

Digitalisation, Intangibles and the Productivity Slowdown

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Based on work with with Carol Corrado, Massimiliano Iommi, Cecilia Jona-Lasinio, Ana Rincon-Aznar. Disclaimer: opinions those of author

Proposition: Intangibles framework (Machlup, 1962, Nakamura, 2001, Corrado-Hulten-Sichel, 2005,9) is helpful for understanding modern economy

- intangible investment growing strongly, see below
- leading companies are intangible-rich e.g. Apple, Microsoft
- aspects of digitisation
 - software/databases
 - AI = fast hardware (tangible asset), using new software (measured intangible asset), searching databases (unmeasured intangible asset)
 - new business models

Features of intangible investment

- have economic properties (Haskel/Westlake, 2007): scale, sunk, spillovers, synergies:
 - spillovers: slowdown in growth might slow $D\ln TFP$
 - scale/synergies: emergence of leading firms
 - sunkness: banks ill-suited to lending
- are mismeasured so
 - might have J-curve effects (Brynjolfsson, Rock, Syverson)
 - might account for apparent rising mark-ups

Recent work

- www.intaninvest.net project: intangibles + tangibles + labour composition to do growth accounting
- extend intangibles growth framework with distinction between process and product innovation: imperfect competition and returns to scale spillovers

What is intangible investment?

- Business intangible investment is **long-lived** spending on:
 - Software and databases
 - R&D
 - Design and other new product development (including mineral exploration, entertainment originals, financial services)
 - Brand and customer development
 - Improvements in organizational practices (including worker training).
- **Intangible capital** is the stock of commercial knowledge resulting from these investments + "free" knowledge generated by, e.g., the conduct of public R&D
- TFP growth reflects the impact of "free" knowledge + excess returns to commercial knowledge as it diffuses throughout an economy (over and above its direct contribution to growth)

The World's Top Companies (by market capitalisation, 2018), from PwC

Company Name	Location	Industry	31 March 2018	31 March 2009
			<i>Market capitalisation (\$bn)</i>	
Apple	United States	Technology	851	94
Alphabet	United States	Technology	719	110
Microsoft	United States	Technology	703	163
Amazon.com	United States	Consumer Services	701	31
Tencent	China	Technology	496	13
Berkshire Hathaway	United States	Financials	492	134
Alibaba	China	Consumer Services	470	-
Facebook	United States	Technology	464	-
JPMorgan Chase	United States	Financials	375	100
Johnson & Johnson	United States	Health Care	344	145

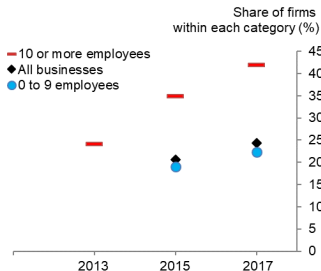
Source: Bloomberg and PwC analysis.

Some questions

- Do the published balance sheet assets of buildings, equipment, vehicles help understand these companies?
- Does R&D help? We can work out capitalised R&D since birth:
 - Alphabet: R&D capital = \$53bn, tangible capital = \$20bn
 - Microsoft: R&D capital = \$85bn, tangible capital \$5bn
 - Amazon: don't report R&D
 - Facebook: R&D capital = \$14bn, tangible capital = \$11bn

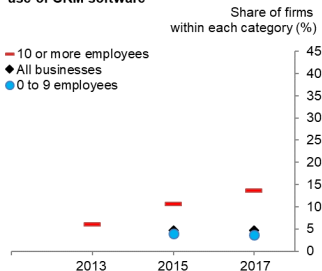
The moving target that is ICT use...

Proportion of UK businesses purchasing cloud computing services over the internet



Source: Office for National Statistics (UK)

Proportion of UK businesses purchasing cloud computing services over the internet: use of CRM software



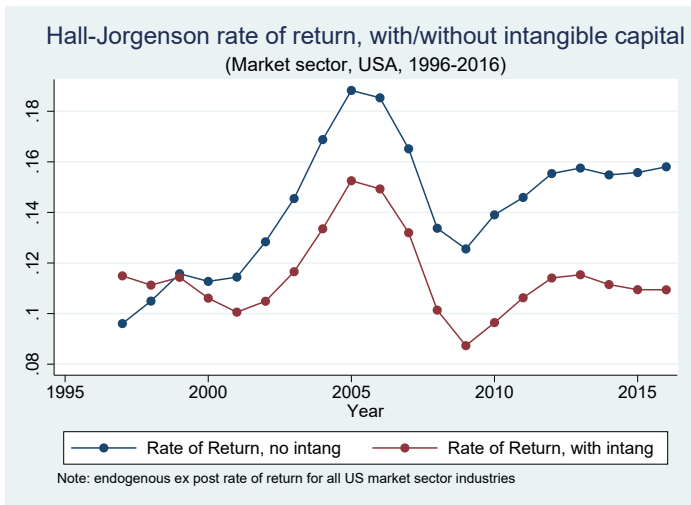
Source: Office for National Statistics (UK)

- Database with multiple dimensions: **country, industry, institutional sector (market and non market), time**
- Tangible and intangible assets (NA, INTAN Invest and SPINTAN)
- Value added and labor variables (NA and EUKLEMS)
- 20 industries (A-U Nace Rev 2), 1995-2013, so far 12 countries:
 - US
 - Big Northern Europe: DE, FR, UK
 - Scandinavian: DK, FI, SE
 - Small Europe: AT, CZ, NL
 - Mediterranean: ES, IT

We build a bottom-up growth accounting data set, constructing capital stocks from raw investment data and consistent capital prices and value added data, augmented with labour composition data. Software and hardware deflators are harmonized to OECD ICT deflators; and non-market rates of return are imputed (Corrado, Haskel, Jona-Lasinio, Iommi (2016)).

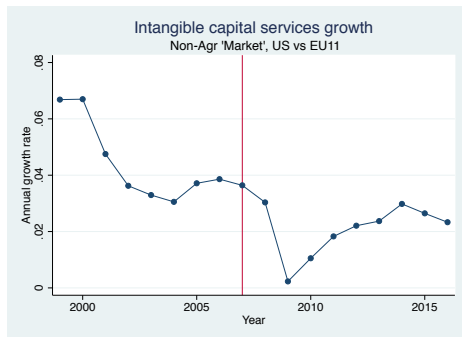
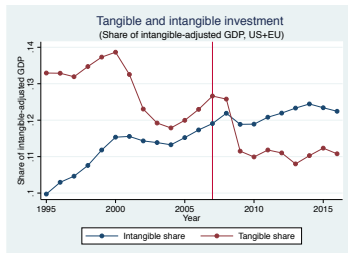
Some findings....

US Rates of return have not risen if you include intangibles



Source: Calculations based on www.intaninvest.net, National accounts, Labour force surveys.

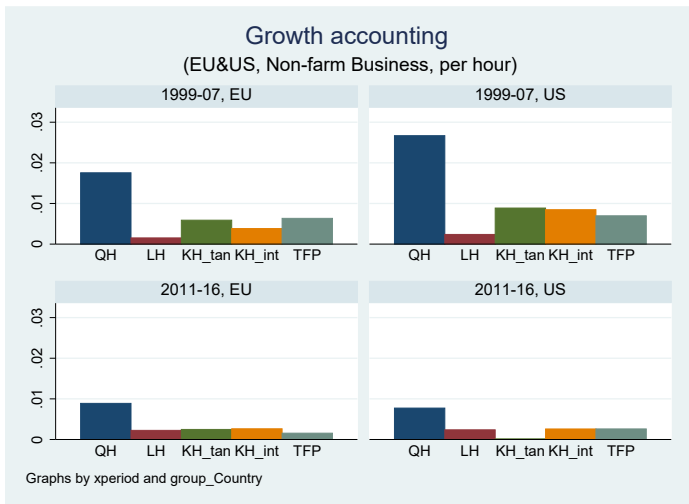
Intangible investment slowed after the financial crisis...



- Nonfarm business sector data for EU11+US, 1995 to 2016

Source: Calculations based on www.intaninvest.net, National accounts, Labour force surveys.

TFP and intangible capital deepening slowed down

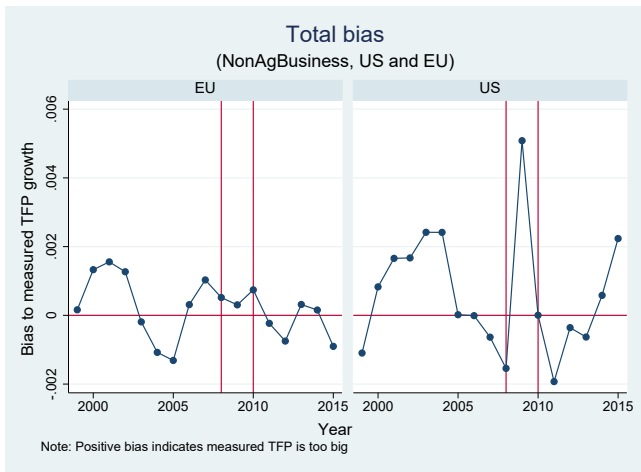


Note: Harmonised ICT deflators.

Source: Calculations based on www.intaninvest.net, National accounts, Labour force surveys.

J curve effects due to mismeasured intangible investment hard to detect

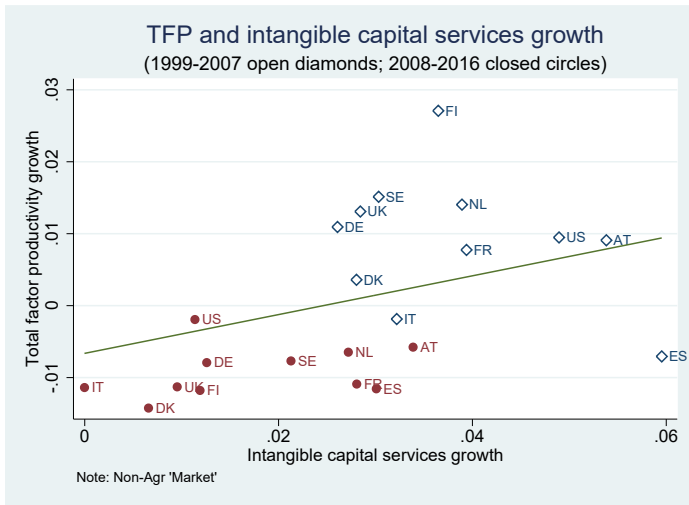
$$B = - \underbrace{\omega_V^Q (dn - dv)}_{\text{missing intan invest}} + \underbrace{\sigma_V^Q dr^V}_{\text{intangibles}} + \underbrace{(\sigma_X^Q - \sigma_X^V) dx}_{\text{K, L share mismeas}}$$



Note: Harmonised ICT deflators.

Source: Calculations based on www.intaninvest.net, National accounts, Labour force surveys.

TFP growth has slowed the most where intang capital services growth slowed...

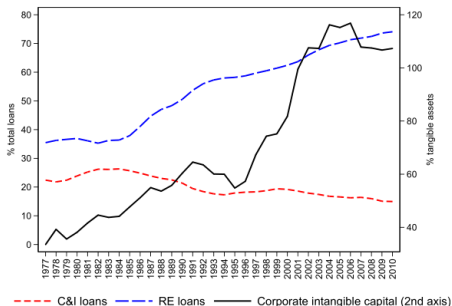


Note: Harmonised ICT deflators.

Source: Calculations based on www.intaninvest.net, National accounts, Labour force surveys,

...as bank lending skews to real estate away from intangibles

Figure 2: Corporate intangible assets, and bank loan portfolios, 1977-2010



otes: The figure plots the average share of corporate intangible capital in total assets for US Compustat firms; e average share of C&I loans in total loans; and the average share of real estate (RE) loans in total loans for US mmercial banks during 1977-2010. Data sources: Compustat, US Call Reports.

Source: DellAricca et al, 2017, "Bank Lending in the Knowledge Economy", IMF Working Paper

- Long run trend towards intangible investment
- But banking system ill-suited to supporting such investment
- Financial crisis and increased demand for safe assets didn't help (Duval et al)
- Intangible investment slowed (Duval et al, Crouzet, Eberly) ==> capital deepening and TFP growth slowed
- Meanwhile, measurement problems keep growing