

# Productivity and Innovation in UK Financial Services: An Intangible Assets Approach\*

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## Abstract

Financial services are typically described as highly innovative (indeed excessively so according to some commentators). However, it is hard to see this by many standard IO innovation and productivity measures. Patenting for financial products in the UK is zero. R&D as a fraction of sales in UK financial services is 0.02%, putting finance (on this measure) less innovative than furniture manufacture (0.3%). Whilst measured labour and total factor productivity growth have been quite rapid, there are doubts over measurement and the residual nature of TFP growth leaves open the question of what drives financial innovation. This paper looks at innovation in UK financial services by trying to bring together the industry productivity/TFP literature with some of the case study evidence. Case studies suggest that much financial innovation (a) can be readily copied and (b) requires investment in product development, software, marketing, training and organisational change. Whilst copying can be captured by TFP, these investments are almost certainly not captured by conventional R&D. Thus we follow the Corrado, Hulten and Sichel (2005) intangibles framework and measure the broad range of intangible/knowledge assets that case studies suggest are important in finance. We document that these investments are very large in UK finance, and that conventional R&D understates them. Incorporating them into the growth accounting picture we show that the method seems to capture much of innovation in financial services and changes the productivity/TFP growth picture to give more intuitive numbers.

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# 1 Introduction

Financial services is widely regarded as being highly innovative. Retail users of banks for example, can bank online, transfer money electronically and trade exotic financial instruments (all from their iPhone). Indeed, the benefits of some financial innovation are hotly contested. Alan Greenspan, speaking in 2002, allocated to financial innovation much of the credit for a previously stable macroenvironment. Warren Buffett, writing in 2002, allocated to (particular forms of) financial innovation the epithet “financial weapons of mass destruction”. Rarely before has innovation in any industry been accused of bringing down the entire capitalist system.<sup>1</sup>

Despite such popular interest, recent surveys bemoan a comparative lack of academic empirical work on financial innovation: see for example, the excellent survey papers by Frame and White (2004) and Tufano (2002). Indeed, in their comprehensive survey, Frame and White (2004) were only able to find 39 empirical studies of financial innovation studying 21 separate phenomena, with six studies preceding the 1990s and 23 since 1998.

Given the gigantic IO/productivity literature on innovation, one might go there first for financial innovation studies. However as Frame and White (2004) point out, that literature, which relies on such measures as R&D, patents and labour or total factor productivity growth (LPG, TFPG) has hardly been used in financial services. On patents, as Hall (2009) points out, this is for good reasons; in the UK for example, regulators have ruled that financial innovation is essentially unpatentable. On R&D, banks have the lowest R&D intensity in the official UK official R&D scoreboard, but this uses R&D from company accounts, which only allow software in the course of development to be counted as R&D.<sup>2</sup> As we document below, R&D intensity (spend over sales) measured by the UK official R&D survey puts financial services (at 0.02%) below furniture manufacture (0.3%).<sup>3</sup> On LPG, the UK Office for National Statistics (ONS) say that output measurement is too unreliable for these data to be relied upon (Vaze, 2002). In addition, since TFPG is a residual this leaves open what is driving financial innovation (besides pure knowledge spillovers).

Thus one important strand of the empirical literature consist of studies of particular forms of financial innovations, suggested by, for example, interviews with market participants or

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<sup>1</sup> Both quoted in Jenkinson (2008). See also Litan (2010) for a review of financial innovation by function and a qualitative assessment of the contribution to productivity. He also quotes Krugman, Volker and Johnson and Kwak on financial innovation, including Volker’s view that the ATM is the most important.

<sup>2</sup> For the US, using such accounting data Lerner (2002) reports that “for instance, neither Citigroup nor Merrill Lynch report any R&D between 1990 and 2002”.

<sup>3</sup> This is similar for the US. US data breaks down R&D in “Finance, Insurance and Real Estate” and finds a share of sales of 0.5% in 2005, compared with 3.6% in manufacturing as a whole (<http://www.nsf.gov/statistics/seind08/append/c4/at04-22.xls> from <http://www.nsf.gov/statistics/seind08/c4/c4s3.htm#c4s31>). That puts financial R&D intensity less than half that of furniture manufacturing (0.8%).

newspaper records (we label these as case studies just as convenient name). Black and Scholes (1974) for example describe the introduction by Wells Fargo Bank of what would now be called an index fund. Tufano (1989) considers 58 financial innovations, 1974-86, where his sample are innovative corporate or mortgage-backed securities, as identified in literature searches or by industry experts. Lerner (2002) documents innovation 1990-2002 via a search for particular news stories in the Wall Street Journal. Litan (2010) also documents financial innovations using a variety of sources including Wikipedia, see his note 46.

This paper attempts to incorporate (at least some of) the important findings of the case study type work into the conventional LPG/TFPG/R&D literature to see if results in this area can be improved. It does this expressly *not* to deny the importance of the detailed innovation literature. Rather, in the light of Frame and White's (2004) request for more empirical work in the area, we wish to see if extending the conventional approach can yield insights. In addition, industry-level productivity studies continue to be staple tools of the profession and statistical authorities have a duty to collect financial services data to compile National Accounts. With this increasing emphasis on measurement of the service sector, this study might be seen as contributing to that literature.<sup>4</sup>

To summarise our work, we proceed as follows. Detailed work on financial services, surveyed below, suggests a number of interesting features of financial innovation. First, much financial innovation is due to new products and services (e.g. subprime mortgages, internet banking, ATMs). Second, much comes from new production processes (e.g. electronic money processing, credit scoring) and organisational forms (e.g. internet only banks) (Frame and White, 2004). Third, much financial innovation can be copied readily (Frame and White, 2004 Lerner, 2002, Tufano, 2002). Thus we need a framework that captures innovation in products, organisational form and imitation.

What does financial product innovation need to happen? Tufano (1998) states that his case studies indicate that a typical financial product innovation needs

*“an investment of \$50,000 to \$5 million, which includes (a) payments for legal, accounting, regulatory, and tax advice, (b) time spent educating issuers, investors, and traders, (c) investments in computer systems for pricing and trading, and (d) capital and personnel commitments to support market-making. In addition, investment banks that innovate typically pay \$1 million annually to staff product development groups.”*

How does all this fit into the conventional LPG/TFPG/R&D Solow-type framework? In that framework, output comes from physical capital, labour and knowledge. As typically measured in conventional growth accounting work, knowledge is measured by TFP. Some of the features of

the detailed studies *can* be captured in this framework at least conceptually (measurement issues aside for the moment). First, such studies emphasise the importance of computers: they are part of physical capital. Second, since products seem to be able to be imitated very quickly and cheaply as knowledge passes very rapidly between financial firms, this can in principle be captured by TFP.

However, these case studies suggest that at least some innovation is not free but requires up-front investment in new knowledge. In Tufano's example above, this is outside conventionally measured R&D, since it is investment in software, product development time for employees, marketing the product, training staff and changing organisational form.

Thus our key argument in this paper is that whilst the productivity/growth accounting framework allows for spending on tangible capital, it needs to be extended to spending on intangible capital, which is what detailed studies suggest financial innovation involves. Central to much of the work of Grilliches (1999) was just this idea, with an emphasis on R&D. But the examples above suggest we have to consider spending beyond just that of R&D. This is exactly what the recent contributions by Corrado, Hulten, Sichel (2005, 2007), applied to the macro economy, do. They argue that knowledge spending should embrace a broad range of investment in knowledge assets, as well as R&D, software, marketing, training, organisational capital and that incorporation of such spending should improve our understanding of growth by, for example, explaining much of the unexplained residual TFPG.<sup>5</sup>

The purpose of this paper is then to apply the CHS framework to see if it gives a more informative picture of innovation and growth in financial services. To the best of our knowledge, this is the first paper to do this. Of course, in so doing we have to rely on a number of assumptions regarding e.g. measurement, returns to scale, competition etc. Thus we regard this paper as an initial exploration into whether it is worthwhile for future work to examine these issues.

We obtain a number of results. First, in applying the framework to financial services we have also to apply it to the rest of the economy (to solve endogenously for rates of return to compute consistent intangible and tangible capital rental rates). Thus we start by comparing (broadly defined) knowledge investment in financial services with the rest of the economy. As discussed above, financial services accounts for a very small share of total measured R&D spend, but it is a disproportionately<sup>6</sup> large spender on other intangible assets: in 2006, 22% of all software spend, 17% of all marketing spend and 19% of all organisational capital spend. Using

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<sup>4</sup> We have nothing to say on patents in this paper, other than to document that UK regulations are that patenting in financial services is more or less completely excluded.

<sup>5</sup> Some of these categories are now counted in the official data as investment, notably software. Software was only fully integrated as investment into the UK National Accounts in 2005 however. R&D will be integrated in 2012.

<sup>6</sup> Financial services value added is about 11% of the market sector and employment 5%, see tables below.

the wider definition then, financial services is actually very “innovation spending” intensive, contrary to the view if one just used measured R&D.

Second, if the conventional measure of R&D is inappropriate for financial services, we need to develop a new one. We do this by following the standard method for measuring own-account software<sup>7</sup>. Using the labour force data, we identify “research” type occupations, where we assume that such occupations produce a knowledge asset, like a new product. We then infer spending on “R&D”, in this case, knowledge development in firms, from costs of these workers. We attempt to validate these assumptions with data from interviews with major financial firms. Such spending turns out to be around £1bn for 2006. Relative to the official R&D measure, of around £20m, this is much larger, although it is small relative to software spending of £4.1bn.

Third, we then estimate the contributions of all these assets to LPG (measured as annual growth in gross output per hour) and the resulting TFPG. Taking no account of intangibles (i.e. spending on knowledge assets such as R&D spend, software, product development etc), LPG in financial services, 2000-05 is 2.94%pa (against 3.02%pa in retail and 3.79%pa in manufacturing). Capital deepening is around 12% of LPG in finance, almost all of which is due to ICT capital. TFPG in financial services is 1.39%pa, about 1½ times manufacturing and 2½ times retail, and around 50% of LPG, (TFPG is 23% of LPG in manufacturing and 20% in retail).

When we incorporate intangible capital, the picture changes. First, a much larger fraction of LPG in financial services is accounted for by capital deepening, 26%. Second, rather than all of such capital deepening being due to tangible ICT capital, around half of it, with the other half due to intangible capital deepening. The bulk of intangible capital deepening is from software and organisational capital. The contribution of software (0.14%pa) in finance is larger than that of manufacturing and retail (both 0.08%pa), according with the intuition that software-related capital deepening is important in financial services. The contribution of organisational capital (0.15%pa) is similar to that in other sectors, but a higher fraction (around 5%) of LPG. Hardware is also very important in financial services, with half of capital deepening due to hardware (in manufacturing and retail the figures are 8% and 31% of total capital deepening), again suggesting the importance of ICT in the sector. Indeed, the sum of hardware and software contributes 20% of (gross output) LPG in financial services as opposed to 14% in retail and 5% in manufacturing. Finally, TFPG in finance is still twice that in manufacturing and 2½ that in retail, but 29% of LPG, thus allowing us to account for much more of LPG when intangibles are included. So, if

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<sup>7</sup> First, occupations are identified that are part of the creation of software (e.g. software engineers and programmers, IT managers). Second, estimates of wage bills using occupational data are computed. Third, the wage bills are multiplied by a fraction of time spend on long-lasting software creation (e.g. this is 50% for software professionals and 15% for managers) and another fraction for overhead costs (1.6). The resulting number is an estimate of the “R&D” costs that firms incur in producing own-account software and these numbers are added to purchased software from surveys (for the UK in 2004, own-account and purchased software came to around £10bn each).

one scores “innovation” in industries as the fraction of LPG accounted for by intangible capital deepening and TFPG, financial services are the most innovative (44%), followed by manufacturing and retail (34% and 26%).

In sum, whilst there is clearly more work to be done relaxing assumptions etc., and we present a number of robustness tests, we think these findings offer a more complete picture than much of the previous work that either relegated all knowledge to TFP or just used R&D and they accord with much of the findings in the detailed industry-specific studies.

The rest of this paper proceeds as follows. The next section reviews the literature on financial innovation. Section 3 sets out our data on knowledge capital in financial services, section 4 our growth accounting results and section 5 concludes.

## **2 Previous work on financial services innovation**

In this paper we seek to measure productivity and innovation in financial services via a growth accounting method. We stress very strongly that this method is but one contribution to a literature which will rightly draw evidence from a number of methods. So the purpose of this section here is to better understand how this method will fit with other methods, and its relative advantages and disadvantages.

Frame and White (2004), in an exhaustive survey, document that there are very few empirical studies of financial innovation, a conclusion supported by Lerner (2002) and the survey of Tufano (2002). In addition, they argue there seems to be no single preferred categorisation of either research method or innovation category.

To start, perhaps the most straightforward, and venerable, approach to innovation is to categorise innovation by product. For example, Tufano's survey of financial innovation documents that lists of security types have been collated since at least the 1930s. He himself also sets out a list, from 1980 to 2001, of new securities. As he mentions, this is but a small amount of innovation in the field and many securities on such a list are near-identical products by different banks. In a similar vein, Lerner (2002) documents innovation 1990-2002 via a search for particular news stories in the Wall Street Journal.

Another approach is case studies. Black and Scholes (1974) describe the introduction by Wells Fargo Bank of (what would now be called) an index fund, the innovation being a product enabling investors to hold a share collection but economising on the transactions costs of buying every stock individually. Black and Scholes (1974) emphasise the high up-front costs of the product; that Wells felt they needed to spend \$60m to go ahead with the fund and also discuss the high costs of marketing and selling the product.

Tufano (1992, page 25) discusses Exchange Traded Funds and personal funds (the latter being a follow-up to index funds, essentially allowing trading in the market index during the trading day with fractional shares). He comments that although the motivation to offer diversified baskets is old, "...it is technology, embedded in improvements in information technologies, that permit personal funds to be technically feasible. Technology may enable these innovators to market these products via the web as well as execute transactions at low costs." This example emphasises the blend of ICT, new since Black and Scholes, and the required coinvestment in marketing, not so new.

Tufano (1989) considers 58 financial innovations, 1974-86, where his sample are innovative corporate or mortgage-backed securities, as identified in literature searches or by industry experts. He has a number of interesting findings in relation to our growth accounting approach here. First, reports that bankers estimate that developing a new financial product

requires “an investment of \$50,000 to \$5 million, which includes (a) payments for legal, accounting, regulatory, and tax advice, (b) time spent educating issuers, investors, and traders, (c) investments in computer systems for pricing and trading, and (d) capital and personnel commitments to support market-making. In addition, investment banks that innovate typically pay \$1 million annually to staff product development groups with two to six bankers.” Like above, this emphasise the coinvestments needed in innovation around the pure notion of a new product. Second, he estimates that imitation of the innovative product is typically very fast: the mean number of days until a rival entered with an imitative product was 77.6 days, and 35 of the products surveyed were imitated within a year of initial marketisation.

Frame and White (2004) categorise classes of innovation by purposes in the financial system. First, they discuss new products (e.g., subprime mortgages) or services (e.g., ATM, debit and pre-paid cards and internet banking for transactions). Second, new production processes. Examples included credit scoring, the electronic processing of payments, asset securitization and new methods of risk management, helped in turn by advances in IT and financial theory. Finally, they discuss new organizational forms (e.g., Internet-only banks).

Lerner (2006) sets out some reasons why innovation in finance might be very different from that in manufacturing. First, he argues that financial innovation is unlikely to be appropriable. Patents in finance have only been introduced very recently (in the US), are essentially unpatentable in the UK (Hall, 2009), and hence new product ideas are diffused very quickly.<sup>9</sup> Indeed, he finds, in his analysis of financial innovations 1990-2002, spillover effects with more financial innovations occurring when there are more innovations in the two-digit zip

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<sup>8</sup> There is no one way of classifying innovation in finance. Mayer (1986) surveys innovation by (a) new instruments and (b) changing practices and structures (such as cross border banking: his survey was written before the internet). Merton (1992) sets out functions of a financial system namely (1) moving funds across time and space; (2) the pooling of funds; (3) managing risk; (4) extracting information to support decision-making; (5) addressing moral hazard and asymmetric information problems; and (6) facilitating the sale of purchase of goods and services through a payment system. Tufano (2002) says that innovation in finance exists for the following reasons: 1. complete inherently incomplete markets. 2) *Innovation persists to address inherent agency concerns and information asymmetries*; (3) *Innovation exists so parties can minimize transaction, search or marketing costs*. (4) *Innovation is a response to taxes and regulation*; (5) *Increasing globalization and risk motivate innovation*. (6) *Technological shocks stimulate innovation*. However, he then documents some innovations that, in practice cross over all these motivations. Litan (2010) classifies innovation by payments, saving, investment and risk-bearing.

<sup>9</sup> Lerner (2002) reports the following on US patents. In the US and UK business methods had not been considered patentable. In the US, this changed with the Signature decision. Signature had a patent on a software program to determine the value of mutual funds. They successfully defended the patent and it appears that business methods can be patented. Despite this, at the time of his paper, patenting was not widespread. For example, universities and academics had patented 4 innovations. However, the position is different for the UK, as reported in Hall (2009). “In the UK, for example, the Patent Office introduced special treatment for business method applications in November 2004, due to the increasing number that had little or no chance of being granted (MIP Week 2004). In so doing, the Director cited applications from Fujitsu for optimizing the scheduling of airline crew, and a system for managing a debt-recovering process as being inherently unpatentable. In general UK practice with respect to software patents is viewed by practitioners as more restrictive than that at the EPO (MIP Week 2007).”

code. Second, much innovation is due to regulation, particularly with respect to taxes. Third, collaboration is likely to be particularly important for example in the syndication of securities.

How does all this fit in with our approach? To stress again, we do not claim that our approach is better than others, but wish here to “stress test” our approach by seeing what elements of other approaches it can and cannot incorporate.

First, there seems much evidence of spillovers: e.g. the banks offering “near identical” securities in Tufano (1989), very fast entry in Tufano (1989), limited use of patents and use of collaboration (Lerner, 2002). All this suggests that one needs a framework which accommodates spillovers as a source of knowledge. In terms of our approach, TFPG will be important in growth.

Second, although there are spillovers, we also have direct evidence that innovation requires investment. The most direct evidence is that from bankers themselves summarised in Black and Scholes (1975) and Tufano (1989). Such spending is of course ICT related, computer hardware for example. Frame and White’s list of innovations, for example, credit scoring, electronic money transfer and internet banking seem especially IT-intensive. So it will be important to measure this and, given the quality-changes in IT, quality adjust for IT. But such innovation investment is not just pure product development (which might be thought of as “R&D” in a manufacturing context) but also marketing, organisational change, and within-company training.

Third, and related, such innovation spending is almost certainly not captured by reported R&D. The UK accounting rules exclude almost all of the headings above (only some software is allowed). Reporting rules for the ONS R&D survey exclude software, marketing and training.

Fourth, and similarly related, if knowledge can easily spillover and so first-mover advantage is particularly important, this suggests that much innovation will be developed in house. Thus it will be not captured in standard business spending surveys that typically ask about purchases of investment goods: such surveys are typically well suited to tangible investment (computers are not made in-house by banks) but not intangible investment.

There has of course been much work on financial services output since the National Accounts has to incorporate financial services when measuring GDP. This work is somewhat unappreciated, perhaps because it is behind the National Accounts scenes and perhaps too because it is recent (so for example, the new measures of financial services were incorporated into US National Accounts in 2003 and in the UK in Summer 2009). Such work is summarised most recently in Fixler, Reinsdorf and Smith (2009), but draws on previous work surveyed in, for example, Triplett and Bosworth (2004) Fixler, Reinsdorf and Smith (2003) and Fixler and Zieschang (1999). Perhaps the easiest way to see this work is to view banking as providing a stream of financial services rewarded by explicit charges and margins. The calculation of the margin is the typical issue and different views are set out in Wang (2003) and Basu et al (2008),

see also the survey in Schryrer (2009). We shall not attempt to adjudicate on such arguments, but use the official UK data, and note the relevant caveats for our approach, which is reviewed in Section 4.

### **3 Knowledge investment in UK financial services**

#### **3.1 *Industry definitions***

Table 1 sets out our industries of interest. The first three columns show the relevant UK SIC codes by letter and number and description. In the paper below we will contrast our data with the official Business Enterprise R&D data (BERD), and the fourth column shows the industry breakdown which they report, namely “AD” defined as “Miscellaneous business activities; Technical testing and analysis”. As the table shows, the BERD category covers most of the J to K sections, with the exception of SIC72 “Computer-related activities” and SIC73 “Research and development”. The final column shows the industries that our paper covers. We present industry analysis for “financial intermediation” and “business services” separately. It will be important in our productivity analysis to note too that the 2digit SIC sector 70 “real estate” also includes sub sector 70.2 “letting of own property”. This subsector has imputed rents included in it. We therefore omit this industry for TFP purposes for we do not measure household dwellings in our capital stock.

#### **3.2 *Spending on product development in financial services***

The case studies suggest that financial service firms have to spend on product development. Hence our requirement here is to try to measure such “R&D” spending. Since it is not officially reported, we go to the labour force data. The UK data uses the Standard Occupational Classification (SOC). The SOC (2000) has nine “major occupational groups”.<sup>10</sup> Excluding all those occupations which perform administrative and routine activities, therefore excludes SOC (2000) major occupational group codes 4 to 9. This leaves us with “managers and senior officials”, major occupational group code 1, “professional occupations” major group 2 and “associate professional and technical occupations” major group 3. We also decided to exclude “financial technicians (brokers, analysts, adviser, etc)” (these occupations are in major group 3) since we judged that they mostly do sales rather than research. We discuss group 1, managers below, but here we therefore discuss group 2, where we settled then the detailed occupational headings set out in Table 2, under the broad headings “researchers” and “other researchers”.

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<sup>10</sup> The major groups in SOC (2000) are: 1 “managers and senior officials”, 2 “professional occupations”, 3 “associate professional and technical occupations”, 4 “administrative and secretarial occupations”, 5 “skilled trades occupations”, 6 “personal services occupations”, 7 “sales and customer services occupations”, 8 “process, plant and machine operatives”, 9 “elementary occupations”.

Researchers are those whose occupational title seems to correspond to the type of occupations one would expect to be designing new products, carrying out analysis and building knowledge capital in financial services, most notably “management consultants, actuaries, economists and statisticians” (who turn out to be much the largest group). We also include scientific and social science researchers. “Other researchers”, consists of a rather disparate group of engineers and other professionals who one might expect to be knowledge creators. In practice, this is a small group, but we set these out to facilitate the comparability of this work to similar work in the US carried by Hunt (2009).

Table 3 reports employment data for these groups, with managers and software professionals added for comparison.<sup>11</sup> It is worth noting just how many IT employees there are in financial services, suggesting they are significant part of innovation in finance.<sup>12</sup>

How do these employment numbers compare with those for R&D? The BERD reports, for 2005, for the UK whole economy, 77,000 scientists and engineers working on civilian R&D and 17,000 working on defence (with respectively 24,000 and 2,000 and 25,000 and 4,000 “technicians, laboratory assistants” and “admin and clerical staff”). Now, for sector AD, which includes financial intermediation, miscellaneous business activities and technical and testing analysis” the data are 6,000, total, 3,000 scientists, and 2,000 technicians and 1,000 admin. Our numbers are of course very much higher than this, with over 30,000 “researchers” and “other researchers” in 2005 in Financial Intermediation.

Having chosen the occupations we believe are potential “knowledge” occupations we are now in a position to estimate implied spending on broad knowledge, or “R&D”. To do this, we adopt the software method by taking the wage bill and assuming (a) the fraction of time each occupation spends on research activities (b) the mark-up on wage costs (due to overheads and

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<sup>11</sup> For software we follow the ONS method that has been built up with industry consultation. Whilst some of what software workers do is likely short-lived, for example fixing bugs and day-to-day advice, some activities, particularly writing code, is likely creating a long lived (knowledge) asset. Our interviews with financial firms have indicated for example, that many buy in software and then use their own in-house software specialists to modify it. Official ONS data includes these types with, in addition, other ICT staff such as technicians. For organisational form, we follow CHS in assuming the following First, one might measure management consulting services bought it, to the extent that they are helping firms in organisational innovation. Second, some fraction of managerial time might be spend on “in-house” development of organisations. Of course, a manager likely builds up experience etc. which is embodied in themselves, but firms have a clear incentive to try to capture and codify at least some of this knowledge, not least because managers might leave.

<sup>12</sup> Employment by occupation is complicated because of two different sources of employment data, the ASHE (Annual Survey of Employment and Hours) and the LFS (labour force survey). The ASHE is a sample of 1% of workers whom have a National Insurance number ending in a certain 2 digits. Employers fill out the survey and report occupation and wages, information on which is then weighted by ONS to be nationally representative. The LFS is a quarterly household survey where workers self-report wages and occupation. Relative to the ASHE, the aggregated employment data from the LFS is sometimes argued to be more accurate, whilst the wage and occupation data to be less accurate, the latter because there is considerable poor reporting in the wage data e.g. for respondents if householders are absent when the surveyor calls and likewise for occupations. In data available on request, we explored both surveys. Managerial employment and researchers are quite close, whereas the LFS has more software.

ancillary costs) that firms incur on such workers. The resulting figure gives the “own-account” spending on broad knowledge activities. The method mirrors the spending in the official R&D survey, which asks for spending on R&D employees, including taxes, plus capital stock associated with such spending and other ancillary costs.

Establishing the fractions in (a) and (b) is a matter of ongoing research. Our data for overheads uses the standard assumptions in software (1.6). Turning to (a), we note that for software the official data uses the results of industry consultations, cross-checked with other countries and uses for example, a figure of 50% for software professionals and 15% for managers.

The fraction of time spent by research occupations in financial has not been examined systematically thus far by official data. We therefore undertook our own preliminary surveys as follows. First, we were given access to an unpublished study of time allocation undertaken by the Council for Industry and Higher Education (2007) for the London office of a very large US-owned investment bank. This covered a number of different grades and occupations and suggested a figure of 50% for researchers, that is, 50% of their time is spending on asset-building activities. Second, we conducted interviews with two other London-based major banks and found a similar kind of figure. Clearly more needs to be done here, although since banking is so concentrated we have covered a rather large fraction of banks even with just a small number of firms. Thus we shall use a figure of 50%, but we shall of course experiment with altering this figure in growth accounting below, it turns out to not make too much difference.

So what are the final numbers and how do they compare with the “official” R&D data? Table 4 sets this out. Column 1 and 2 shows our assumed R&D investment, in £bn, for selected years due to researchers and “other researchers”. Columns 3 to 6 are the data on software and organisational capital, purchased and own-account where own-account organisational capital is 20% of managerial wages and salaries in managerial occupations applied consistently across industries and the software data are official ONS data. As the data show, spending on other researchers is not large. But spending on researchers is about a quarter of total spending on software in recent times, but both less than spending on organisational capital.

Finally, for comparison columns 7 and 8 set out R&D in financial services. In column 7, we show R&D from the Department for Business Innovation and Skills (BIS) R&D scoreboard publication, giving R&D reported in company accounts<sup>13</sup>. This is £0.86bn, a fraction of 0.45% of sales in the lower panel. This number is well below that our research number and indeed below software, which accords with the point that only some software is allowable to be capitalised as R&D in company accounts.

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<sup>13</sup> According to the BIS Scoreboard (2008) notes, the only type of R&D capitalised by banks is investment in the development of internally generated software. For a comparison see their figure 8 where R&D as a fraction of sales in banks is very low (figure 8, p20).

Column 8 sets out our estimates of R&D spend as measured by the ONS BERD data. The reported spend covers both financial and some business services, so the numbers in the table are our best estimate of the part accounted for by financial services.<sup>14</sup>

What conclusions can we draw from this? First, the BERD data suggests a “research” spend of about 1/100<sup>th</sup> of that from the researchers evidence. So “research” spend, we believe is underestimated by the BERD: instead of being 0.01% of sales in 2006, it is 0.52% of sales. Second, spending on other knowledge assets is considerable; in 2006 software investment for example is 2.09% of sales.

### **3.3 *Spending on other knowledge activities in financial services***

Following CHS (2006) we distinguished between three main classes of intangible assets: i) computerised information (software and databases); ii) innovative property (R&D, mineral exploration, copyright, product development in finance, design); and iii) economic competencies (branding, firm-funded training, organisational investment).

Computerised information comprises computer software, both purchased and own-account, and computerized databases. Such data are already capitalised in the National Accounts and we use this data. The purchased comes from purchasing surveys and the own-account from software-related occupations using the method we have used for product development above.

Innovative property consists of the headings. For Scientific R&D, as mentioned before, we use BERD, where to avoid double counting of R&D and software investment, R&D spending in “computer and related activities” (SIC 72) is subtracted from R&D spending.<sup>15</sup>

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<sup>14</sup> This allocation is rather complicated for it is hard to know how firms in industry J report when they report their R&D to the ONS. First, the R&D definition in the Frascati manual upon which BERD draws has changed somewhat over the years, with pre1992 excluding pretty much all R&D in financial services. Second, whilst in recent years the opening part of the form has asked for R&D not mentioning the word scientific, the final part asks firms to report scientists, technicians and related administrative workers, a classification that might make financial institutions not report their R&D work. At any rate, as set out in Table 2, the reported BERD R&D data is for is reported for sector AD which consists of industry J, SIC65, 66, 67,70 and 71 (financial intermediation, pensions, and auxiliary activities, real estate and renting of machinery) plus SIC74 (other business activities). There are a number of reasons to suppose that quite a small proportion should be allocated to J. First, ONS informed us that a very small number of financial firms actually returned the BERD, too small to pass disclosure (that is, under 10 firms). Indeed, the ABI, which forms the sampling frame for the R&D questionnaire was not sent to financial service firms and so another survey was required to form the sampling frame. Second, the R&D survey (until 2009) asks respondents to allocate employment into that covered by scientists, technicians and other R&D-related administrative areas. If we duplicate these classifications, using the Standard occupational codes from the ASHE for SICs 65to71 and 74, we find that 95% of total wage bills comes from scientists employed in SIC74 (and 92% of technicians, but the bulk of technicians in Sector J are in the “not elsewhere classified” part of the technicians’ occupation classification). Thus we decided to allocate 5% of the BERD spending for BERD sector AD to financial services. That figure, for 2006, is about £19m (allocating by total employment gives £92m).

<sup>15</sup> Other items that do not affect financial services are mineral exploration, and copyright and license costs all of which are already capitalised in the National Accounts, thus we use ONS Gross Fixed Capital Formation (GFCF). R&D in social sciences and humanities is estimated as twice the turnover of R&D in

Design is a major category in aggregate, where we collect purchased data from IO tables and own-account data from architects and designer occupations (who are mostly “architects” and “design and development engineers”, (SOC 2431 and SOC2126) and “designers” minor group SOC342)<sup>16</sup>. By this method, financial services has almost no own-account spending, since almost none of these occupations are in financial services. However, the input/output tables reveal quite considerable purchases of design and architectural services; around 2/3<sup>rd</sup>s of that in manufacturing. Upon further investigation, it turns out that almost all of such purchases are by the insurance sector. Further work will need to use interviews with major insurance companies to probe this spending more, but for the moment we shall regard this spending as particularly uncertain knowledge investment, but experiment with setting it to zero in the growth accounting exercises. Results are presented in the appendix.

The final group of intangible spending is economic competencies. Advertising expenditure is estimated from the IO Tables by summing intermediate consumption on Advertising (product group 113) across all industries. Firm specific human capital, is estimated from cross sections of the National Employer Skills Survey (NESS 2004, 5) and a one-off survey from 1998. Finally, investment in organisational structure relies on purchased management consulting, on which we have used the Management Consultancy Association (MCA), and own-account spending. Such own-account spending is hard to measure, and so we have taken, following CHS, 20% of the value of managerial time. Such a time allocation is clearly arbitrary, and it requires more data, but for the moment we note the following. First, we report below robustness checks to different assumed time fractions. Second, regarding managerial time, we do have two (albeit small) microdata surveys on intangible investment, set out in Haskel and Pesole (2009) and Barnett (2009). These papers use, respectively, intangible spending from the ONS pilot Intangible Investment Survey, carried out in Summer 2008 and the Warwick/Aston survey, carried out in Summer 2009. In both those surveys, respondents were asked directly about spending on organisational capital, including asking them to estimate managerial time. In both cases, the spending figure is remarkably close to the derived figure assuming 20% of managerial time. At the time of writing the new extended ONS survey, that asks companies for spending on all intangible assets is in the field, so this will provide vital extra information. Our current starting point is at least in line with the current data on this area.

Table 5 sets out the share of investment in the particular asset in the indicated industry as a share of total investment of the same asset in the total market sector, with, in the lower panel, shares of value added and employment shown for comparison. Thus, looking at column 1 for example, in 2000, manufacturing accounted for 19% of software investment, 79% of R&D

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“Social sciences and humanities” (SIC 73.2), where the doubling is assumed to capture own-account spending.

<sup>16</sup> We left out other engineers in case of double counting with R&D.

investment, 32% of design etc. Financial services is much less R&D intensive (R&D here includes our imputed R&D figure based on occupations and official R&D figure from BERD) but very software intensive, accounting for 21% of all market sector software investment. This is considerable bearing in mind the size of financial services, see the lower panel of Table 5. Likewise, there is a large share of investment, relative to employment or value added share, in brand equity and organisational capital.

## **4 Productivity growth and innovation in financial services revisited**

### **4.1 *Output values and price indices in financial services***

Our output data is taken from the EUKLEMS dataset, see Timmer, O'Mahony and van Ark, (2008). This dataset gives consistent data on output, labour and tangible capital input for many UK industries and is widely used. Since it is derived from the National Accounts, the question is what National Accounts practices have been adopted to measure output. This is an area much discussed, see for example the exchange between Bosworth and Triplett (2004) and Fixler (2004) and Diewert (2007) and Basu, Inklaar and Wang (2007) and Scheryer (2007) for example on the conceptual issues, with a extensive recent review by Colangelo and Inklaar (2010). See Appendix B for a simple formal model of output measurement in banking.

ONS has changed the output measure in financial services since August 2009, revising therefore national accounts data issued in 2008, see in Williams, Fender and Drew (2009). Their current method is to use a combination of direct value and volume measures and deflated FISIM (Financial Intermediation Services Indirectly Measured). The direct value measures include bank fees charged and volume measures include volume of cheques transacted, insurance policies written and stock exchange transactions (see Williams, Fender and Drew, 2009, Table A1). FISIM is designed to measure services that are not directly charged for and so are implicitly priced by means of bank margins. For example, safeguarding money in the bank safe is typically not charged for explicitly, but is presumably covered in the margin between with the bank rewards lenders and charges borrowers. In the UK, FISIM is calculated as the differential between the interest rate charged on loans or paid out on deposits and a “reference” or risk-free rate, see Akritidis (2007).

This year is the first to incorporate FISIM fully into national accounts. In the latest ONS data release (July 2009) there is for example a major jump in real bank output in 1999 which seems to correspond to changes in data collection arrangements. Similarly, the method has been called into question with the recent turmoil in financial markets, as reference rates have fallen essentially to zero and margins have risen, possibly due to the exercise of market power or a

change in attitudes of banks to risk. However, the EUKLEMS, which has a partial adoption of FISIM into financial services, does not appear to have any unusual patterns in it.<sup>17</sup>

The next question is what deflator should be used to get a volume index from the value measures. This is set out in Williams, Fender and Drew (2009). FISIM is deflated by the GDP deflator. The bank fee indicator is deflated by, in Banks and Building Societies, the “average earnings index AEI for Financial Intermediation, excluding bonuses – adjusted for changes in productivity”. This reflects the unavailability of adequate price indices, and so the average earnings index is used instead with the assumption that the price of output is largely dependent on the price on the main input, labour, with the price adjusted for assumed changes in productivity. There are a number of issues here however. First, the index excludes bonuses for lack of data. This could be a substantial distortion depending upon how widespread bonuses are in the sector. Second, the productivity adjustment to the deflator of course automatically confers some productivity growth to financial services by construction, which turns out to be 0.44%pa.<sup>18</sup>

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<sup>17</sup> Insurance output is a direct volume indicator of the number of policies written. Colangelo and Inklaar (2010) have an extensive review of output measurement in the Euro area and suggest that output is too high since the reference rate used is inappropriate, since the reference rate should be free of term and risk premia. For an opposing view, based in part on practical objections, see Fixler, Reinsdorf and Smith (2008, section 1.2). There are also a host of complications from the growth of the shadow banking market in Ashcraft and Steindel (2008). We chosen not to adjust the EUKLEMS financial output here since it is consistent with factor inputs and factor incomes in the data set and we do not have the detail to perform an adjustment to all these terms. Since we carry out growth accounting for all industries in the economy, to solve for an economy-wide rate of return, we would need to adjust other industries too.

<sup>18</sup> ONS have reported to us that the productivity adjustment used is taken from the growth in GVA per Job for ‘Total Services’ (G-P), as published in the ONS First Release and is incorporated: Deflator growth = ((AEI growth - Prod growth Adj) / 2 where AEI is average earnings index and RPIY is the retail price index less alcohol and housing. . To get some idea of this adjustment, average growth in the AEI for Financial Intermediation (excl bonuses) is 3.7% from 2000-08. Average growth in labour productivity for total services over the same period was 1.7%. Since 26% of monetary intermediation (65.1: Banks & BS) is deflated by this adjustment, then the everything else remained constant, real output in this sector would grow by  $0.26 \times 1.7\% = 0.44\%$ pa purely from the assumed productivity adjustment.

#### 4.2 *Productivity growth with intangibles: theory*

We now apply these ideas to the productivity growth data. For a full discussion, see Corrado, Hulten and Sichel (2004, 2006). Define the accumulation of tangible and intangible/knowledge capital as follows

$$\begin{aligned}\Delta K^{TAN} &= I^{TAN} - \delta^{TAN} K^{TAN} \\ \Delta K^{INTAN} &= I^{INTAN} - \delta^{INTAN} K^{INTAN}\end{aligned}\tag{1}$$

where  $K^{TAN}$  is tangible capital stock (i.e. plant, machinery, industrial buildings, vehicles),  $I^{TAN}$  investment in  $K^{TAN}$  and  $K^{INTAN}$ , intangible capital stock (i.e. stock of knowledge in software, design, reputation, training, organisational capital etc.) , and investment in intangibles  $I^{INTAN}$ . If we suppose a consumption sector, producing final consumers goods from stocks of labour, tangible capital and intangible/knowledge capital; an investment sector, using the same inputs to produce investment goods and an “ideas” sector, producing new ideas from those inputs, a production function in each sector and perfect competition, we may write economy-wide output growth as

$$\Delta \ln V \equiv s_L \Delta \ln L + s_{K^{TAN}} \Delta \ln K^{TAN} + s_{K^{INTAN}} \Delta \ln K^{INTAN} + \Delta \ln TFP\tag{2}$$

where  $V$  is real value added and  $L$  is labour. Relative to the conventional approach, growth accounting is expanded, since we have an extra capital asset, namely  $K^{INTAN}$ . Note too that value added rises since there is more production, in this case of intangible capital and that increased value added is equal to a payment for the use of such capital, captured in the share of intangibles,  $s_{K^{INTAN}}$ .

Finally, it will be important to distinguish between product and process innovation. In the case of a process innovation, with competition all output goes to the lowest cost firm and prices fall in proportion to TFPG in the process innovation. In the case of a product innovation in inputs, computers for example, that should be accounted for by the hedonic adjustment of computer prices, which is done here following US methods. In the case of a product innovation in output, statistical practice is not to quality adjust output. Thus the growth in real-quality

adjusted output is faster than  $\Delta \ln V$  in (2) and thus  $\Delta \ln TFP$  is understated. See e.g. Hulten (2009).<sup>19</sup>

### 4.3 Growth accounting data and results

Before setting out our growth accounting results we give more complete details on the input measures on the right hand side of (2). The primary source of our data is the industry-level data from EUKLEMS (March 2008 release, the most recent at time of writing). Since the intangibles data by industry are only feasible for seven industry groups (Gil and Haskel, 2008), this is the level of aggregation we use (our industry groups are: 1 Agriculture, Fishing and Mining, 2, Manufacturing, 3 Electricity, Gas and Water Supply, 4 Construction, 5 Wholesale and Retail Trade, Hotels and Restaurants, Transport and Communications, 6 Financial Intermediation and 7 Business Services).

Beginning with L, it is often thought that financial services uses increasingly skilled labour, and so we have to allow for this. Therefore, we use quality-adjusted person hours, taken from EUKLEMS which generates labour services by weighting growth in hours for different age/education and gender worker groups using wages.

Turning to tangible capital, these are the EUKLEMS measures consisting of 12 different capital groups. Real capital stocks, of both tangible and intangible capital, are build by a perpetual inventory method and then changes in log real stocks are weighted together by capital shares, the capital shares using rental rates endogenously determined to exhaust all factor payments including intangibles.

Table 6 sets out the results of applying this framework without intangibles. We report results for 2000-2005, for financial intermediation and business services, manufacturing and retail, hotels and transport (for comparison) as well. The only assets are tangible capital assets and (quality adjusted) labour. The tangible assets are split into ICT-hardware (which is computers and communications equipment) and other.

In Table 7, we include intangible capital assets. We report software, R&D (which in finance is our measure derived from researcher time but otherwise is BERD R&D), design, brand equity, firm-financed human capital and organisational capital.

Table 6 shows slow LPG in financial services relative to manufacturing, about equal to retailing and faster than business services (2.94%pa against 3.79%pa , 3.02%pa and 1.93%pa).

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<sup>19</sup> In Hulten's model, define quality adjusted output  $Q^E=V/P^E$  where  $V=PQ$ . Then  $Q^E/Q=P/P^E$  and since  $P^E<P$  i.e. quality corrected prices are less then observed prices, then  $Q^E>Q$  i.e. a "better" good is like having "more of the good". In this model, Hulten derives  $\Delta \ln TFP = \Delta \ln TFP^e - (\Delta \ln p - \Delta \ln p^e)$  where  $\Delta \ln TFP$  in efficiency units is denoted  $\Delta \ln TFP^E$ . This expression shows the relation between observed TFPG, which reflects process innovation and quality adjusted TFPG, which reflects process and product innovation and the term  $-(\Delta \ln p - \Delta \ln p^E)$ . Assuming improvements in product quality,  $\Delta \ln p^E < \Delta \ln p$ , and hence  $-(\Delta \ln p - \Delta \ln p^E) < 0$ . Thus observed  $\Delta \ln TFP$  grows more slowly  $\Delta \ln TFP^E$ .

The total capital deepening column shows that in manufacturing 8% (0.30/3.79) of LPG is due to total capital deepening, with 30%(0.09/0.30) of that capital deepening due to ICT. TFPG is about 23% (0.81/3.79) of LPG. In Financial Services, the picture is different. 11% (0.34/2.94) of LPG is capital deepening. Of the capital deepening all of it (138%) is due to ICT-hardware. Almost 50% of LPG is TFPG (1.4/2.94). In business services almost a quarter of LPG is due to capital deepening which in turn is mostly due to ICT. TFPG is about 34%. Thus the conventional results stress the importance of software and hardware in financial services, but leave other intangibles in the TFPG term, which is itself 50% of LPG. Can the augmented approach give more information?

Table 7 shows the augmented approach with all intangibles. First, TFPG is now 10% of LPG in manufacturing and retailing (0.38/3.75 and 0.29/3.07) and 29% in financial services (0.85/2.89). It is of interest to notice that TFP in business services once we account for intangible goes to a very small number, only 1%. So our first result is that whilst TFPG in finance is relatively high, which is to be expected if products are costless to imitate, it has gone from 50% of LPG to 29%.

Second, consider capital deepening. In finance, intangible capital deepening accounts for around 50% of that total capital deepening, with the bulk of the contributions from software, organisational capital, training and product design. The contribution of software (0.14%pa) in finance is larger than that of manufacturing and retail (both 0.08%pa), documenting how important ICT is in financial services. The contribution of organisational capital (0.15%pa) is similar to that in other sectors, but a higher fraction (around 5%) of LPG. Hardware is also very important in financial services, with half of capital deepening due to hardware (in manufacturing and retail the figures are 8% and 31% of total capital deepening), again suggesting the importance of ICT in the sector. Indeed, the sum of hardware and software contributes 20% of (gross output) LPG in financial services as opposed to 14% in retail and 5% in manufacturing.

We also undertook a number of robustness checks. First, to guard against double counting we subtracted the BERD R&D spend from our research occupation measure, but the results were almost identical. Second, we halved the fraction of managerial time allocated to 10% (full results reported in the appendix). This did affect the results, own account organisational capital essentially raising financial services TFP by 0.08pppa, and lowering the contribution of organisational capital to 0.08pppa (changing the time again to 5% hardly changed the 10% result in fact). It is worth noting that the effect in manufacturing was very small. So clearly for service industries this is an area worth examining more. Third, we subtracted purchased design activities from the insurance sector in financial services, which added 0.11 percentage points to TFP.

There are clearly a number of issues that we might want to address in future work. Firstly, the measurement of output in financial services is clearly not easy, but the approach here is consistent with National Accounts conventions. Second, we do not have a very good measure of

prices in financial services, which might again be examined. Third, to do growth accounting one must assume perfect competition so that factor shares measure the (unobserved) output elasticities. To some extent this does not matter in this exercise, since we are most interested here in how the LPG and TFPG picture changes when one moves from excluding intangible assets to including them. Such a conclusion is not of course affected by the degree of imperfection in competition.

Finally, we clearly need better micro measures to back up the macro assumptions. An extended R&D survey is currently in the field that asks both R&D but also intangible assets questions, the results of which should be available early 2010.

## **5 Conclusion**

We have re-examined innovation, productivity and total factor productivity in financial services. We have done this by calculating knowledge spending taking account of the wider spending on knowledge indicated by detailed studies of financial innovation. These studies suggest spending on software, training, marketing and organisations are integral to financial innovation, as well as copying of innovation from other companies. Using this approach changes TFPG from around 50% of LPG to 29% of LPG, reducing the “measure of our ignorance” but confirming that TFPG is important in financial services, as case studies suggest. It also confirms the relative importance in financial services of ICT (software and hardware spend): they account for twice as much LPG as in manufacturing and retail. Finally, it suggests important contributions from organisational spending and training.

Is innovation in financial services “good”? The method here values output by what individuals are willing to pay for it and input at their costs. If externalities of, say, confidence contagion are present, then prices deviate from social costs and some parts of innovation might be socially bad.

Future work will of course look at many areas in this paper, such as the time spent on research activities and better measurement of TFP in imperfect competition situations. But this paper suggests this intangibles approach is likely to be worth exploring further.

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Table 1: UK Industry Classifications and relation to BERD industry sector classification AD

SIC division	SIC code	Description	BERD sector AD	Industry description in this paper
J	65	Financial intermediation, except insurance and pension	√	Financial services
	66	Insurance and pension funding, except compulsory social security	√	Financial services
	67	Activities auxiliary to financial intermediation	√	Financial services
K	70	Real estate, renting and business act's		
	<i>Of which:</i>			
	70.1	<i>Real estate activities with own property</i>	√	<i>Business services</i>
	70.2	<i>Letting of own property</i>	√	X
	70.3	<i>Real estate activities on a fee or contract basis</i>	√	<i>Business services</i>
	71	Renting of machinery and equipment	√	Business services
	72	Computer related activities	X	Business services
73	Research and development	X	Business services	
	74	Other business activities	√	Business services

**Notes:** the BERD classification covers the indicated SICs where ticked. BERD classification is called "Miscellaneous business activities, technical and testing analysis". In the paper, if we quoted BERD data for a subsector of the AD sector, this is prorated data by wage bills.

**Source:** SIC (2003) and EUKLEMS industry definitions

Table 2 : Knowledge Occupations in Financial Services, Industry J

<b>SOC 2000</b>	<b>Description</b>
	<b><i>Researchers</i></b>
2423	Management consultant, actuaries, economist and statisticians
2321	Scientific researchers
2322	Social science researchers
2329	Researchers n.e.c.
	<b><i>Other Researchers</i></b>
2431	Architects
3122	Draughtspersons
2433	Quantity surveyors
2434	Chartered surveyors
2122	Mechanical eng
2125	Chemical eng
2121	Civil eng
2123	Electrical eng
2124	Electronics eng
2128	Planning and quality control eng
2127	Production and process eng
2129	Engineering professional
2112	Biological scientists and biochemists
2113	Physicist,geologist and meteorologist
2111	Chemists
2212	Psychologists
2432	Town planners

**Source:** ONS, SOC classifications 2000.

Table 3: Employment in Annual Survey of Hours and Earnings (ASHE) by broad occupational classification

Year	Managers	IT professionals	Researchers	Other Researchers	Total
1997	252,089	79,141	14,114	4,983	350,327
2000	274,006	87,306	18,983	5,265	385,560
2005	326,432	88,434	24,455	6,938	446,259
2008	338,196	78,734	33,012	5,042	454,984

**Notes:** Each column reports the weighted to population figure for the different occupation categories. Please refer to table 2 and table A2 in Appendix for the SOC 2000 detailed code.

**Source:** Authors' computation on ASHE.

Table 4: Knowledge investment in financial services, Industry J

	1	2	3	4	5	6	7	8
Year	Researchers	Other researchers	Software own account	Software purchased	Managers own account	Managers purchased	R&D, BIS scoreboard	R&D, BERD
<i>investment in £bn</i>								
1990	0.25	0.04	0.8	0.3		0.2		0.004
2000	0.5	0.05	1.8	1.4	2.4	0.9		0.006
2004	0.5	0.1	2.2	1.5	3.1	1.1		0.017
2006	0.9	0.1	2.2	1.8	3.6	1.2	0.86	0.019
<i>as a % of sales</i>								
1990	0.39%	0.06%	1.26%	0.47%		0.31%		0.01%
2000	0.42%	0.04%	1.50%	1.17%	2.00%	0.75%		0.00%
2004	0.31%	0.06%	1.37%	0.94%	1.94%	0.69%		0.01%
2006	0.47%	0.05%	1.15%	0.94%	1.88%	0.63%	0.45%	0.01%

**Notes:** The top panel reports investment (£bn) from different sources. The second panel shows the percentages of the top panel data in nominal Gross Output. The first two columns are data based on calculations in this paper, with columns 1 and 2 from the researcher data set out above. Column 3 and 4 are based on official ONS software data. Column 5 and 6 are based on spending on management consultants for bought in spending and 20% of managerial time for own account. Column 7 is the BIS R&D scoreboard for financial services, which is R&D spend from accounting data (the only type of R&D capitalised by banks is investment in the development of internally generated software) and column 8 is official data from BERD allocated between financial services and other services as set out in the text, see section 3.2.

**Source:** Authors' computations, EUKLEMS, BERD, R&D BIS scoreboard

Table 5: Share of Intangible Investment by industry and asset.

Year	2000		2006	
	Manufacturing	Financial Services	Manufacturing	Financial Services
Intangible assets				
Software	0.19	0.21	0.15	0.22
Total R&D	0.79	0.06	0.78	0.06
Design	0.32	0.08	0.26	0.07
Brand equity	0.21	0.20	0.17	0.17
Firm-human capital	0.21	0.07	0.13	0.05
Organisational capital	0.25	0.19	0.25	0.19
<i>Memo</i>				
<i>employment</i>	21	5	17	5
<i>hours</i>	23	5	18	5
<i>value added</i>	25	7	19	11

**Notes:** Each cell in upper part of the table is investment in the particular asset in the indicated industry as a share of total investment of the same asset in the total market sector. Total R&D is defined as the sum of conventional R&D, R&D in social sciences and new development of financial products. Cells in lower part of the table under “memo” are shares for the indicated industry over total market sector.

**Source:** See text. Memo cells from EUKLEMS.

Table 6: Growth Accounting, 2000-2005, excluding intangibles, selected industries

	1	2	3	4	5	6	7
	Labour Productivity	Capital Deepening			Labour Quality	Intermed Input Deep	TFP
		Total	ICT Tangible	Non-ICT Tangible			
<i>Manufacturing</i>	3.79	0.3	0.09	0.2	0.29	2.32	0.89
<i>Retail, transports and hotel</i>	3.02	0.56	0.33	0.23	0.22	1.63	0.62
<i>Business activities</i>	1.93	0.51	0.38	0.13	0.3	0.46	0.66
<i>Financial Services</i>	<b>2.94</b>	<b>0.34</b>	<b>0.47</b>	<b>-0.14</b>	<b>0.27</b>	<b>0.94</b>	<b>1.39</b>

**Notes:** The table reports selected industries, other industries are Agriculture, Construction, Gas, Electricity and Water. The data are average growth rates per year 2000-2005 in percent. The first column is growth in industry gross output per hour. Column 2 is the total contribution of capital services per hour, namely growth in capital services per hour times share of capital in Gross Output (GO). Column 3 is growth in computer capital services times share in GO. Column 4 is growth in other tangible capital services (buildings, plant, vehicles) times share in GO. Column 5 the contribution of labour services per hour, namely growth in labour services per hour times share of labour in GO. Column 6 is the contribution of intermediate inputs per hour, namely growth in intermediate inputs per hour times their nominal share in GO. Column 7 is TFP, namely column 1 minus the sum of columns 2, 5 and 6.

**Source:** Authors' computations

Table 7: Growth Accounting, 2000-2005, including intangibles, selected industries

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Labour Productivity	Capital Deepening				Software	Total R&D	Design	Brand equity	Firm-human capital	Org cap own account	Org cap purch	Labour Quality	Intermed Input Deep	TFP
		Total	ICT Tangible	Non-ICT Tangible	Intangible capital										
<i>Manufacturing</i>	3.75	1.25	0.1	0.24	0.92	0.08	0.37	0.16	0.03	0.11	0.1	0.07	0.29	1.83	0.38
<i>Retail, transports and hotel</i>	3.07	1.11	0.35	0.27	0.49	0.08	0.02	0.07	0.05	0.16	0.08	0.02	0.22	1.45	0.29
<i>Business activities</i>	2.21	1.41	0.4	0.15	0.86	0.13	0.03	0.25	0.07	0.24	0.13	0.01	0.3	0.49	0.01
<i>Financial Services</i>	2.89	0.77	0.43	-0.08	0.42	0.14	0.02	0.07	0	0.05	0.11	0.04	0.27	1	0.85

**Notes:** The table reports selected industries, other industries are Agriculture, Construction, Gas, Electricity and Water. The data are average growth rates per year 2000-2005. The first column is growth in real gross output per hour. Column 2 is the total contribution of capital services per hour, namely growth in capital services per hour times share of capital in Gross Output (GO). Column 3 is growth in computer capital services times share in GO. Column 4 is growth in other tangible capital services (buildings, plant, vehicles) times share in GO. Column 5 is growth in intangible capital services times share in GO. Columns 6-12 are the breakdown contribution by asset of intangible capital services per hour; respectively the shares in gross output times growth per hour in software, R&D (including for financial services R&D derived from research occupations, as set out in the paper), Design, Brand equity (investment in marketing and branding), Firm-specific human capital (training financed by firms) and organisational capital (namely investment in management consultants for bought in spending and 20% of managerial time for own account). Column 13 is the contribution of labour services per hour, namely growth in labour services per hour times share of labour in GO. Column 14 is the contribution of intermediate inputs per hour, namely growth in intermediate inputs per hour times their nominal share in GO. Column 15 is TFP, namely column 1 minus the sum of columns 2, 13 and 14.

## APPENDIX A

In this section we try to relax some of the measurement assumptions in the paper to check the sensitivity of our results to those. As Table 7 shows, the contribution to LPG of organisational capital in finance accounts for the biggest share in intangible capital deepening. The breakdown between own account and purchased shows how the bulk of it comes from the own account measured on an assumed 20% fraction of time spent by managers on knowledge activities. We therefore relax this assumption and reduce the time fraction of a half. Table A.1 panel A, below reports growth accounting decompositions where managerial own-account organisational capital formation is assumed to be 10% of time as opposed to 20% in the baseline results above. The contribution of own account organisational capital decreases of 0.08ppa, from 0.11 (Table 7, column 11 last row) to 0.03 here. This change entirely goes to TFPG. That is TFPG increase 0.08 percentage points relative to the baseline case in Table 7, column 15 last row. A second measurement issue we want to explore is the contribution of purchased design in finance. Looking at the intermediate consumption reported by SU tables the insurance sector accounts for almost the entire purchases of design services by finance. The investment nature of such spending is uncertain. We present in the bottom row of table A.1 panel B the growth accounting results setting to zero purchased design in financial services. Setting to zero the capital stock of design in finance brings to a nil contribution for the asset and an increase in TFPG.

Table A.2, following in the appendix, presents the complete list of SOC code and description used to compute investment in own account organisational capital following CHS, and the occupations chosen by ONS in their software estimates.

Table A.1: Growth Accounting, 2000-2005, robustness check assuming 10% of managerial time is on organisational capital building

	Including all intangibles														
	Labour Productivity	Capital Deepening				Software	Total R&D	AED	Brand equity	Firm-human capital	Organ'al capital Own-account	Organ'al capital Purchased	Labour Quality	Intermed Input Deep	TFP
		Total	ICT Tangible	Non-ICT Tangible	Intangible capital										
<i>PANEL A: MANAGERIAL TIME 10%</i>															
<b>Manufacturing</b>	3.75	1.17	0.1	0.23	0.84	0.08	0.37	0.16	0.03	0.11	0.02	0.07	0.29	1.88	0.41
<b>Financial Services</b>	2.91	0.68	0.43	-0.08	0.33	0.13	0.02	0.07	0	0.04	0.03	0.04	0.27	1.03	0.93
<i>PANEL B: PURCHASED DESIGN =0</i>															
<b>Financial Services</b>	2.9	0.69	0.43	-0.08	0.34	0.13	0.02	0	0	0.04	0.1	0.04	0.27	0.98	0.96

Notes to table., please refer to note table 7 above.

Table A.2 “Full SOC description of Managers and IT professional”

<b>SOC 2000</b>	<b>Description</b>
	<b><i>Managers</i></b>
1112	Directors and chief executives of major organisations
1114	Senior officials of special interest organisations
1121	Production, works and maintenance managers
1122	Managers in construction
1131	Financial managers and chartered secretaries
1132	Marketing and sales managers
1133	Purchasing managers
1135	Personnel, training and industrial relations managers
1136	ICT managers
1137	Research and Development managers
1151	Financial institution managers
1152	Office managers
1161	Transport and distribution managers
1162	Storage and warehouse managers
1163	Retail and wholesale managers
1212	Natural environment and conservation managers
1219	Managers in animal husbandry, forestry and fishing n.e.c.
1231	Property, housing and land managers
1234	Shopkeepers and wholesale/retail dealers
1235	Recycling and refuse disposal managers
	<b><i>ICT Professional</i></b>
1136	Information and communication technology managers
2131	IT strategy and planning professionals
2132	Software professionals
3131	IT operations technicians
3132	IT user support technicians
4136	Database assistants/clerks
5245	Computer engineers, installation and maintenance

**Source:** ONS, Standard Occupational Classification 2000.

## Appendix B

Define the nominal output of a financial intermediary,  $V$ , as the value of priced and unpriced services

$$V = V^{\text{EXP}} + S^L + S^D \quad (3)$$

where  $V^{\text{EXP}}$  are services explicitly charged for and  $S^L$  and  $S^D$  are unpriced services to lenders and depositors respectively.

Consider first unpriced services to depositors. Following e.g. Fixler, Reinsdorf and Smith (2003) and Diewert and Scheryer (2004)<sup>20</sup>, a bank (or any other financial intermediary, which we call a bank for short) must offer its depositors a flow of implicitly priced services,  $S^D$ , to induce them to deposit their money  $Y^D$ , for a period with the bank and not put it elsewhere at a market return to depositors of  $r^{\text{MKT},D}$ . Thus in equilibrium

$$Y^D_{t-1} (1+r^{\text{MKT},D}) = S^D_t + Y^D_t (1+r^{\text{DEP}}) \quad (4)$$

Where  $r^{\text{DEP}}$  is the interest, which may be zero, offered by the bank to the depositors. Hence we can write the implicitly value of services offered to depositors  $S^D$  as

$$S^D_t = Y^D_{t-1} (r^{\text{MKT},D} - r^D + \pi^D) \quad (5)$$

Where  $\pi$  is the gain in the value of the deposit. This is the user-cost of money formula which simply states that the margin values the flow of services offered per dollar of loan. Fixler, Reinsdorf and Smith (2008) offer an example of an internet-only bank that offered 4% on deposits with limited service and non-internet banks who offered 3%. That margin, they argue, reflects the implicitly priced services to the consumer of a mortar-based bank.

Turning to the implicit value of services offered to lenders  $S^L$ , if a now if the bank wants to lend out money it faces an opportunity cost of funds,  $r^{\text{MKT},L}$ . If it does lend, it charges  $r^L$  and provides  $S^L$ . Thus in equilibrium,

$$Y^L_{t-1} (1+r^{\text{MKT},L}) = -S^L_t + Y^L_t (1+r^L) \quad (6)$$

And so

$$S^L_t = Y^L_{t-1} (r^L - r^{\text{MKT},L} + \pi^L) \quad (7)$$

---

<sup>20</sup> Except we use end of period payments. In Scheryers notation, if one defines  $S$  to be paid at the end of the period, one has  $PL = (RL+P1L)/(1+r) - SL/(1+r)$  Which gives  $SL = (RL-rPL+ P1L- PL)/(1+r) = (rL - r + \pi) PL$ .

Where  $\pi^L$  is the gain or loss in the value of the loan. Thus the value added of bank services are the value of services less intermediate costs to the bank,  $wX$ ,

$$V^{\text{EXP}} + S_t^D + S_t^L - wX = V^{\text{EXP}} + Y_{t-1}^D (r^{\text{MKT}, D} - r^{\text{DEP}} + \pi^D) + Y_{t-1}^L (r^L - r^{\text{MKT}, L} + \pi^L) - wX \quad (8)$$

From which we are now able to make the following observations. First, the second and third terms in the equation describe FISIM. Second, the (new) ONS procedure for implementing (8) is, following SNA93, to replace  $r^M$  with a risk-free rate  $r^F$  and exclude any capital gains, giving  $V = V^{\text{EXP}} + S_t^D + S_t^L = V^{\text{EXP}} + Y_{t-1}^D (r^{\text{M}, D} - r^F) + Y_{t-1}^L (r^L - r^F) - wX$  where we note too that  $Y^L$  is measured excluding loans to households for mortgages, since household mortgages are not considered to be financing productive activity (but financing a flow of housing services).

Second, is it correct to replace  $r^M$  with  $r^F$ ? As Basu, Diewert, Scheryer point out, theory provides a guide for  $r^{\text{M}, D}$  and  $r^{\text{M}, L}$ , namely the opportunity costs of financial capital for households depositing money with banks and banks lending money out. Briefly, if the bank absorbs the risk of the loan, it has for example a very large pool of loans so it can lend out at more or less the risk free rate, then  $r^{\text{M}, L} = r^F$  and value of services that the bank offers includes absorbing the risk. If the bank gets another party, such as a shareholder, to absorb the risk of the loan, then  $r^{\text{M}, L} > r^F$  by a risk premium and so the value of services is less than measured FISIM. Note that the ONS uses different margins on a variety of different loans to in an attempt to better match the loan types with their correct opportunity costs in terms of risk premia and time to payback.

Third, it is standard in SNA to exclude capital gains and losses since they are not defined as returns on productive activity. Scheryer states that given however that a bank makes capital gains and losses on many items on its balance sheet, which might be associated with financial services, this issue cannot be ignored. Fixler and Reinsdorf (2006, note 5) note that such gains and losses can be very significant, provisions for credit losses for example, ranging being around 10-20% of net interest income.

Finally, the current financial crisis came too late for these data, but it is worth noting that since 2007, Williams, Fender and Drew (2009) show that margins have risen on loans but fallen on deposits. According to the FISIM logic, such a widening of the premium over  $r^F$  means that banks are providing more services and less services respectively. The popular discussion however, is that they are rebuilding balance sheets. How can this be reconciled or, are banks really providing different services? In the light of the above theory, a rise in  $r^D - r^F$  is consistent with a number of scenarios. First, it could be reflective of imperfect competition, in which case the margin incorporates a monopolistic mark-up (absent from the expression above since it assumes competition) and so there is no rise in  $S^L$ . Second, it could be that banks absorb the risk so that  $r^{\text{M}} = r^F$  and indeed  $S^L$  is rising. Third, banks are not absorbing the risk so that measured FISIM overstates  $S^L$  and indeed that  $r^{\text{M}}$  has grown relative to  $r^F$ . For example, Northern Rock before the crisis, would be to borrow from other banks at LIBOR and lend to consumers. Since  $\text{LIBOR} \approx r^F$  then loans made at  $r^L$  made a profit of

$r^L - \text{LIBOR} \approx r^L - r^F$ , suggesting that measured FISIM provided quite a good measure of  $S^L$ . During the crisis, LIBOR climbed strongly above  $r^F$ , rendering the Northern Rock model unprofitable. That is, they were no longer profitably able to lend at such a low  $r^L$ . This suggests that the risk free rate may not be a good guide to cases where banks are exposed to the risk of not getting a supply of funds to enable loans and further that in times of crisis measured FISIM might not measure  $S^L$  well.