FEATURE

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Measuring innovation and productivity in a knowledge-based service economy

SUMMARY

This article provides a review of measurement conventions for the services sector and for investment in knowledge assets. It is widely argued that activity in modern-day economies is increasingly becoming concentrated in the services sector and in the form of spending on knowledge, assets like design software, training and research and development (R&D).

The article summarises recent work and concludes that productivity measurement in the services sector is not as unreliable as some have said but more needs to be done to incorporate knowledge assessment into measurement.

Are current measurement systems adequate to document and understand productivity? There are two main arguments to say that they are not, both stemming from the assertion that statistical systems have not kept pace with structural change in the economy. First, it is argued that the services sector has grown and that productivity in it is not well measured. Second, it is argued that the knowledge economy has grown and that measurement conventions have missed this altogether.[1] This article reviews both these arguments, drawing on recent work by academics and statistics agencies.

The services sector

Market services are around 42 per cent of gross domestic product (GDP), with public services about 22 per cent. One helpful generic way of thinking about services is to think of output as having the dimensions of quantity, space and time. Consumers clearly value the quantity of output for the stream of consumption services it yields. But consumers also presumably value the location of a good in terms of space and time. In terms of space, consumers value having goods readily available near them, hence the transportation and retailing industry. As for time, consumers wish to smooth consumption and producers to borrow money against future projects. This service is provided in part by the financial services industry, which holds savers' money safely and screens borrowers.

In some cases, of course, consumption and production cannot be separated in time or space: haircuts, medical operations and teaching, for example. Thus Melvin (1990) defines services that overcome the time or space separation between consumers and producers as 'intermediation services'. This includes transport, retailing and some financial services. He defines 'contact services' as those that arise when production and consumption cannot be separated, for example, haircuts, education, medical and financial advice.

How does this help define output? The output of a shoe shipper who transports shoes from the manufacturer is not the shoes. Rather, it is the bundle of intermediation services involved in the transport of those shoes. Similarly, the output of the shoe retailer who sells the shoes on to the final consumer from the manufacturer is not the shoes themselves; rather, it is the bundle of retail services, such as ambience, assortment, and convenience to the shopper.

In contact services, such as education, since it is hard to separate consumption and production, there would be the temptation to measure the number of teachers, or number of bankers providing financial advice. But once again, what is being produced here is a bundle of services, in these cases education and advice.

At first sight, this complicates the problem, since a bundle of services, like advice, retailing services or transport would appear to be too intangible to measure (as opposed to the bundle of shoes produced by the shoe manufacturer). However, if the service is valuable, then someone should be willing to pay for it. The point should be obvious to anyone who has bought a bottle of wine in a restaurant and calculated the premium over what it would have cost at a nearby supermarket. This margin between the retail price consumers pay for a good and the wholesale cost of buying it in is, in a well-functioning market, a reflection of the valuation that consumers place on the bundle of services (in this case the ambiance of drinking wine in the restaurant).

The general approach of measuring the value of a service, given that many services are intermediation activities, is to measure the margin involved in providing that service. This has an obvious resonance in retailing and restaurants and can be simply applied to transport (here, the price charged for transport services is the margin, since no ownership changes hands).

One aspect of services is that providers can vary the level of service that they deliver and in many cases shift it to the consumer. An obvious example is self-service, in retailing, or restaurants; however, the margins measurement method is likely to be robust to this. A self-service restaurant is cheaper than a full-service one and this correctly reflects the smaller bundle of services that such a restaurant supplies. Another example is travel. Many people book their travel on the internet themselves, a powerful reflection of the shifting of a service almost entirely onto the consumer. Yet these prices are cheaper than going via travel agents, which correctly reflects the reduced service levels received.

If this method is used to work out the nominal value of the bundle of services offered, what can be said about the real value? The usual method of converting nominal (money) into real values is to collect data on the price of the good in question. However, with services, more care is required in some cases. If restaurants move to more self-service with, perhaps, worse ambience, then it will be important to make sure that collected prices are differentiated by restaurant type to account for this. Such a quality adjustment is not unknown for manufactured goods.

One area where there needs to be more progress, argued by Oulton (2004), is that while there are many price indices collected for manufacturing, the price indices for corporate services, which are much of services and 23 per cent of GDP, are thinner on the ground. Data for these service areas began in 1992. As Allsopp (2004, pp 63 and 64) reports, the Office for National Statistics (ONS) calculates and publishes 32 services producer price indices, covering 55 per cent of corporate services. In contrast, price indices for 1,000 manufacturing products and price indices for around 250 four-digit manufacturing industries are published.

Recent developments in measurement of services, both improvements in coverage of price indices and the work underpinning designation of the Index of Services as a National Statistic, are outlined in Tily (2006) and in Drew and Morgan (2007).

There are clearly some areas where the margin approach is problematic. First, in many public services, there is no market that transacts the service from which a margin can be inferred. In a number of sectors therefore, the convention had grown up to measure the output by the input, for example, the number of doctors, or number of teachers. The ONS public sector measurement programme is designed in large part to confront this question.

Second, problems might also arise if transactions are priced, but bundled together. For example, many banks offer 'free' banking for a range of transactions. In reality of course, transactions are not free, but the price is bundled together with a range of other services. Bundling also occurs in other sectors, for example, mobile phone contracts, so this is not likely to be a problem just confined to financial services.

A third problem is double-deflation[2] of margins requiring data on both the prices of outputs and inputs. Since in many sectors, for example, retailing, the margin is a relatively small number arising from the difference between two relatively large numbers, inaccurate price indices can result in seriously biased double-deflated margins.

One area where the margins approach has been applied is in the financial intermediation industry. As set out in Akritidis (2007), under standard national income accounting conventions, interest payments are not regarded as payments for a productive service. This is because production is defined as an activity involving labour and capital in which inputs become outputs and so factor incomes are generated. Lending, according to this view, is not such an activity. In a bank, the major sources of income are explicit charges for services and interest earned. In practice, however, explicit charges are small. So, value added, which by convention is the explicit charges, less intermediate input costs of running the bank (heating, stationery, and so on), is typically negative.

Under the new national accounts conventions, the value of financial services is inferred from a margin. The idea is that at least some of the services provided by a bank, for example unpriced transactions and safekeeping of money, are revealed implicitly by the margin between interest payments received and what would be earned in some risk-free environment outside a bank. So, for example, payment made by banks on deposits with instant access is typically less than long-term savings payments, and this margin presumably reveals the services that a customer values of having their money instantly. Equally, the margin between the interest payment made by a consumer on a loan and the risk-free rate is a proxy for the services that consumers are willing to pay for to get the facility of the loan.

The knowledge economy

When European leaders met at the March 2000 Lisbon summit, they set the European Union the goal of becoming 'the most dynamic and competitive knowledge-based economy in the world' by 2010. The Spring European Council of 22–23 March 2005 placed renewed focus on growth, innovation and employment and in particular on supporting knowledge and innovation. Consider the following quote from this document:

> Knowledge is a critical factor with which Europe can preserve its international competitive advantage… Greater and more efficient investment in knowledge and innovation is needed… (EU, 2005)

Whatever the realism or otherwise of these goals, it clearly places the 'knowledge economy' in the forefront of policy interest and it sets out a number of objectives in terms of raising investment in knowledge. Therefore (at least) two questions might reasonably be asked. First, how is such investment in knowledge measured? Second, if there were to be more investment, how would that show up in measures of competitiveness? The way to begin addressing these questions is by considering research and development (R&D).

Knowledge investment in research and development

The prime focus of the Lisbon Agenda is R&D spending, with a specific target of 3 per cent for R&D spending as a fraction of GDP. So how is R&D spending measured? R&D spending data are collected fairly consistently across EU countries by official surveys that rely on the Frascati manual.

The key point here is that R&D is of a particular form, essentially scientific R&D. Therefore, for example, financial services typically do zero-measured R&D. Nor are any marketing activities related to R&D, such as market research in order to develop a product, allowed as R&D.

The emphasis on scientific knowledge is set out in the definitions of R&D spending that qualifies for tax credit, HMRC (2007a). They are worth considering in some detail. They say that an R&D project which seeks, for example, to:

- extend overall knowledge or capability in a field of science or technology
- create a process, material, device, product or service which incorporates or represents an increase in overall knowledge or capability in a field of science or technology
- make an appreciable improvement to an existing process, material, device, product or service through scientific or technological changes, or
- use science or technology to duplicate the effect of an existing process, material, device, product or service in a new or appreciably improved way (for example, a product which has exactly the same performance characteristics as existing models, but is built in a fundamentally different manner)

will be R&D for tax purposes if the project seeks to achieve an advance in overall knowledge or capability in a field of science or technology, not a company's own state of knowledge or capability alone.

A number of interesting points emerge from this. First, the emphasis on science[3] is clear. To make this point further, the guidelines give an example of what is not R&D (HMRC, 2007b). These examples are items such as:

- commercial and financial steps for innovation, development or marketing of an innovation
- work to develop non-scientific or non-technological aspects of an innovation
- the production and distribution of goods and services
- administration and other supporting services
- general support services (such as transportation, storage, cleaning, repair, maintenance and security)

A second point to notice is that the final sentence in the generic project detailed above requires that the R&D spending will bring benefits outside the firm, not just within the firm. This is a suitable criterion for giving a tax credit, since it requires that the social returns exceed the private returns. The definition of R&D in the Frascati manual does not specify this criterion and so is slightly broader. There are, of course, sound reasons for a narrow definition, since it aids compatibility and also accuracy. It might well be also that to the extent public policy is interested in spillovers from R&D, such spillovers are confined to scientific R&D.

Suppose, however, that this measure of R&D is considered correct and as accurately capturing knowledge spending in the economy. What then are the consequences for GDP of economies spending more on R&D? Conceptually, the way to think of this is that if output is due to increases in inputs, and one of those inputs is the knowledge stock, then the knowledge stock rises and output rises by the elasticity of output to the input, in this case the knowledge stock. Thus output has risen and investment has risen. Labour productivity has risen, but multi-factor productivity (MFP) has remained the same, since the increase in output is due to an increase in inputs.

There are, however, a number of measurement conventions that prevent these from being apparent in measured data. From this viewpoint, the main issue is that, under current conventions, R&D is not measured as an investment, but rather as an intermediate. Therefore any measured increase in value added (due to the unmeasured increase in the knowledge stock that enables firms to make cheaper or more desirable goods) is entirely due to MFP, since all that has happened is a rise in intermediate spending. Indeed, as the economy becomes more knowledge-intensive, investment rates will tend to fall.

This treatment of R&D has been widely argued to be inconsistent. If intangible spending does create a long-lived asset, then it should also be treated as investment and so should affect output. Indeed, Hill and Youngman (2002) argued it was conceptually correct to include intangibles as investment and pointed out that current SNA treatment was somewhat inconsistent. So, for example, mineral prospecting expenditure, that generates knowledge about new mineral deposits, is treated as investment. More recently, software, both purchased and own-account has also been treated as investment.

Consequently a number of questions arise. First, what spending on intangibles might be treated as creating long-lived assets? In particular, should R&D or other measures be used? Second, if such spending is treated as capital and not intermediate expenses, then what are the effects on GDP?

The categories of spending on knowledge building have been discussed by in a series of papers by Corrado, Hulten and Sichel (2005, 2006) and Nakamura (1999, 2001, 2003), who also try to quantify such spending for the US. They argue that R&D, in the sense of investing in knowledge, is much broader than just scientific R&D. For example, it could be argued that employer-spending on training is R&D in staff (and like scientific R&D in products, may or may not succeed and may or may not stay within the firm). Or, spending on market research is as much knowledge investment as is spending on the technical details of developing the machine itself. Therefore Corrado, Hulten and Sichel classify spending on intangibles into three categories:

- computerised information (mainly software)
- innovative property (mainly scientific and non-scientific R&D, the latter including design), and
- firm competencies (company spending on reputation capital, human capital and organisational capital)

These categories are all designed to capture dimensions of investment in knowledge assets. Regarding the first category, the computer age has naturally changed the face of tangible investment, via hardware, but the merest casual inspection suggests that spending on software is just as likely to be important, if not more so. As for the second category, this is designed to capture spending on knowledge-building of innovative property of the firm, while the last category is expenditure on the competencies of an organisation that make it more than the mere sum of the employee headcount.

Giorgio Marrano and Haskel (2006) have attempted to calculate investment in these categories for the UK and their results are set out in **Table 1**. The top section show expenditure on computerised information, amounting to nearly £22 billion, which is 18 per cent of total intangible investment. The second section shows R&D and non-scientific R&D. R&D itself is about one-third of this total category and 10 per cent of total intangible investment (note that software is 18 per cent of total intangible spending). New architectural and engineering designs are 15 per cent of total spending, but these are very much guesstimates since it is so hard to quantify innovation here. More work is clearly needed in this area. Finally, around 50 per

Table 1

Intangibles, 2004

	Type of intangible investment	Data source	Total spending (£ billion)	Percentage of total intangible investment[1]
	Computerised information			
1	Computer software and databases	ONS estimates	21.6	*18*
	Innovative property			
2	Scientific R&D	Current expenditure on R&D from BERD.[2] R&D in computer industry subtracted	12.4	*10*
3	Mineral exploration	National Accounts	0.4	*0*
4	Copyright and licence costs	National Accounts	2.4	*2*
5	New product development costs in the financial industry	20% of all intermediate purchase by financial services industry, ONS data	6.0	*5*
6	New architectural and engineering designs	Half of the total turnover of the architecture and design industry SIC[3] 742, ABI[4] data, plus twice the turnover of speciality design activities SIC 74782	18.0	*15*
7	R&D in social science and humanities		0.3	*0*
8	Total (2+3+4+5+6+7+8)		39.5	*32*
	Economic competencies			
9	Advertising expenditure	Total spending on advertising as reported by Advertising Association, less expenditure on classified ads	14.0	*7*
10	Market research	Twice revenues of the market and consumer research industry, ABI[4]	4.5	*2*
11	Firm-specific human capital	NESS05[5], a survey of employer-provided training	28.8	*24*
12	Organisational structure: purchased	Revenues of management consulting industry from Management Consulting Association	7.0	*5*
13	Organisational structure: own-account	20% of value of executive time (using executive wages from ASHE[6])	15.3	*13*
14	Total (9+10+11+12+13)		69.6	*50*
15	Grand total		130.7	*100*

Notes:

1 It is assumed that 60 per cent of '10' and '11' and 80 per cent of '13' are intangible investment.
2 Business Enterprise Research and Development.
3 Standard Industrial Classification.
4 Annual Business Inquiry.
5 National Employer Skills Survey.
6 Annual Survey of Hours and Earnings.

Source: Giorgio Marrano, Haskel and Wallis (2007)

cent of total investment is on firm spending on reputation, human and organisational capital (economic competencies).

One feature to emerge from Table 1 is that some of these investments are counted as part of GDP in the UK National Accounts, for example, mineral exploration and copyright and licence costs. Recent National Accounts have also incorporated these as GDP software, although not all own-account software has been so incorporated. The US is aiming to incorporate R&D as an investment by 2009.

What then is the effect on GDP of assuming these categories as investment? This is investigated in Giorgio Marrano, Haskel and Wallis (2007). The main findings follow naturally from the argument above. First, market sector gross value added (MGVA) is understated by about 13 per cent in 2004 and 6 per cent in 1970. This follows from treating spending on intangibles as investment so that GVA rises. Second, instead of the nominal business investment/MGVA ratio falling since 1970, it has been rising. Third, the growth of intangible investment has been sufficient to raise labour productivity growth over the 1990s, although it has fallen between 2000 and 2004.

Conclusion

Changes in the nature of the economy require statistical agencies to change measurement. This article has highlighted two particular cases. First, the growth of the services sector requires development of more price indices on services, as is in train. Second, the shift of investment to more knowledge assets requires consideration of how these might be incorporated into the SNA. Software has now been fully incorporated in UK GDP, and ONS has helped to head international research on the treatment of R&D. The research on intangibles outlined here shows the importance of continuing this work. It also provides a broad scale map of the ground that needs to be covered.

Notes

1 Two other arguments are often heard. First, that productivity is poorly measured in the government sector and that this therefore renders GDP per labour input inaccurate as a productivity measure (because, for example, output in the government sector is measured using inputs; previous UK measurement conventions used the number of teachers as an output measure in education). Second, that due to other factors such as pollution and psychological well-being, economic output is not a good measure of societal welfare and so output per head is not a meaningful welfare measure.
2 Double-deflation is a method to estimate real GVA by deflating output and intermediate inputs separately before subtracting the latter from the former. This is in contrast to the single deflation method whereby the subtraction is done at current prices and the difference (that is, GVA at current prices) is deflated using an output deflator to arrive at real GVA estimates. This means that an industry's gross output is deflated by the price of its output, while each input is deflated by its own price index.
3 Science is further defined in the guidelines. 'Science is the systematic study of the nature and behaviour of the physical and material universe. Work in the arts, humanities and social sciences, including economics, is not science for the purpose of these guidelines. Mathematical techniques are frequently used in science, but mathematical advances in and of themselves are not science unless they are advances in representing the nature and behaviour of the physical and material universe.'

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