Office for National Statistics

An Innovation Index in the UK

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Can Creativity Be Measured?
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Outline of presentation

- Motivation and background
- Previous research
  - Corrado, Hulten, Sichel (CHS) (2005, 2006)
  - Giorgio Marrano, Haskel (2006) Giorgio Marrano, Haskel, Wallis (2007)
- Latest developments
  - Design (Galindo-Rueda, Haskel, Pesole (2008))
  - Interviews with firms (Whittard et al (2009))
- Next steps

Knowledge economy and innovation

- Research questions
  - Innovation accounting:
    - How much are firms investing in knowledge/intangible assets?
  - Innovation index:
    - What is the impact of that knowledge investment on growth?
    - More precisely, our innovation index will be: the fraction of productivity growth accounted for by knowledge investment

Our key argument to measure innovation

- Assume economy is Ryanair flying from A to B
- Imagine this economy with *no* innovation: how could we get more output?
  - Lay on another plane and another crew
  - Deepening physical capital and labour = *duplication*
- Imagine this economy with innovation: how would we get more output?
  - Faster boarding, turnaround, better software, “work smarter”
  - Deepening knowledge capital = *innovation*
- Summary: innovation is:
  - Extra output over and above that from use of additional physical capital and labour
  - Or, the extra output from use of new knowledge capital
- Implications for measurement:
  - Measure growth in output (GDP), and in inputs: physical capital, knowledge capital, labour
  - *Innovation accounts* are data on knowledge investment
  - *Innovation index* is contribution of market sector knowledge investment to output growth (rest is capital investment)

Why can’t we do innovation accounting on existing data?

- National accounts mostly ignores knowledge spend
  - Most is expensed
  - Surveys not well-developed/non-existent
- Much effort into R&D
  - Measured R&D is mostly scientific R&D
  - But innovation is broader and deeper than this:
    - Upstream: design, software, R&D
    - Downstream: business organisation, marketing, training
- Our work
  - Measure this “broader” innovation
  - Impact on economy (redo National Accounts and growth record)
  - Better measure of productivity

Example of impact on national accounts - 1

ALL CURRENT OUTPUTS	**Widgits** EUR	**Knuts** EUR	**GDP(E)** EUR	**GDP(I)** EUR	**GDP(O)** EUR	Notes
Turnover	100	200				
Sales Analysis						
Sales to other firms	40	50				
Sales to final consumers	60	150	210			
Cost Analysis						
Inputs from other firms	50	40				1
Labour costs	50	160		210		
Memo: value added	50	160			210	2
Return on capital	0	0		0		3
"Own account" spending on:						1
Widgits	0	20				
Knuts	25	0				
GDP			210	210	210	

1. Widgits/Knuts used up in production of Knuts/Widgits
2. Turnover less inputs from other firms
3. Value added less Labour costs

Example of impact on national accounts - 2

WIDGITS CAPITALISED	**Widgits** EUR	**Knuts** EUR	**GDP(E)** EUR	**GDP(I)** EUR	**GDP(O)** EUR	Notes
Gross Output	100	220				1
Sales Analysis						
Sales to other firms	40	50	40			2
Sales to final consumers	60	150	210			
Cost Analysis						
Inputs from other firms	50	0				3
Labour costs	50	160		210		
Net Output	50	220			270	
Return on capital	0	60		60		
"Own account" spending on:						
Widgits	0	20	20			4
Knuts	25	0				
GDP			270	270	270	

1. Gross Output includes Own account spending on Widgets
2. Sales of Widgits = GFCF
3. Purchases of Widgits not used up in producing Knuts
4. Own account spending on Widgits = GFCF

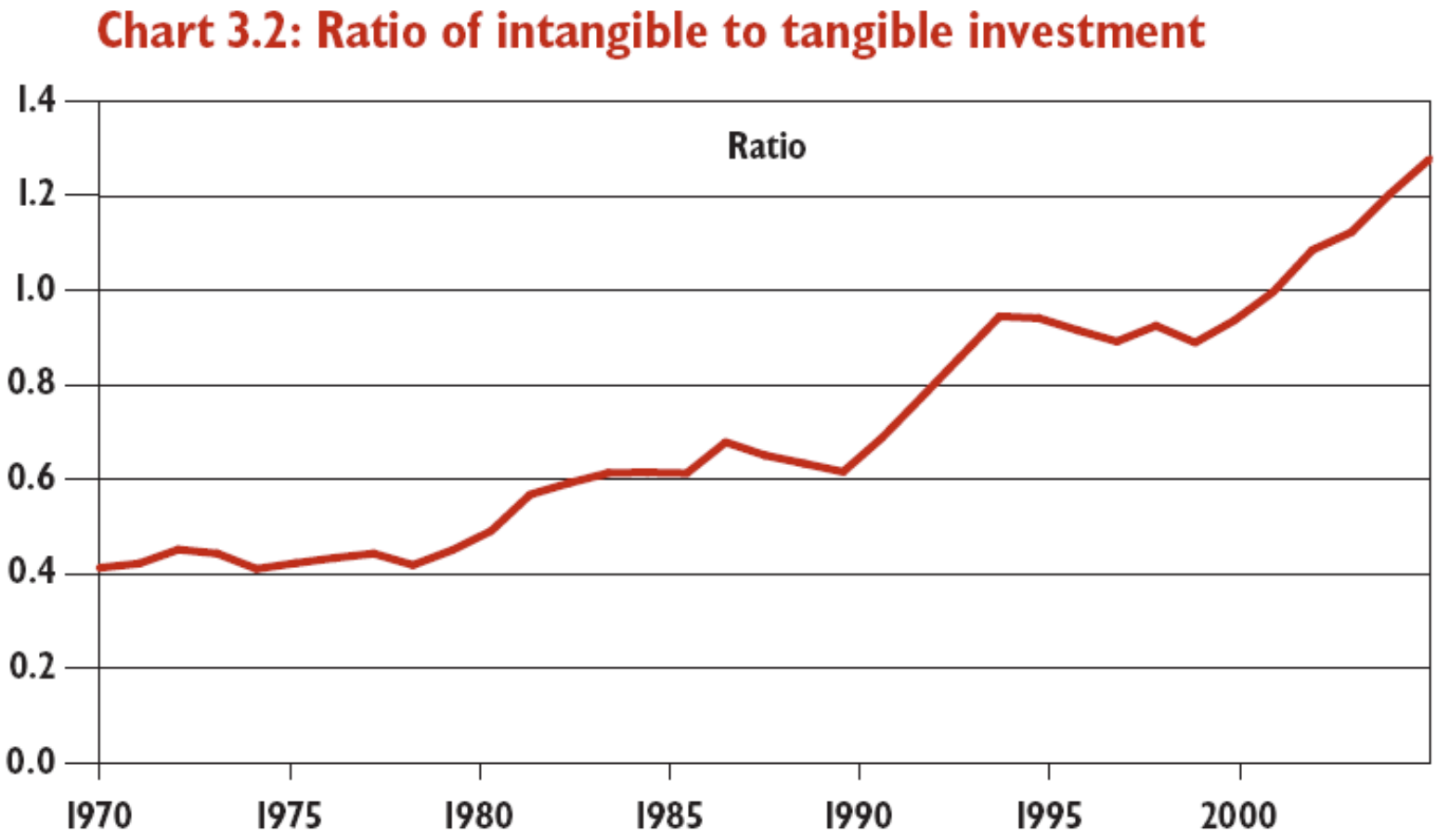
Previous research - 1

Table 3 **Expenditures on Intangibles as a % of GDP, U.S., Japan, UK and Netherlands**

	US 1998-2000	UK 2004	Japan 2000-2002	Neth'lnd 2004
1. Computerized and information	1.7	1.7	2.0	1.2
a) Software and databases: purchased		0.6	1.4	0.8
a) Software and databases: own account		1.1	0.6	0.4
2. Innovative property	4.6	3.2	3.7	2.4
a) R&D incl. social sciences and humanities	2.9	1.8	2.1	1.5
R&D in financial industry	0.8	0.7		0.0
b) Mineral exploration and evaluation	0.2	0.0	0.1	0.1
c) Other innovative property	1.5	1.4	1.6	0.9
Copyright and license costs	0.8	0.2	0.9	0.1
New architectural & engineering designs	0.7	1.2	0.7	0.7
3. Economic competencies	6.9	6.0	2.5	4.6
a) Brand equity	2.5	1.6	1.0	2.6
Advertising expenditure	2.3	1.2		2.3
Market research	0.2	0.4		0.2
b) Firm specific human capital	1.3	2.5	0.3	0.8
Direct firm expenses	0.2	1.3		0.5
Wage and salary costs of employee time	1.0	1.2		0.3
c) Organizational structure	3.1	1.9	1.2	1.2
Purchased	0.9	0.6		1.2
Own account	2.3	1.3		---
Total intangible expenditure as % of GDP	13.1	10.9		8.3
Intangible capital expenditure as % of GDP	11.7	10.1	8.3	7.5

Note: Netherlands excludes own accounts expenditure on organizational structures
All countries are for business sector only (Netherlands for total economy excl. government sector) except Japan which is for total economy
Sources: Netherlands from van Rooijen-Horsten, van den Bergen and Tanriseven (2007)
U.S. from Corrado, Hulten and Sichel (2005), UK from Haskel and Marrano (2007)
Japan from Fukao, Hamagata, Miyagawa, and Tonogi (2007)

Previous research - 2



Source: HMT Working Paper (2007)

Previous research - 3

Table 5.1: Labour productivity growth accounting[1]

	Labour productivity growth	Capital deepening	Human capital deepening	Total factor productivity growth
Excluding software				
1990-1995	2.93	1.40	0.83	0.70
1995-2000	2.72	1.82	0.44	0.46
2000-2004	2.53	1.18	0.29	1.07
Including software				
1990-1995	3.01	1.55	0.81	0.65
1995-2000	2.91	2.00	0.43	0.48
2000-2004	2.64	1.35	0.28	1.00
Including all intangibles				
1990-1995	3.09	1.90	0.73	0.46
1995-2000	3.23	2.27	0.38	0.57
2000-2004	2.61	1.71	0.25	0.65

[1] *All data are average percentage growth rates per annum.*

Source: HMT Working Paper (2007)

Latest developments - Design

- Galindo-Rueda, Haskel, Pesole (2008).
- Detailed application of CHS methodology to architectural and engineering design in the UK.
- Key conclusions:
  - In 2004 private sector spending on purchased design services was around £17bn.
  - Spending on own account design services was about £27bn
  - Investment in design is around half these totals
  - The manufacturing sector accounts for about 50% of total design spending.

Pilot interviews

- **The purposes of this study were:**
  - To gather answers on R&D asset lives
  - To gather answers on the characteristics and asset lives of other intangible investments
  - To test the feasibility of the study

- **Voluntary survey:**
  - Pilot phase one — 10 Interviews (9 face to face & 1 telephone)
  - Phase two — 30 telephone interviews

- **Feasibility study vs. Data collection objectives**

- **Input from:**
  - National Endowment for Science, Technology and the Arts (NESTA)
  - Organisation for Economic Co-operation and Development (OECD)
  - New Economy Measurement (ONS)
  - Economic Methods (ONS)
  - Surveys and Administrative Sources (ONS)
  - Survey Methodology and Quality (ONS)

Characteristics of firms interviewed

Size of firm: Employment

“High-tech” mean:	820
“Low-tech” mean:	566
“All firms” mean:	707
Sample minimum:	< 20
Sample maximum:	> 6,000

Response rates (ability to provide data)

	Part A	Part B
R&D manager	86%	59%
Finance manager	88%	88%
Director	70%	100%

Method of interview

Face to face	9
Telephone	31

‘Technical’ R&D spend

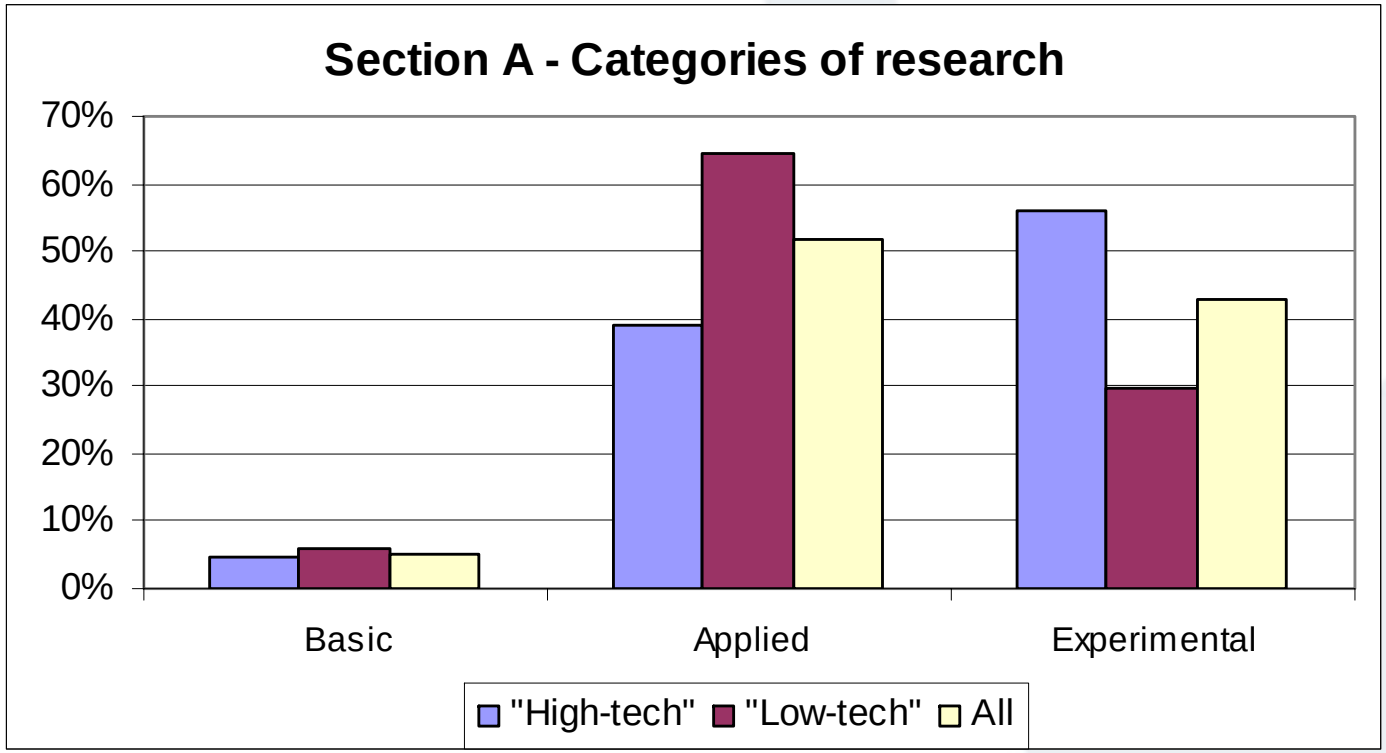
“High-tech” mean:	£15.7mil
“Low-tech” mean:	£950k
“All firms” mean:	£11.4mil
Sample minimum:	< £50k
Sample maximum:	> £200mil

“Non-technical R&D” spend

“High-tech” mean:	£45.1mil
“Low-tech” mean:	£1.7mil
“All firms” mean:	£22.5mil
Sample minimum:	< £10k
Sample maximum:	> £400mil

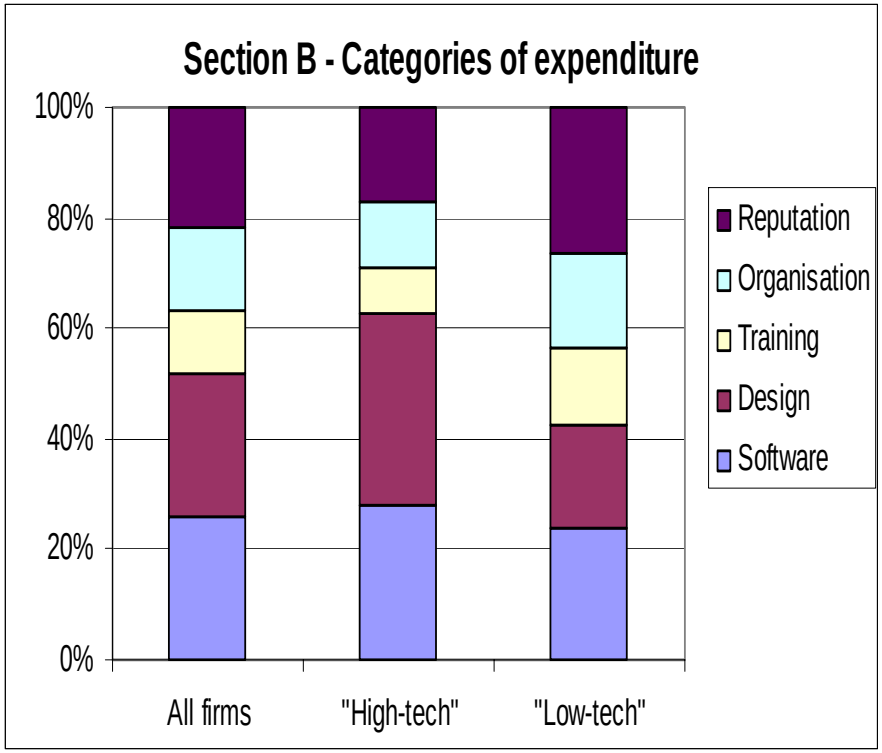
*All averages reported are un-weighted unless stated otherwise

Categories of technical research



- All sectors spend the smallest proportion of their R&D spend on “Basic” research
- High-tech sectors spend proportionately most on “Experimental development”
- Low tech sectors spend proportionately most on “Applied research”

Categories of intangible spending



Non-technical (R&D) –
Spending to support the commercialisation of new knowledge in your business, or spending to develop new business processes or organisation

- **Level of activity**
- **Ability to answer with tangible units**
- **Correct interpretation of activities**

"Some of these activities are answered at group level; I can only speak for this plant."

"The company does these activities but I cannot give you figures here. No one person would know about all of these."

"Some of these activities are very hard to physically measure in terms of pounds and pence."

Technical R&D project life-lengths

	Development (years)	Transition (years)	Use (years)	Total (years)
"High-tech"	2.3	1.0	9.9	**13.1**
"Low-tech"	1.5	0.9	6.0	**8.4**
Mean	**2.0**	**1.0**	**8.6**	**11.5**

	Projects
Shorter	16
Typical	42
Longer	9
Total	**67**

- ‘Use’ is often interpreted as an anticipated period
- One year “high-tech” development yields **4.3** years use
- One year “low-tech” development yields **4.0** years use

	Development (years)	Transition (years)	Use (years)	Total (years)
Manufacturing – Chemical & Pharmaceutical	4.2	0.9	12.3	**17.4**
Manufacturing – Electrical & Communication	1.1	0.9	5.6	**7.6**
Manufacturing – Other High Tech	2.0	1.1	9.8	**12.8**
Manufacturing – Other Low Tech	1.3	0.9	6.0	**8.2**
Services	1.1	0.7	4.7	**6.5**

Intangible project-lengths

	Development (years)	Transition (years)	Use (years)	Total (years)
“High-tech”	0.7	0.7	5.1	**6.5**
“Low-tech”	0.6	0.3	5.0	**5.9**
Mean	**0.6**	**0.5**	**5.0**	**6.2**

	Development (years)	Transition (years)	Use (years)	Total (years)
Manufacturing – Chemical & Pharmaceutical	0.2	0.2	7.5	**7.9**
Manufacturing – Electrical & communication	0.8	0.6	6.8	**8.3**
Manufacturing – Other high tech	0.7	0.8	4.2	**5.7**
Manufacturing – Other low tech	0.6	0.4	6.3	**7.3**
Services – Finance & Business	0.7	0.6	3.2	**4.5**
Services – Other	0.5	0.2	4.1	**4.8**

- 53 projects reported
- One year “high-tech” development yields **7.3** years use
- One year “low-tech” development yields **8.3** years use

Next Steps

- Measuring innovation needs data on:
  - Occupations involved in “knowledge asset building” activities;
  - Time spent by those occupations, and related non-labour costs;
  - Link between spending on knowledge and investment;
  - Life lengths of knowledge investment.
- Two main routes:
  - Roll out pilot questionnaire to several thousand firms;
  - Hold expert group meetings with key stakeholders to develop methodology and test assumptions:
    - Design
    - Organizational Capital
    - Human Capital.

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Knowledge Assets

Intangible investment type	Includes the following intangibles
Computerised information	(1) Computer software
	(2) Computer databases
Innovative property	(1) Scientific R&D
	(2) Mineral exploration
	(3) Copyright and license costs
	(4) New product development costs in the financial industry
	(5) New architectural and engineering designs
	(6) R&D in social science and humanities
Economic competencies	(1) Brand Equity
	(2) Firm-specific human capital
	(3) Organisational structure