Understanding innovation better: an intangible investment approach*

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Abstract

We set out a way of understanding innovation using the intangible asset approach. It attempts to set out a framework that is married to national accounts and understands innovation and its consequences in particular where innovation might not be patented.

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1 Introduction

As this conference is about innovation I am going to try to say something about the "intangible asset" approach to innovation. This is an approach inspired by Corrado et al. (2005, 2009) although it is rooted firmly in the "knowledge as capital" approach dating at least from Machlup (1962) and including Jorgenson and Griliches (1967).

I start from a quote from former Fed chairman Ben Bernanke who said in a 2011 speech "we will be more likely to grow at innovation activities if we are able to measure it more effectively and document its role in economic growth." [1] There are a number of approaches to innovation in the literature which address Ben Bernake's question: the study of total fact productivity, the study of patents and R&D, copyrights and trademarks, and the many innovation surveys. For a survey see Corrado et al. (2013). For example the European community innovation survey and other surveys from elsewhere ask firms about whether they have innovated or not and of course there is a large body of work in the management studies area which has looked at innovation (for an economics contribution to this see Bloom and Reenen (2010) .

And so I would like to ask the question: how do these frameworks apply to British innovation? I apologize first of all for coming along and talking about British innovation at a conference in Taiwan but let me try to give you a feel of why I was motivated to look at this particular approach to innovation and hopefully it will have some relevance to your particular country as well.

At this point I normally ask people to guess Britain's most famous innovation. People typically guess Concorde, Dyson vacuum cleaners or Sherlock Holmes. But my view is that there is one incredible famous innovation which I guarantee everybody in the entire world knows about. There are people in tribes where they haven't even discovered modern living and they know all about it. I suggest that Harry Potter is Britain's most famous innovation. Given I teach at a business school people say to me: if you study innovation tell me about Harry Potter? This was the first kind of conversation that got me thinking about a way of trying to apply the intangibles innovation framework to these issues. But before that consider some more British innovations: set out in 1.

In that figure, Tesco is on the left. It is now the 3rd largest supermarket in the world. It began in very humble beginnings by an immigrant to Britain one hundred year ago. On the right, London Bridge is actually an innovative bridge, designed by Arup, but the point is that the bridge goes to the City of London, home of the London financial services industry which (some think) is extremely innovative. Grand Theft Auto is one of the world's best-selling computer software games. It looks like what British people think inner-city Detroit looks like but it's written by a company who started in Glasgow in Scotland. Of course, the Beatles are a British innovation: Amy Winehouse is another example and I could also talk about Monty Python.

These are all examples of what British innovation is known for and I find these examples quite interesting. More formally, there is an interesting study by Tufano (1989) who did an econometric study of 58 financial innovations between 1974 and 1986. He begins his paper with an interesting interview with a bank executive. The exective says that developing a new financial product requires and investment of US$50,000 to US$5m. There arepayments for legal services, time spent educating issuers, investors and traders, investments in computer systems. He documents that investment banks have a team of bankers paid $1m dollars for staff product development groups.

Why do I find these examples interesting? Here are a number of reasons. The first reason is that there is

[1] Speech in Washington DC at Athena Alliance/OECD Conference, May 2011.

Figure 1: British innovation

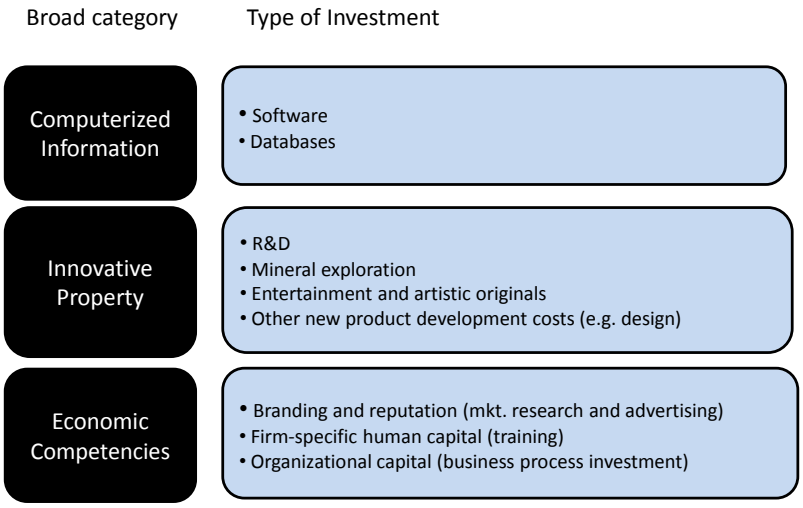
essentially no R&D going on in any of these innovations. In Harry Potter there's no R&D. In British banks, the British statistical authorities until recently never even sent an R&D questionnaire to firms in financial services, because they believed that financial services were not doing R&D. In software, software firms lost a long legal battle to claim an R&D tax credit because what they do, although it costs hundreds of millions of pounds, is not defined as R&D.

I don't want to say R&D is unimportant. It's vital that we document R&D and its spillovers. But R&D does not to apply immediately to the type of innovations I have just discussed. So that's the first point. The second point close to that is there is probably no patenting going on of this kind of innovations but of course there is IP protection via copyright and trademarks (Greenhalgh and Rogers (2007)).

The third point is I'm not sure how people or firms would respond to the innovation questionnaires which ask "have you innovated?" If researchers go to Goldman Sachs or Grand Theft Auto or Tesco, who run multi-billion dollar businesses all over the globe and ask them: "have you innovated?" I don't know how they would reply to that question. Fourthly, as in Peter Tufano's study, innovation seems to need a range of investments alongside R&D: training, marketing and things like that. So that's why I find them interesting. Thus I believe that the intangible assets approach which in many ways started with work by Fritz Machlup (Machlup (1962)) which is an amazingly prescient book, was propelled by an important paper by Len Nakamura (Nakamura (2001)and perhaps most fully articulated in Corrado, Hulten, Sichel (CHS, Corrado et al. (2005, 2009)). I think this framework helps quantify these innovations and links them firmly to macro aggregates to use them for policy analysis.

And so I want to just say a little bit about the framework see if its helpful. Now the key to this framework

Figure 2: The CHS framework: measure investment in expanded range of assets



Source: Corrado, Hulten and Sichel, 2005, 2009 and Carol Corrado, OECD/MIT presentation, NAS, December, 2012

is essentially to measure investment in an expanded range of assets. So one way of thinking about this framework is to think about the financial services quote and ask the question: how could we measure the types of investment that financial services companies appear to be making around their innovation? CHS propose investment under the following headings (some are also in Machlup (1962)), and they are set out in 2

The first asset category is computerized information. CHS propose measuring investments in software and investments in databases. Investments in software are currently in the system of national accounts so that's being done. Let me mention a little bit investments in databases. I'm sure in many of the countries represented here there's lots of discussion around Big Data. One way to think about Big Data is that firms are going to be investing in developing and analyzing the databases that they hold, they might buy those databases, they might analyze those databases, and they might hire analytic companies that do this. Now, database investment is supposed to be captured in the national accountants. And there is an on-going set of studies by the OECD to how that is done. Note there is a tricky national accounts issue here, since national accounts guidance suggests that measurement of the investment to develop and make usable databases should be counted, but not investment in creating the original numbers. Note too that computerised information is clearly going to be very important in financial services. If we look at the disaggregated data, we know that banks spend an enormous amount of money on software (for the UK see e.g. Borgo et al. (2013). So that will get us a little bit of the way to understand innovation in the financial services area which as I mentioned before is an important question at least in the UK.

The second broad asset group is "innovative property": R&D, and intangible investment in design, artistic

orginals and other, possibly IP related spending, such as mineral exploration. I just spent a very nice week in Australia and obviously in Australia minerals and mining is a very important industry and understanding better the types of investment that those types of companies are making in innovation is very important. Likewise, in the UK and many European companies, investment in entertainment and artistic originals comprises hundreds and hundreds of millions of pounds in the case of a Harry Potter film for example. Indeed, such spending is investment into an asset which is then hopefully copyrighted which will hopefully make some returns. Measurement issues are important here. In the UK, the ONS formally sampled film companies for their spending, but their sample had turned down Harry Potter and hence their development costs were not in the data. So that's why the measurement issues are important. Finally, in this cateogory we have "other product development costs " or design. The UK has a very active design industry who are designing, doing fashion, architecture and so on.

The third type of intangibles is grouped under the heading of "economic competencies". Theseare investments in things like branding, reputation, market research and so forth. Given the attention in economics to human capital this is important. If we think of the locus of education as being only at home and in formal schools that misses a large area of human capital namely education investment by firms. That turns out to be a very large number in the UK and is another area of importance in financial services.

And then finally, a very difficult area to measure, organizational capital. What is this? There is a reason why Wallmart and Tesco have got to be the biggest retailers in the world and left the other retailers behind. They are process engineers in a very expert kind of way. I think of airlines, especially low cost airlines, very popular in Asia, as being process engineers. They spend a lot of their time thinking about the process of offering airline services and that organizational capital which they have built up would be something we would want to since that's an important part of their investment.

2 Model

A formal model is set out below. The intangible sector produces new knowledge N using inputs labour, L, tangible capital, K and intangible capital, R with prices in consitent notation. The production function and payment flow equation are

$$[N_t = F^N(L_{N,t}, K_{N,t}, R_{N,t}, t^N); \quad P_t^N N_t = \mu \left(P_t^L L_{N,t} + P_t^K K_{N,t}\right) \tag{1}$$

where we assume knowlege for the creation of new investment goods is free but that the N sector might have monopoly power to mark-up prices over costs (μ). For the tangible and consumption goods sector, who produce investment and consumption goods, I and C, the corresponding expressions are

$$I_t = F^I(L_{I,t}, K_{I,t}, R_{I,t}, t^I); \qquad P_t^I I_t = P_t^L L_{I,t} + P_t^K K_{I,t} \tag{2}$$

and

$$C_t = F^C(L_{C,t}, K_{C,t}, R_{C,t}, t^C); \quad P_t^C C_t = P_t^L L_{C,t} + P_t^K K_{C,t} + P_t^R R_{C,t} \tag{3}$$

Thus the consumption sector produces final consumption goods and rents labor, capital and knowledge. Where does that knowledge come from? The knowledge comes from the intangible sector so this is the slightly new part although all this is implicit in the works of Fritz Machlup and Jorgenson and Griliches (Jorgenson and Griliches (1967)). The knowledge sector here produces new knowledge by using labor capitol

and knowledge itself. And what does it do? It produces that knowledge on the basis of its labor and capital, we assume that it gets knowledge for free for various reasons. And we imagine that it might have a markup on that knowledge for Romer-style reasons, following Romer's 1990 paper (Romer (1990)).

Capital accumulates according to a perpetual inventory method

$$R_{C,t} = N_t + (1-\delta^R)R_{C,t-1} \quad and \quad K_{J,t} = I_t + (1-\delta^K)K_{J,t-1}, J = C, I, N \tag{4}$$

and the rental and asset prices are those from Hall and Jorgenson (1967)

$$P_t^R = P_t^N(r_t - \pi_t^R + \delta^R) \quad and \quad P_t^K = P_t^I(r_t - \pi_t^K + \delta^K) \tag{5}$$

What implications does this have? First of all, GDP is different, so we think of GDP usually as being consumption plus investment but of course there is more investment now. Because there is investment in these intangibles so there is extra GDP consumption plus this added investment as well and that is balanced off by extra capital payments to the owners of that knowledge. Likewise, there is extra GDP growth if there is strong investment in knowledge growth. We can do growth accounting here and again this just expands the (Jorgenson and Griliches (1967)) framework where we have the extra output depending upon labor and capital and here is the knowledge input and the contribution of TFP.

We may see this in equation form as follows. First, consider new GDP it the top line and its growth in the second line

$$\begin{aligned} P^Q Q &= P^C C + \underbrace{P^I I + P^N N}_{\text{Total investment}} = P^L L + \underbrace{P^K K + P^R R}_{\text{Total capital payments}} \\ d\ln Q &= s_Q^C d\ln C + s_Q^I d\ln I + \underbrace{s_Q^N d\ln N}_{\text{Addition to GDP growth}} \end{aligned} \tag{6}$$

Next we may set out an enhanced view of innovation as follows

$$\begin{aligned} &Q = F(L, K, R) \\ &\underbrace{d\ln Q}_{\text{Differentoutput}} = s_Q{}^L d\ln L + s_Q{}^K d\ln K + \underbrace{s_Q^R d\ln R}_{\text{Moreinput}} + d\ln TFP \\ &\text{compare} \\ &V = AF(L, K) \\ &d\ln V = s_V{}^L d\ln L + s_V{}^K d\ln K + d\ln TFP^V \end{aligned} \tag{7}$$

As the top line shows, compared with the usual approach which just simply takes labor and capital and conventional value added and just attributes everything to TFP, there is extra output, extra inputs, of knowledge goods and changed TFP. I believe there are three advantages of this framework. First, this is an "investment in innovation" framework that links innovation to GDP . In my introductory remarks, I said we think of innovation as being important to growth. Since we conventionally measure growth by GDP, this framework links all of these things up and allows economists working in the innovations area to talk to central bankers and policy-makers in a common language.

The second is that innovation is not just the TFP residual. It consists of paid for innovation, $s_Q^R d\ln R$, which is the increase in knowledge capital times its rental term and the remaining will be spillovers.[2] The third is there's lots of discussion in the UK about the "creative economy", with many policy departments

[2] There are a number of complications around what we assume for μ: in this case $\mu = 1$for simplicity.

working on the "creative economy". These are industries and products like Harry Potter music, design, and movies . This is a big area where policy makers in the UK want to have a way about thinking about all of this. How do we think about this in this framework? In the standard approach, one identifies "creative industries" such as design and looks up official data on value added in those industries. This approach says to do something different. We can think of the creative economy as investment in knowledge assets. Note they are both creative sectors *and also* on the own account. So for example, one of the important issues about creative investment is that some of it will be done in, say, the design sector but much of it will be done within industries themselves e.g. design in the car industry. We then can then work out the contributions of the creative economy to GDP growth via the $s_Q^R d\ln R$ term.

Fourthly, we can use this measurement frameworks to evaluate the EU innovation scoreboard. This is essentially a combined measure of many different dimensions of innovation e.g. patents, spend on software, employment in hi-tech industries etc. Each has an equal weight. And if a new dimension were to be admitted, then there would be $n+1$ measures and so a new set of weights. But it's hard to know what to do with a mix of inputs and outputs: here that is very clear and the weights are by value which uses the market to weight inputs by their elasticity which is the point of the exercise.

Finally, in the UK and in Europe, statistics agencies are under a lot of budgetary pressure and they want to know where to allocate their resources. They look to academics to give them some guidance. And in thinking about improved measures, improved surveys and where statistics agencies might allocate their money I find this framework rather helpful. That's helps economists to talk to statistics agencies and have that two-way relationship.

There are clearly a lot of difficult measurement issues around what we are going to measure and how much we are going to deflate things by and so forth. There are a number of conceptual objections such as "intangible spending is not investment", "ideas don't depreciate" etc. Some evidence on this is set out in Corrado et al. (2013). So for example, we have done some survey evidence to try and document that much of this intangible investment lasts for more than a year and should be counted as investment.

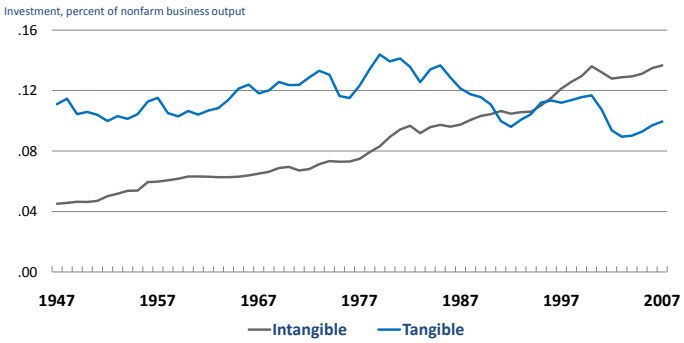
3 Facts and policy implications

What facts and policy implications if any have we uncovered? Have missed a lot or a little investment? Does capitalizing intangibles make a large difference? All of these points are discussed in Corrado et al. (2013)we go through a number of these issues. First, we have tried to build a harmonized cross country data set. This is based on EU-funded works, so we can only work with the EU countries. It relies on a mix of structural businesses surveys the output of design companies, training issues, training surveys, advertising surveys and so forth. So we have investment data for twenty-seven EU countries and growth accounting for twelve countries and we have added the USA (and thanks to Professor Kyoji Fukao, Tsutomu Miyagawa, Kentaro Mukai, Yukio Shinoda, and Konomi Tonogi from Japan we have added in some Japanese data as well, Fukao et al. (2009))). For all these data, see `www.intan-invest.net`.

To give some context, figure 3 sets out US intangibles v tangibles investment shares of GDP in long run.

US tangible investment as a proportion of GDP fell very strongly since the 1970s. Intangible investment, on the other hand, rose and is now higher as a proportion of GDP than tangible investment. So that immediately starts you are thinking about whether we measure investment well. In the US there is a big argument about secular stagnation and the unwillingness of firms to invest. They may not be investing in tangible assets but they are certainly investing in intangible assets. I think this may be an opportunity to

Figure 3: US intangibles v tangibles investment shares of GDP



Source: calculations by Carol Corrado

change the debate over stagnation in the US but that's for another paper.

Figure 4 shows the European data as well. In the EU-15 as a whole, tangible investment is more important on average in the 1990s and the 2000s than intangible investment but this hides a lot of variation. As we have just seen in the US, intangible investment is more that tangible investment in Scandinavian countries. In the UK and in Ireland the UK has very high intangible investment. The Mediterranean countries, Greece and Italy for example, have very low intangible investment. There is some interesting cross country variation clearly.

What about R&D? They are part of intangibles, but as figure 5 shows the

cross country R&D rank does not determine the intangible investment rank. Take the UK as one example. It has high intangible investment and relatively low or in the middle of R&D investment. So there is more to intangibles than just R&D investment.

As the above algebra shows, when you capitalize intangible investments you affect both outputs and inputs. Figure 6 shows that capitalising intangibles mostly raises $\Delta ln(Q/H)$, but mostly lowers $\Delta lnTFP$.

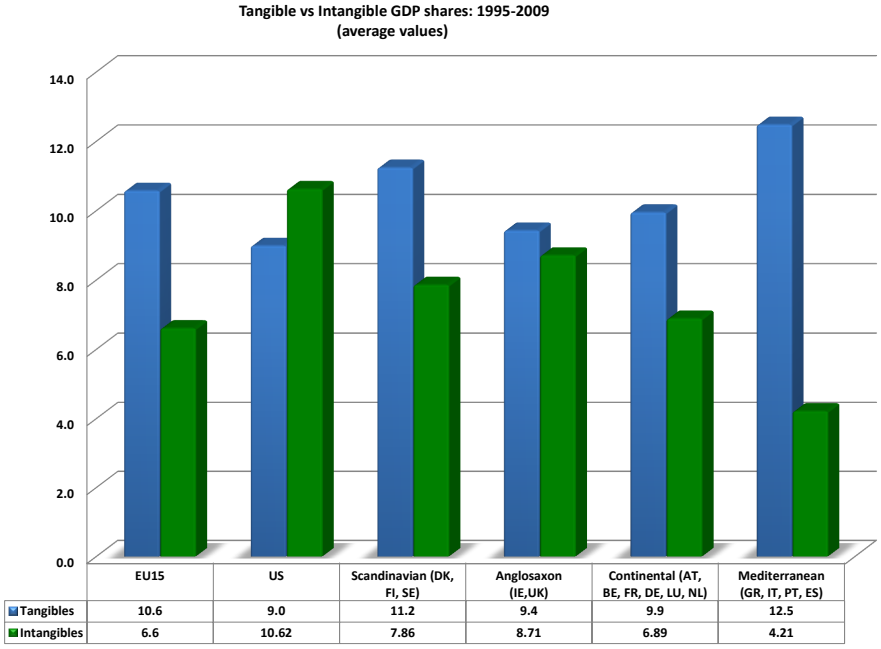
Finally, figure 7

sets out average intangible investment (as % of GDP) and employment protection, days to start a business and government R&D (these latter indicators are from the OECD). There is a negative correlation for the first two, suggesting that various policy measures are associated with less intangible investment, but positive with the third. The policy implications of all this are interesting and worthy of more study.

4 Conclusion

I think that this a coherent framework to approaching innovation. I think it's likely to be increasingly important in thinking about knowledge-intensive economies. I think it could be adapted to national accounts and inform the measurement agenda. And it can look at policy analysis. The challenges are significant

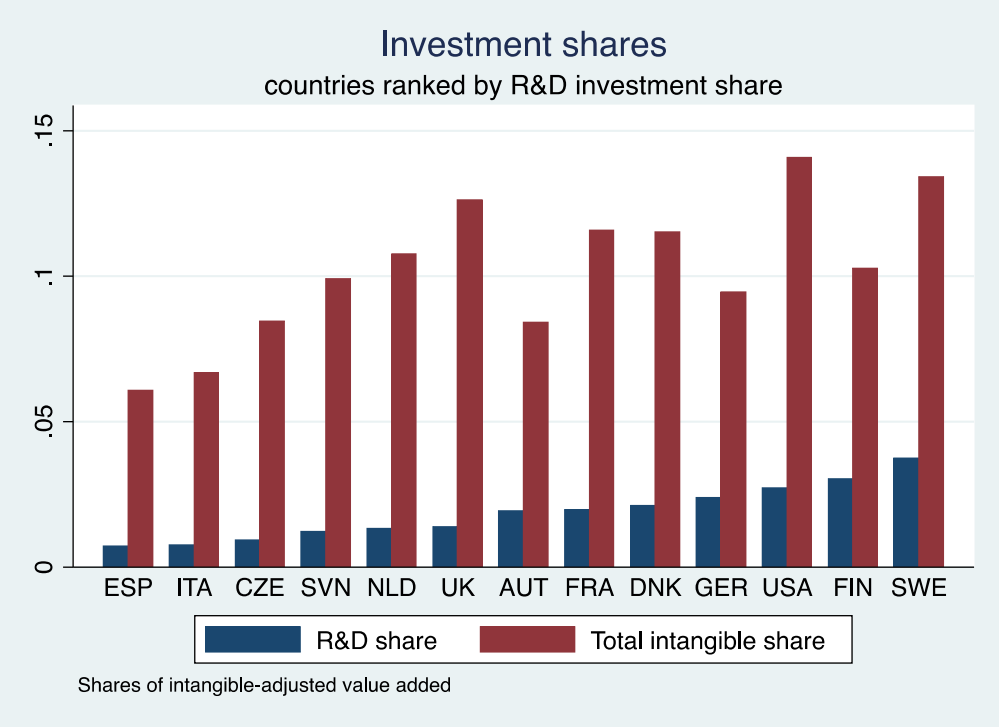
Figure 4: EU15 & US investment shares (tangible and intangible investment shares of GDP, 1995-09)



	EU15	US	Scandinavian (DK, FI, SE)	Anglosaxon (IE,UK)	Continental (AT, BE, FR, DE, LU, NL)	Mediterranean (GR, IT, PT, ES)
Tangibles	10.6	9.0	11.2	9.4	9.9	12.5
Intangibles	6.6	10.62	7.86	8.71	6.89	4.21

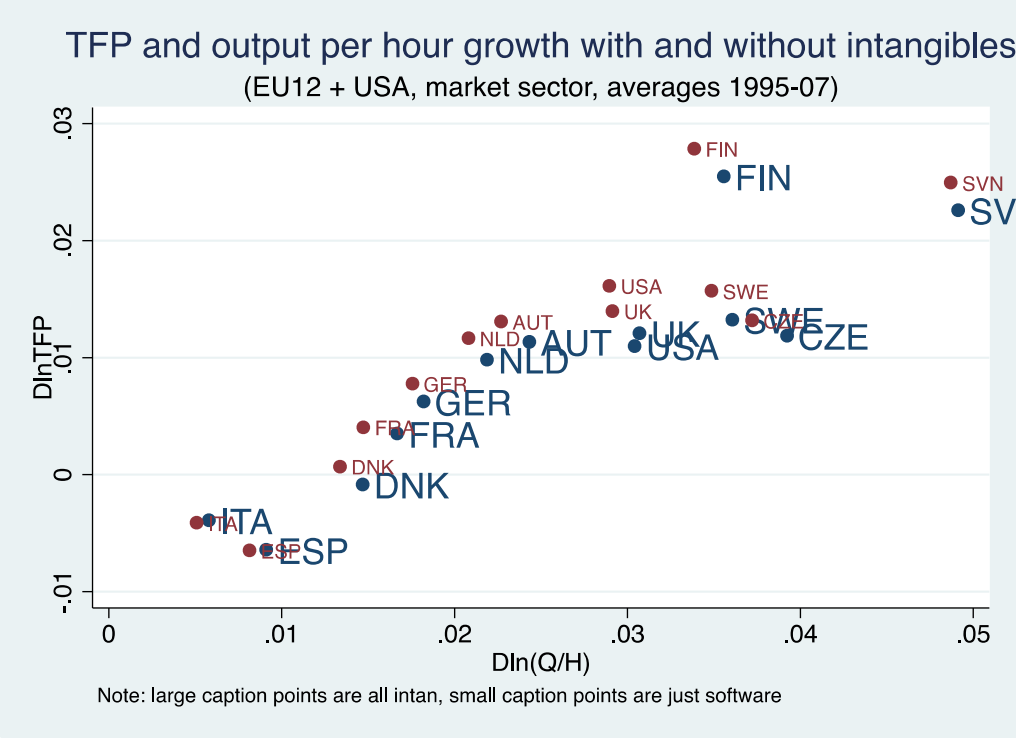
Source: `www.intan-invest.net`

Figure 5: R&D and total intangible investment shares of GDP



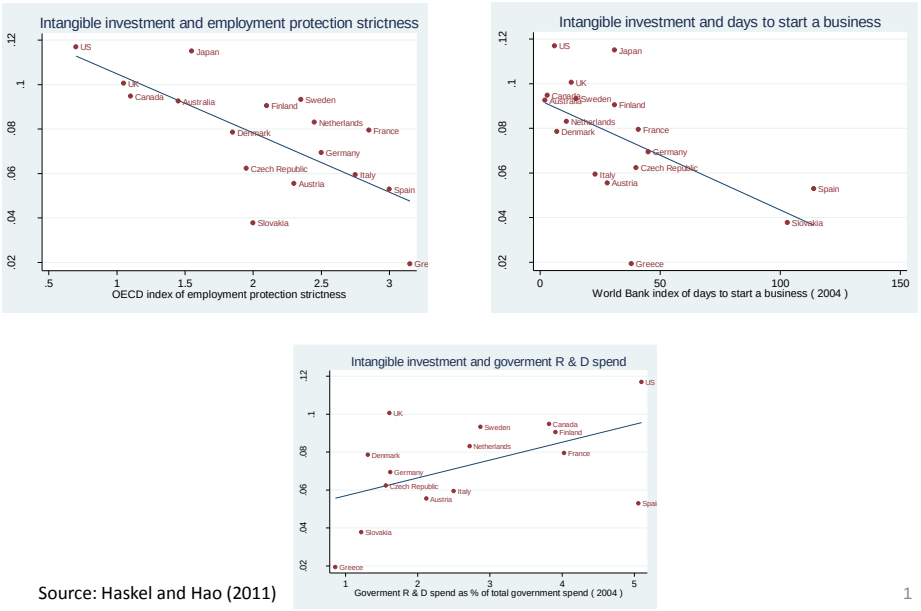
Source: `www.intan-invest.net`

Figure 6: Effect on $\Delta lnQ/H$ and $\Delta lnTFP$ of capitalizing intangibles



Source: Author calculations from `www.intan-invest.net`

Figure 7: Intangible investment (as % of GDP) and employment protection, days to start a business and government R&D



Source: Haskel and Hao (2001)

however. There are lots of assumptions to be tested; the approach needs a lot of measurement; better questionnaires, and especially measuring investments on the own account. Nonetheless, on the basis of measurements so far, I think the intangibles approach gives a slightly different innovation picture to R&D. There seems to be some interesting correlations with structural variables and the productivity and TFP growth picture change. Better data will take the questions and their answers further.

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