

COINVEST

www.coinvest.org.uk



Intangible investment, innovation and growth: industry level results for the UK Market Sector

Tony Clayton, Mariela Dal Borgo, Jonathan Haskel

j.haskel@ic.ac.uk

www.ceriba.org.uk

FP7 Mannheim, November 2008



UK agenda

- Slowing prod growth
- Better measures of innovation
 - CIS very volatile
 - Not integrated with rest of economic data

Growth and innovation accounting, outline

- 1. Data on invest in intang assets by industry
- 2. Deflate and build real intang asset stocks
- 3. Recalculate GDP and factor shares to include intang
- 4. Build Hall/Jorgenson capital services to add assets together
- 5. Build labour quality adjustment
- 6. Calculate LPG, capital and labour deepening, TFPG
 - By industry
 - Accounting for whole econ building up from industries
- 7. Innovation
 - Innov accounting is spending on intang assets
 - Index is share-weighted knowledge capital growth plus TFPG

Industry framework

Capital and labour aggregation

$$\Delta \ln K = \sum_k \bar{w}_k \Delta \ln K_k, \quad \text{capital type } k$$

$$\Delta \ln L = \sum_l \bar{w}_l \Delta \ln L_l, \quad \text{labour type } l$$

$$\bar{w}_k = P_{K,k} K_k / \sum_k (P_{K,k} K_k), \bar{w}_l = P_{L,l} K_l / \sum_l P_{L,l} K_l, K_j = \sum_k K_{k,j} \forall k, L_j = \sum_l L_{l,j} \forall l,$$

$$\bar{w}_t = 0.5(w_t + w_{t-1})$$

Industry relationships

$$v_{T,j} = \Delta \ln Y_j - \bar{v}_{K,j} \Delta \ln K_j - \bar{v}_{L,j} \Delta \ln L_j - \bar{v}_{X,j} \Delta \ln X_j$$

$$\Delta \ln Y_j = \bar{v}_{V,j} \Delta \ln V_j + \bar{v}_{X,j} \Delta \ln X_j$$

Definition of econ-wide TFPG and econ-wide real value added

$$v_T \equiv \Delta \ln V - \bar{v}_K \Delta \ln K - \bar{v}_L \Delta \ln L$$

$$\Delta \ln V \equiv \sum_j \bar{w}_j \Delta \ln V_j, \quad w_j = P_{V,j} V_j / \sum_j (P_{V,j} V_j), \quad \bar{w}_j = 0.5(w_{j,t} + w_{j,t-1})$$

Agg and ind TFPG

$$\begin{aligned} v_T &= \sum_j \frac{\bar{w}_j}{\bar{v}_{V,j}} v_{T,j} && \text{Domar agg} \\ &+ \left(\sum_j \bar{w}_j \frac{\bar{v}_{K,j}}{\bar{v}_{V,j}} \Delta \ln K_j - \bar{w}_K \Delta \ln K \right) && \text{reall_K} \\ &+ \left(\sum_j \bar{w}_j \frac{\bar{v}_{L,j}}{\bar{v}_{V,j}} \Delta \ln L_j - \bar{w}_L \Delta \ln L \right) && \text{reall_L} \end{aligned}$$

A. Computerized information

	Method and data sources
Computerized information	
Computer software	Purchased: via surveys. Own account: labour force data on software professionals. Source: National Accounts
Computerized databases	Included

B. Scientific and creative property

Innovative property	
Scientific R&D	Current expenditure on R&D from BERD. R&D in computer industry subtracted
Mineral exploration	Mainly R&D in mining and spending on mineral exploration. National Accounts
Copyright and license costs	Spending on creation of originals e.g. TV, movies, books. National Accounts
<i>Other product development, design and research</i>	
New product development costs in the financial industry	20% of all intermediate purchase by Financial Services industry, ONS data. Intermediate purchases reduced by purchases of adv, software, consulting and design.
New architectural and engineering designs	Sales of architecture and design industry SIC 742, ABI data. Own account using labour costs data.
R&D in social science and humanities	No broad statistical information. Estimated as twice industry revenues of social science and humanities R&D industry

C. Economic competencies

<i>Brand equity</i>	
Advertising expenditure	Total spending on advertising as reported by Advertising Association, less expenditure on classified ads
Market research	Twice revenues of the market and consumer research industry as reported in ABI.
<i>Firm-specific human capital</i>	NESS05, survey of employer provided training. Includes: A) Direct firm expenses (in-house trainers, outside trainers, tuition reimbursement, and outside training funds) B) Wage and salary costs of employee time in training.
<i>Organizational structure</i>	
Purchased	Data on revenues of management consulting industry from Management Consulting Association.
Own account	No broad statistical information. Estimated as 20% of value of executive time using ASHE data on wages in executive occupations, excluding software occupations.

Industries

TABLE 1

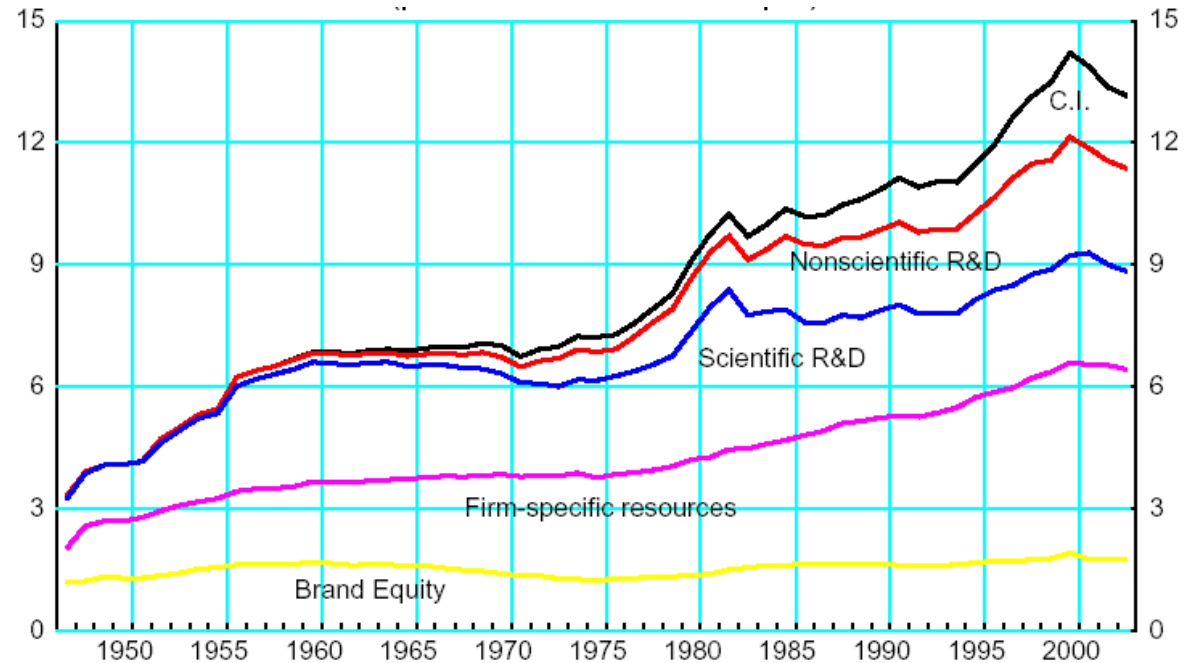
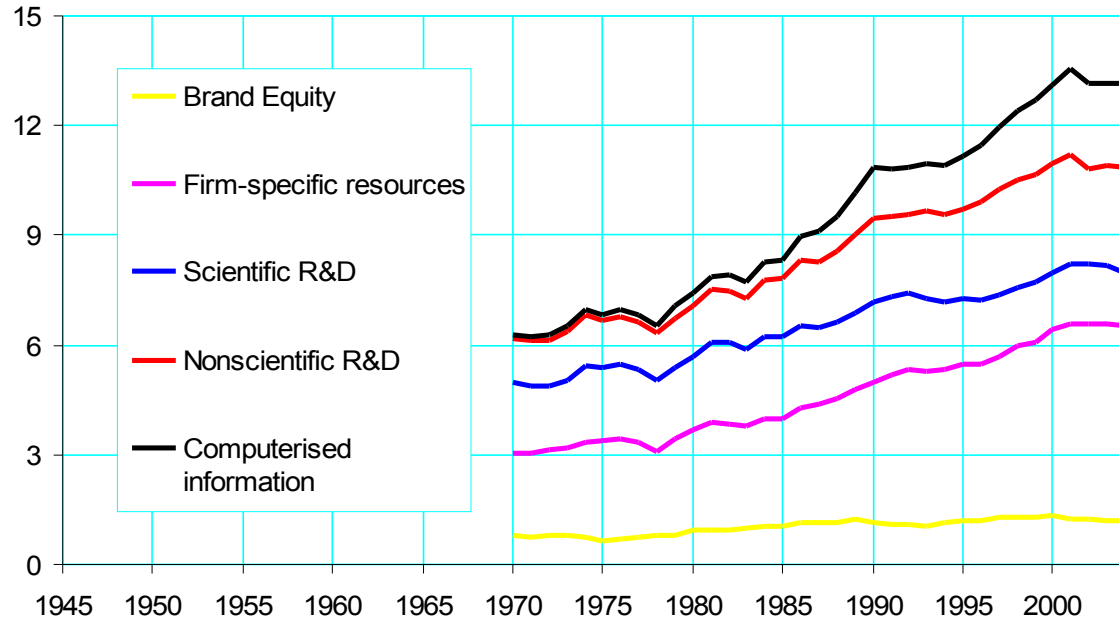
Assignment of SIC codes and NACE1 sections to our 6 industries

	Proposed sector categories	SIC code	NACE1 sections
1	Agriculture, Fishing and Mining	1 - 14	A Agriculture, hunting and forestry B Fishing C Mining and quarrying
2	Manufacturing	15 - 37	D Total manufacturing
3	Electricity, Gas and Water Supply	40 - 41	E Electricity, gas and water supply
4	Construction	45	F Construction
5	Wholesale and Retail Trade, Hotels and Restaurants, Transport and Communications	50 - 64	G Wholesale and retail trade H Hotels and restaurants I Transport and storage and communication
6	Financial Intermediation and Business Services	65 - 74	J Financial intermediation K Real estate, renting and business activities

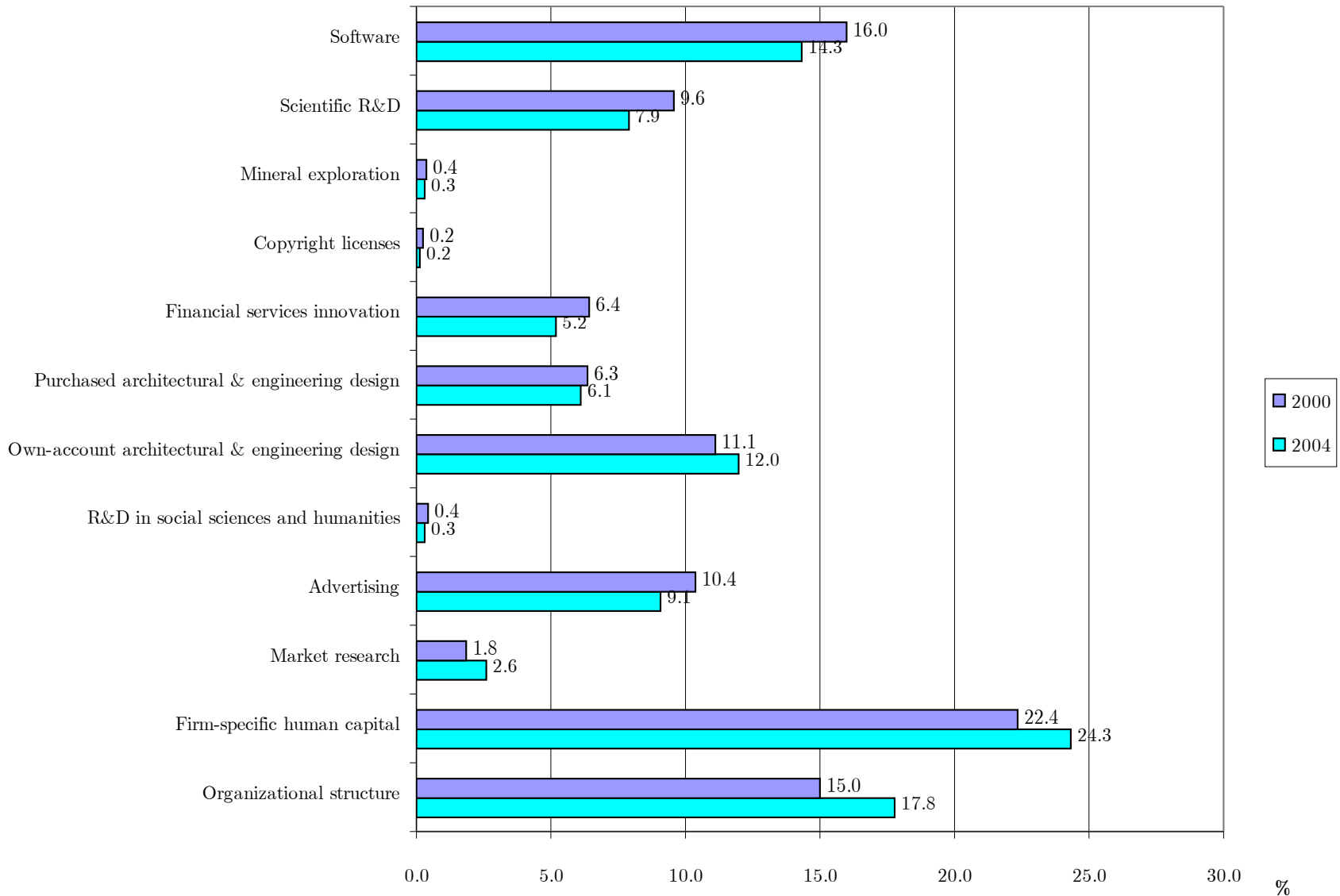
Summary of results

- Innovation accounting
 - 1997: Tang invest = £81bn, knwlg invest = £76bn
 - 2005: Tang invest = £96bn, knwlg invest = £117bn
 - *Of which* R&D = 7%, software = 14%, training = 25%
- Innovation index
 - 2000-05 mkt sector lab prod. growth= 2.74 pppa,
 - Contrib of knowledge capital= 1.24 pppa.
 - Contrib of mfring knowledge capital = 0.75pppa

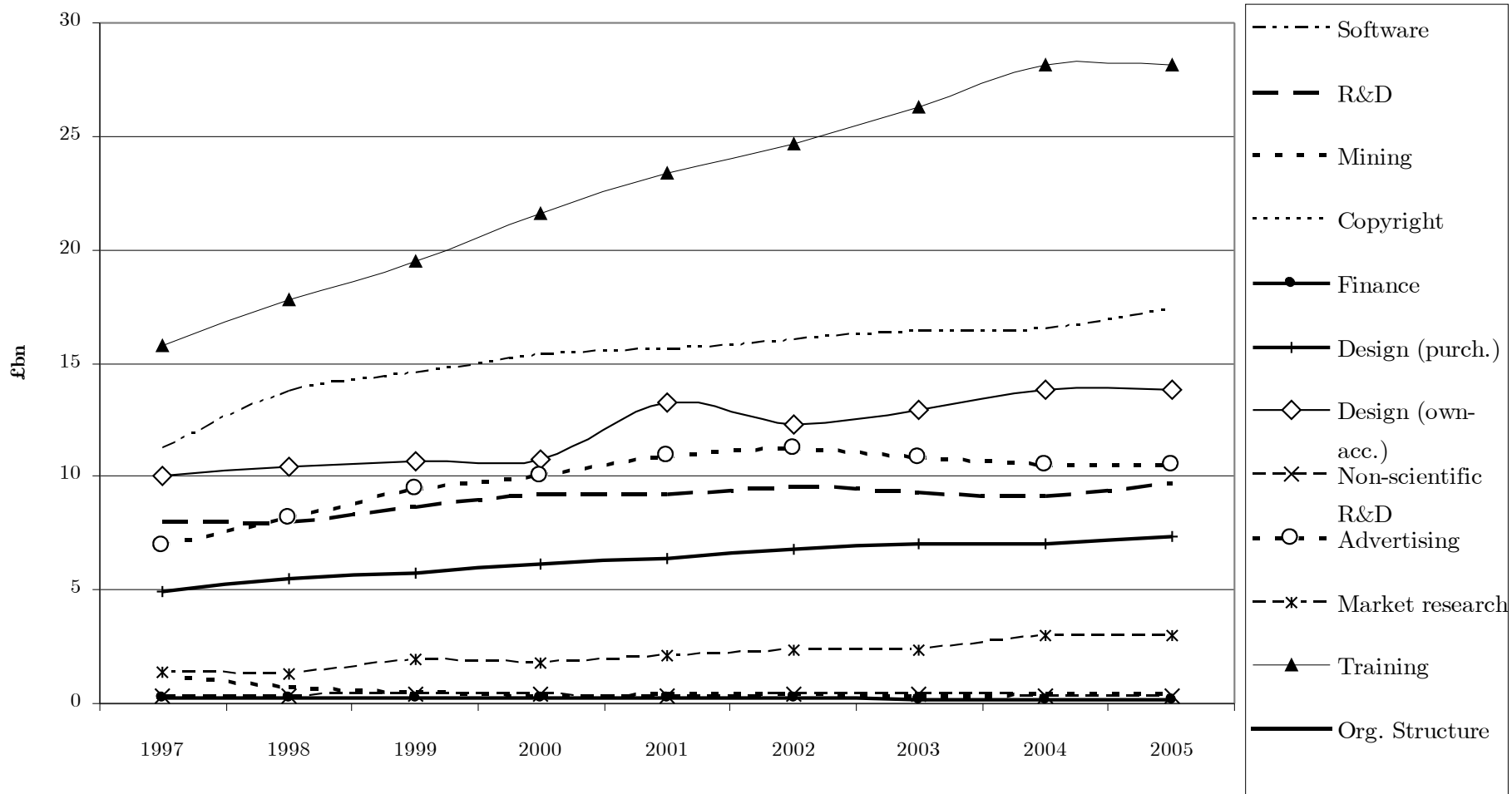
Intangible investment by asset type, % of MGVA



Intan investment by type (% total)



Mkt sector intang invest, by asset type

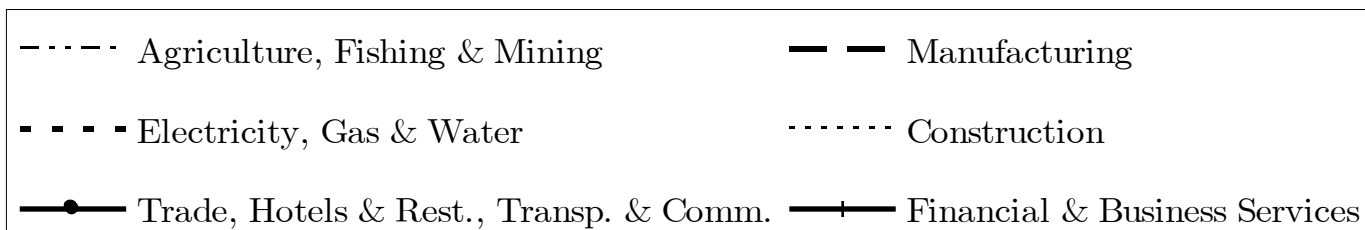
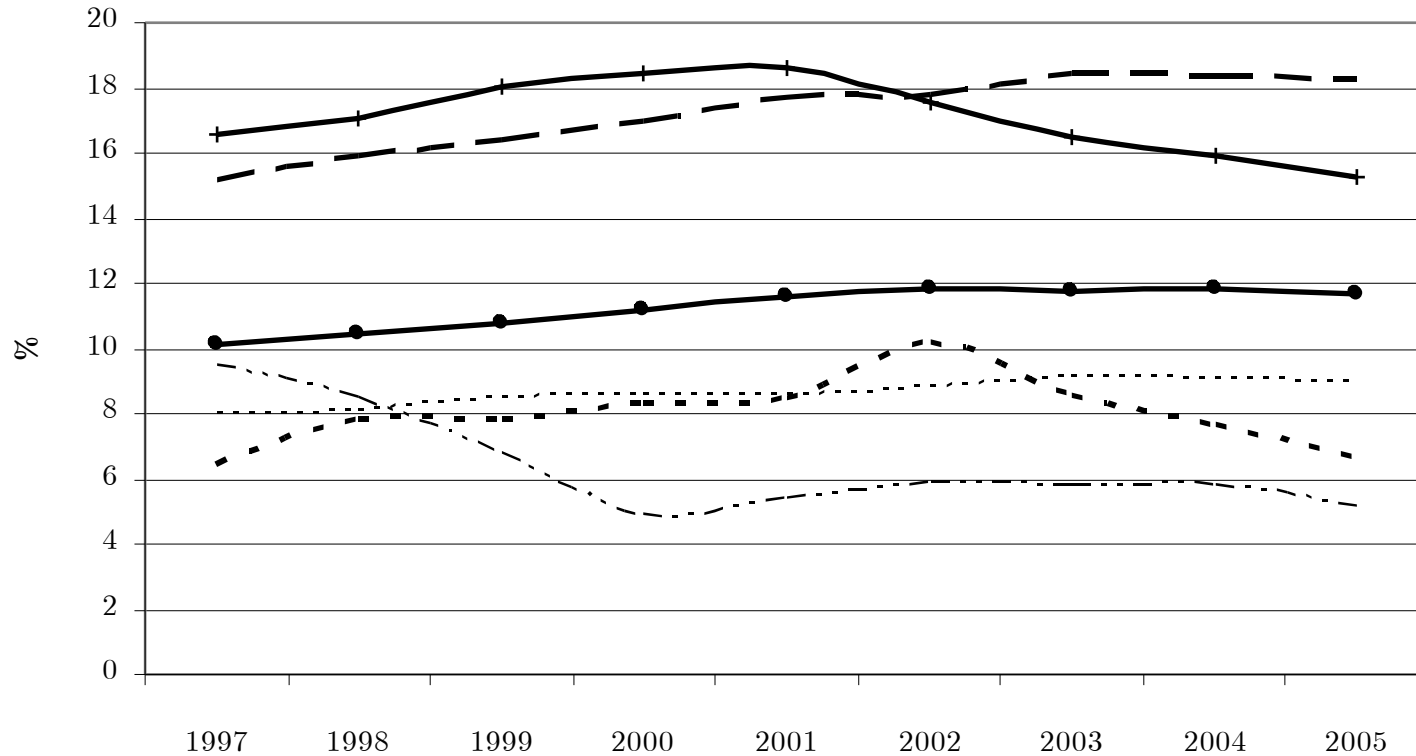


Tan and intang invest by ind

Total tangible and intangible investment by industry, 1997-2005 (£bn).

	Agriculture, Fisihing & Mining		Manufacturing		Electricity, Gas & Water		Construction		Trade, Hotels & Rest., Transport & Comm.		Financial & Business Services		Total Market Sector	
	Tangibles	Intangibles	Tangibles	Intangibles	Tangibles	Intangibles	Tangibles	Intangibles	Tangibles	Intangibles	Tangibles	Intangibles	Tangibles	Intangibles
1997	7.2	2.5	19.8	26.1	5.3	1.1	1.9	3.2	30.8	17.6	16.1	25.1	81.0	75.6
2005	6.5	1.8	13.0	31.4	5.4	1.5	2.5	6.4	37.0	31.2	31.9	45.0	96.3	117.3

Intan investment by ind (% indVA)



Decomposition of ALP

	Excluding Software	Including All Intangibles
	Growth Rates	
Aggregate Value-Added	2.81	2.80
Average labour productivity	2.74	2.74
Hours	0.08	0.07
	Contributions	
Average labour productivity	2.74	2.74
Capital Deepening	1.15	2.23
ICT Tangible Capital Deepening	0.52	0.47
Non-ICT Tangible Capital Deepening	0.63	0.58
Intangible Capital Deepening	-	1.19
Labour Quality	0.52	0.45
Aggregate TFP	1.07	0.05

Innovation index

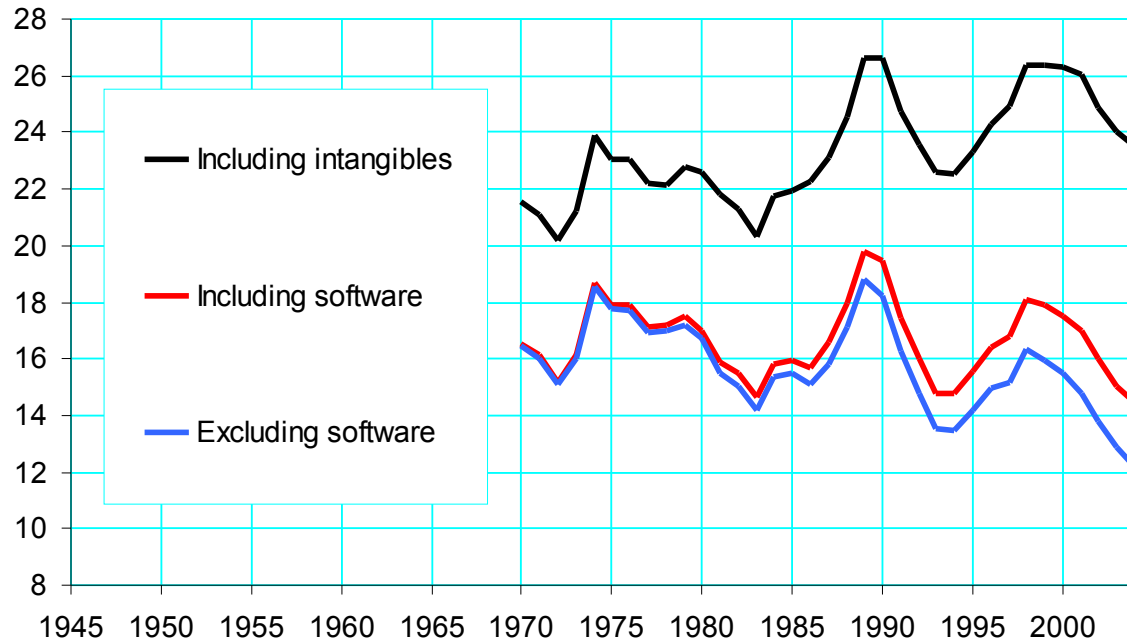
	Contribution of Intangible Capital Deepening	Contribution of Aggregate TFP	Total
All industries	1.19	0.05	1.24
1 Agriculture, Fishing and Mining	0.01	-0.19	-0.18
2 Manufacturing	0.54	0.18	0.72
3 Electricity, Gas and Water Supply	0.02	-0.02	0.00
4 Construction	0.08	-0.02	0.06
5 Trade, Hotels & Rest., Transport & Comm.	0.29	0.18	0.47
6 Financial Intermediation and Business Services	0.25	-0.08	0.17
<i>% of column totals</i>			
1 <i>Agriculture, Fishing and Mining</i>	<i>1%</i>		<i>-15%</i>
2 <i>Manufacturing</i>	<i>45%</i>		<i>58%</i>
3 <i>Electricity, Gas and Water Supply</i>	<i>2%</i>		<i>0%</i>
4 <i>Construction</i>	<i>7%</i>		<i>5%</i>
5 <i>Trade, Hotels & Rest., Transport & Comm.</i>	<i>24%</i>		<i>38%</i>
6 <i>Financial Intermediation and Business Services</i>	<i>21%</i>		<i>14%</i>
6 Total	100%		100%

Extra slides

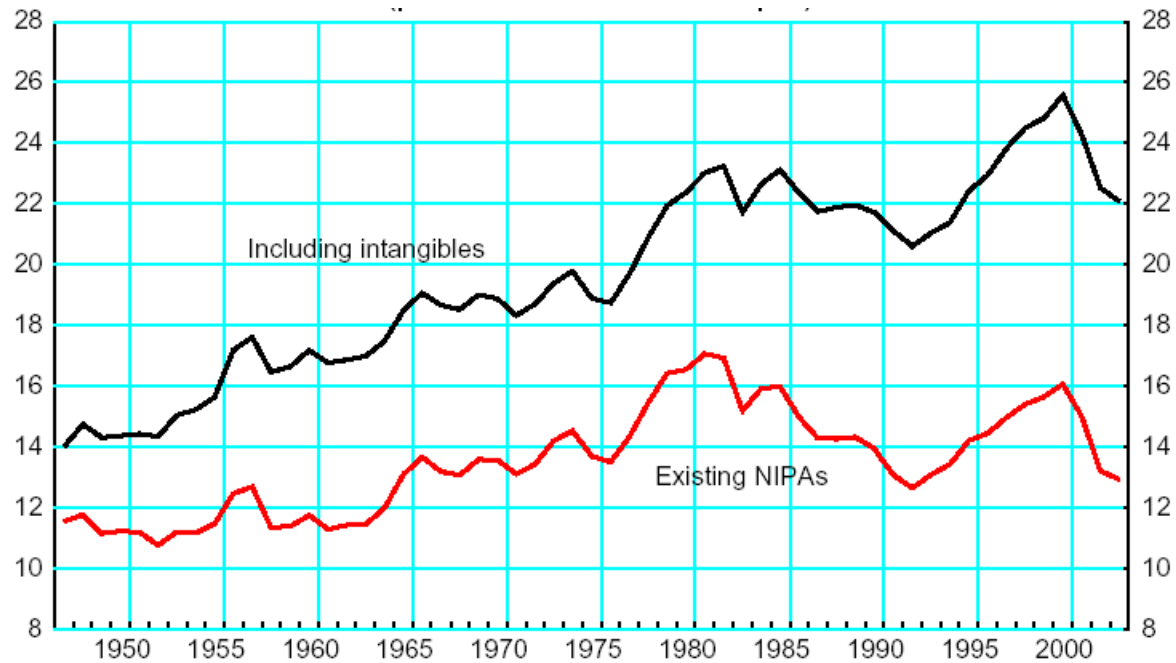
GHW Results for 2004

Innov spend category	Measurement	Amount 2004, £bn	% tot intan invest
<i>Intangible goods</i>			
Software	ONS surveys	22	18%
Scientific and non-sci R&D	Sci R&D:ONS surveys. Non-sci R&D, guesstimate	18	15%
Patents, copyrights, mineral exploration	ONS	3	2%
Design	Turnover of design ind	18	15%
<i>Intangible competencies</i>			
Product reputation	Adv and mkt research spending	19	8%
Human competencies	Employer-training	29	24%
Organisational competencies	Purchased: management consultancy. Own-account: 20% of value of management time	22	18%
Total		130.7	100%

Invest share of MGVA

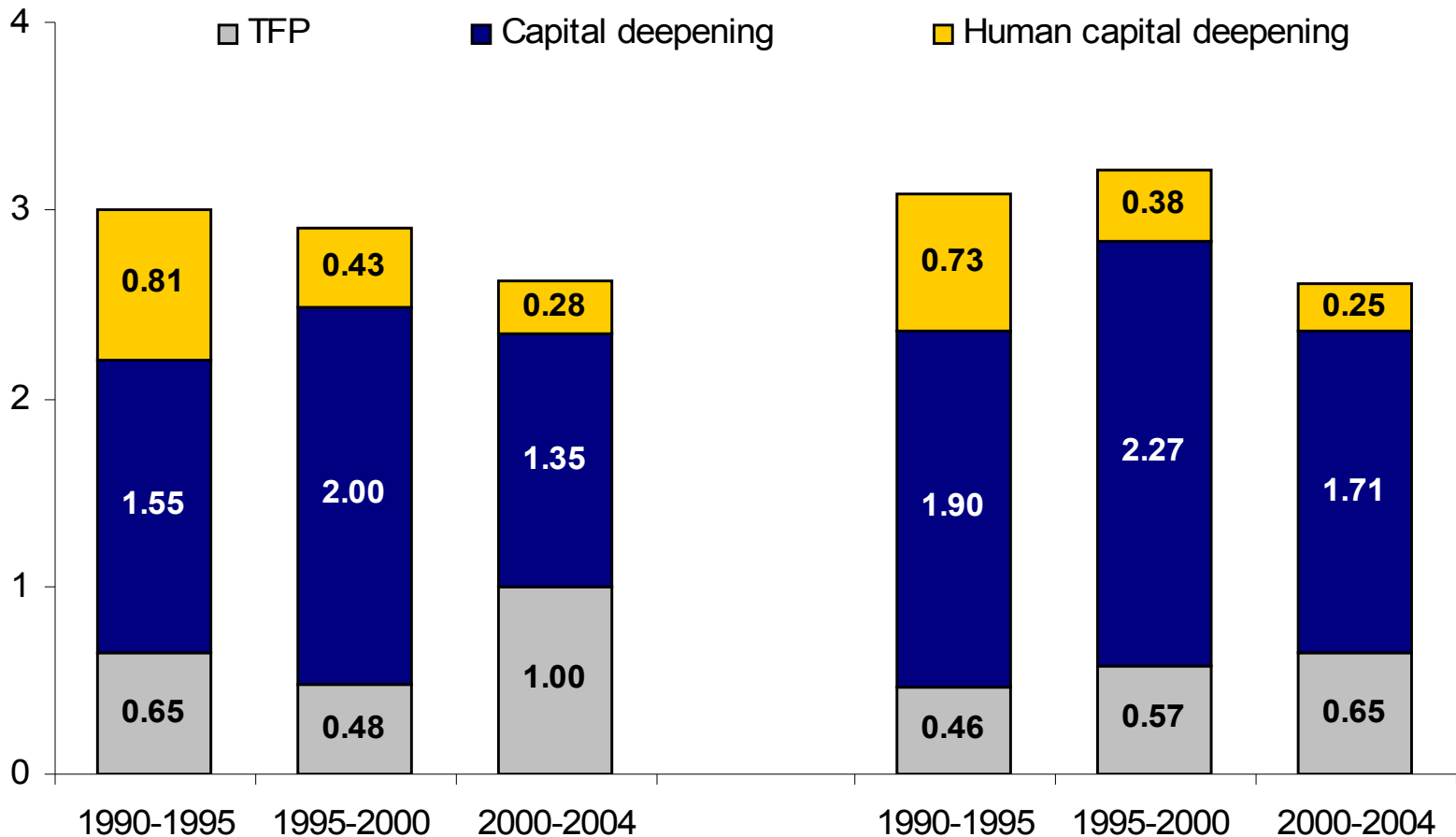


UK



US

LPG and TFPG



**Existing National
Accounts**

**Including all
intangibles**

Spares

Future work: extended

Intangible investment type	Includes the following intangibles	Status
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	X
	(5) New architectural and engineering designs	Part
	(6) R&D in social science and humanities	√
Economic competencies	(1) Brand Equity	Part
	(2) Firm-specific human capital	Part
	(3) Organisational structure	X

Initial feedback from summer pilot

- ‘Extended R&D’ survey
 - Firms understand technical/non-technical innovation input
 - Important who we talk to, need more than one contact
 - ‘Boundary of firm’ issues – with MNEs
 - Some industry differences in approach
 - Hard areas
 - Own account organisational capital
 - Training – including ‘opportunity cost’

Output concepts in the National Accounts

	Firm A (Electricity provider) £	Firm B (Car producer) £
Elect	100	100
Cars		200
Output	100	200
Value added	100	100

Output with different treatment of intangibles

	Firm A (Advertising services provider) £	Firm B (Car producer) with advertising treated as intermediate consumption £	Firm B (Car producer) with part of advertising treated as investment £
Advertising	100	100	50
Cars		200	200
Output		200	200
Value added	100	100	150

Treatment of intangibles in national accounts

Category	Type of knowledge capital	Treatment in accounts
Computerized information •Computer software •Computer databases	Knowledge embedded in computer programs and computerized database	Major component, computer software, mostly expensed
Scientific and creative property •R&D •Mineral exploration •Copyright and license costs •Other product development	Knowledge acquired through scientific R&D and non-scientific inventive and creative activities	Most scientific and non-scientific R&D is expensed
Economic competencies •Brand equity •Firm-specific human capital •Organizational structure	Knowledge embedded in firm-specific human and structural resources, including brand names	No items recognised as assets of the firm

Should intangibles/knowledge assets be included in investment?

- Definition of investment:
 - Spending today to create an asset that generates income in the future
- Examples:
 - R&D: creates scientific knowledge stock, future returns
 - Software: creates computerised knowledge, future returns
 - Training: creates knowledge in workforce, future returns

Practical problems

- **Definitions:** do intangibles generate an asset for the firm?
 - Brands, yes
 - Workforce training, belongs to workers
- **Measurement of intangible expenditure**
 - Own account/purchased e.g. software
 - Valuation of intangibles e.g. brand names, organisational capital
- **How much expenditure is investment?**
 - Advertising: long term brand building versus short term publicity
- **Redefining national accounts**
 - Intangible investment is income to firms
 - So labour share of output changes

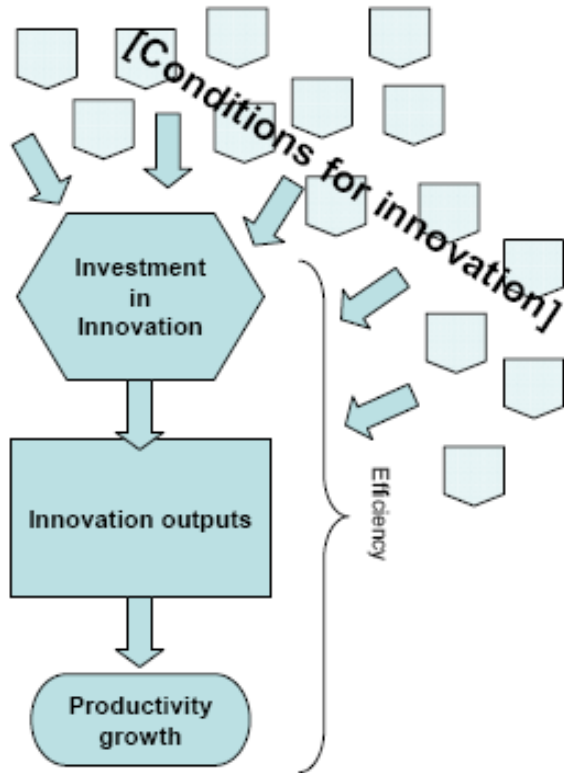
Our key argument to measure innovation

- Imagine an economy with *no* innovation
- How could we get more output?
 - Lay on another plane and another crew
 - Deepening physical capital and labour = *duplication*
- How would we get more output from innovation?
 - Faster boarding, turnaround: better software
 - 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 knowledge investment to output growth

What our measure is and is not

- Output
 - output of more goods and services.
 - Not number of inventions or ideas
 - GDP as currently measured does not fully capture this
- Inputs
 - knowledge capital
 - Needs investment e.g. R&D
 - Comes for free e.g. imitating
 - knowledge capital investment is more than just R&D
 - R&D, software, design, firm-funded training, organisational capital
 - Investment is not just purchases from the “creative inds” since in house too. So covers hidden innovation
- Inputs to outputs
 - Needs assumptions on life lengths of knowledge stock, deflators
- Relation to other innovation definitions, see paper

Intangibles and innovation



- Axioms
 - Innovation is the implementation of something new
 - It needs investment (unless pure spillover)
- Consistent framework: accounting for intangibles
 - Activity
 - Innovation needs investment in knowledge
 - Knowledge investment is more than just R&D, the creative industries, an intermediate input
 - Knowledge investment produces knowledge or “intangible” assets
 - Impact
 - Investment raises value added
 - Service flow from kn assets contributes to growth

Details of g a/c method

1. Collect nominal investment in intangibles time series
 - What investment measures?
 - Availability of data over time e.g. training
 - Measures for market sector only: some interp needed

1. Deflate to get real investment series
 - Choice of deflator. Use mkt sector deflator
 - Software and hardware:
 - Soft: purchased and own account (own a/c pro'y adjust)
 - Hardware

Method contd

1. Build real capital stock using perpetual invent method

- Starting point (1970=0)
- Depreciation rates: use CHS rates. Experiment.
- Adjustment for annual data (assumes investment comes on stream in mid-point of year)
- Assets:
 - Tang: buildings, plant, vehicles, computers
 - Intang: see below, main are software, R&D, advertising, training

Method contd

4. Re-calculate market sector GVA to include intangibles

- Adjusted Nominal GVA
 - Unadjusted nominal m.sector GVA + nominal investment
- Adjusted Real GVA growth
 - Weighted growth in real market sector GVA + weighted growth in real investment
 - Weights are shares of nominal market sector GVA and nominal investment in unadjusted market sector GVA

5. Adjust operating surplus of m.sector GVA

- Adj op surpl = adjusted GVA – m.sector labour compensation
- Mixed income: allocated prorata (note BofEng, to wages)

Method contd

6. Build Hall/Jorgenson VICS measures

- Rental rates and rate of return assume:
 - equalised rates of return across all assets
 - rental rates times stock = Π
 - Tax adjustment
- Generate VICS for each asset as share of asset in payments in Π times real asset growth rate
- Generate economy-wide VICS summing VICS for each asset

Method, contd.

7. Build quality-adjusted labour index

- BofE index adjusts hours for
 - Education
 - Gender
 - Age

8. Do growth accounting