Labor Share Decline and Intellectual Property Products Capital*

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Abstract

We study the behavior of the US labor share over the past 90 years. We find that the observed decline of the labor share is entirely explained by the capitalization of intellectual property products in the national income and product accounts.

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JEL Classification: E01, E22, E25

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1 Introduction

After carefully analyzing the most recent national income and fixed assets data, we show that the secular decline of the labor share (LS), an observation that motivates a growing body of research on factor income shares (Elsby et al., 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.

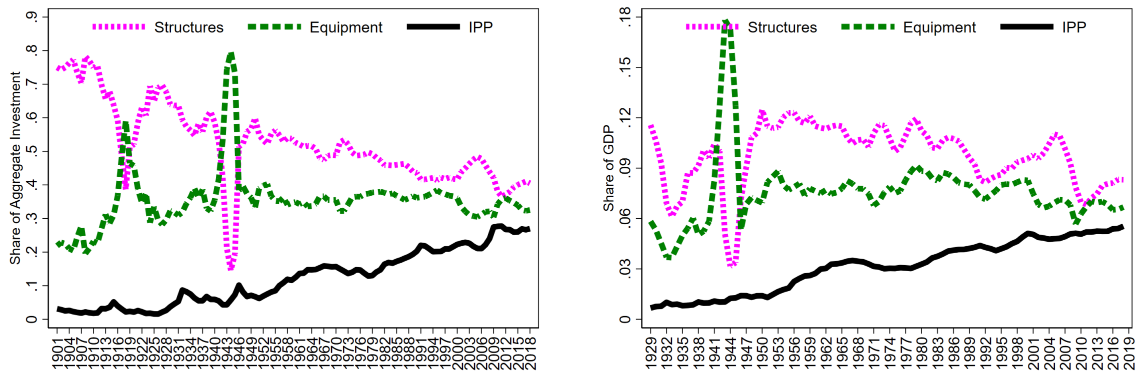
The capitalization of IPP has been gradually introduced by the Bureau of Economic Analysis (BEA) through two comprehensive revisions of the NIPA. In 1999, the 11th BEA revision capitalized software expenditures by business, NPISH, and government. Prior to this revision, software expenditure was considered 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 investment 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 et al., 2005, McGrattan and Prescott, 2010, 2014, Akcigit et al., 2016). Notably, the share of IPP in aggregate investment secularly increases from 3.1% in 1901 to 27.0% in 2018; see panel (a) of Figure 1. Similarly, the share of IPP in GDP increases from 0.7% in 1929 to 5.5% in 2018; see panel (b) of 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 between 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 4.3% of nonresidential aggregate investment in 1901 to 33.2% in 2018. In the corporate sector, the shares increase from 4.9% of total corporate investment in 1929 to 35.8% in 2018.

Figure 1: Investment Shares, BEA 1929–2018

(a) Shares of Aggregate Investment (b) Shares of Gross Domestic Product



Notes: All data were retrieved from the BEA on Sep. 25, 2019. We use the longest time series available. Note that investment series and its components start in 1901 from the Fixed Assets Accounts Tables (panel (a)), and the gross domestic product series starts in 1929 from the National Income and Product Accounts Tables (panel (b)). 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 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 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

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

is consistent with the accounting rule in which all IPP is considered as an expense, as was the procedure before the revisions that capitalized 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 instead of capitalized is absolutely trendless. That is, the capitalization of IPP explains the entire secular decline of the 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 LS in Section 3. In that section, we also examine the decline of the LS by institutional sector including the corporate sector and by using broader measures of intangible capital beyond those captured by the BEA. We provide international evidence in Section 4. We examine the BEA's assumptions on the factor distribution of IPP rents and provide further discussion in Section 5. Section 6 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 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

[3] 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 on Sep. 25, 2019 and we find that our results are not altered by this most recent revision.

that the business expenditure in own-account IPP, I_o, becomes part of gross output.[4] That is, 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).

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 (or 0.93%) in 1947 and by \$931.1 billion (or 5.44%) in 2018.

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. 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 11.4% in 2018.

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,

[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 are not sold in the market, the BEA estimates the own-account production of software and R&D as the sum of costs (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.

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

	Notation	USD Bill. 1947	USD Bill. 2018
1. Gross output, pre-revision	Q	430.5	31,943.5
2. Plus own-account IPP	I_o	1.5	687.6
3. *Equals*: Gross output, post-revision:	$Q + I_o$	432.0	32,631.1
4. Intermediate expenditure, pre-revision	$M + I_p$	216.4	14,839.0
5. Less purchased IPP	I_p	0.5	243.5
6. *Equals*: Intermediate expenditure, post-revision	M	215.9	14,595.5
7. Value added, pre-revision (L. 1−4):	$Q - (M + I_p)$	214.1	17,104.5
8. Plus own-account and purchased IPP (I_b)	$I_o + I_p$	2.0	931.1
9. *Equals*: Value added, post-revision (L. 3−6)	$(Q + I_o) - M$	216.1	18,035.6
10. Compensation of employees	W	110.4	8,929.2
11. Gross operating surplus (GOS), pre-revision (L. 7−10)	$Q - (M{+}I_p) - W$	103.7	8,175.3
12. Plus own-account and purchased IPP (I_b)	$I_o + I_p$	2.0	931.1
13. *Equals*: GOS, post-revision (L. 9−10)	$(Q + I_o) - M - W$	105.7	9,106.4
14. Depreciation, pre-revision	D	16.3	1,931.6
15. Plus depreciation of business IPP	D_{I_b}	1.4	794.2
16. *Equals*: Depreciation, post-revision	$D + D_{I_b}$	17.7	2,725.8
17. Net operating surplus (NOS), pre-revision (L. 11−14):	$Q - (M{+}I_p) - W - D$	87.4	6,243.7
18. Plus own-account and purchased IPP (I_b)	$I_o + I_p$	2.0	931.1
19. Less depreciation of IPP	D_{I_b}	1.4	794.2
20. *Equals*: NOS, post-revision (L. 13−16)	$(Q + I_o) - M - W - (D + D_{I_b})$	88.0	6,380.6

Notes: All data were retrieved from the BEA on Sep. 25, 2019. Gross output, intermediate input expenditure, and value added refer to all private industries obtained from the BEA Industry Accounts for 1947-2018. The compensation of employees for all private industries is available from the BEA NIPA Table 6.2 for 1929-2018. The depreciation for the business sector is obtained from Table 3.4 in the BEA Fixed Asset Tables (FAT). Own account Investment is obtained from the BEA R&D Satellite Account for 1987-2007. We apply the average ratio of own-account R&D investment to private investment on R&D for the sample period 1987-2007 (i.e., 0.74) to the aggregate investment on IPP in the BEA to obtain own account and purchased IPP for 1947-2018.

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 0.69% in 1947 and by 2.19% in 2018.

2.2 Effects of IPP Capitalization on Private and Government Accounts

We now discuss the NPISH and government sector which includes all federal, state, and local governments. Businesses and NPISH together form the private sector, and with the government sector, they complete the discussion of the effects of IPP capitalization 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 government 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 \$1,127 billion in the GDP in 2018, that is, an increase of 5.79% with respect to its pre-revision counterpart. The effect is much lower in 1929, with an increase of \$0.6 billion, that is, an increase of 0.58% 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

[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. 1929	2018
Private sector:			
1. Personal consumption expenditure, pre-revision	C	77.4	14,002.8
2. Less: NPISH net investment in IPP	$I_{np} - D_{I_{np}}$	0	4.1
3. *Equals*: Personal consumption expenditure, post-revision	$C - (I_{np} - D_{I_{np}})$	77.4	13,998.7
4. Gross private investment, pre-revision	X	16.6	2,697.2
5. Plus: Gross private investment in IPP	$I_b + I_{np}$	0.6	931.1
6. *Equals*: Gross private investment, post-revision	$X + I_b + I_{np}$	17.2	3,628.3
Government sector:			
7. Government consumption, pre-revision	C_g	6.8	2,913.4
8. Less: Government net investment in IPP	$I_g - D_{I_g}$	0.1	9.1
9. *Equals*: Government consumption, post-revision	$C_g - (I_g - D_{I_g})$	6.7	2,904.3
10. Gross government investment, pre-revision	X_g	2.8	478.1
11. Plus: Gross government investment in IPP	I_g	0.1	209.1
12. *Equals*: Gross government investment, post-revision	$X_g + I_g$	2.9	687.2
13. Government expenditure, pre-revision (L. 7+10)	G	9.6	3,391.5
14. Plus: Government depreciation in IPP	D_{I_g}	0	200.0
15. *Equals*: Government expenditure, post-revision (L. 9+12)	$G + D_{I_g}$	9.6	3,591.5
Gross domestic product, GDP:			
16. GDP, pre-revision (L. 1+4+13)	$C + X + G$	104.0	19,453.2
17. Plus: Business investment in IPP	I_b	0.6	903.5
18. Plus: NPISH depreciation in IPP	$D_{I_{np}}$	0	23.5
19. Plus: Government depreciation in IPP	D_{I_g}	0	200.0
20. *Equals*: GDP, post-revision (L. 3+6+15)	$C + (X + I_b + D_{I_{np}}) + (G + D_{I_g})$	104.6	20,580.2

Notes: All data were retrieved from the BEA on Sep. 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.

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 of the amount of IPP investment to the product account is balanced by an equal addition to GOS in 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 LS. Clearly, if IPP investment is strictly positive, then the capitalization of IPP unambiguously decreases the 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.[6] Then, the difference between the post-revision LS, LS_{Post}, and the pre-revision LS, LS_{Pre}, is:

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

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 of the 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 LS. This is the quantitative question that we explore next.

3 The Effects of IPP Capitalization on the LS

We construct our benchmark LS using an economy-wide definition standard in the macroeconomics literature (Cooley and Prescott, 1995). We split the components of national income that cannot be unambiguously attributed to capital or labor by using the factor shares of the

[6] Here we use GOS interchangeably with capital income, although part of GOS cannot be unambiguously attributed to capital (i.e., proprietor's income and taxes and subsidies on production and imports). While this is innocuous for the qualitative argument of this section, we carefully correct for proprietor's income and taxes and subsidies on production and imports in our quantitative analysis in Section 3.

unambiguous income of the economy. This is equivalent to the following definition of the LS:

$$LS = 1 - \frac{GOS^{adj}}{Y} \tag{1}$$

where Y is GDP and we adjust gross operating surplus, GOS, for the ambiguous income in the economy, that is, proprietor's income, PI, and taxes (less subsidies) on production and imports, TS. Our adjusted gross operating surplus is $GOS^{adj} = (GOS - \theta(PI + TS))$ where we set θ to be the labor share of the unambiguous income of the economy.[7,8]

Figure 2 shows the time series of the benchmark LS (i.e., the economy-wide BEA LS labeled as "BEA LS"). Clearly, the LS exhibits a relentless secular decline. Linearly, the LS declines at an annual rate of -0.072% between 1929 and 2018. A historic high is achieved in 1946 at 69.4%, and a historic low is achieved in 2010 at 61.5%. On average, the benchmark LS is 65.2%.

To assess the effects of IPP capitalization on the LS, we compare our benchmark LS with a counterfactual accounting LS consistent with the accounting treatment of IPP before the 1999 BEA revision. Specifically, we subtract the gross investment in business IPP (I_b), the NPISH IPP capital depreciation ($D_{I_{np}}$), and the government IPP capital depreciation (D_{I_g}) from GOS and Y as described in Section 2. The counterfactual accounting LS that follows the pre-1999 accounting rule is as follows:

$$LS_{Pre\text{-}1999} = 1 - \frac{GOS^{adj} - (I_b + D_{I_{np}} + D_{I_g})}{Y - (I_b + D_{I_{np}} + D_{I_g})}. \tag{2}$$

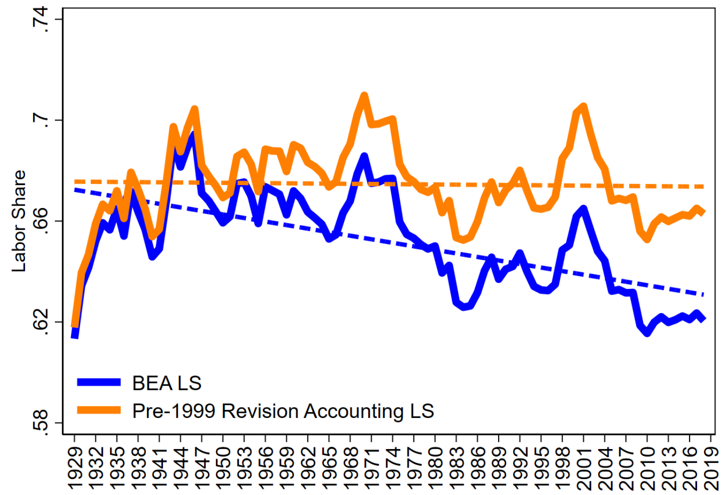
The comparison between our benchmark LS (blue line, Figure 2) and the pre-1999 revision counterfactual LS (orange line, Figure 2) delivers the main result of our paper: In sharp contrast to the decline of the benchmark LS, the pre-1999 revision counterfactual LS is absolutely trendless, with an average value of 67.5%. That is, the decline of the 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 have displayed no secular trend.[9]

[7] That is, $\theta = 1 - \frac{GOS-PI-TS}{Y-PI-TS}$. Note that this also implies that $LS = 1 - \frac{GOS-PI-TS}{Y-PI-TS}$

[8] In the *Online Appendix*, we also add capital income from consumer durables and government capital to both GOS^{adj} and Y, by using the net rate of return of the private business and the respective depreciation rates for consumer durables and government capital from the Fixed Assets Tables (FAT), see Cooley and Prescott (1995). This is consistent with the definitions of the LS in the business cycle literature (Gomme and Greenwood, 1995, Boldrin and Horvath, 1995, 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.

[9] Our results are also externally validated using vintage data; see our *Online Appendix*.

Figure 2: Economy-Wide US Labor Share, BEA 1929–2018: Pre- Vs. Post-Revision Accounting



Notes: All data for the construction of LS were retrieved from the BEA on Sep. 25, 2019. 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 1929 to 2018, the latest year available. The pre-1999 revision counterfactual accounting LS uses equation (2) to replicate the accounting rule in which IPP is expensed. Dotted lines show linear trends from 1929 to 2018. Our data and results are available in this permanent link: US Factor Shares.

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.[10] To understand the role played by software and R&D respectively, we provide a second counterfactual accounting LS consistent with the accounting rule right 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 consistent with the pre-2013 accounting rule is as follows:

$$LS_{Pre\text{-}2013} = 1 - \frac{GOS^{adj} - (I_{b,R\&D} + D_{I_{np,R\&D}} + D_{I_{g,R\&D}})}{Y - (I_{b,R\&D} + D_{I_{np,R\&D}} + D_{I_{g,R\&D}})}. \tag{3}$$

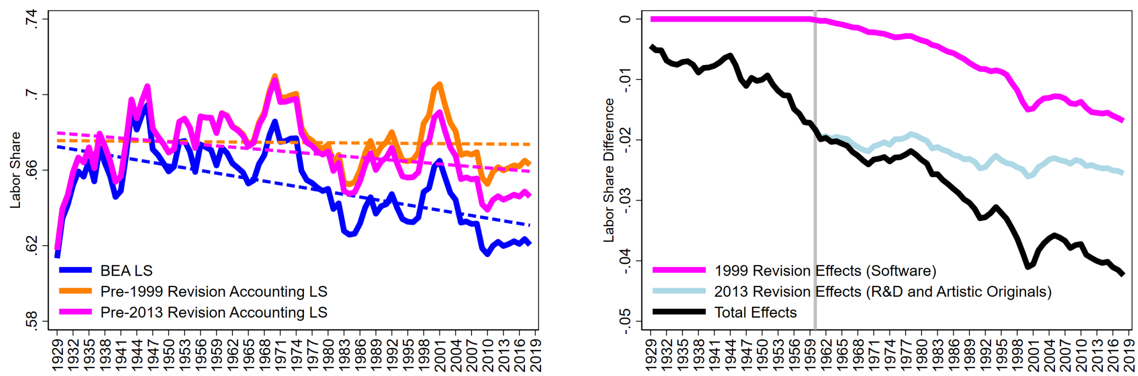
Compared with the benchmark LS, the pre-2013 revision counterfactual LS displays a milder decline that starts in the mid-1970s and is approximately half of that of the benchmark LS over the sample period (panel (a), Figure 3). This suggests a quantitatively similar role for software and R&D in explaining the decline of the 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 (1)] and the pre-2013 revision counterfactual LS [equation (3)]. Second,

[10]For ease of reference, we subsume artistic originals to the R&D; thus, in the notation that follows, 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 Labor Share

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



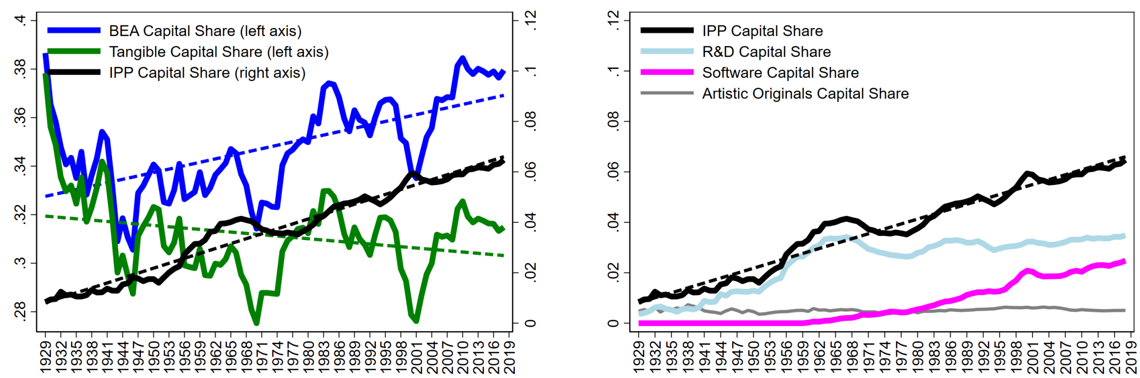
Notes: All data were retrieved from the BEA on Sep. 25, 2019. In panel (a), the pre-2013 revision counterfactual LS uses equation (3) to replicate the accounting rule in which software is capitalized and R&D (and artistic originals) are expensed. The BEA LS [equation (1)] and the pre-1999 revision counterfactual LS [equation (2)] are reproduced from Figure 2. Dotted lines show linear trends from 1929 to 2018. In panel (b), we compute the total LS decline as the difference between the BEA LS and the pre-1999 revision counterfactual 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 counterfactual LS. The effects of software capitalization on the LS decline is computed as the difference between the pre-2013 revision counterfactual LS and the pre-1999 revision counterfactual LS. The vertical gray line in 1960 indicates the first year with nonzero software investment in NIPA. Our data and results are available in this permanent link: US Factor Shares.

the effects of software capitalization on the LS decline can be computed as the difference between the pre-2013 revision counterfactual LS [equation (3)] and the pre-1999 revision counterfactual LS [equation (2)]. The total decline of the LS is the sum of these two effects. Our results are in panel (b) of Figure 3. Clearly, it is the capitalization of software what solely drives the declining trend of the LS after 1980s, 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. Another way to explore this issue is by decomposing the increase of the capital share into that of its components. In panel (a) of Figure 4, we plot the capital share, i.e., $1 - LS$, and that of its components, the IPP capital share ($\frac{I}{Y}$, black line) and the tangible capital share ($\frac{GOS^{adj}-I}{Y}$, green line). Clearly, the sole driver of the rise of the capital share is the income rents from IPP. In contrast, the tangible capital share declines over time. In panel (b) of Figure 4, we find that the rise of the IPP capital share is driven largely by R&D before the 1980s and by software after the 1980s. Artistic originals play a minor role in the level and trend of the IPP capital share.

This result speaks to earlier work on the decline of the LS that relies solely on the pre-2013 revision data (Elsby et al., 2013, Karabarbounis and Neiman, 2014). We show that the decline of the LS observed in that earlier work—that uses data for which software is capitalized but not R&D—is fully explained by the capitalization of software. To see this, we can simply compare the declining pre-2013 revision LS in which software is capitalized (pink line, panel (a) of Figure 3)

Figure 4: Tangible and IPP Capital Share of Income, BEA 1929–2018

(a) Capital Share and Its Components (b) IPP Capital Share and Its Components



Notes: The BEA capital share (blue line) is $\frac{GOS^{adj}}{Y}$, or one minus the BEA LS [equation (1)] plotted in Figure 2. The IPP capital share of income (black line) is computed as the ratio of investment in IPP to GDP, that is, $\frac{I}{Y}$. The tangible capital (i.e., equipment plus structures) share of income (green line) is $\frac{GOS^{adj}-I}{Y}$. Our data and all the results of our analysis are available in this permanent link: US Factor Shares.

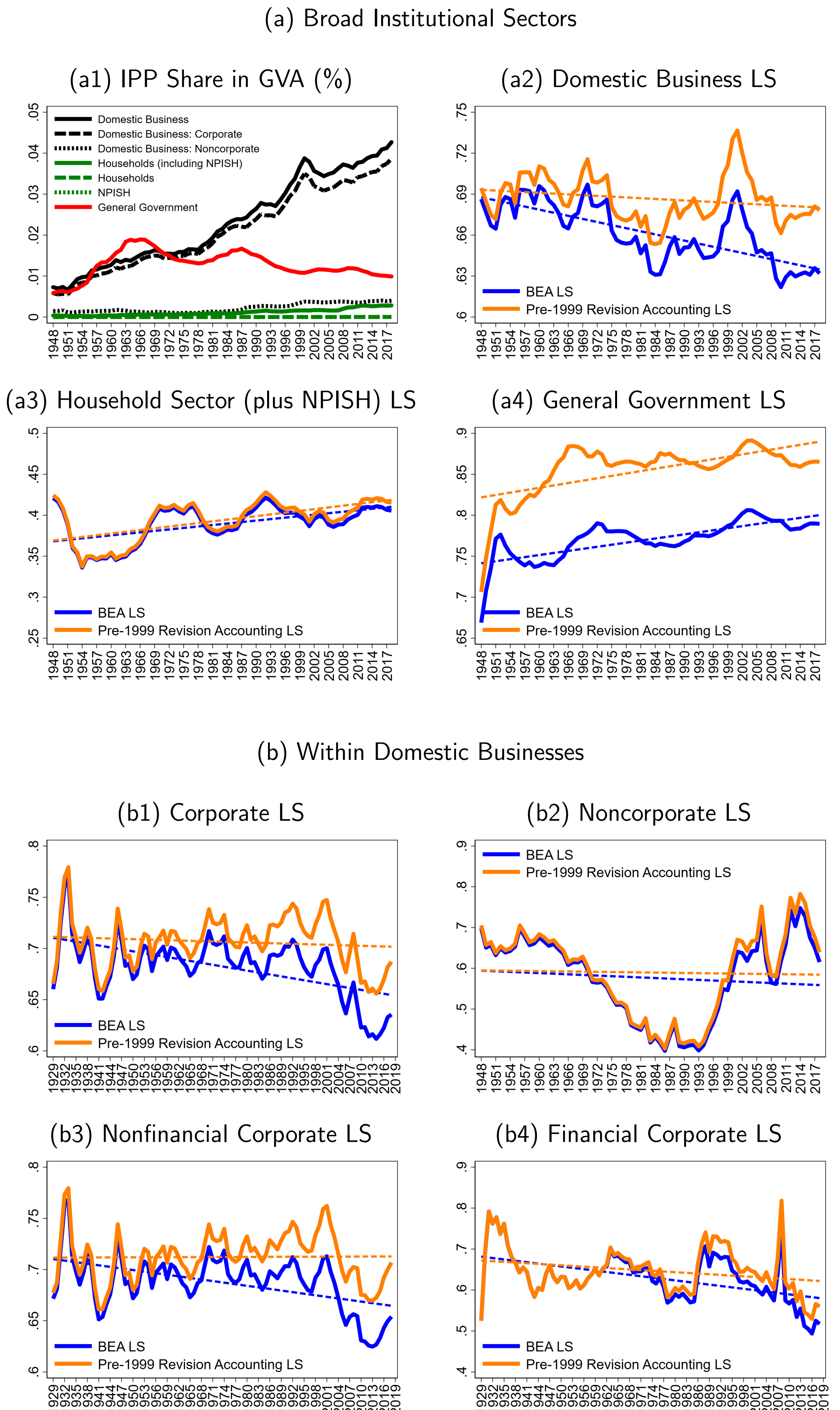
with the trendless pre-1999 revision LS in which software is not capitalized (orange line, panel (a) of Figure 3).

Institutional Sectors. We now conduct our analysis by institutional sectors. We first examine three broad institutional sectors that exhaustively capture the economy: (1) the domestic business sector, (2) the household sector (including NPISH) and (3) the general government.[11] We show IPP investment for these institutional sectors as a share of aggregate gross value added (GVA) in panel (a1) of Figure 5. From 1948, the first year in our sample, to early 1970s, the domestic business and government sectors make roughly equal contribution to IPP investment. However, since the mid-1960s the government's contribution to IPP is steadily decreasing as a share of GVA, whereas the IPP share of domestic businesses keeps rising throughout the entire period. Over the sample period, the growth of IPP share is mainly driven by the domestic business sector. In 2018, the share of IPP in GVA contributed by domestic businesses is 4.3% while that by the general government sector is only 0.9%. The contribution of households (including NPISH) to IPP growth is a positive, albeit minor, 0.3% of GVA.[12] Second, as is the case with the economy-wide LS, the capitalization of IPP explains the entire decline of the LS in domestic businesses; see panel (a2) of Figure 5. The pre-1999 revision LS in domestic businesses is trendless with a long-run average of 68.7%. In contrast, the LS in the household sector and the LS in the government sector are increasing in both post-2013 and pre-1999 revision data; see panels (a3) and (a4) of Figure 5. The level of the LS for these sectors also differs from that of domestic

[11]This analysis is limited to the period 1948-2018, for which the data by institutional sector are available. Only income components of the corporate sector (and of the aggregate economy) are available from 1929 to 2018.

[12]In our *Online Appendix*, we further study differences between the household sector and the NPISH sector.

Figure 5: Effects of IPP Capitalization by Institutional Sector



Notes: All data were retrieved from the BEA on Sep. 25, 2019. We retrieve GVA by institutional sectors from NIPA Table 1.3.5; CE and Tax-Sub by institutional sectors from NIPA Table 1.13; IPP investment by institutional sectors from FAT 4.7 and 7.5. Our data and results are available in this permanent link: US Factor Shares.

businesses, with the household sector averaging a lower LS of 39.4% and the government sector averaging a higher LS of 85.6%. This broad institutional analysis shows that the business sector drives the effects of IPP capitalization on the economy-wide LS.

We further decompose the domestic business sector into (1) the corporate sector (including nonfinancial and financial corporations) and (2) the noncorporate sector that includes sole proprietorships, partnerships and government enterprises. The first observation is that most of the IPP investment in domestic businesses is captured by the corporate sector. For example, in 2018, IPP investment by the corporate sector accounts for 3.9% of aggregate GVA , while IPP investment in the noncorporate business sector accounts for a much smaller 0.4% of GVA. The behaviors of the corporate and noncorporate LS are depicted respectively in panel (b1) and (b2) of Figure 5.[13] Although the long-run trend of the corporate LS with current data displays an annual decline of -0.093%, the pre-1999 revision counterfactual corporate LS consistent with expensing IPP is trendless. That is, the main result we obtain from the economy-wide analysis extends to the corporate sector. A further decomposition between nonfinancial and financial corporations (respective panels (b3) and (b4)) shows that the results of the corporate sector are largely driven by nonfinancial corporations. The effects of IPP capitalization on the noncorporate LS are minor (panel (b2)). To sum up, domestic businesses, in particular, the nonfinancial corporations, are responsible for the effects of IPP capitalization on the secular behavior of the economy-wide LS.

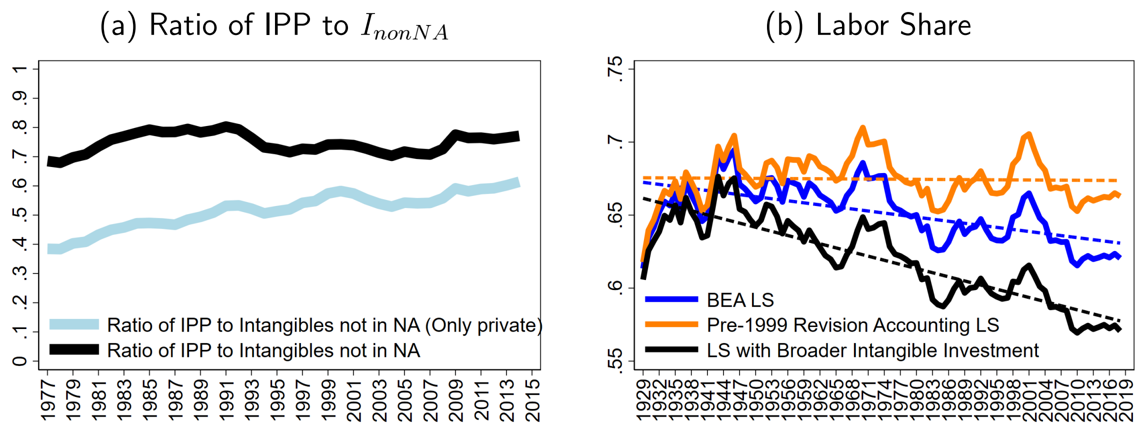
Broader measures of intangible capital. IPP, as measured by the BEA, captures some types of intangible capital in the economy, but not all (Corrado et al., 2009, McGrattan and Prescott, 2010). We now assess the effects of capitalizing a broader set of intangible investments on the long-run behavior of the LS. In particular, we use the series constructed by Corrado et al. (2009) and their updates for intangible items not included in national accounts, I_{nonNA}.[14] These series of intangible investment consist of (1) Finance and insurance new product development, (2) Design, (3) Brand, (4) Training, and (5) Organizational capital.

In panel (a) of Figure 6, we compare the properties of intangible investment incorporated in national accounts (i.e., IPP) with intangible investment not incorporated in national accounts

[13] Previous work on the LS has focused on the corporate sector. An advantage of focusing on the corporate sector is that the corporate sector does not have ambiguous income (i.e. proprietor's income), for which the attribution to factor income is less straightforward. In addition, the corporate sector does not include either households or governments, for which the measurement of the LS is subject to criticism (Gomme and Rupert, 2004, 2007).

[14] We would like to thank Daniel Sichel and Carol Corrado for providing us with these updated series.

Figure 6: The Effects of Capitalizing Broader Measures of Intangible Capital



Notes: Panel (a) shows the ratio of the investment on intangible capital currently incorporated in national accounts (i.e., IPP) to the investment on intangible that is not incorporated in national accounts, using the data from Corrado et al. (2009) and their updates. In panel (b), the current BEA LS that capitalizes IPP is constructed as $LS = 1 - \frac{GOS-TS-PI}{GDP-TS-PI}$; the pre-1999 revision counterfactual labor share that treats current IPP as intermediate expenditure is $LS = 1 - \frac{GOS-TS-PI-IPP}{GDP-TS-PI-IPP}$; and the counterfactual LS that capitalizes broad measures of intangible investment is $LS = 1 - \frac{GOS-TS-PI+I_{nonNA}}{GDP-TS-PI+I_{nonNA}}$.

(i.e., I_{nonNA}).[15,16] We find that I_{nonNA} is larger than IPP. The ratio of private IPP to private I_{nonNA} increases from 38.6% in 1977 to 61.4% in 2014. That is, IPP in the BEA grows faster than the intangible investment not incorporated in national accounts. However, once we incorporate government IPP investment, the differences between IPP and I_{nonNA} decrease. We find that the ratio of the two is large, on average approximately 74.7% for the entire sample period, and it increases from 68.6% in 1977 to 77.2% in 2014. This implies that if national accounts were to incorporate the total intangible investment (i.e., IPP plus I_{nonNA}), then the current measure of intangible investment of the BEA would increase by a factor of 2.34.[17]

The implications of these broader measures of intangible investment for the long-run behavior

[15] Since the BEA provides a longer time series of IPP (i.e., software, R&D and artistic originals) than Corrado et al. (2009) and their updates, we use the BEA series for these forms of intangible capital. We find minor differences between these two sources: Software in the BEA tends to be smaller and R&D tends to be larger than their counterparts in Corrado et al. (2009). This is due to the fact that, after BEA's 2018 revision, R&D in software, which was part of the software account in previous versions of the BEA data, is now part of the R&D account.

[16] The BEA incorporates mineral exploration in structures since, at least, the 1999 BEA revision, whereas other countries include this type of investment in intangible capital in national accounts. The BEA did not reclassify the mineral exploration to IPP at the 2013 comprehensive revision because they did not have enough information to disentangle exploration drilling (conceptually an investment in R&D) from production drilling (conceptually an investment in structures).

[17] Precisely, incorporating I_{nonNA} to national accounts implies that intangible investment goes up by a factor of (1+1/0.747)=2.34. In other words, the BEA currently captures 42.7% of the total intangible investment measured by Corrado et al. (2009).

of the LS are reported in panel (b) Figure 6. The broader measure of intangible investment enlarges the long-run decline of the LS. Specifically, if the national accounts were to capitalize the broader set of intangibles, then the LS would significantly decline at an annual rate of -0.15%, which is a rate twice as large as the decline of the LS with the current IPP in NIPA. Finally, note that this analysis does not alter the pre-1999 revision counterfactual LS that remains trendless.

4 International Evidence

The 2013 BEA comprehensive revision that capitalizes R&D and artistic originals in the U.S. is based on the capitalization guidelines provided by the System of National Accounts 2008 (SNA08).[18] The SNAs are quinquennially updated and provide the international accounting standards and principles that are implemented by national statistics offices.[19] Indeed, most OECD countries already follow the SNA08's guide on IPP capitalization. We now extend our main analysis to several countries that currently capitalize IPP. Because we are interested in the long-run behavior of the LS, we focus on a selection of countries for which long time series dating back at least to the 1960s are available: Canada, France, Denmark, Sweden and Japan.[20]

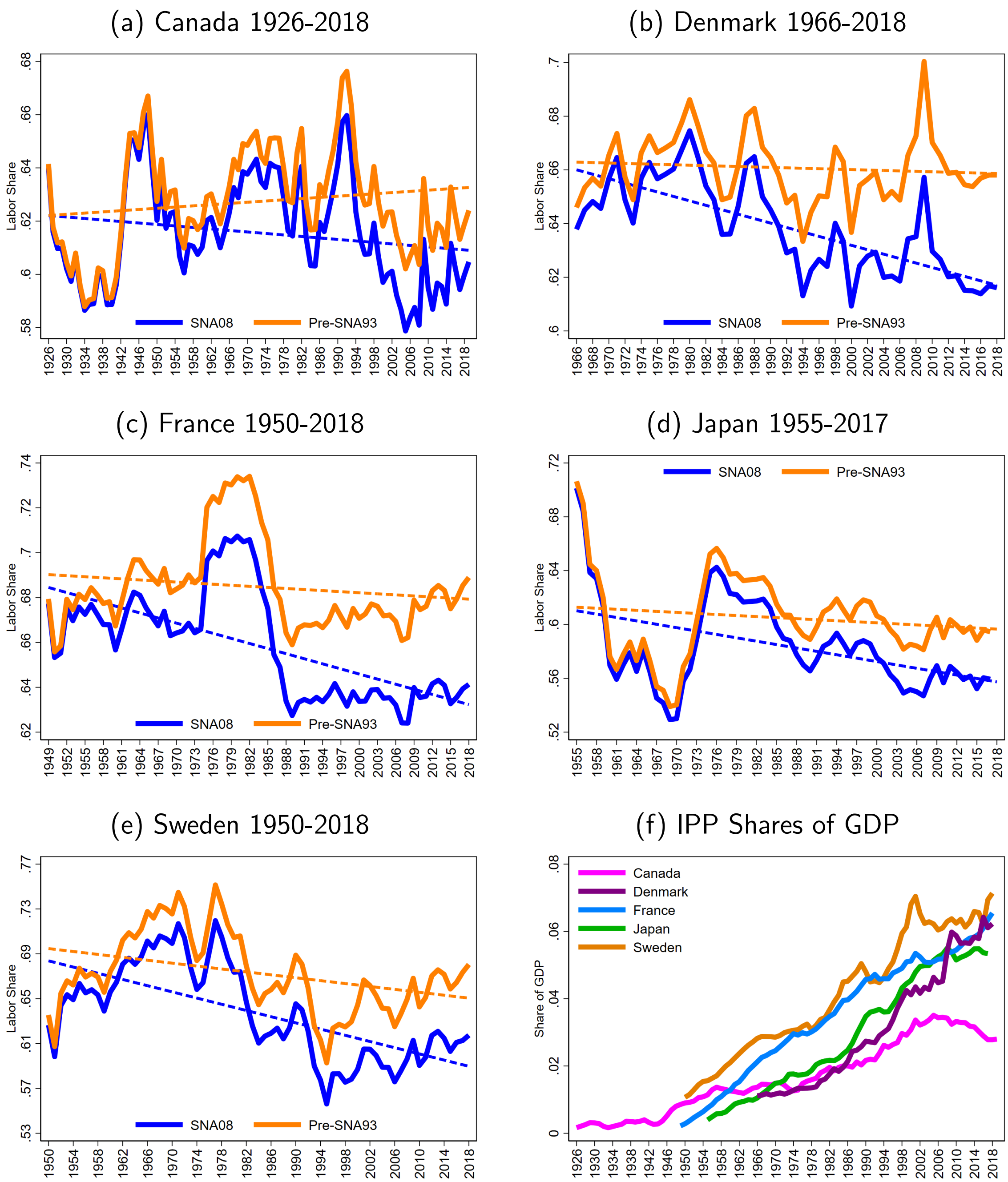
The results for these countries are similar to those for the U.S., see Figure 7. First, the LS (blue line) declines significantly in all five countries. For the country with the longest period of available data, Canada, the LS shows a long-run (linear) trend that annually decreases by -0.023% from 1926 to 2018 (see panel (a) in Figure 7). The LS linearly declines by an annual -0.130% in Denmark between 1966 and 2018 (panel (b)), by an annual -0.116% in France between 1950 and 2018 (panel (c)), by an annual -0.13731% in Japan between 1955 and 2017 (panel (d)) and by an annual -0.217% in Sweden between 1950 and 2018 (panel (e)). The decline is significant at 1% level in all countries except Canada, in which the significance is at 10% level. Second, the share of IPP investment in GDP rises in each of the five countries (see panel (f) of Figure 7). The IPP investment share in GDP increases from a level below 1% at the beginning of the sample period to a level that is approximately 5.5% of GDP in the late 2010s in all countries except Canada, where it grows to approximately 3% of GDP in the 2010s. Third, we assess the effects of IPP capitalization by constructing a counterfactual accounting LS consistent with the pre-SNA93 accounting rule in which IPP is expensed. The effects of the IPP capitalization on the long-run behavior of the LS are similar across countries. In all countries, the counterfactual accounting LS is trendless. Specifically, the long-run trend of the pre-SNA93 counterfactual LS is an annual slope of 0.019% in Canada, -0.012% in Denmark, -0.023% in France, -0.036% in Japan

[18] In the same fashion, the System of National Accounts 1993 (SNA93) provided the guidelines for the capitalization of software that the BEA adopted in the 1999 comprehensive revision of national accounts.

[19] The System of National Accounts: https://unstats.un.org/unsd/nationalaccount/sna.asp.

[20] Details about the construction of the LS for these countries can be found in our *Online Appendix*.

Figure 7: The Effects of IPP Capitalization on the Labor Share, International Evidence



Notes: The data for each country was retrieved from the country's statistical office for national accounts. Specifically, the data for Canada was retrieved from Statistics Canada (`https://www.statcan.gc.ca/eng/start`), the data for Denmark from Statistics Denmark (`https://www.dst.dk/en`), the data for France from INSEE (`https://www.insee.fr/en/accueil`), the data for Japan from the Cabinet Office (`https://www.cao.go.jp/index-e.html`) and the data for Sweden from Statistics Sweden (`https://www.stat.fi/index_en.html`). Details about the country-level data and the construction of LS with longer sample periods can be found in our *Online Appendix*. Our data and results are available in this permanent link: US Factor Shares.

and -0.095% in Sweden, none of which is significantly different from zero. The only exception is Sweden, in which IPP accounts for more than 56% of the LS decline but leaves a significant 44% of the decline unexplained.

5 Discussion

The finding that the capitalization of IPP explains the decline of the LS raises some questions over the accounting procedure that capitalizes the IPP. In particular, we question a critical accounting assumption on the factor distribution of rents generated from IPP. Let $1 - \chi \in [0, 1]$ denote the fraction of IPP rents attributed to labor and χ the fraction attributed to capital. The BEA assumes that all rents from IPP go to capital, which effectively sets χ to one (see Section 2).

How can we interpret $1 - \chi$? Our preferred interpretation of $1 - \chi$ is the portion of IPP rents paid to workers in the form of equity. For example, corporate 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 the compensation of employees in BEA's income account.[21] More generally, this interpretation is akin to the notion of sweat equity in McGrattan and Prescott (2010, 2014). It describes a scenario in which workers are paid wages lower than their marginal value product in return for some equity.[22] Along this line of argument, a growing literature in corporate finance documents that an essential property of intangible capital is that it is partly embodied in key talents such as managers, engineers, and research employees of the firm, and is hence portable (Lustig et al., 2011, Eisfeldt and Papanikolaou, 2014, Sun and Xiaolan, 2019). The property right over such capital is different from physical capital: the key talents own, at least partially, the cash flow from intangible capital in the form of equity.[23]

[21]BEA aims at including in the compensation of employees an employee's gain from exercising nonqualified stock options (NSOs) at the time they are exercised, but does not include ISOs at all. 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 attempts to include the NSOs in compensation. However, its attempt faces serious challenges because not all US states mandate the collection of this information and even if they do, the accuracy is questionable (Moylan, 2008). It is for this reason that NIPA does not provide a separate time series for NSOs. In contrast to the NSOs, the ISOs are taxed as long-term capital gains when sold and are completely absent in 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*.

[22]This is also the case for unincorporated businesses, whose owners invest time in accumulating intangible capital for their businesses, such as building the client list or brand equity (Bhandari and McGrattan, 2018).

[23]The divergence of the labor compensation in measurements and in theory is also the subject of study in Hartman-Glaser et al. (2019), Bhandari and McGrattan (2018), Eisfeldt et al. (2019), and Smith et al. (2019). However, not all the literature studying equity compensation focuses on IPP-related employees, which is our concern here.

What are the values of χ for which the secular LS is trendless? To answer this question, we write the LS explicitly as a function of χ,

$$LS = 1 - \frac{GOS^{adj} - (1-\chi)I}{Y}. \tag{4}$$

Under the current BEA accounting assumption that sets χ equal to one, the LS declines; see panel (a) of Figure 8. In the opposite extreme, where all IPP rents are attributed to labor income (i.e., $\chi = 0$), the LS displays a significant upward trend. An intermediate value of $\chi = 0.5$ delivers a trendless LS. Clearly, the value of χ has direct implications on the secular behavior of the LS. Moreover, χ is not necessarily constant.[24] We now examine the effects on the LS of various hypothetical linear time-series of χ using the following specification: $\ln(1-\chi) = \ln(1-\chi_0) + \gamma t$. Panel (b) of Figure 8 shows the combinations of initial values (horizontal axis) and growth rates (vertical axis) that imply either a secularly increasing LS (upper right region) or a secularly decreasing LS (lower left region). Sandwiched between the two regions is the region of χ that implies a secularly trendless LS (solid black line) with the associated 95% confidence interval. First, if $1-\chi$ is constant (i.e., γ equals zero), then the range of values for which the LS is trendless is $(1-\chi) \in [0.52, 0.91]$. That is, the LS significantly declines for values of $1-\chi$ below 0.52 and significantly increases for values of $1-\chi$ above 0.91. Second, the area in which the LS secularly declines is smaller the larger is the growth of $1-\chi$. For example, if we assume that $1-\chi$ grows by twenty per cent over the course of a century (i.e., an annual growth of 0.18%), then the range of values for which the LS is trendless is $(1-\chi) \in [0.34, 0.73]$.

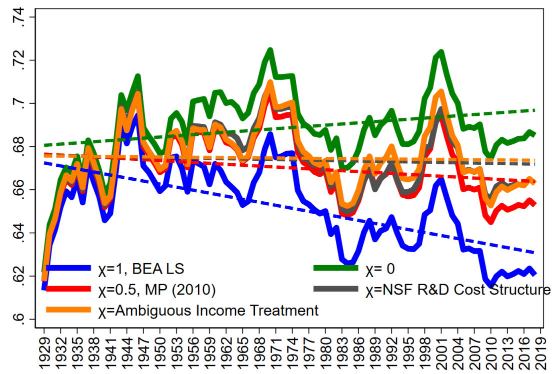
What are plausible values for χ? If some rents generated from IPP, which should be attributed to labor, are not captured by the BEA's compensation of employees (e.g., equity compensation for software developers), then empirically plausible values for χ must be less than one. Though inconclusive, the current estimates for χ suggests that this is the case. McGrattan and Prescott (2010) use a latent variable approach to recover intangible assets (including but not limited to IPP) in a U.S. model economy and calibrate a benchmark value of χ equal to 0.5. Using a nonrepresentative sample of the corporate sector, Lerner and Wulf (2007) show that the ratio of the value of long-term incentives to cash compensation for corporate R&D heads more than doubled over the course of the 1990s, which implies that $1-\chi$ increases from 0.25 in 1988 to 0.57 in 1998.[25] In panel (c) of Figure 8, we plot the aforementioned estimates of $1-\chi$ against

[24] Moylan (2008) documents that, for an average executive, the share of equity-based compensation of total compensation increases from 1994 to 2005. Eisfeldt et al. (2019) provides estimates of the aggregate equity-based compensation as a share of total value added for the US from 1960 to 2005, which increases rapidly in the last three decades (Figure 4 in their paper).

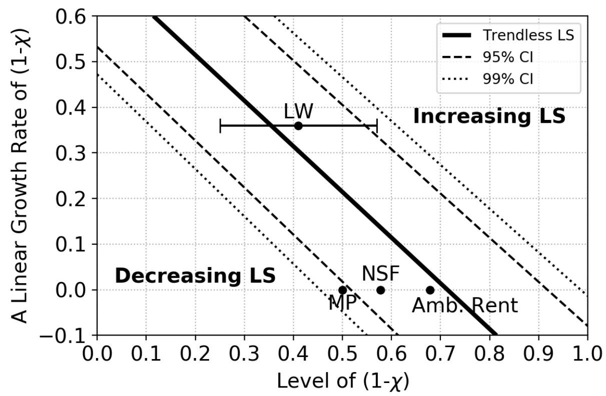
[25] Lerner and Wulf (2007) find that the long-term incentives to cash compensation ratio increases from 0.39 in 1988 to 0.87 in 1998. We define $1-\chi$ as the ratio of long-term incentives to cash compensation times the LS.

Figure 8: US Labor Share under Alternative Assumptions on the Factor Distribution of IPP, χ

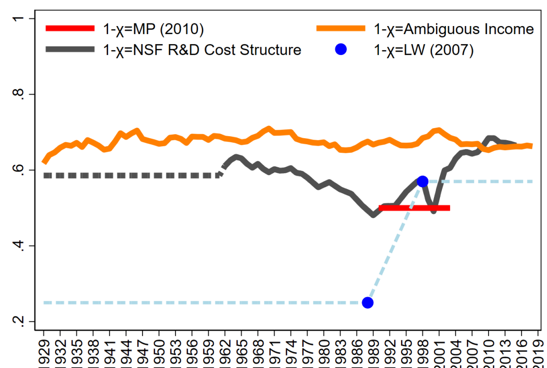
(a) Economy-wide LS Adjusted by χ



(b) Effects of the Level and Growth of χ on the LS



(c) Factor Distribution of IPP Rents: $1 - \chi$



Notes: LS is constructed based on different capital-labor splits of IPP rents (χ) in equation (4). In the extreme, IPP rents can be either fully assigned to capital income ($\chi = 1$) or to labor income ($\chi = 0$). As a less extreme case, We use a model-based value for $\chi = 0.5$ from McGrattan and Prescott (2010) (labeled as "MP"). Additionally, we use two point estimates from Lerner and Wulf (2007) (labeled as "LW") and take a linear trend over the 90 years as the growth rate of $(1 - \chi)$. An alternative case is based on the cost structure of R&D from the nationally representative Business Research and Development and Innovation Survey (BRDIS) conducted by NSF (labeled as "NSF"). Another possible value for χ could be based on a value that treats IPP investment rents as ambiguous income (labeled as "Amb. Rent"). Our data and results are available in this permanent link: US Factor Shares.

their associated sample periods. We also entertain two alternative ready-to-use series of χ. First, because the BEA equates the income generated from IPP investment to the expenditure on IPP, it seems natural to base the assumption about the factor distribution of IPP rents on the cost structure of IPP. Specifically, we construct $1-\chi$ using the cost structure of R&D from the nationally representative Business Research and Development and Innovation Survey (BRDIS) of for-profit nonfarm businesses with five or more employees operating in the U.S. with known R&D activity.[26] For our calculation of χ, we use information about domestic R&D paid for by type of costs for all years available.[27] Precisely, we use information about R&D costs in terms of wages, salaries, fringe benefits, and intermediate expenditures. This implies a measure of $1-\chi$ equal to (Wages + Salaries + Fringe Benefits)/(Total R&D Cost - Intermediate Expenses). We subtract R&D costs paid for materials and supplies as intermediate expenses from the total costs, because the classification of the cost as either capital or labor is ambiguous.[28] Second, we treat IPP rents as ambiguous income in the same manner as we treat proprietor's income and taxes (less subsidies) in the construction of the LS. This implies $\chi = 1 - \frac{GOS-I}{Y-I}$ in equation (4). This measurement of χ has the advantage that it is available for our entire sample period and is also invariant to the introduction of more types of intangible capital in national accounts.[29] Panels (a) and (b) of Figure 8 show that all these alternative estimates of χ deliver a secular LS that is trendless.

Related issues on the measurement of investment. Our findings are directly related to the measurement of investment. The incorporation of IPP investment into GDP raises questions about how national accounts distinguish between intermediate expenditure and investment. The SNA proposes that expenditure that provides economic return for more than a year be considered as investment (see United Nations (2009) pp.121-123); an accounting principle which, although followed by national statistical offices, is nevertheless arbitrary. Further, there is the added difficulty of measuring and determining the duration of economic returns that exceed the one-year threshold, in particular, for items with relatively high depreciation rates (e.g., software).

An alternative to the challenging measurement of χ and that of investment is to focus on a LS defined as the ratio of compensation of labor to total payouts to labor and owners of firms,

[26] See BRDIS (`https://www.nsf.gov/statistics/srvyindustry/`) for the years of 1991-2016 and the Survey of Industrial Research and Development (SIRD: `https://www.nsf.gov/statistics/srvyindustry/sird.cfm`)—the predecessor to BRDIS—for the years of 1962-1991. NSF sends out a standard survey to companies with known R&D activities and a short survey screener to other companies. The sample size is 42,122.

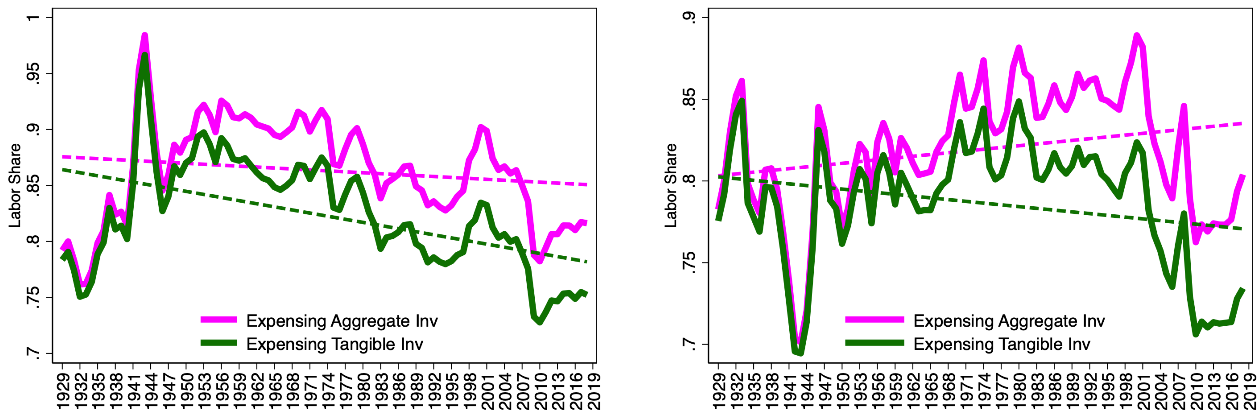
[27] The distribution of R&D costs was collected biennially for years between 1977 and 1997 in BRDIS and SIRD.

[28] A measure of stock-based compensation is available in the NSF survey, but only after 2008. In addition, the NSF questionnaire does not specify what types of stock-based compensation are included, so it is solely up to the respondents to decide what to report. We decided not to include these reported payments in our analysis.

[29] Further, it is straightforward to see that the χ implied by treating IPP rents as ambiguous income delivers a LS that is equivalent to one in which IPP investment is expensed.

Figure 9: Expensing Aggregate Investment, BEA 1929–2018

(a) Economy-wide LS (b) Corporate LS



Notes: Panel (a) shows a LS in which only tangible investment is expensed (green line) and another LS in which aggregate investment (i.e., both tangible and IPP investment) is expensed (pink line). Panel (b) shows the same LS series for the corporate sector. Our data and results are available in this permanent link: US Factor Shares.

where the measure of total payouts to labor and owners of firms is the sum of compensation of employees (CE) and gross operating surplus (GOS) less investment in equipment, structures, and intellectual property products.[30] In effect, this is the LS in Barro (2019) where aggregate investment is expensed,

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

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. If aggregate investment is fully expensed, then the economy-wide counterfactual accounting LS is trendless; see panel (a) of Figure 9. Nevertheless, expensing tangible investment alone cannot generate this result. To see this, we isolate the effects of expensing tangible investment (green line) and expensing both tangible and IPP investment (magenta line) respectively. If we expense only tangible investment, then the counterfactual accounting LS still declines. The LS flattens out only when we additionally expense IPP investment. For the corporate sector, the LS is even increasing after expensing aggregate investment; see panel (b) of Figure 9.

6 Conclusion

We show that the change in the accounting treatment of IPP gradually implemented by the BEA since 1999 is the sole driver of the decline of the LS. Moreover, our analysis indicates that less

[30]We thank Andy Atkeson for sharing this insight with us.

extreme accounting assumptions on the factor distribution of IPP rents yield a secularly trendless LS. At the same time, the medium-run behavior of the LS (e.g., its rise in the 1960s, 1990s and 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.

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