US Factor Shares.

LS. Only when IPP is capitalized do we find differences in the trends between gross and net LS (panel (b), Figure 4) because the IPP depreciation measured by the BEA increases over time (from 70.6% of gross investment in IPP in 1947 to 87.8% in 2017). That is, the decline of the gross LS relative to the net LS is entirely due to the capitalization of IPP.[15]

The corporate LS. Previous work has partly focused on the corporate sector and on subperiods, mainly on the post mid-1970s. This is the case of the previous work by Karabarbounis and Neiman (2014) that examines the corporate LS for the period 1975 to 2010.[16] Two remarks are in order.

[15] Piketty and Zucman (2014) also study the decline of the net LS. These authors report a LS for the US that starts at the level of 0.80 in 1974 and decreases to 0.71 in 2010. The larger LS decline found by these authors is most likely due to the difference in the data sources, in particular, as argued in Bonnet, Bono, Chapelle, and Wasmer (2014), to the use of market prices for housing capital. Instead, our LS construct is strictly based on BEA national income data.

[16] Elsby et al. (2013) study LS constructs provided by the Bureau of Labor Statistics (BLS). After highlighting important caveats of the benchmark BLS LS, these authors argue for the use of the economy-wide LS (which we use as our benchmark) and the BLS "asset-basis" LS which, as we show in our *Online Appendix*, closely resembles the behavior of the corporate sector LS. Karabarbounis and Neiman (2014) mainly focus on the corporate LS but, at the same time, provide LS estimates for the aggregate economy using national income data.

First, as these authors point out, the construction of the corporate LS is purged from ambiguous income (i.e., there is no proprietors' income).[17] In addition, the corporate sector does not include either the housing sector or the government sector, where the measurement of the accounting LS is subject to criticism (Gomme and Rupert, 2004, 2007). However, a caveat of the corporate LS with respect to our benchmark economy-wide measure of the LS is that it misses a large part of the economy, approximately half of GNP after early 2000s.[18] Second, focusing on the 1975-2010 subperiod (or others) has the peril of potentially attributing to long-run behavior what truly is cyclical behavior. It is for that reason that, in order to provide informative results for long-run macroeconomic models, we have chosen to focus on the entire set of standardly available U.S. national income data starting in 1947. Strictly for comparison purposes with Karabarbounis and Neiman (2014), we now reconduct our accounting exercise for the corporate LS and the 1975-2010 subperiod.

We find that the effect of the capitalization of IPP on the LS does not depend on the definition of the LS. For the full sample 1947 to 2017 period, the corporate LS shows a significant negative secular trend (short-dashed blue line, Figure 5), whereas the counterfactual accounting corporate LS consistent with the pre-1999 treatment of IPP is trendless (short-dashed orange line, Figure 5). The same occurs for the 1975-2010 subperiod in which the corporate LS shows a significant decline (long-dashed blue line, Figure 5), whereas the counterfactual accounting corporate LS consistent with the pre-1999 treatment is trendless (long-dashed orange line, Figure 5).[19]

4 Discussion

Our previous exercise shows that had the BEA kept IPP as an intermediate expense consistent with the pre-1999 revision accounting rules, then the accounting LS would be absolutely trendless. In Section 4.1, we show that the secular behavior of the accounting LS and, therefore, any economic intepretation of the LS decline critically relies on the accounting assumption that the share of rents generated from IPP that goes to capital income is equal to one (i.e., $\chi = 1$). In reality, however, some of the IPP rents go to labor compensation and are not captured by the BEA compensation of employees, which implies that empirically plausible values for χ must be less than one. In Section 4.2, we discuss the potential effects of unobservable intangible investment

[17] See also the discussions in Boldrin and Peralta-Alva (2009) (among others).

[18] The gross value added of the corporate sector represents 51% of GNP in 1947 and 56% in 2017. This proportion reaches a maximum of 60% in 2000 after a steady increase in the 1990s, and it decreases to a relatively constant 56% after the 2000s.

[19] For the full 1947-2017 sample period, the corporate LS shows a significantly negative linear trend of -0.046, whereas the counterfactual corporate LS consistent with the pre-1999 treatment of IPP is not significantly different from zero. Similar numbers are attained for the 1975-2010 subperiod for which the corporate LS trend is -0.071, which is significantly negative, whereas the counterfactual LS is again statistically not different from zero.

on the secular behavior of the accounting LS. In Section 4.3, we discuss how our results relate to the literature that takes the LS decline as an economic phenomenon.

4.1 The Factor Income Distribution of IPP Rents, χ

Typically, the funders of IPP reserve some, if not all, rights to the economic benefits from IPP. This is established through contractual arrangements on firm's (equity) ownership. Take the example of a new tech startup business. The founder of the startup, who owns the business idea, seeks funding from venture capitalists and external investors, who acquire equity of the firm in return for investment. Nonetheless, the founder as well as employees of the startup retain a substantial portion of firm's equity. Indeed, the fact that workers are paid below their marginal value product in exchange for future firm's equity effectively helps fund the business idea. Since the founder and employees receive equity in exchange for the labor service that they provide, the return from their equity of the firm should be considered as labor income.[20] This implies a firm ownership structure that consists of not only capital owners (i.e., investors) but also labor input owners (i.e., founders and employees).

The idea of labor input ownership of firm's intangible capital conforms to the notion of sweat equity in McGrattan and Prescott (2010, 2014). This is the case for both unincorporated and incorporated businesses. For example, unincorporated business owners invest time in cumulating intangibles for their businesses such as building their client list or improving brand equity (Bhandari and McGrattan, 2018). At the same time, in corporate businesses, R&D workers and lab managers obtain a large part of their labor compensation in incentive stock options (ISOs), restricted stock units, and other forms of stock-based compensation (Lerner and Wulf, 2007), which are currently absent in BEA's compensation of employees income account.[21] Clearly, intangible investment generates rents that not only reward capital owners but also the labor input (either from business

[20] A startup typically go through a sequence of funding rounds (labeled alphabetically as round A, B, C etc) to raise capital for expansion. The majority of startups that is in series A or B funding round on average dedicates 52% of the ownership to founders/employees, according to the 2018 Private Company Equity Statistics Report published by Capshare. For the extremely successful startups which go to series D funding round and beyond, founders and employees still control an average of 36% of the ownership.

[21] The BEA's compensation of employees aims at including employee gains from exercising nonqualified stock options (NSOs) at the time they are exercised but does not include incentives stock options (ISOs). This choice follows the accounting principle of not including capital gains in NIPA, because they do not produce goods or services. Since the NSOs are treated as additional taxable income by the tax authorities at the time they are exercised, the BEA tries to include the NSOs in compensation; however, the attempts to incorporate NSOs into the NIPA face important challenges because not all the US states mandate the collection of this information and even if they do, the accuracy is questionable (Moylan, 2008). It is for this reason the NIPA does not provide a separate time series for NSOs compensation. In contrast with the NSOs, the ISOs are taxed as long-term capital gains when sold and BEA does not attempt to add them to NIPA; see Table 1 of Chapter 10 "Compensation of Employees" in the *NIPA Handbook: Concepts and Methods of the US National Income and Product Accounts, November, 2017.*

owners or workers). Along the same line of argument, a large and growing literature on intangible capital in corporate finance documents that an essential property of intangibles is that they are partly embodied in key talents such as managers, engineers, research employees of the firm and hence are portable (Lustig et al., 2011, Eisfeldt and Papanikolaou, 2014, Sun and Zhang, 2019). The property right over such capital is different from physical capital: the key talents own, at least partially, the cash flows from intangible capital to the extent that such capital is portable. As a result, these talents are usually compensated in equity.

In this context, let $\chi \in [0,1]$ denote the fraction of IPP investment rents attributed to capital owners and $1-\chi$ the fraction attributed to the labor input. As discussed, while the presence of sweat equity implies a lower-than-one value for χ, the current BEA assumption is that all IPP rents are allocated to capital (i.e., $\chi = 1$); see our Section 2. We now examine the consequences of this assumption for the secular behavior of the LS. To do so, recall that on the income side of the accounts the capitalization of IPP boosts GOS (i.e., corporate profits, proprietors' income and depreciation, see Section 2) by the current year's gross investment in IPP (I). Therefore, the labor share adjusted by χ is,

$$LS = 1 - \frac{GOS - (1-\chi)I}{Y}. \tag{5}$$

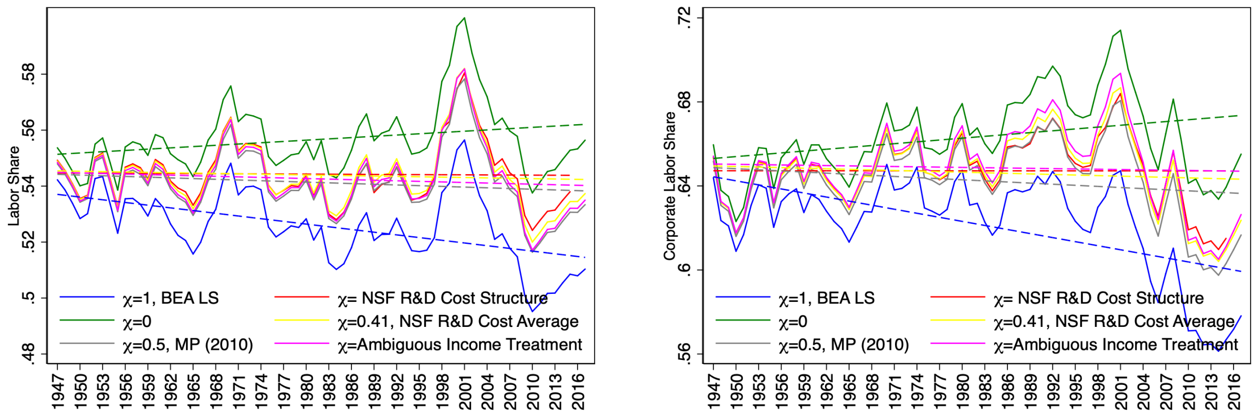
Clearly, a major difficulty in adjusting the LS with the factor split of IPP rents is that although our earlier discussion suggests that χ must be below one, the actual value of χ is unknown because the returns from sweat equity are not directly observable. For this reason, we discuss several possibilities for χ obtained using alternative sources of micro data, though none of which is without caveats.

Our results are in Figure 6. The benchmark accounting LS (blue line) follows the current BEA assumption that all IPP rents are allocated to capital income (i.e., $\chi = 1$) and shows the downward trend documented earlier. Interestingly, if we attribute all IPP rents to labor income (i.e., $\chi = 0$), that is, the opposite extreme of the current BEA practice, then the LS (green line) displays a clear upward trend (panel (a), Figure 6). Similar results are attained for the corporate LS (panel (b), Figure 6). However, our previous discussion suggests that there are less extreme and perhaps more reasonable splits of IPP rents between capital and labor that put χ between zero and one. In particular, since the BEA equates the income generated from IPP to the (investment) expenditure on IPP, it seems natural to construct a measure of χ based on the factor cost structure of IPP. To do so, we focus on the R&D cost structure—for which we use annual data from the NSF surveys of business R&D expenditures (BRDIS).[22] We find that the

[22] We obtain the cost structure of R&D from the annual NSF surveys of the Business R&D and Innovation

Figure 6: US Labor Share with Alternative Assumptions on the Factor Distribution of IPP, χ

(a) Economy-Wide LS Adjusted by χ (b) Corporate LS Adjusted by χ



Notes: The accounting LS is constructed based on different capital-labor splits of IPP investment rents (χ) in equation (5). In the extreme cases, IPP rents are either fully assigned to capital income ($\chi = 1$) or to labor income ($\chi = 0$). The BEA's assumption is $\chi = 1$. Less extreme cases are based on the time series of the cost structure of R&D investment from NSF surveys, its average value $\chi = 0.41$, and a value for χ that treats IPP investment rents as ambiguous income. We also use a model-based value for $\chi = 0.5$ from McGrattan and Prescott (2010). Our data and results are available in this permanent link: US Factor Shares.

ratio of wages paid to R&D labor as a fraction of R&D investment (i.e. $\frac{W_{R\&D}}{I_{R\&D}}$) are trendless and fluctuate around an average of 0.59 (see our *Online Appendix*).[23] If we use this proxy for the factor split of IPP rents, then we find that the accounting LS adjusted for χ is absolutely trendless for both the economy-wide LS and the corporate LS. Whether we use the time-series of χ constructed from the R&D cost structure (red line), our preferred measure for χ, or its average (yellow line), does not alter our results.

There are potentially important caveats to this measurement of χ. First, we have measured χ using the R&D cost structure which is not necessarily the same across all forms of IPP. It is nonetheless preferable to the cost structure of software, for which no direct measure exists.[24] Second, even if this structure is similar across IPPs, we do not know if the cost structure of IPP resembles the factor distribution (i.e., the ownership structure) of IPP rents, χ. In the particular case of R&D, however, we can assess whether this is the case or not by looking into the long-term

Survey (BRDIS) from 1962 to 2015. See the *Online Appendix* for details. (See *Detailed Statistical Table* 13 in National Science Foundation (2016).)

[23] This figure is similar to that in Crawford et al. (2014) that document the ratio $\frac{W_{R\&D}}{I_{R\&D}}$ for a sample of years between 1929 and 2013, see their Table 13.

[24] To derive the costs of software, the BEA computes wage compensation in software production by multiplying the number of programmers and systems analysts in selected industries times the wage rate in those industries (Crawford et al., 2014). Even more questionable is BEA's estimates of the cost of own-account software, where the BEA simply reduces wages by half, under the assumption that programmers and analysts spend only approximately half their time working on the development of new or enhanced own-account software. Despite that the estimates of the R&D cost structure build on less questionable assumptions, the main limitation is that whether the R&D cost structure is similar to the cost structure of the rest of intangibles remains unknown.

incentive provision (e.g., stock options and stock awards) to R&D workers and executives in the sample of publicly traded firms in Compustat. In our *Online Appendix*, we show that using the information of workers' and executives' equity ownership, we arrive at a trendless LS consistent with the results based on the NSF cost structure of R&D.[25] This result, though reassuring, still leaves the question open whether it extends to all intangible assets beyond IPP. Interestingly, the quantitative implications on the secular behavior of the LS that we have derived so far from various empirically motivated χ's are similar to those under a $\chi = 0.5$ estimated in McGrattan and Prescott (2010), where intangible capital is treated as a latent variable. A critical difference is that these authors recover χ from a model that recognizes the full set of intangible investments, while our measure of χ is solely based on the cost structure of R&D. Finally, an altogether different approach is to treat the income rents generated from IPP investment as ambiguous income which implies setting $\chi = \frac{GOS-I}{Y-I}$ in equation (5). It turns out that the use of this χ in which IPP investment rents are treated as ambiguous income delivers an accounting LS that is equivalent to one in which IPP investment is expensed (see our next Section 4.2). Again, this implies a trendless accounting LS (magenta line) in Figure 6.

In summary, the factor distribution of IPP rents, χ, is shown to be critical to understanding the secular behavior of LS. Under a set of plausible and less extreme assumptions on χ than that implemented by the BEA, the structural shift to a more IPP–intensive economy does not alter the factor distribution of income at all. This renders the decline of the LS a mere artifact of the accounting assumption ($\chi = 1$) implemented by the BEA in the capitalization of the IPP.

4.2 Unobservable Intangible Investment

The measurement of the factor income rents generated from IPP investment—i.e., the intangible investment observed by the BEA—is challenging not only because of the measurement of χ but also because a large part of investment on intangible capital is not directly observable. In this context, what is the effect of intangible investment on the secular behavior of the LS? This is an open question whose answer hinges on whether the investment that we do not observe grows or not at the same rate as output and on how the rents generated from the unobservable intangible investment are split between capital and labor (i.e., χ).[26] These issues are at the

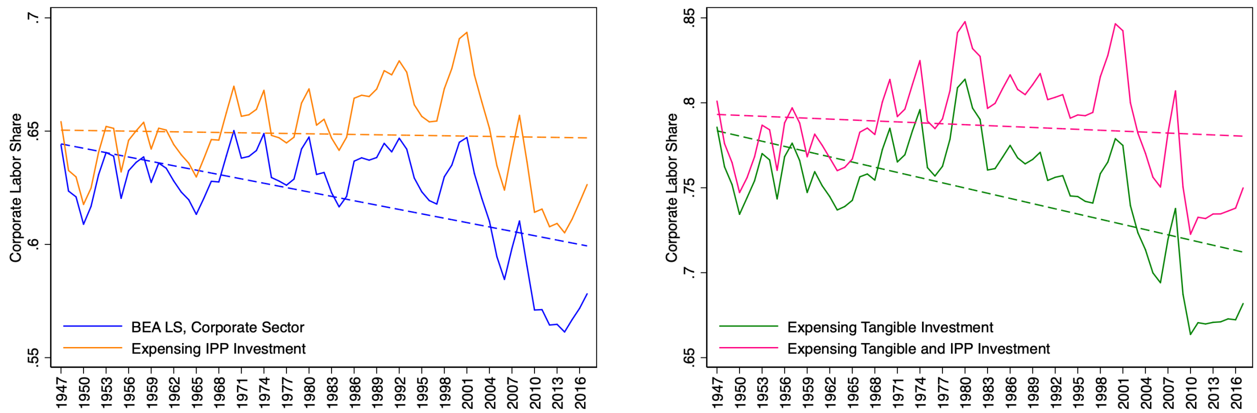
[25] We develop some estimates for χ by combining the information of the compensation structure, which includes stock-based compensations, of R&D workers and executives from Compustat with information of the labor cost of R&D provided by BRDIS. We show under a variety of scenarios of plausible assumptions, our estimated χ's deliver a trendless LS. See our *Online Appendix* for details.

[26] For example, if the correct measurement of the unobserved intangible investment were to imply that there is no structural shift toward a more intangible-investment intensive economy (that is, that intangible investment grows at the same rate as output), then the capitalization of these unobserved intangibles would change the level of the accounting LS but would not change the trend behavior of the LS for any constant value of χ.

Figure 7: Corporate Labor Share with Expensed Investment, BEA 1947–2017

(a) Expensing IPP Investment

(b) Expensing Aggregate Investment



Notes: Panel (a) shows benchmark BEA LS (blue line) and the LS that expenses IPP investment (orange line) as in equation (7). In panel (b), we construct a LS in which only tangible investment expensed (green line) and a LS in which aggregate investment (i.e., both tangible and IPP investment) are expensed (pink line). Our data and results are available in this permanent link: US Factor Shares.

core of economic theory that incorporates intangible investment that is not measured in national accounts (McGrattan and Prescott, 2010).

In the pursuit of carefully mapping theory to data, growth and business cycle practitioners construct objects from national accounts (e.g., the accounting LS) that are consistent with the economic objects that arise from theory (Cooley and Prescott, 1995). This task becomes increasingly difficult with the presence of intangible investments in economic theory that are typically not measured in national accounts. In terms of the secular behavior of the LS, one way to get around the discrepancy between intangible investment in the model and intangible investment in national accounts is to focus on model-consistent measures of the LS that can be constructed from observed components in national accounts. For example, one can focus on the accounting LS constructed from the tangible side of the economy. In effect, this implies expensing intangible investment in both theory and national accounts or, equivalently, treating the investment rents generated from intangibles as ambiguous income, which designates a specific value for χ equal to $\frac{GOS-I}{Y-I}$ in (5) when constructing the LS.[27] Clearly, this does not resolve the

[27] Treating IPP investment rents as ambiguous income implies that we attribute a share of these rents to capital (i.e., χ) that is identical to the capital share of the unambiguous income in the economy. Precisely, define χ as the fraction of unambiguous capital income (i.e., gross value added minus IPP investment) to unambiguous income (i.e., gross value added minus IPP investment),

$$\chi = \frac{GOS - I}{Y - I}. \tag{6}$$

Notice that if we plug this specific χ into equation (5), then we obtain an accounting LS in which intangible investment is expensed as in equation (7). That is, treating intangible investment as an expense is identical to treating the investment rents generated from intangibles as ambiguous income under one of the specific values issue of correctly measuring the unobservable intangible investment which remains at large, but it helps in providing a mapping between economic theory and national accounts that is immune to the incorrect measurement of the unobservable intangibles in national accounts. The accounting LS that expenses intangible investment is constructed as,

$$LS = 1 - \frac{GOS - I}{Y - I} = \frac{CE}{Y - I}, \tag{7}$$

where I stands for intangible investment (IPP in national accounts), GOS is gross operating surplus, CE is compensation of employees, and $Y = GOS + CE$ is gross value added.[28] Focusing on the corporate sector, panel (a) of Figure 7 shows that the accounting LS that expenses IPP investment is trendless. This is perhaps not surprising once we notice equation (7) is consistent with the accounting LS constructed using the pre-1999 BEA accounting rules.

An alternative is to focus on a definition of the LS that corresponds to the ratio of compensation of labor to total payouts to labor and owners of firms where the measure of total payouts to labor and owners of firms is the sum of compensation of employees and gross operating surplus less investment in equipment, structures, and intellectual property products.[29] In effect, this implies the expensing of aggregate investment—tangible and intangible–in the construction of the LS, that is,

$$LS = 1 - \frac{GOS - X - I}{Y - X - I} = \frac{CE}{CE + DIV}, \tag{8}$$

where $DIV = GOS - X - I$ and X is tangible investment. Notice that it makes no difference to the payout to owners of firms if expenditures on intangible investment are recorded as final investment expenditures or as expenditures on intermediate goods. The implications of fully expensing aggregate investment in national accounts are in panel (b) of Figure 7. The result is clear. If aggregate investment is fully expensed, then the accounting LS is trendless. Notice that the trendless secular behavior of the accounting LS that solely expenses IPP (panel (a) of Figure 7) resembles that of the accounting LS that expenses aggregate investment (panel (b) of Figure 7). This implies that it is the expensing of IPP investment, and not tangible investment, that generates this result.[30] To see this we isolate the effects of separately expensing tangible

of χ discussed in Section 4.1. Indeed, the accounting LS with expensed intangibles (orange line in panel (a) of Figure 7) is the same as the accounting LS in which intangible investment rents are treated as ambiguous income (magenta line in panel (b) of Figure 6).

[28]We lump taxes on GOS. The insights are the same if we treat taxes as ambiguous income.

[29]We thank Andy Atkenson for sharing this insight with us.

[30]Relatedly, from the standpoint of intertemporal budget constraint for consumption, Barro (2019) recently argues that investment is counted twice in national accounts. First as it occurs. Second, in present value when the capital stock generates rental income. One way to address this issue is by expensing aggregate investment.

investment (green line) and expensing both tangible and IPP investment (magenta line). If we expense only tangible investment, then the accounting LS declines. The accounting LS flattens out only when we additionally expense IPP investment. Again, it is straightforward to see that expensing aggregate investment is identical to treating aggregate investment as ambiguous income in the construction of the accounting LS.

4.3 Implications for the Economic Interpretation of the LS Decline

Our results directly speak to a growing literature that interprets the decline of the accounting LS as an economic phenomenon at face value. This literature then argues for U.S. macroeconomic models that generate an economic secular decline of the LS.[31] By contrast, in light of our results, we argue that the observed secular decline of the LS is an accounting phenomenon, not an economic one. In our view, there is no need to search for economic mechanisms to explain an economic phenomenon that does not exist.

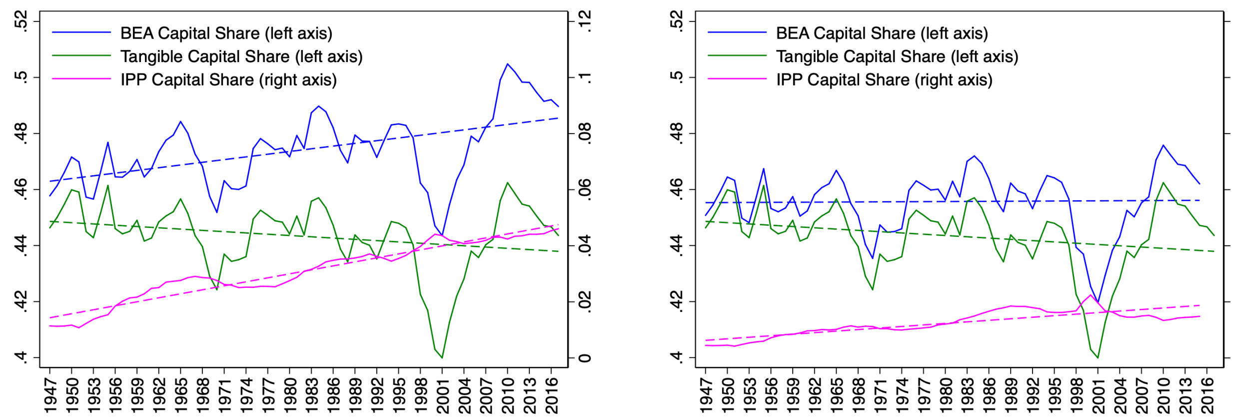
We have already showed how the secular behavior of the LS critically depends on the capital-labor income split (χ) of IPP investment rents (Section 4.1 and 4.2). In addition, we now separately show the secular behavior of the tangible (structures and equipment) and IPP components of the accounting capital share as a function of χ. This decomposition between tangible capital share and IPP capital share is useful to discriminate across potential models of the U.S. economy. First, to relate to the existing models which implicitly accept BEA's assumption of $\chi = 1$, we examine this decomposition under that assumption. The results are in panel (a) of Figure 8. The IPP capital share of income increases over time ($\frac{I}{Y}$, pink line) and is clearly the sole driver of the increase (decline) of the accounting capital (labor) share that surfaces under $\chi = 1$. By contrast, the capital share of equipment and structures declines over time ($\frac{GOS-I}{Y}$, green line). This behavior of the components of the accounting capital share should be relevant for the literature that takes the decline of the LS as an economic phenomenon and that implicitly complies with the BEA assumption of $\chi = 1$. We believe that this literature misses this important insight from the data that it is the IPP capital share that is driving their result. Second, we focus on one of our preferred measures of χ that is based on the NSF cost structure of R&D. The results are in panel (b) of Figure 8. We find that—consistently with the behavior of the accounting LS described in Section 4.1—the accounting capital share is trendless. That is, under plausible values for χ, the structural shift toward a more IPP–intensive economy coexists with a trendless accounting LS.

[31] This is done through a wide set of economic mechanisms. For example, trade linkages (Elsby et al., 2013), the price of investment (Karabarbounis and Neiman, 2014), the evolution of tasks and automation (Acemoglu and Restrepo, 2018), and the productivity slowdown (Grossman et al., 2017) have been proposed as potential economic explanations that take the decline of the accounting LS as an economic phenomenon at face value.

Figure 8: Tangible and IPP Capital Share Adjusted by the Factor Distribution of IPP (χ)

(a) $\chi = 1$, BEA

(b) χ_t from NSF R&D Cost Structure



Notes: The BEA capital share (blue line) is $\frac{GOS}{Y}$ (or one minus the BEA LS in Figure 1) where the economy–wide GOS is computed as in equation (1), and Y is GNP. The IPP capital share of income (pink line) is computed as the ratio of investment in IPP to GNP, that is, $\frac{I}{Y}$. The tangibles' (i.e., equipment plus structures) capital share of income (green line) is $\frac{GOS-I}{Y}$. Our data and all the results of our analysis are available in this permanent link: US Factor Shares.

Finally, we can show that a theory that succeeds in rationalizing the secular behavior of the capital (labor) and that replicates the behavior of its components, the tangible capital share and IPP capital share, as a function of χ, is one in which tangible capital augmenting technological change is endogenous and takes the form of IPP capital deepening; see our *Online Appendix*. This can be achieved through an aggregate production with a constant elasticity of substitution (CES) between aggregate capital and labor input where aggregate capital is a CES composite between tangible capital and IPP capital. This framework can be used to estimate the elasticity of substitution between capital and labor, $\sigma \in [0, \infty)$, through a standard 2-stage estimation process and for different values of χ. The results of the estimation of the aggregate elasticity of substitution between aggregate capital and labor for different values of χ are in Table 3. Although under the BEA assumption that $\chi = 1$ we find larger-than-one estimates of σ (as in Karabarbounis and Neiman (2014)), under plausible values of $\chi < 1$ we cannot reject the hypothesis of a Cobb-Douglas aggregate production function. This shows the importance of the measurement of χ for the understanding of the U.S. macroeconomic model.

5 Conclusion

The lack of attention to measurement can severely misguide economic theory. We demonstrated that the change in the accounting treatment of IPP—from expensed to capitalized—gradually implemented by the BEA since 1999 is the sole driver of the decline of the accounting LS. Moreover, our examination of the accounting assumptions behind the capitalization of IPP—

Table 3: The Elasticity of Substitution between Capital and Labor (σ), US 1947-2017

		Adjusting for the Factor Distribution of IPP ($\chi < 1$)			
		NSF Data R&D Cost Structure			
	$\chi = 1$ BEA	Time-Varying	Constant	Model-Based MP (2010)	Ambiguous Income
σ	(1)	(2)	(3)	(4)	(5)
Economy-Wide	1.048***	1.003	1.004	1.011	1.008
	[1.033, 1.062]	[0.989, 1.018]	[0.989, 1.019]	[0.996, 1.025]	[0.993, 1.023]
Corporate	1.093***	1.003	1.009	1.022	1.002
	[1.054, 1.132]	[0.972, 1.034]	[0.973, 1.044]	[0.986, 1.057]	[0.964, 1.039]

Notes: The estimates are for the entire sample years 1947-2017. The numbers in brackets are 95% confidence intervals. We denote significance level at 10 percent with (*), 5 percent with (**) and 1 percent with (***). We report significance with respect to a value of one, that is, we explore whether the aggregate production function is significantly different from Cobb-Douglas. The estimation of σ is conducted through a standard two-stage estimation process. Details are in our *Online Appendix*.

mainly that all IPP investment rents are attributed to capital—indicates that less arbitrary and extreme assumptions on the factor distribution of IPP rents yield a trendless accounting LS. In other words, the decline of the LS is an accounting phenomenon, not an economic one. This is at odds with current macroeconomic theory that seeks economic explanations behind this decline of the accounting LS.

We argue that future research efforts should be devoted to accurately measuring the factor distribution of these rents, i.e., χ, in national income and across all intangibles assets. This is challenging because neither χ nor the entire set of intangible assets is directly observable. In the quest of informing the value of χ, we find promising the collection of microevidence on the ownership of firm between capital investors and workers together with macroeconomic theory that deals with the unobservability of intangible investment. We believe that this argument calls for the explicit introduction of the structure of firm ownership in macroeconomic theory.

Finally, the cyclical behavior of the LS (e.g., its rise in the late 1990s, peak around the year 2000, decline in the 2000s, rebound during the 2010s) and other higher-frequency fluctuations as described in Ríos-Rull and Santaeulàlia-Llopis (2010) do not seem to be accounted for by the capitalization of IPP and still beg for an explanation.

References

Acemoglu, D. and P. Restrepo. The Race Between Machine and Man: Implications of Technology for Growth, Factor Shares and Employment. *American Economic Review*, 108(6):14881542, 2018.

Akcigit, U., M. A. Celik, and J. Greenwood. Buy, Keep, or Sell: Economic Growth and the Market for Ideas. *Econometrica*, 84(3):943–984, 2016.

Barro, R. J. Double-Counting Investment. Technical report, 2019.

Bhandari, A. and E. R. McGrattan. Sweat Equity in U.S. Private Business. NBER Working Papers 24520, National Bureau of Economic Research, Inc, April 2018. URL https://ideas.repec.org/p/nbr/nberwo/24520.html.

Boldrin, M. and A. Peralta-Alva. What Happened to the U.S. Stock Market? Accounting for the Past 50 Years. *Federal Reserve Bank of St. Louis Review*, 91(6):627–46, 2009.

Bonnet, O., P.-H. Bono, G. Chapelle, and E. Wasmer. Does Housing Capital Contribute to Inequality? A Comment on Thomas Piketty's Capital in the 21st Century. Technical report, April 2014.

Bridgman, B. Is Labor's Loss Capital's Gain? Gross versus Net Labor Shares. *Macroeconomic Dynamics*, 2017.

Cooley, T. F. and E. C. Prescott. Economic Growth and Business Cycles. In Cooley, T. F., editor, *Frontiers of Business Cycle Research*. pp. 1-38. Princeton University Press, Princeton, NJ, 1995.

Corrado, C., J. Haltiwanger, and D. Sichel. *Measuring Capital in the New Economy*. University of Chicago Press, 2005.

Crawford, M. J., J. Lee, J. E. Jankowski, and F. A. Moris. Measuring R&D in the National Economic Accounting System. *Survey of Current Business*, November 2014.

Eisfeldt, A. L. and D. Papanikolaou. The Value and Ownership of Intangible Capital. *American Economic Review: Papers and Proceedings*, 104:189–194, 2014.

Elsby, M., B. Hobijn, and A. Sahin. The Decline of the U.S. Labor Share. *Brookings Papers on Economic Activity*, 47(2):1–63, 2013.

Gomme, P. and P. Rupert. Measuring Labor's Share of Income. *Federal Reserve Bank of Cleveland Policy Discussion Papers*, November 2004.

Gomme, P. and P. Rupert. Theory, Measurement and Calibration of Macroeconomic Models. *Journal of Monetary Economics*, 54(2):460–497, March 2007.

Grossman, G., E. Helpman, E. Oberfield, and T. Sampson. The Productivity Slowdown and the Declining Labor Share: A Neoclassical Exploration . Working Paper 23853, National Bureau of Economic Research, September 2017.

Hall, R. E. e-Capital: The Link between the Labor Market and the Stock Market in the 1990s. *Brookings Papers on Economic Activity*, 2:73–118, 2000.

Karabarbounis, L. and B. Neiman. The Global Decline of the Labor Share. *Quarterly Journal of Economics*, 129(1):61–103, 2014.

Koh, D. and R. Santaeulàlia-Llopis. Countercyclical Elasticity of Substitution. Barcelona GSE, Working Paper 946, 2017.

Kravis, I. B. Relative Income Shares in Fact and Theory. *American Economic Review*, 49(5): 917–49–62, 1959.

Lerner, J. and J. Wulf. Innovation and Incentives: Evidence from Corporate R&D. *The Review of Economics and Statistics*, 89(4):634–644, 2007.

Lustig, H., C. Syverson, and S. V. Nieuverburgh. Technological Change and the Growing Inequality in Managerial Compensation. *Journal of Financial Economics*, 99:601–627, 2011.

McCulla, S. H., A. E. Holdren, and S. Smith. Improved Estimates of the National Income and Product Accounts. *Survey of Current Business*, September 2013.

McGrattan, E. R. and E. C. Prescott. Unmeasured Investment and the Puzzling U.S. Boom in the 1990s. *American Economic Journal: Macroeconomics*, 100(4):1493–1522, 2010.

McGrattan, E. R. and E. C. Prescott. A Reassessment of Real Business Cycle Theory. *American Economic Review*, 104(5):177–82, May 2014.

Moylan, C. E. Employee Stock Options and the National Economic Accounts. *BEA Briefing*, February 2008.

National Science Foundation. Business R&D and Innovation: 2013. Detailed Statistical Tables NSF 16-313. National Center for Science and Engineering Statistics, Arlington, VA, 2016.

NIPA Handbook. Concepts and Methods of the U.S. National Income and Product Accounts, 2017.

Piketty, T. and G. Zucman. Capital is Back: Wealth-Income Ratios in Rich Countries, 1700-2010. *The Quarterly Journal of Economics*, pages 1255–1310, 2014.

Ríos-Rull, J.-V. and R. Santaeulàlia-Llopis. Redistributive Shocks and Productivity Shocks. *Journal of Monetary Economics*, 57(8):931–948, 2010.

Sun, Q. and M. X. Zhang. Financing Intangible Capital. *Journal of Financial Economics*, 132: 472–496, 2019.