



INTELLECTUAL
PROPERTY OFFICE

The Role of Intellectual Property Rights in the UK Market Sector

Shikeb Farooqui, Peter Goodridge, Jonathan Haskel

July 2011

Intellectual Property Office is an operating name of the Patent Office

2011/2

The Role of Intellectual Property Rights in the UK Market
Sector*

Shikeb Farooqui
European University Institute

Peter Goodridge
Imperial College Business School and
UK Innovation Research Centre (UKIRC)

Jonathan Haskel
Imperial College Business School
and UK Innovation Research Centre (UKIRC)

Keywords: copyright, patents, trademarks, design rights, IP,
innovation, knowledge, investment, productivity growth,
capital

JEL reference: O47, E22, E01

July 2011

*Contacts: Jonathan Haskel and Peter Goodridge, Imperial College Business School and UK Innovation Research Centre (UKIRC), Imperial College, London. SW7 2AZ. j.haskel@ic.ac.uk, p.goodridge10@ic.ac.uk. We are very grateful for financial support for this research from the UK Intellectual Property Office. This work contains statistical data from ONS which is Crown copyright and reproduced with the permission of the controller of HMSO and Queen's Printer for Scotland. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates. We thank Tony Clayton for very helpful suggestions. All errors are of course our own.

Abstract

This report estimates (a) the level of UK market sector investment in knowledge assets protected by Intellectual Property Rights (IPRs) and (b) the impact of investment in those assets via their contribution to labour productivity growth in the UK market sector. Estimates for investment and the stock of IPR capital are based on previous work and includes new estimates for investment in artistic originals, funded by the Intellectual Property Office (IPO) and featured in the accompanying report. We also comment on additional spending on IP-protected goods that do not represent investments, although the coverage of this category is far from complete. Our main findings are: 1) On average, between 2000 and 2008, 48% of knowledge investment in the UK market sector was protected by IPRs 2) The majority of IPR investment is on assets protected by copyright and design rights 3) In 2008 approximately 62% of the stock of knowledge assets in the UK market sector was protected by IPRs 4) On average, between 1990 and 2008, 10.6% of growth in labour productivity was due to growth in capital deepening of IPR-protected assets. Comparable figures for ICT equipment and knowledge capital not protected by IPRs are 11.1% and 10.3% respectively.

1. Purpose of the report

This report builds on previous work which estimated UK market sector investment in knowledge capital and its contribution to growth: the most recent example being the NESTA Innovation Index (Haskel et al, 2011). Knowledge capital investment adds to the stock of intellectual property (IP) in the economy. Not all that investment is protected by IP rights (IPRs) such as copyright and patents: software is protected, but business processes are not. Thus this paper attempts to answer the following questions: (a) what proportion of knowledge investment is protected by IPRs; and (b) how much economic growth is therefore accounted for by such protected investment?

To answer these questions we first introduce new measures of investment in copyright-protected ‘artistic originals’ – wholly new art, film, literature, TV/Radio productions or music – using new data drawn from various sources including industry estimates, collecting societies and US depreciation indices.¹

Second, we apportion various knowledge investments to IPRs. Improvements to the data and methodologies used to estimate investment in artistic originals means that, when combined with official UK software investment data (Chamberlin et al, 2007), we can offer a better estimate for UK investment in copyright-protected assets. As well as other categories of knowledge assets, our dataset includes estimates of investment in research and development (‘R&D’), ‘Advertising’ and ‘Architectural and Engineering Design’, upon which we base our estimates for investment in ‘Patents’, ‘Trademarks’ and ‘Design Rights’. Of course, not all such investment is protected by IPRs, so we use Community Innovation Survey data to estimate the proportion that is protected. Around 30% of R&D spending is IPR-protected.²

Third, with these investment data, we calculate how much knowledge capital in the UK is IPR-protected which we combine with official data from the UK National Accounts to estimate the contribution of IPR-protected capital to labour productivity growth. We also note that not all UK spending on IPR-protected goods can be capitalised as investments: not all spending is on the creation of IP assets (goods that contribute to output for more than one year). In seeking to measure investment, we have also identified such expenditure, although our coverage of total ‘IPR production’ is far from complete.

Our main findings are as follows:

1. On average, between 2000 and 2008, approximately 48% of UK market sector investment in knowledge was protected by IPRs.
2. Approximately 75% of IPR investment is in assets protected by copyright and unregistered design rights.

1 For further information on the data and methods used in estimation, please consult the accompanying report: *Film, Television & Radio, Books, Music and Art: UK Investment in Artistic Originals* (Goodridge and Haskel, 2011).

2 More details are in a companion paper, Farooqui, Goodridge, Haskel (2011).

3. In 2008, approximately 62% of the stock of knowledge assets in the UK market sector were protected by IPRs.
4. On average, between 1990 and 2008, 10.6% of growth in labour productivity was due to growth in the use of IPR-protected assets, similar to the 11.1% contribution of ICT equipment. The contribution of knowledge capital *not* protected by IPRs is around 10.3%, slightly less than that of protected IPRs.
5. We view our results as a lower bound of the total contribution of IPR-protected assets. Patents protect a specific innovation but reveal information to others for free. The same is true for other forms of IPR-protected knowledge. Such freely available information contributes to growth via total factor productivity (TFP) - effects on total output not caused by inputs -, which we estimate contributes around 45% of labour productivity growth. Thus the true contribution of IPRs would include a share of this.

The following table summarises our results for investment in assets protected by IPRs.

Summary Table: Investment in IPRs, by type (£bn, current prices)

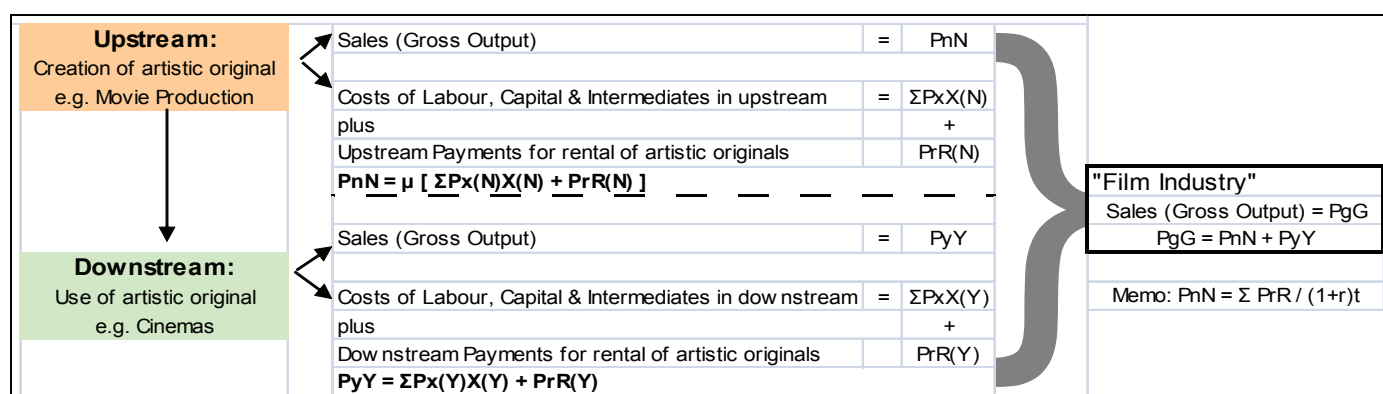
Year	1990	1995	2000	2008
<i>Investment by IPR</i>				
Copyright	8	13	20	26
Patents	2	2	3	4
Trademarks	5	6	10	12
Design Rights (Registered & Unregistered)	13	13	15	23
Total: All IPRs	28	35	48	65

In section 2, we set out our conceptual framework. In section 3, we discuss measurement in the context of that framework. In section 4, we present our estimates for UK market sector expenditure and investment in knowledge. In section 5 we summarise our methods of measuring the proportions of knowledge investment protected by IPRs. In section 6 we present the results of a growth-accounting exercise, where the decomposition of growth includes the contributions of IPR-protected assets. Section 7 provides our conclusions.

2. Conceptual Framework: Upstream and Downstream (Investment, Production and Consumption)

The following section is a summary of the appropriate conceptual framework to consider production, investment and consumption of intellectual property. It is based on the concept of 'upstream' and 'downstream' sectors where the upstream creates the original asset and the downstream uses the IP to generate final output, for instance the distribution and marketing of copies. For a fuller discussion please see Goodridge and Haskel, 2011.

Figure 1: Theoretical Framework. Upstream and Downstream in the Movie Industry



Note to Figure: To make the symmetry clear, a term for μ could also be included in the downstream. We assume that the downstream is competitive, so $\mu=1$, always. Monopoly power does however exist in the upstream, due to the ownership of rights to a unique asset. So in the upstream, $\mu>1$.

Consider the above diagram in the context of an economy with an innovation and a final output sector. The innovation sector (upstream) produces long-lasting UK artistic originals which contribute to the final output (downstream) sector: so the making of a feature film occurs in the upstream and its showing in cinemas is downstream output. Note that in practice, a film studio might make both long lasting assets but also short lasting goods e.g. a feature film versus seasonal flu jab information. In this economy we may then write the value of gross output in the artistic/innovation sector as $P(N)N$. This is equal to factor and intermediate costs in the sector multiplied by any mark-up (μ) over those costs, where μ represents the monopoly power of the artist due to protection through intellectual property rights (IPRs) for a unique asset, which we can write as:

$$(1) \quad P(N)N = \mu(\sum P(X)XN + P(R)RN)$$

where X is a vector of inputs to the innovation sector (such as labour, capital, materials etc.), $P(X)$ their competitive prices, and μ the mark-up over competitively priced inputs. $P(R)RN$ represents the rental payments for the use of other originals in production such as the use of original music in film production.

Consider next the final output or downstream sector, which uses the innovative or artistic good. If they buy the asset rights (or some component of them) outright, then their input costs are just $P(N)N$ plus the costs of labour, intermediates and other forms of capital. If they rent the good by paying a licence fee, $P(R)R$, for T years to the IPR-holding innovation sector then capital market equilibrium implies that:

$$(2) \quad P(N)N = \sum P(R)R / (1+r)^t$$

Where R is the stock of knowledge created by the good; in a perpetual inventory model (PIM) this might be represented by:

$$(3) \quad R_t = R_{t-1}(1-\delta) + N_t$$

Equation (2) says that the asset value of the good must equal the discounted rental payments from the users of the good.³

The final output sector, which uses the long-lived artistic asset, produces output, $P(Y)Y$

$$(4) \quad P(Y)Y = \sum P(X)X^Y + P(R)R^Y$$

where $P(X)X^Y$ are made up of labour, physical capital and materials payments in the using sector, and $P(R)R^Y$ are the rental payments for using the artistic capital created in the innovative sector. We assume that the final output sector is competitive and so there is no mark-up, μ .

Gross output in both sectors is given by the sum of gross output in the innovative and output sectors.

$$(5) \quad P(G)G = P(Y)Y + P(N)N$$

Finally, value added in each sector is given by $P(Y)Y$ and $P(N)N$ minus the intermediate inputs in each sector, where the intermediates are inputs that are used and transformed in the course of production – electricity used to heat the cinema and power the cameras, for example. That is $P(Y)Y - PMM(Y)$ and $P(N)N - PMM(N)$. If the intermediate sector, which produces $P_M(M(Y)+M(N))$, employs labour only at a cost of $PL L(M)$, then we may write the sum of all outputs and inputs as, setting $\mu = 1$.

$$(6) \quad PYY + PNN + PMM =$$

$$PKK(N) + PLL(N) + PRR(N) + PKK(Y) + PLL(Y) + PR R(Y) + PLL(M)$$

Which since $P_M M = P_L L^M$ gives that

3 At first it may appear that there is a measurement issue in the sense that both the upstream and downstream are renting from the artistic stock. This is not the case in this model. The upstream is renting a different type of asset to that which it is producing. For example, the producer of broadcasting assets is renting music assets.

$$(7) \quad P_Y Y + P_N N = P_K K(N) + P_L L(N) + P_R R(N) + P_K K(Y) + P_L L(Y) + P_R R(Y)$$

The left hand side is value added in the whole economy which thus equals the sum of payments to primary factors K (physical capital), L (labour) and R (knowledge capital). Value added can be calculated as here, but adding the total output of the investment (N) and final output (Y) sectors, or adding the value added of these two sectors plus the output of the intermediate sector (M).

We can now make a number of points. First, we need to consider a number of distinctions that are made in the literature. Since UK investment in IP is the production of long-lived IP assets that are owned by UK residents, it conceptually crosses both industry and country boundaries, and has to have a service life of at least one year. Consider then the following distinctions:

- ‘UK IP production’ is all IP production that takes places in the UK, regardless of ownership and duration;
- ‘UK IP investment’ is restricted to production of IP goods with a service life of more than one year used in the future production of output (assets), that are owned by a UK individual/organisation;
- ‘UK IP consumption’ is the use of short- or long-lived IP, in UK downstream firms resident in the UK, regardless of the residency of the owner;
- ‘Consumption of UK IP’ is the use of UK-owned short- or long-lived IP, in *all* downstream firms worldwide (not just in the UK);
- ‘UK consumption of UK IP’ is use of short- or long-lived UK IP in UK downstream firms.

So, returning to original film, a feature movie produced in the UK but owned by an American firm would be classed as UK production but *not* UK investment. The projection of that same film in a UK cinema is ‘UK IP consumption’, but not ‘consumption of UK IP’.

There are also weaknesses to official datasets. Suppose that we wish to measure the value of a TV or radio drama production ($P(N)N$). Our framework illustrates why this is hard to do from published industry data as classified by the Standard Industrial Classification of Economic Activities (SIC). Consider the SIC class ‘Television and Radio Activities’. This does not distinguish between the production of programmes and their broadcast. Moreover, production and broadcasting are often both undertaken by the same organisation. So, both upstream and downstream activities are included in this SIC class. Thus, a measure of sales for the whole industry, $P(G)G$, includes: the revenues earned by the broadcaster from the use of IP ($P(Y)Y$); whether they are long-lived IP assets or short-lived IP goods; all UK IP production, including short-lived news or sports programmes; and UK IP investment. Likewise, it can include investment from abroad, such as a US network funding and owning the rights to a programme produced in the UK.

This means we cannot use published SIC data to identify UK IP production. Instead, we must use data from production companies or network production arms. Such data are

reported for ITV, BBC, Channel 4. This allows us to make a $P(X)X(N)$ calculation, based on the upstream input costs in asset creation. However, we have to undertake a number of adjustments. First, to identify investment, we must subtract the costs of production of short-lived goods such as news and sports. Second, we must deduct the costs of production for exported products (not UK-owned) and add in the value of imports (UK-owned). Third, converting such costs into output values requires an estimate of the mark-up, m , the value of which is uncertain. Finally, if one is going to use $P(G)G$ data, one has to make an assumption about what fraction of $P(G)G$ is accounted for by $P(N)N$. Similarly if one is going to use $P(Y)Y$, an assumption is necessary on what fraction is accounted for by $P(R)R$.

There is a further problem if we wish to assess the “creative” industry. This model provides two possible approaches. We could assess the value of newly created long-lived artistic originals (here $P(N)N$). Alternatively, we might calculate the value added of the creative industry. The second option is about the level of *all creative activity*, whereas the first is about the creation of *new artistic originals*. So, our second calculation depends on the definition of the “creative industry”. Suppose it is the value added by all film production. Then, it is upstream value added *plus* the value added/costs of production of short-lived films (which would be in the downstream sector in our model, since they produce consumption goods not assets) *plus* the value-added of all exported films (their rights are not UK-owned). Suppose it is value added in both the upstream and downstream: then it is PvV , as explained above. An accurate calculation would require us to include not only the value added in separate production companies, but also the value added within vertically integrated production and broadcast companies. This is another reason why the SIC structure is not helpful to our model. More broadly, this illustrates why “value added in the creative industries” is not necessarily equal to “investment in new creative assets”. Both are interesting, but different, questions.

Finally, an alternative to trying to measure the gross output ($P(N)N$) from the production side is to recognise that such output produces a flow of royalties, ($P(R)R$) and use data from royalty collecting societies. Here one has to be careful. First, not all artists’ earnings are mediated through the collecting societies (for example, the proportion of admissions tickets for live music earned by artists for performance of their own works). Second, the flow of rentals accrues over a period of time, so that an accurate measure of output requires us to match such flows back to their original period and discount correctly. Moreover, measurement of the ‘UK consumption of IP’ requires data on the payments and rentals (including implicit rentals) paid by UK downstream firms for the use of IP goods and assets respectively. Estimation of ‘consumption of UK IP’ requires similar data on payments and rentals but only where they flow to UK producers, and such payments can come from downstream users across the world.

Our aim in this project has been to identify UK investment – the annual production value of long-lived artistic originals owned by UK residents – that adds to the UK stock of intangible artistic capital. In some cases the data has also allowed us to comment on UK production and consumption of intellectual property. We present those estimates where we have relevant data but most production measures are incomplete. For instance, our data for TV & Radio (and Design and Advertising) do not include IP produced in the UK but exported elsewhere.

3. Measurement

Our measurement approach is designed to be consistent with the UK National Accounts and therefore with official measures of output, income (accruing to labour and capital) and expenditure (including consumption and investment). We start by estimating investment in knowledge assets as identified by Corrado, Hulten and Sichel (2006), hereafter CHS, and Haskel et al (2011) for the UK. We then extend the official data from the National Accounts accurately to count spending on knowledge assets with a shelf-life of more than a year as investment rather than consumption, in a logically coherent framework that avoids double counting.

The categories of knowledge assets in our dataset are as featured in the NESTA Innovation Index, and discussed in greater detail below. New to this report are our improved estimates for investment in 'Artistic Originals', discussed in greater detail in the accompanying report (Goodridge and Haskel, 2011).

In our work to measure investment in UK originals, we have also identified additional spending on copyright-protected goods that do not meet asset definitions. Examples include expenditure on the creation of short-lived television formats, and UK production of films that are exported to an overseas owner or funder. We present these data for completeness and to inform wider discussion on UK consumption and production of copyright-protected goods. We recognise that our coverage of such spending is in no way complete and that these data are just a small component of such a measure.

As well as a new measure of GDP, adjusted for investment in knowledge assets including those protected by IPRs, and with income shares re-calculated to include the income which flows to knowledge and IPR-protected capital, our dataset now includes the following:

- Investment in IP-protected assets, by industry;
- A split between registered rights (patents, trademarks) and unregistered (secrecy, unregistered designs and all copyright);
- A detailed split of investment, by specific right and asset category;
- An estimate of other IP production that is not UK asset creation, which came from our estimates of intangible.

We then apply those estimates to a growth-accounting framework, which allows us to assess the contributions of the nature of the workforce (labour composition), capital deepening (a measure of the increased use of capital per worker) and total factor productivity (TFP) to labour productivity growth. The contribution of capital deepening is disaggregated by asset type, providing estimates for ICT capital, other forms of physical capital and each category of knowledge capital. Uniquely we provide a breakdown based

on that part of knowledge capital deepening protected by IPRs. We present this decomposition in a number of ways. First, we present the total contribution of capital deepening in IPR-protected assets to UK market sector growth.⁴ Second, we split this contribution into that of registered and unregistered rights. Third, we present the contribution of individual IPRs.

This leaves total factor productivity, defined in the NESTA Innovation Index as the contribution to growth of freely available knowledge. Some portion of freely available knowledge is clearly derived from IPR-protected assets. For instance, after a patent expires, its original ideas are freely available to competitors, new entrants and any other individual or organisation. Even before expiration, reading a patent can result in the free transfer of knowledge. Likewise, some copyrighted originals generate spillovers since they create new genres, formats or types of art such as the creation of 'alternative comedy', 'CGI animation' or 'reality TV'. Therefore some proportion of TFP growth does represent part of the contribution of IPR-protected capital. Therefore our estimate of the contribution from IPR capital deepening can be viewed as a lower bound of the total contribution from IPR assets.

Our new estimates of knowledge investment, and the proportion protected by IPRs, allow us to make three significant contributions:

1. An estimate of how much UK firms spend on knowledge assets protected by IPRs;
2. An estimate of some of the additional spend on IPR-protected goods that do not meet asset definitions, by category (consumption rather than investment);
3. An estimate of the contribution to re-stated market sector labour productivity growth of knowledge capital deepening in IPR-protected assets, over the period 1990-2008.

4 For the purposes of this report we define the market sector as sections A-K excluding dwellings, according to the 2003 Standard Industrial Classification. Dwellings are removed for both conceptual and practical reasons. First, housing services produced by households (imputed rents) do not represent true economic output. Second, dwellings are not a part of productive capital stock and so its associated services are removed from the output data to be consistent with the capital input data. Third, they inhibit international comparability since the proportions of people that choose to own/rent housing varies across countries for social and cultural reasons. This is standard practice in growth accounting exercises

4. UK Market sector: Expenditure and Investment in Knowledge Capital

The following section provides a brief description of the methodologies and sources used to estimate expenditure and investment on UK production of knowledge goods, by asset type. For a more extensive description please consult past work such as Haskel et al (2011) and Giorgio Marrano, Haskel and Wallis (2007).

Following Corrado, Hulten and Sichel (2006) we identify three broad groups of knowledge assets: i) Computerised information; ii) Innovative property; iii) Economic competencies. The following table sets out UK investment for each of these groups and the asset types within them.

New to this report are our estimates for Artistic Originals, presented within 'Mineral Exploration & Artistic Originals'. Estimates for other assets are as used in the NESTA Innovation Index (Haskel et al, 2011). The methodologies used in our new measures of the creation of originals are set out in detail in the accompanying report (Goodridge and Haskel, 2011), and summarised alongside information for other assets below. We wish to add that we regard the estimates as a step forward but do not consider them finalised. We plan to collaborate with ONS on this work in the near future, with the aim of incorporating new estimates of investment in Artistic Originals into the National Accounts in time for Blue Book 2012.

Table 1: UK Market Sector Investment; Tangible & Intangible, £bns nominal

Year	1990	1995	2000	2008
All tangibles	67	62	87	104
Intangible category				
Computerised Information	6	10	16	22
Software (Own-account; Purchased)	6	10	16	22
Innovative property	25	27	31	44
R&D (Scientific; Non-scientific; Financial)	8	9	12	16
Design (Own-account; Purchased)	13	13	15	23
Artistic Originals (Film; TV & Radio; Music; Books; Misc Art)	2	3	4	4
Mineral Exploration	2	1	0	1
Economic Competencies	26	34	51	73
Branding (Advertising; Market Research)	5	7	12	15
Training	12	15	21	27
Organisational (Own-account; Purchased)	9	12	17	31
All intangibles	57	70	98	139

We now go on to discuss each asset in more detail, starting with artistic originals, which are new to this report.

1. Artistic Originals

From **Table 1**, our latest estimate for investment in ‘Artistic Originals’ in 2008 is approximately £4bn. Previous estimates for investment in Artistic Originals were based on official ONS estimates in the National Accounts. Those official estimates are undergoing improvement as part of ongoing efforts to improve measurement. Our new estimates attempt to contribute to this work and aim to be logically consistent with the Eurostat/ OECD methodological framework.

a. Film

ONS estimates of investment in UK-owned film originals are based solely on the funds provided for a subset of UK productions. By contrast, we build bottom-up estimates of expenditure on UK productions using a microdata set of all UK films produced since 1991. Our dataset also includes information on co-producing partner countries and indicators on majority and minority funding. We use such information to construct ownership shares for each individual film, providing us with an estimate of investment in each UK-owned film original.

Figure 2. Film Originals: UK Production and Investment, Nominal £mns



Source: UK Film Council, British Film Institute, the-numbers.com

The data show that for our most recent estimates, 2009, UK expenditure on the production of film was around £750m. Of that sum, our estimate is that £264m constituted investment in the creation of long-lived IP asset owned by UK entities. Corresponding figures for 2008 are as follows: UK production expenditure of £405m and UK investment of £191m.

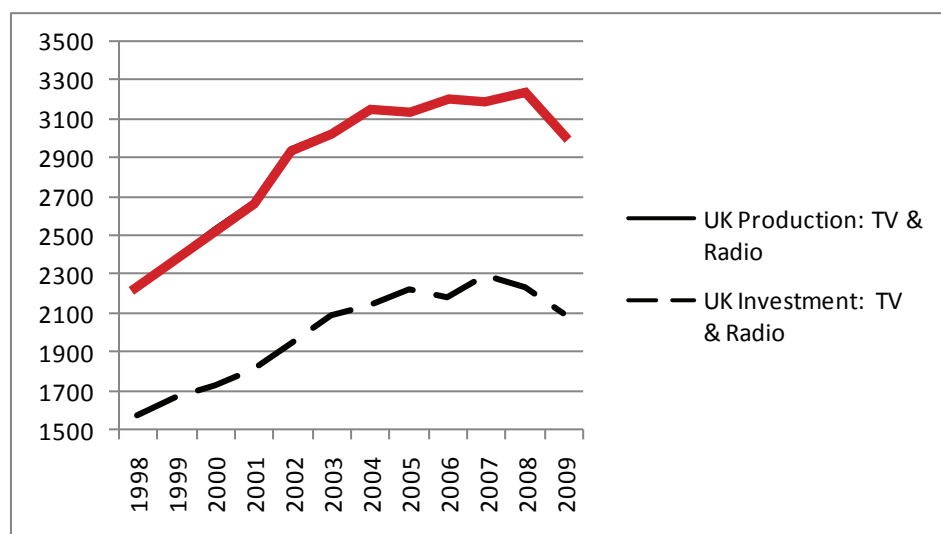
Estimates based on our own dataset go back to 1991. Our growth accounting exercise begins in 1990. To construct capital stocks with a reasonable initial value we therefore extend our series back to 1947 using growth rates from an expenditure series for joint UK/US productions, kindly supplied to us by Rachel Soloveichik of the US Bureau of Economic Analysis.

b. Television & Radio

ONS estimates of investment in television and radio are based on data for production costs, published in the annual reports of the UK public service broadcasters. Our estimates are based on similar data published in the OFCOM Annual Report into those broadcasters.

Not all UK expenditure on the creation of television and radio productions is counted as investment in the National Accounts, since some is on short-lived genres or formats such as 'News' or 'Current Affairs'. A grey area is 'Sports', since some sports broadcasts do have long-service lives. On average however, their life-lengths are short, so we exclude them for both conceptual and practical purposes.

Figure 3. TV & Radio Originals: UK Production and Investment, Nominal £mns



Source: OFCOM

Note to figure: The series entitled 'UK Production' is actually UK TV Production spend (including spend on short-lived programmes) by Public Service Broadcasters (and therefore does not include spend by multichannel platforms such as Sky) plus investment

in Radio (which does not include expenditure on the creation of Radio productions that are not assets).

We estimate that in 2008 UK investment in the creation of TV & Radio Originals was £2,238m. Our data from OFCOM only go back to 1998. Data in the National Accounts extend back to 1970. Therefore we backcast our series using growth rates from market sector GVA.

c. Books

ONS estimates for 'Books' are calculated as a proportion of UK book sales⁵, with the implicit assumptions that UK book sales serve as a reasonable proxy of the downstream revenues generated from UK-owned literary originals and that the annual capital income earned by authors from UK book sales serves as a reasonable proxy of annual investment. The former implicitly assumes an approximate balance in international trade for book originals.⁶ The latter assumption requires invoking steady-state conditions and complementary assumptions on life-lengths.

Eurostat recommend, where possible, estimating investment in literary originals using data on their lifetime royalties, splitting those revenues into price and volume. In competitive equilibrium the owner will invest up to the net present value (NPV) of expected future revenues. Since copyright provides market power, the outcome is not competitive, and revenues will include additional rents extracted by the monopoly owner.⁷

We had planned to estimate investment in the creation of literary originals using individual asset-level microdata on royalties for various types of rights, as held by the collecting societies. Unfortunately legal and administrative complications have prevented us from accessing that data. Instead our estimates are an approximation of the upstream input costs to asset creation. The method is imperfect, for reasons explained in the accompanying report. We do, however, believe that the estimates are more representative than those currently recorded in the UK National Accounts, since we consider the investments made by both the author and publisher. We feel this view is supported in our comparisons with US data on Artistic Originals.

Figure 4 presents our estimate of UK investment in the creation of literary originals. In the case of books we do not estimate non-asset IP production since we are unable to distinguish between assets and final or intermediate goods. Therefore we may be over-representing UK asset creation, but we feel this is somewhat counter-balanced by poor sampling of authors and writers in the Annual Survey of Hours and Earnings (ASHE).

5 http://www.statistics.gov.uk/downloads/theme_economy/ESA95_GDP_Expenditure.pdf

6 That is, that the earnings from copies of UK originals sold outside the UK are roughly equal to overseas earnings from the sale of copies of non-UK originals in the UK. This assumption requires invoking steady-state conditions and complementary assumptions on life-lengths.

7 Further discussion is provided in the accompanying report (Goodridge and Haskel, 2011).

Again, the superior method for estimating investment in this asset type would be the longitudinal analysis of asset-level microdata.

Figure 4. Book Originals: UK Investment, Nominal £mns



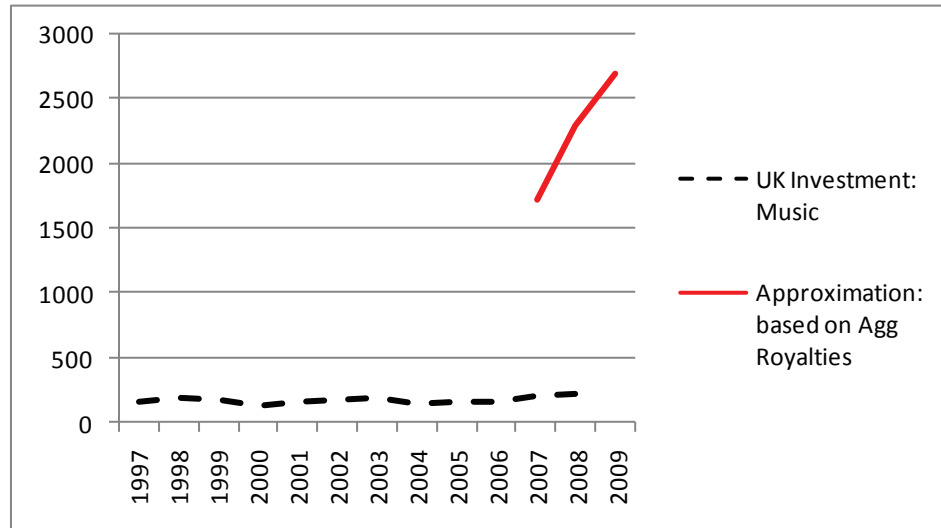
Source: Own estimates based on ASHE

We estimate that in 2008, UK investment in the creation of Literary (Book) Originals was £915m. Since the ASHE data only extend back to 1998, to construct estimates of the initial capital stock we extend the series back to 1970 using the growth rates implied by market sector GVA.

d. Music

The ONS method for recording originals, or Music, is the same as that for Books with the same underlying implicit assumptions and an assumed royalty rate to estimate capital income.

Eurostat recommends using the royalties data stored by the UK collecting societies, but we have only been able to obtain three years of such data. The following chart presents our estimate of UK investment in the creation of recorded originals (again, the absence of a breakdown of the proportions of output that are assets and final or intermediate goods means we are unable to estimate IP consumption). There is clearly a large difference between the estimate using costs and the royalty data. A more informed estimate requires a longitudinal study of the royalty revenues distributed by UK collecting societies and additional revenues earned from music capital, using asset-level microdata: we hope to conduct this in future work.

Figure 5. Music Originals: UK Investment, Nominal £mns

Source: Series entitled “UK Investment: Music” are our own estimates based on ASHE. Series entitled “Approximation: based on Agg Royalties” are based on aggregate royalty payments plus additional implicit royalties, kindly supplied by Will Page and Chris Carey of PRS.

As shown in Figure 6, our primary estimate of UK investment in Recording (Music) Originals in 2008 is £224m. Included in the chart are some approximations of cross-sectional aggregate annual royalties that accrue to UK music. Under the assumption of steady-state conditions, and equal values and life-lengths for all individual assets, it can be shown that such aggregates approximate annual investment levels. Using this method results in an estimate of £2,298m in 2008. Of course such assumptions are highly unrealistic especially for Music, and the challenges faced by the industry in recent years mean that the assumption of steady-state conditions is particularly inappropriate. Nevertheless, the magnitude of the estimates does provide some indication of the potential scale of under-estimation in our estimates.

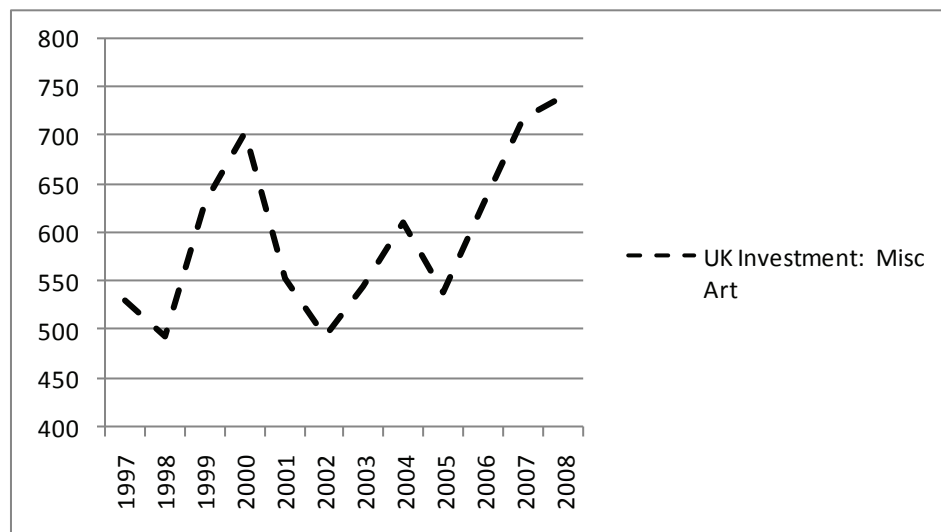
To construct estimates of the initial capital stock for use in the growth-accounting analysis, we again extend the series back from 1998 to 1970, using growth rates in market sector GVA.

e. Miscellaneous Art

ONS estimates of artistic originals do not yet include estimates for other art forms such as photography/images, theatre, choreography, cartography and art. A US study (Soloveichik, 2010) has shown that such activities include considerable amounts of investment so we have investigated this issue in the UK.

The main problem is ensuring that what is being counted is the creation of productive assets that contribute to future output for more than one year. This is why national statistical institutes (NSIs) exclude such categories of investment.⁸ In the absence of data on royalties and licence fees, our interim best estimate is again based on an approximation of upstream input costs for asset creation in photography, choreography and art. Although we can improve our estimates using data on the revenues earned by individual assets, the scale of estimates for both the UK and US mean that even our rough approximation is better than simply excluding these assets.

Figure 6. Miscellaneous Art: UK Investment, Nominal £mns



Source: Own estimates based on ASHE

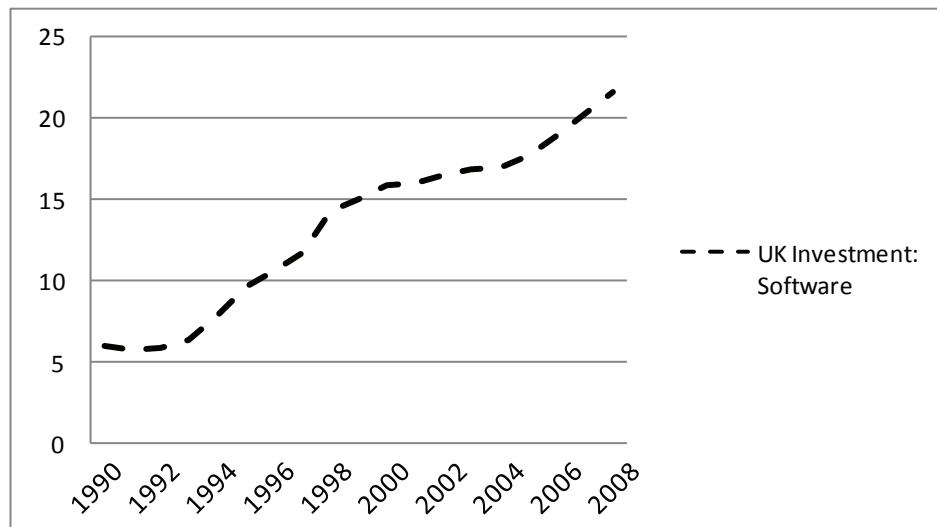
For 2008 we estimate UK investment in Miscellaneous Art at £740m. To construct an estimate of the initial capital stock we extend the series using data for investment on 'architectural and engineering design'.

⁸ For further information please consult the accompanying report including Appendix 1 for a discussion of 'Valuables' (Goodridge and Haskel, 2011).

2. Computerised Information

As **Table 1** shows, software investment in 2008 was considerable at approximately £22bn, comfortably exceeding a broad definition of R&D. Total Software investment (Computerised information) comprises both purchased and own-account⁹, and also computerised databases. Software is already capitalised in the National Accounts, and our main source for computer software investment is contained in the ONS work described by Chamberlin et al (2007). The estimates of purchased software are based on company investment surveys. For own-account software, they use the earnings of employees in computer software occupations. To avoid double counting, additional spending on computerised databases is excluded as it is already included in the ONS software estimates. The data in this paper, which run from 1970 to 2008, rely on updated data from the ONS, consistent with Blue Book 2010.

Figure 7. Software: UK Investment, Nominal £bns



Source: ONS

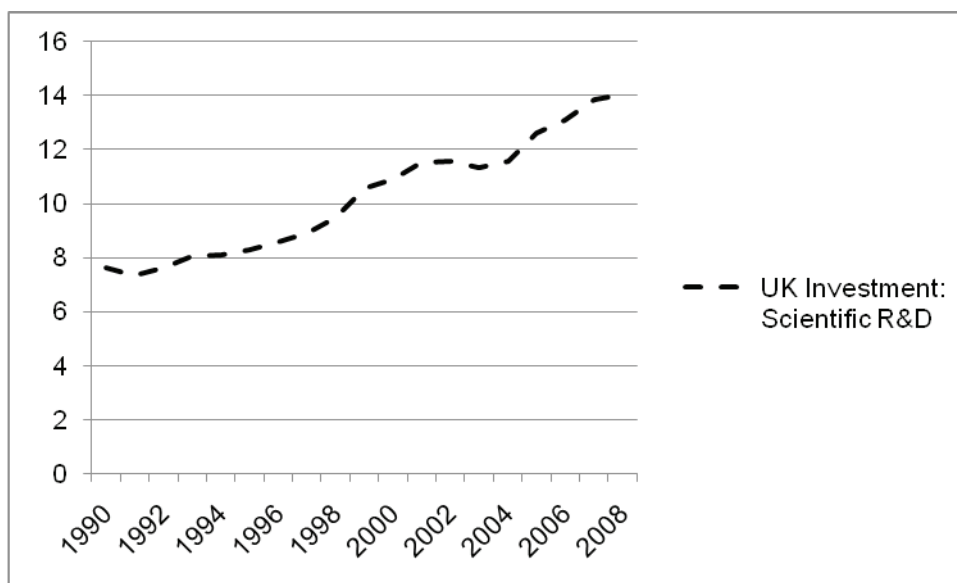
⁹ Own-account software is customised software developed by in-house employees

3. R&D

a. Scientific R&D

As shown in **Table 1**, in 2008 total investment in R&D according to a broad definition of R&D activity was £16bn. Of this Scientific R&D was £14bn. For *Scientific R&D* performed by businesses in the UK, expenditure data are derived from the Business Enterprise R&D survey (BERD). 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,¹⁰ since this is already included in the software investment data. The series for scientific R&D is presented below.

Figure 8. Scientific R&D: UK Investment, Nominal £bns

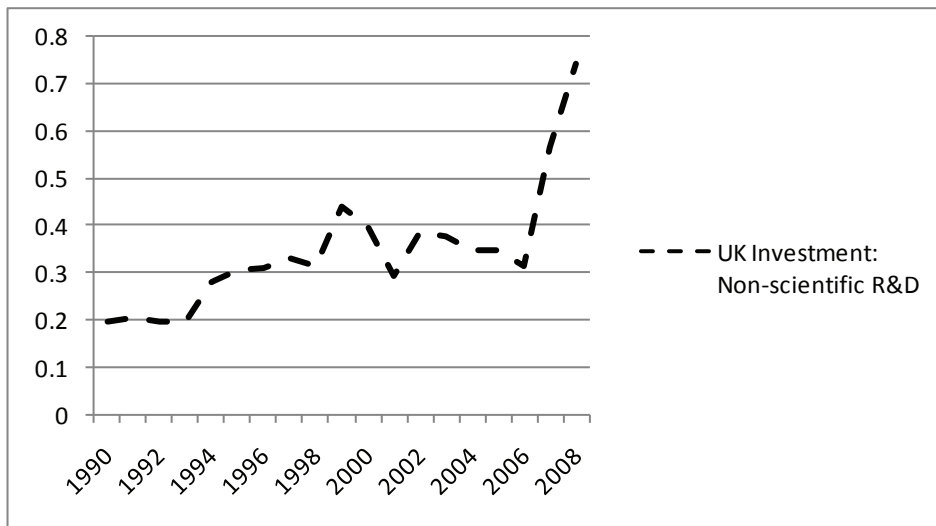


Source: ONS

b. Non-scientific R&D

In **Table 1** the estimate for non-scientific R&D is within our broader R&D definition, and was £0.7bn in 2008. R&D in social sciences and humanities is estimated as twice the turnover of R&D in “Social sciences and humanities” (SIC 73.2), where the doubling is assumed to capture own-account spending. Turnover data are taken from ABI and are available for 1992 to 2006. This is a small number and we suspect there is little marginal benefit to improving its measurement. The series for non-scientific R&D is presented below.

¹⁰ Work at ONS on the upcoming capitalisation of R&D is currently ongoing.

Figure 9. Non-Scientific R&D: UK Investment, Nominal £bns

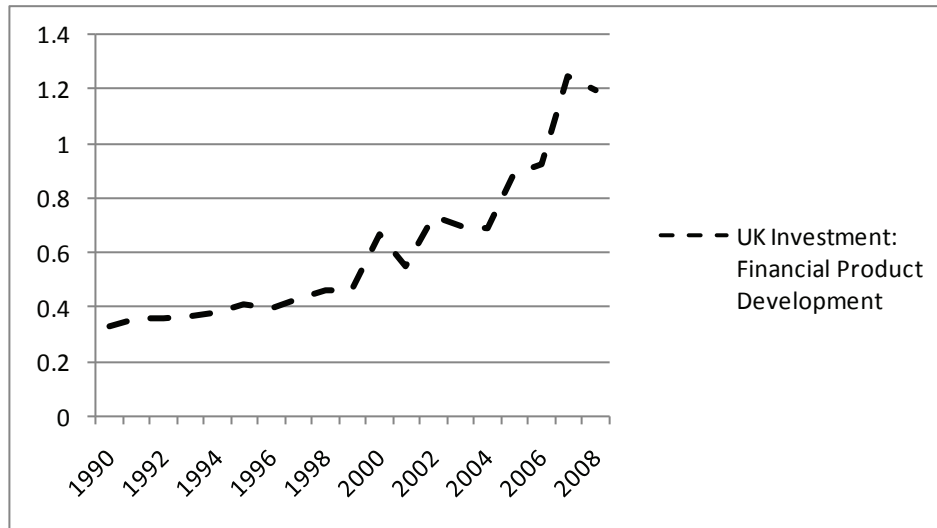
Source: ABI

c. Mineral Exploration

As shown in **Table 1**, in 2008 investment in Mineral Exploration was around £1bn. Like computerised information and artistic originals, *mineral exploration* is already capitalised in the National Accounts and the data here are simply data for Gross Fixed Capital Formation (GFCF) from the ONS. Expenditure on mineral exploration is valued based on “payments made to contractors or costs incurred on own account. The costs of past exploration, not yet written-off, are re-valued (which in this case may well *reduce* the value). This expenditure covers the costs of drilling and related activities such as surveys. It is included in GFCF whether or not the exploration is successful.” (ONS National Accounts 2008). Three subcategories are reported: a) mineral exploration other than oil and coal, b) continental shelf exploration expenditure, and c) coal mineral exploration. Exact values for mineral exploration are not presented here due to disclosure issues.

d. Financial Product Innovation

In **Table 1**, estimates for Financial Product Innovation are recorded within our broad category for R&D but in 2008 we estimate investment in this asset to have been £1.2bn. The measurement methodology for *New products development costs in the financial industry* follows that of own account software, and therefore builds innovation in financial services up from assumptions on the wage bill of occupations involved in product development, based in turn on interviews with financial firms. Further details are in Haskel and Pesole (2009). We assume that such investment is not covered by formal IP rights.

Figure 10. Financial Product Development: UK Investment, Nominal £bns

Source: Own estimates

4. Architectural and Engineering Design

As shown in **Table 1**, for 2008 we estimate investment in Design at approximately £23bn in 2008. For new *architectural and engineering design* we also use the own-account software method. Purchased data are taken from the supply-use Input Output (IO) tables. Full details are set out in Galindo-Rueda et al (2010), and we summarise some of that discussion here.

Design activity can be defined as the process of originating and developing a plan for a product, structure or component. It is usually considered in the context of the applied arts, engineering, architecture and other related creative endeavours. In spending on design, companies aim to produce valuable new blueprints – in other words, guidance on how to produce goods and services combining a range of aesthetic and functional features.

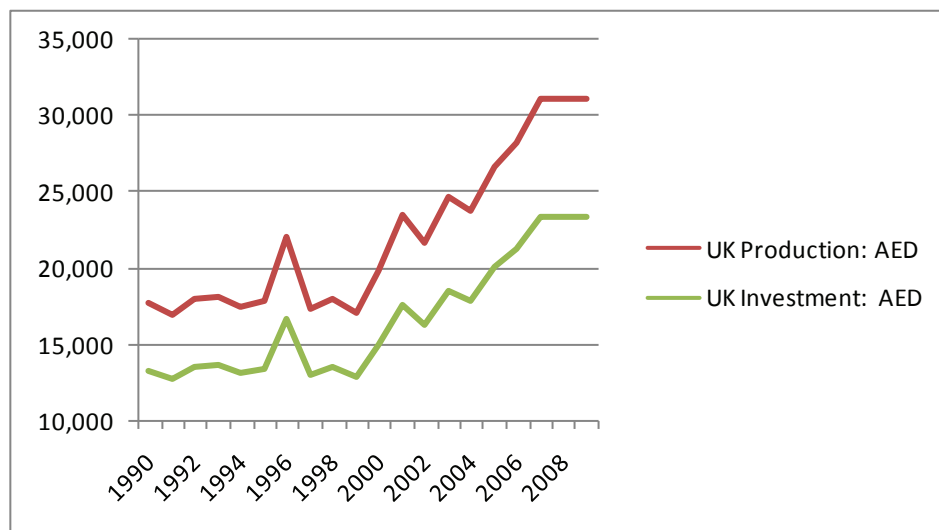
In what sense is such spending an investment? The key point is that if blueprints can be used repeatedly over time, design activities could be regarded in principle as the production of a potentially lasting economic asset – defined as a good that provides services to its owner over a more than one-year period. Consider commercial interior design, which is very important in retail, for example. Their designs are typically used first in flagship stores, and then “rolled out” in other branches. We interviewed some design companies in this area who described this process in large chains, where the complete roll-out can take two years and redesigns typically happen every four to five years.

Here, we focus on architectural, engineering and design (AED) activities, including architects, engineers (excluding software) and general designers (graphic, product and clothing designers). We estimate the value of design that is externally sourced, using the

input/output tables, and own-account using data on occupations and wages following the recommended software method. To adjust wages for time spent on design (as opposed to administration) and therefore lasting investments, we rely on a series of interviews with leading design companies in Summer-Winter 2010. We received a variety of responses from different agencies with specific specialisms (e.g. package design, interior design), but some common features. Many firms keep staff time sheets, typically for billing purposes, but sometimes for internal monitoring. Thus they were able to talk about the allocation of staff time and we were shown (confidentially) a number of time sheets. Allocations of time varied by seniority (younger staff spend almost all their time on design, with very little on personnel or marketing. More senior staff spend less time on design, but more on internal issues or pitching for work). Thus, for professional designers, we assigned 50% of their time to 'long lived design' and engineers only 10%, with 60% to the rest.

Our series for UK investment in architectural and engineering design is presented below. As mentioned, as a by-product of estimating investment, we can also say something about UK production. In the case of Design this is based on our time-use findings, so the production measure is based on the total output of UK designers, regardless of its service life. Of course this does not provide a full picture, but the data are presented for information.

Figure 11. Architectural and Engineering Design: UK Production and Investment, Nominal £mns



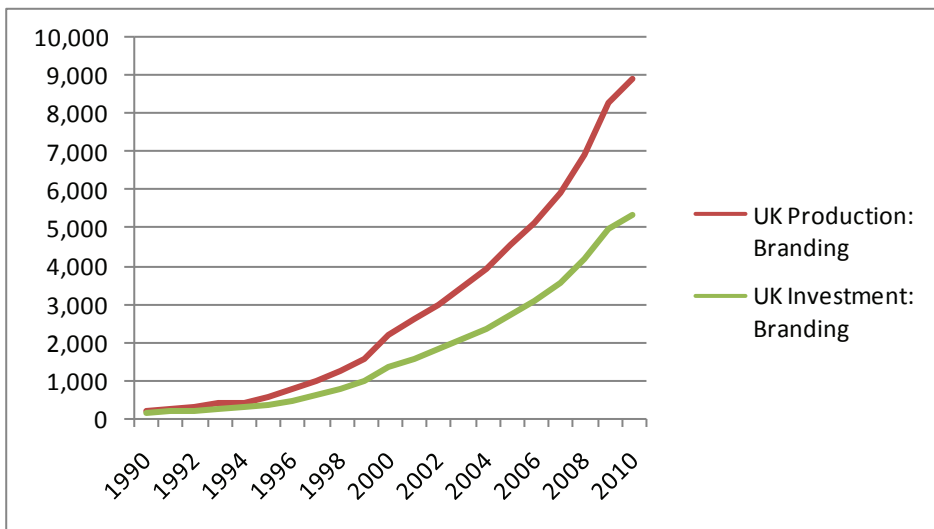
Source: Own estimates (Haskel et al, 2011)

5. Branding: Advertising and Market Research

As shown in **Table 1**, in 2008 we estimate total investment in Branding to have been around £15bn. Of this, advertising made up £12bn, and market research £3bn. *Advertising expenditure* is estimated from the Input Output tables by summing intermediate consumption on Advertising (product group 113) across all industries. These data are available to 2004 and so subsequent years are interpolated. Market research is also estimated with data from the IO tables.

Our series for investment in Branding is presented below. Again we can also say something about UK production regardless of the service life of output and so those data are also presented for information. Again our data for UK production is far from complete. For instance the production figures for Branding do not include UK-produced branding services that are exported. Likewise for Design. We present the data for completeness and to inform discussion of UK IP production, not as definitive estimates of UK IP production.

Figure 12. Branding: UK Production and Investment, Nominal £mns



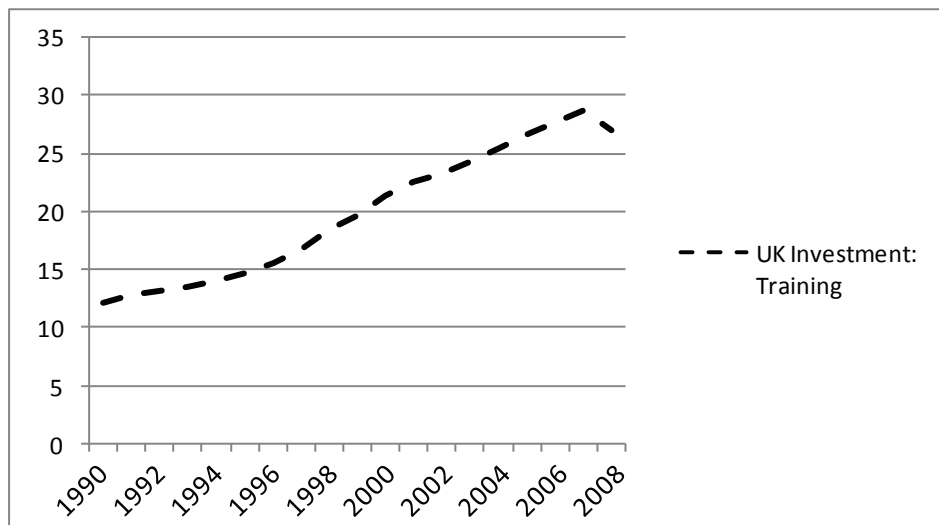
Source: Own estimates (Haskel et al, 2011)

6. Firm-specific human capital (Training)

From **Table 1**, our estimate of investment in Training is around £27bn in 2008. *Firm specific human capital* - training provided by firms - was estimated using cross sections from the National Employer Skills Survey for 2004, 2006, 2007. We also have data for 1988 from an unpublished paper by John Barber. We thus backcast the series using the EU KLEMS¹¹ wage bill time series benchmarking the data to three cross sections.

We have recently refined our data by subtracting spending on Health and Safety training. Such expenditure is about 10% of the total (firms are asked in the training survey to quantify this) and it has been put to us that such training should not be regarded as an investment in knowledge capital for workers. We lack independent evidence on this issue, but note here that whilst this subtraction lowers the level of training spending, it turns out to affect the contribution of training to growth at only the fourth decimal place. Our series for investment in Training is presented below.

Figure 13. Training: UK Investment, Nominal £mns



Source: Own estimates

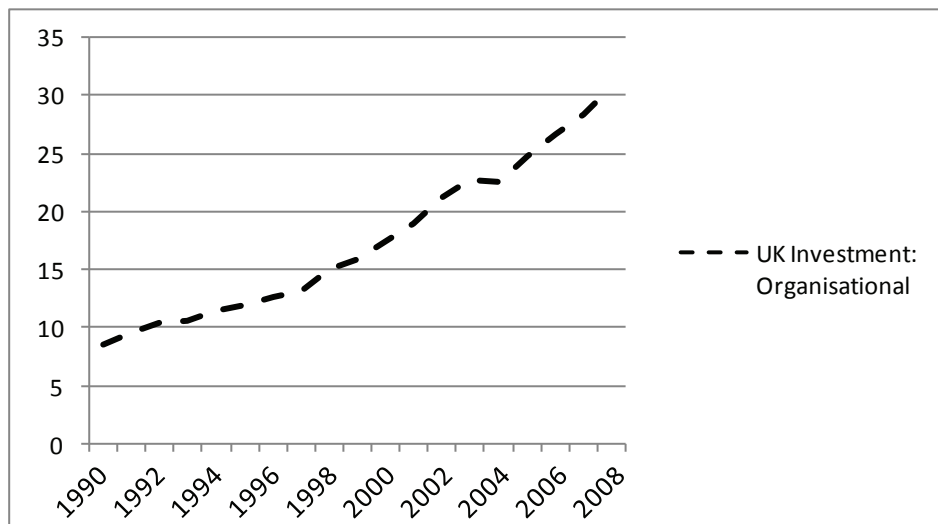
11 http://www.euklems.net/project_site.html

7. Organisational Structure

As shown in **Table 1**, for 2008 we estimate investment in organisational structure at £31bn. Our data on investment in *organisational structure* relies on purchased management consulting, on which we have consulted the Management Consultancy Association (MCA), and own-account time-spend, as before. This method relies on identifying managers by occupation. An ONS decision has been taken to re-classify some managers in the Standard Occupational Classification, since UK employers tend to use the title 'manager' more liberally than employers in other countries, which will lower the UK managerial total. This work is still preliminary and so it has not been possible to incorporate it into the current calculations.

We also assume that not all purchased organisational knowledge represents investment. Therefore 20% of purchased consultancy is removed from the investment figure, on the basis that not all of the knowledge acquired is long-lived capital. Our series for organisational investment is shown below.

Figure 14. Training: UK Investment, Nominal £mns



Source: Own estimates

5. Estimating the proportions of knowledge investment protected by IPRs

In measuring investment in assets protected by different types of IPRs, we also need to estimate what proportion of investment is protected by IPRs. In this section we briefly discuss our methods to do that. For fuller details please see the accompanying report¹² (Farooqui, Goodridge and Haskel, 2011).

IPRs can be split into two broad groups: registered and unregistered rights. The first requires formal application from innovators, the second is automatic and invoked by the innovator when necessary. Table 2 summarises the IP rights considered in this report, how they fit into each of these groups and previews our findings of what proportion of investment is protected by IPRs (by asset type).

Table 2: IP Assets: Registered and Unregistered Rights

Registered	Unregistered
Patents (30% of Investment in 'Scientific R&D')	Copyright (100% of Investment in 'Artistic Originals' and 'Computerised Information')
Trademarks (100% of Investment in 'Branding')	Unregistered Design Rights (100% of Investment in 'Architectural and Engineering Design')

First consider 'Artistic Originals'. One of the criteria set out by Eurostat for classification of an item as an artistic original is that it must be covered by copyright. Therefore we consider our estimates of investment in these assets to all fall within the category of 'investment in copyrights'. Regarding software, since all copyrighted works are recognised automatically when asserted by the owner, we classify all investment in software (own-account and purchased) as 'investment in copyrights', alongside investment in artistic originals.

¹² Using CIS to uncover the Importance of Intellectual

For Design, we make a similar assumption. We allocate 100% of investment in design to 'unregistered design rights' since such rights are automatic. It is worth noting that although (unregistered) design rights only last five years, the estimated depreciation rate for design assets is high at 20% p.a. meaning the asset will have lost most of its value by the time the right expires, allowing us to use the same depreciation rate. The other IPR relevant to Design is registered rights. We did try to use the CIS to determine what proportion of investment in Design is covered by registered rights but found little information, for further details please see appendix on registered rights. Therefore we just work with unregistered design rights in this paper, which cover all design, but recognise that some small proportion of design is also covered by registered rights.

For Trademarks we also estimate that 100% of our investment measure is protected. Our reasoning is as follows. We recognise that not all expenditure on advertising and market research constitutes investment. Based on industry discussions we estimate investment in brands as 60% of expenditure on advertising and market research. In doing so, we effectively remove all short-lived expenditure. Since the remaining investment is by definition long-lived, we allocate all of that to our category 'investment in trademarks'.

In determining what proportion of R&D is protected we largely used the CIS, applying a mix of averaging and regression methods. Together this work suggests a central estimate that 30% of R&D investment is covered by patents, and the wider literature is supportive of this finding. Full details are set out in the accompanying paper (Farooqui, Goodridge and Haskel, 2011) but we summarise our main findings here. We have the following.

First, there is a small body of work that attempts to ask what type of protection methods are used by firms. In US work a minority of firms report using formal IP protection methods, and instead typically report the use of first-mover advantages, secrecy or no formal protection at all. Cohen, Nelson and Walsh (2000) asked firms whether they introduced a process and/or product innovation and which IP protection mechanism they considered effective. In a sample of 1,065 American research laboratories in manufacturing, 1991-93, patents were considered effective in 34% of product innovations and for 23% of process innovations. Patents were considered most effective in pharmaceuticals (50%) and medical equipment (55%). Secrecy scored 51% for product and 51% for process in all firms, with lead times 53% and 35% for product and process respectively.

Second, in Europe, Arundel (2001) studies the question using the 1993 CIS for innovative manufacturing firms in Norway, Germany, Luxembourg, the Netherlands, Belgium, Denmark, and Ireland. He presents the percentage of the 2,848 R&D performing firms who give the highest rating to lead time, secrecy, complexity, patents and design registration. Patents score 11.2% and 7.3% for product and process innovations (lead time 54.4% and 46.7%).

Third, to examine this for the UK, we use three successive waves of the Community Innovation Survey (CIS) CIS 3 (1998-2000), 4 (2002-2004) and 5 (2004-2006). We pool responses from the three surveys and transform the data which leaves us a reduced workable sample of 15,181 observations. In a section "Protection of Innovation" firms are asked to report the relative importance of eight different protection mechanisms:¹³

1. Design Registration;
2. Trademarks;
3. Patents;
4. Copyright;
5. Confidentiality Agreements;
6. Secrecy;
7. Complexity of Design;
8. Lead time advantage over competitors.

We find that 52% of firms report using none of these mechanisms. Of the remaining 48% of firms, 14% rate all eight mechanisms as having some importance and the rest at least one.

It might be argued that those relying on mechanisms like patenting would be the spending-intensive firms. So we need to weight the stated importance by expenditure to find out how much spending is associated with importance. We might do this in three ways:

1. Spending is attributed to any reported protection method that is higher than the firm-average importance across all methods. This attributes 40% of R&D to patents;
2. Spending is attributed only to the highest-reported protection method of the firm-level average importance across all methods. This attributes 4% of R&D spend to patents;
3. Spending is attributed to protection methods based on a regression of expenditure on all protection methods. Protection methods are measured on a common scale, so the weight for each method is its coefficient in the regression as a proportion of the sum of all coefficients. This controls for a large number of factors and the simultaneous use of protection methods by firms. We obtain very similar results regardless of regression method: 20% of R&D spending is associated with patents as an important protection method and about 50% of all intangible spending is associated with some form of IP as an important protection method (patents, copyright, trademarks). That said, the 20% hides some variation between industries: patents are important in chemicals (31%, including pharma) but copyright is important in services.

¹³ See Appendix of the accompanying report for details on questionnaire wording.

It is worth saying a little more on the variation by industry. Table 3 below shows that in Manufacturing, only 31% of firms report using patents, but these firms spent 94% of the aggregate industry R&D spend of £4.4bn during 1998-2006. They also spent 81% of the aggregate £0.7bn on design. By contrast 31% of Manufacturing firms also used Design Registration, but they contributed only 49% of total design expenditure and 82% of R&D. In Financial Intermediation we find that 20% of firms used trademarks and accounted for 50% of total design and 62% of R&D spending. In the same industry firms using copyright account for 66% of R&D spending while patent users only account for 52%. However only 11% of these firms patent.

Table 3: Reported importance of IP methods, by industry

Industry	Agric, Fish, Mining			Manufacturing			Gas Elect Water			Construction		
	Firms	R&D spend (£'000s)	Design Spend (£'000s)	Firms	R&D spend (£'000s)	Design Spend (£'000s)	Firms	R&D spend (£'000s)	Design Spend (£'000s)	Firms	R&D spend (£'000s)	Design Spend (£'000s)
	367	84209	6492	12819	4479866	760295	104	11262	910	3517	57174	99812
	%	%	%	%	%	%	%	%	%	%	%	%
Firms using Patents	17	94	81	31	94	81	15	2	91	9	71	90
Firms using Trademarks	19	88	66	35	92	80	17	89	94	13	80	89
Firms using Design	14	89	34	31	82	49	16	1	40	11	73	34
Firms using Copyrights	13	92	32	30	90	50	24	91	49	11	71	33
Industry	Distbn, retails, hotels, restu			Financial intermed			Business Service			Other		
	Firms	R&D spend (£'000s)	Design Spend (£'000s)	Firms	R&D spend (£'000s)	Design Spend (£'000s)	Firms	R&D spend (£'000s)	Design Spend (£'000s)	Firms	R&D spend (£'000s)	Design Spend (£'000s)
	11245	362422	130779	1533	130314	37942	8815	2095602	310993	132	3336	239
	%	%	%	%	%	%	%	%	%	%	%	%
Firms using Patents	13	72	45	11	52	20	17	89	91	14	5	24
Firms using Trademarks	20	70	84	20	62	50	23	85	81	21	19	25
Firms using Design	15	66	38	14	53	8	18	79	40	15	7	11
Firms using Copyrights	15	65	25	20	66	36	25	85	49	33	26	36

Note to table. Each cell shows, by industry, the percentage of firms using each protection type and the fraction of all spending on R&D and design in that industry that those using firms account for. Note that firms can report that they use more than one protection type.

In our weighted (regression-based) results, it is apparent that the R&D intensive industries place even more importance on Patents and formal IP rights in general than the results of the entire sample suggest. In the Chemicals industry, almost 65% of R&D to sales is protected through formal IP mechanisms. Patents protect nearly one third of these, while copyright protects one quarter. By contrast, in Telecommunications, only 45% of R&D to sales is protected by formal IP. This is much closer to the proportions we calculated for the entire sample. Only 14% of R&D intensity is protected by patents in this sector. On the other hand secrecy protects 23% of R&D intensity and confidentiality agreements another 17%.¹⁴

14 For simplicity we have only included a brief summary of our results in this report. For a fuller description of the data and methods, including cleaning procedures and robustness checks, please consult Farooqui, Goodridge and Haskel (2011).

Table 4: Regression-based importance weights of IP contribution to R&D, by industry

SIC	D	24	73	72	64	D x 24	G-P x 64	G-P x 64, 72	G-P x 64, 72, 73
Industry	manuf	chemicals	R&D	software	telecomms	manuf excl chems	services excl telecomms	services excl telecomms and software	services excl telecomms, software and r&d
Trademarks	0.13	0.10	0.18	0.15	0.20	0.13	0.14	0.12	0.09
Patents	0.20	0.31	0.25	0.22	0.14	0.20	0.31	0.30	0.13
Confidentiality	0.08	0.24	0.12	0.13	0.11	0.08	0.13	0.14	0.03
Copyright	0.18	0.09	0.09	0.12	0.17	0.18	0.07	0.03	0.30
Secrecy	0.14	0.04	0.06	0.15	0.23	0.14	0.11	0.09	0.12
Complexity	0.15	0.11	0.17	0.13	0.06	0.15	0.14	0.19	0.30
Lead Time	0.12	0.11	0.14	0.10	0.09	0.12	0.10	0.13	0.03
Fraction spend covered by formal	0.51	0.49	0.51	0.49	0.52	0.51	0.52	0.46	0.52

Note to table: SIC labels and definitions are according to the 2003 classification

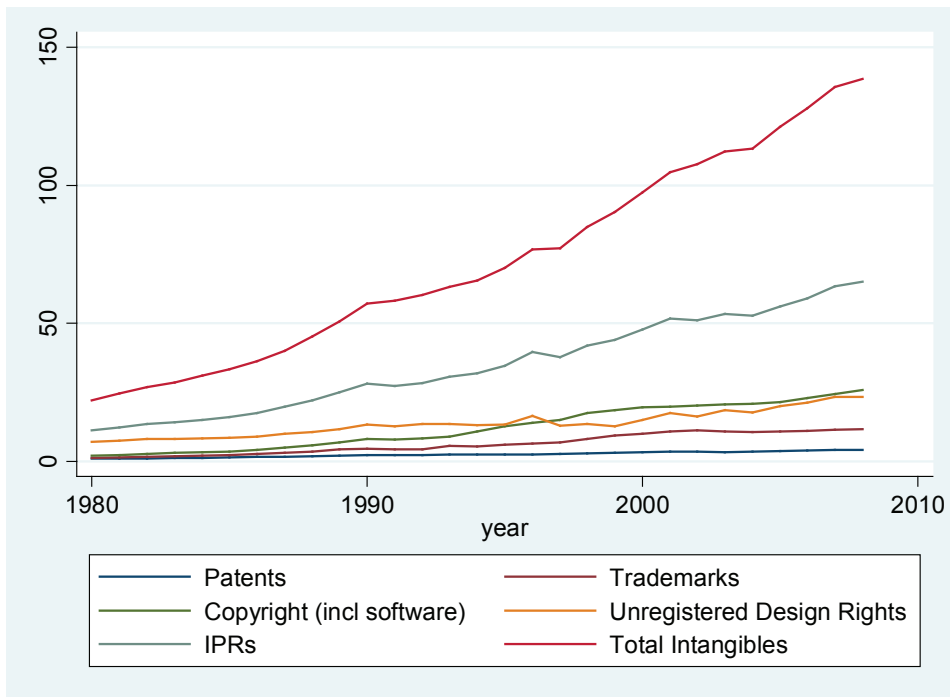
This work uses CIS data. In Haskel et al (2011), we found that the R&D spending questions are quite well answered on the CIS, but the intangibles expenditure questions poorly answered. Thus we regard these results as giving the most robust results for R&D spending.

In the end therefore, we settled on a central estimate of 30% of R&D expenditure attributed to patents. A potential higher bound is 40%, using responses higher than the reported firm average response. However, using either 30% or 40% makes almost no difference to the final result of our growth accounting exercise presented in section 6.

Of the remaining assets not discussed in this section, such as Training and Organisational Structure, we assume that none of these investments are protected by IP rights. Of course certain licensing rights apply to activities such as Mineral Exploration, but not IP rights which are our interest in this report.

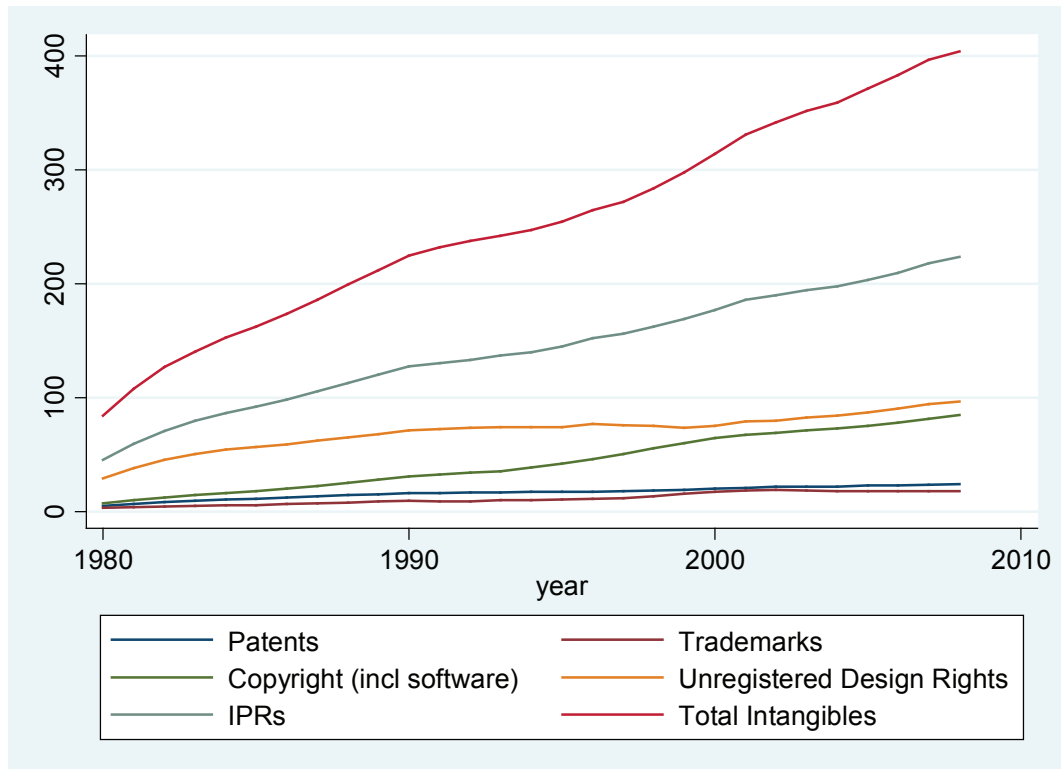
We now apply our estimates of what proportion of investment is protected by IPRs, to our dataset. Figure 15 presents estimates of UK investment, by IP category. We estimate that almost half of knowledge investment is protected by formal IPRs. Of that half, copyright and unregistered design right are the largest components. The data for patents are the lowest of the four presented. Although we feel our finding on the proportion of R&D that is protected by patents is robust it is worth noting that the results for patents and aggregate IPRs are not sensitive to the proportion used, since investment in R&D is relatively small in the context of UK investment, UK knowledge investment and investments protected by IPRs.

Figure 15. Investment, Nominal £bns



Source: Own estimates (Haskel et al, 2011)

Figure 16 presents a breakdown of the UK intangible stock, by type of IP right. We estimate that over half of the UK stock of knowledge assts is protected by some form of IPR. Again, copyright and unregistered design rights are the most significant components. Registered design rights are too small to assign proportions to in the UK CIS.

Figure 16. Capital Stocks, Real £bns

Source: Own estimates (Haskel et al, 2011)

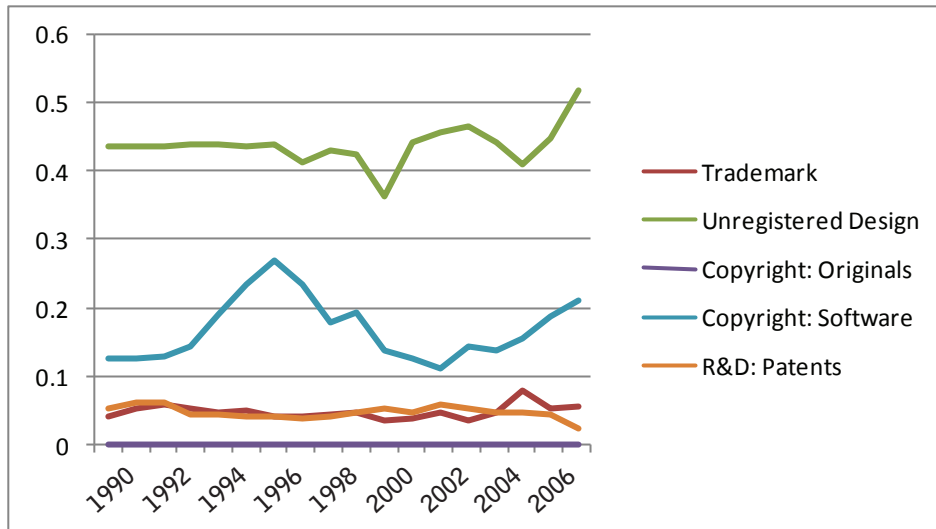
Industry-level investment in UK IP

In the growth-accounting results that follow, we estimate the contribution of IP to UK labour productivity growth at the market-sector level, defined as the aggregate of seven broad industries for which we have data on knowledge investment. Data for artistic originals largely refer to an eighth industry, broadly 'Recreational, Social and Personal Services', which includes film and television activities.¹⁵ Music and Book creation are allocated to the relevant publishing industries in manufacturing.

The following charts present data on IP investment for the seven industries. We also present investment for artistic originals in the eighth sector not yet included in our market sector aggregate. We intend to complete our dataset for the eighth industry and use the data for a full market sector and (eight) industry-level growth decomposition in the near future.

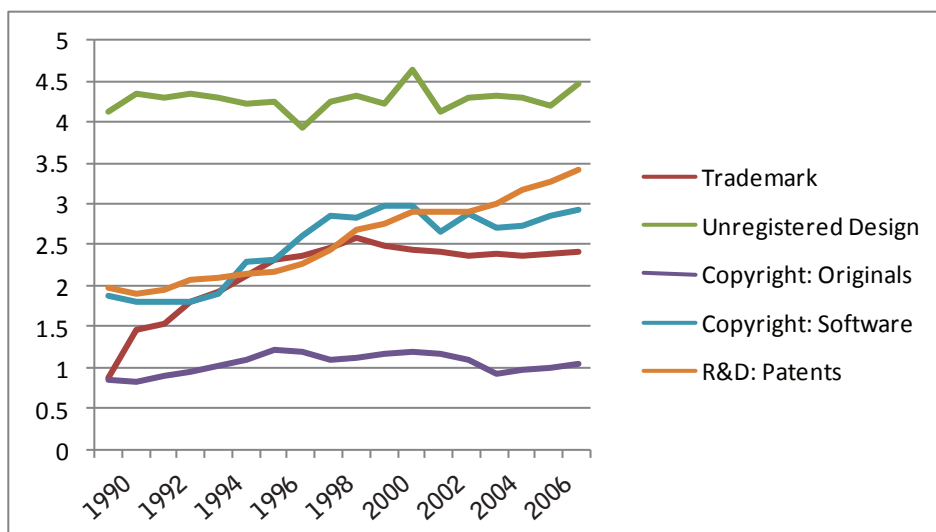
¹⁵ In our investment data we correctly allocate data for artistic originals in the case of Film and TV to 'Recreational Services'. In the growth-accounting analysis all of artistic originals are allocated to manufacturing since we do not have complete data for 'Recreational Services' for either knowledge investment or the other components of output.

Figure 17. IP investment, Agriculture; Mining & Quarrying (ABC), Nominal, £bns



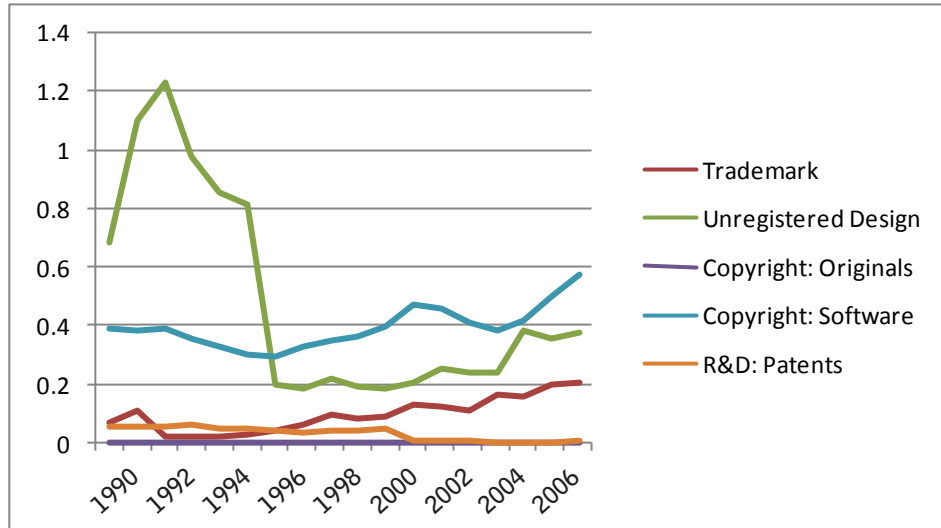
Source: Own estimates (Haskel et al, 2011)

Figure 18. IP investment, Manufacturing (D), Nominal, £bns



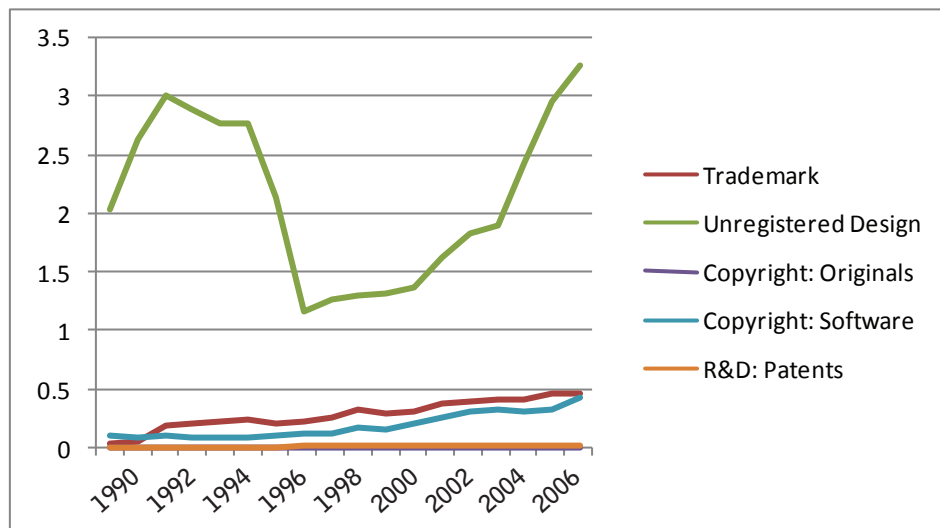
Source: Own estimates (Haskel et al, 2011)

Figure 19. IP investment, Utilities (E), Nominal, £bns



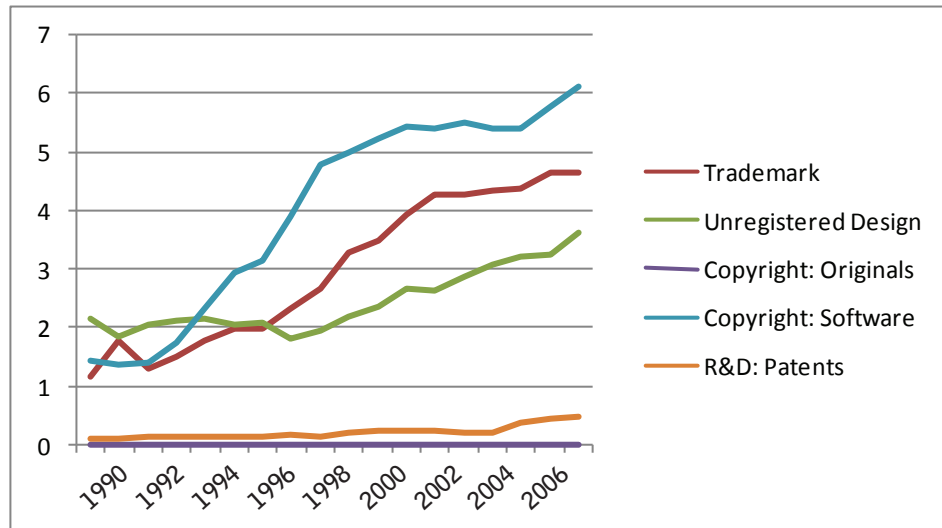
Source: Own estimates (Haskel et al, 2011)

Figure 20. IP investment, Construction (F), Nominal, £bns



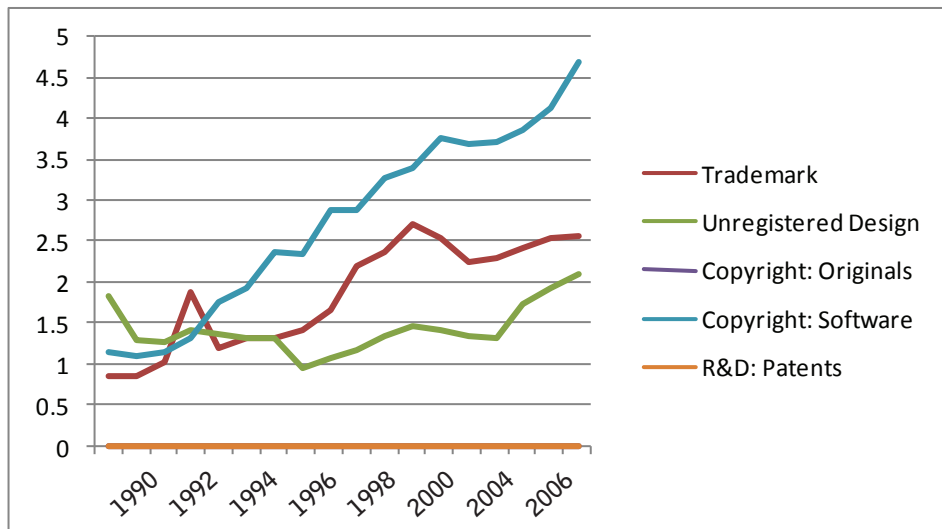
Source: Own estimates (Haskel et al, 2011)

Figure 21. IP investment, Distribution; Hotels & Restaurants; Transport & Communications (GHI), Nominal, £bns

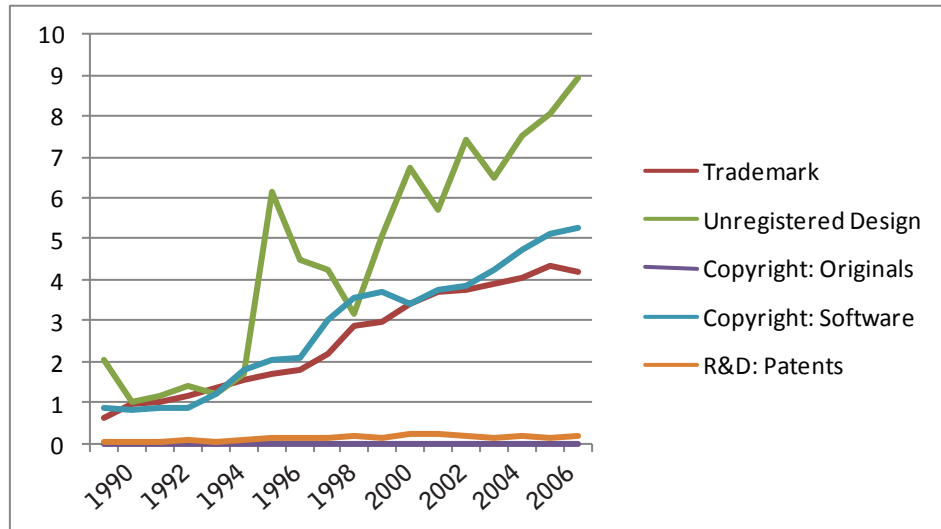


Source: Own estimates (Haskel et al, 2011)

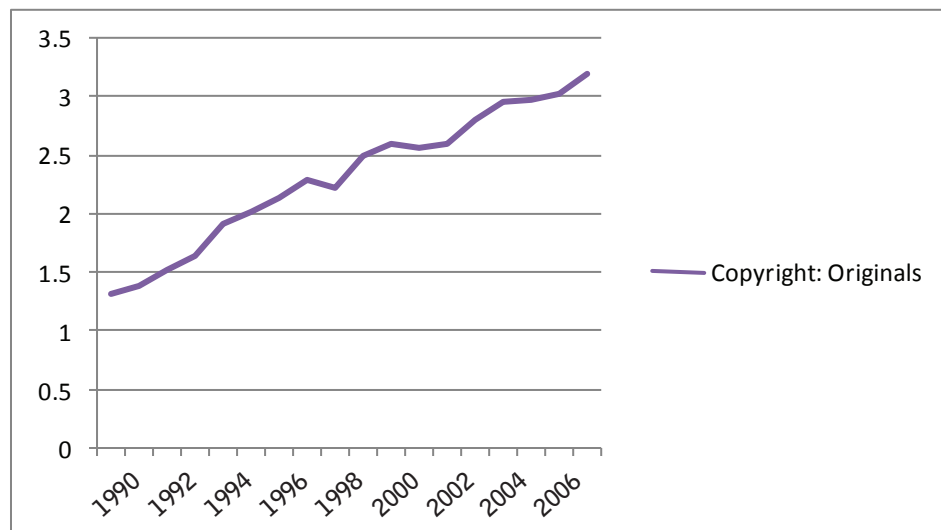
Figure 22. IP investment, Financial Services (J), Nominal, £bns



Source: Own estimates (Haskel et al, 2011)

Figure 23. IP investment, Business Services (K), Nominal, £bns

Source: Own estimates (Haskel et al, 2011)

Figure 24. IP investment, Recreational, Social and Personal Services (O), Nominal, £bns

Source: Own estimates (Haskel et al, 2011)

Note to figure: Data for other types of knowledge investment in this industry have not yet been estimated

6. Contribution of IP capital to UK Market Sector Growth

a. A formal model and definitions

Our formal model is set out fully in Haskel et al (2011) and follows entirely Corrado, Hulten and Sichel (2009). Briefly, we suppose three sectors. The final goods sector produces consumption goods, goods with no investment property. The other two sectors produce investment goods, or assets. These sectors produce new tangible capital (I) and new knowledge/intangible capital (N). The tangible capital stock accumulates according to:

$$K_t = I_t + (1 - \delta_K)K_{t-1} \quad (1)$$

where K is the real stock of tangible capital, and I investment in tangible capital. The intangible capital stock is given by R_t which also accumulates according to:

$$R_t = N_t + (1 - \delta_R)R_{t-1} \quad (2)$$

Some new investment in knowledge, and some of the stock from earlier years, is protected by IPRs.

Rather than knowledge being an intermediate input, we assume that all sectors rent tangible and knowledge capital so that their production functions and profit identities can be written as:

$$\begin{aligned} \text{(a) Intangible sector : } N_t &= F^N(L_{N,t}, K_{N,t}, R_{N,t}, t); & P_t^N N_t &= P_t^L L_{N,t} + P_t^K K_{N,t} + P_t^R R_{N,t} \\ \text{(b) Tangible sector : } I_t &= F^I(L_{I,t}, K_{I,t}, R_{I,t}, t); & P_t^I I_t &= P_t^L L_{I,t} + P_t^K K_{I,t} + P_t^R R_{I,t} \\ \text{(c) Consumption sector : } C_t &= F^C(L_{C,t}, K_{C,t}, R_{C,t}, t); & P_t^C C_t &= P_t^L L_{C,t} + P_t^K K_{C,t} + P_t^R R_{C,t} \end{aligned} \quad (3)$$

As above, we may now calculate value added across each sector to give value added across the economy and its corresponding real growth rate:

$$\begin{aligned} P^V V &= P^C C + P^I I + P^N N \\ \Delta \ln V &= \frac{P^C C}{P^V V} \Delta \ln C + \frac{P^I I}{P^V V} \Delta \ln I + \frac{P^N N}{P^V V} \Delta \ln N \end{aligned} \quad (4)$$

We assume that all inputs are paid the same across all sectors giving economy-wide definitions as

$$X = \sum_{i=C,I,N} X^i, \quad X = K, L, N$$

$$\Delta \ln X = \sum_{i=C,I,N} \frac{P^X X^i}{P^X X} \Delta \ln X^i, \quad X = K, L, N \quad (5)$$

The first term simply defines economy-wide employment of input X as the sum across industries and the second term defines the growth of aggregate real inputs as the share-weighted industry-specific growth. We can now see how real aggregate output grows - the relationship between increased output and increased human, tangible and intangible inputs. Differentiating the production functions in (3) and substituting the resulting expressions for $\Delta \ln C$, $\Delta \ln I$ and $\Delta \ln N$ into (4) and using (5) we can write the sources of economy-wide value added growth in terms of economy-wide input growth as:

$$\Delta \ln V = s^K \Delta \ln K + s^L \Delta \ln L + s^R \Delta \ln R + \Delta \ln TFP \quad (6)$$

where $s^X = (P^X X / P^V V)$, $X=K, L, R$ i.e. the factor input shares of value added.

Equation (6) shows that the economy can grow due to $\Delta \ln K$ and $\Delta \ln L$ - i.e. with the addition of more tangible capital and labour alone. It can also grow due to commercialisation of knowledge. The effect of ideas on $\Delta \ln V$ is captured by the $s^R \Delta \ln R$ and $\Delta \ln TFP$ terms. The first measures the impact on output growth from knowledge spending at the individual firm and the second from knowledge flows from outside the firm (and other unmeasured factors). The first terms can also be further broken down into contributions from capital that is or is not IPR-protected.

b. Growth Accounting: Results

Table 5 provides our results. The first column is labour productivity growth (LPG) per hour. Column 2 shows the contribution of labour services per hour, derived by multiplying growth in labour services per hour by the share of labour in market sector Gross Value Added (MGVA). Column 3 is growth in computer capital services multiplied by the share of payments for computer services in MGVA. Column 4 is growth in other tangible capital services (buildings, plant, vehicles) multiplied by share in MGVA. Column 5 is growth in copyrighted intangible capital services multiplied by share in MGVA. Column 6 is growth in patented intangible capital services multiplied by share in MGVA. Column 7 is growth in trademarked intangible capital services multiplied by share in MGVA. Column 8 is growth in intangible capital services from assets protected by unregistered design rights multiplied by share in MGVA. Column 9 is Total Factor Productivity (TFP), namely column 1 minus the sum of columns 2 to 8. Column 10 is the share of labour payments in MGVA.

The data show that LPG rose in the 1990s and then fell back in the 2000s. The contribution of labour quality (column 2) is fairly steady throughout. Tangible capital input grew quickly

in the 1990s, but fell in the 2000s, especially computer hardware. Thus the overall TFP record was a rise in the second half of the 1990s followed by a fall.

Consider now columns 5 to 9. In column 5 we see the contribution of copyrighted intangible inputs; strong in the 1990s and weaker in the 2000s. In column 6, we see a steady but relatively small contribution from patented R&D. This result reflects the contribution of total R&D, and the nominal share of R&D:GDP has been falling or flat in recent years. Recent studies suggest that the price of R&D has been falling rapidly due to technological innovation in the R&D upstream sector (Corrado, Goodridge and Haskel, 2010). This has significant implications for the contribution of R&D and patented R&D. The contribution of patented capital deepening therefore be viewed as a lower bound. If the performance of R&D is becoming less costly and more productive, due to new technologies, such as improved communications, as seems likely, then its contribution and that of patented R&D will be higher than current measurement suggests.

In Column 7, we see a strong contribution from trademarked capital in the late 1990s, with much smaller contributions in the early 1990s and 2000s. It may be that this reflects heavy investments and associated output from new goods and the changes to the way those goods were distributed in that period. Column 8 shows the contribution of capital protected by unregistered design rights, which has been relatively small and turned negative in the late 1990s. Column 9 reports the remaining contribution of intangible capital deepening not protected by IPRs.

Figure 8 reproduces Table 5 in graphical form with the contribution of IPR-protected capital summed to form one category, and Figure 9 expresses those same data as percentages of labour productivity growth. The data show that since 1990 around 10% of labour productivity growth has been driven by contribution of capital deepening in IPR protected assets.

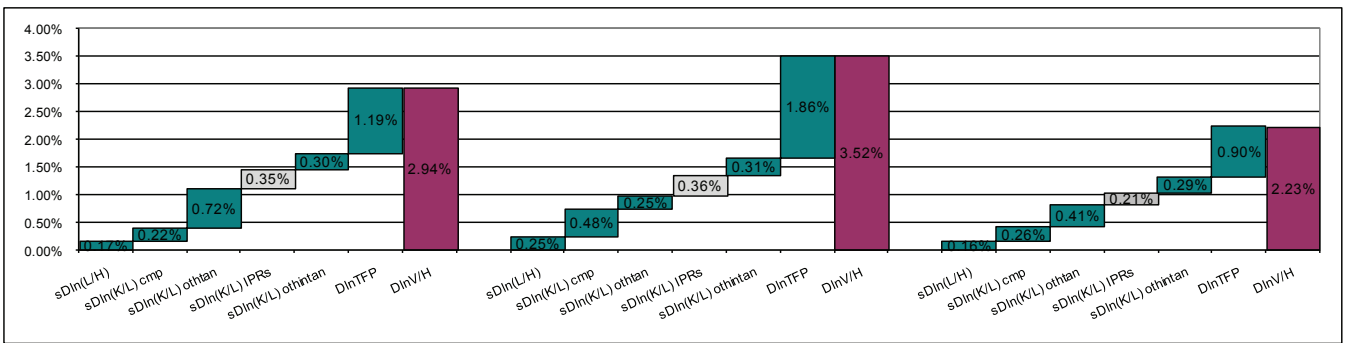
Table 5: Decomposition of labour productivity growth: by IPR type

	DlnV/H	sDln(L/H)	sDln(K/L) cmp	sDln(K/L) othtan	sDln(K/L) copyright	sDln(K/L) patent	sDln(K/L) trademark	sDln(K/L) design rights	sDln(K/L) oth intan	DlnTFP	Memo: sLAB
1990-95	2.94%	0.17%	0.22%	0.72%	0.21%	0.02%	0.05%	0.07%	0.30%	1.19%	0.57
1995-00	3.52%	0.25%	0.48%	0.25%	0.25%	0.02%	0.12%	-0.02%	0.31%	1.86%	0.55
2000-08	2.23%	0.16%	0.26%	0.41%	0.11%	0.02%	0.01%	0.09%	0.29%	0.90%	0.57
1990-08	2.90%	0.20%	0.32%	0.46%	0.19%	0.02%	0.06%	0.05%	0.30%	1.32%	0.56

Notes to table. Data are average growth rates per year for intervals shown. First column is labour productivity growth in per hour terms. Column 2 is the contribution of labour services per hour, namely growth in labour services per hour times share of labour in MGVA. Column 3 is growth in computer capital services per hour times share in MGVA. Column 4 is growth in other tangible capital services per hour (buildings, plant, vehicles) times share in MGVA. Column 5 is growth in copyrighted capital services per hour times share in MGVA. Column 6 is growth in patented capital services per hour times share in

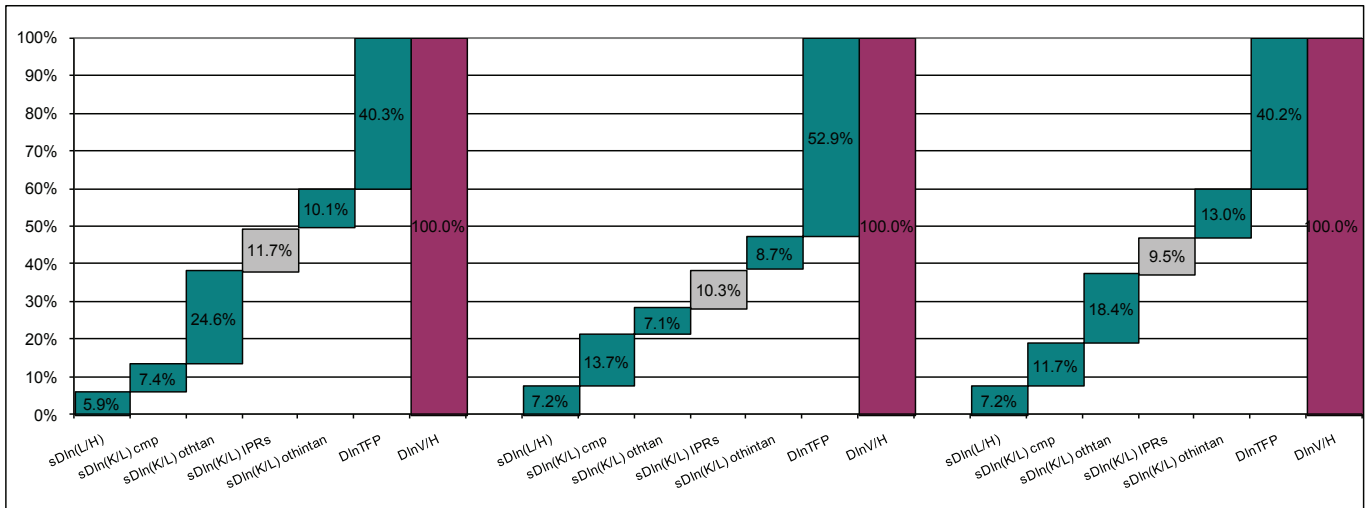
MGVA. Column 7 is trademarked capital services per hour times share in MGVA. Column 8 is growth in capital services protected by design rights per hour times share in GVA. Column 9 is capital services from non-IPR protected intangible capital per hour times share in MGVA. Column 10 is TFP, namely column 1 minus the sum of columns 2 to 9. Column 11 is the share of labour payments in MGVA.

Figure 25. Decomposition, average p.a., 1990-1995, 1995-2000, 2000-2008



Note to figure: Data from Table 2. Numbers do not quite correspond due to rounding

Figure 26. Decomposition as a % of LPG, averages p.a., 1990-1995, 1995-2000, 2000-2008



7. Conclusions

According to the intangibles framework, most recently used in the NESTA Innovation Index (Haskel et al, 2011), investment in IPR-protected assets in the UK makes up almost half of market sector knowledge investment. In 2008, the UK market sector invested £65bn in assets protected by IPRs. Total investment in intangible assets in 2008 was £139bn.

IPR investment data are based on identified expenditure on long-lived goods protected by copyright, trademark, patents and unregistered design rights. Taking each IPR in turn, for 2008 we identify £26bn of investment in copyright-protected assets, £11.7bn in trademark-protected assets, £23.3bn in assets protected by unregistered design rights and £4.2bn in assets protected by patents.

Regarding industry breakdown, we find that Business Services is a heavy investor in unregistered design rights, investing almost £9bn in 2007. Other significant investors are Manufacturing at around £4.5bn and Construction at just over £3bn, for the same year. For copyrights, we find that Business Services (£5.3bn), Financial Services (£4.7bn), Recreational Services (£3.2bn), Distribution & Communications (£6.1bn), and Manufacturing (£4bn) all invest heavily. The largest investors in trademarks are Distribution & Communications (£4.7bn), Business Services (£4.3bn), Financial Services (£2.6bn) and Manufacturing (2.4bn). For patents, Manufacturing invests £3.4bn, out of a total of £4.2bn investment in this type of IPR in 2007.

Since protected asset categories typically depreciate slightly less quickly than other knowledge assets, the IPR-protected stock is over half of the total market sector stock of knowledge capital. As a result, IPR protected assets have made a significant contribution to UK market sector labour productivity growth since 1990, on average 10.6% of LPG per year. Comparable annual estimates for computers and other tangible capital are 11.1% and 15.9% respectively. Knowledge capital not protected by IPRs has contributed 10.3% annually. The remainder is made up of the contributions of labour composition and total factor productivity, at 6.8% and 45.4% respectively. It should also be noted that the TFP residual includes the contributions of freely available knowledge and all externalities and spillovers that derive from knowledge assets, as we have already argued using the example of spillovers generated from new formats of artistic originals. Other examples could include the knowledge embedded in patents that becomes freely available once expired, and knowledge contained in products or held by workers when they move between firms/industries. Therefore the contribution of IPR-protected assets should be viewed as conservative estimate, since some additional contribution is almost certainly present in TFP.

Of course, this is not to say that the contributions are higher than they would have been if those assets were not protected by IPRs. That area requires further work. Whilst some evidence suggests that the ability to use IPRs increases innovation through the incentive of monopolist revenues, others suggest that the same mechanism reduces innovation by removing the incentive to continually innovate.

Nevertheless, the role of IPR-protected assets and their contribution to growth is not fully appreciated – their contribution is just as high as that of computers, equivalent to that of other knowledge capital, and comparable with that of other tangible capital. Considering the latter includes all buildings, non-ICT plant & machinery, and vehicles, their role as a driver of growth deserves greater consideration in both measurement and policy.

References

Chamberlin, G., Clayton, T. and Farooqui, S. (2007), *New measures of UK private sector software investment*, Economic and Labour Market Review, Vol. 1, No. 5, pp17-28

Corrado, C., Goodridge, P. and Haskel, J. (2010), *Constructing a Price Deflator for R&D: Calculating the Price of Knowledge Investments as a Residual*, Working Paper

Corrado, C., Hulten, C. and Sichel, D. (2006), *Intangible Capital and Economic Growth*, NBER Working Papers 11948, National Bureau of Economic Research, Inc.


Galindo-Rueda, F., Haskel, J. and Pesole, A. (2010), *How much does the UK employ, spend and invest in design?*

Goodridge, P. and Haskel, J. (2011), *Film, Television & Radio, Books, Music and Art: UK Investment in Artistic Originals*

Haskel, J., Clayton, T., Goodridge, P., and Pesole, A. (2009), *Innovation, knowledge spending and productivity growth in the UK*

Haskel, J. And Pesole, A. (2009), *Productivity and Innovation in UK Financial Services: An Intangible Assets Approach*

Soloveichik, R. (2010), *Artistic Originals as a Capital Asset*, Working Paper



Concept House
Cardiff Road
Newport
NP10 8QQ

Tel: 0300 300 2000
Minicom: 0300 0200 015
Fax: 01633 817 777

For copies in alternative formats please

contact our Information Centre.

**When you no longer need this booklet,
please recycle it.**

DPS/E100-06.11



INVESTOR IN PEOPLE



The Government Standard