Industry-level Expenditure on Intangible Assets in the UK*

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JEL reference: O47, E22, E01

Keywords: intangible assets, R&D, training, organisational capital, investment

October 2007
Revised, November 2008

Abstract

We present data on expenditure on intangible assets for the UK market sector for six industries over the last decade or so (data availability allowing). The sectors are (1) Agriculture, Fishing and Mining; (2) Manufacturing; (3) Electricity, Gas and Water; (4) Construction; (5) Wholesale and Retail, Hotels and Restaurants, Transport and Communications; (6) Financial Intermediation and Business Services. We use new methods relative to previous work particularly in advertising and design. Our main findings are as follows. First, overall intangible expenditure was, in 2004, around £152bn (investment was £92bn). Second, to give an illustration of the manufacturing results, in 2004 manufacturing intangible investment was £30bn and tangible £12bn and intangible, a ratio of 2.5 to 1 up from 1.2 to 1 in 1977. So whilst the ratio of manufacturing tangible investment to value added has been falling, the ratio of manufacturing intangible investment to value added has been rising, leaving the overall ratio about the same. Third, manufacturing accounted in 2004 for 12% of total tangible investment and 31% of total intangible investment.

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1. INTRODUCTION

This paper reports estimates of investments in intangibles by industry following the whole economy work in the US by Corrado, Hulten and Sichel (2002, 2004, henceforth CHS) and the UK by Giorgio Marrano, Haskel and Wallis (2007, GHW). We use mostly the same sources of data and methods followed by CHS and GHW and additionally we attempt to estimate expenditure on intangible assets at an industry level instead of at the all private sector level.

Table 1 summarises the sources and the industry split available. The first column shows the categories of intangible assets used by CHS. The second column reports the sources which are a mix of National Accounts, of official surveys and estimates from other sources. The third column shows the industry breakdown and the fourth column reports time series data availability.

The rest of this paper is as follows. The next section explains how we get a common industry split for all the intangibles, the third section gives details of the specific procedure followed for the estimation of expenditure for each intangible asset. The fourth section presents further analysis for the manufacturing sector. The fifth section concludes. The appendix discusses in more detail some conceptual points such as our foreign trade adjustment, treatment of licences etc. Finally, all data from this paper are available for download from the COINVEST website (www.coinvest.org.uk).[1]

2. THE INDUSTRY BREAKDOWN

To measure expenditure on intangibles at an industry level we return to the original data sources used to compile the whole market sector data. Some of these sources provide an industry breakdown, but industry split they use does not always relate to the official industry classification. This is because some of the surveys are not ONS officially collected data, or have been collected for purposes requiring a non-SIC division, which means they do not necessarily use the SIC classification. Based on

[1] We are very grateful to Annarosa Pesole for preparing the data and programmes in accessible form.

the existing sources, we propose a structure that combines the available sources at the lowest common possible level of aggregation.

Table 2 illustrates how the sectoral classifications for key intangible investment items relate with each other. Column 1 shows the industries corresponding to the Input/Output definitions, which is the source of the data for software (purchased and own-account). Column 2 shows the industry breakdown for the training data, from the *NESS05* (see below). These data are collected for the Learning and Skills Councils and are therefore provided at that level of industry disaggregation, which we have mapped into the SIC. Column 3 shows the industry breakdown of the R&D data, from the *BERD* Inquiry and column 4 that of the purchased organisational structure data. The latter is spending on knowledge from the *Management Consultants Association* and is quite aggregated. By pooling these sources, a common classification involving six main sectors emerges. These are depicted using different shades and summarised in Table 3.

As table 3 shows, we have six feasible categories:

1) Agriculture, Fishing and Mining
2) Manufacturing
3) Electricity, Gas and Water
4) Construction
5) Wholesale and Retail, Hotels and Restaurants, Transport and Communications
6) Financial Intermediation and Business Services

We exclude sections L (Public Administration), M (Education), N (Health), O (Personal services), P (Private Households) and Q (Extra-Territorial). These involve activities mostly outside the market sector for which we have no reliable output or other input data.

Regarding further disaggregation of manufacturing, first, a more detailed disaggregation for the manufacturing sector does exists for the categories other than organizational investment at around a two-digit level. Nevertheless, it is possible to provide a more detailed disaggregation of intangible investment in the manufacturing sector for software, R&D, training, advertising, market research, own-account expenditure on organizational structure and design.

2. ESTIMATION OF INVESTMENT BY INTANGIBLE ASSET CLASS

2.1 COMPUTERISED INFORMATION

Computerised information comprises computer software, which includes purchased and own account software development, and the value of new computerised databases.

The main source for computer software investment is the work already carried out by the ONS, described in Chamberlain, Chesson, Clayton and Farooqui (CCCF, 2006 and CCCF, 2007). Estimates of purchased software are based on data from three different company investment surveys: Business Spending on Capitalised Items (BSCI), the Capital expenditure Survey (Capex) and the Annual Business Inquiry (ABI).

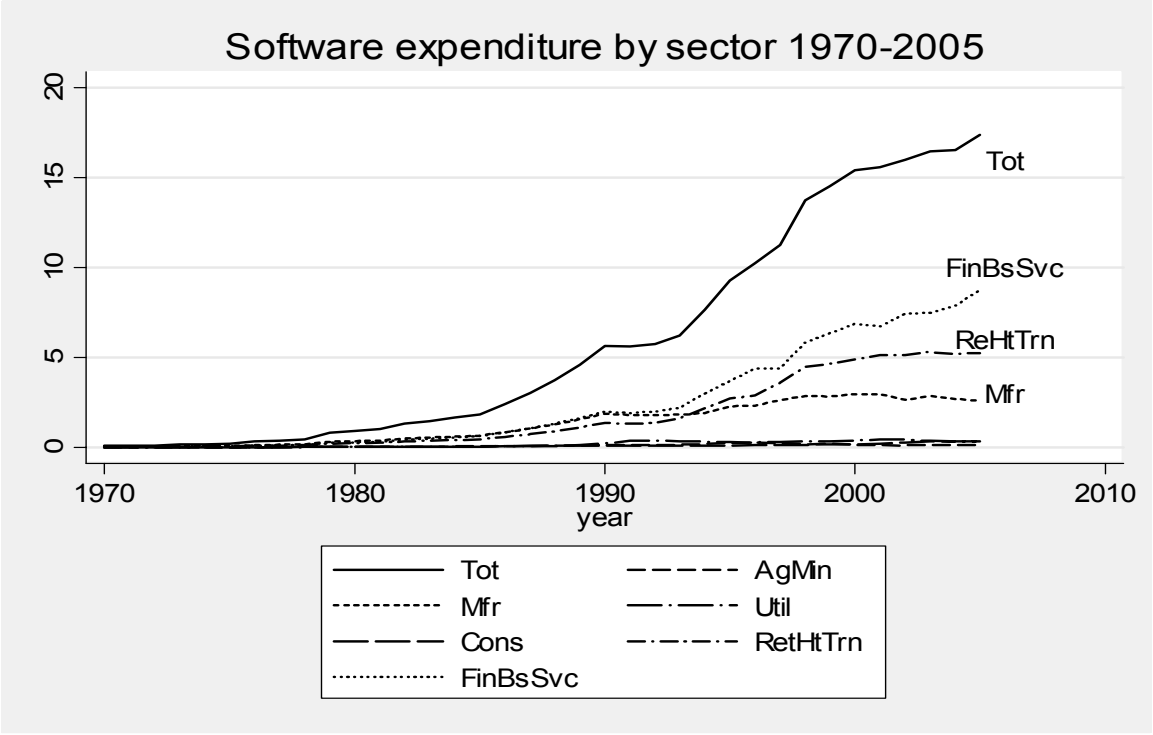
For own account spending, estimates are based on the earnings of employees in computer software occupations, using the Annual Survey of Hours and Earnings (ASHE). CCCF chose the occupations of ICT managers, IT strategy and planning professionals, software professionals, IT operations technicians, user-support technicians, database assistants/ clerks and computer engineers and installation and maintenance personnel. They estimated headcounts and wages, upwards adjusted the numbers to reflect the full employment cost and then downward adjusted them to reflect the fractions of time spent on development versus maintenance. A final adjustment is made to reflect possible sales to other firms that would imply double counting.

To avoid any double counting we do not consider any additional spending on computerised databases as the ONS software figures already factor these in - two of the three computer purchase surveys asked firms to include database spending as part

of software spending and the own account data include the wages of database assistants and clerks.

Regarding the industry breakdown of software expenditure, both own-account and purchased software time series are available at the 123 industry level. Figure 2.1 shows the total expenditure on software from 1970 to 2005. The private sector expenditure has gone up in recent years while the manufacturing expenditure growth accounts for only a small proportion of the total increase. In 2005 the manufacturing sector spent £2.6 bn on software, while the overall private sector spent £15.15 bn. The financial and business sector is responsible for almost the half of this total.

Fig 2.1



In May 2007 the ONS has revised down the estimates on software expenditure (see CCF, 2007). The previous private sector total expenditure for 2004 showed in Giorgio Marrano, Haskel, Wallis (GHW) (June 2007) was £21.59bn, the new total is £16.5bn.

In the National Accounts the total software investment is estimated to be about £19.5 billion in 2004. However this includes about £1.2 bn of public sector purchased investment and also a small amount of public sector own-account. Taking away these portions the private sector software investment is £18.16 bn. The difference between this total and our total presented above (£16.5bn) is due to the different method we used to estimate the private sector. As explained in page 3 we compute the private sector excluding sections from L to Q, therefore we are not including the private sector investment on software of these industries.

Table 4 shows the data for 2004 only, with the expenditure data for each sector and the fractions of overall software spending accounted for by sector. Spending by Financial and Business services dominates this intangible investment class at 48% of total spending, with Retail etc. accounting for 31%.

2.2. INNOVATIVE PROPERTY

2.2.1 Scientific Research & Development

Expenditure data on R&D performed by businesses in the UK are derived from the Business Enterprise R&D survey (BERD). This survey complies with the OECD international standards set out in the Frascati Manual (FM).

Although the FM definition of R&D is more general, BERD questionnaires are intended to capture R&D aiming to resolve scientific and technological problems. Items such as design, market research are explicitly excluded.

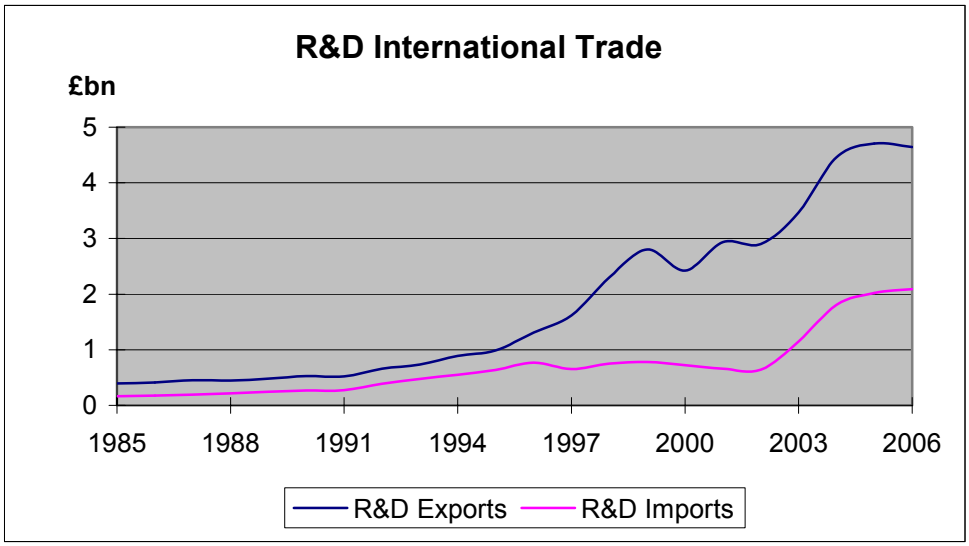
Double counting of R&D and software investment is a potential problem. Firms in the computer industry asked to report their R&D are advised as follows:
"For software development to be classified as R&D, its aim must include the resolution of scientific or technological uncertainty on a systematic basis. Routine software is not R&D. The use of software for a new application or purpose does not by itself constitute R&D; the application must be significantly different and resolves

uncertainties of general relevance. Software development within an R&D project should be classified to the product sold by your company that makes use of the software in its manufacture or within the product itself. For example work on software to be used within a motor vehicle engine would be allocated to the motor vehicle product group. Software which is developed and sold as software for direct use by customers should be allocated to product group AE (computer and services).”

We therefore decided to subtract R&D spending in the “computer and related activities” industry (SIC 72) from the R&D spending figure of the financial intermediation and business service sector (our sector 6) to avoid potential double-counting.

The BERD data exclude R&D purchased from companies abroad and include R&D undertaken for companies abroad. In order to derive a measure of UK investment we subtract R&D exports and add R&D imports, see section 4 for more details on this. In brief, first, we collect the R&D exports and imports time series from the ONS. Fig 2.2.1.a illustrates the exports and imports time series.

Fig.2.2.1.a



Second, to allocate exports and imports by sector we compute the sector-specific imports share: the Supply Table 2.1 in the Blue Book shows the imports of goods

and services by sector. We compute the ratios between the total imports of all goods and services for each sector and the total imports for all goods and services by the private sector. We then apply these ratios to both the exports and imports time series by assuming that the sector-specific export-shares are equal to the sector-specific import shares[2]. Finally, we subtracted exports and added imports to the BERD R&D industry data (for more on the reason for this, see the section below).

The industry split of R&D is provided by ONS. However, a number of points are worth making regarding the accuracy of the industry split. First, the provided industry split relates to the main product produced by enterprises rather than the activity sector of their establishments (activities are preferred in National Accounts guidance). Sector SIC73 is specifically designed to cover the delivery of R&D services and SNA93 suggests that vertically integrated companies who do R&D and final production should provide separate data for these separate activities, the former of which should be allocated to SIC73.

For example, a pharmaceutical company that undertakes substantial R&D would be asked for National Accounting purposes to allocate its R&D activity to a separate establishment belonging to the R&D sector. Its output will be intermediate consumption of the "main" establishment in the Pharmaceutical sector. BERD will record this company's R&D as corresponding to the Pharmaceutical sector because that is the main product. This example poses no misattribution problems because it is the pharmaceutical sector that genuinely undertakes the investment.

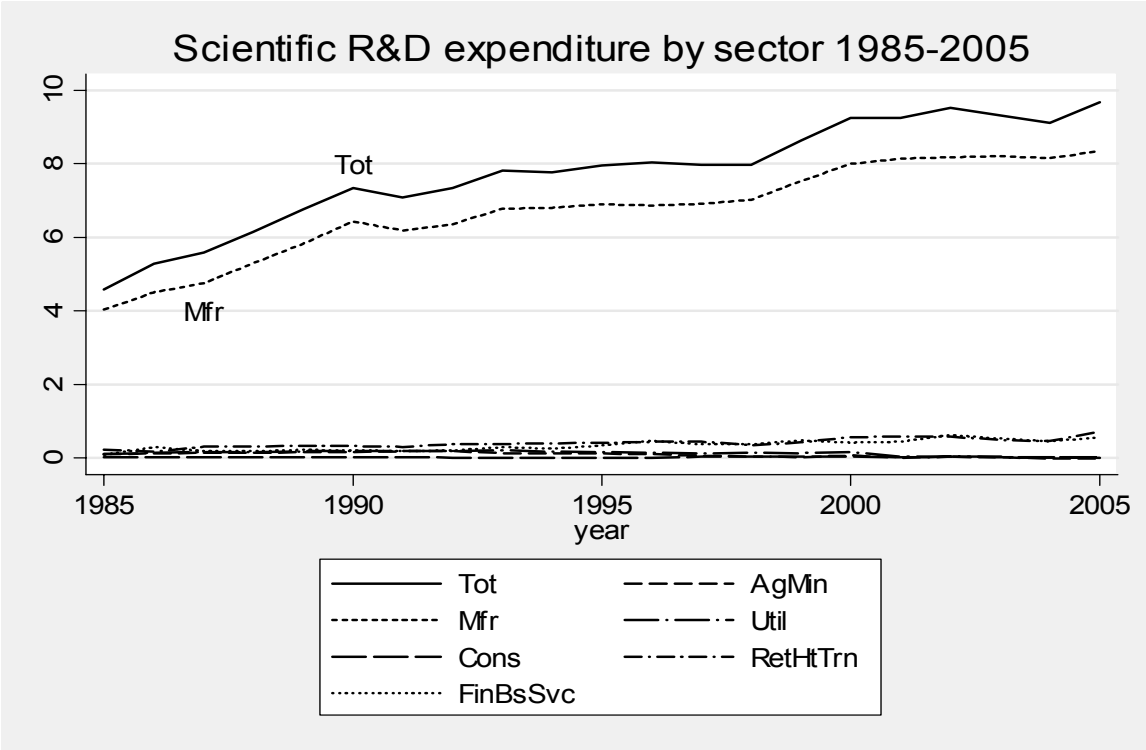
Second, because of the way that BERD is collected the industry "doing" the R&D is the industry that is *performing* the R&D. Every firm who claims to be undertaking R&D expenditure (in a simple yes/no question) on the ABI is then surveyed on the BERD. So a vertically integrated aerospace company who spends £100 of in-house R&D means the manufacturing does £100 of R&D and services none. If it then spins off the R&D to an independent company, then manufacturing R&D falls to zero and services rises to £100. An alternative method is to try to calculate the R&D undertaken by sector of *funding* and not performing. So if the original company

[2] We follow the same procedure in doing the trade adjustment for purchased organizational structure.

funded the now-independent company for £100, then in terms of the sector funding the R&D the sectoral allocation would not change.

Figure 2.2.1b shows the evolution of the six sectors expenditure on R&D. This confirms that manufacturing is the main contributor to overall scientific R&D.

Figure 2.2.1b



As it is illustrated in the graph, the total expenditure on R&D for 2004 is £9.11bn whereas in GHW this figure is £12.4bn. However, this difference is mainly due to our adjustment for the international trade. In fact, before doing this adjustment the total expenditure for 2004 is £12.27bn.

When we try to measure the UK investment in R&D we end up with a lower value for total spending as a significant amount of the performed R&D captured by the BERD is actually R&D undertaken for foreign companies (R&D exports).

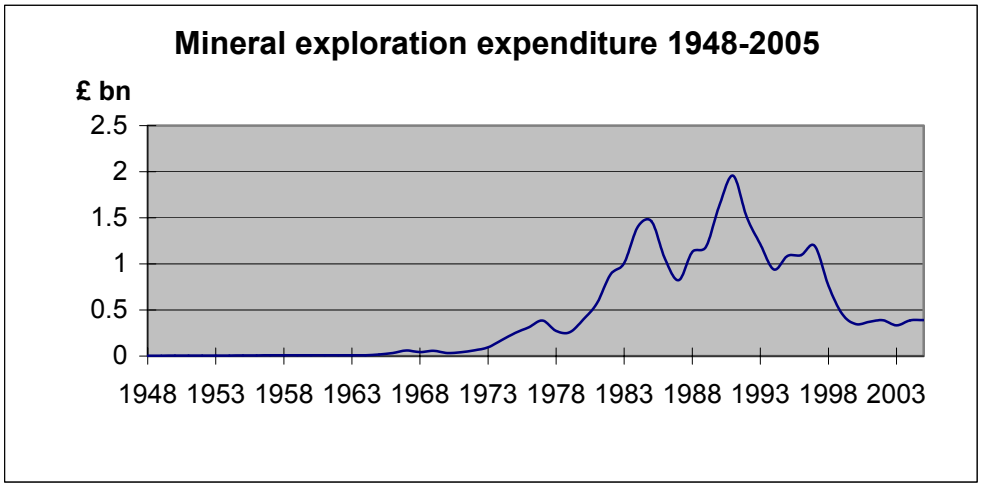
Table 4 sets out the shares of R&D by sector, including the trade adjustment, for 2004 and confirms that manufacturing does the lion's share of measured scientific R&D. Its share is 83%, which differs from the figure of about 75% which is often

quoted, derived from R&D total expenditure in 2005 at about £13bn and manufacturing being about £10bn, which is 76%. But we subtract spending on computer and related activities so as not to double count software. Since software is in the service sector, then the manufacturing share is about 10/12=83%.

2.2.2 Mineral Exploration

Expenditure on mineral exploration is already counted as an investment in the National Accounts. It includes the cost of drilling and related activities such as surveys. As it is the R&D undertaken by the mining sector only, we do not provide an industry split. To estimate this expenditure we add the time series of coal mineral exploration, continental shelf companies and mineral exploration other than coal and oil. These estimates are the same as presented in GHW. Fig. 2.2.2 shows the trend of the expenditure on mineral exploration.

Fig.2.2.2



Further details of this sector are as follows, see National Accounts, Concepts, Sources and Methods (NACSM) (2006, para 15.60ff). For mineral oil and natural gas, estimates of GFCF, including exploration costs, are based on information collected in the DTI quarterly inquiry into the oil and natural gas industry. The estimates cover fixed capital formation by exploration licensees, production licensees, operators appointed by production licensees and specialised contractors selling services to the industry. The fixed capital formation of contractors who may operate in the North Sea or other oil fields is included only where the contractors are

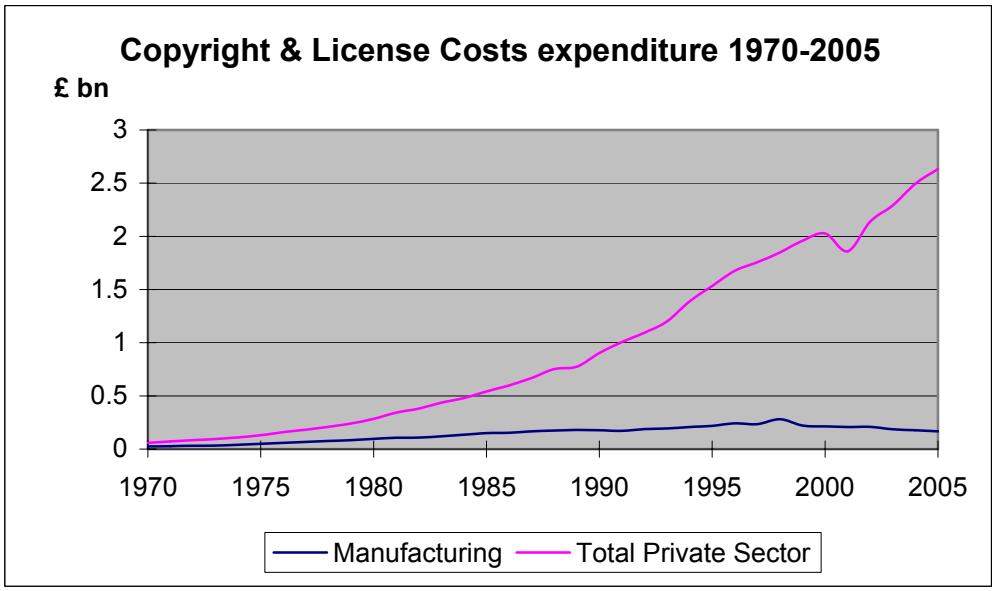
registered UK companies. Where operators work as part of a consortium, expenditures are allocated in proportion to their shares. For other mining and quarrying, estimates of GFCF, including exploration costs, in the coal industry are derived from information collected in ONS quarterly capital expenditure inquiries.

2.2.3 Copyright & license costs

The National Accounts records this intangible item as an investment. The Source and Methods Manual says *"The production of books, recordings, films, software, tapes, disks, etc, is a two-stage process of which the first stage is the production of the original and the second stage the production and use of copies of the original. The output of the first stage is the original itself over which legal or de facto ownership can be established by copyright, patent or secrecy. This is recorded as capital formation. The value of the original depends on the actual or expected receipts from the sale or use of copies at the second stage, which have to cover the costs of the original as well as costs incurred at the second stage.*"

We estimate copyright and license costs by adding up the time series of: "artistic originals: broadcasting and recording", "Entertainment, literacy and artistic originals: Public Corporations", "Artistic originals: Publishing". The last one can be accounted in the manufacturing sector whereas the first two are in "Recreational, Cultural and Sporting Activities" (SIC 92). These are out of the market sector according to our definitions. These estimates are the same as presented in GHW. Fig.2.2.3 shows the manufacturing expenditure compared to the total expenditure in copyright and license.

Fig.2.2.3



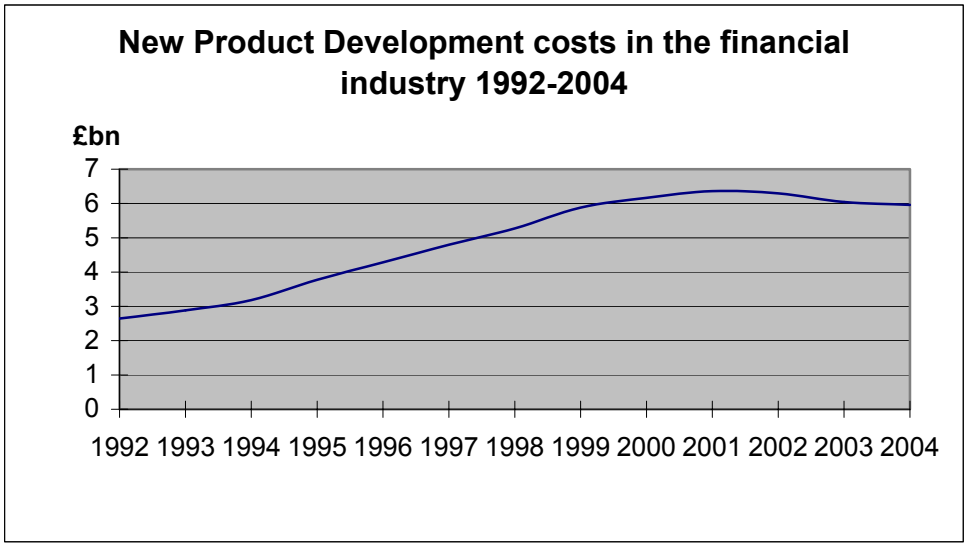
Further details of this sector are as follows, see NACSM, para 15.60ff. They state that to measure the investment due to the production of originals in this sector, the data relate only to the TV and radio, publishing and music industries. The BBC is included. NACSM notes that estimates are based on information from BBC annual reports and various other sources. No detailed description is provided on how the relation between spending on originals and copyrights, licenses etc. translates into investment.

OTHER PRODUCT DEVELOPMENT, DESIGN AND RESEARCH

2.2.4 New product development costs in the financial industry

Following CHS we measure new product development in financial services as 20% of total intermediate consumption by the financial services industry, taking the data from the Use Table. This intermediate spending includes also the purchase of advertising, software, consulting services and architectural and engineering activities which are counted elsewhere in the spending calculations. Therefore we subtract the purchase amount and take the 20% of this adjusted figure. These estimates are the same as presented in GHW. Fig 2.2.4 shows the results of our estimation.

Fig. 2.2.4



2.2.5 New architectural and engineering designs

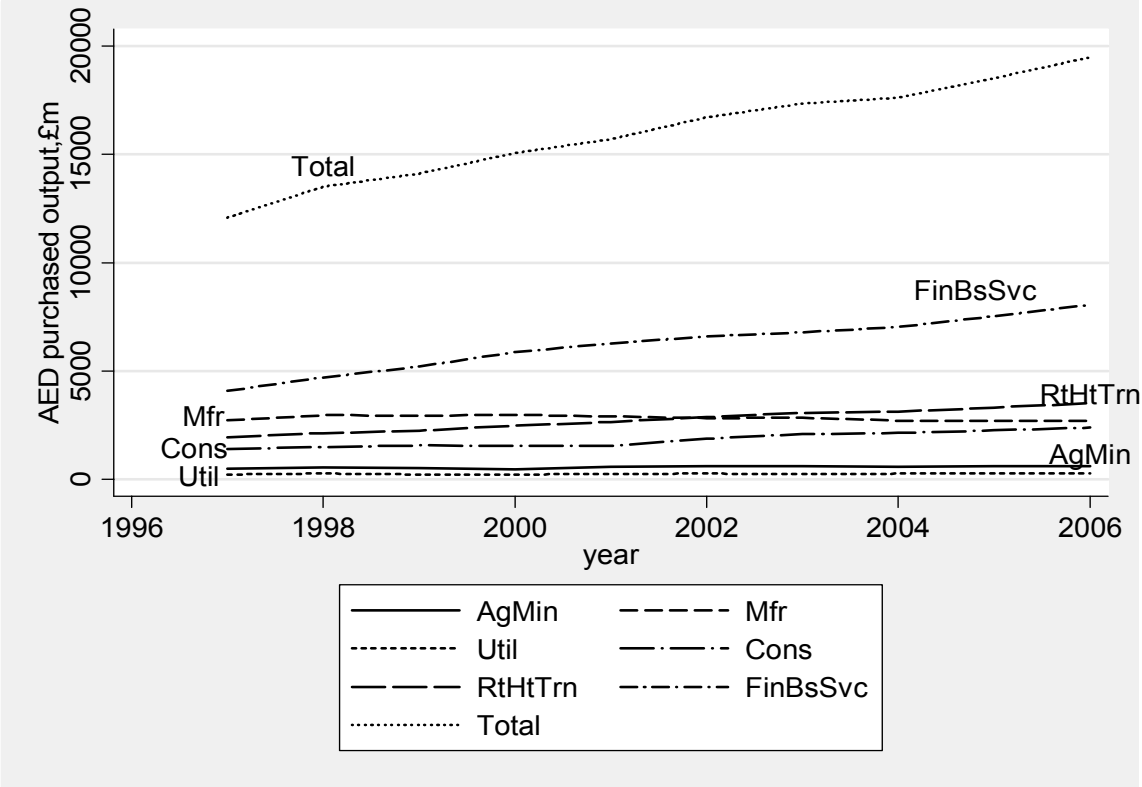
In Galindo-Rueda, Haskel and Pesole (GHP from now on, 2008) we set out results for own-account and expenditure in Architectural and Engineering Design (AED) for the UK market sector. We use these numbers in that paper here.[3] Briefly, in GHP we exploit the information from the SU tables to obtaining improved figures for both own-account output and the purchased output attributable to the AED industry. We do that using information from several sources (i.e. ABI, Business Structure Database, ASHE) to scale down the total output reported by the SU tables for industry 112, which represents a broader category than the AED industry. As in this paper, in GHP we use the turnover share from ABI to remove SIC 74.3 "Technical testing and analysis" from industry 112. In addition, we remove some subsector of SIC 74.2 "Architectural and engineering activities and related technical consultancies" in which AED activities do not incur.

[3] The expenditure numbers in GHP are larger than those originally reported in the earlier version of this GH paper and indeed in the GHW paper, but the investment numbers are very similar. The reason for the difference is the following. In GHP we use the software method of estimating own-account spending by industry via labour market data on design occupations by industry. We did not do this in GHW, but, following CHS, halved all purchased design to estimate total purchased and own-account. In the earlier version of this paper we also used labour market data, but used a broader set of occupations than we do in GHP and assumed they were more costly. Finally, as we explain in GHP although we have higher spending data than GH, our design survey suggests that we should allocate a lower level to investment, leaving us with about the same investment levels as in GHW and the earlier GH paper.

First, we estimate the purchased component from the IO Tables. We derive the AED purchased output as the sum of Intermediate Consumption (IC) and Gross Fixed Capital Formation (GFCF). We reallocate IC and GFCF between products according to the import and export data reported in the Pink Book (2005). We use these data to fully balance the supply and use side. This method is consistent with the construction of the SU tables.

Fig. 2.2.5.a illustrates the expenditure on purchased AED by industry, showing financial and business services at about half of this group.

Fig. 2.2.5.a Purchased AED output by industry , 1997-2006



To measure the AED own account, looking at the SU tables, we construct a hypothetical cost-structure that will incur in the production of in-house AED. Implementing these adjustments to our initial figure for the output of industry 112 we obtain the output for the AED industry, which we denote Y_{22}. Thus, we can now determine the AED output outside the AED industry in industry *i* as:

$$Q_i = \frac{Y_{22}}{WN_{ind=AED}^{occ=AED}} WN_{ind=i}^{occ=AED}$$

where both the wage bill for designers inside and outside the AED industry are revised for an estimate of the time spent in AED activities and the number of self employed.

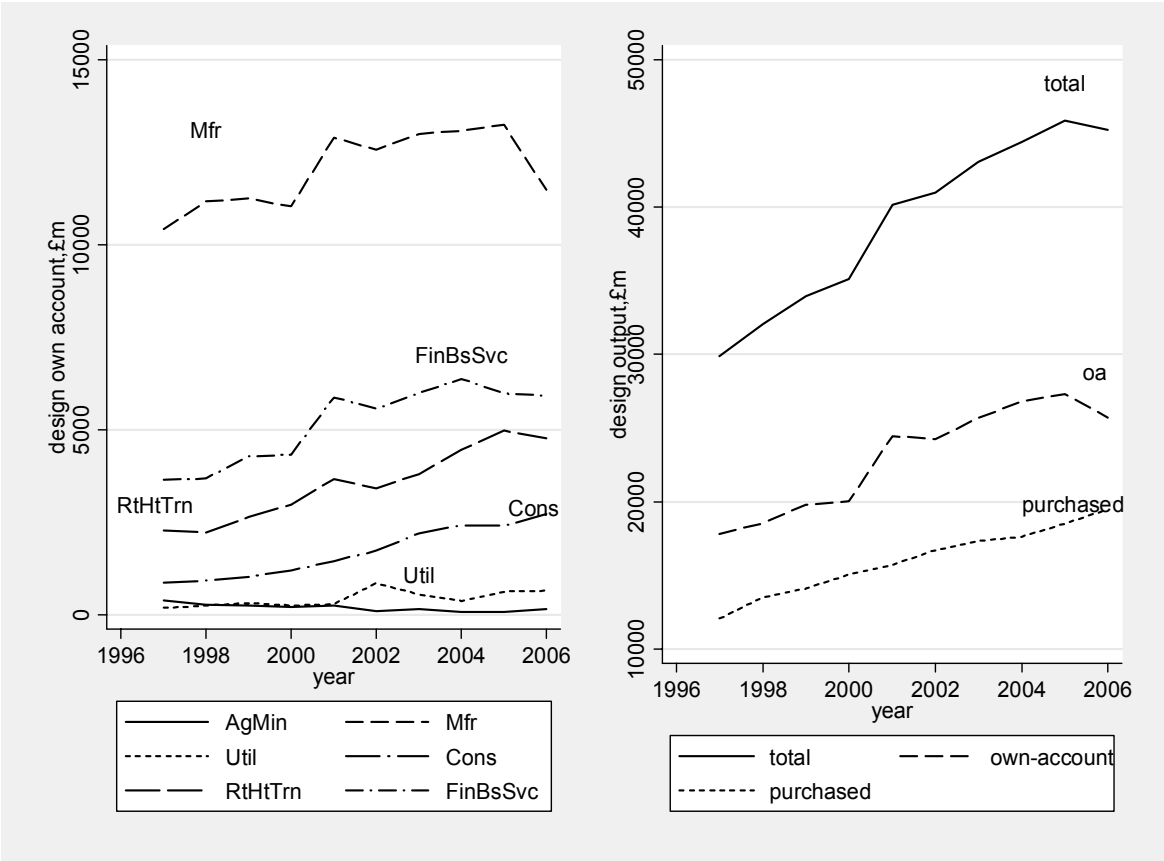
A last adjustment is needed to obtain the AED own account. We need to subtract to the AED output reported above the amount of AED output sold in the market place.

Doing so we avoid any double counting since the latter is already accounted by National Statistics.

In 2004, we find that own account spending in AED is about £27m. Private sector spending on purchased AED is about £17m. Thus, our final figure for the total expenditure in AED is roughly £45m. Note that these are expenditure data: we shall multiply these by 50% to obtain investment, relying on the survey evidence in GHP.

Finally, in Figure 2.2.5.b the left hand figure shows the own account spending by industry and the right hand figure the spending for purchased and own account in the whole economy. A number of points regarding the figure are worth noting. First, the data for 2005 and 2006 are provisional, being extrapolations of the 2004 data since the 2005 and 2006 IO tables are not available. Second, manufacturing accounts for the lion's share of total spending, although the trend in Finance and Business Services is upward.

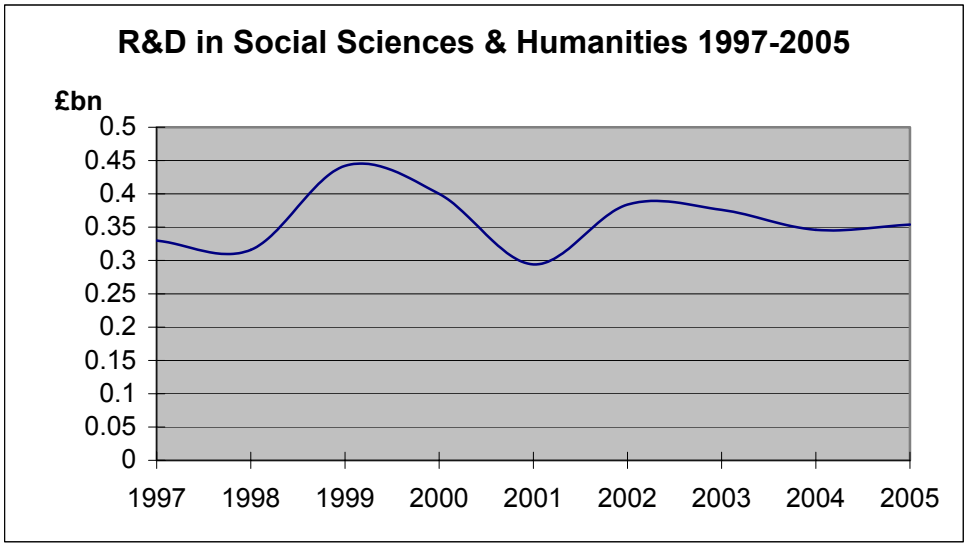
Fig.2.2.5.b Expenditure on AED by industry, 1997-2006.



2.2.6 R&D in social science and humanities

As in GHW it is estimated as twice the turnover of R&D in the SIC 73.2 "Social Sciences and Humanities", with the doubling being assumed to capture own-account spending. Fig.2.2.6 shows the trend of the expenditure on this intangible item.

Fig.2.2.6



2.3 ECONOMIC COMPETENCIES

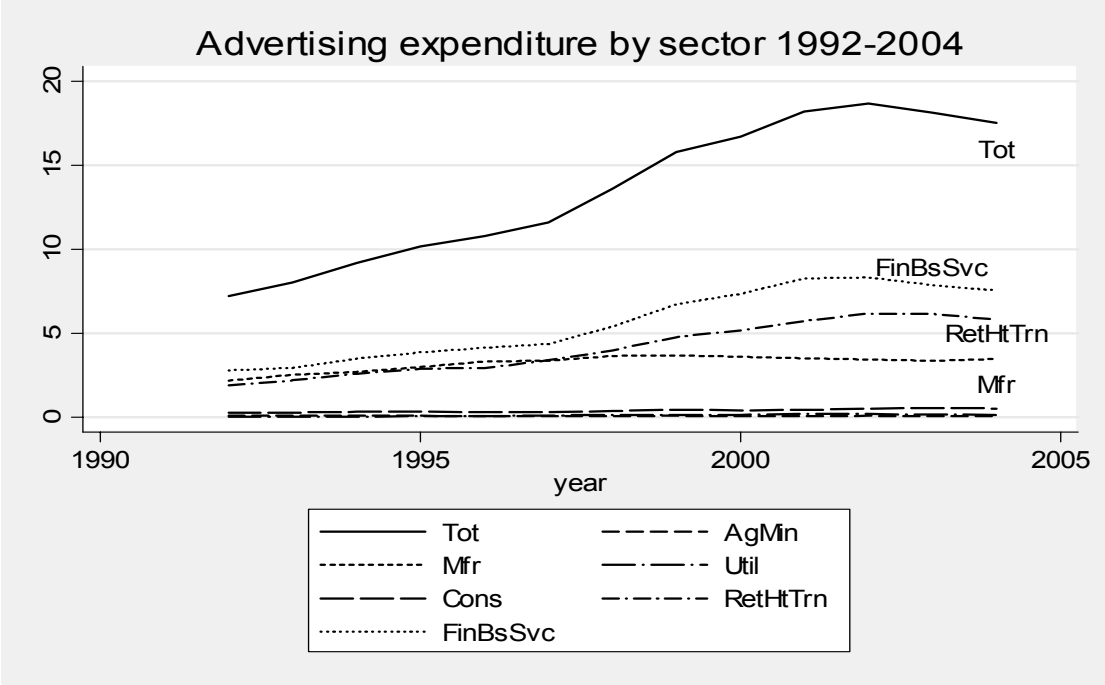
EXPENDITURE ON BRAND EQUITY

2.3.1 Advertising

We estimate advertising expenditure from the IO Tables. The Use table 3 provides intermediate consumption in Advertising (product group 113) by industry (at the 123 industry level). Thus we take the sum of these purchases across all industries. In this case there is no value to add from the Gross Fixed Capital Formation (GFCF). A number of points are worth noting. On one hand it is likely that the figures obtained underestimate the investment in advertising as we are not capturing the own-account component. On the other hand they include the classified advertising (i.e. small advertising appearing at the end of newspapers typically for small items of sale or vacancies) which is unlikely to be asset building.

Figure 2.3.1 shows the expenditure trend on advertising undertaken by all sectors. It is evident that advertising expenditure for both private sector and Financial & Business services has grown in the recent years and is valued respectively at £17.5 billions and at £7.54 billions in 2004.

Figure 2.3.1



Comparing these results with GHW we do not find similar estimates: in GWW the total expenditure on advertising for 2004 is £14bn, in the current work is £17.5bn. Financial and Business Services sector accounts for almost 50% of this expenditure.

Note in passing that a previous version of this paper found a somewhat smaller total (£12bn, but this excluded classified advertising), but a quite different distribution of advertising expenditure across industries. That version used Advertising Association data on spending on billboards, TV and internet etc. that was disaggregated by industry. On those data, manufacturing industry spent about 52% of total advertising. Part of the difference might be due to the implicit inclusion of own-account advertising in the Advertising Association data, but part might be due to differences in classification in that data.

We must however stress caution on the attribution of advertising to industries. First, an advertisement for cheap product X in supermarket Y might be building a brand for the product or the supermarket. Second, there is a generic problem of assigning any activity, be it advertising or anything else, to a firm who does both service and manufacturing activities. Suppose that an integrated firm A makes cars and

employers cleaners. To what industry is that firm assigned? ONS have completed a recent paper on this issue and it turns out to be not straightforward. The general treatment of a firm involved in different activities is to split the firm up into different reporting units and ask them to report on activities separately, so that firm A will have one aggregated firm record but two reporting unit records. Each reporting unit is assigned to the industry in which it belongs, but the firm as a whole is assigned into the industry which the majority of employment is located in, which in the firm A example is manufacturing. This then gives the well-known problem that if there is contracting out of services, manufacturing apparently shrinks. If the manufacturing part of the firm keeps on advertising, then the allocation of advertising to this firm does not change, but the share of employment that advertising is compared to does.

A further slightly different example is as follows. Suppose integrated firm B has a distribution arm and a manufacturing arm, but with employment such that the overall firm is manufacturing and advertising is classified there. Next suppose that it disintegrates (and suppose sends the manufacturing abroad). Then the advertising is assigned to services.

The way to make this consistent might be to have the original breakdown by reporting unit, in which case the employment share of manufacturing, in this example, was previously overstated. Note that this would have to be done for the service sector too: consider for example a retail bread shop with a bakery in the store. This is classified as services on a firm basis, if most of the staff work on retailing, but on a reporting unit basis should have been part manufacturing. The likelihood is that the reporting unit records are not robust enough to track this and so a consistent assignment of activity to industries by reporting unit is not going to be possible.

Thus a combination of disintegration and cross-country knowledge flows make the attribution of advertising to industries a matter of caution which it is hoped that future work will address.

2.3.2 Market Research

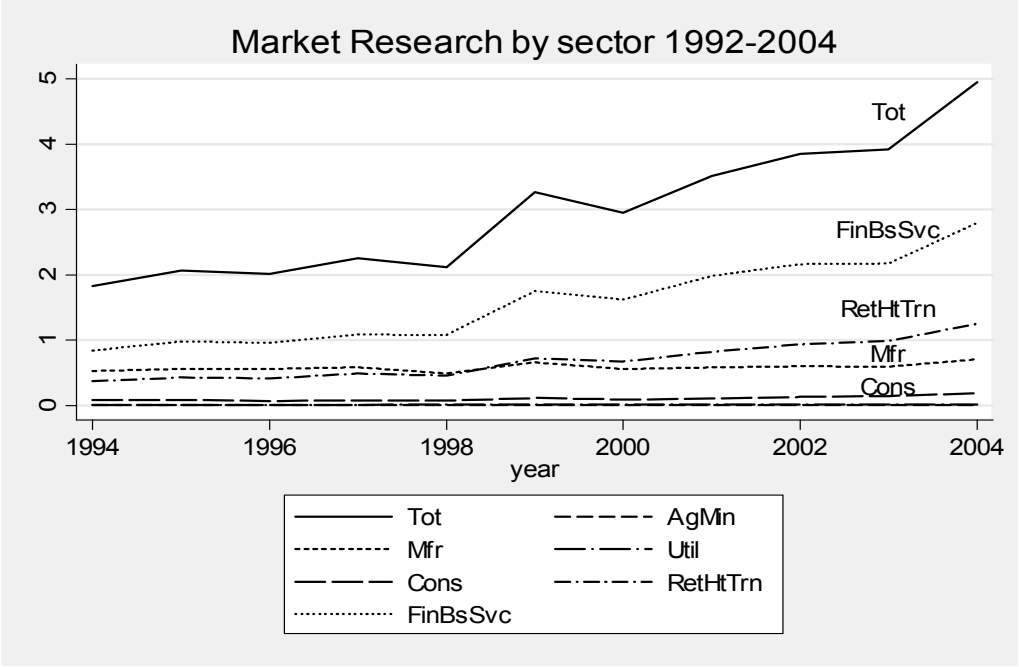
Our previous work simply used the turnover of the market research industry (SIC74.13, £2.3bn, then doubled to reflect own account). The main source of data here to estimate market research by industry is the Use Table which provides the intermediate consumption in market research and management consultancy (product group 111) split by sector (123 industry detail). In addition, we add in the product group 111 in the Gross Fixed Capital Formation (GFCF) by industry IO table.

The product group 111 includes market research and management consultancy data. We are able to compute a market research share by using data on market research and management consultancy value added from the ABI. We then apply this share to the intermediate consumption and GFCF by industry data.

Afterwards we gather the data in order to get our six categories. Finally we double the figures in order to consider the own account market research.

Figure 2.3.2 shows the market research expenditure for all the sectors. It is possible to see how the expenditure on market research has grown up in the resent years. In 2004 the total private sector spending on market research is £4.95bn. The financial and business sector is responsible for more than half of this total.

Figure 2.3.2



Comparing these results with GHW we find similar estimates: in GHW the total expenditure on market research for 2004 is £4.5bn, in the current work it is £4.95bn.

2.3.3 FIRM-SPECIFIC HUMAN CAPITAL

Most of the available data on training provides an indicator of whether the respondent received training. Other surveys tend to focus on skill shortages experienced by employers and hard-to-fill vacancies as perceived by employers. Collecting data on cost of employer-provided training is more complicated since the cost of employer-provided training not only encompasses the cost of providing training but also the opportunity costs of paid employee time whilst undergoing training.

We estimate the training expenditure by using the data from the National Employer Skills Survey 2004 (NESS2004). The NESS obtains training expenditure in two stages: first it surveys a large number of firms (74,500 employers) to see if they are training or not and second they conduct a separate follow-up inquiry on the firms

who say they had funded or arranged training in the previous 12 months (who represents the 65% of the interviewed employers in the first step).

This second survey is more detailed and estimates employer expenditure on training. The sample of employers for this second study is representative of the profile of training employers from the main survey by size, sector and the type of training the establishments provides (off-the-job training only, on-the job-training only or both type of training).

The cost of training involves labour costs of those receiving and delivering or organising training. In particular, on-the-job training cost includes trainee and trainers labour cost. Off-the-job training includes trainee labour cost, fees to external providers, training management, travel and subsistence etc…

The NESS survey provides the training expenditure figures by sector skills council (SSC). SSCs are the employer-led organizations charged with leading the skills and productivity drive in sectors recognised by employer. One limitation is that this split is provided just for the year 2004. We build a training expenditure time series at an industry level by backcasting using two main sources:

- the training expenditure in the 27 sectors classification for 2004
- The EU KLEMS wage bill time series 1970-2004

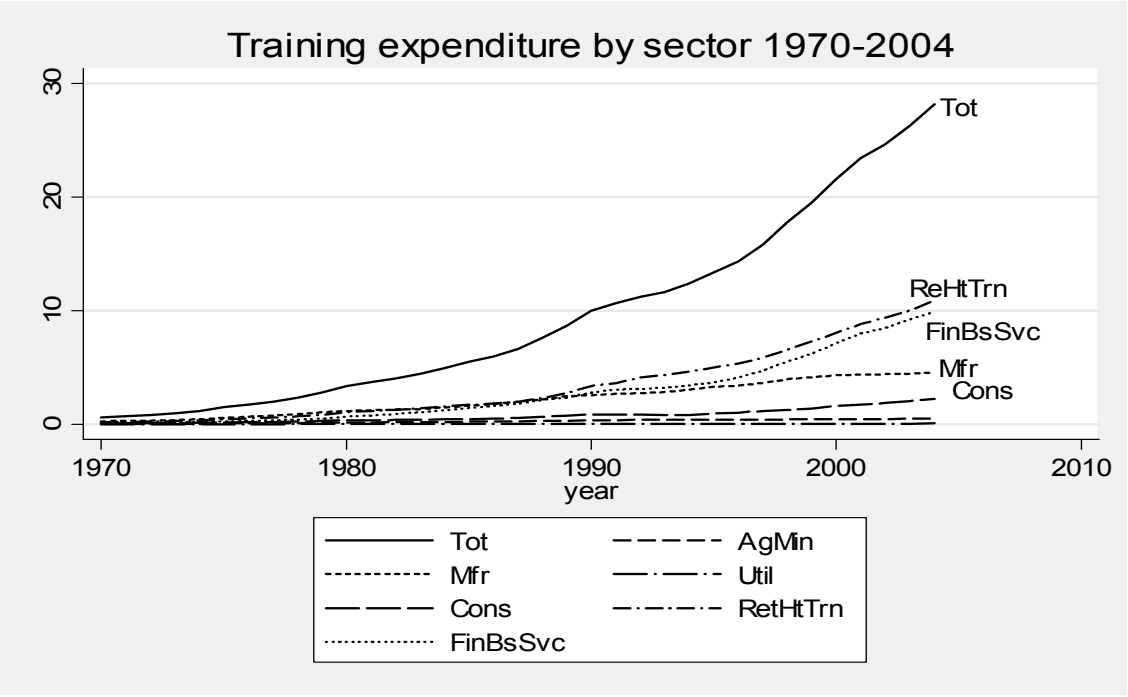
The idea is to construct a constant incidence time series which will show changes in training according to changes in industry composition. We proceed by firstly computing the sector-specific incidence for 2004 and secondly by applying the incidence to the wage bill time series available for each sector. A constant incidence time series could misrepresent the effective training expenditure trend. In fact one could expect the training incidence to increase over time for two reasons: Firstly, the fraction of professionals, who receive a lot of training, has gone up since the 1960s. Secondly, the size of the firms has risen and large firms are those who train more.

As a result, we follow Nakamura's assumption that the incidence has been growing by 2% since 1956 (so it doubles in 50 years). Thus we apply to our time series a discount rate of 2%.

Finally, since the NESS survey covers just England, we apply the ratio of the employees receiving training in UK and in England to the training expenditure time series obtained above.

Figure 2.3.3 shows the training expenditure by sector. The manufacturing training expenditure does not present significant growth.

Figure 2.3.3



Comparing these results with GHW we find very similar estimates: in GHW the total expenditure on training for 2004 is £28.8bn, in the current work it is £28.15bn.

2.3.4 ORGANIZATIONAL STRUCTURE

Organizational structure also presents us with challenge of accounting for purchased and own-account investment. The own-account component is assumed to be the value of the executive time spent on improving the effectiveness of business

organizations. The purchased component is represented by the management consultant fees.

The expenditure on purchased management is estimated as the revenues of the management consulting industry. The main data source is the survey set up by the UK Management Consulting Association (MCA) of 64 firms in the UK consulting industries. They estimate their members are 70% of the industry and put their members fee income, in 2005, at £7.66bn, giving an estimated industry turnover of £11.9 billion.

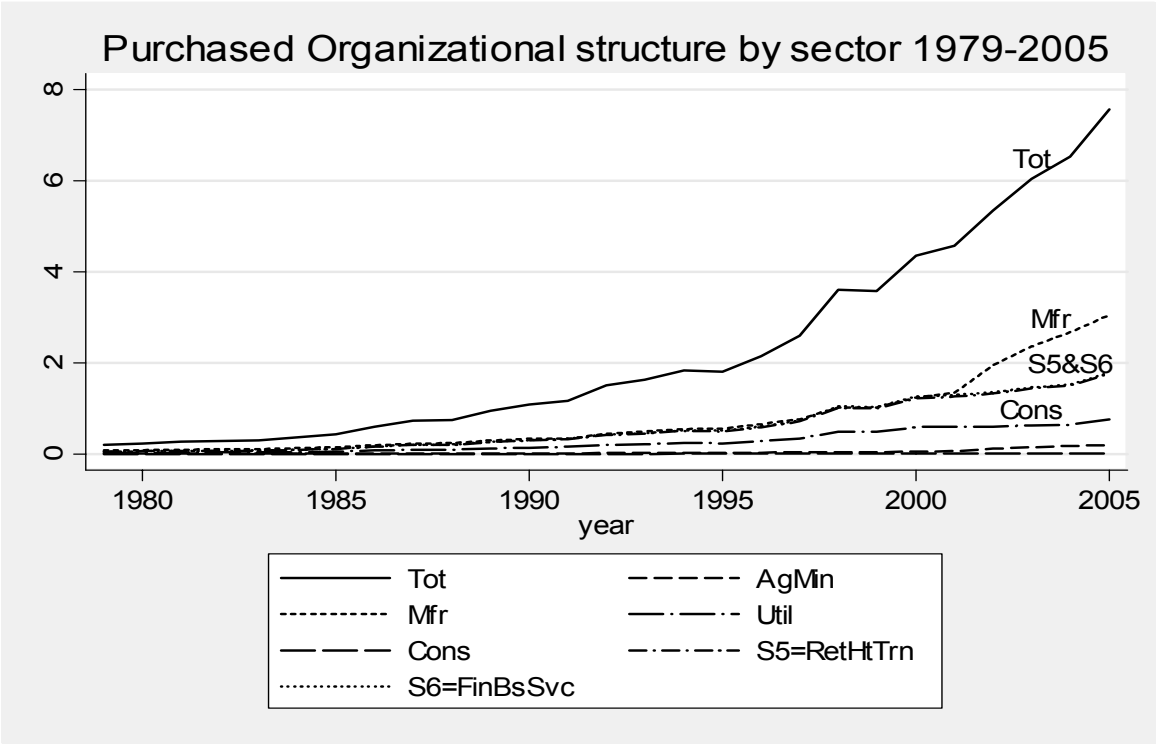
The MCA survey includes management consulting services (for example business-process re-engineering, strategy, change management) outsourcing-related consulting and IT-related consulting. It might be that some expenditure double count with investment or are destined to activities too short-lived to be asset-building. Given the difficulty in understanding how much of this expenditure is investment, for the moment we left them as they are.

The MCA report provides an industry breakdown of 2005 fee income. After converting the available split in to our common classification, we construct the sector-specific expenditure time series by adopting the same procedure we followed for the advertising and market research expenditure time series. Assuming a constant incidence of the sector-specific expenditure on the private sector total expenditure, we compute the sector shares for the year 2005 and applied them to the estimated time series of the private sector expenditure on management consulting.

In order to consider the consulting services purchased from abroad we add the management consultancy imports. As the MCA figures include the consulting services purchased by UK firms only we do not need to subtract the exports.
Figure 2.3.4.a shows the expenditure by sectors on management in the period 1979-2005. Comparing these results with GHW we find similar estimates: in GHW the total expenditure on purchased organizational structure for 2004 is £7bn, in the current work it is £6.53bn (before the trade adjustment it is valued £4.3bn).

The share of bought-in management consulting taken by manufacturing, computed on this basis, is 41%. This differs from the share implied by data in ONS' Input-Output tables. The basis of the difference remains to be investigated.

Fig. 2.3.4.a

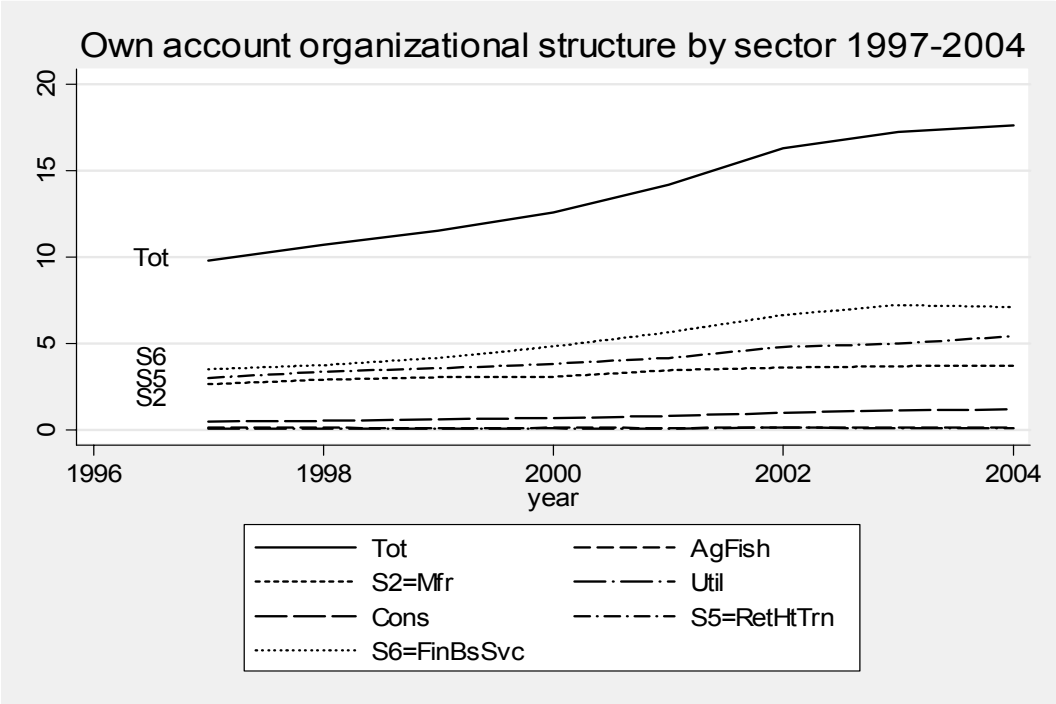


The expenditure on own-account organizational structure is estimated as 20% of the managers' earnings. We are following the CHS assumption that 20% of time is spent on organization building activities. Our source of data is the ASHE (Annual Survey of Hours and Earnings). In the appendix we present the list of the SOC codes of the managerial occupations we have considered for estimating this spending. In 2000 the

SOC 1990 was revised and updated and published as SOC 2000. For this, in the years 1997-2001 we refer to the occupations codes of SOC 1990. For the period 2002-2006 we refer to the occupations codes of SOC 2000. In our estimation we exclude the managers consulting industry SIC 74.15 as is it is already included in the purchased organizational structure figures. The earnings are computed as the average gross annual earnings, thus they include incentives, additional premium payments and overtime pay.

Fig. 2.3.4.b shows the expenditure on own-account organizational structure by sector. In almost all sectors the expenditure presents an increasing trend.

Fig.2.3.4.b



Comparing these results with GHW we find different estimates: in GHW the total expenditure on purchased organizational structure for 2004 is £15.3bn, in the current work it is £17.62bn. This is due mainly to a revision in the choice of the managers' occupations codes.

3. FURTHER ANALYSIS OF THE MANUFACTURING SECTOR

In this section we try to answer the following question: how much does the manufacturing spend on intangible assets relative to tangible assets? How much of the total investment in intangible assets is undertaken by manufacturing?

We have to be careful here on matters of definition. We use the EUKLEMS data on investment and measure tangible investment as the sum of investment in ICT, excluding software, transport equipment, buildings, machinery and other.[4] In addition, our data above are for expenditures on various intangible categories. To go from expenditure to investment we follow CHS and assume that all such expenditures are investment with the exception of advertising (0.6) and bought in organisational capital (0.8). We also apply a factor of 0.5 to our design data, see above.

Table 5 shows some key variables. Column 1 shows the ratio of manufacturing intangible investment to manufacturing tangible investment. Spending by manufacturing on intangible investment is now more than twice that on tangible investment. The second column of shows the ratio of manufacturing intangible investment to total intangible investment and shows that is has been falling. However as columns 3 and 4 show the share of manufacturing value added and employment in the total are also falling.

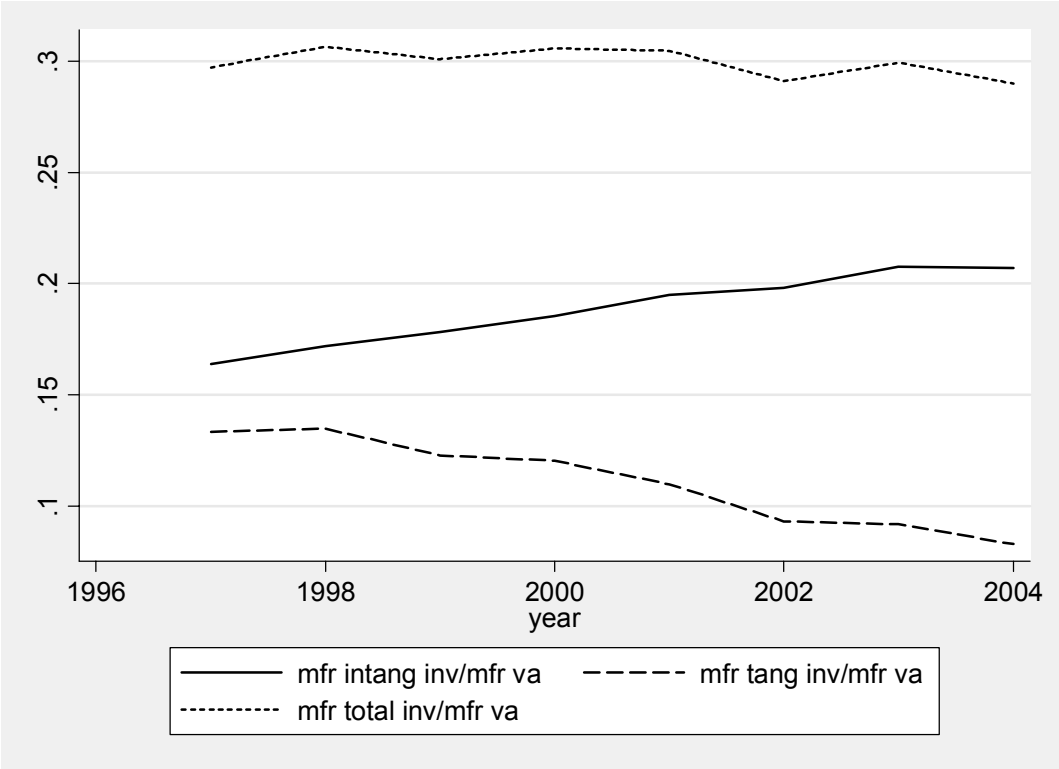
Figure 3.1 shows the resulting shares of tangible and intangible investment in manufacturing value added time (manufacturing value added is the raw data from EUKLEMS and not adjust for the capitlisation of intangibles). The lowest line shows that tangible investment in manufacturing divided by value added in manufacturing has been falling.[5] The middle line shows the ratio of intangible

[4] As a matter of fact, these data were close to the ONS manufacturing investment data published in the Monthly Digest.

[5] Note that both these series are nominal. An alternative approach might be to compare the real investment to real value added or, say real investment. That would of course answer a different question. The nominal/nominal comparison asks about the share of all investment. The real/ real comparison asks what share of tangible investment the business sector would have to spend on investment to buy those investment capital goods that it bought in the particular year, at the prices they faced for those goods in some base period. Since the prices for some intangibles have been falling, driven a lot by software, this has of course been rising. Now, if investment prices have been falling then it is of course true that the same ratio of investment would buy more or better goods.

investment in manufacturing to value added in manufacturing has been rising. The top line shows the total, which is slightly falling.

Fig 3.1: Ratios of manufacturing tangible investment, manufacturing intangible investment and their sum, to manufacturing value added



Note: manufacturing tangible investment is manufacturing ONS measured investment less our measure of manufacturing software.

4. CONCLUSION

We attempted to measure intangible investment by industry for the UK, using some new methods relative to previous work particularly in advertising and design. We present data on expenditure on intangible assets for the UK market sector for six industries over the last decade or so (data availability allowing). The sectors are (1) Agriculture, Fishing and Mining; (2) Manufacturing; (3) Electricity, Gas and Water; (4) Construction; (5) Wholesale and Retail, Hotels and Restaurants, Transport and Communications; (6) Financial Intermediation and Business Services. We use new methods relative to previous work particularly in advertising and design. Our main findings are as follows. First, overall intangible expenditure was, in 2004, around £154bn (investment was £92bn). Second, to give an illustration of the manufacturing

results, in 2004 manufacturing intangible investment was £40bn and tangible £12bn, a ratio of 2.5 to 1 up from 1.2 to 1 in 1977. Third, manufacturing accounted in 2004 for 12% of total tangible investment and 31% of total intangible investment.

References

Sumiye Okubo, Carol A. Robbins, Carol E. Moylan, Brian K. Sliker, Laura I. Schultz, and Lisa S. Mataloni (2006), "BEA's 2006 Research and Development Satellite Account: Preliminary Estimates for 1959-2002; Effect on GDP and Other Measures" available at <http://www.bea.gov/industry/iedguide.htm#rdsa>

National Accounts, Concepts, Sources and Methods (2006), available at (http://www.statistics.gov.uk/downloads/theme_economy/Concepts_Sources_&_Methods.pdf)

Table 1: Sources & method

INVESTMENT ITEM	SOURCES & METHODS	INDUSTRY BREAKDOWN AVAILABILITY	PERIOD AVAILABLE
Computerized information			
Computer software	ONS estimates	123 industries breakdown	Own Account & Purchased: 1970-2005
Computerized databases	Included in software estimates	Included in software estimates	As above
Innovative property			
Scientific R&D	ONS Business Performed R&D (BERD)	Main product breakdown	1981-2005
Mineral exploration	National Accounts, ONS series	Series for coal, UKCSC oil and other mineral	1948-2005
Copyright and license costs	National Accounts, ONS series	Series for publishing, public and broadcasting/recording consumption	1970-2005
Other product development, design and research			
New product development costs in the financial industry	Estimated as 20% of Financial Services industry's intermediate purchases (ONS data), discounting advertising, software, consulting and design purchases .	All in financial intermediation services	1992-2004
New architectural and engineering designs	Purchased are estimated for the IO tables.Own-account are estimated using designers' earnings from ASHE data	Detailed industry breakdown available in ASHE data	1997-2006
R&D in social science and humanities	Estimated as twice industry revenues of social science and humanities R&D industry (73.2) from services inquiry (now ABI)	no breakdown	2004-1992
Economic competencies			
Brand equity			
Advertising expenditure	Estimated from the IO tables.	123 Industry breakdown	1992-2006
Market research	Estimated from the IO tables. We then double the figures to consider the own-account	123 industries breakdown	1992-2005
Firm-specific human capital	NESS05, direct & indirect costs of employer provided training, adjusted to all UK	NESS05 specific 27 industry split	2005
Organizational structure			
Purchased	Data on revenues of management consulting industry from Management Consulting Assocation.	Specific industry breakdown provided by the management and consulting association	1979-2005
Own account	Estimated as proportion of managers' earnings using ASHE	Detailed industry breakdowon	1997-2006

Tab.2 Sectoral classifications for key intangible items

SIC codes grouped as supply use tables coding (123 industries)	Training	R&D	Organizational Structure (purchased)
1	1t5	1t5	1t14
2			
5			
10	10t14	10t14	
11 + 12			
13			
14			
15.1	15t16	15t16	15t37
15.2 + 15.3			
15.4			
15.5			
15.6			
15.7			
15.81 + 15.82			
15.83			
15.84			
15.85 to 15.89			
15.91 to 15.97			
15.98			
16			
17.1	17t19	17t19	
17.2			
17.3			
17.4			
17.51			
17.52 to 17.54			
17.6 + 17.7			
18			
19.1 + 19.2			
19.3			
20	20t21	20t22	
21.1			
21.2			

22	22		
23	23t26	23	
24.11 + 24.12		24 (except 24.4)	
24.13			
24.14			
24.15			
24.16 + 24.17			
24.2			
24.3			
24.4		24.4	
24.5			
24.6			
24.7			
25.1		25	
25.2			
26.1		26	
26.2 + 26.3			
26.4			
26.5			
26.6 to 26.8			
27.1 to 27.3	27t28	27.1+27.2+27.3+27.51 +27.52 27.4+27.53+27.54	
27.4			
27.5			
28.1		28	
28.2 + 28.3			
28.4 + 28.5			
28.6			
28.7			
29.1	29t33	29	
29.2			
29.3			
29.4			
29.5			
29.6			
29.7			
30		30	
31.1 + 31.2		31	
31.3			
31.4 to 31.6			
32.1		32	
32.2			
32.3			

33		33	
34	34t35	34	
35.1		35(except 35.1 + 35.3)	
35.2 + 35.4 + 35.5		35.1	
35.3		35.3	
36.1	36t37	36	
36.2 + 36.3			
36.4 + 36.5			
36.6 + 37		37	
40.1	40t41	40t41	40t41
40.2 + 40.3			
41			
45	45	45	45
50	50t52	50t55	50t52
51			
52			
55	55		55
60.1	60t64	60t63	60t64
60.2 + 60.3			
61			
62			
63			
64.1		64	
64.2			
65	65t67	65t71 + 74	65t67
66			
67			
70.1 + 70.2(pt)	70t74		70t74
70.2 (pt)			
70.3			
71			
72		72	
73		73	
74.11		74 is above	
74.12			
74.13 to 74.15			
74.2 + 74.3			
74.4			
74.5 to 74.8			

Tab.3 Common industry disaggregations available

PROPOSED SECTOR CATEGORIES	SIC CODES (2 DIGIT)	NACE SECTIONS A17	INDUSTRY DESCRIPTION
1	1t14	A+B+C	Agriculture, Fishing, Mining
2	15t37	D	Manufacturing
3	40t41	E	Electricity, Gas & Water Supply
4	45	F	Construction
5	50t64	G+H+I	Wholesale & Retail Trade, Hotels & Restaurants, Transport & Communications
6	65t74	J+K	Financial Intermediation, Business Services

Tab.4 Expenditure by sector on key intangible assets in 2004

Intangible	Sector	Expenditure £bn	Sector expenditure as a percentage of the total spending on this intangible
Software			
	1 AgMin	0.13	1%
	2 Mfr	2.69	16%
	3 Util	0.33	2%
	4 Cons	0.33	2%
	5 RetHtTrn	5.19	31%
	6 FinBsSvc	7.86	48%
	total	**16.53**	
Scientific R&D			
	1 AgMin	0.01	0.05%
	2 Mfr	8.15	89%
	3 Util	0.02	0.20%
	4 Cons	0.03	0.30%
	5 RetHtTrn	0.46	5%
	6 FinBsSvc	0.46	5%
	total	**9.12**	
New architectural & engineering design			
	1 AgMin	0.66	1.30%
	2 Mfr	15.77	38.50%
	3 Util	0.63	0.73%
	4 Cons	4.56	7.60%
	5 RetHtTrn	7.57	17.40%
	6 FinBsSvc	15.23	34.40%
	total	**44.43**	
Advertising			
	1 AgMin	0.06	0.00%
	2 Mfr	3.46	20%
	3 Util	0.12	0.01%
	4 Cons	0.52	0.03%
	5 RetHtTrn	5.81	33%
	6 FinBsSvc	7.54	43%
	total	**17.51**	
Market Research			
	1 AgMin	0.00	0.08%
	2 Mfr	0.71	14.34%
	3 Util	0.01	0.20%
	4 Cons	0.19	3.84%
	5 RetHtTrn	1.25	25.25%
	6 FinBsSvc	2.79	56.36%
	total	**4.95**	
Firm-specific Human Capital			
	1 AgMin	0.51	2%
	2 Mfr	4.55	16%
	3 Util	0.06	0%
	4 Cons	2.23	8%
	5 RetHtTrn	10.89	39%

	6 FinBsSvc	9.90	35%
	total	**28.15**	
Organizational Structure (Purchased)			
	1 AgMin	0.17	3%
	2 Mfr	2.67	41%
	3 Util	0.64	10%
	4 Cons	0.01	0%
	5 RetHtTrn	1.50	23%
	6 FinBsSvc	1.52	23%
	total	**6.53**	
Organizational Structure (Own-account)			
	1 AgMin	0.14	1%
	2 Mfr	3.70	21%
	3 Util	0.08	0%
	4 Cons	1.17	7%
	5 RetHtTrn	5.42	31%
	6 FinBsSvc	7.10	40%
	total	**17.62**	
	Total (Purch+Own Account)	**24.15**	
Total			
	1 AgMin	1.68	1%
	2 Mfr	41.7	27%
	3 Util	1.89	1%
	4 Cons	9.04	6%
	5 RetHtTrn	38.09	25%
	6 FinBsSvc	52.4	33%
	total	144.84	
	including all the other itangibles	**154**	

Note to table: final bold total is the total of all numbers shown in table plus those intangibles not shown here as allocated to different industries i.e. minerals exploration (£0.38bn) is allocated to sector 1; copyright and licensing (£2.49bn) is allocated to sector 2; financial services innovation (£5.95bn) and R&D in social science and humanities (£0.34bn) are allocated to sector 6.
The numbers for New architectural and engineering design have been revised according to the results in Galindo-Rueda, Haskel and Pesole (2008).

Table 5. Ratios of intangible to measured investment

YEAR	$\frac{I^{N,Mfr}}{I^{T,Mfr}}$	$\frac{I^{N,Mfr}}{I^{N,Tot}}$	$\frac{Va^{Mfr}}{Va^{Tot}}$	$\frac{L^{Mfr}}{L^{Tot}}$
1997	1.23	0.39	0.26	0.25
1998	1.27	0.37	0.25	0.24
1999	1.45	0.36	0.24	0.23
2000	1.54	0.35	0.22	0.22
2001	1.78	0.34	0.21	0.21
2002	2.13	0.32	0.20	0.20
2003	2.26	0.32	0.19	0.19
2004	2.50	0.32	0.18	0.18

N=intangible asset
T= measured (mostly tangible) assets

Appendix Table. Occupational Titles of those who we classified as managers

	MANAGERS OCCUPATIONS SOC CODES
	SOC 2000
	111 Corporate Managers And Senior Officials
OUT	1111 Senior officials in national government
IN	1112 Directors and chief executives of major organisations
OUT	1113 Senior officials in local government
IN	1114 Senior officials of special interest organisations
	112 Production Managers
IN	1121 Production, works and maintenance managers
IN	1122 Managers in construction
OUT	1123 Managers in mining and energy
	113 Functional Managers
IN	1131 Financial managers and chartered secretaries
IN	1132 Marketing and sales managers
IN	1133 Purchasing managers
OUT	1134 Advertising and public relations managers
IN	1135 Personnel, training and industrial relations managers
OUT	1136 Information and communication technology managers
IN	1137 Research and development managers
	114 Quality And Customer Care Managers
OUT	1141 Quality assurance managers
OUT	1142 Customer care managers
	115 Financial Institution And Office Managers
IN	1151 Financial institution managers
IN	1152 Office managers
	116 Managers In Distribution, Storage And Retailing
IN	1161 Transport and distribution managers
IN	1162 Storage and warehouse managers
IN	1163 Retail and wholesale managers
	117 Protective Service Officers
OUT	1171 Officers in armed forces
OUT	1172 Police officers (inspectors and above)
OUT	1173 Senior officers in fire, ambulance, prison and related services
OUT	1174 Security managers
	118 Health And Social Services Managers
OUT	1181 Hospital and health service managers
OUT	1182 Pharmacy managers
OUT	1183 Healthcare practice managers
OUT	1184 Social services managers
OUT	1185 Residential and day care managers

	121 Managers In Farming, Horticulture, Forestry And Fishing	
OUT	1211 Farm managers	
IN	1212 Natural environment and conservation managers	
IN	1219 Managers in animal husbandry, forestry and fishing n.e.c.	
	122 Managers And Proprietors In Hospitality And Leisure Services	
OUT	1221 Hotel and accommodation managers	
OUT	1222 Conference and exhibition managers	
OUT	1223 Restaurant and catering managers	
OUT	1224 Publicans and managers of licensed premises	
OUT	1225 Leisure and sports managers	
OUT	1226 Travel agency managers	
	123 Managers And Proprietors In Other Service Industries	
IN	1231 Property, housing and land managers	
OUT	1232 Garage managers and proprietors	
OUT	1233 Hairdressing and beauty salon managers and proprietors	
IN	1234 Shopkeepers and wholesale/retail dealers	
IN	1235 Recycling and refuse disposal managers	

SOC 1990

10 General Managers and Administrators in National and Local Government, Large Companies and Organisations

OUT 100 General administrators; national government (Assistant Secretary/Grade 5 and above)
IN 101 General managers; large companies and organisations
OUT 102 Local government officers (administrative and executive functions)
OUT 103 General administrators; national government (HEO to Senior principal/Grade 6)

11 Production Managers in Manufacturing, Construction, Mining and Energy Ind.

IN 110 Production, works and maintenance managers
IN 111 Managers in building and contracting
IN 112 Clerks of works
OUT 113 Managers in mining and energy industries

12 Specialist Managers

IN 120 Treasurers and company financial managers
IN 121 Marketing and sales managers
IN 122 Purchasing managers
OUT 123 Advertising and public relations managers
IN 124 Personnel, training and industrial relations managers
IN 125 Organisation and methods and work study managers
OUT 126 Computer systems and data processing managers
OUT 127 Company secretaries

13 Financial Institution and Office Managers, Civil Service Executive Officers

OUT 130 Credit controllers
IN 131 Bank, Building Society and Post Office managers (except self-employed)
OUT 132 Civil Service executive officers
IN 139 Other financial institution and office managers nes

14 Managers in Transport and Storing

IN 140 Transport managers
IN 141 Stores controllers
IN 142 Managers in warehousing and other materials handling

15 Protective Service Officers

OUT 150 Officers in UK armed forces
OUT 151 Officers in foreign and Commonwealth armed forces
OUT 152 Police officers (inspector and above)
OUT 153 Fire service officers (station officer and above)
OUT 154 Prison officers (principal officer and above)
OUT 155 Customs and excise, immigration service officers

16 Managers in Farming, Horticulture, Forestry and Fishing

OUT 160 Farm owners and managers, horticulturists
IN 169 Other managers in farming, horticulture, forestry and fishing nes

17 Managers and Proprietors in Service Industries

IN 170 Property and estate managers
OUT 171 Garage managers and proprietors
OUT 172 Hairdressers and barbers managers and proprietors
OUT 173 Hotel and accommodation managers
OUT 174 Restaurant and catering managers
OUT 175 Publicans, innkeepers and club stewards
OUT 176 Entertainment and sports managers
OUT 177 Travel agency managers
OUT 178 Managers and proprietors of butchers and fishmongers
IN 179 Managers and proprietors in service industries nes

19 Managers and Administrators NEC

OUT 190 Officials of trade associations, trade unions, professional bodies and charities
OUT 191 Registrars and administrators of educational establishments
OUT 199 Other managers and adminis

APPENDIX 2: SOME CONCEPTUAL ISSUES

In this section we set out some conceptual issues to help justify the approach taken to data and adjustments above. First, we set out the measures of intangibles from the demand and supply side and thus the circumstances in which one might want to try to adjust for imports and exports. Second, we point out that the stylised supply and demand approach does not work when there is own-account production, as when a company writes its own software for example. We therefore discuss this question. Third, another software-relevant case is when trade is not buying and selling the final product, as in many machines, but a licence to use the product, as in software. This raises the question of how one should count such licences etc. Fourth, a worry is that some intangible investment is embodied in labour and might be double counted if labour quality is included in a growth accounting analysis for example.

2.1 AN ILLUSTRATIVE MODEL AND ADJUSTING FOR EXPORT/IMPORTS

The GHW assumes no foreign trade of intangibles. What is the right concept to use? The key issue is as follows. We wish to measure, ultimately, the flow of services to UK based-firms[6] from their tangible and intangible/knowledge capital. To do this, we start by trying to measure their investment in such capital; we then measure the stock of such capital and then the service flow from such a stock.

Before considering foreign trade, it is of course worth noting that if there are pure spillovers of knowledge, in which case firms can acquire a knowledge stock and a set of flows on the basis of no expenditure at all. When we come to do our growth accounting however, this should show up as TFP which is appropriate.

Returning to the trade issue, when we ask a UK firm to record its *tangible* investment expenditure at home and abroad such investment builds tangible capital at home and abroad respectively and the capital service flow from that investment accrues at

[6] UK-based firms is a GDP concept. UK-owned firms would be a GNP concept. The reason we aim here to try to correspond with UK-based firms is that we ultimately wish to relate intangible investment to UK GDP i.e. the output from the productive activities of UK-based firms.

home and abroad respectively. But when we ask a UK firm to record its *intangible* investment expenditure at home and abroad the capital service flow from, say R&D abroad, might accrue to the firm at home. What steps can we take to address this?

We have in our data a number of ways that we are trying to measure investment in intangible assets. To help understand what adjustments we should make, in particular with foreign trade, we consider a stylised scheme of data gathering.

An illustration is set out in Table 1. Suppose there are two firms, C-type and I-type firms who produce consumption and investment goods respectively. There are at least two surveys we might run to try to find out total investment in the economy.

a. survey C-type and I-type and ask for I in both firms. This gives overall demand/expenditure on I.
b. survey only I firms and ask for output. This gives us supply/output of investment goods.

Turning to the table, consider first a closed economy. In row 1, we ask all firms for their investment expenditure. In row 2 we survey only the I-type firms and ask for their output. In column 4 we see the total demand and column 5 total supply, and the equality of demand and supply in column 6 sets I=Y.

Now consider the open economy in rows 3 and 4. In row 3, we ask firms for their investment in the UK, giving total investment in column 3. In row 4, we ask the I-type firms for their output of investment goods. However, since some investment goods can be exported, we must ask for their exports and output for their domestic customers. In column 5 we see that total supply consists of domestic supply plus any imported goods. Domestic supply is in turn total supply, Y, less exports X. Thus, as shown in column 6, we can measure total investment by Y-X+M of investment goods, (i.e. on the production side) or by total investment demand by all firms (i.e. column 4, on the demand side).

Table1. Illustrative sampling scheme to show how to gather investment data

		1 Firm-type	2 firm-type	3	4	5	6
		C-type	***I-type***	***Total***	***Demand***	***Supply***	***S=D condition***
	Closed						
Survey type 1	Ask for I	I_C	I_I	$I= I_I+I_C$	I		
Survey type 2	Ask for Y	(not applic)	Y	Y		Y	I=Y
	Open				***Dom demand***	***Dom supply***	
Survey type 3	Ask for I	$I^{UK}{}_C$	$I^{UK}{}_I$	$I^{UK}= I^{UK}{}_I+I^{UK}{}_C$	I^{UK}		
Survey type 4	Ask for Y	NA	Y^{UK}, X	$Y=Y^{UK}+X$		$Y^{UK}+M= Y-X+M$	I=Y-X+M

Note in passing there is a complication if firms invest on their own account. If the investment surveys ask for bought-in goods e.g. software, but firms have in-house software writers, then the in-house investment will not be counted. The standard method for dealing with this is to use occupation surveys to try to count spending on wages of software-related occupations (with a need in turn to adjust for any in-house software that is then sold outside, which would be double-counting with the investment survey).

a. application to R&D survey

Consider for example the R&D survey. It just samples R&D performers and asks for their R&D output. Thus it corresponds to a survey of only I-type firms. It asks for all output of R&D, that is Y in row 4.[7] Thus to get I, which is what we want, we have no direct observation of I but have to back it out from the S=D condition in column 6.

To do this in turn, means getting data on R&D exports and imports. There are two methods of getting R&D exports. The first is that the R&D survey also asks firms who funds their R&D (domestic, rest of world, government). One assumption then is that an R&D export is that part of produced R&D funded by the rest of the world. A second way of getting R&D exports is from the International Trade in Services (ITIS) survey. This asks all firms (i.e. all type-C and type-I firms) to record their exports (and imports) of R&D services, defined as R&D services for which they make a payment.

Data on R&D imports is also available from two sources. First, we can use data from ITIS. Second, in the BERD, surveyed firms are asked for not only for their output of R&D, but also for their purchases of extra-mural R&D. They are asked further to break this down into purchases from home and abroad, and so the latter are imports of R&D services. This is then a demand side measure, but note however, that this only asks the type-I firms so understates imports since it omits demand from non-R&D performing firms.

Thus should we obtain investment in domestic R&D from Y-X+M? A number of points are worth noting. First, as a matter of theory, if knowledge is not appropriable, it is questionable whether one should do this: for example, if knowledge generated at home and then exported does not in fact leave home territory then subtracting it to get domestic knowledge generation may not be appropriate. Second, against this, as a matter of data, the X and M data from ITIS are payments for R&D services. One might imagine that R&D that is contracted for by a foreign

[7] Note that in asking for output it actually asks for inputs, namely spending on workers, capital items and other. To convert these inputs into outputs one has to proceed as follows. First, spending on capital e.g. erecting a new building is investment and so has to be subtracted or else there is double counting. Second, and related, one of the costs should be costs of capital and so this has to be added in (typically it is inferred from capital spending). Third, part of "other" e.g. overheads is also likely a return on capital and has to be added too.

firm and where it is sold to them is likely to mostly migrate overseas. Within-firm knowledge is less likely to be appropriable solely at home or abroad, but this is not in practice measured in the data.

Finally, it is worth recording how these concepts relate to others such as BERD and GERD etc, which are set out in Moris (2006, p.13). BERD (Business Enterprise Expenditures on R&D) is the part of GERD (see below) performed by the business sector. GERD (Gross Domestic expenditure on R&D) are total intramural expenditures on R&D in a given period performed in the country. This includes expenditure performed in the country and funded from abroad, but excludes payments for R&D that is performed abroad. Finally NGERD (Gross national expenditure on R&D) are total expenditures on R&D in a given period financed by institutions in the country. This will exclude R&D performed in the country but financed from abroad, but includes R&D performed outside the country but financed by the country (so NGERD=GERD-funding from abroad+funding funded abroad).[8]

b. Application to management consultancy survey

Our data on bought-in organisational capital is derived from spending on management consultancy. The data is derived from the revenues of management consultants. Conceptually, it is therefore like surveying the output of the type-I producers. One point is that firms are asked in the survey for their sales to UK companies, and so this is equivalent to Y^{UK} in our diagram. Hence since $I=Y^{UK}+M$, we have to add imports.

c. Design

Our data on design in the GHW paper was derived from turnover of the design sector. This was not adjusted for imports and exports. In this paper, we use the IO tables. These data are derived from an (extended) purchases survey asking all firms for their expenditure on design. Thus this source corresponds to a row 3 type investment survey. The extra feature is that we have to add in own-account spending

[8] According to Odeye et al (2006), p.59, the current BEA US R&D satellite account treats all domestically-performed business R&D as US assets and excludes R&D performed abroad by US companies. It excludes imports and exports of R&D services and R&D of MNEs.

which will not be picked up from a purchases survey. We do this by using occupational data. Thus we do not adjust for imports and exports here.

2.2 LICENCE PAYMENTS

The survey method above assumes that investment can be either measured by asking all firms how many machines they are buying (for use in the UK) or asking the machine-producing sector how many machines they are producing (and then adjusting for imports and exports). In the case of software for example, although there is some outright purchase, much software is bought by licences of various kinds. Thus it is important to look at the treatment of these expenditures.

Much software is bought by paying (typically Microsoft) for a "licence to use". Is such a payment an investment? At first sight, if the software lasts for more than a year then it would appear to be so. But the problem is that there may be double counting. It appears unarguable that Microsoft has invested when they spend the money to design the software. Would it be double counting to count the payments to use the software as well?

To see the issues involved it is helpful to start with the treatment of tangible assets as set out in the SNA.[9] This relates to the definition of investment, what constitutes and asset and what conventions are used when assets are rented. On the issue of what is investment, para 10.26 of SNA says the following "The gross fixed capital formation of an institutional unit or sector is measured largely by the value of its acquisitions less disposals of new or existing fixed assets. Disposals do not include consumption of fixed capital. Fixed assets consist of tangible or intangible assets that have come into existence as outputs from processes of production and that are themselves used repeatedly or continuously in other processes of production over periods of time of more than one year."

The definition of an asset is in para 10.2, the thrust of which is that an asset is expected to be a source of benefit to the owner over a period of years. The paragraph

[9] e.g. http://unstats.un.org/unsd/sna1993/toctop.asp).

says: The assets recorded in the balance sheets of the System are economic assets. These are defined as entities (a) Over which ownership rights are enforced by institutional units, individually or collectively; and (b) From which economic benefits may be derived by their owners by holding them, or using them, over a period of time". Consider then the position when an airline buys an aircraft. This is the acquisition of an asset since the airline has ownership of it. The aircraft counts as an asset since it is used repeated in the process of production over time periods of more than one year.

It will be important in what follows to understand the position when the asset is leased (as is in fact frequently the case in the airline industry). The SNA convention here is that if the lease is for a repeated period of time then the convention is that ownership should reside with the lease (i.e. the airline) and so rental payments should be counted as GFCF by the airline. Note that this runs the risk of double counting, since the one does not want to count as investment both the purchase of the airliner by the leasing company and also the rental payments by the airline, but nonetheless the convention has been established.

Finally, there are a number other circumstances which differentiate investment from intermediate consumption. First, the "small tools rule" excludes expenditures on durable producer goods that are small and inexpensive (e.g. hammers, spanners etc) from investment. Second, maintenance and expenditure is treated as intermediate consumption, although it is acknowledged this is a difficult area to measure. Finally, rights to reproduce intangible assets, such as payments to show films in a cinema, are treated as intermediate consumption (SNA 6.158).

Let us turn now to intangibles and consider software. One can think of broadly two categories of software, "original" and "reproduced" (or "software copies"). In turn, originals can be thought of as (a) originals intended for reproduction and (b) other, the latter group being mostly in-house production of bespoke software. Software copies, being reproductions of originals, essentially give users the right via licence in two categories. First, "licences-to-use" where copies cannot be sold, but pre-packaged software can be used. Second, "licences-to-reproduce" where companies can copy software for subsequent sale.

Consider then originals. Originals produced under the "other" category are treated as investment if they produce assets lasting for more than a year. Originals produced for reproduction, such as Microsoft producing the software that is the original for Excel are also counted as investment. (This would appear to run the risk of double counting when we consider the licences-to-use Excel, but see below). At this stage, note that the adopted convention is to regard the production of the original and the reproductions as different goods. One way of thinking about this is to regard the original as a machine that produces software copies.

Turning now to software copies, licences-to-reproduce are regarded as intermediate consumption, just as in the film example above. Licences-to-use are regarded, provided they are above a certain threshold (500 Euros) and are used in production for more than a year, as investment. Let us consider the definitional and double counting issues. The main problem here from a definitional point of view is that most licences to use specify that ownership rests with the original seller and so conceptually hard to see why it is an asset. There are a number of answers to this. One is that license holders own the right to use the asset. A second is that the position is analogous to renting of tangible assets where the convention is that repeated rental is regarded as ownership. Thus the practical answer depends somewhat on the license arrangement. A license for use of less than one year is intermediate consumption. An outright purchase with a single up-front payment for ownership for the duration of the goods lifetime is investment. Annual payments are an intermediate case which varies case by caste. A sequence of annual payments to use of the software is investment if there is a commitment to provide the asset for all or nearly all its expected lifetime. If not, it is intermediate consumption.

Turning to double-counting, the concern here is that regarding Microsoft's investment into developing Windows and also subsequent payments to use it as both being investment might be double-counting. This argument was rejected by the SNA for the following reasons.

First, it is argued that the right way to view an original piece of software is as a machine which enables one to then produce copies. Thus we count spending on a

truck factory as investment and spending on trucks (by firms) as also being investment, despite the factory being an essential input into the production of the truck. The difference with software is that the production of the copy does not involve any depreciation of the original. But we would still count the truck factory and the trucks as investment even if there was no deprecation of the factory in producing the truck. So for example, if programs could only be reproduced and sold on expensive CDs then we would still treat their purchase as investments. An alternative way of thinking about the problem is to think of there being two production activities, the activity of producing the original and of reproducing it. Whilst the actual cost of reproducing the asset might be small there are other intermediate costs such as marketing and documentation.

A second pragmatic argument is that in practice creation of the original comes before reproduction and so in practice creation is measured as costs of doing so which may not necessarily double count subsequent returns (depending on how much the company chooses to spend in the prospect of future returns and how much margin is added to measured wage costs of production). An added pragmatic argument is that in practice few firms capitalise their innovation expenditure, since accountants tend to prefer a prudent approach that expenses such spending.

A third argument would be that payments for copies should be subtracted from the value of the original so that global investment remains the same but is just re-distributed from the owner of the original the maker of the copy. The main reason for rejecting this is practicality. If one regards the rationale behind this as licences being part sales of the original, one practical objection is that if costs of reproduction are non-negligible one would have to measure such reproduction costs. A second is that if one regards the rationale as being payment for access rights, then one can think of software users as paying to rent the intangible part of the original. So owners of a book are renting the story, whilst owning the pages, or owners of a mobile phone are renting the software whilst owning the tangible components. Again, the measurement problems here are too formidable.

2.3 OWN ACCOUNT

The examples above rely on firms purchasing machines or software externally and so measuring this from market transactions. Some output, e.g. of design, software will be own account. The convention in software is to proceed as follows. First, identify occupations that are concerned with software writing and calculate their wage bill. Second, identify the fraction of their time they likely spend on writing the software and adjust the wage bill accordingly. Third, adjust the wage bill up to reflect other costs such as labour taxes, and non-labour costs. Fourth, adjust the wage bill down in cases where own-account software is then sold to external clients. For details, see e.g. Chamberlin, Clayton and Farooqui (2007). Our wage bill numbers here for management and design are not adjusted (and the employment weights are those from the NES not the LFS).

2.4 LABOUR QUALITY

The final question revolves around whether any investments in intangible assets become embodied in workers and are therefore potentially double counted if we use labour quality in a growth accounting exercise. The obvious issue here arises with training. Our data uses training expenditures paid for by the firm. According to the Becker training model, training can be company-specific or general (that is useful outside the company). In the absence of binding contracts to keep the worker at the firm, firms should be willing to pay for company-specific training and workers for general training. Workers paying are an equilibrium outcome since they get the benefits of such training because they raise their wages since they are more valuable in the market. Firms paying is also equilibrium since firms accrue the returns to such training. Thus company-provided training expenditures should reflect payments for returns that are company-specific. There are a number of points worth making.

First, the SNA definition of investment requires economic benefits from an asset and workers are not owned by the firm. Nonetheless there may be some contracts that firms can sign to bind workers to the firm for a number of years when the firm pays for training, or require the payment back. Or, one might view wages as a sequence of rental payments in the reasonable expectation of repeatedly renting an asset. Second, a more difficult issue is the use of wages and salaries of workers as a measure of own-account investment in software, organisational capital and here, design (and in practice R&D since much of R&D is wages and salaries of scientists).

If this is regarded as a return to intangible capital should such labour be removed from the employment numbers? In these data is that this is likely a small effect in practice.