# Measuring Intangible Capital with Market Prices

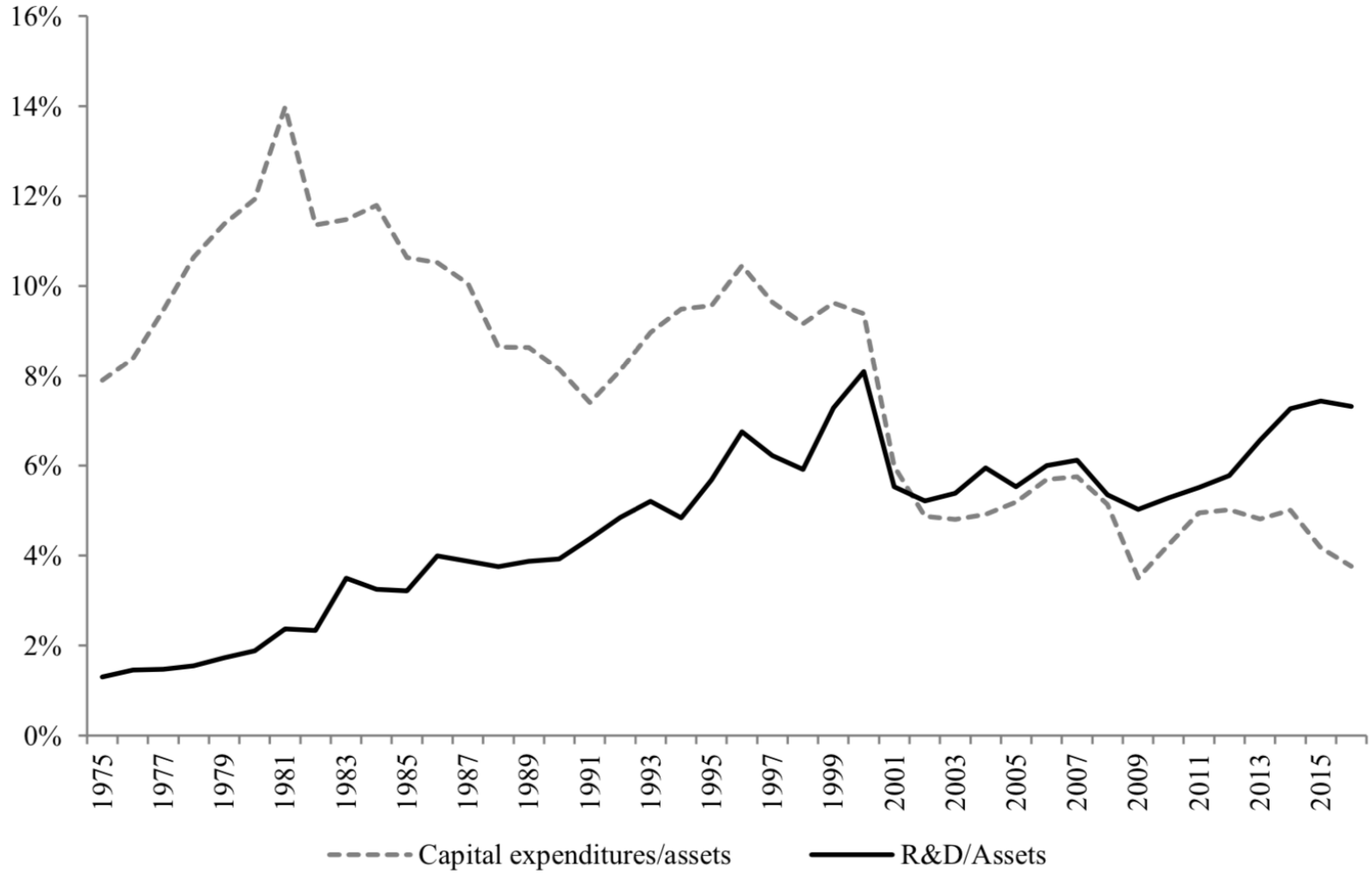
Michael Ewens
Caltech & NBER

Ryan Peters
Tulane University

Sean Wang
SMU

# Intangible investments increasing over time

**Figure 5. Capital expenditures versus research and development expenditures.**




Doidge, Kahle, Karolyi and Stulz (2018)

# Missing intangibles…blame the accountants

From 2016-2017, Apple spent $21.6 BB of R&D. What shows up on its balance sheet?

| Non-current, non-financial assets: | Sep. 2017 | Sep. 2016 |
|---|---|---|
| Property, plant and equipment, net | 33,783 | 27,010 |
| **Goodwill** | **5,717** | **5,414** |
| **Acquired intangible assets, net** | **2,298** | **3,206** |
| Other non-current assets | 10,162 | 8,757 |
| Total non-current assets | 51,960 | 44,387 |

Total **On-Balance** Sheet Intangibles (IIA +GW) actually **decreases** during this period due to the impairment of previous acquired intangibles.

GAAP mandates that cash outlays on R&D and SG&A are recorded as *expenses* rather than *investments*

Why?

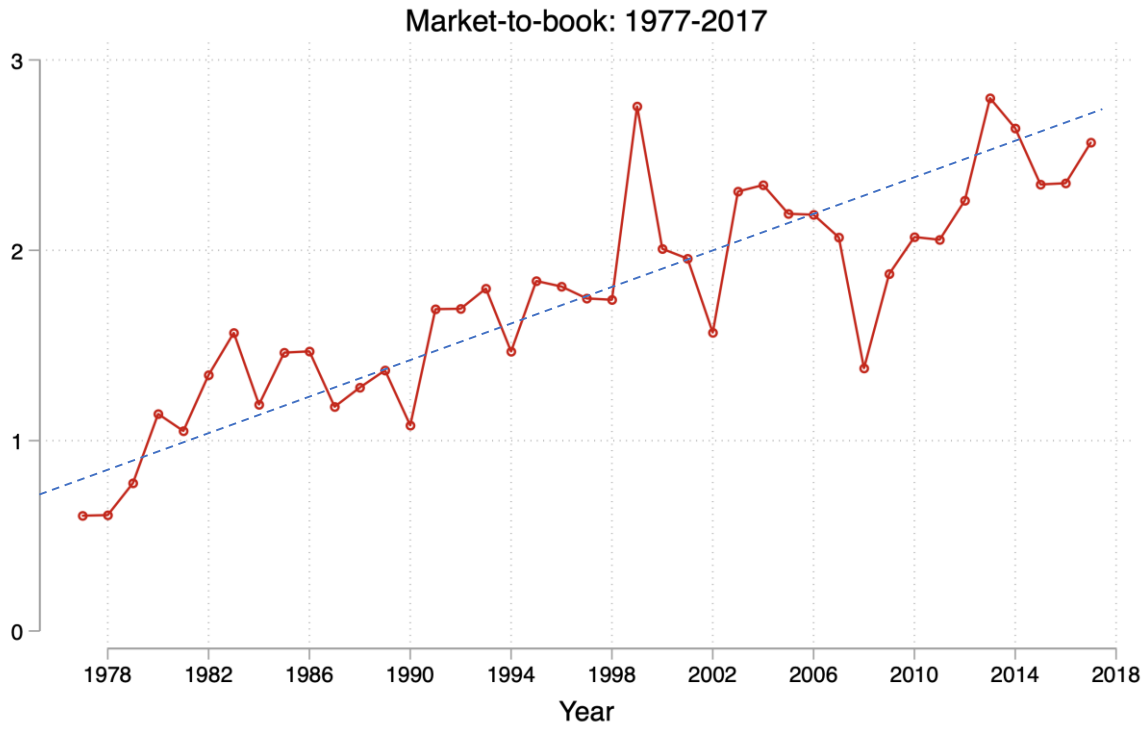
R&D/Assets 1% in 1977 (FAS 2, 1974)

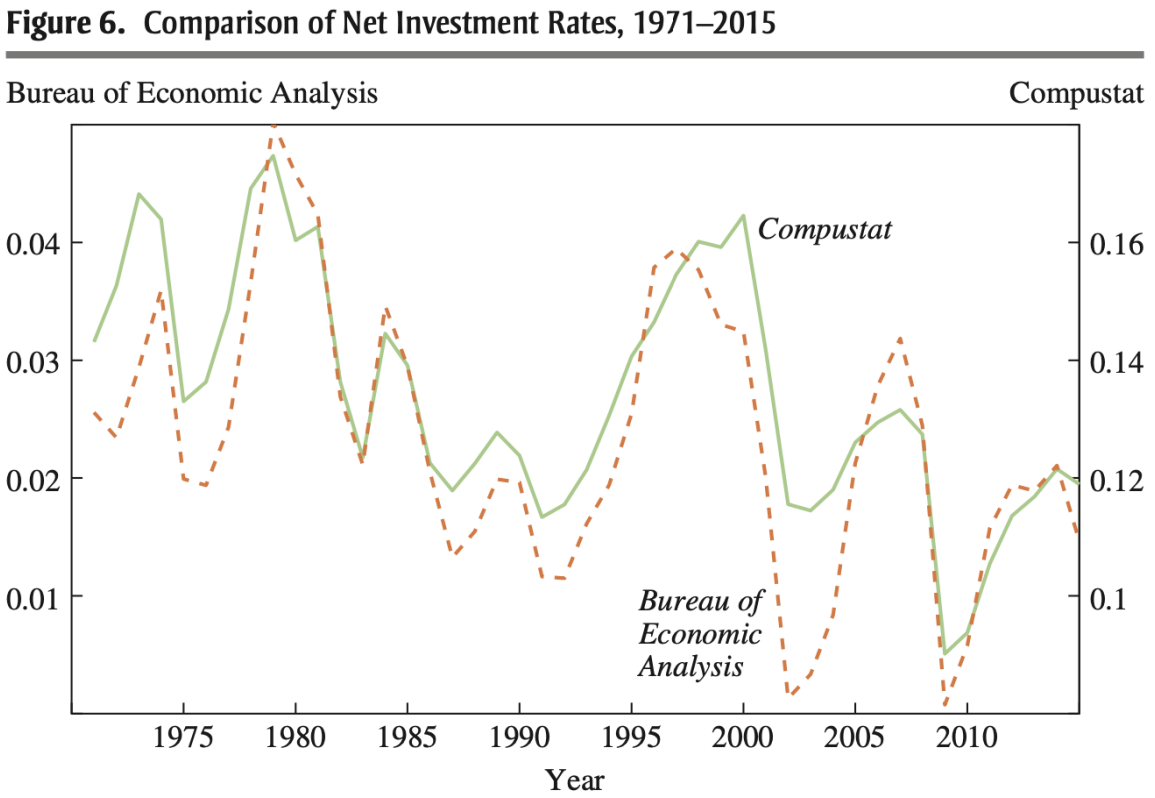
High uncertainty measuring value of internally-generated intangibles

- Challenging to "match" outlays to earnings
- Difficult to verify and low reliability

→ R&D and SG&A expenditures skip balance sheet

# Consequence of unrecorded intangibles?




As firms increasingly use intangibles to fuel future growth, possible that the downward bias in book value becomes larger, resulting in upward trend in M/B.

Gutierres and Philipon (2017)

# Summary of results

Use acquisition prices of intangible capital to estimate parameters for intangible stock measures.

Parameters :

$\delta_G =$ R&D Depreciation Rate

$\gamma =$ Fraction of SG&A that represents organizational capital

New stocks for all Compustat firms:

- Capitalized R&D → Knowledge Capital
- Capitalized SG&A → Organizational Capital

Relative to the existing literature:

- On average, *smaller* total intangible stocks but with more industry-level variation
- Better performance in (i) explaining firm valuations (ii) predictability of HML portfolios (iii) predicting personnel risk (iv) correlation with patents/brands

# A brief history on measuring intangible capital

## Knowledge Capital (via R&D):

- Hall (1990): $\delta_G$ =15%
  - Default assumption for lit.
- Li and Hall (2016): BEA-NSF data
  - Covers < 11 % of SIC codes, and 28% of Compustat firms.
- Implied useful life of capital: 14 years

## Organizational Capital (via SG&A):

- Hulten and Hao (2008) estimate γ = 30%, 30% of SG&A spending represents long-term investment
  - This estimate comes from aggregate data of **6** pharmaceutical firms in 2006
- Status quo $\delta_S$ =20%
  - Current measurements do not allow for any industry variation.

Hereafter, the “current method” will be called “BEA-HH”.

E.g.) Capitalize R&D using Hall (2016) data if available, and HH assumptions for org cap.

# The Setting: Acquisition—Purchase Price Allocations

August 26, 2008:

- HP acquires Electronic Data Services

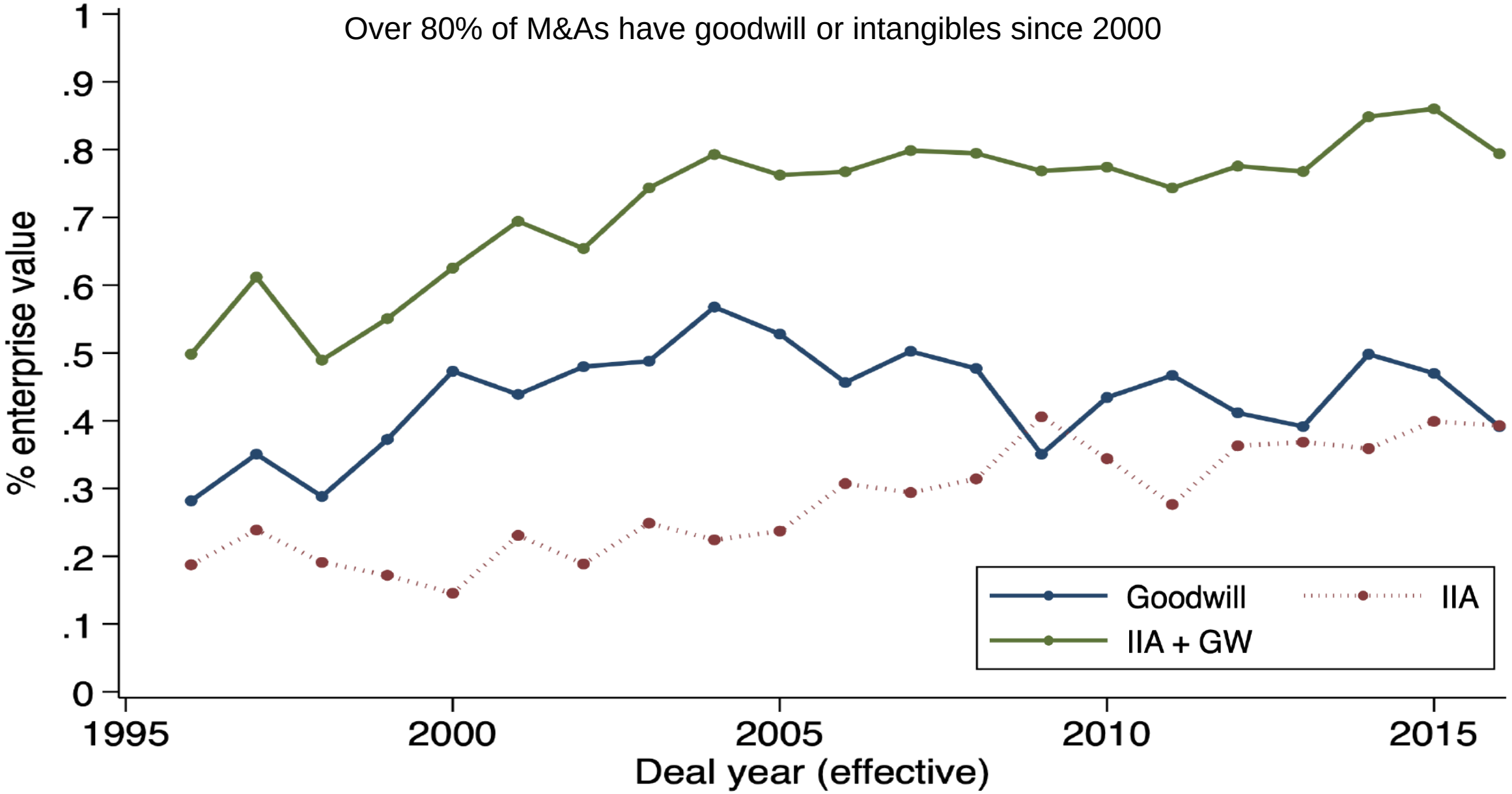
Purchase price allocation of total price paid = $13b

- Net tangible assets ≈ -$1.9b
  - (Net tangibles with other current/financial assets/liabilities)
- Intangible Assets ≈ $14.9b
  - $4.5b in identifiable intangible assets (contracts, relationships, technology and trade names)
  - $10.4b in goodwill (adj. to $4.6b)

| | In millions | |
|---|---|---|
| | Cash and short-term investments | $ 3,034 |
| | Accounts receivable | 2,549 |
| Tangible Assets | Property, plant and equipment | 3,203 |
| Tangible Assets | Other tangible assets | 3,126 |
| Liabilities | Notes payable and debt | (3,298) |
| Liabilities | Pension liability (Note 15) | (2,243) |
| Liabilities | Restructuring liability (Note 8) | (1,515) |
| Liabilities | Net deferred tax liabilities | (1,427) |
| Liabilities | Other liabilities assumed | (5,370) |
| | Total net tangible liabilities | $ (1,941) |
| | Amortizable intangible assets: | |
| IIA | Customer contracts and related relationships | 3,199 |
| IIA | Developed technology and trade name | 1,349 |
| GW | Goodwill | 10,395 |
| IIA | IPR&D | 30 |
| | Total preliminary estimated purchase price | $13,032 |

# % Intangibles in the Acquisition

Over 80% of M&As have goodwill or intangibles since 2000



# Are acquisition prices representative?

Acquisition prices include two pieces that we aim to remove:

- Synergy value
  - E.g. cost savings, increased market power, change in management
- Overpayment or underpayment
  - Agency issues, hubris (Roll (1986))

- Bhagat, Dong, Hirshleifer, and Noah (2005) merger value estimation:
  - 5 day window CAR estimate for acquirer and target
  - Difference between offer price and end-of-day price provides estimate of probability of successful acquisition

# Data

Strategy: Use intangibles' market prices to estimate parameters in intangibles capitalization model.

- 1521 acquisitions from SDC M&As 1996–2017; public firm/target
  - Manually collect purchase price allocation (PPA) for (i) identifiable intangibles and (ii) goodwill
  - Search 10-Ks, 10-Q and 8-Ks
- 479 acquisitions in bankruptcy using recovery rates from Moody's
- Merge with Compustat and CRSP
- Adjust allocations for announcement return of acquirer to avoid capturing overpayment or synergies

# Parameter Estimates

$$\log(1+\mathrm{P}_{it}^{I}) = \log(1+IIA_{i,t}+GW_{i,t}) = \log(\rho_t) + \log\left(1+I_{it}+\sum_{k=0}^{9}(1-\delta_G)^k RD_{i,t-k} + \gamma\sum_{k=0}^{9}(1-0.2)^k SGA_{i,t-k}\right)$$

| | Estimates | | | | Previous estimates | |
|---|---|---|---|---|---|---|
| | $\gamma$ | $\delta_S$ | $\delta_G$ | N | $\bar{\delta}_G^{BEA}$ | $\bar{\delta}_G^{lit}$ |
| All | 0.27 | 0.20 | 0.33 | 2000 | 0.28 | 0.164 |
| | (0.024) | | (0.037) | | | |
| Consumer | 0.19 | 0.20 | 0.33 | 511 | 0.31 | 0.153 |
| | (0.026) | | (0.29) | | | |
| Manufacturing | 0.22 | 0.20 | 0.42 | 233 | 0.25 | 0.156 |
| | (0.056) | | (0.168) | | | |
| High Tech | 0.44 | 0.20 | 0.46 | 715 | 0.315 | 0.255 |
| | (0.055) | | (0.072) | | | |
| Health | 0.49 | 0.20 | 0.34 | 245 | 0.181 | 0.172 |
| | (0.135) | | (0.065) | | | |
| Other | 0.34 | 0.20 | 0.30 | 296 | N/A | 0.15 |
| | (0.064) | | (0.195) | | | |

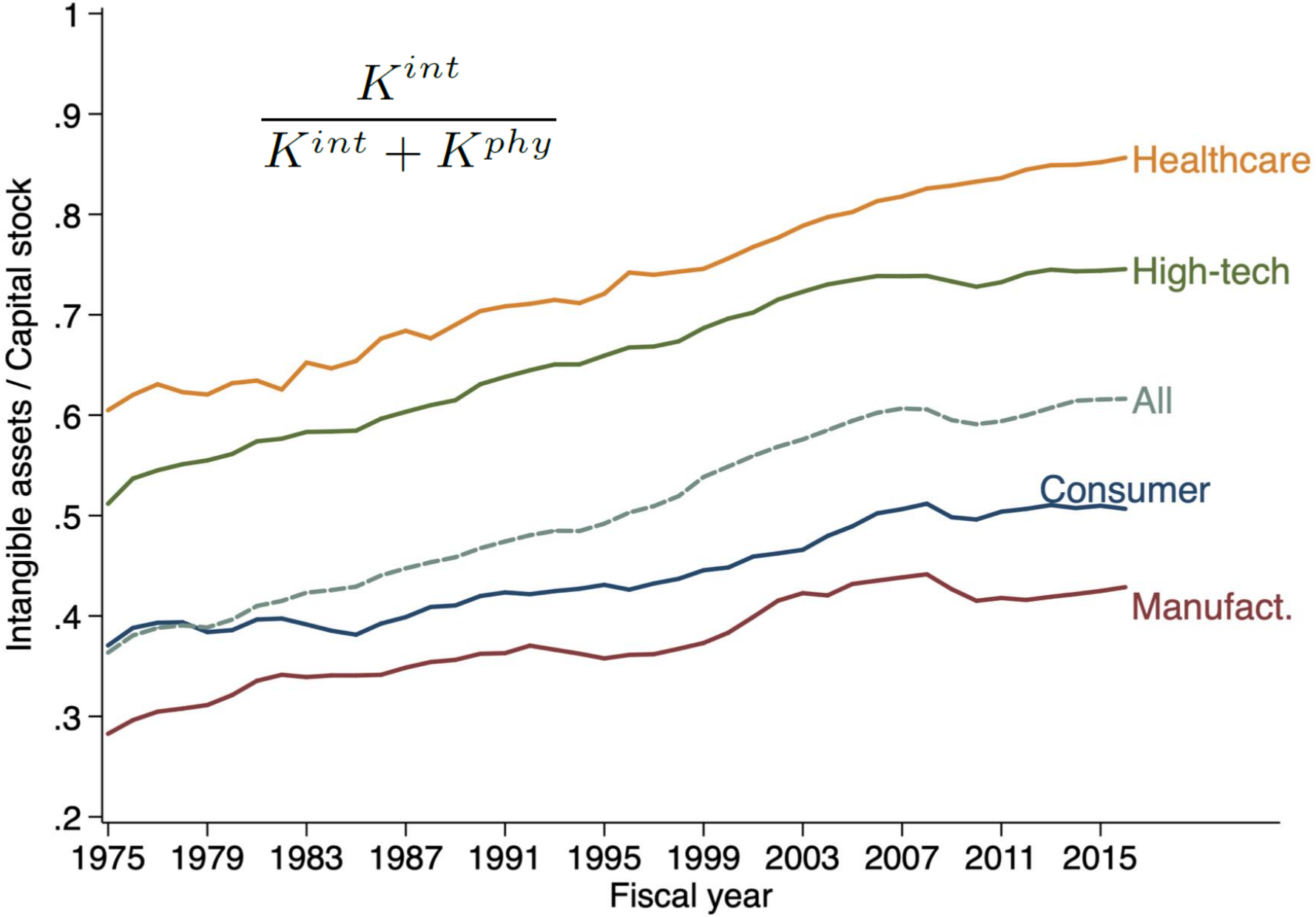
Pseudo-$R^2$: .515

$\gamma$ = Fraction of SG&A that is organizational capital.

Literature assumes $\gamma = 0.3$

$\delta_G$ = Depreciation rate of R&D knowledge capital

# Intangible asset intensity over time



# Are these estimates better?

Short answer: yes.

# Are these new stocks *better*? Explaining firm value

Can the inclusion of intangible assets better explain cross-section of firm value?

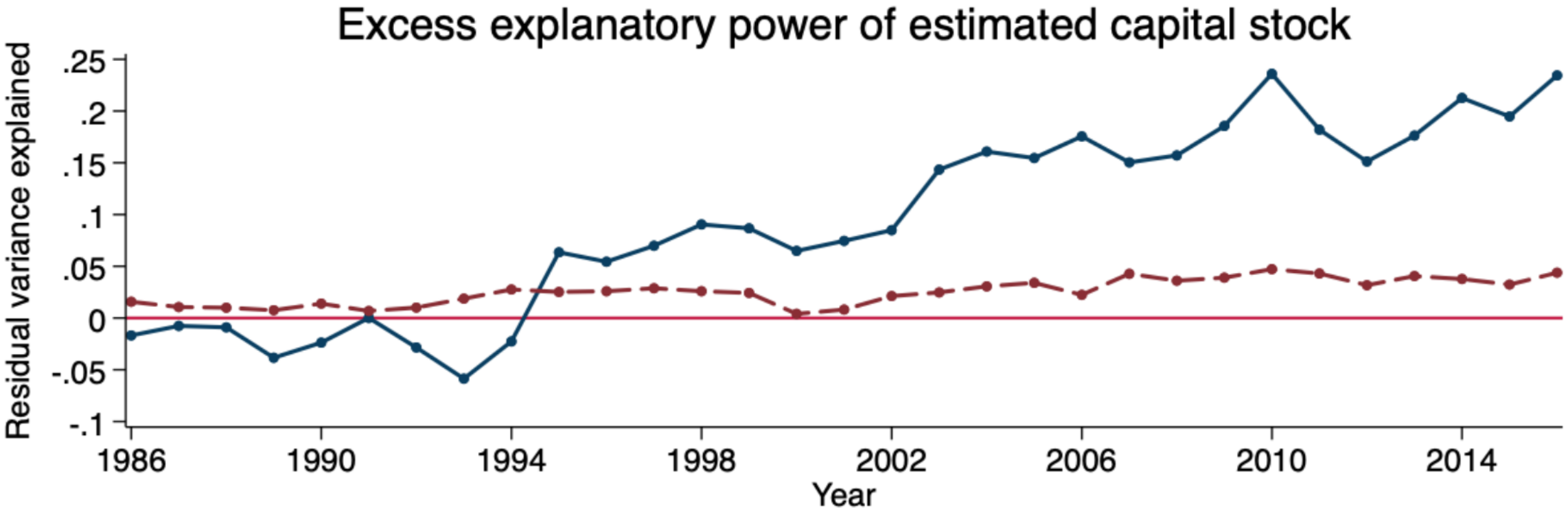
Regress market valuations on book assets:

$$M_{it} = \beta_0 + \beta_1 K_{it}^{phy} + \rho_t + \epsilon_{it}$$

Adjust the assets:

- standard PPE (net)
- + BEA-HH-implied intangible assets
- or, + EPW (our) intangible assets

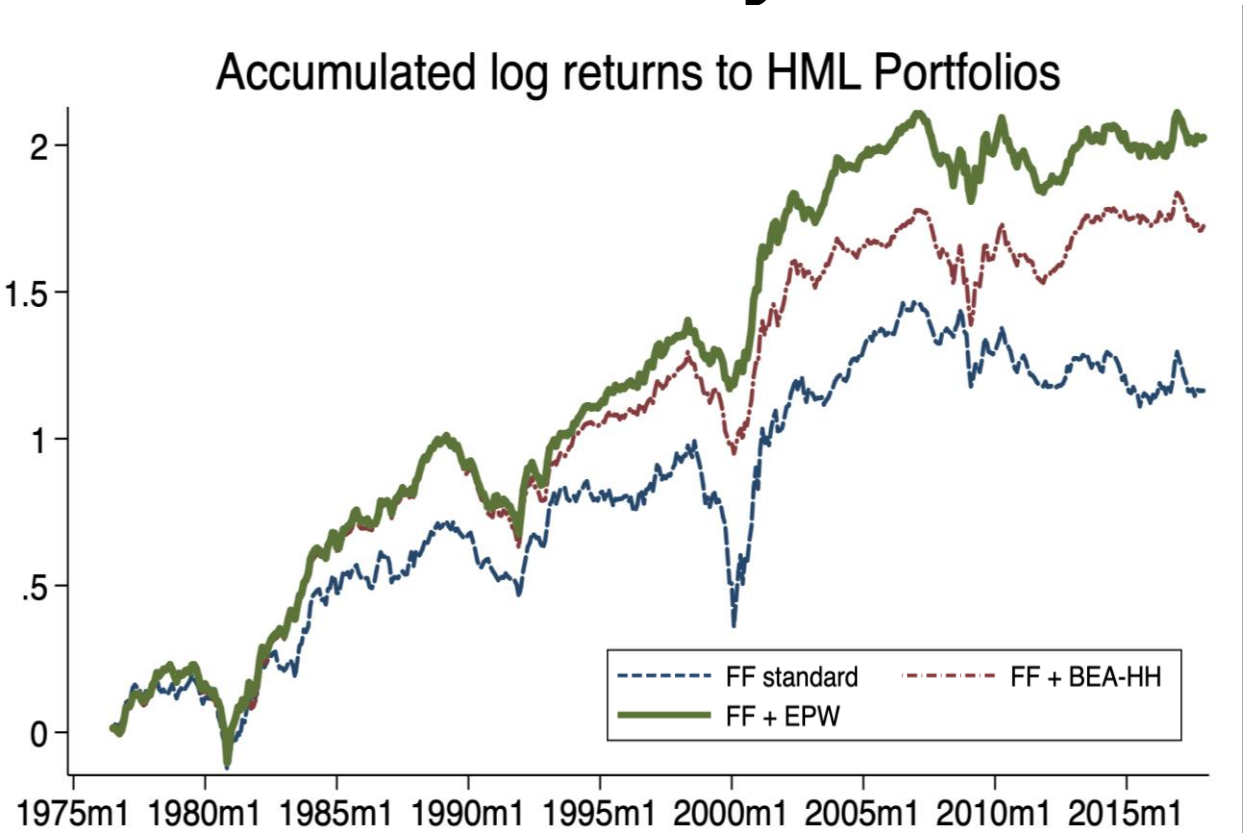
# Intangible assets ↑ explanatory power up to 25%




1-3% Increase in $\frac{RSS* - RSS^{EPW}}{RSS*}$ compared to BEA-HH

# Validation: Return Predictability

- **Does capitalizing intangibles improve return predictability for growth/value premium?**
  - Fama-French (1992)
    - Reconstruct monthly returns from HML factor portfolio including capitalized intangibles.




- EPW intangibles outperform both FF and BEA-HH adjusted HML:

| HML | Obs | Mean | P(=FF) | St. Dev. | Sharpe |
|---|---|---|---|---|---|
| Fama-French | 498 | 0.28 | | 2.96 | 0.32 |
| BEA-HH | 498 | 0.38 | 0.12 | 2.46 | 0.53 |
| EPW | 498 | 0.43 | 0.05 | 2.49 | 0.60 |

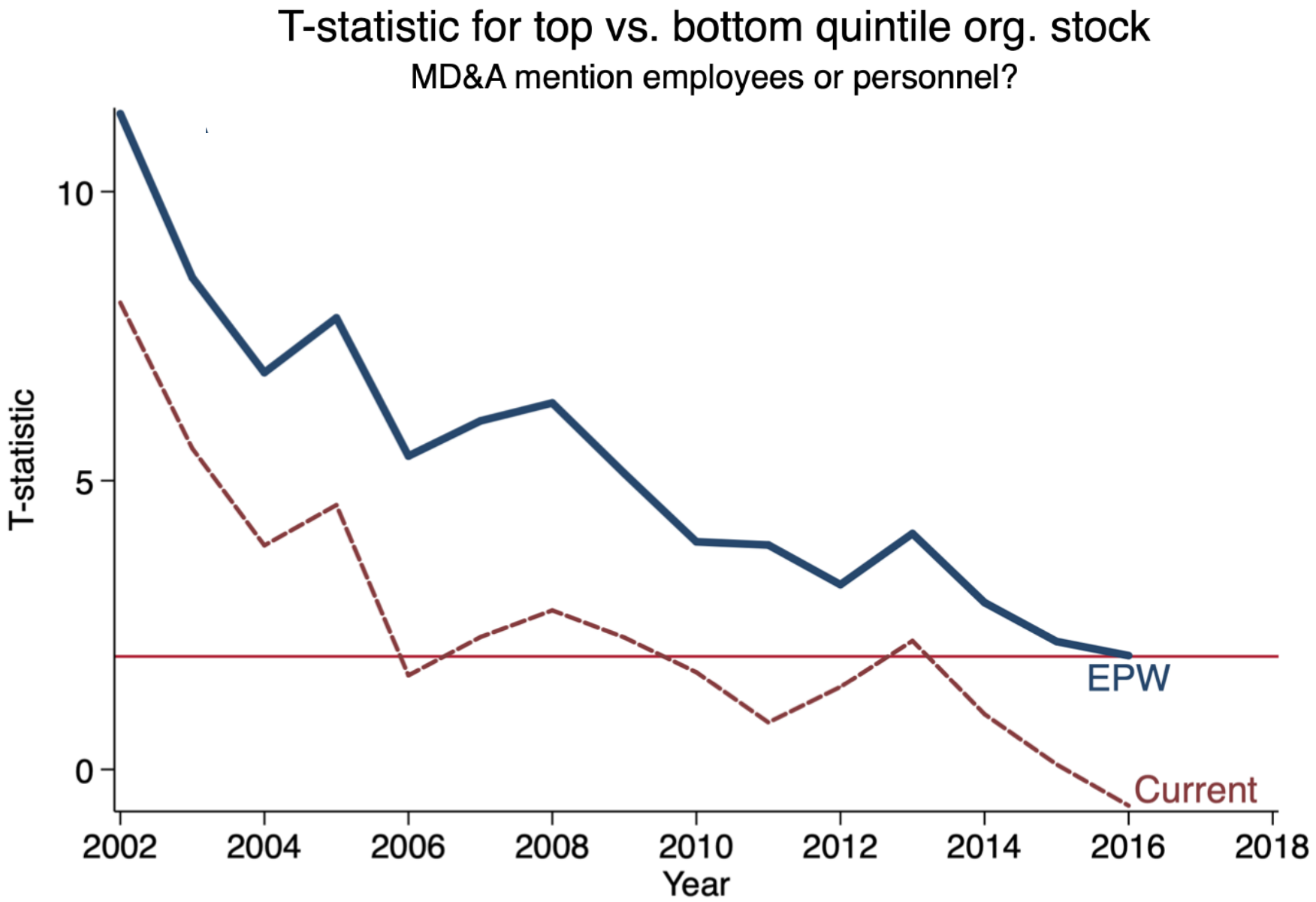
# Organizational capital and human capital risk

- Can firm sorts by the new Org-Cap capture human capital risk?
  - Follow Eisfeldt and Papanikolaou (2013)

- Approach:
  - Text crawl all 10-K filings since 2002
  - Search for personnel = [“key personnel”, “talented employee”]
  - Sort firms into annual quintiles using org. cap. stocks
    - Our stock estimate vs. previous literature measure
  - Compare quintiles in terms of Prob(mention one of those words)

Data and code: http://github.com/michaelewens/SDC-to-Compustat-Mapping

# Improved sorts by org. capital stocks



# Do we really need acquisition prices?

Publicly traded firms potentially acquisition prices already:

$$MV_{\text{Intangibles}} = MV_{\text{Assets}} - MV_{\text{Tangible}}$$

…but, tangible assets on balance sheet recorded at historical cost.

- Hence, $\text{MV}_{\text{intangibles}}$ measured with error.
- Assets = Liab + Common Equity + Pref Equity, thus:

$$MV_{\text{Intangibles}} = (MV_{\text{Equity}} + L + PS) - MV_{\text{Tangible}}$$

- Have $\text{BV}_{\text{Tangible}}$ → must make markup assumption

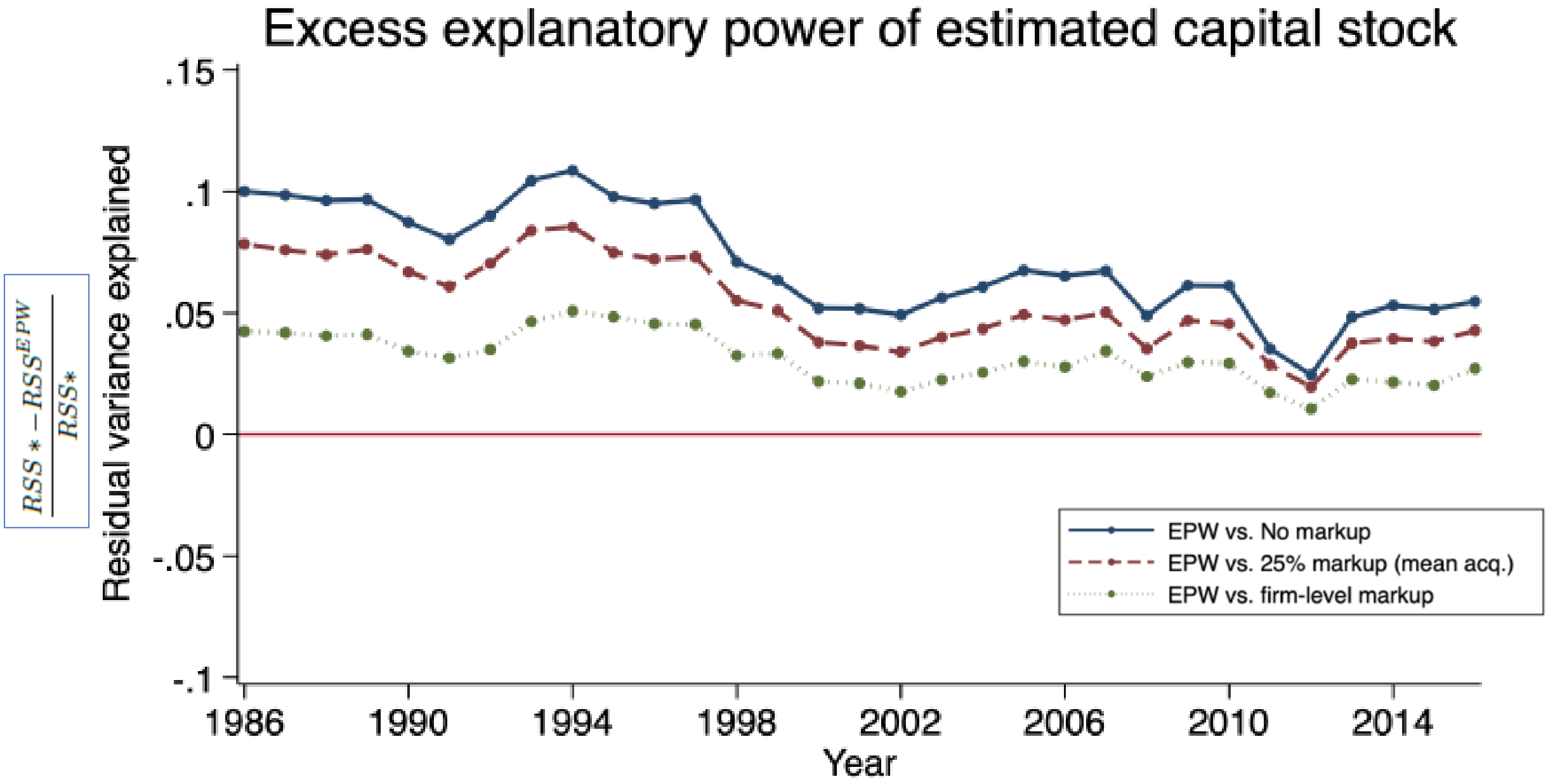
Assumptions for physical markup:

- 0% Markup
- 25% (avg. from M&As)
- Add back half of the depreciation on PP&E (firm-level).

Panel D: Public market estimation

| | $\gamma$ | $\delta_S$ | $\delta_G$ | N | $\bar{\delta}_G^{BEA}$ | $\bar{\delta}_G^{lit}$ |
|---|---|---|---|---|---|---|
| Baseline | 0.29 | 0.20 | 0.31 | 2000 | 0.28 | 0.164 |
| No Markup | 0.53 | 0.20 | 0.24 | 15,054 | 0.28 | 0.164 |
| 25% markup | 0.45 | 0.20 | 0.23 | 15,054 | 0.28 | 0.164 |
| Firm-level markup | 0.39 | 0.20 | 0.27 | 15,054 | 0.28 | 0.164 |

# Comparison to Estimation Using Public Market Prices



# Robustness

…it still works.

# Testing assumptions

- Ignore acquisitions in bankruptcy?
  - Depreciation rates lower; worse performance in horse races
- Do not adjust goodwill?
  - Gamma changes significantly – smaller – and under-performs
- Set goodwill to zero
  - Lower R^2 in main estimation and worse performance
- Does it matter what we assume for depreciation of org. stock?
  - No, but the pair – gamma and $\delta_S$ -- are closely tied together

# Conclusion

What do acquisition transactions of intangible assets reveal about capitalizing intangible investments?

- Large intangible capital stocks of public firms
- New parameter estimates imply lower aggregate intangible asset stocks than existing methods, but with more cross-industry heterogeneity
- Intangible assets – capitalized in this way – are a significant fraction of public firm capital stocks

- Researchers can use this data now:

http://bit.ly/intan_cap

See http://github.com/michaelewens for SDC mapping, 10-K data and more.