

# Labor Share Decline and the Capitalization of Intellectual Property Products

Dongya Koh <sup>1</sup>    Raül Santaepulàlia-Llopis <sup>2</sup>    Yu Zheng <sup>3</sup>

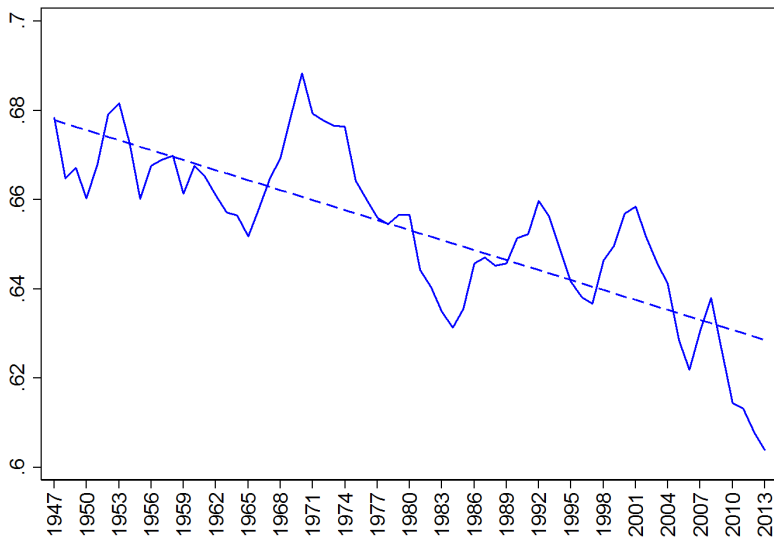
<sup>1</sup>University of Arkansas

<sup>2</sup>Washington University in St. Louis  
Universitat de València

<sup>3</sup>City University of Hong Kong

June 14, 2015

## US LABOR SHARE (LS), BEA 1947-2013



# THE DECLINE OF US LABOR SHARE

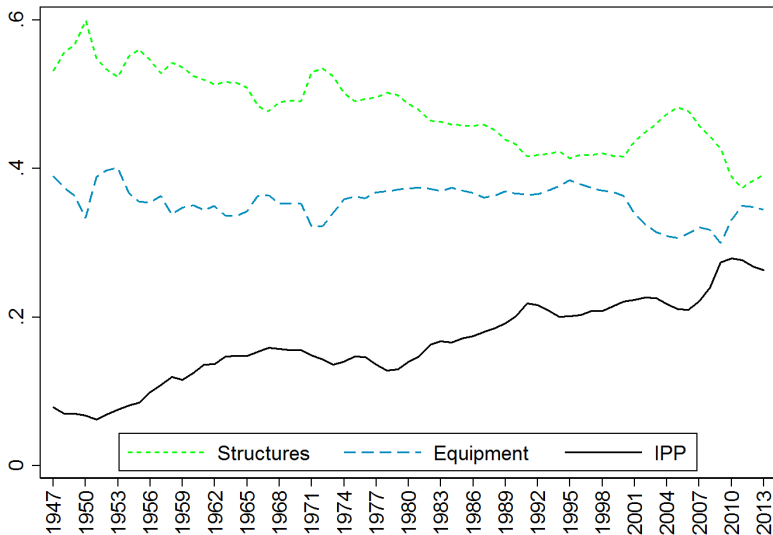
- One of the great fantasies of contemporary macroeconomics is finally gone: The LS declines.
- Our findings: The decline of the US LS is entirely driven by **intellectual property products** (IPP) capital: software, R&D, and artistic originals.

Recent discussion: Elsby, Hobijn, & Sahin '13, Karabarbounis & Neiman '14, Piketty & Zucman '13, and Piketty '14.

## 2013-BEA REVISION ON IPP CAPITALIZATION

- On July 31, 2013, the BEA released the 14th comprehensive revision of the NIPA and the FAT.
- The major change: Incorporate a larger set of IPP capital.
  - ▶ Software was already capitalized as part of equipment since the 1999 BEA revision.
  - ▶ BEA now treats expenditures for R&D and artistic originals as investments.
  - ▶ Before the revision, they were treated as expenditures in intermediate non-durable goods or as final consumption.

## STRUCTURES, EQUIPMENT AND IPP INVESTMENT SHARES, BEA 1947-2013



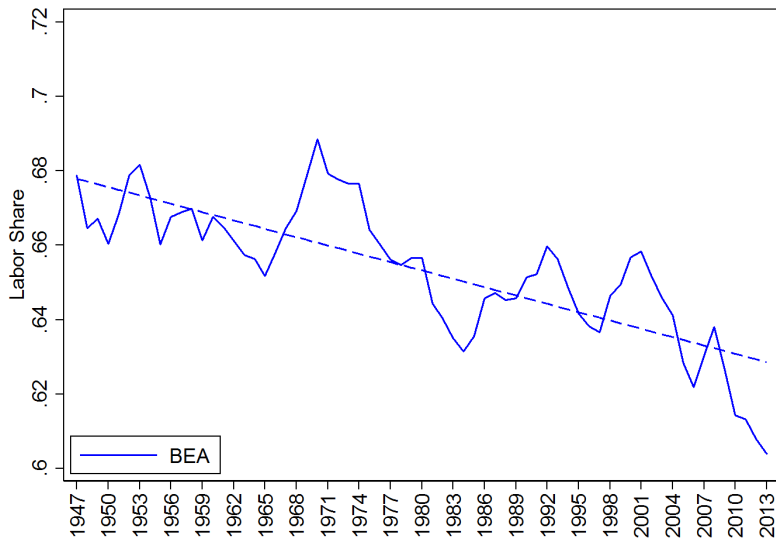
## CONSTRUCTION OF LS

- We use a standard definition and apply it to national income data from BEA. Cooley and Prescott '95.
- Unambiguous Capital Income (UCI) = Rental Income + Corporate Profits + Net Interest + Current Surplus Government Enterprises
- Unambiguous Income (UI) = UCI + Depreciation (DEP) + Compensation of Employees (CE)

## CONSTRUCTION OF LS

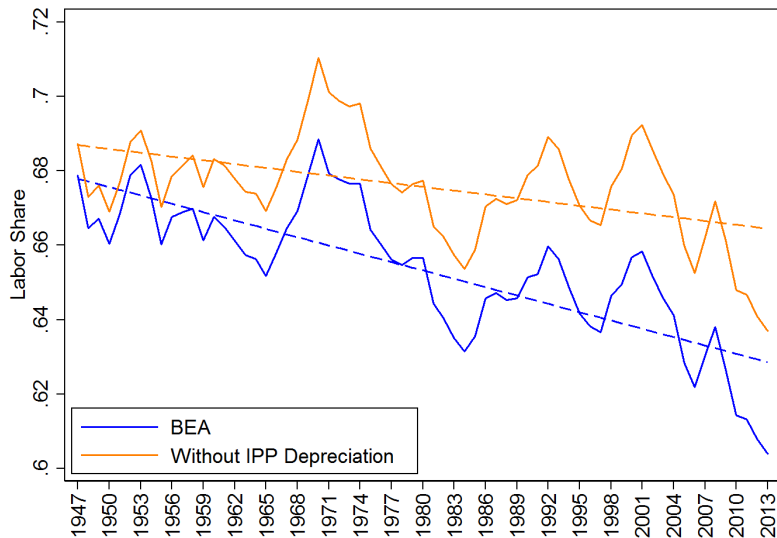
- Ambiguous Income (AI) = Proprietors' Income + Taxes on Production – Subsidies + Business Current Transfers Payments + Statistical Discrepancy
- Ambiguous Capital Income (ACI) =  $\frac{UCI+DEP}{UI} \times AI$ .
- Capital Income:  $Y_K = UCI + DEP + ACI$
- Labor Share =  $1 - \text{Capital Share} = 1 - \frac{Y_K}{Y}$

# LS NET OF IPP DEPRECIATION

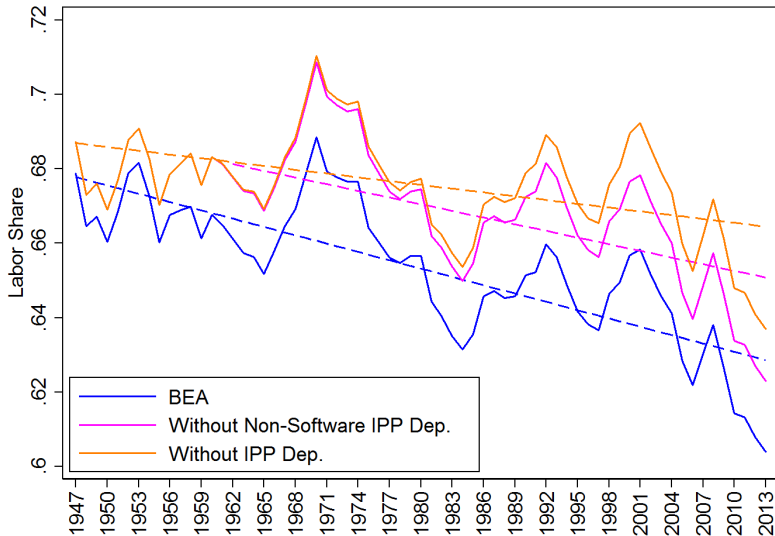




# LS NET OF IPP DEPRECIATION



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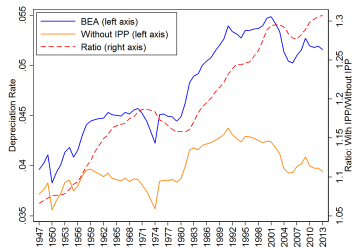
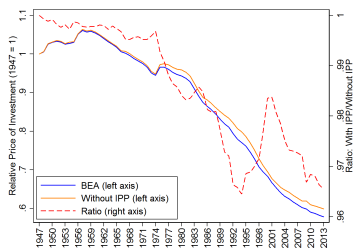
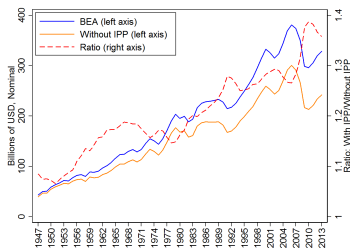


## ... BUT IPP IS NOT ONLY DEPRECIATION

The full effects of IPP on LS are captured by three channels:

1. Aggregate Investment
2. Price of Investment
3. Depreciation Rate

# EFFECTS OF IPP ON AGG. INVESTMENT, ITS PRICE, AND DEPRECIATION RATE



## A ONE-SECTOR INVESTMENT MODEL AS ACCOUNTING DEVICE

- Assume one sector and one good economy. CRS production:

$$y_t = f(k_t^x, l_t; \Omega_t)$$

- Aggregate investment:

$$x_t = v_t l_t \quad (1)$$

where  $v_t$  is the (inverse of) the relative price of investment.

- Capital accumulation:

$$k_{t+1}^x = x_t + (1 - \delta_t) k_t^x \quad (2)$$

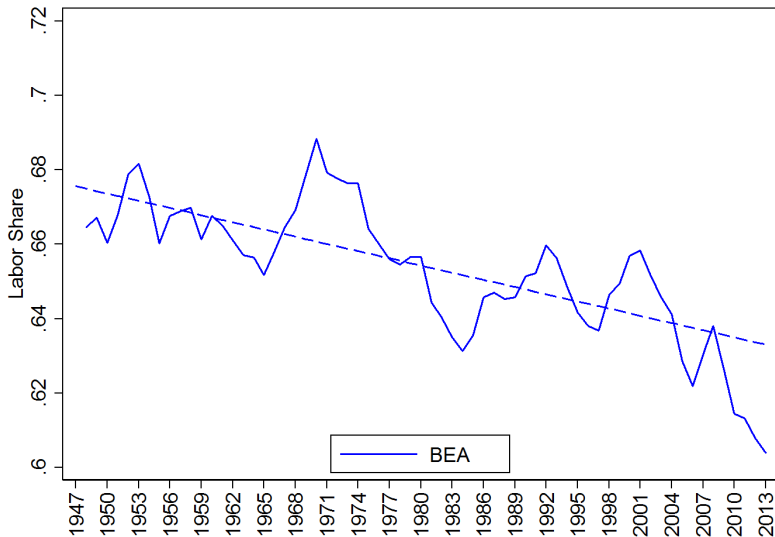
- From firms' investment problem, the gross rate of return to capital is

$$R_{t+1} \equiv \frac{\partial f(k_{t+1}, l_{t+1})}{\partial k} = \frac{1}{v_t}(1 + r_{t+1}) - \frac{1}{v_{t+1}}(1 - \delta_{t+1}) \quad (3)$$

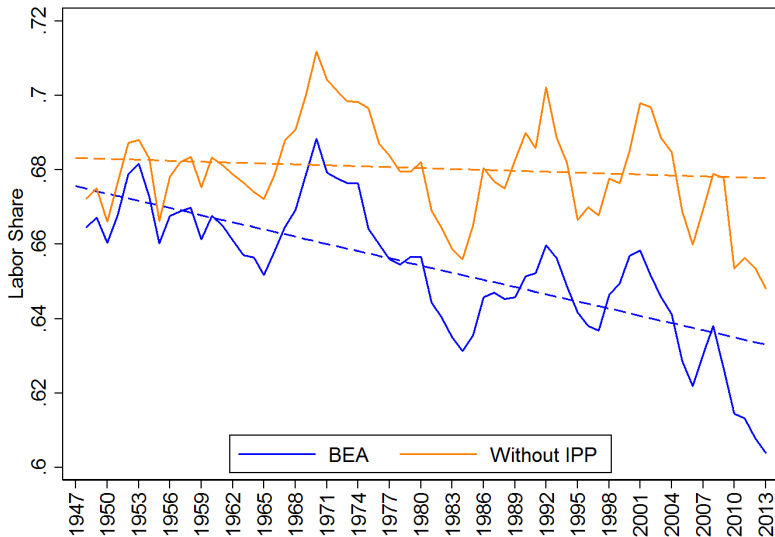
- Labor Share:

$$LS_t = 1 - \frac{R_t k_t^x}{y_t} \quad (4)$$

# EFFECTS OF IPP CAPITALIZATION ON LS, US 1947-2013



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- The secular decline in the LS can be entirely attributed to the increase in IPP capital.
- The LS with only structures and equipment capital (i.e., without IPP) is absolutely trendless over the past 65 years.

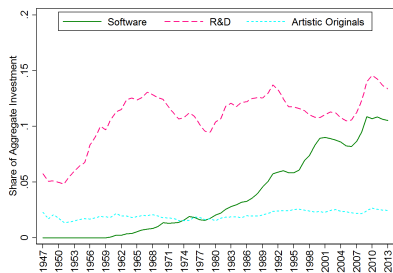
▶ LS 1929-2013

▶ Pre-software BEA Era

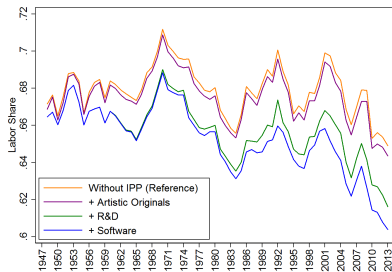
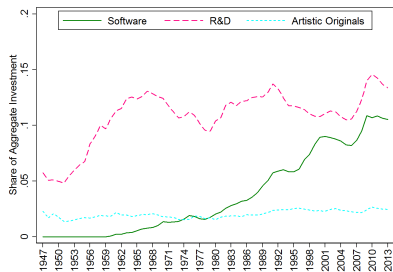
## FURTHER DECOMPOSITIONS AND ROBUSTNESS

- (1) R&D is the most important IPP component behind the LS decline. Software more role since the 1980s. [▶ Appendix](#)
- (2) Private IPP is behind the LS decline. Government IPP changes the LS level but not the trend. [▶ Appendix](#)
- (3) Without IPP capital, the Corporate LS is also absolutely trendless. [▶ Appendix](#)
- (4) At the industry level, more IPP capital → industry LS declines. Dramatic for the manufacturing sector. [▶ Appendix](#)
- (5) Adding advertising to NIPA & FAT shifts the LS down, but minor contributions to the decline. [▶ Appendix](#)

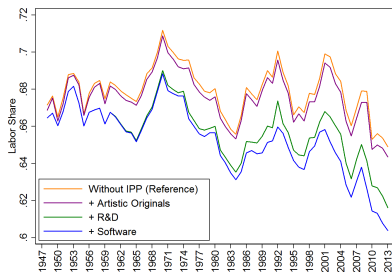
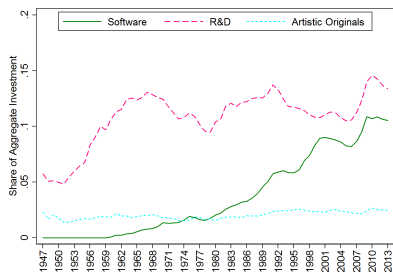
# SOFTWARE, R&D, AND ARTISTIC ORIGINALS



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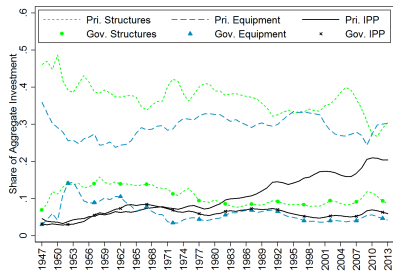


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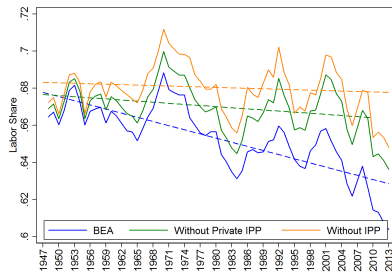
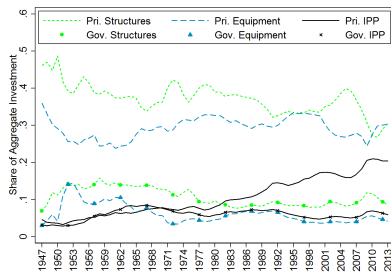


R&D is the most important IPP component behind the LS decline. Software more role since the 1980s.

# PRIVATE AND GOVERNMENT IPP

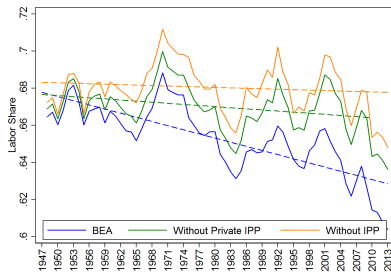
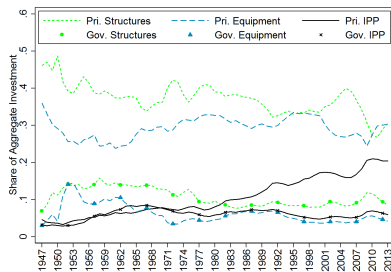


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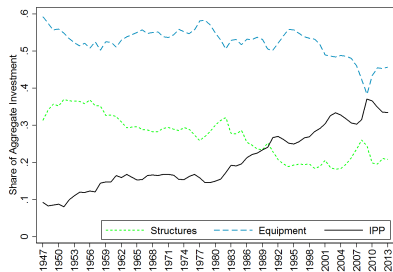


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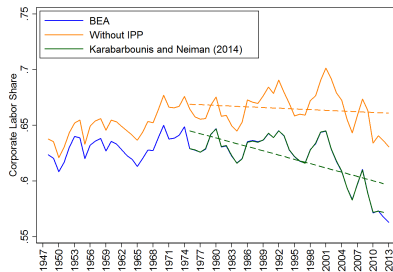
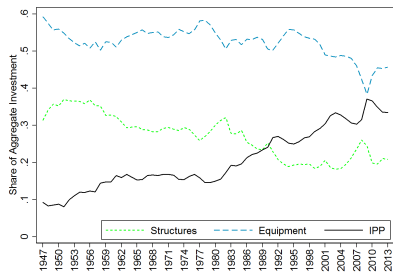


Private IPP is behind the LS decline. Government IPP changes the LS level but not the trend.

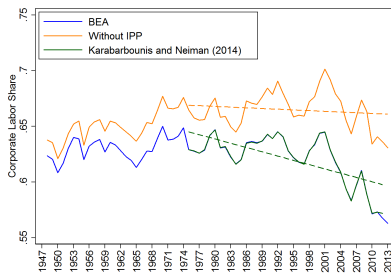
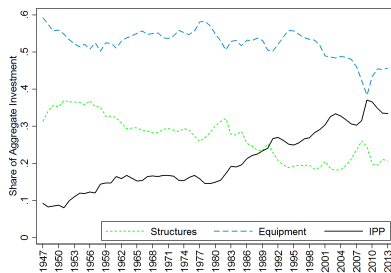
# ROBUSTNESS TO CORPORATE LS



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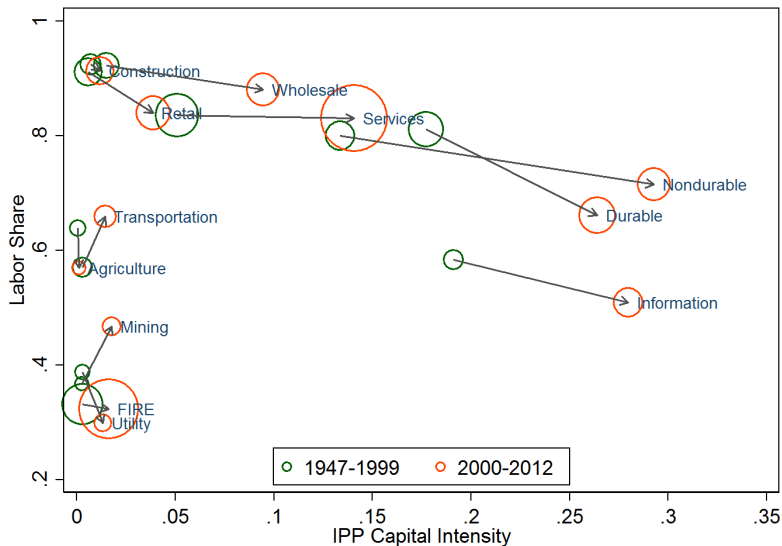


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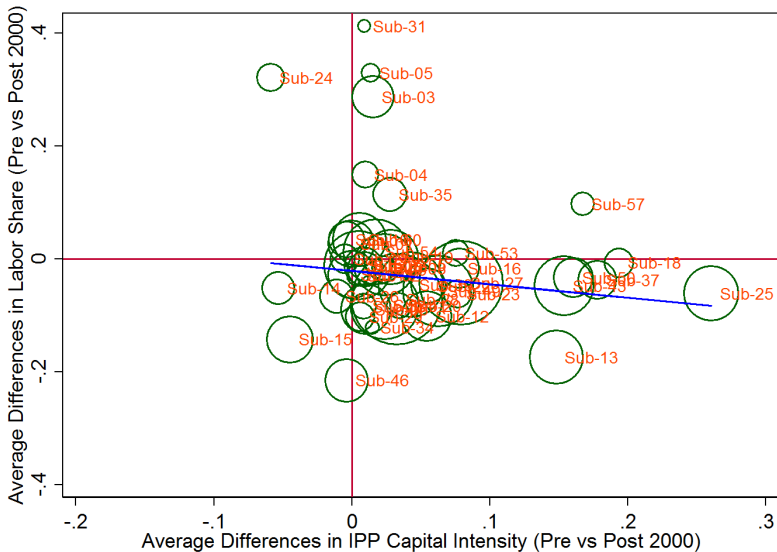


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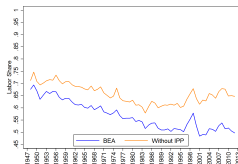
# LS AND IPP CAPITAL INTENSITY BY INDUSTRY



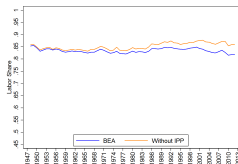
## ... BY SUB-INDUSTRY



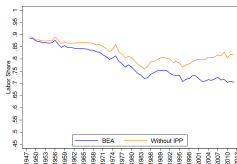
# LS DECLINE BY INDUSTRY



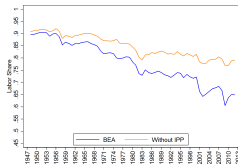
(a) Information



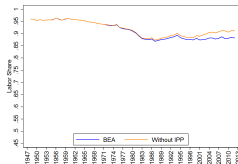
(b) Services



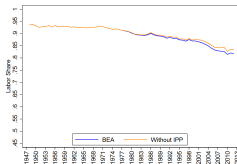
(c) Manufacturing:  
Nondurable goods



(d) Manufacturing:  
Durable goods



(e) Wholesale Trade



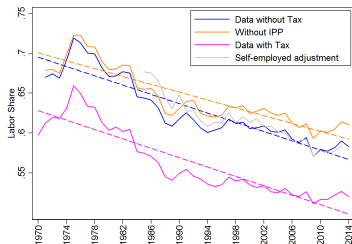
(f) Retail Trade

# CONCLUSION

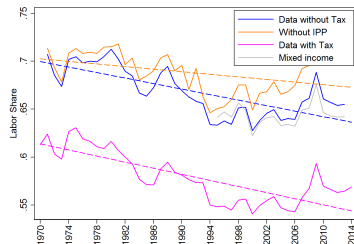
- IPP capital explains US LS decline.
  - ▶ Structures and equipment capital → LS is trendless for the past 65 years.
- LS decline should therefore be seen as the result of a shift toward a more IPP-intensive economy, a shift induced by continuing technological change.
- Looking ahead:
  - ▶ Multicountry analysis and firm-level analysis
  - ▶ Cyclical labor share still begs for an explanation.
  - ▶ To jointly explain LS decline and inequality, innovators generating IPP are potentially important.



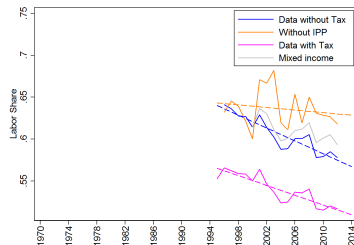
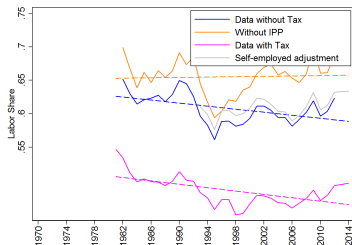
## ... PRELIMINARY EVIDENCE FROM MORE OECD COUNTRIES (AFTER SNA2008 ADOPTION) (WITH SANGMIN AUM)



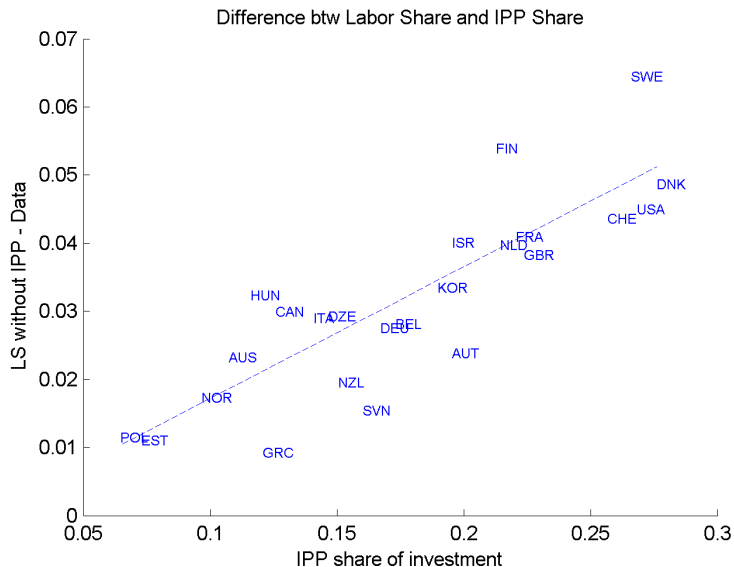
(g) Australia



(h) Denmark



# LABOR SHARE AND IPP: 25+ OECD COUNTRIES 2010

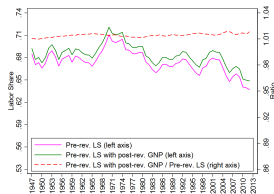


## PRELIMINARY CONCLUSIONS FROM GLOBAL ANALYSIS

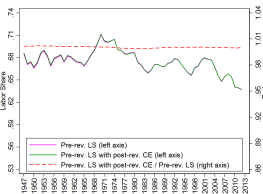
1. We find that 35% of Global Labor Share decline due to Intellectual Property Products.
2. This is very much a lower bound: Because of years and countries sample.

# Appendix

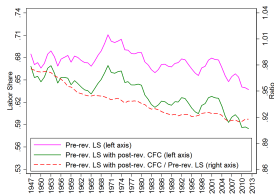
# LS BY NATIONAL INCOME COMPONENT



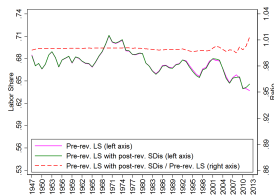
(a) GNP



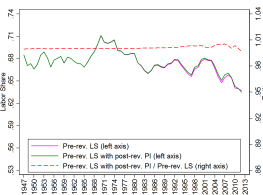
(b) CE



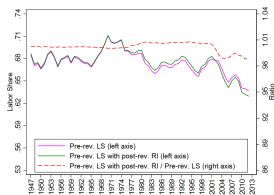
(c) CFC



(d) SDIs

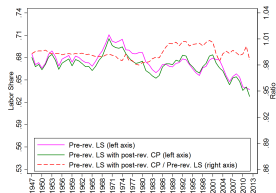


(e) PI

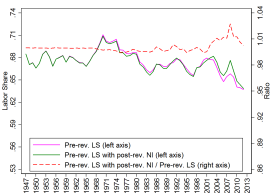


(f) RI

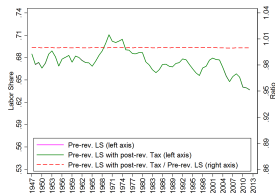
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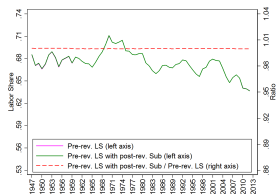
(g) CP



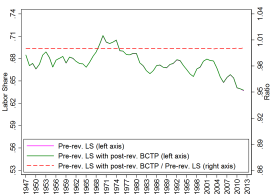
(h) NI



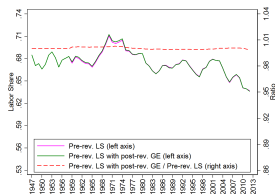
(i) Tax



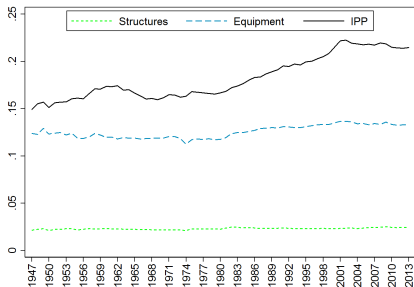
(j) Sub



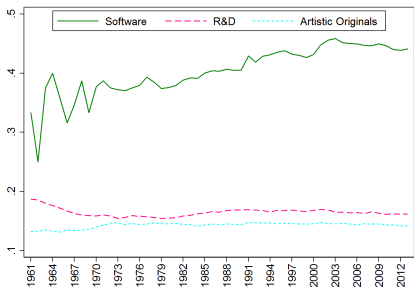
(k) BCTP



(l) CSGE

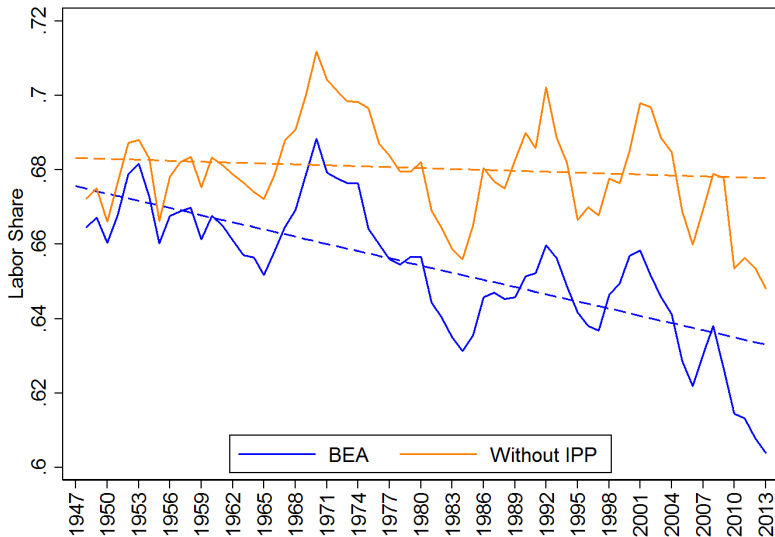


(m) Depreciation Rates of Structures, Equipment and IPP



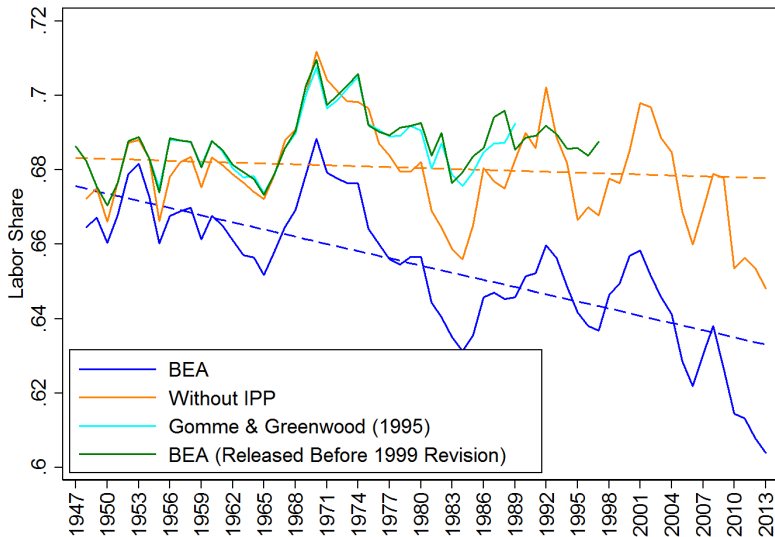
(n) Depreciation Rates of IPP Components

# LABOR SHARE WITH PRE-SOFTWARE BEA DATA, 1947-2013

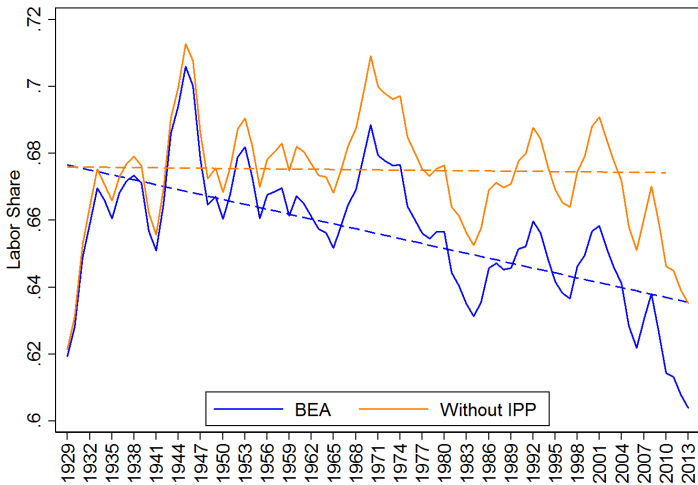




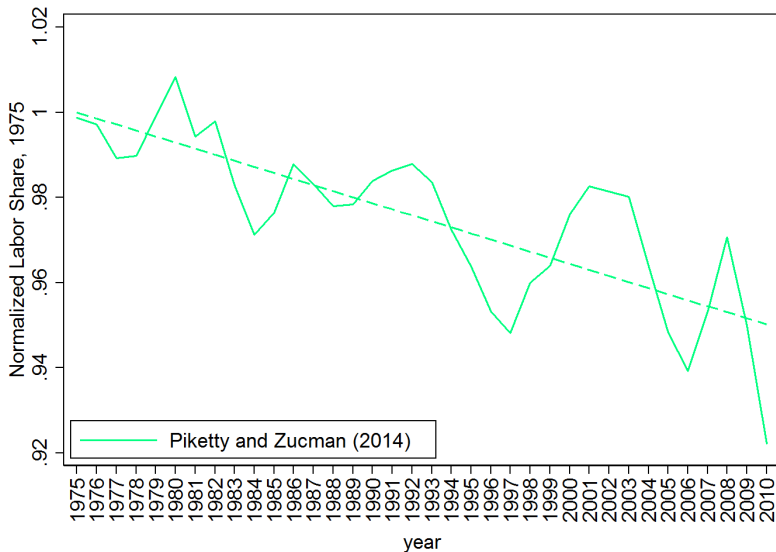
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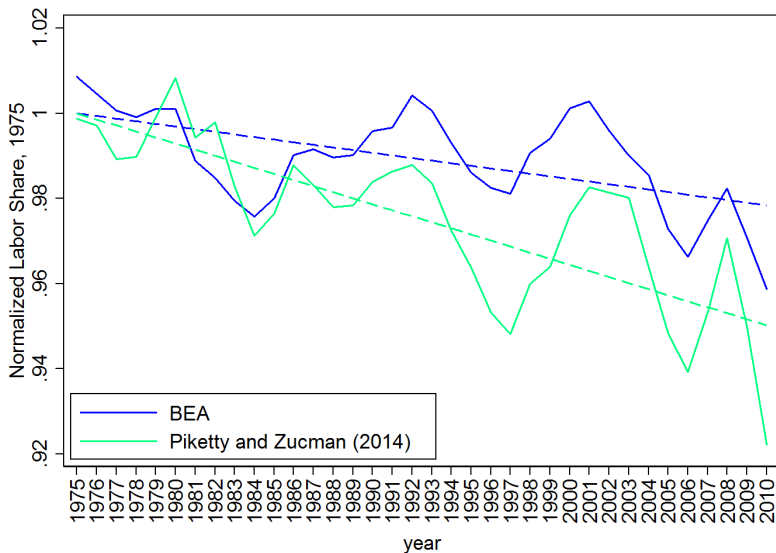
# US LABOR SHARE, BEA 1929-2013

[Back](#)

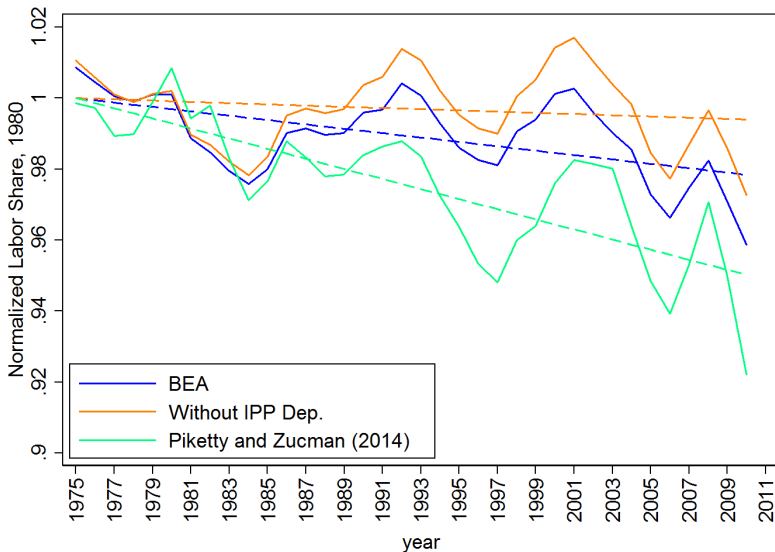
# PIKETTY AND ZUCMAN '14, PIKETTY '14 SAMPLE PERIOD



# PIKETTY AND ZUCMAN '14, PIKETTY '14 SAMPLE PERIOD



# PIKETTY AND ZUCMAN '14, PIKETTY '14 SAMPLE PERIOD



## DECOMPOSITION OF TOTAL EFFECTS

(1) Removing IPP depreciation:

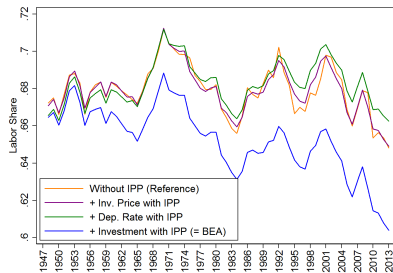
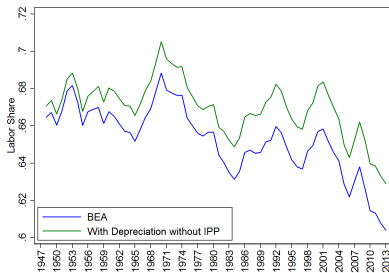
$$R_t k_t^x = \left( \frac{1 + r_t}{v_{t-1}} - \frac{1}{v_t} \right) k_t^x + \frac{1}{v_t} \delta_t k_t^x = \left( \frac{1 + r_t}{v_{t-1}} - \frac{1}{v_t} \right) k_t^x + DEP.$$

(2) Adding back IPP effects on  $1/v_t$ ,  $\delta_t$ , and  $i_t$ .

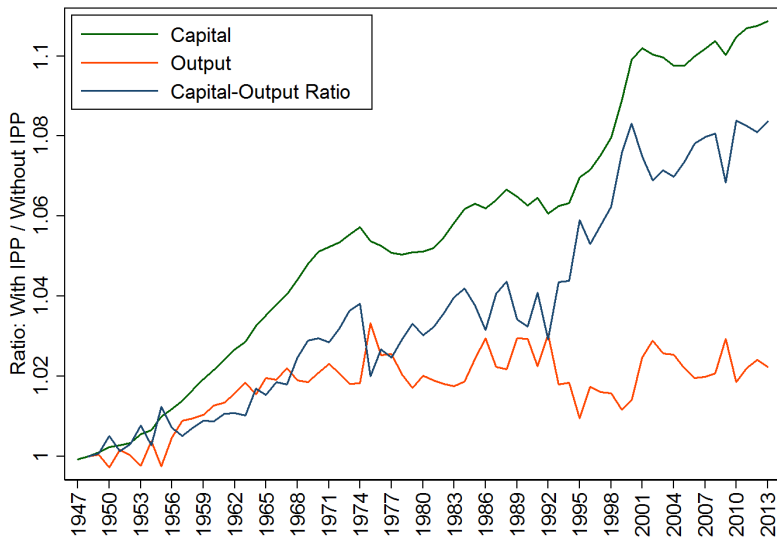
(3) IPP effect in  $1/v_t$  through  $R_t$  and capital accumulation

(4) IPP effect in  $\delta_t$  through  $R_t$  and capital accumulation

# DECOMPOSITION OF TOTAL EFFECTS

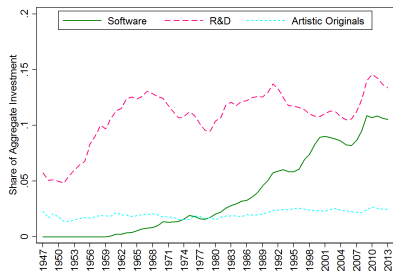


# THE EFFECTS OF IPP CAPITALIZATION ON AGGREGATE CAPITAL

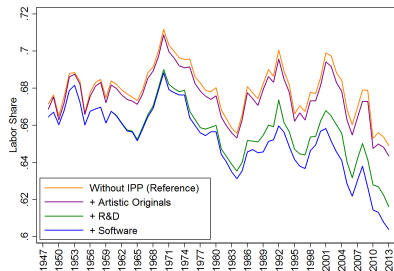
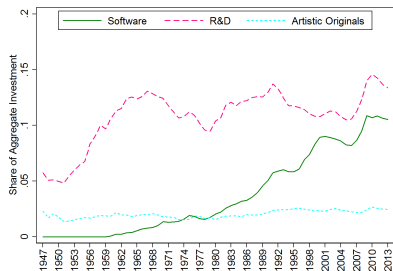




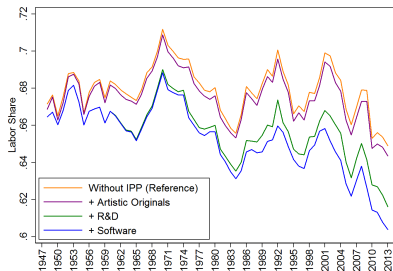
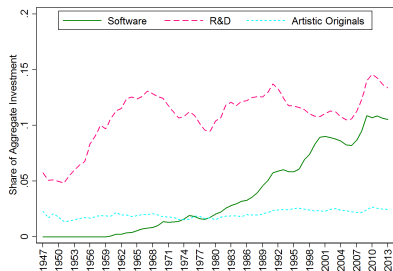
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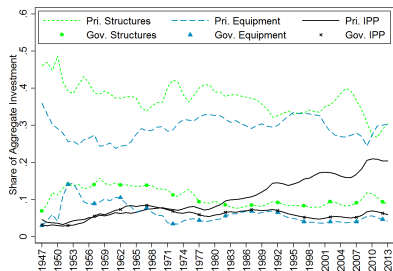
# SOFTWARE, R&D, AND ARTISTIC ORIGINALS



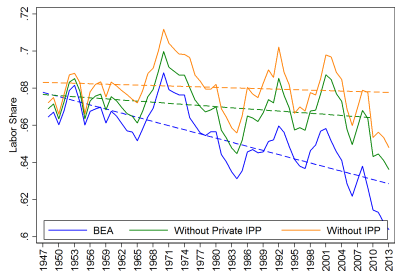
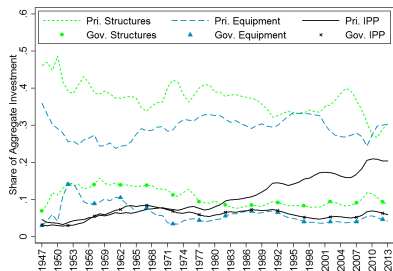
R&D is the most important IPP component behind the LS decline. Software more role since the 1980s.

▶ Back

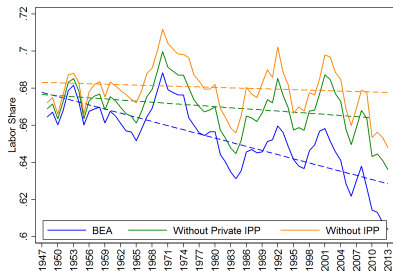
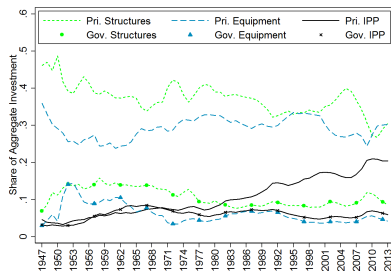
# PRIVATE AND GOVERNMENT IPP



# PRIVATE AND GOVERNMENT IPP



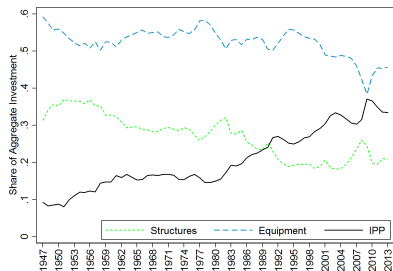
# PRIVATE AND GOVERNMENT IPP



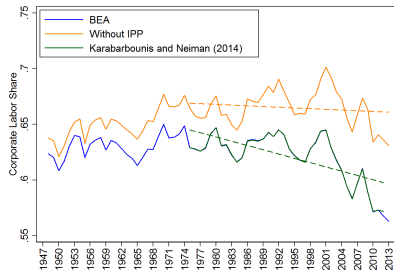
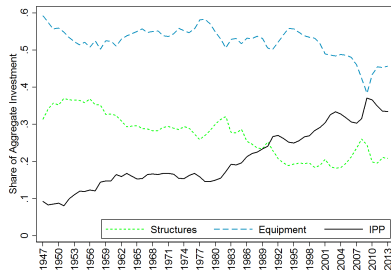
Private IPP is behind the LS decline. Government IPP changes the LS level but not the trend.

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# ROBUSTNESS TO CORPORATE LS

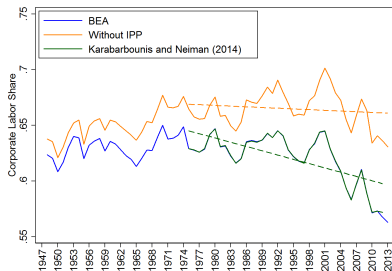
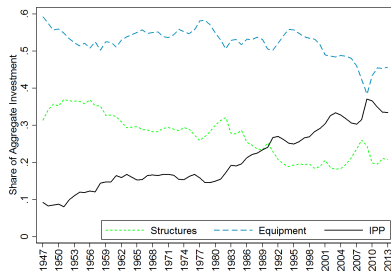


# ROBUSTNESS TO CORPORATE LS





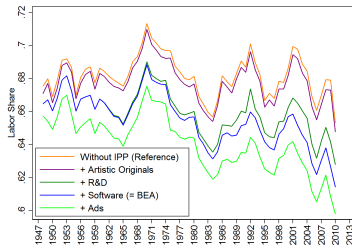
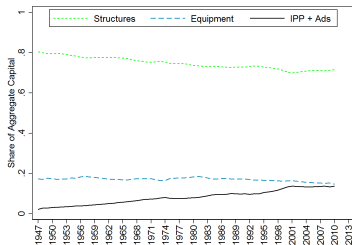
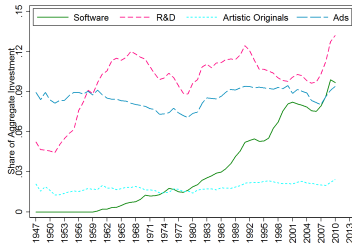
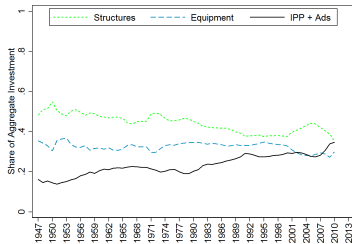
# ROBUSTNESS TO CORPORATE LS



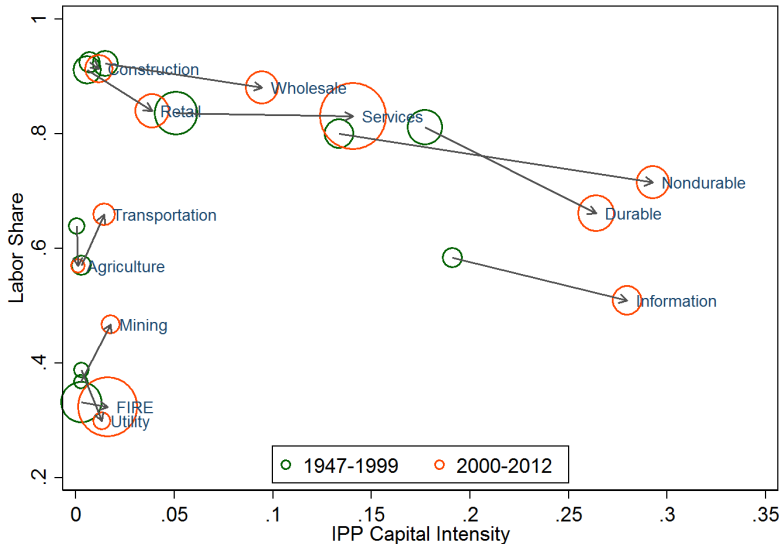
Without IPP capital, the Corporate LS is also absolutely trendless.

▶ Back

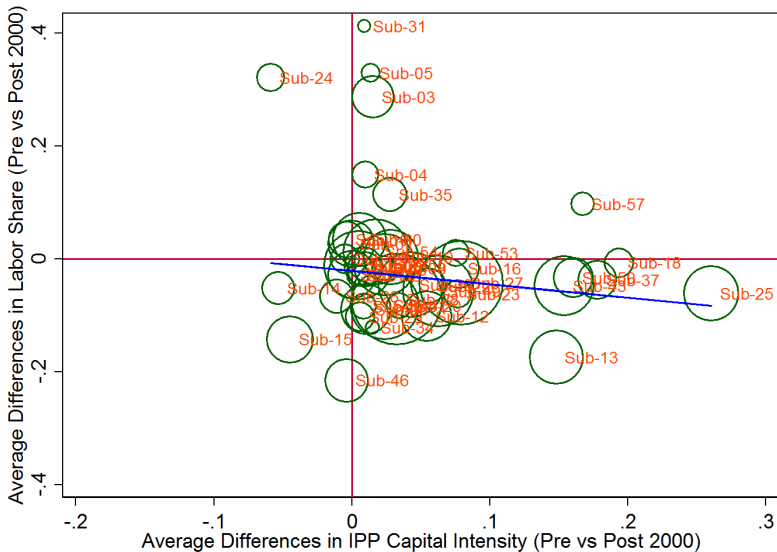
# ADDING ADVERTISING TO BEA IPP ACCOUNTS



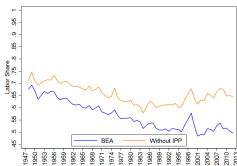
# LS AND IPP CAPITAL INTENSITY BY INDUSTRY



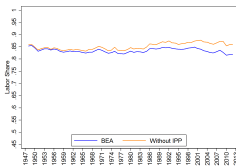
## ... BY SUB-INDUSTRY



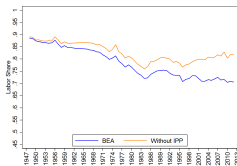
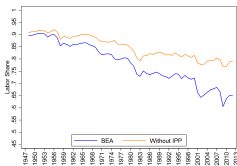
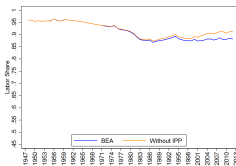
# LS DECLINE BY INDUSTRY



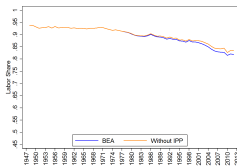
(a) Information



(b) Services

(c) Manufacturing:  
Nondurable goods(d) Manufacturing:  
Durable goods

(e) Wholesale Trade



(f) Retail Trade

## AN INTERPRETATION OF OUR RESULTS

- Main result: The decline in the US LS is driven by IPP capital.
- Any US model that features LS decline needs to allow for IPP capital.
- We examine this point with a two-sector model almost identical to McGrattan and Prescott (2010,12)

## A TWO-SECTOR MODEL WITH IPP

- Utility maximizing planner's problem:

$$\max E \sum_{t=0}^{\infty} \beta^t u(c_t, l_t)$$

- The final good sector produces a consumption good:

$$y_t = A_{1,t}(k_{1,t})^{\theta_1}(d_t)^{\phi_1}(l_{1,t})^{1-\theta_1-\phi_1}.$$

- IPP sector produces an IPP investment good:

$$x_t^d = A_{2,t}(k_{2,t})^{\theta_2}(d_t)^{\phi_2}(l_{2,t})^{1-\theta_2-\phi_2}.$$

- Laws of motion of two capitals are

$$k_{t+1} = (1 - \delta_k)k_t + x_t^k,$$

$$d_{t+1} = (1 - \delta_d)d_t + x_t^d,$$

## A TWO-SECTOR MODEL WITH IPP

- The resource constraint is

$$c_t + \frac{1}{v_t^k} x_t^k + \frac{1}{v_t^d} x_t^d = y_t$$

- Total capital and labor are

$$k_t = k_{1,t} + k_{2,t} \text{ and } l_t = l_{1,t} + l_{2,t}$$

- The LS in the final good sector,  $1 - \theta_1 - \phi_1$ , and in the IPP sector,  $1 - \theta_2 - \phi_2$ , are constant.
- The aggregate LS can be expressed as

$$LS_t = (1 - \theta_1 - \phi_1) \frac{y_t}{y_t + \frac{1}{v_t^d} x_t^d} + (1 - \theta_2 - \phi_2) \frac{\frac{1}{v_t^d} x_t^d}{y_t + \frac{1}{v_t^d} x_t^d}.$$



## A TWO-SECTOR MODEL WITH IPP

- Our empirical results suggest that the LS in the IPP sector may well be lower than that in the rest of the economy.
- That is,  $1 - \theta_1 - \phi_1 > 1 - \theta_2 - \phi_2$ .
- This mechanism declines the aggregate LS in response to increases in the IPP output share.
- If, however, the ratio between IPP and non-IPP output remains constant, the aggregate LS must be constant as well.
- This implies that the US economy is still in transition to a larger IPP sector.