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 70 years. We find that the capitalization of intellectual property products in the national income and product accounts entirely explains—in a purely accounting sense—the observed decline of the US labor share. 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

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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 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 increases from 8% in 1947 to 26% in 2016 in the NIPA.[1]

This reclassification of IPP from expenditure to investment unambiguously lowers LS in a purely accounting sense. 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 sector.[2] To restore the accounting identity, 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), that is, to capital income. This attribution

[1] This structural shift toward a more IPP–intensive economy is large and does not show signs of deceleration. Excluding residential investment accentuates this shift: IPP investment increases from 11% of nonresidential aggregate investment in 1947 to 33% in 2016. In the corporate sector, the shares are 9% in 1947 to 35% in 2016.

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

automatically lowers the LS, which is one minus the ratio of the GOS to the VA. 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 accounting LS.

To measure the effects of the capitalization of IPP on the secular behavior of the accounting LS, we compare our benchmark LS, which is constructed using current post-2013 BEA revision data, with a counterfactual accounting LS in which we de-capitalize 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 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 in the accounting LS.[3]

Since the decline of the LS is strictly the result of an accounting—not an economic—change, we scrutinize the economic interpretation of the LS decline. Our examination of the accounting rules behind the capitalization of IPP—mainly, the BEA assumption that all IPP investment rents are capital income—shows that less arbitrary and less extreme assumptions on the factor distribution of IPP rents yield a trendless accounting LS. Therefore, rather than attempting to rationalize the decline of the accounting LS as an economic phenomenon, we argue that the way forward is to devote research efforts to accurately measuring the factor distribution of IPP rents in national income and extending the analysis across all the intangibles assets. The main challenge is that neither the factor distribution of IPP rents nor the entire set of intangible assets is directly observable. We are in urgent need of more microeconomic evidence together with the creative use of macroeconomic theory to recover these unobservable investments and their distribution across factors of production.

The reminder of this paper is organized as follows. We describe the BEA revisions that

[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.

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 and discuss the implications of our results for the US model and the way forward in Section 4. Section 5 concludes.

2 Effects of the Capitalization of IPP on 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 the 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, 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).

[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 (i.e., wags, 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). We discuss this measurement in more detail in Section 4. 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	2016
1. Gross output, pre-revision	Q	430.3	27,935.5
2. Plus own-account IPP	I_o	1.5	544.1
3. *Equals*: Gross output, post-revision:	$Q + I_o$	431.8	28,479.6
4. Intermediate expenditure, pre-revision	$M + I_p$	216.0	12,443.6
5. Less purchased IPP	I_p	0.5	188.6
6. *Equals*: Intermediate expenditure, post-revision	M	215.5	12,255.0
7. Value added, pre-revision (L. 1–4):	$Q - (M + I_p)$	214.2	15,491.9
8. Plus own-account and purchased IPP (I_b)	$I_o + I_p$	2.0	732.7
9. *Equals*: Value added, post-revision (L. 3–6)	$(Q + I_o) - M$	216.2	16,224.6
10. Compensation of Employees	W	110.4	8,082.8
11. Gross operating surplus (GOS), pre-revision (L. 7–10)	$Q - (M{+}I_p) - W$	103.9	7,409.2
12. Plus own-account and purchased IPP (I_b)	$I_o + I_p$	2.0	732.7
13. *Equals*: GOS, post-revision (L. 9–10)	$(Q + I_o) - M - W$	105.9	8,141.9
14. Depreciation, pre-revision	D	16.4	1,754.5
15. Plus depreciation of business IPP	D_{I_b}	1.3	636
16. *Equals*: Depreciation, post-revision	$D + D_{I_b}$	17.7	2,390.5
17. Net operating surplus (NOS), pre-revision (L. 11–14):	$Q - (M{+}I_p) - W - D$	87.5	5,654.7
18. Plus own-account and purchased IPP (I_b)	$I_o + I_p$	2.0	732.7
19. Less depreciation of IPP	D_{I_b}	1.3	636
20. *Equals*: NOS, post-revision (L. 13–16)	$(Q + I_o) - M - W - (D + D_{I_b})$	88.2	5,751.4

Notes: All data were retrieved from the BEA in February 2018. 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-KLEMS Industry Accounts. The depreciation for the business sector is obtained from Table 2.4 in the BEA Fixed Asset Tables (FAT).

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 732.7 billion in 2016. Since the gross investment in the IPP as a share of the value added increases from 1% in 1947 to 5% in 2006, 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 4.73% in 2016.

On the income side of the business accounts, we denote the compensation of employees by W and obtain the GOS as the value added minus W. A key accounting assumption behind the IPP capitalization implemented by the BEA is that the entire IPP investment is allocated to GOS.

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). More specifically, GOS is revised up by 1.93% in 1947 and by 9.89% in 2016.

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. 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 1.71% in 2016.

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 capital, $D_{I_{np}}$, (or the depreciation of government 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 the 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 investment in IPP, $I_b + I_{np}$. These results imply that private product is revised up by 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]

[5] McCulla et al. (2013) document that there were two additional changes introduced in reclassifying government

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

	Notation	USD Bill. 1947	USD Bill. 2016
Private sector:			
1. Personal consumption expenditure, pre-revision	C	161.9	12,824.7
2. Less: NPISH net investment in IPP	$I_{np} - D_{I_{np}}$	-0.1	4.0
3. *Equals*: Personal consumption expenditure, post-revision	$C - (I_{np} - D_{I_{np}})$	162.0	12,820.7
4. Gross private investment, pre-revision	X	35.1	2,301.0
5. Plus: Gross private investment in IPP	$I_b + I_{np}$	2.0	756.2
6. *Equals*: Gross private investment, post-revision	$X + I_b + I_{np}$	37.1	3,057.2
Government sector:			
7. Government consumption, pre-revision	C_g	34.7	2,666.5
8. Less: Government net investment in IPP	$I_g - D_{I_g}$	0.4	8.4
9. *Equals*: Government consumption, post-revision	$C_g - (I_g - D_{I_g})$	34.3	2,658.1
10. Gross government investment, pre-revision	X_g	4.3	414.5
11. Plus: Gross government investment in IPP	I_g	1.4	195.2
12. *Equals*: Gross government investment, post-revision	$X_g + I_g$	5.7	609.7
13. Government expenditure, pre-revision (L. 7+10)	G	39.0	3,081.0
14. Plus: Government depreciation in IPP	D_{I_g}	1.0	186.8
15. *Equals*: Government expenditure, post-revision (L. 9+11)	$G + D_{I_g}$	40.0	3,267.8
Gross domestic product, GDP:			
16. GDP, pre-revision (L. 1+4+13)	$C + X + G$	246.8	17,685.5
17. Plus: Business investment in IPP	I_b	2.0	732.7
18. Plus: NPISH depreciation in IPP	$D_{I_{np}}$	0.1	19.5
19. Plus: Government depreciation in IPP	D_{I_g}	1.0	186.8
20. *Equals*: GDP, post-revision (L. 3+6+15)	$C + (X + I_b + D_{I_{np}}) + (G + D_{I_g})$	249.9	18,624.5

Notes: All data wereretrieved from the BEA in February 2018. Personal consumption expenditure, C, gross private domestic investment X, government expenditure (including consumption and gross investment), G, and GDP come from Table 1.1.5 and 3.9.5 in NIPA. The measure of GDP incorporates net exports of goods and services, that is, 10.8 billion in 1947 and -521.2 billion in 2016, which are unaffected by IPP capitalization. Gross business, NPISH, and government investment in IPP come from Table 2.7 and 7.5, and their depreciation from Table 2.4 and 7.3 in FAT.

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.[6] Therefore, the revised GDP is increased by an amount equal to the increase

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 even larger than government R&D consumption. Because we do not replicate these additional changes to calculate pre-2013 levels, our subtraction of government IPP in our counterfactual LS is a lower bound.

[6] Because the IPP reclassification from expenditure to investment does not affect exports and imports or the

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 939.0 billion in the GDP in 2016, that is, an increase of 5.3% 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.[7]

2.3 Implications for the Accounting LS

The capitalization of IPP unambiguously decreases the accounting LS. To observe this decrease, define the LS as,

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

where the ratio of GOS to gross national product (Y) is the capital share of income. Then, the difference between the post-revision accounting LS, LS_{Post}, and the pre-revision accounting LS, LS_{Pre}, is as follows:

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

where $GOS_{\text{Post}} - GOS_{\text{Pre}} = \Delta = Y_{\text{Post}} - Y_{\text{Pre}}$, and $\Delta = I_b + D_{I_g} + D_{I_{np}}$. The negative sign in the last inequality in equation (1) is explained by Y being larger than its components, that is, $Y > GOS$, and $Y > \Delta$. The interesting question is how the change in the accounting treatment of IPP affects the secular trend of the accounting LS. We explore this quantitative question in Section 3.

trade and current account balances, we ignore net exports from GDP.

[7] Precisely, corporate profits increase by the net IPP investment of corporate business and proprietors' income increases by the net IPP investment of unincorporated businesses (McCulla et al., 2013).

3 The Decline of 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) is computed as

$$GOS = \text{UCI} + \text{DEP} + \text{ACI}, \tag{2}$$

and our benchmark accounting LS is

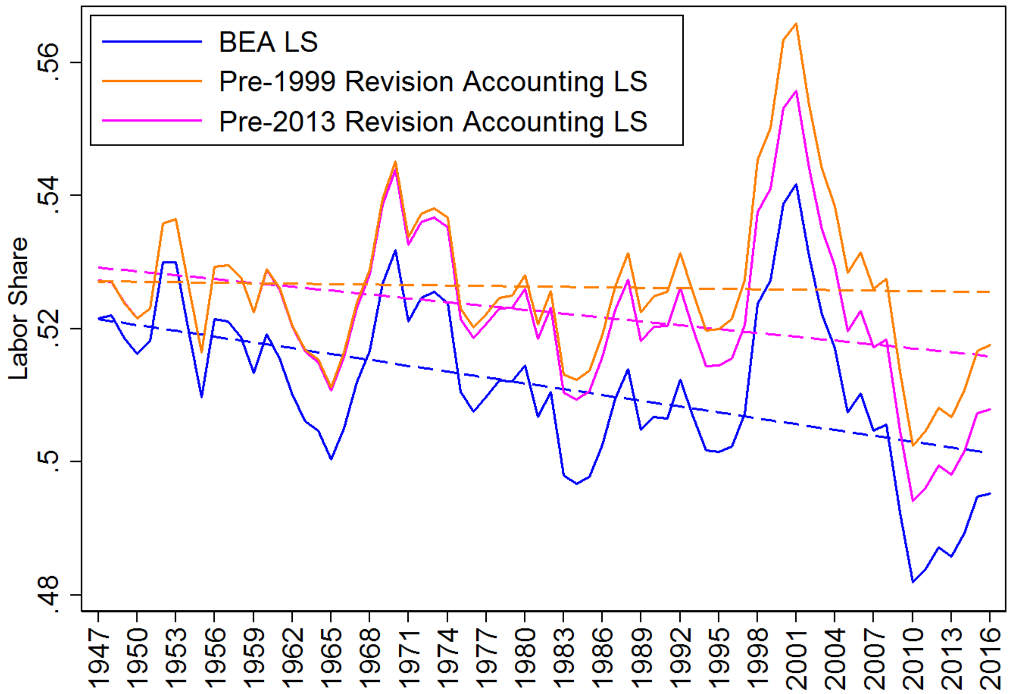
$$LS = 1 - \text{Capital Share} = 1 - \frac{GOS}{Y}, \tag{3}$$

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 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 Appendix A for details.[9]

[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 2016 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

Figure 1: Economy-Wide US Labor Share, BEA 1947–2016: Pre- Vs. Post-Revision Accounting



Notes: All the time series are computed using current BEA data, see 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 2016, the latest available year. The pre-1999 revision accounting LS uses equation (4) to replicate the accounting rule in which IPP is expensed. The pre-2013 revision accounting LS uses equation (5) to replicate the accounting rule in which software is capitalized and R&D (and artistic originals) are expensed. Dotted lines show linear trends from 1947 to 2016. Our data and results are available in this permanent link: US Factor Shares.

Figure 1 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 52% in 1947 and reaches a value of roughly 49% in 2016 with a historical low at 48% in 2010, that is, a decline of 4 LS points, or approximately 8 percentage points.[10]

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 Appendix B.

[10]To put this paper in perspective, the recent debate about the secular decline of the LS (Elsby et al., 2013, Karabarbounis and Neiman, 2014, Piketty and Zucman, 2014) has notably relied on evidence from the pre-2013 revision data. There are several remarks to be made. First, Elsby et al. (2013) focus on LS constructs provided by the Bureau of Labor Statistics (BLS), which we discuss in online Appendix B.2. Second, Karabarbounis and Neiman (2014) focus on the corporate LS—see our discussion in Appendix B.1—although these authors also provide estimates for the aggregate economy using national income data and Penn World Tables data. Third, while our analysis, as in Elsby et al. (2013) and Karabarbounis and Neiman (2014), focuses on the gross LS, Piketty and Zucman (2014) study the decline of the net LS. Piketty and Zucman (2014) construct 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,

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,

$$LS_{Pre\text{-}1999} = 1 - \frac{GOS - (I_b + D_{I_{np}} + D_{I_g})}{Y - (I_b + D_{I_{np}} + D_{I_g})}. \tag{4}$$

The comparison between our benchmark LS (blue line, Figure 1) and the pre-1999 revision counterfactual LS (orange line, Figure 1) 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 52.6%. That is, the decline of the accounting LS is entirely explained by the capitalization of IPP in national accounts. The change in the accounting treatment of IPP—from expensed to capitalized—is what generates the declining pattern of the LS. In the Appendix, we demonstrate that the same result is obtained using the corporate sector LS as well as the "asset-basis" LS from the Bureau of Labor Statistics (BLS).[11]

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 and artistic originals from national accounts. 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. 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,

$$LS_{Pre\text{-}2013} = 1 - \frac{GOS - (I_{b,R\&D} + D_{I_{np,R\&D}} + D_{I_{g,R\&D}})}{Y - (I_{b,R\&D} + D_{I_{np,R\&D}} + D_{I_{g,R\&D}})}. \tag{5}$$

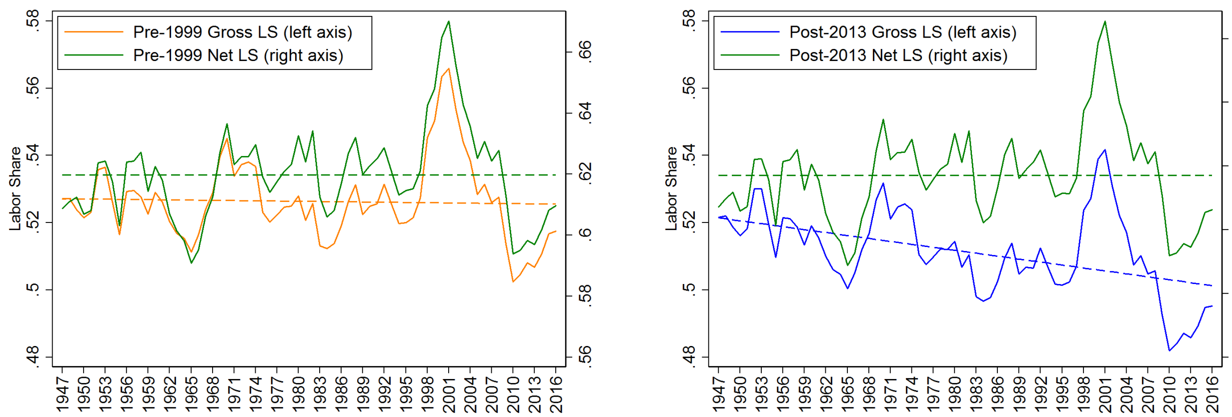
and Wasmer (2014), to the use of market prices for housing capital. Instead, our LS construct is strictly based on BEA national income data.

[11]Precisely, from 1947 to 2016, the linear trend of the benchmark LS is -0.0205 and that of the pre-1999 revision counterfactual LS is not significantly different from zero. In Appendix B, we show that the same result is obtained by using the corporate sector LS or the "asset-basis" LS from the BLS (BLS LS), which is almost identical to the corporate LS by construction. In the corporate sector, the linear trend of the benchmark LS is -0.0429, whereas that of the pre-1999 revision counterfactual LS is again not significantly different from zero. We find that the extension of our analysis to a larger sample period from 1929 to 2016 does not change our results either. Finally, our results are externally validated using vintage data, see Appendix B.3.

Figure 2: Gross Vs. Net Labor Share

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

(b) Post-2013 Revision Accounting, BEA LS [IPP Capitalized]



Notes: Net LS is constructed by subtracting depreciation from our measure of GOS [see equation (2)] 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 0.0096 and 0.0072. Our data and results are available in this permanent link: US Factor Shares.

Compared with the benchmark LS, the pre-2013 revision counterfactual LS (pink line, Figure 1) displays a milder decline that is approximately half of that of the benchmark LS, suggesting a quantitatively similar role for the capitalization of software and the capitalization of R&D in explaining the decline of the accounting LS.

Thus far, we have focused on the gross LS. The 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, 2014).[12] We show that this phenomenon is also the result of IPP capitalization. In Figure 2 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 2), and the depreciation in structures and equipment merely shifts down the LS. Only when IPP is capitalized do we find differences in the trends between gross and net LS (panel (b), Figure 2). That is, the decline of the gross LS relative to the net LS is entirely due to the capitalization of IPP, and, in particular, because the IPP depreciation measured by the BEA increases from 70.5% of gross investment in IPP in 1947 to 88.5% in 2016.

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

4 Discussion

The decline of the LS is strictly the result of an accounting change in the treatment of IPP; thus, we scrutinize the economic interpretation of this accounting phenomenon. First, we study the accounting assumptions behind the capitalization of IPP and their implications for the secular decline of the LS. Our examination renders the decline of the LS an artifact of the assumptions implemented by the BEA to capitalize IPP (Section 4.1). This result restricts the economic interpretation of the LS decline, which has been a central topic of the debate (Section 4.2). We discuss the implications for the US macroeconomic model and the way forward in Section 4.3.

4.1 An Examination of the Accounting Assumptions Behind IPP Capitalization

The key assumption behind the capitalization of IPP is that, on the income side of the accounts, the entire rents from IPP investment are attributed to GOS and, hence, to capital income (Section 2). This assumption is arbitrary and extreme. Define $\chi \in [0, 1]$ as the fraction of the rents from IPP investment attributed to capital income (e.g., financed by capital owners) and $1 - \chi$ is the fraction attributed to labor income (e.g., financed by workers).[13] This can be rationalized by having workers paid wages lower than their marginal value product in return for some equity in the firm as in McGrattan and Prescott (2010). Then, the LS is defined as follows:

$$LS = 1 - \frac{GOS - (1-\chi)I}{Y} \tag{6}$$

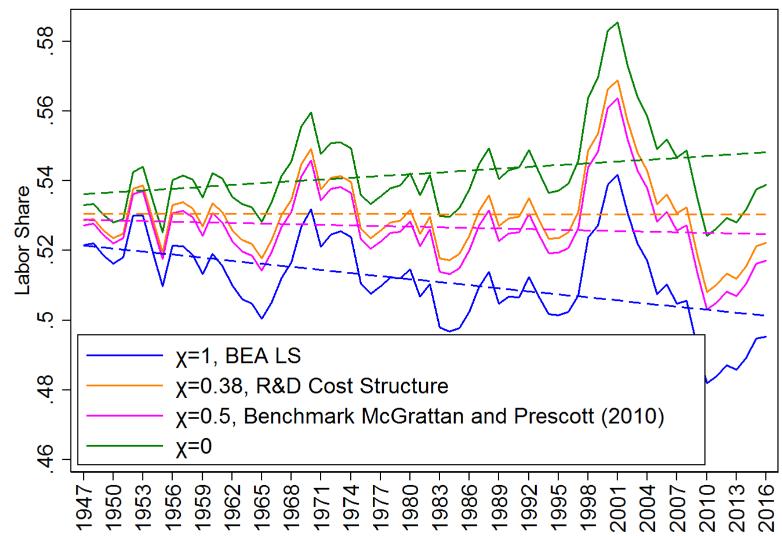
where I is gross IPP investment, GOS is gross operating surplus, and Y is gross national product.

Figure 3 shows the implications of alternative splits of IPP investment between capital and labor income for the secular behavior of the LS. Our benchmark accounting LS (blue line) follows the current BEA assumption that all IPP rents are allocated to capital income (i.e., $\chi = 1$), clearly showing a downward trend. By contrast, 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.

There are less arbitrary and extreme assumptions about how to split IPP between capital and labor. 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

[13] This is consistent with the BEA definition of the owner (or investor) of R&D as the funder of the R&D. This decision was made largely because funders typically reserve some, if not all, rights to the outcome of the R&D and receive economic benefits from the R&D.

Figure 3: US Labor Share with Alternative Assumptions on the Factor Distribution of IPP, χ



Notes: LS is constructed based on different capital-labor splits of IPP output (χ) using equation (6). In the extreme cases IPP output is either fully assigned to capital income ($\chi = 1$) or to labor income ($\chi = 0$). The BEA assumption is $\chi = 1$. Less extreme cases are based on the cost-structure of R&D investment from NSF surveys, $\chi = 0.38$, and the benchmark value, $\chi = 0.5$, in McGrattan and Prescott (2010). Our data and results are available in this permanent link: US Factor Shares.

cost structure of IPP. For example, focusing on the R&D cost structure—for which we have data from the NSF surveys of business R&D expenditures—we find that payments to capital account for an average of 38% of R&D output, that is, $\chi = 0.38$.[14] Under this capital-labor split of IPP rents we obtain a trendless LS with an average LS of roughly 53.1% (orange line, Figure 3). This trendless secular behavior of the LS is similar to the one that we obtain using the benchmark value of $\chi = 0.5$ in McGrattan and Prescott (2010) (pink line, Figure 3). The critical difference is that McGrattan and Prescott (2010) incorporate the full set of intangible investments (e.g., brand equity, organizational competences), whereas the IPP-measure of the BEA accounts for only approximately one–third of intangible investment.[15] Alternatively, the BEA could assume that the proportion of IPP income attributed to labor income is identical to the LS in the rest of the economy, that is, $\chi = 1 - \frac{GOS-I}{Y-I}$, and, this is equivalent to treating IPP income as ambiguous income in the computation of the economy-wide LS. This capital–labor split also yields a trendless LS with an average LS of 53.3%.

[14] We obtain the cost structure of R&D from the NSF surveys of the Business R&D and Innovation Survey (BRDIS). See *Detailed Statistical Table* 13 in National Science Foundation (2016). The value of χ ranges between 0.38 and 0.48 for businesses R&D and between 0.44 and 0.51 for the academic R&D from 1929 to 2013, see Tables 13 and 15 in (Crawford et al., 2014).

[15] McGrattan and Prescott (2010) study the implications of a US model with intangible assets and use a latent-variable approach to recover these assets. Then, to be logically consistent between their model and the BEA measurement of that time, that is, the pre-2013 accounting scenario, these authors remove the IPP expenditure attributed to capital owners (i.e, χI) from GOS in their model as a BEA accountant would do before 2013.

In summary, the factor distribution of IPP rents, χ, is critical to understanding the secular behavior of LS. Under a set of less arbitrary and extreme assumptions on χ than that implemented by the BEA, an increase in IPP investment in the economy—that is, a structural shift to a more IPP–intensive economy as is observed in the US economy—does not alter the factor distribution of income at all. This renders the decline of the LS a mere artifact of the accounting assumptions implemented by the BEA in the capitalization of the IPP.

4.2 Implications for the Economic View of LS Decline

The decline of the accounting LS has spurred a growing literature that attempts to rationalize this decline through a wide set of economic mechanisms (e.g. Elsby et al., 2013, Karabarbounis and Neiman, 2014, Acemoglu and Restrepo, 2016, Grossman et al., 2017).[16] This literature interprets the decline of the accounting LS as an economic phenomenon at face value. By contrast, we argue that the economic interpretation of the decline of the accounting LS is not warranted unless it is logically consistent with the measurement responsible for its generation, that is, the capitalization of IPP.

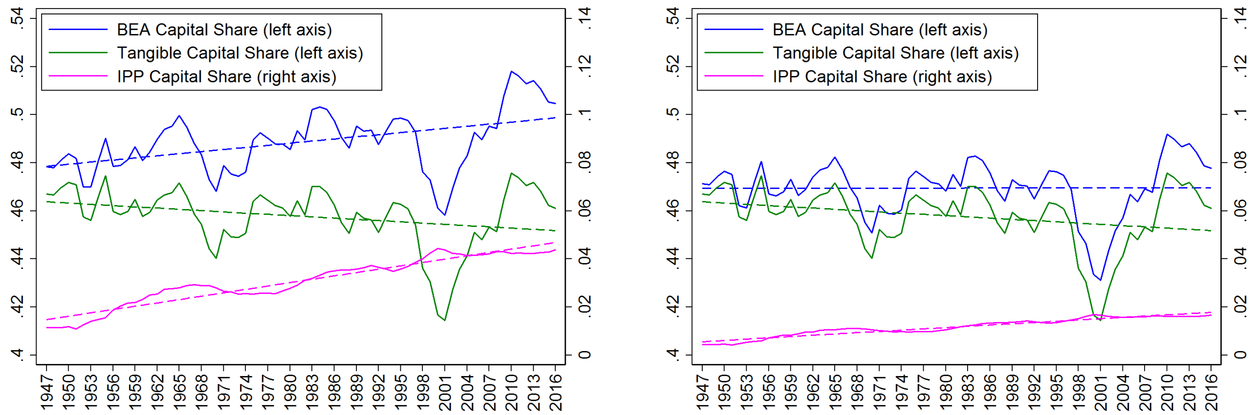
The logical consistency between theory and measurement imposes two restrictions on the economic models that target the decline of the accounting LS as an economic phenomenon. First, these models must incorporate IPP as investment like the BEA does, and the reason for this is simple. If IPP is expensed in the model—that is, if IPP is not part of the model aggregate investment—then theorists must map their models to the pre-1999 accounting LS to establish consistency between model and measurement. Unfortunately, the vast majority of the current literature on the topic violates this logical consistency by providing economic theories that aim at explaining the decline of the accounting LS without incorporating IPP investments. Indeed, theories that do not incorporate IPP as an investment must be consistent with a trendless accounting LS, as opposed to a declining one (Section 3). In other words, if economic theory rationalizes the decline of the LS without incorporating IPP investment, then economic theory is logically inconsistent with the very same measurement—that is, the decline of the accounting LS—that it aims at explaining.

Second, the incorporation of IPP investment must be explicit. Clearly, formulating economic theories by using the current aggregate measures of investment and capital provided by the BEA, which implicitly incorporate IPP investment is possible; however, without explicitly separating IPP investment and tangible investment, economic theory entirely misses that IPP investment—and

[16] For example, trade linkages (Elsby et al., 2013), the price of investment (Karabarbounis and Neiman, 2014), automation (Acemoglu and Restrepo, 2016), and the productivity slowdown (Grossman et al., 2017) have been proposed as potential explanations of the decline of the accounting LS.

Figure 4: US Capital Share and IPP Capitalization

(a) $\chi = 1$, BEA (b) $\chi = 0.38$, 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 (2), 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.

not tangible investment—is the driver of the decline of the accounting LS. Panel (a) in Figure 4 decomposes the behavior of the accounting capital share of income (blue line), $\frac{GOS}{Y}$, that is, one minus the accounting LS, into the sum of two components: the IPP investment (or capital) share of income (pink line), $\frac{I}{Y}$, and the tangible capital (i.e., structures and equipment) share of income (green line), $\frac{GOS-I}{Y}$. The IPP investment share of income that increases over time is clearly the sole driver of the increase (decline) of the accounting capital (labor) share. By contrast, the capital income share of equipment and structures declines over time.

We conclude by emphasizing that the starting point for any economic interpretation of the decline of the accounting LS must be the acceptance of the BEA assumptions behind the distribution of IPP investment rents (i.e., $\chi = 1$), which we showed generate the decline of the accounting LS. Consistent with Section 4.1, panel (b) in Figure 4 shows that, with a more reasonable value for χ, for example, based on the R&D cost structure, the accounting capital share is trendless. This result implies that a structural shift to a more IPP–intensive economy does not affect the factor distribution of income. But why should economic theory comply with the BEA accounting assumptions behind the ownership of IPP investment rents? Considering our results in Section 4.1, we cast doubt on this compliance and discuss the way forward in Section 4.3.

4.3 The Way Forward

An essential aspect of the US macroeconomic model is the factor distribution of income. Our examination shows that less extreme assumptions about the share of IPP investment rents allocated to capital, χ, yield a trendless accounting LS (Section 4.1). This result contrasts with the declining accounting LS found under the current BEA accounting rules that arbitrarily attribute all IPP rents to capital (i.e., $\chi = 1$). Therefore, rather than attempt to rationalize the LS decline as an economic phenomenon in a manner that consistently complies with the BEA accounting rules on the split of IPP rents, we argue that the way forward is to devote research efforts to accurately measuring the factor distribution of IPP rents in national income, χ, across all intangibles assets. The main challenge in this quest is that neither the factor distribution χ nor the entire set of intangible assets is directly observable.

Because intangible investment is largely unobservable, its measurement is challenging (Corrado et al., 2005, McGrattan and Prescott, 2005, 2010). The lack of observable investments in intangibles helps explain why the BEA focuses on a subset of these investments that are arguably easier to measure, such as software and R&D; however, these are not free of problems either. For example, software and R&D purchases are captured with receipts from sales data from the Census Bureau, but a large part of IPP is produced by own-account and 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 intermediaries) plus a markup based on the net operating surplus of the miscellaneous professional, scientific, and technical services industry (Crawford et al., 2014).[17] This estimation is clearly problematic because whether the assumed markup reflects the market value is simply unknown, and remains unknown unless data on actual transactions are obtained.

The BEA's choice of χ has no justification either. The BEA allocates all IPP rents to capital (i.e., $\chi = 1$), and this is perhaps a reasonable assumption for tangible capital but not for IPP. Neither the IPP measured by the BEA (e.g., R&D) nor the rest of the intangibles (e.g., brand equity, client list) generate rents that reward capital owners only. For example, R&D workers obtain incentive stock options (ISOs) as part of their compensation, which are currently absent in NIPA.[18] That is, R&D workers can earn income—on top of their wages—from exercising

[17] Notably, measured profits from proprietors and corporate firms using IPP (e.g., software or higher-quality and newer inputs developed through R&D) already incorporated the net returns from the use of IPP before the capitalization of IPP (Fraumeni and Okubo, 2005). For example, Amazon's software engineers are constantly improving the efficiency of production and distribution. The increase in revenue from using newer versions of the in-house software is already present in the measured profit (BLS, 1989).

[18] The NIPA 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 not added to NIPA; see Table 1 of Chapter 10 "Compensation of Employees" in the *NIPA*

ISO, that is, either selling them to obtain capital gains or holding them to collect potential net dividends.[19] This suggests that a reasonable estimate for χ must be below one, an idea that conforms to the notion of sweat equity in McGrattan and Prescott (2010, 2014), where workers are paid in wages below their marginal value product in exchange for some form of the firm's equity.[20]

In this context, we must also assert that our current approach to obtain χ, based on the cost structure of R&D, is still far from ideal for two reasons. First, the cost structure of R&D, that is, the only IPP cost structure directly observable from NSF BRDIS, is not necessarily the same across all intangible assets, although it is preferable to the cost structure of software for which no direct measure exists. 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. Second, even if this structure is similar, we do not know if the cost structure of IPP resembles the factor distribution of IPP rents, χ. We argue that a promising avenue to inform the value of χ is the collection of microevidence on the ownership of firm equity split between capital investors and workers, where the latter group earns a form of compensation in the form of equity through, for example, exercised stock options—as described earlier. This argument implies the explicit introduction of the structure of firm equity by ownership in macroeconomic theory.

Finally, we note that the estimation of IPP depreciation is intrinsically linked to the understanding of the factor distribution of IPP investment rents, χ. In contrast with the current BEA practice of attributing all IPP depreciation to capital (i.e., $\chi = 1$), the depreciation of the IPP for more reasonable lower-than-one values of χ implies forgone income for both the capital and labor who funded the investment. In this way, χ plays the same role in the gross and net LS. Two additional remarks on IPP depreciation are in order. First, the BEA does not provide an

Handbook: Concepts and Methods of the US National Income and Product Accounts, November, 2017.

[19]The dollar amount of these stock options is unknown (Moylan, 2008).Using a nonrepresentative sample, Lerner and Wulf (2007) show the ratio of the value of long-term incentives to cash compensation for a sample of corporate R&D heads more than doubled over the course of the 1990s: from 0.39 to 0.87.

[20]The same probles occur for unincorporated business owners that invest time in building up intangibles for their businesses (e.g., improving brand equity, enlarging their client list), see Bhandari and McGrattan (2018). First, the return on these intangibles—which can only be observed when owners sell their businesses—are considered capital gains and, hence, are never part of NIPA. Second, because business owners invest their own time building up these intangibles, a large part of these returns should be considered labor compensation (i.e., $\chi < 1$).

accounting measure of IPP depreciation but an economic one. A key challenge of measuring IPP depreciation is that, unlike tangible capital goods, it is not physical. Conceptually, the depreciation of IPP captures obsolescence and competition, which are not directly observable. In this context, the BEA estimates IPP depreciation using an economic model that maximizes profits over R&D choices with ad-hoc assumptions on the effect of R&D on profits (Li and Hall, 2016). Hence, the BEA's measurement of IPP depreciation is only logically consistent with theories that comply with the BEA economic model of IPP depreciation. Second, the estimation of IPP depreciation requires IPP prices that we do not observe because there are no transactions of in-house production of intangibles. To construct R&D prices, the BEA uses an input cost index as a proxy; however, by construction, an input cost index does not capture the impact of productivity change on real R&D output. Arguing that R&D increases aggregate productivity, the BEA uses the economy-wide measure of multifactor productivity (MFP) from the BLS as a proxy for unobserved R&D productivity and subtracts the growth rate of MFP from the input cost index (Crawford et al., 2014). Again, this is a breeding ground for logical inconsistencies between theory and measurement if theory does not comply with the MFP from the BLS, by assuming, for example, an IPP-specific technical change.

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. Furthermore, our examination of the accounting assumptions behind the capitalization of IPP—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 LS decline is an artifact of the change in the accounting treatment of IPP in national accounts, and this is at odds with current macroeconomic theory that considers the accounting decline as an economic phenomenon at face value.

Therefore, rather than attempting to rationalize the LS decline as an economic phenomenon and, hence, comply with the BEA accounting assumptions on the distribution of IPP rents, we argue that the way forward should include research efforts devoted to accurately measuring the distribution of χ in national income and across all intangibles assets. The main challenge is that neither the factor distribution χ nor the entire set of intangible assets is directly observable. The need for additional microevidence combined with the creative use of macroeconomic theory to recover these unobservable investments and their distribution across factors of production is urgent.

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