Intangibles, Innovation and Growth

Jonathan Haskel
Imperial College Business School and Tuck School of Business, Dartmouth College
CAED, April 2012

(Papers at http://www3.imperial.ac.uk/people/j.haskel)

Motivation

- *"We will be more likely to promote innovative activity if we are able to measure it more effectively and document its role in economic growth"* Ben Bernanke, May 2011, Speech in Washington DC at Athena Alliance/OECD Conference
- Plenty of approaches to innovation in economics, management, psychology e.g.
  - Firm innovation activity surveys e.g. CIS
  - Patents/R&D
  - Growth accounting/spillovers
  - Within-firm studies of motivation, teams, leadership
- Competition is good! So all have part to play
- Start with a narrow, but hopefully revealing question: how do these approaches help understand some of the innovation that my Business School students ask me about?

Britain’s most famous recent innovation

Innovation in Britain

Innovation in financial services

- Tufano (1989) , studies 58 financial innovations, 1974-86
- Interview with a financial firm
- Developing a new financial product requires *"an investment of $50,000 to $5 million, which includes*
  - *payments for legal, accounting, regulatory, and tax advice,*
  - *time spent educating issuers, investors, and traders,*
  - *investments in computer systems for pricing and trading, and*
  - *capital and personnel commitments to support market-making.*
- *In addition, investment banks that innovate typically pay $1 million annually to staff product development groups with two to six bankers…"*

Why I find these examples interesting

- No R&D
- No patenting (although maybe copyright and trademarks)
- Not sure how firms/people would respond to typical innovation survey question “have you innovated”
- A lot of software spending (e.g. movies, spinoff products, retailing, banking). Much likely to be within-firm. With no explicit purchase, may not leave easily-observable economic footprint
- Innovation seems to need a range of investments beside opportunity cost of product developer time: training, marketing etc.
- Innovation firmly linked to growth, profits, investment

A model that captures this

Sectors

(a) Intangible sector :

$$N_t = F^N(L_{N,t}, K_{N,t}, R_{N,t}, t); \quad P_t^N N_t = \mu\left(P_t^L L_{N,t} + P_t^K K_{N,t}\right)$$

(b) Tangible sector :

$$I_t = F^I(L_{I,t}, K_{I,t}, R_{I,t}, t); \qquad P_t^I I_t = P_t^L L_{I,t} + P_t^K K_{I,t}$$

(c) Consumption sector :

$$C_t = F^C(L_{C,t}, K_{C,t}, R_{C,t}, t); \quad P_t^C C_t = P_t^L L_{C,t} + P_t^K K_{C,t} + P_t^R R_{C,t}$$

Asset prices

$$P_t^R = P_t^N(r_t - \pi_t^R + \delta^R) \quad \textit{and} \quad P_t^K = P_t^I(r_t - \pi_t^K + \delta^K)$$

Asset accumulation

$$R_{C,t} = N_t + (1-\delta^R)R_{C,t-1} \quad \textit{and} \quad K_{J,t} = I_t + (1-\delta^K)K_{J,t-1}, J = C, I, N$$

Implications

1. New investment means new GDP

$$P^Q Q = P^C C + \underbrace{P^I I + P^N N}_{\text{Total investment}} = P^L L + \underbrace{P^K K + P^R R}_{\text{Total capital payments}}$$

$$d\ln Q = \frac{P^C C}{P^Q Q} d\ln C + \frac{P^I I}{P^Q Q} d\ln I + \underbrace{\frac{P^N N}{P^Q Q} d\ln N}_{\text{Addition to GDP growth}}$$

2. TFP with and without intangibles

$$d\ln TFP = d\ln Q - (s_Q{}^L d\ln L + s_Q{}^K d\ln K + s_Q^R d\ln R)$$

compare

$$d\ln TFP^- = d\ln Q^- - (s_Q^{-L} d\ln L + s_Q^{-K} d\ln K)$$

Key questions raised by framework

- Measurement
  - Relation with alternative measurement e.g. innovation surveys
  - Difficult measurement issues
    - List of assets
    - Investment
    - Prices of intangible assets
    - Depreciation
- Conceptual objections
  - “Intangible spending is not investment since it does not last”
  - “Investment in intangibles is ultimately people. So it’s all double counting with human capital”
  - “Ideas don’t depreciate”
- What facts and policy implications (if any) have we uncovered?
  - Facts: Have we missed a lot or a little investment? Has TFP changed? Do we have the right statistical systems to measure it with confidence?
  - Policies: Are there intangible spillovers? Can policy help?

Measurement 1/4: which assets?

Table 1. Intangible Capital Asset Types	
Asset type	**Included in National Accounts?**
Computerized information	
1. Software	Yes
2. Databases	?
Innovative property	
3. Mineral exploration	Yes
4. R&D (scientific)	Satellite for some
5. Entertainment and artistic originals	EU-yes, US-no
6. New product/systems in financial services	No
7. Design and other new product/systems	No
Economic competencies	
8. Brand equity	
a. Advertising	No
b. Market research	No
9. Firm-specific resources	
a. Employer-provided training	No
b. Organizational structure	No

Asset list: what do others do?

- **UK Competition Commission**, Home Credit, Inquiry, valued:
  - corporate reputation/brand
  - the trained workforce
  - the customer base
  - IT systems and development
    - (See *Home Credit Inquiry*, 2006, Appendix 3-6 and 3-8)
- **US tax code** specifies 12 intangible assets to be valued and listed as financial assets following a merger or acquisitions, including
  - the value of the business information base,
  - the workforce in place,
  - know-how (e.g. patents and designs),
  - customer and supplier bases.
    - (See US IRS *Publication 535*, *Business Expenses*, pp. 28-31).

Measurement 2/4: nominal investment

- Measure nominal investment flows
  - Spending ≠ investment e.g. TV news and *Downton Abbey*
  - Purchased and own-account for asset J in sector S

$$P^N N_t = \sum_{j=1}^{J} \mu_j (P^L L_{j,t} + P^K K_{j,t})$$

$$= \sum_{j=1}^{J} \mu_j^{shadow} (P^L L_{j,t} + P^K K_{j,t})^{own-account} + P_j^N N_{j,t}^{purchased}$$

$$\cong \sum_{j=1}^{J} \sum_{s=1}^{S} (\mu_{s,j}^{shadow} (P^L L_{s,j,t} + P^K K_{s,j,t})^{own-account} + P_j^N N_{s,j,t}^{purchased})$$

$$= \sum_{j=1}^{J} \sum_{s=1}^{S} (\mu_{s,j}^{shadow} \lambda_{s,j} OwnCost_{s,j,t}^{Indicator} + \gamma_{s,j} Purchased_{s,j,t}^{Indicator})$$

Progress in measuring nominal investment flows?

$$P^N N_t = \sum_{j=1}^{J} \mu_j^{shadow} (P^L L_{j,t} + P^K K_{j,t})^{own-account} + P_j^N N_{j,t}^{purchased}$$

- Some relatively easy areas
  - UK Creation of artistic originals= film, books, music. Measured only some films, used x% and y% of publishing and music industry sales
  - Scope for improved measures using
    - Many data sources on “creative” sector
    - Royalty payments to artists by collecting societies
- Open issues
  - Spending versus investment e.g. design
  - Mark-ups
  - International trade

Measurement 3/4: deflators

- Hard since
  - knowledge not typically traded
  - Knowledge production is typically in-house so buried "inside" even industry-level prices, TFP etc.
- Corrado, Goodridge, Haskel (2011), R&D prices
- Price duals of above (mu=1, steady state)

$$\Delta \ln P^N = s_N^K \Delta \ln P^K + s_N^L \Delta \ln P^L - \Delta \ln TFP^N$$

$$\Delta \ln P^Y = s_Y^K \Delta \ln P^K + s_Y^L \Delta \ln P^L + s_Y^N \Delta \ln P^N - \Delta \ln TFP^Y$$

Price deflators, 2

$$\Delta \ln P^N = s_N^K \Delta \ln P^K + s_N^L \Delta \ln P^L - \Delta \ln TFP^N$$

$$\Delta \ln P^Y = s_Y^K \Delta \ln P^K + s_Y^L \Delta \ln P^L + s_Y^N \Delta \ln P^N - \Delta \ln TFP^Y$$

- Upstream method 1: Directly measured quality-adjusted prices. Examples
  - Hardware (late 1990s-2000s, falls around 17% pa)
  - Communications equipment (Doms, Byrne/Corrado, falls around 4% pa)
  - Pre-packaged software (falls around 4.5%pa)
- Upstream method 2: Input cost-based
  - Include capital costs (US does not, UK does)
  - What to assume about $\Delta \ln TFP^N$? (mostly $\Delta \ln TFP^N = 0$)
  - Mark-ups?
- Downstream method: use $\Delta \ln P^Y$ for "information-intensive" goods
  - Which goods?
  - $\Delta \ln P^Y \neq \Delta \ln P^R$ in general
- Downstream method: use $\Delta \ln P^{GDP}$.
  - Implicit in European targets for R&D/GDP = $P^N N / P^Y Y$

Developing the downstream method: application to UK R&D

$$\Delta \ln P^N = s_N^K \Delta \ln P^K + s_N^L \Delta \ln P^L - \Delta \ln TFP^N$$

$$\Delta \ln P^Y = s_Y^K \Delta \ln P^K + s_Y^L \Delta \ln P^L + s_Y^N \Delta \ln P^N - \Delta \ln TFP^Y$$

$$\Rightarrow$$

$$\Delta \ln P^N = \left(\Delta \ln P^Y - (s_Y^K \Delta \ln P^K + s_Y^L \Delta \ln P^L + \Delta \ln TFP^Y) \right) / s_Y^N$$

- Corrado, Goodridge, Haskel (2011), develop downstream method, at industry level
  - Method, use re-arranged downstream equation to back out $\Delta \ln P^N$
  - For UK, merge KLEMS with R&D data
  - Can separate out upstream and downstream K and L to measure s^K , s^L, s^N
  - Use observed $\Delta \ln P^Y$
  - Derive $\Delta \ln TFP^Y$ from steady-state relation

$$\Delta \ln TFP^{measured} = \Delta \ln TFP^Y + s_Y^N \Delta \ln TFP^N$$

  - Gives $\Delta \ln P^N$ as a residual and can calculate an implied $\Delta \ln TFP^N$

Results

1985-2005	*ΔlnP^N (%pa)*	*$\Delta lnTFP^N$ (%pa)*	*Contrib to GDP from R&D (%pa)*	*Share of total $\Delta lnTFP$ due to $\Delta lnTFP^N$*
Method:				
Input cost	+4.0	0 (by assumption)	0.03	0 (by assumption)
Residual	-7.5	11.7	0.25	16%

Memo: GDP deflator = 3.5, R&D weighted output price change = 2.1

Measurement 4/4: depreciation

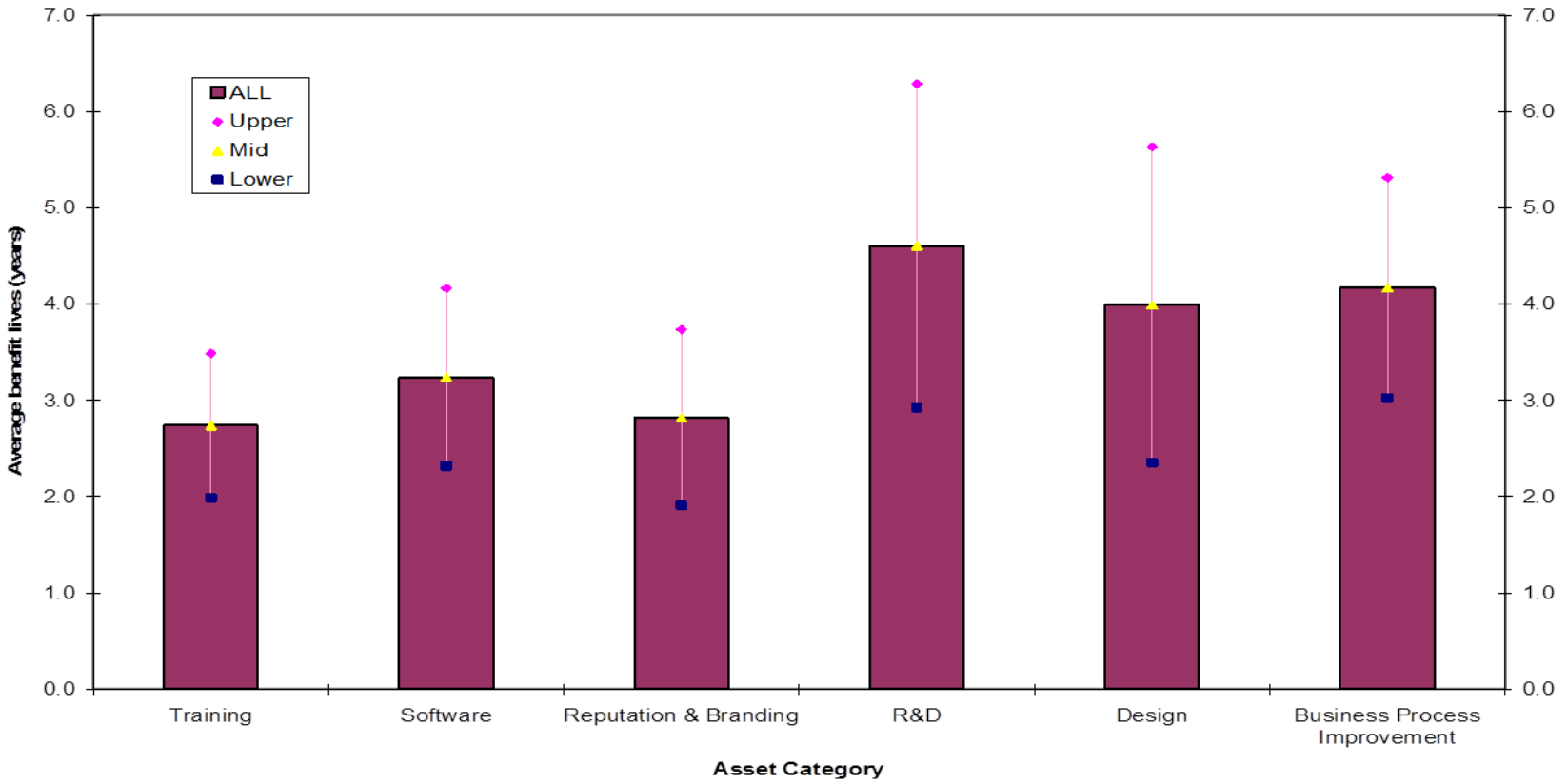
$$K_{i,t} = \sum_{\tau=0}^{T} \frac{f_\tau}{f_{\tau=0}} F_{i,\tau} \frac{IN_{i,t-\tau}}{p^A_{i,t-\tau,age=0}}$$

- Productive capital stock sums real investment weighted by
  - "decay" : f_τ /f = marginal product of age = τ relative to new machine.
  - "discard" : F= Fraction of machines of age = τ surviving
- In PIM, "depreciation" captures both decay and discard
  - Tangible capital? Likely decays with "wear and tear"
  - Intangible capital?
    - May not decay if knowledge does not "wear out"
    - But is discarded e.g. old versions of Word.

Evidence on depreciation

- Israeli Statistics Bureau, Peleg (2008)
  - Asked R&D intensive firms about time taken for
    - Gestation
    - Application
    - Use in production
- Awano et al, 2010
  - Extended official R&D survey to ask about intangible spend and life length
  - “On average, how long does the business expect to benefit from a typical investment in […]
    - Software
    - Reputation and branding
    - Business process
    - Design
    - Training
    - R&D

Intangible asset life lengths

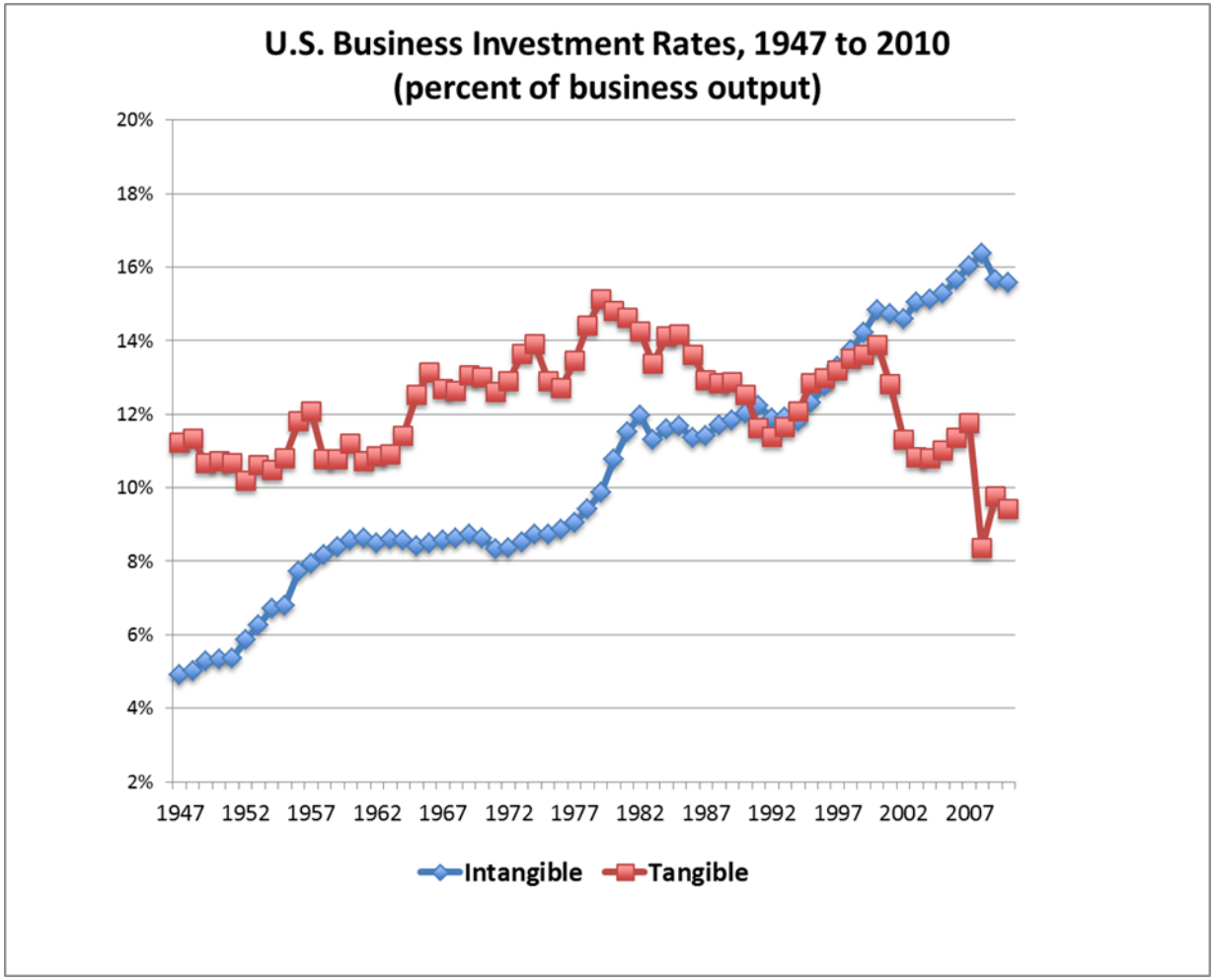


Source: Awano et al, Economic & Labour Market Review, July 2010

Some findings

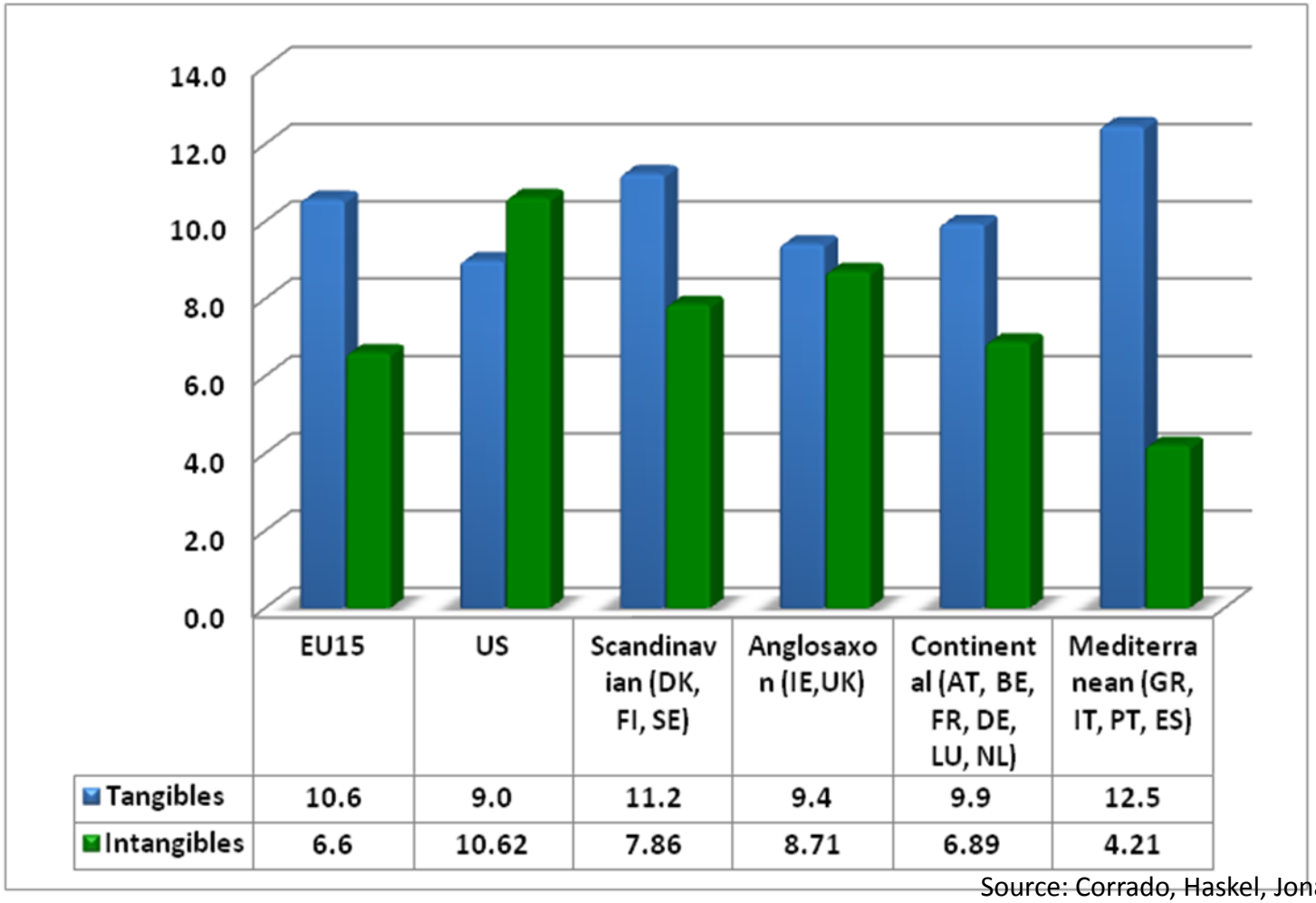
- Tangible versus intangible investment
- Role in growth
- Policy
  - Effects on intangible investment?
  - Spillovers?
- Harmonized data base “INTAN-INVEST”: Corrado, Haskel, Jona-Lasinio, Iommi (2012, forthcoming)
  - New estimates of financial products
  - Software deflators to be harmonized

Tangible v intangible investment: US



Source: Carol Corrado

Tangible and Intangible investment: cross- country GDP shares, 1995-2009



	EU15	US	Scandinavian (DK, FI, SE)	Anglosaxon (IE,UK)	Continental (AT, BE, FR, DE, LU, NL)	Mediterranean (GR, IT, PT, ES)
Tangibles	10.6	9.0	11.2	9.4	9.9	12.5
Intangibles	6.6	10.62	7.86	8.71	6.89	4.21

Source: Corrado, Haskel, Jona-Lasino, Iommi (2012)

Contributions to growth

Table 4. Contributions to the growth of output per hour, 1995 to 2007

	Labor productivity growth	*Contribution of components:*				
		Total Capital Deepening	Tangibles	Intangibles	Labor Composition	Multifactor productivity
	(1)	(2)	(3)	(4)	(5)	(6)
Austria	2.4	.8	.3	.5	.2	1.4
Belgium	1.8	.7	.2	.5	.1	.9
Czech Republic	4.2	2.4	1.9	.5	.3	1.5
Denmark	1.3	1.1	.7	.4	.2	.0
Finland	3.7	.8	.2	.6	.2	2.6
France	1.8	1.0	.4	.5	.4	.4
Germany	1.7	1.0	.7	.3	.0	.8
Ireland	3.7	1.4	.8	.6	.1	2.1
Italy	.5	.6	.5	.1	.2	-.4
Netherlands	2.2	.8	.4	.5	.4	1.0
Slovenia	5.3	1.7	1.2	.5	.8	2.7
Spain	.8	.9	.7	.2	.5	-.6
Sweden	3.6	1.9	1.1	.8	.3	1.3
United Kingdom	2.8	1.4	.8	.6	.4	1.1
United States	2.6	1.3	.6	.6	.2	1.1
Memos		*Average percent contribution of component:*				
EU countries		57.3	36.1	21.2	16.7	25.3
US		49.7	24.9	24.8	7.7	42.1

Source: Authors' calculations based on intangible investment databases developed by the authors and/or partners in previous works. See text for further discussion.
Note—For individual countries, figures in column (1) are annual percent changes, and figures in columns (2) through (6) are percentage points.

Source: Corrado, Haskel, Jona-Lasino, Iommi (2012)

Intangible investment in UK financial services

(% total intang investment of that asset, 2006)

Intangible assets	Manufacturing	Financial Services
Software	0.15	0.22
R&D/Prod devel	0.78	0.06
Design	0.26	0.07
Brand equity	0.17	0.17
Firm-human capital	0.13	0.05
Organisational capital	0.25	0.19
Memo		
hours	*18*	*5*

Source: Haskel and Pesole (2011)

Policy

- Spillovers?
- Policy and intangible investment?

Spillovers?

- Suggestive evidence from R&D studies on social rates of return. Typical regression

$$\Delta \ln TFP^{B}_{it} = \alpha \Delta \ln R^{R\&D} + \varepsilon_{it}$$

or

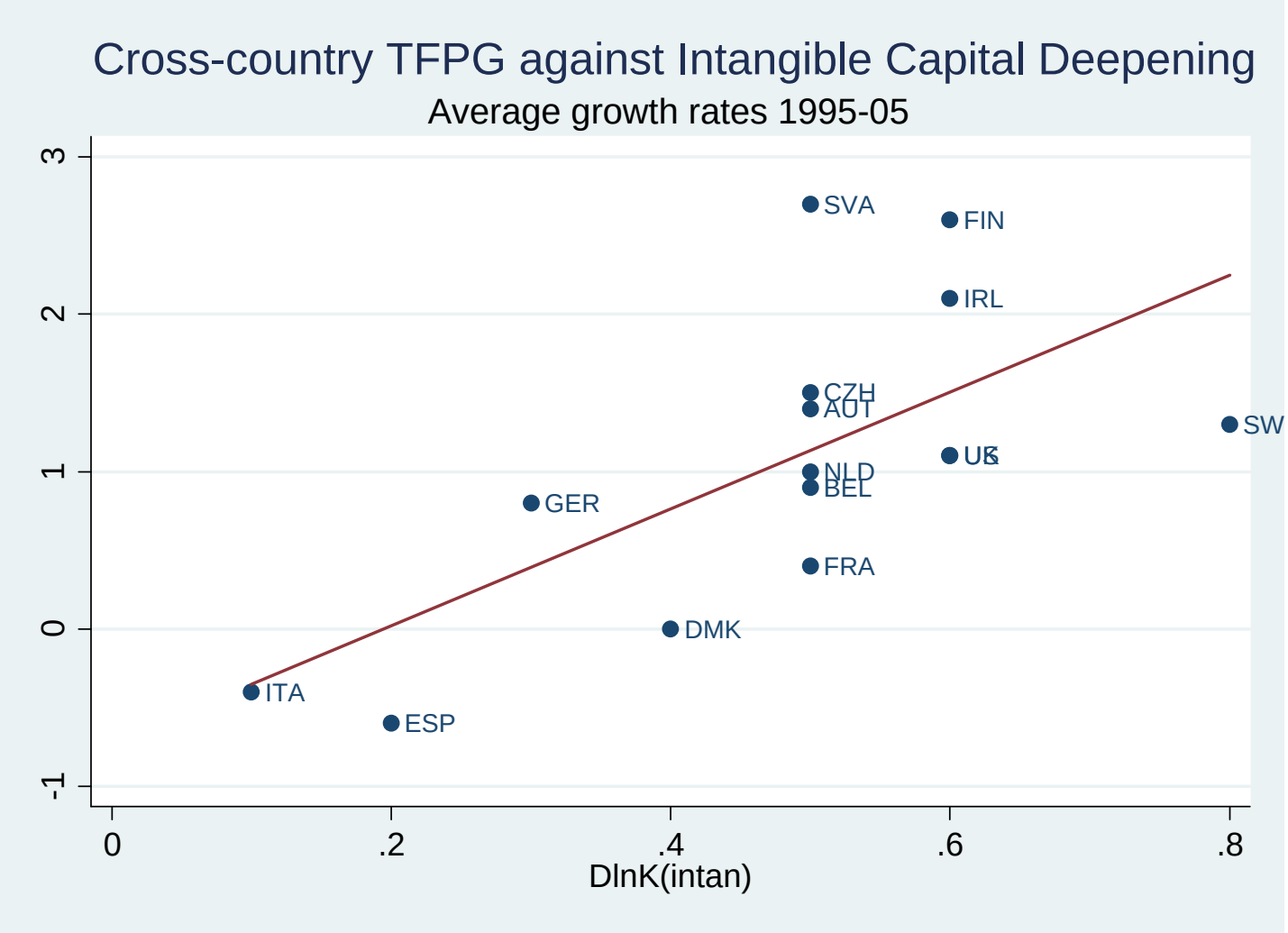
$$= \alpha \left(\frac{P_N N^{R\&D}}{P_Y Y} \right)_{it} + \varepsilon_{it}$$

- Interest here

$$\Delta \ln TFP^{A}_{it} = \alpha \Delta \ln R^{INTANG}_{it} + \varepsilon_{it} \quad country\ i$$

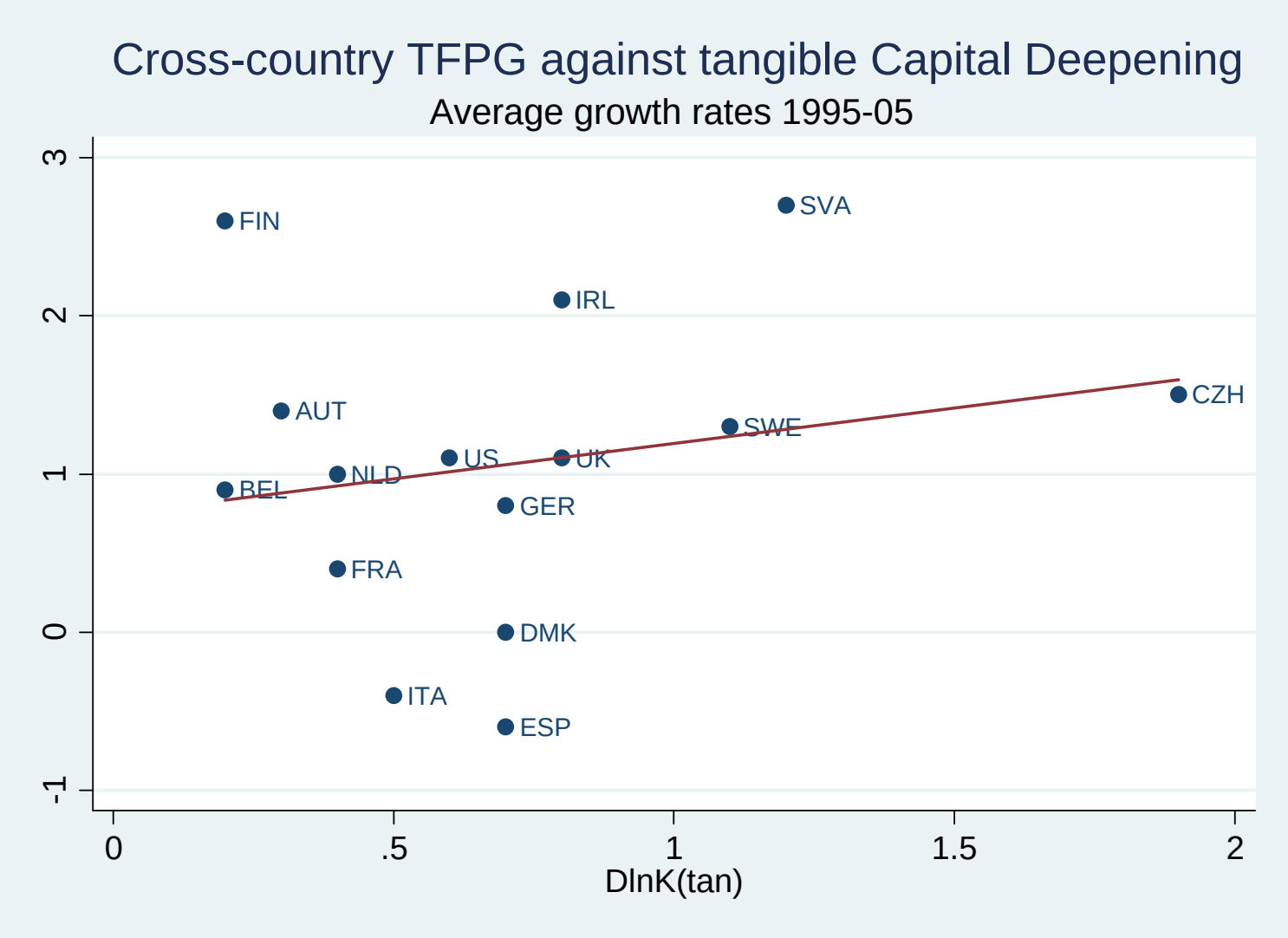
$$\Delta \ln TFP^{A}_{jt} = \alpha \sum\nolimits_{\_j} \left(w_{\_j} \Delta \ln R^{INTANG}_{\_jt} \right) + \varepsilon_{jt} \quad industry\ j$$

Evidence: cross country



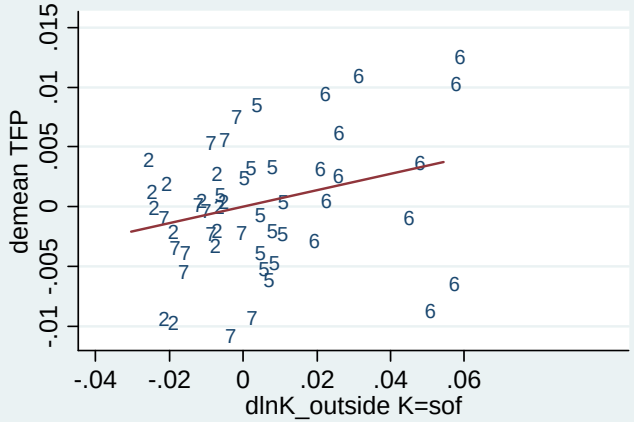
Source: Corrado, Haskel, Jona-Lasino, Iommi (2012)

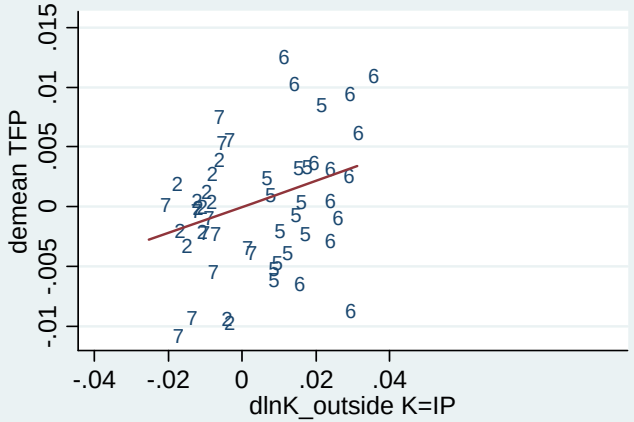
Evidence: cross country

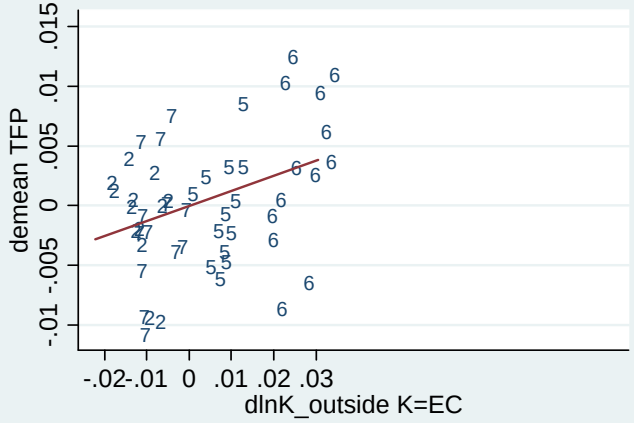


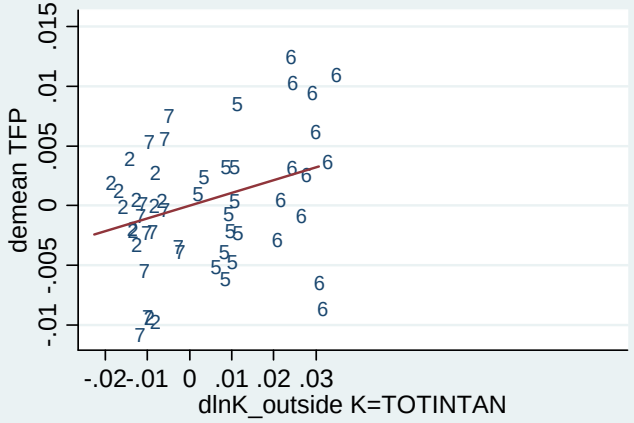
Source: Corrado, Haskel, Jona-Lasino, Iommi (2012)

Evidence: cross-industry for UK









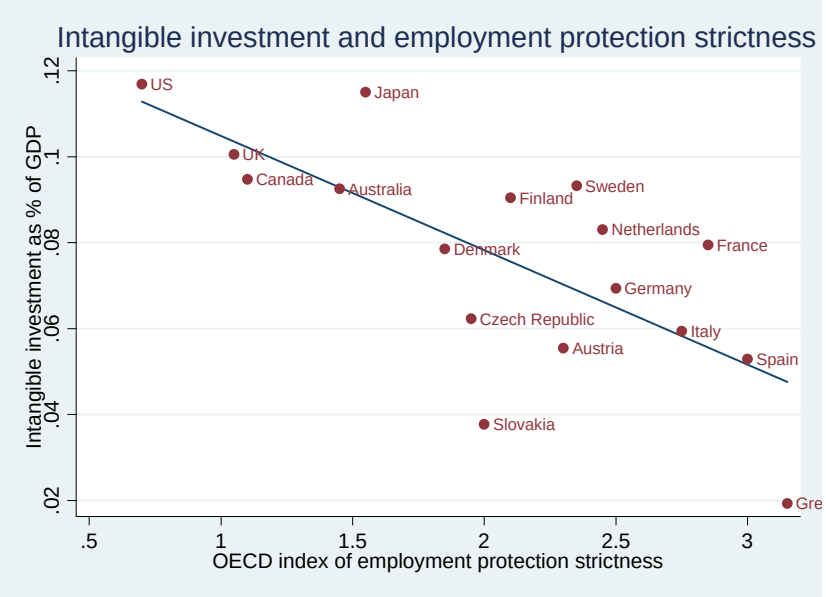
Note: Weights on "outside" industries by Input/Output intermediates. All variables deviation from industry-time means. Panels are for intang= software, innovative properties, economic competencies, total intangibles. Industries are 2= mfring, 5 = retail, 6= fin svcs, 7 = other

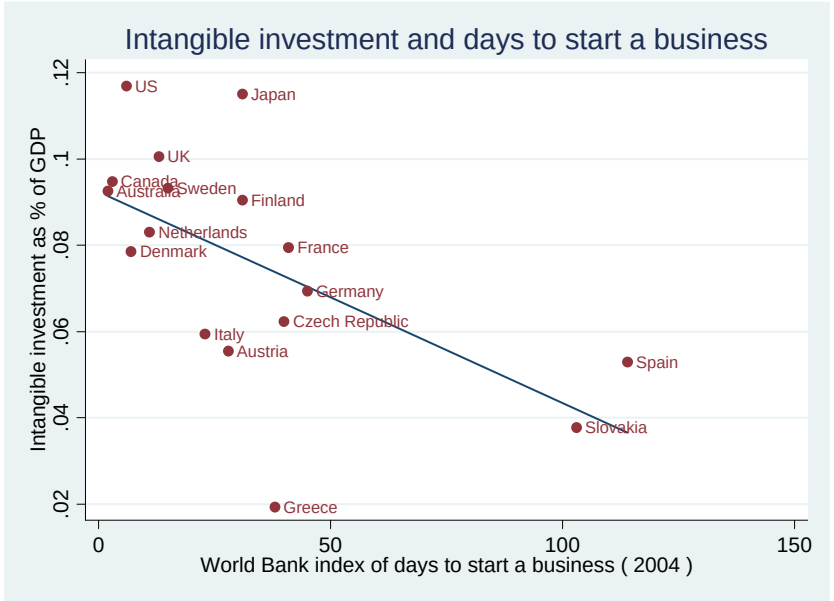
Source: Goodridge, Haskel, Wallis (2012)

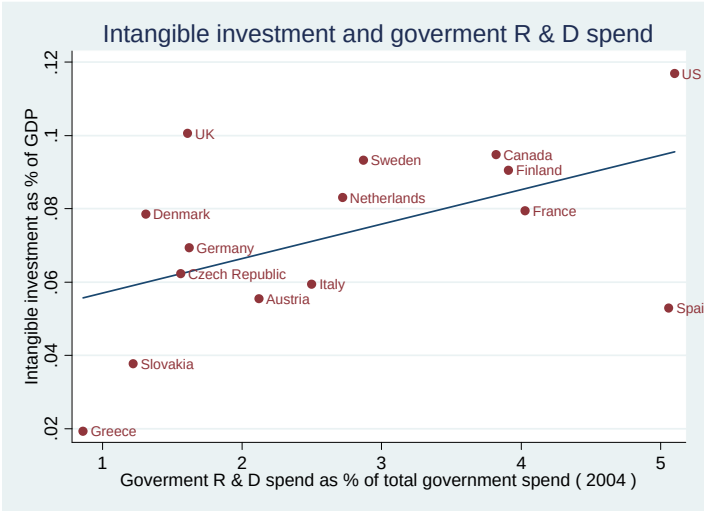
Policy

- Spillovers?
- Policy and intangible investment?

Intangible investment (as % of GDP) and employment protection, days to start a business and government R&D







Source: Haskel and Hao (2011)

Conclusions

- Have we shed light on?
  - Artistic originals: Harry Potter
  - Innovation without R&D and patents
    - Retailing
    - Financial services
  - Innovation and growth
- The “to do” list
  - Harmonize cross-country work especially software
  - Micro surveys
    - Link with R&D. Reshape innovation questionnaires
    - Life lengths
  - Prices and output in hard-to-measure industries
    - Innovation in the innovation sector?
  - Policy
    - What are the spillovers, if any?
    - Does the EU have the right institutions for an “intangible intensive” economy
  - Links with microdata and firm-dynamics work of CAED
    - Using new UK microdata set on intangible investment. Kauffman data too.
    - Are start-ups intangible intensive?