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ECONOMIC COMMISSION FOR EUROPE

Statistics Netherlands

MEASURING CAPITAL – BEYOND THE TRADITIONAL MEASURES

Proceedings of the Seminar Session of the 2OO7 Conference of European Statisticians

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Note

FOREWORD

At the 55th plenary session of the Conference of European Statisticians (CES) held in Geneva on 11-13 June 2007, one of the two seminars was devoted to the issue of measuring capital – beyond traditional measures. The seminar was organised and chaired by Statistics Netherlands. Since the seminar was regarded as very fruitful the Conference recommended that the proceedings of the seminar be published.

The traditional conception of capital as the tangible means of production, such as machinery, transport equipment and buildings, has become obsolete. The (share) values of companies are increasingly determined by their innovative capacities. These are mainly driven by intangible forms of capital, such as human knowledge, scientific research, information technology, and brand building.

In addition, the concepts of social and natural capital have been introduced to indicate society's dependency on a much broader range of capital stocks, such as social networks and the natural environment.

For statisticians, this poses the question of how these supplementary forms of capital can be captured by official statistics. One may argue that the national accounts balance sheets in their current form only provide a partial picture of an economy's net worth, due to these new forms of capital. A fundamental question in this context is to what extent can these new forms of capital be quantified in monetary values. Or are there other ways in which these capital stocks and the changes therein can be measured in a meaningful way?

The seminar concluded that national statistical offices have an important role in developing measures of intangibles and improving national and international statistical systems to better capture the impact of innovation and knowledge creation on the economy. They should play an active role in the development of environmental accounts; otherwise these statistics are likely to be compiled by others. Capitalization of R&D is not a question of if, but of how. Therefore, exchange of experience and international cooperation is much needed. Measuring human capital in official statistics is still in its early stages and much caution should be taken, even with experimental calculations and estimations. Developing satellite accounts on human capital is not yet feasible but it is important to continue work in this area. The development of the concept of social capital is still in its initial phase and countries are encouraged to exchange experiences to come to a common understanding of its possible definitions and uses.

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INTRODUCTION

by Geert Bruinooge, Statistics Netherlands

Within the framework of the preparation of the programme of the Conference of European Statisticians for 2007, Statistics Netherlands supported the theme "Measurement of capital – Beyond the traditional measures" and volunteered as the main organiser of the seminar.
Statistics Netherlands chose to support this theme because of its importance in the revision of the System of National Accounts 1993, the measurement difficulties of capital which go beyond those of tangible capital and the ongoing discussions on the measurement of human and social capital. With the support of other statistical offices and contributions of international institutes and experts, the measurement of capital became one of the key themes discussed by the Conference of European Statisticians in 2007.

Professor Bart van Ark from the University of Groningen noted in his keynote speech on "Innovation, intangibles and economic growth: towards a comprehensive accounting of the knowledge economy" that developing an overall measure of the macroeconomic impact of innovation has proven to be difficult. The need for better metrics of the knowledge economy and its contribution to economic growth presents both a challenge and an opportunity for official statistics.

Professor William Nordhaus from Yale University discussed in the session on "Policy drivers" the way to acknowledge the costs of environmental and social effects in National Income and National Accounts. As examples, he used the treatments of pollution effects, global warming and future externalities where activities today have external effects in the future (chapter I).

In the session on "Capital boundaries in the revision of the System of National Account 1993" (chapter II), the inherent difficulties of the measurement of intangible capital were discussed. There still exist severe challenges in capital estimates for computer software and the next hurdle is the compiling of R&D capital stocks. For example, is R&D capitalisation meaningful when satisfying output related volume measures cannot be found? Should R&D be acknowledged as capital even when ownership cannot be identified?

In the sessions on "Measurement of human capital" and "Measurement of social capital" (chapter III and chapter IV respectively), the introduction of the concept of human capital and social capital in the System of National Accounts was the central theme. It was concluded that although the development of the concepts of social capital and especially human capital has progressed substantially, there is still a long way to go before a satisfactory way to include these concepts has been found. However, both human and social capital are increasingly important areas for policymakers which deserve priority attention by statisticians.

Many national and international statistical institutions and experts contributed to the preparation and subsequently to the lively discussions during the one-day seminar. Many interesting findings and rich experiences were presented, thus contributing to the success of the seminar. Consequently, the Conference, in its conclusions, confirmed the importance of the "measurement of capital", particularly stressing the ongoing exchange of experience on this theme. I hope that this documentation of the seminar will contribute to the further development of the measurement of capital, tangible and intangible.

Innovation, intangibles and economic growth: towards a comprehensive accounting of the knowledge economy

Keynote speech by Bart van Ark, University of Groningen, and Charles Hulten, University of Maryland

An earlier version of this paper was presented at a seminar on “Measurement of capital – beyond the traditional measures” at Conference of European Statisticians, 12 June 2007, Geneva; and at a conference on “Productivity and Innovation” organized by Statistics Sweden, October 24–25 2007, Grand Hotel, Saltsjöbaden. We are grateful to the participants for in these seminars for their comments. We also express our gratitude to our co-authors in the original projects underlying this paper, notably Marcel Timmer and Mary O’Mahony as concerning the EU KLEMS work, and Carol Corrado and Dan Sichel concerning the intangibles analysis for the United States. Any errors in this paper are of course entirely ours.

Introduction

We live in an era of rapid, almost dizzying, innovation in products and processes. These innovations have improved consumer welfare through the introduction of new goods and services, improvements in the quality and lower costs of existing products, and greatly increasing the amount of information about available products. They also revolutionized the organization of production, not just the ‘technology’ of production as narrowly conceived, but also the management and global reach of corporations around the world.

While the impact of innovation is evident ‘on the ground,’ and widely supported in the academic literature, it has proved surprisingly hard to develop an overall measure of the magnitude of the macroeconomic impact. How much of the recent growth in GDP is due to this revolution? What is the impact on living standards and worker productivity? Some progress has been made in answering these questions, particularly in measuring the impact of ICT capital on growth, but the answers tend to be piecemeal or incomplete.
Various attempts have been undertaken to construct comprehensive innovation indicators, both in the U.S. (for example, at the National Academy of Science) and in Europe (for example, the Community Innovation Survey), but the lack of a coherent analytical framework within which to evaluate these indicators and the difficulty to arrive at bottom-line financial metrics, have left many questions unanswered.

The need for better metrics of what constitutes the knowledge economy and how it contributes to economic growth presents both a challenge and an opportunity. There is a clearly a perceived need for improvements in official national statistics and international statistical systems. There is also a need to connect the large body of microeconomic survey and interview data on innovation to the macro statistics. The size and complexity of the connection process is daunting, but it is already beginning to happen. Piecemeal efforts at ‘connecting the dots’ may simply produce more dots. What is needed is an ongoing program that develops and maintains a set of macroeconomic innovation accounts built on official statistics, but going beyond them.

In this paper we argue that in order to improve our understanding of innovation, we need a systematic and comprehensive accounting framework for the knowledge economy. Growth accounting, which has become the empirical work horse of growth economics, involves a simple way of decomposing the growth rate of output per worker into its component sources, capital formation and innovation. Growth accounts are typically developed by researchers parallel to official national accounts, and can therefore be relatively easily linked to official statistics of NSI's.

Several national statistical institutes (NSI's) have begun to construct growth and productivity accounts in conjunction to their national income and product accounts. However, the quest for the contribution of innovation to growth needs to go beyond this – by now well-established – sources of growth model. The traditional model typically stops short of moving beyond the measurement of the contribution of tangible capital to growth. The outlays for research and development, other types of knowledge creation, organizational innovation and other economic competencies, such as branding and marketing, are usually expensed in the accounts framework. As a result, these expenses do not add to GDP and the residual growth that remains after accounting for the contribution of tangible investments, called multifactor productivity (MFP) growth, may hide the effects from unmeasured intangible investments.

All to the good, this has recently changed with some major attempts to capitalize the key components of intangible investments. Corrado, Hulten and Sichel (CHS, 2005) have developed an estimate of intangible investment for the past five decades in the United States. They subsequently integrated a measure of intangible capital in the growth accounts of the U.S. (CHS, 2006). This work has recently been replicated for some other countries, including the United Kingdom, Japan, and presently also for some continental European countries. Even though we are still in early days, it is clear that for a full understanding of how the knowledge economy operates in a macroeconomic setting, the extension of growth accounts towards including intangible inputs and output is a crucial component of this work.

The paper proceeds as follows. In section 2 we lay out the present situation with regard to the measurement of innovation and knowledge creation in relation to economic growth and we identify the areas that urgently require attention in future work. These are (1) the use of an extended growth accounts framework that allows for a detailed decomposition of output into the input components (labor, capital and intermediate inputs); (2) the measurement of intangible investment, covering ICT, knowledge inputs and economic competencies; and (3) the integration of the latter in a growth accounts framework.

In Section 3 we briefly describe the EU KLEMS Growth and Productivity Accounts as an illustration of the state of the art in growth accounting. The results from EU KLEMS are summarized in Timmer, O'Mahony and van Ark (2007) and van Ark, O'Mahony and Ypma (2007).[1] EU KLEMS is one of the most recent and most comprehensive efforts to build a system of growth accounts across a wide range of European countries, as well as the U.S. and Japan, with a breakdown to industry level and a decomposition of the contributions from labor input, capital input and intermediate inputs to growth.

[1] See also the Economics Focus section on "Use IT or lose it" in *The Economist*, May 19th 2007, p. 82.

Section 4 summarizes the recent work in the area of measurement of intangible capital and growth in the United States, as developed in the work by Corrado, Hulten and Sichel (2005, 2006).

Section 5 provides an international comparison of measures of spending on intangibles in the early 2000s for those countries for which such measures are now available. It compares the pioneering estimates for the U.S. by Corrado, Hulten and Sichel (2005, 2006), with more recent estimates for the United Kingdom (Haskel and Marrano, 2007), for Japan (Fukao et al., 2007) and the Netherlands (van Rooijen-Horsten, 2007).

Finally, section 6 reviews the issues ahead of us.

Innovation and growth: how far are we in establishing the link empirically?

There is no doubt that the relationship between innovation and economic growth is not straightforward. Innovation refers to a broad range of activities aimed in part at incremental improvements to existing products, processes, services ("new ways of making current products better, faster, cheaper") and in part at revolutionary, breakthrough developments ("creating something not previously created"). The mix and relationship between incremental and radical innovations varies a lot and has very different impact on growth.

It has turned out very difficult not only to measure the innovation activities itself, but also to measure its relationship to economic performance. Real GDP per capita is the most widely used indicator, which is convenient because of its link to the closely related statistic on the production side, that is real GDP per worker ('labor productivity'). The productivity of labor in producing goods and services is a key determinant of the volume of products available for consumption, now or in the future, and is thus associated with the underlying utility-based standard of living. Real GDP per worker can also be linked to the economic factors that lead to increases in output per worker over time: capital formation and innovation in products and production processes. The relation between these factors and the resulting output is the subject of a huge theoretical literature on economic growth and development, and an even larger literature on empirical growth analysis and the estimation of production functions.

Growth accounting, as it developed since the early work of Tinbergen (1942), Solow (1957), Denison (1967) and Jorgenson and Griliches (1967) provides a simple way of decomposing the growth rate of output per worker into its component sources, capital formation and innovation. The measurement of the corresponding levels is also a part of this framework. Innovation appears in several forms in the sources of growth framework: through the explicit breakout of IT capital formation, through the addition of intangible capital to both the input and output sides of the source-of-growth equation, through the inclusion of human capital formation in the form of changes in labor "quality," and through the "multifactor productivity" (MFP) residual, which includes the effects of technological externalities and spontaneous improvements in organization and technology of production (although this cannot be separated from other factors in the residual, like measurement error).

In our view the growth accounts framework is the most promising way of developing a summary metric of the overall impact of innovation on output per worker, and through this, to changes in the standard of living. Still it is an incomplete and imperfect framework, whose defects are pointed out in various studies (see, for example, Hulten 2001), but it is by far the least incomplete and imperfect way of linking innovation to living standards in a reasonably comprehensive way.

Despite the significant contribution of growth accounting to our understanding of how innovation contributes to growth, the traditional growth accounts framework and the national accounts system as we have it today clearly cannot be seen as comprehensive. The lag between innovation in the economy and its appearance in the national statistics is due, in part, to the fact that innovation involves new ideas and products whose nature and significance take time to understand. However, a large part of the problem also results from the way both national statistics and firm financial data are organized. In neither case are the accounts organized to show innovation. In fact, accounting practice tends toward a conservatism that emphasizes accuracy and continuity with the past over innovation and approximation.[2] Thus, accounting practice has traditionally concentrated on market data generated by arms-length transactions and avoided making imputations where possible. One important consequence of this conservatism is that non-market intangibles like internally produced like R&D are treated as a current expense rather than as an investment in the future of the company. This means, for example, that the typical biotechnology company does not add to the GDP in the first years of its existence, nor is its research program deemed to have a long-run impact on value of the company or the economy.

The perverse treatment of intangibles is beginning to change in national accounting practice, with the decision in the late 1990s to capitalize software expenditures and include them as an investment that contributes to GDP. This treatment has recently been extended to scientific R&D in the U.S. national accounts, as a satellite account, and by the decision by the United Nations to do likewise in its System of National Accounts. Regrettably, financial accounting practices continue to be stuck in the past. Moreover, the full range of value-building intangible assets are not likely to be accorded the treatment of scientific R&D in the national accounts, even though surveys show that assets like marketing and employee-training expenditures are important coinvestments with R&D.

The treatment of intangibles is by no means the only problem area in understanding the link between innovation and economic growth. Product innovation is another aspect of the ongoing technological revolution but, with the exception of computer prices, it is poorly represented in official statistics. Improvements in the quality of existing products are picked up for some items (like computers), but this is not done systematically for a full range of products. The treatment of entirely new goods is even more troubling. The improvements in consumer well-being due to the introduction of cellular telephones, cholesterol–lowering drugs, and the internet are effectively ignored in the procedures used in constructing the consumer price index (see, for example, Hausman 1999). This reflects the conservatism of the statistical system noted above, which, in the case of price measurement, tends to treat product innovation as an

[2] The account scandals of recent years illustrate the virtues of accounting accuracy. But the obvious need for investor confidence should not obscure the need for accounting metrics that reveal the true dynamism and future prospects of a company. Accounting practice should ideally be able to accomplish both objectives.

adjustment to price indexes and not something that is valuable in its own right.[3] These price statistics are used in the national accounts to express income and product in constant prices in order to measure real GDP. The failure to capture innovation in the price statistics thus carries over to errors in the measurement of economic growth and productivity.

There are other problems as well. Data on research and development are one of the most important sources of information about the source of innovation in the economy. However, these data are collected for scientific R&D only and exclude research in important areas like financial services and retail distribution (the research and development of new financial products at places like Morgan Stanley and Goldman Sachs, the development of retailing models like that of Walmart or Carrefour). Significant efforts are being undertaken to fill the gaps in the data collection on innovation. For example, the European Union member states are collecting a wider range of statistics on innovation activities, including marketing and training, in their Community Innovation Survey (CIS). However, these surveys often lack important information on the euro expenses on innovation activities which seriously complicates economic analysis of its effects. The U.S. National Science Foundation (NSF) supports numerous projects that conduct surveys and interviews, and these provide an important base of information about the micro innovation process. But the consensus of a recent NSF workshop on innovation metrics was that broader innovation surveys are needed to help 'connect the dots.' There is a parallel need to insure that these new metrics can be connected to the dollar and euro metrics needed to improve current accounting practice.[4]

EU KLEMS growth and productivity accounts[5]

The purpose of growth accounting is to support empirical and theoretical research in the area of economic growth, such as study of the relationship between skill formation, investment, technological progress and innovation on the one hand, and productivity, on the other. In addition, it may facilitate the conduct of policies aimed at supporting productivity growth and competitiveness. These policies require comprehensive measurement tools to monitor and evaluate progress. Growth accounts should also support the systematic production of high quality statistics on growth and productivity using the methodologies of national accounts and input-output analysis.

The EU KLEMS Growth and Productivity Accounts is the result of a research project, financed by the European Commission, to analyse productivity in member states of the European Union as well as Japan and the U.S. at the industry level. It includes measures of output growth,

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[3] Amazingly, there is still a debate over the question of whether the CPI should be based on a fixed market basket of products. In this view, apparently shared by some members of the recent NRC price-statistics panel, the CPI should reflect the change in the prices of the same bundle of items year after year (the "Cost of Goods Index discussed in the NRC report). If the logic of this view were to prevail, and it is not the dominant view of price-measurement specialists, it would virtually remove product innovation from official price statistics.
[4] Other measurement issues related to innovation include the need to improve existing measures of tangible capital, particularly in the areas of capital-embodied technical change, depreciation and obsolescence. More emphasis on the role of human capital and "human-embodied" technical change is also needed, as well as on developing stronger links to data for the household sector.
[5] A more detailed account of the EU KLEMS database is provided by Timmer, O'Mahony and Van Ark (2007). See also the EU KLEMS website (www.euklems.net).

employment and skill creation, capital formation and multifactor productivity (MFP) at the industry level for individual countries from 1970 onwards. The input measures include various categories of capital (K), labor (L), energy (E), material (M) and service inputs (S).

Growth accounting is theoretically motivated by, among others, the seminal contribution of Jorgenson and Griliches (1967) and put in a more general input-output framework by Jorgenson, Gollop and Fraumeni (1987) and Jorgenson, Ho and Stiroh (2005). It allows one to assess the relative importance of the contributions of labor, capital and intermediate inputs to growth, and to derive measures of multifactor productivity (MFP) growth. MFP indicates the efficiency with which inputs are being used in the production process and is an important indicator of technological change.[6] Under the assumptions of competitive factor markets, full input utilization and constant returns to scale, the growth of output in each industry is expressed as the (compensation share) weighted growth of inputs and multifactor productivity (MFP) growth.

Accurate measures of labor and capital input are based on a breakdown of aggregate hours worked and aggregate capital stock into various components. Hours worked are cross-classified by educational attainment, gender and age with the aim to proxy for differences in work experience, which provides 18 labor categories (3*2*3 types). Typically, a shift in the share of hours worked by low-skilled workers to high-skilled workers will lead to a growth of labor services which is larger than the growth in total hours worked. We refer to this difference as the labor composition effect.

Similarly, capital stock measures are broken down into stocks of different asset types. Importantly, we make a distinction between three ICT assets (office and computing equipment, communication equipment and software) and four non-ICT assets (transport equipment, other machinery and equipment, residential buildings and non-residential structures). Short-lived assets like computers have a much higher productivity than long-lived assets like buildings, and this should be reflected in the capital input measures. Aggregation takes into account the widely different marginal products from the heterogeneous stock of assets. The weights are related to the user cost of each asset. Finally, the contribution of intermediate inputs is broken down into the contribution of energy goods, intermediate materials and services.

The growth accounting analysis from the EU KLEMS Growth and Productivity Accounts concentrates on a sub-sample of eleven "old" EU countries. In Table 1, a decomposition of value added growth in the market economy is given for the periods 1980-1995 and 1995-2004. GDP growth in the EU accelerated from 1.9% before to 2.2% after 1995, completely due a strong improvement in the contribution of labor input, increasing from a zero contribution to a 0.7 percentage point contribution. About two thirds of this came from faster growth in total hours worked and one third from improved labor composition, as the overall skill level of the workforce has continued to increase significantly. GDP growth in the U.S. market economy

[6] Under strict neo-classical assumptions, MFP growth measures disembodied technological change. In practice, MFP is derived as a residual and includes a host of effects such as improvements in allocative and technical efficiency, changes in returns to scale and mark-ups and technological change proper. All these effects can be broadly summarised as "improvements in efficiency", as they improve the productivity with which inputs are being used in the production process. In addition, being a residual measure, MFP growth also includes measurement errors and the effects from unmeasured output and inputs, notably intangible output and inputs (see Section 4).

accelerated much faster than in the EU since 1995 (from 3.0% before 1995 to 3.7% after 1995), but the contribution of labor slowed down rather than accelerated, even though it did not fall behind the European growth in labor input.

Table 1 Gross value added growth and contributions, 1980-1995 and 1995-2004 (annual average volume growth rates, in %)

A. European Union-15 (excluding Greece, Ireland, Luxembourg, Portugal and Sweden)

	VA	L	*H*	*LC*	K	*KIT*	*KNIT*	MFP
	(1)=(2)+(5)+(8)	(2)=(3)+(4)	(3)	(4)	(5)=(6)+(7)	(6)	(7)	(8)
1980-1995								
MARKET ECONOMY	1.9	0.0	-0.3	0.3	1.1	0.4	0.7	0.7
.Electrical machinery, post and communication	3.9	-0.7	-0.8	0.2	1.6	0.9	0.8	2.9
.Manufacturing, excluding electrical	1.2	-1.3	-1.5	0.3	0.8	0.2	0.6	1.7
.Other goods producing industries	-0.2	-1.2	-1.4	0.2	0.9	0.2	0.7	0.2
.Distribution services	2.6	0.4	0.0	0.3	0.8	0.3	0.5	1.4
.Finance and business services	3.6	2.2	1.9	0.3	1.9	0.8	1.0	-0.7
.Personal and social services	1.8	1.8	1.5	0.3	1.0	0.3	0.7	-1.1
1995-2004								
MARKET ECONOMY	2.2	0.7	0.4	0.2	1.2	0.6	0.6	0.3
.Electrical machinery, post and communication	6.0	-0.4	-0.6	0.2	1.7	1.2	0.5	4.7
.Manufacturing, excluding electrical	1.0	-0.3	-0.6	0.3	0.7	0.3	0.4	0.6
.Other goods producing industries	1.2	0.0	-0.2	0.2	0.7	0.1	0.6	0.5
.Distribution services	2.3	0.7	0.6	0.1	1.2	0.5	0.7	0.4
.Finance and business services	3.5	2.1	1.9	0.3	2.3	1.3	1.0	-1.3
.Personal and social services	1.7	1.5	1.4	0.1	0.9	0.3	0.7	-0.9

B. United States

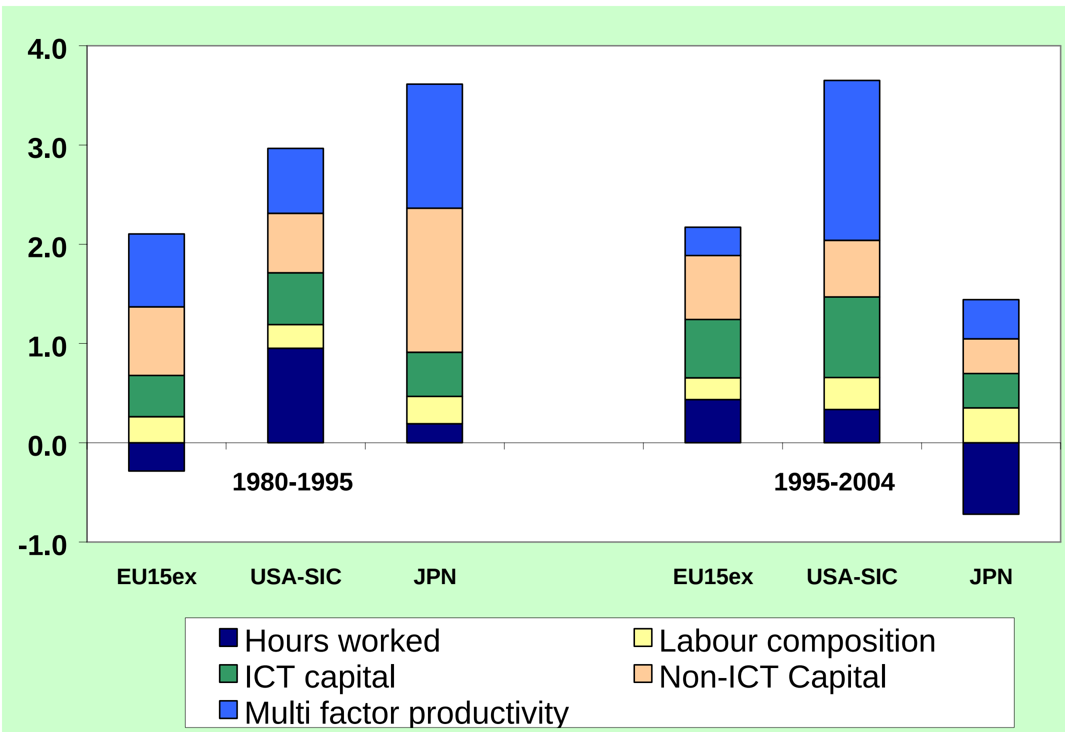
	VA	L	*H*	*LC*	K	*KIT*	*KNIT*	MFP
	(1)=(2)+(5)+(8)	(2)=(3)+(4)	(3)	(4)	(5)=(6)+(7)	(6)	(7)	(8)
1980-1995								
MARKET ECONOMY	3.0	1.2	1.0	0.2	1.1	0.5	0.6	0.7
.Electrical machinery, post and communication	6.6	0.1	-0.3	0.4	1.9	1.0	0.9	4.6
.Manufacturing, excluding electrical	1.7	0.1	-0.2	0.3	0.6	0.3	0.3	0.9
.Other goods producing industries	0.7	0.7	0.4	0.3	0.7	0.2	0.5	-0.7
.Distribution services	3.9	1.3	1.2	0.2	1.2	0.6	0.6	1.3
.Finance and business services	4.4	2.9	2.7	0.2	1.8	1.0	0.9	-0.3
.Personal and social services	2.8	2.5	2.5	0.1	0.5	0.2	0.3	-0.2
1995-2004								
MARKET ECONOMY	3.7	0.7	0.3	0.3	1.4	0.8	0.6	1.6
.Electrical machinery, post and communication	8.9	-0.3	-0.9	0.6	2.5	1.5	0.9	6.8
.Manufacturing, excluding electrical	0.7	-1.1	-1.5	0.3	0.7	0.4	0.3	1.1
.Other goods producing industries	1.6	1.0	0.9	0.1	0.9	0.2	0.6	-0.3
.Distribution services	4.7	0.5	0.2	0.3	1.4	1.0	0.4	2.8
.Finance and business services	4.9	2.0	1.6	0.4	2.0	1.2	0.7	0.9
.Personal and social services	2.6	1.7	1.4	0.2	1.0	0.4	0.6	0.0

Source: EU KLEMS Database, March 2007, http://www.euklems.net. See Timmer, O'Mahony and van Ark (2007)

Notes: VA= Gross Value Added growth
L= Contribution of Labor input growth
H= Contribution of Total hours worked
LC= Contribution of Labor composition
K= Contribution of Capital input growth
KIT= Contribution of ICT capital
KNIT= Contribution of Non-ICT capital
MFP= Contribution of Multifactor productivity growth

The contribution of capital input to value added growth has not changed much at the aggregate level, but the distribution has shifted somewhat from non-ICT capital to ICT capital. However, compared to the United States the shift towards intensive use of ICT capital has generally not been as pronounced. Notably, when comparing the ratio of capital to labor contributions to growth in the EU, there are signs of a declining capital intensity in the EU. This development is in contrast to the slightly increased U.S. trend in capital intensity since 1995. The factor contributing most to the diverging trends in Europe and the U.S. is the trend in multifactor productivity growth. While contributing 0.7 percent to market economy GDP during 1980-1995 in both regions, the trend accelerated to 1.6 percent in the U.S., but declined to 0.3 percent in the EU after 1995 (see Figure 1).

Figure 1 Contributions to market economy GDP growth 1980-1995 vs. 1995-2004 (in %), major regions



Source: EU KLEMS Database, March 2007, http://www.euklems.net. See Timmer, O'Mahony and van Ark (2007)

When decomposing the growth contribution further to industry level, it appears that market services tell a major part of the divergent performance of European economies since 1995, both among themselves as well as relative to the United States. Table 1 shows that while the contribution of factor inputs to growth has generally stayed up, multifactor productivity growth in the market services stagnated or even turned negative in many European countries. The reasons for the slowdown in multifactor productivity growth in market services are an important avenue for further research, not further pursued in this paper.[7] Instead the focus here is on

[7] See, for example, Inklaar, Timmer and van Ark (2007).

another possible factor affecting the MFP residual, which is the impact of unmeasured inputs, notably intangible capital.

What does intangible capital add to the U.S. growth story?

Despite its recognized importance, the challenges concerning the conceptualization of intangible capital, its measurement and integration into a production function or growth accounting framework are substantial (Van Ark, 2002). For example, Howitt (1996) classified some inherent measurement difficulties of intangible capital going beyond those of tangible capital as follows:

- the knowledge-input problem, which concerns the measurement of the resources devoted to the creation of knowledge which can often not be distinguished unambiguously from other inputs, such as labor and capital;
- the knowledge-investment problem, which refers to the output of the process of knowledge creation which is typically not measured at all because knowledge mostly does not directly produce a commodity or service;
- the quality improvement problem, which relates to the need to pick up the improvement of the goods and services which results from knowledge creation;
- the obsolescence problem which stresses the need with any type of capital to find a measure of depreciation, which is very difficult for intangible capital measures.

However, as clarified in Corrado, Hulten and Sichel (CHS, 2005), there is no clearcut distinction between tangibles and intangibles that would justify a distinction between the former being capitalized and the latter being expensed. In fact "any outlay than is intended to increase future rather than current consumption is treated as a capital investment" (CHS, 2005, p. 13). Various definitions of intangible capital are possible with different coverage of activities but most definitions are offsprings from Schumpeter's classification including the development of new products and production processes, organisational change, management, marketing and finance (Schumpeter, 1934).

CHS (2005) developed an estimate of a broad range of intangibles for the U.S. in the 1990s. This list is shown in Table 2 along with an annualized estimate for each category. The first general category is computer software, which has already been capitalized in the U.S. national accounts. Innovative property includes both NSF-style scientific property with what may be called 'non-scientific' R&D, although this is somewhat misleading because much of this category, which includes the development of innovative new financial products and architectural modeling, is conducted by personnel with scientific degrees. It is worth noting here that spending on nonscientific R&D exceeds the amount spent on the conventional science-lab type. The third category, firm-specific human competencies, includes three subcategories: brand equity, worker-training, and management capability. This is by far the most controversial group, and it is also the largest. The choice of what to include in this broad category was based on the studies noted in the bibliography in CHS (2005, 2006).

Table 2 Expenditures on a broad list of intangible capital U.S. nonfarm business sector, 1998-2000 (average) (billions of dollars)

COMPUTERIZED INFORMATION ($154)

- COMPUTER SOFT WARE ($151)
- COMPUTERIZED DATABASES ($3)

INNOVATIVE PROPERTY ($424)

- SCIENTIFIC R&D ($184)
- MINERAL EXPLORATION ($18)
- COPYRIGHT AND LICENCE COSTS ($75)
- OTHER PRODUCT DEVELOPMENT ($149)

ECONOMIC COMPETENCIES ($642)*

- BRAND EQUITY (ADVERTISING) ($236)
- FIRM-SPECIFIC HUMAN CAPITAL (TRAINING) ($116)
- ORGANIZATIONAL STRUCTURE MANANGEMENT ($291)

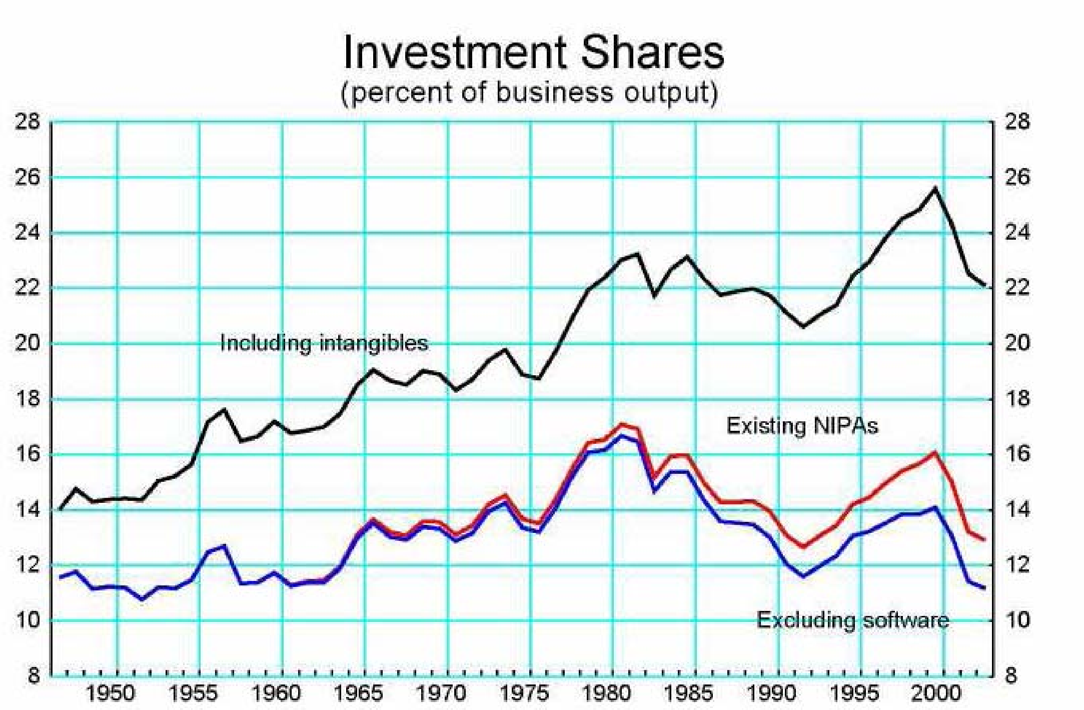
Source: Corrado, Hulten, and Sichel (2006).
* $505 of this category is considered investment

The key finding of this research is that intangible investment by U.S. businesses averaged $1.2 trillion per year during the 1998-2000 period. This is also the amount by which U.S. GDP is increased by the capitalization of this broad list of intangibles. In percentage terms, the resulting estimate of GDP is 10 percent larger. The software portion of this is already included in current GDP estimates, but this amounts to only 13 percent of the $1.2 trillion increase. Moreover, even if scientific R&D were added to this percentage, it would only rise to 28 percent. In other words, intangibles matter.

The $1.2 trillion of intangible investment equals the total amount spent by businesses for their tangible plant and equipment. When these figures are extended backward in time in order to obtain a broader perspective on economic growth, it also becomes apparent that these intangibles have become more important over the last five decades. Figure 2, from CHS (2006), shows investment as a fraction of business output over this period, and compares the results for tangible and intangible investment combined with those of tangibles alone. For the latter, the share of business output is around the 12 percent for the period as a whole, while the combined share grows from 14 percent of output to more than 22 percent. Intangibles not only matter for the level of GDP, they also matter for the rate of growth. Figure 3 shows which intangibles have been the most dynamic growers, and surprisingly, scientific R&D has been a rather flat contributor to the overall increase (as has brand equity). Thus, the move to incorporate scientific

R&D in U.S. GDP in 2010 will not lead to a boost in the growth rate of GDP, if current trends hold.

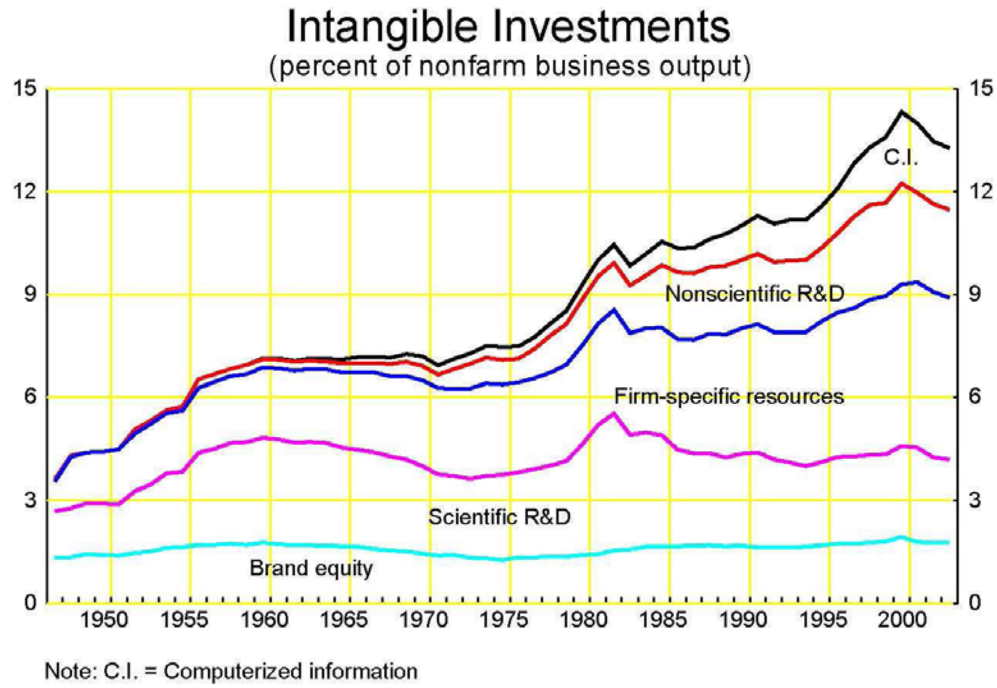
Figure 2 Investment shares, United States



Source: Corrado, Hulten and Sichel (2006) [Figures 2 and 3 about here]

It is important to recognize that in a growth accounts framework the capitalization of intangibles adds to income as well as output, in the form of increased gross operating income accruing to capital. The share of labor and capital compensation in total output changes as well. While the share of income going to labor in the traditional growth accounts for the U.S. has been relatively constant at around 70 percent over the last 50 years, with intangibles CHS (2006) find that labor's share has fallen considerably.

Figure 3 Intangible investments



Source: Corrado, Hulten and Sichel (2006)

There are also important productivity effects associated with intangibles. CHS (2006) show that capitalization leads to an estimate of the average growth rate output per hour in the U.S. non-farm business sector that is more than one tenth larger than the conventional BLS estimate of around three percent for the period 1995-2003. This is not a huge effect, but the 2003 end point of the period saw a downturn in intangible spending, so that the gap between the old and the new estimates for the period 1995-2001 is even somewhat larger. However, the main effect of intangibles is to restate the relative importance of the various sources of growth. When intangibles are included in the analysis, they explain more than a quarter of the total growth rate of output per worker and become the most important *systematic* source of growth. The importance of multifactor productivity, a non-systematic residual category or 'measure of our ignorance', is considerably reduced.

The restated sources-of-growth analysis in CHS (2006) contains another message. The combined importance of intangibles, IT capital, and labor quality (which largely reflects human capital) explains nearly 60 percent of productivity growth. This reflects the importance of 'knowledge capital' – our measure of innovation – as a driver of growth. This effect is enhanced by the high probability that R&D and human capital spillover externalities are an important component of the residual MFP measure. Conventional plant and equipment, excluding IT capital, accounts for less than ten percent.

An international comparison of expenditure on intangible capital

The extension of the conventional sources-of-growth analysis to include intangible inputs and outputs is still in its infancy, though the literature is expanding. The recent work of Haskell and Marrano (HM) (2007) for the United Kingdom, Fukao et al. (2007) for Japan and van Rooijen-Horsten for the the Netherlands are fairly complete reproductions of the CHS approach. Haskell and Morrano (HM) (2007) and Fukao et al. (2007) also provide growth accounting estimates for the UK and Japan respectively.

In this section we only provide an international comparison of expenditure on intangibles for the four countries mentioned above. Table 3 shows that the measures of intangibles expressed as percentage of GDP for the U.S. are about 1.5 percentage points higher than for the UK. The U.S. shows somewhat higher levels of innovative property, in particular R&D, and economic competencies, in particular brand equity and own-account organizational innovations. In contrast, the UK seems to be characterized by higher expenses of firms on human capital.

The intangible capital expenditure estimates as percentage of GDP for Japan and the Netherlands are lower than in the UK and the U.S. The estimates for both countries are 3.5 percentage points below the U.S. and 2 percentage points below the UK. Before drawing too strong conclusions from these differences it should be stressed that there are some differences. Notably the Japanese estimates refer to the aggregate economy rather than to the business sector only. Furthermore the Japanese estimate may be somewhat understated relative to the UK and the U.S. due to the lack of reliable data for the estimation of investment in other product development, design, and research, firm-specific human capital, and organizational structure. Indeed the estimate for economic competencies (Fukao et al., 2007, p. 4). The estimates for the Netherlands exclude a figure for expenditure on own-account organizational structure. Indeed, taking account of the missing estimate for own-account organizational structure, the Dutch estimate is quite comparable to that for the UK. There is also some likelihood that the Netherlands study somewhat understate development expenditures by the financial sector and firm specific training.

Table 3 Expenditures on intangibles as a % of GDP, U.S., Japan, UK and Netherlands

	US 1998-2000	UK 2004	Japan 2000-2002	Neth'lnd 2004
1. Computerized and information	1.7	1.7	2.0	1.2
a) Software and databases: purchased		0.6	1.4	0.8
a) Software and databases: own account		1.1	0.6	0.4
2. Innovative property	4.6	3.2	3.7	2.4
a) R&D incl. social sciences and humanities	2.9	1.8	2.1	1.5
R&D in financial industry	0.8	0.7		0.0
b) Mineral exploration and evaluation	0.2	0.0	0.1	0.1
c) Other innovative property	1.5	1.4	1.6	0.9
Copyright and license costs	0.8	0.2	0.9	0.1
New architectural & engineering designs	0.7	1.2	0.7	0.7
3. Economic competencies	6.9	6.0	2.5	4.6
a) Brand equity	2.5	1.6	1.0	2.6
Advertising expenditure	2.3	1.2		2.3
Market research	0.2	0.4		0.2
b) Firm specific human capital	1.3	2.5	0.3	0.8
Direct firm expenses	0.2	1.3		0.5
Wage and salary costs of employee time	1.0	1.2		0.3
c) Organizational structure	3.1	1.9	1.2	1.2
Purchased	0.9	0.6		1.2
Own account	2.3	1.3		---
Total intangible expenditure as % of GDP	13.1	10.9		8.3
Intangible capital expenditure as % of GDP	11.7	10.1	8.3	7.5

Note: Netherlands excludes own accounts expenditure on organizational structures
All countries are for business sector only (Netherlands for total economy excl. government sector) except Japan which is for total economy
Sources: Netherlands from van Rooijen-Horsten, van den Bergen and Tanriseven (2007)
U.S. from Corrado, Hulten and Sichel (2005), UK from Haskel and Marrano (2007)
Japan from Fukao, Hamagata, Miyagawa, and Tonogi (2007)

Table 3 makes a distinction between total intangible expenditures and capital expenditures. Clearly expenditure on intangibles should only be treated as an investment when it concerns the acquisition or own account production of an asset, implying that it must lead to benefits for more than one year. Not all spending is necessarily capital spending.

The difference between expenditure and investment is especially relevant for the R&D category, as there is still debate on whether freely available (public) R&D should be capitalized. For example, the Dutch estimates exclude government consumption of R&D. Moreover, the Dutch estimates exclude some spending categories from advertising expenses, in particular free local papers and advertising pamphlets. Despite these larger deductions from expenditure, the Dutch estimate still shows a smaller adjustment than for the UK and the U.S. This is probably due to the fact that – with the exception of R&D – all capital spending estimates were directly obtained from the national accounts. This was not as easy for the UK and the U.S. which therefore had to go obtain total expenditure estimates requiring adjustments. CHS (2005) and HM (2007) assume that 60% of their estimates of expenditures on advertising are investments, 80% of own-account organisational structure expenditure and 100% of other types (such as software, R&D and firm-specific human capital).

Work on estimates of intangible expenditure is also ongoing at Statistics Finland and at The Conference Board (for France and Germany) (see Hao, Manole, and van Ark, 2007). A European Union-funded consortium, funded from the 7th Framework Program, to get to an overall coverage of intangibles in European Union member states, is envisaged to start its work in 2008/2009.

Conclusions and future research

Achieving a rising living standard is a central objective of economic policy in nations around the world, rich and poor, and the growth in output per worker hour is a key determinant of the standard of living. If workers can produce more goods and services, they can consume more, both now and in the future. However, sustained growth in output per worker does not happen automatically or autonomously. The standard sources-of-growth model reminds us that it is the result of systematic investments in a broad range of capital assets and improvements in productive efficiency (measured as a residual). This is why it is important to count all the sources of innovation, not just those that are more easily measured.

As research proceeds, measures of the intangible components will hopefully be refined, though this may require major changes in corporate financial accounting practice. Unfortunately, so far no parallel development has occurred in corporate financial account practice, which continues to treat R&D and other intangibles as current expenses. Preliminary research suggests that this practice has the effect of understating the net income and total assets of some of the most dynamic companies in the economy.[8] The Conference Board is presently undertaking a project to measure intangibles at the corporate level. Using the accounting model established in the research of Corrado, Hulten, and Sichel as a guide, the financial statements of a collection of U.S. and foreign corporations are being restated to include a broad range of intangibles. The preliminary work uncovered areas in which more information is needed to improve the accuracy of the estimates (for example, the write-off periods over which intangibles are amortized, spending on human resource development and long-term strategic planning). Additionally, considerable effort will be required to develop a consistent time series, in light of the mergers and acquisitions that take place over time, and accounting changes like the recognition of employee stock options. These are challenging data problems, made all the more difficult by the

[8] CHS provide references to the large literature documenting both a positive rate of return to R&D spending, and its positive impact on share prices (both are tests of whether R&D should be considered as an investment or as a current expenditure with no future consequences). For specific references to the value-building effects of the other categories of intangible capital, see the papers by Abowd et. al. (2005), Black and Lynch (1996), Brynjolfsson and Yang (1999), and Brynjolfsson, Hitt, and Yang (2000), and B. Hall (1993). The recent paper by Bloom and Van Reenen (2006) is especially noteworthy, since it links one of the most controversial forms of intangible capital, corporate management practice (an important aspect of corporate "culture"), strongly and positively to the value of a company's shares.

fact that intangibles are not recognized on corporate financial statements, and because surveys of corporate leaders has revealed some confusion about the nature of intangibles.

The results from a project on corporate intangibles will not only provide richer insight into the true dynamism of firms, but will also be invaluable to national income accounting practice, which relies heavily on the data provided by the business sector. This, in turn, would enrich the macroeconomic analysis of the sources and drivers of growth.

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CHAPTER I: POLICY DRIVERS

1. Summary of the session

The session was organised by Mr. Steve Landefeld (U.S. Bureau of Economic Analysis, United States). The session was based on a presentation by Professor William Nordhaus from Yale University on issues in non-market accounting: pollution accounting in theory and practice.

Prof. Nordhaus' presentation addressed the question of how the environmental effects of economic production can be quantified in terms of statistics. He demonstrated how externalities could be incorporated in the national income and product accounts, and provided concrete examples of possible treatments of pollution effects, global warming, and future externalities.

The following points were made in the discussion:

- the United Nations Statistical Commission decided to elevate the System of Environmental and Economic Accounting to the level of a standard that hopefully all United Nations countries will apply in the future;
- although improvements have been made in environmental accounting over the last decades, there are still some methodological and practical problems linked with the development of environmental accounts;
- the experiences of some countries show that there are major problems with the valuation of externalities to arrive at "true" or green Gross Domestic Products. However, the production of physical stocks and flows consistent with national accounts concepts could provide useful information to the policy makers and society;
- some externalities, e.g., emissions, will become tradable and should be taken into account in compiling the national accounts; concern was expressed about the increasing use of assumptions and imputations in the accounts.

2. Issues in non-market accounting: pollution accounting in theory and practice

Invited paper by William Nordhaus, Yale University, United States

Introduction

This paper discusses a very boring topic – redesigning national income and product accounts to incorporate the environment. However, as Enron has shown, even boring topics become exciting, and accountants are the center of attention, when major issues are involved. In a recent debate about global warming, it was argued that we should use a high discount rate on future damages because the rate of return on capital, as measured in the standard national accounts, is relatively high. A distinguished economist demurred, saying that the standard accounts may not include important external effects, and he speculated that, if these are included, we might find negative economic growth, negative net investment, and negative rates of return. This contribution will not resolve that question, but it will ask how we might go about addressing this concern.

This terrain has been traveled many times in the literature on environmental and green accounting (see the note on the literature at the end of this paper). The analytical questions involve the design of accounts that incorporate externalities. There appears to be no consensus about how to, and perhaps little inclination to, redesign the standard national accounts to incorporate externalities. This clearly raises important analytical and empirical questions. The empirical questions include how to measure these effects and how important all these effects are. This note addresses each of these briefly.

Analytical issues of externalities

Current treatment in the national accounts

We can start with a simple example where there is an externality in the market economy. We have two industries. Suppose that a farm produces $400 worth of market berries with labor if there is no pollution (I will later extend this example to non-market berries or health). The second industry is power, which produces pollution and $750 of power with capital. For this example, we assume that the power production has an external effect which reduces berry production by $125 and, because of imperfect property rights, the berry farmer is not compensated for the loss (hence an externality).

How do our standard national income and product accounts (SNA) treat this question? Table 1 shows a set of input-output tables that reflects the current treatment of externalities. Total net output (NNP) is measured as $750 + ($400 - $125) = $1025. The industrial values added are calculated as $750 for power and $275 for berries. The externalities get lost in the current accounting system.

Treatment with internalized externality ("Polluter Pay Principle")

It is not clear how we should change the accounts to capture the effects of pollution. For now, we continue to assume that all the effects are inside the market's boundaries. One useful experiment would be to interpret the problem as imperfect property rights – that there are uncompensated transactions. Suppose that the imperfect property rights in section A are corrected by the "polluter pays principle." Under this approach, the berry farmers own the property rights not to be harmed by pollution. In this case, the power plant purchases the pollution rights from the berry farmer at the opportunity cost, which is $125 of lost berries.

For our purpose, it is useful to define a new industry, "abatement." This fictitious industry is not unlike owner-occupied housing. There is a definitional question about what the "zero production" is here. I assume that zero pollution is the natural origin, so the power plant buys pollution rights (abatement) to reflect actual pollution. The abatement industry buys pollution permits from the farmer (these are in essence berries) and sells them to the power producer, as shown in Table 2. The shaded cells in Table 2 are flows that are estimated or imputed to reflect abatement. We have defined the activity as abatement rather than pollution because we want to preserve the positive prices and quantities for the activity. We then show the transactions between the synthetic abatement industry and other industries as balancing items. Because these are bought and sold, they are also intermediate goods in Table 2.

The NNP calculation does not change (because we are just rearranging items within the market's boundary). But the industry totals change, and incomes may change. Berry net product rises from $275 to $400 to reflect its contribution to abatement, and power production declines by the corresponding amount to reflect intermediate purchases of abatement. If rights are allocated to the berry farmers, incomes (including the sale of permits) are equal to net product. Earlier treatments of environmental accounts have generally ignored the income side of the transactions. None of this is particularly surprising, but it is a reminder that in a complete set of accounts, we need to make all the connections when we internalize the externality. The output corrections are pretty straightforward, while the income corrections are a little unfamiliar, and will become even more so in a moment.

Pollution permits allocated to polluters ("Polluter Wins Principle")

By some strange ethical logic, societies generally allocate the right to pollute to polluters (at some base or regulated level), and the polluters may have the right to sell these permits to other entities. No one would consider this arrangement for pickpockets or horse thieves, but we are not here to debate ethics. We show the case of the "polluter wins principle" in Table 3.

Total industry incomes are the same as the current national account treatment (as long as permits are treated as factor incomes). However, the industry contribution to NNP (measured excluding the permit income) is the same as Table 2, reflecting the actual flow of goods and services to the economy.

Imputing outputs and incomes with externalities

Now return to the realistic situation where the externality is *not* internalized. Here, we need to construct a set of "as if" accounts that show the pollution and abatement flows. How to do this is not, I believe, settled in national income accounting. A reasonable approach would use the basic frameworks in Tables 2 and 3. This would add a fictitious abatement industry, and then impute the values. The quantities in this imputed industry would be actual qualities, and the prices would be net marginal damages. (The presence of an externality means that marginal cost is not equal to marginal damage. By changing the valuation of abatement flows from zero marginal cost to positive marginal damage, the output measure becomes a welfare measure in which the valuation of output consistently uses marginal utility valuation.)

There is a major question here, however, about how to treat the incomes associated with the pollution flows when there are no actual flows (reflecting the fact that there are not well-established property rights). Unless we are careful, the constructed income accounts no longer balance outputs. The problem is that the $125 of imputed output of the berry industry (which is counted as abatement) does not show up as the income to any industry; similarly, the $125 of costs of the power industry from purchasing abatement does not get charged to the power industry.

There is no obvious answer to this. However, the closest approximation to reality is the situation described by the "polluter wins principle" in Table 3. In most countries, polluters have the right to pollute up to the legal standard, and they may actually be allocated tradable emissions allowances. One possible approach is shown in Table 4, where I have tentatively labeled the income entry as a "pollution transfer." This reflects the fact that the implicit property right has been transferred to the power producer. Note that the real output and the market incomes by industry are not affected by whether the transfer or allocation of property rights is to polluter or pollute (as we see in Tables 2 and 3). However, the total value added as computed here (which includes the implicit or explicit sale of pollution permits) will be affected by the treatment of the transfer.

In summary, to create a set of environmental accounts, we need the following steps:

- estimates of the quantities, prices, and values of the pollution (or abatement) flows among the different industries;
- establishment of a fictitious abatement industry that buys and sells the abatement output among the different industries;
- addition of a new entry of "pollution transfers" or some similar entry that is the balancing item in the income accounts and ensures that the entries add up within and across industries.

The major analytical question is how to incorporate the imputed income flows, which I have resolved as incorporating the "pollution transfers." The major empirical difficulty is the estimation of the (external) pollution flows, and especially the valuations, among the different industries.

Non-market activities

The examples shown up to now assume that all the activities take place within the boundaries of the market. The next step would be to consider pollution flows that affect non-market values. These might be human health, wild berries, ecosystem values, and the like.

We can use exactly the same accounting framework as Tables 1 through 4 for the non-market accounts. We simply reinterpret the "berries/health" industry as the non-market sector, while leaving the power sector as the market sector. NNP is then the various flows only for the power industry. Comparing Table 1 (the current NIPA) with Table 2 through 4, we see that the current accounting approach overestimates market NNP because it does not correct for non-market externalities.

Estimating the correct number would require adding a component of the non-market sector. We would get accurate estimates of NNP if the externalities were to be internalized, in which case the market industries would buy permits from the non-market sectors as in Tables 2 or 3. Here, we would need to include the sales of permits from the non-market sectors as costs of production.

Alternatively, and of greater relevance, we could set up the imputed environmental accounts as in Table 4. This would require that we include that part of the non-market sectors that interact with the market sectors in the appropriate places. We show in Table 5 the extension of Table 4, where only the power sector is in the market. The power sector is shown as a shaded row and column, while the non-market sectors are shown as unshaded rows and columns. The conventional accounts provide an incorrect estimate of NNP because they omit the intermediate goods of the abatement sector. Using the fictitious abatement industry, imputed flows, and pollution transfers, we can calculate the correct NNP from either the product or income side, as shown in Table 5. Note that we would *not* need to construct a complete set of augmented non-market accounts to correct the market accounts, as long as we make all the appropriate adjustments to the market accounts shown in Table 5.

This example does emphasize that a minimum inclusion of the non-market sectors is necessary to get correct calculations when some of the impacts involve the non-market sectors. But, fortunately, correction of the market accounts does not require "accounts of everything."

Externalities in the future

Another issue would rise with "stock externalities." These are case, like global warming, public health investments, or basic scientific research, where activities today have external effects in the future. The conceptual framework is similar to that just addressed. However, we would need to calculate a consumption shadow price on the externality flow during each period. For example, if current U.S. emissions of carbon dioxide are x billion metric tons per year, then we would need to correct NNP in the market accounts by imputing the marginal damage shadow price times the flow.

International externalities

Yet a final issue is stock externalities that cross national borders. These would involve a combination of three components: estimates of the quantities of the externality flows for each country and period, estimates of the shadow prices on the flows for each country and period, and a matrix of marginal quantitative impacts of the flows from each country to each other country. In the next section, I will use the example of global warming. This is a simple example because the shadow prices are equal in each country.

An example for carbon dioxide emissions and global warming

To apply the ideas described above, I turn to the case of carbon dioxide emissions and global warming. The basics are straightforward and well-known. Climatologists and other scientists warn that the accumulations of carbon dioxide (CO_2) and other greenhouse gases are likely to lead to global warming and other significant climatic changes over the next century. Greenhouse warming is the granddaddy of all public goods. Because of the climate externality, the production of greenhouse gases will differ from the efficient level. Emissions of CO_2 are conceptually negative investments in "climate capital" that are not counted in current national accounts.

In the accounting framework described above, the external impacts of global warming are probably not included in GDP estimates. (I say probably because it is possible that some modest carbon taxes are included for some European countries, but it seems unlikely that these amount to a substantial amount.) The different parts of the analysis are the following:

- estimates of 2005 emissions of CO_2 come from a variety of sources, including principally the U.S. Energy Information Agency. I have aggregated these into twelve major regions as described below;
- estimates of the externality price of CO_2 emissions come from the DICE-2007 model. Modelers have developed integrated assessment models to project the emissions and damages of greenhouse gas emissions in the coming decades. From the present point of view, the key finding involves the "social cost of carbon," or SCC, which is the marginal damage caused by an additional ton of carbon emissions. In a dynamic framework, it is the discounted value of the change in consumption caused by a unit emission of CO_2, denominated in terms of current consumption. The Fourth Assessment Report of the IPCC cites an average value from a survey of $43 per ton carbon emissions. For these estimates, however, I will use figures from the DICE-2007.δ.4 version, which provide a complete accounting framework and has an estimate of $29.28 per ton C for 2005 in 2005 US dollars (see http://www.econ.yale.edu/~nordhaus/ DICEGAMS/DICE2007.htm for a discussion). If the reader is convinced by the logic of the recent *Stern Review,* the SCC is about ten times larger than our estimates, so the numbers here should be multiplied by a factor of about 10;
- estimates of impacts come from worksheets behind the DICE-2007 model and are drawn from a variety of different sources. These figures are derived from estimates of damages by

region, damage ratios by region, and year 2100 projections of GDP by region. These have low reliability but provide order of magnitude estimates.

Table 6 shows the basic data used in the calculations. These are necessary and sufficient for the calculations developed in this paper.

The major results are shown in Table 7, with the supporting detail in Table 8. Using our estimates of the SCC, the global negative net investment in "climate capital" in 2005 was $223 billion, of which $48 billion of negative investment occurred in the U.S., $40 billion in China, and $37 in the EU region. According to BEA, net national saving in 2005 in the U.S. was $6 billion, so after correction for climate disinvestments, net investment was -$36 billion. We do not have good data for China, but a reasonable guess was that net national savings for China was in the order of $500 to $1000 billion, so the CO_2 subtraction would not make a major dent in China's net investment.

In terms of international transfers, the U.S had net transfers of $32 billion. In other words, the U.S. imposed net uncompensated costs on the rest of the world of $32 billion according to these calculations. Western Europe/EU ($23 billion) and Russia ($16 billion) were also major net contributors. The major regions having negative transfers (that is, incurring damages net of emissions) were India ($47 billion), Latin America ($20 billion), and sub-Saharan Africa ($17 billion).

Of course, the U.S. is today borrowing at a substantial rate from abroad. The current account balance for the U.S. was $ -792 billion in 2005. The CO_2 account would add another $32 billion of borrowing to that. However, the CO_2 account has no counterpart in net U.S. indebtedness as it represents an uncompensated "pollution transfer" from the rest of the world to the U.S.

This example shows how environmental accounts may be used to illustrate the economic impacts of externalities. The numbers are only illustrative at this stage, but they suggest that a full set of accounts might have significant effects on the accounts of countries.

APPENDIX

Note on the literature

There is by now a vast literature on environmental accounting, but there are few attempts to incorporate such accounts in the standard national accounts framework. The closest thing to an international consensus is the rambling *Handbook of National Accounting: Integrated Environmental and Economic Accounting* (UN, 2003), sometimes called the SEEA. This approach has an input-output matrix of physical quantities, but no value accounts (see particularly p. 98 and Chapters 3 and 9). SEEA designates an “environment industry” as the constructed element shown below, but it is unclear whether a valuation framework is also envisioned. The SEEA is also unclear about whether to use damage-based pricing or cost-based pricing, although it seems conceptually clear that damage-based pricing is necessary to implement a welfare-based concept of output.

Some of the issues discussed here were developed in William Nordhaus and James Tobin, “Is Growth Obsolete?” *Fiftieth Anniversary Colloquium V* (New York: National Bureau of Economic Research, Columbia University Press, 1972). The major effort of the U.S. Bureau of Economic Analysis was contained in its IEESA (Integrated Economic and Environmental Satellite Accounts), which were an accounting framework that covers the interactions of the economy and the environment *(Survey of Current Business,* April 1994). This effort was derailed by the Congress and has not gotten back on track. The IEESA and other accounting efforts, as well as the substantial literature on environmental accounting, was reviewed in National Research Council, *Nature’s Numbers (*National Academy Press, 1999).

The theoretical background for environmental accounting is discussed in Kirk Hamilton, “Pollution and Pollution Abatement in the National Accounts,” *Review of Income and Wealth* 42 (1), 13–33, 1996. The staff of the World Bank have made a series of estimates of “genuine savings rates” that include a number of corrections for investments that are excluded from the standard national accounts, including human capital and depletion of sub-soil assets (see Kirk Hamilton, “Genuine Saving as a Sustainability Indicator,” World Bank discussion paper, October 2000). A number of important issues are reviewed in the contributions in Ignazio Musu and Domenico Siniscalco, *National Accounts and the Environment* (Kluwer Academic Publishers, London, 1996).

Table 1 Current national accounts with externality

		Industries		Final uses		
Commodities		Power	Berries/ health	Total Intermediate use	Total final uses (NNP)	Total commodity output
	Power	0	0	0	750	750
	Berries/ health	0	0	0	275	275
	Total Intermediate	0	0			
	Compensation	0	275			
	Net operating surplus	750	0			
	Total value added	750	275			
	Industry NNP (excluding permit transfers)	750	275	Measured NNP		1025
	Total industry output	750	275	True NNP		1025

Table 2 Accounts with internalization and sales of pollution permits by berry industry

		Industries			Final uses		
Commodities		Power	Berries/ health	Abate-ment	Total Intermediate use	Total final uses (NNP)	Total commodity output
	Power	0	0	0	0	750	750
	Berries/ health	0	0	125	125	275	400
	Abatement	125	0	0	125	0	125
	Total Intermediate	125	0	125			
	Compensation	0	275	0			
	Sale of pollution permits	0	125	0			
	Net operating surplus	625	0	0			
	Total value added	625	400	0			
	Industry NNP (excluding permit transfers)	625	400	0	Measured NNP		1025
	Total industry output	750	400	125	True NNP		1025

Note: Shaded entries are new and reflect internalization of pollution.

Table 3 Accounts with allocation of pollution permits to power industry

		Industries			Final uses		
Commodities		Power	Berries/ health	Abate-ment	Total Intermediate use	Total final uses (NNP)	Total commodity output
	Power	0	0	0	0	750	750
	Berries/ health	0	0	125	125	275	400
	Abatement	125	0	0	125	0	125
	Total Intermediate	125	0	125			
	Compensation	0	275	0			
	Sale of pollution permits	125	0	0			
	Net operating surplus	625	0	0			
	Total value added	750	275	0			
	Industry NNP (excluding permit transfers)	625	400	0	Measured NNP		1025
	Total industry output	750	400	125	True NNP		1025

Note: Entries in bold italics are new entries arising from internalization of pollution.

Table 4 Proposed environmental accounts with constructive internalization and pollution transfers

		Industries			Final uses		
Commodities		Power	Berries/ health	Abate-ment	Total Intermediate use	Total final uses (NNP)	Total commodity output
	Power	0	0	0	0	750	750
	Berries/ health	0	0	125	125	275	400
	Abatement	125	0	0	125	0	125
	Total Intermediate	125	0	125			
	Compensation	0	275	0			
	Imputed pollution transfer	125	0	0			
	Net operating surplus	625	0	0			
	Total value added	750	275	0			
	Industry NNP (excluding permit transfers)	625	400	0	Measured NNP		1025
	Total industry output	750	400	125	True NNP		1025

Note: Entries in bold italics are imputations.

Table 5 Proposed environmental accounts with constructive internalization and pollution transfers. Power sector is market sector and berry/health are non-market sector

		Industries			Final uses		
Commodities		Power	Berries/ health	Abate-ment	Total Intermediate use	Total final uses	Total commodity output
	Power	0	0	0	0	750	750
	Berries/ health	0	0	125	125	275	400
	Abatement	125	0	0	125	0	125
	Total Intermediate	125	0	125			
	Compensation	0	275	0			
	Imputed pollution transfer	125	0	0			
	Net operating surplus	625	0	0			
	Total value added	750	275	0			
	Industry NNP (excluding permit transfers)	625	400	0	Measured NNP		750
	Total industry output	750	400	125	True NNP		625

Note: Entries in bold italics are imputations.

Table 6 Basic data used in calculating international pollution transfers from global warming

	Projected GDP (2100)	CO2 emissions, 2005	Price of carbon emissions, 2005	Damages as share of GDP a 2.5 oC warming	Share of global total damages
	[billions, 2005 US international $]	[Million tons C]	[2005 US$ per ton C]	[percent]	[percent]
US	41,481	1,649	29.28	1.1%	7.1%
WE/Euro	22,032	1,274	29.28	1.8%	6.5%
OHI	17,211	280	29.28	0.3%	0.8%
Russia	4,921	484	29.28	-1.0%	-0.8%
EE/FSU	9,949	246	29.28	0.9%	1.5%
Japan	6,606	351	29.28	1.1%	1.2%
China	96,983	1,359	29.28	1.1%	17.1%
India	37,673	327	29.28	4.2%	25.6%
MidEast	8,935	379	29.28	1.6%	2.4%
SSA	11,486	283	29.28	6.1%	11.5%
LA	27,856	404	29.28	3.2%	14.4%
OthAsia	21,639	582	29.28	3.6%	12.8%
Sum or average	306,773	7,619	29.28	1.68%	100.0%
Reliability:	Low	High	Medium	Low	Low

Table 7 Estimated damages emitted and received, and net international pollution transfers, by region from CO_2 emissions externality, 2005.

	Total damages emitted	Total damages received	Net international pollution transfers
	Total net international transfers, 2005		
	[Billions of 2005 $]		
US	-48.3	15.9	32.4
WE/Euro	-37.3	14.5	22.8
OHI	-8.2	1.9	6.3
Russia	-14.2	-1.7	15.9
EE/FSU	-7.2	3.4	3.9
Japan	-10.3	2.6	7.6
China	-39.8	38.1	1.7
India	-9.6	57.0	-47.4
MidEast	-11.1	5.3	5.8
SSA	-8.3	25.6	-17.3
LA	-11.8	32.0	-20.2
OthAsia	-17.0	28.5	-11.5
Sum	-223.1	223.1	0.0

Table 8 Estimated bilateral transfers among regions underlying calculations

Emitting Region	Total cost of CO2 emissions [billions of 2005 $]	US	WE/Euro	OHI	Russia	EE/FSU	Japan	China	India	MidEast	SSA	LA	OthAsia
		---- Damaged regions ----											
		Damage as percent of 2100 output											
		7.1%	6.5%	0.8%	-0.8%	1.5%	1.2%	17.1%	25.6%	2.4%	11.5%	14.4%	12.8%
		Gross transfers from region at left to region at top (2005 US $)											
US	48.3	3.44	3.13	0.40	-0.37	0.73	0.57	8.25	12.34	1.14	5.53	6.94	6.17
WE/Euro	37.3	2.66	2.42	0.31	-0.29	0.56	0.44	6.38	9.54	0.88	4.27	5.36	4.77
OHI	8.2	0.58	0.53	0.07	-0.06	0.12	0.10	1.40	2.09	0.19	0.94	1.18	1.05
Russia	14.2	1.01	0.92	0.12	-0.11	0.21	0.17	2.42	3.62	0.33	1.62	2.04	1.81
EE/FSU	7.2	0.51	0.47	0.06	-0.06	0.11	0.09	1.23	1.84	0.17	0.83	1.04	0.92
Japan	10.3	0.73	0.67	0.09	-0.08	0.16	0.12	1.76	2.63	0.24	1.18	1.48	1.32
China	39.8	2.84	2.58	0.33	-0.31	0.60	0.47	6.80	10.17	0.94	4.56	5.72	5.09
India	9.6	0.68	0.62	0.08	-0.07	0.14	0.11	1.64	2.45	0.23	1.10	1.38	1.23
MidEast	11.1	0.79	0.72	0.09	-0.09	0.17	0.13	1.90	2.84	0.26	1.27	1.60	1.42
SSA	8.3	0.59	0.54	0.07	-0.06	0.13	0.10	1.42	2.12	0.20	0.95	1.19	1.06
LA	11.8	0.84	0.77	0.10	-0.09	0.18	0.14	2.02	3.02	0.28	1.35	1.70	1.51
OthAsia	17.0	1.21	1.10	0.14	-0.13	0.26	0.20	2.91	4.35	0.40	1.95	2.45	2.18
Total value of damages received	223.1	15.9	14.5	1.9	-1.7	3.4	2.6	38.1	57.0	5.3	25.6	32.0	28.5

CHAPTER II: CAPITAL BOUNDARIES IN THE REVISION OF THE SYSTEM OF NATIONAL ACCOUNTS 1993

1. Summary of the session

The session was organised by Mr. Rob Edwards (IMF). Mr. Walter Radermacher (Germany) served as the discussant. The session was based on invited papers by Australia, the Netherlands, Switzerland, and Eurostat, and a supporting paper by Korea.

The session focused on the challenges in measuring different forms of intangible capital, such as computer software and research and development (R&D). The Conference considered how to deal in practice with the difficult measurement issues; making rough estimates may mislead the users, but, on the other hand, making no estimates may damage the macroeconomic quality of the accounts. Questions were raised as to whether national accounts data should be based on statistically measurable variables rather than imputations, and whether the capital boundary would need to be extended.

Furthermore, the following points were made in the discussion:

- if R&D is not measured, a big share of economic growth will remain unexplained;
- R&D should be considered in the broader context of intellectual capital and its globalisation;
- efforts should be made to advance the implementation of the R&D satellite accounts; surveys and sufficient information are already available in several countries;
- the development of R&D satellite accounts is especially important in the EU countries in relation to the Lisbon agenda (e.g., estimation of the R&D intensity);
- at the European level, the national accounts are legally binding, therefore a more pragmatic and realistic approach has to be developed. A Eurostat task force will be established to set up clear priorities;
- user needs for data on R&D have to be taken into account. In the absence of precise data, it is better to make rough estimates and explain their limitations to users;
- the theory around intangibles is still developing; however, the users cannot wait years until the theoretical basis is fully developed;
- the robustness of the measurement methods is important, as the values of some intangible assets may be very volatile;
- the question is not whether to measure R&D but how to do it in practice; e.g., what surveys are needed to improve the source data for the national accounts estimates, what questions should be included in surveys, etc.

The session organiser concluded the session with the following key points:

- further practical work needs to be done on measurement of R&D to help national statistical offices to develop the estimates;
- Canberra II Group could be an appropriate forum for such work to take place;
- future work should focus not only on the national accounts perspective, but also on business surveys that will provide the input data for R&D estimates.

2. An integrated system of capital flow and stock statistics

Invited paper by Peter Harper, Australian Bureau of Statistics

Introduction

Statistics on (physical) capital are an important part of the national accounts. Traditionally, the wealth aspects of capital have been the focus of national accounts compilation efforts. These wealth aspects relate to the initial accumulation of capital through investment and the 'running down' of these investments over time by way of consumption of fixed capital (depreciation). Flows associated with the accumulation of new capital and the depreciation of existing capital are recorded in the national accounts capital account. The (written down) values of capital assets are recorded in the balance sheets. The change in the value of the balance sheets over time can be explained by the transactions recorded in the capital account and, to the extent there are price changes or other changes in volume affecting the capital assets, by the flows recorded in the other changes in assets account.

However, there is another dimension of capital that has attracted increasing attention by national accountants in recent years, and that is the role of capital in productivity analysis. Broadly defined, productivity represents the difference in growth rates between outputs and inputs and, as such, is a source of economic growth. Accordingly, it is often the focus of government economic policy because, all other things equal, a higher rate of productivity allows an economy to grow more rapidly for a given set of inputs. In Australia, for example, much of the government's economic policy is built around the 3P's framework – population, participation and productivity -- which taken collectively are seen as the fundamental drivers of economic growth. Capital, of course, is one of the traditional economic inputs along with labour, so any comprehensive analysis of productivity must include an analysis of the role that capital plays in productivity.

The wealth and productive dimensions of capital are not independent and in fact, as will be demonstrated shortly, the latter drives the former. Because of the dependencies that exist between the two measures, the estimates for both dimensions should be compiled within a single, coherent framework. This is the approach taken in Australia. The Australian Bureau of Statistics (ABS) has developed a perpetual inventory model that produces estimates for both the wealth and productive dimensions of capital in an integrated fashion. The benefit of this approach is that the wealth measures contained in the national accounts are fully consistent with measures used for productivity analysis. This is important because the end target of productivity analysis – economic growth – is one of the fundamental measures provided in a set of national accounts.

A simple capital model

Suppose that there is an asset that will be used in production for two years. In year 1, the value of that asset's contribution to production is estimated to be 50. In year 2, the asset is estimated to also contribute 50 to production. We also suppose that the interest rate is 10% and that there are no price changes.

At the beginning of year 1, the value of the asset can be estimated to be 95, which is equal to its first year's contribution to production of 50 plus the second year's contribution of 50 discounted by 10%, or 45. In properly functioning markets, the new value of the asset will be 95. Users of the asset will be willing to pay up to 95, but no more, to acquire the asset. As well as representing the amount that is needed to acquire the asset, the 95 represents the initial wealth value of the asset.

At the beginning of year 2, the asset is worth 50, which is the value of the asset's contribution to production in year 2. Thus, in year 1, the value of the asset has fallen by 45 (95 – 50). It is this amount which is shown as consumption of fixed capital in the national accounts. At the end of year 2, the asset is worthless and the consumption of fixed capital during year 2 is therefore 50.[1]

We now have a pattern for the change in the value of the asset over time – 95, 50 and 0. This pattern is known as the *age-price* profile. The values generated by the age-price profile are the values of *net capital stock*, which is the essential measure of capital from a wealth perspective.

Turning now to look at the asset from a productivity perspective, we can see that the asset contributes equally to production in both years. This means that the asset is equally efficient in both years – there has been no decline in efficiency between years 1 and 2. A light bulb is a good example of this type of asset. The two estimates of the asset's value in production – 50 and 50 – represent the asset's *age-efficiency* profile. Using the age-efficiency pattern an alternative measure of capital stock – *productive capital stock* – can be derived. This measure is calculated by expressing each year's age-efficiency value as a proportion of the new value of the asset and it is a measure of the productive capability of an economy's capital stock.

There are a few important implications that arise from the foregoing. First, it is the age-efficiency profile that determines the age price-profile, and not vice versa. In other words, the amount of consumption of fixed capital on an asset is directly related to the asset's productive capacity over time. This can be demonstrated by changing the assumption about the value of the asset's contribution to production in year 2 from 50 to 30. In this case, the age-price profile of the asset changes to 77 (new), 30 (at the beginning of year 2) and 0 (at the end of year 2). The resultant estimates for consumption of fixed capital are now 47 in year 1(compared to 45 in the earlier example) and 30 in year 2 (compared with 50 in the previous example). The change in productive capacity has caused the pattern of depreciation to be significantly altered, with more consumption of fixed capital now being recorded in the first period and less in the second.

Second, the values of the asset's contribution to production in each year represent the input of capital into the production processes. It is precisely these inputs (generally when measured in volume terms) that are of interest to productivity studies. In productivity analysis, these capital

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[1] It may be interesting to note at this point that, although the asset's contribution to production in both years is 50, there are different amounts of consumption of fixed capital in the first and second years.

inputs are known as *capital services*. When capital is provided under rental arrangements, in properly functioning markets the value of the rental is equal to the capital services provided by the asset (ignoring other costs for simplicity).

Third, the value of the capital services in any given period can be seen to be equal to the sum of consumption of fixed capital plus the 'unwinding of the discount'. In our original example, the capital services in year 1 of 50 is equal to consumption of fixed capital of 45 in year 1 plus 10% of the value of the capital at the end of year 1, or 5.[2] This value of 5 is also sometimes known as the *return to capital*. It is important economically because an owner will only invest in a capital asset if its return from production covers both the loss in value of an asset via consumption of fixed capital and the opportunity cost of the owner investing his funds in the asset compared to some alternative investment. One of the features of SNA Rev 1 will be a discussion of the relationship between capital services and 'traditional' national accounts measures of capital, including suggestions for supplementary tables designed to highlight the capital services/return to capital dimensions of capital.

Clearly, the examples above are simplistic. But the basic points illustrated relate to all kinds of capital assets with many and varied assets lives and productive capacities. And it is possible to mathematically express these relationships. It is these mathematical expressions that are at the heart of the integrated capital stock system in Australia.

To summarise, there are three relevant capital flows:

- accumulation (or initial investment);
- consumption of fixed capital (or depreciation);
- capital services;

and three relevant capital stock measures:

- gross capital stock, which represents the initial, new, value of assets;
- net capital stock, which represent the 'written down' value of capital due to consumption of fixed capital;
- productive capital stock, which represents the 'written down' value of the asset in accordance with its change in efficiency.

The various measures of capital, and the relationships between them, are set out in a more substantial manner in the OECD's Manual on *Measuring Capital* (2001).

[2] Strictly speaking, the discount should be applied to the average value of the capital during the period, not at the end of the period. But the identity that capital services equals the sum of consumption of fixed capital plus the unwinding of the discount still holds, because in 'proper' capital stock models the wealth values are calculated by applying the discount continuously and not just at the end of the period as in our simple examples.

Perpetual inventory models

As mentioned above, Australia uses a *perpetual inventory model (PIM)* to compile its capital stock estimates.

The PIM involves the compilation of a 'rolling' inventory of capital stocks; in any particular period investment in capital assets is added to stocks, and retired assets are deducted. To apply the PIM, the following are generally required:

- the average length of asset lives, i.e. average of the length of time they are used in production;
- the extent to which assets are retired before, on or after the average asset life for that asset - the retirement distribution. Alternatively, retirements can be expressed as a survival function;
- the age-price function of assets (used to derive net capital stock estimates and estimates of consumption of fixed capital);
- the age-efficiency function of assets (used to derive productive capital stock estimates and estimates of capital services);
- gross fixed capital formation (GFCF) for the period for which the capital stock estimate is required and for prior periods prior up to the maximum life of the assets;
- price indexes for the entire time span of GFCF.

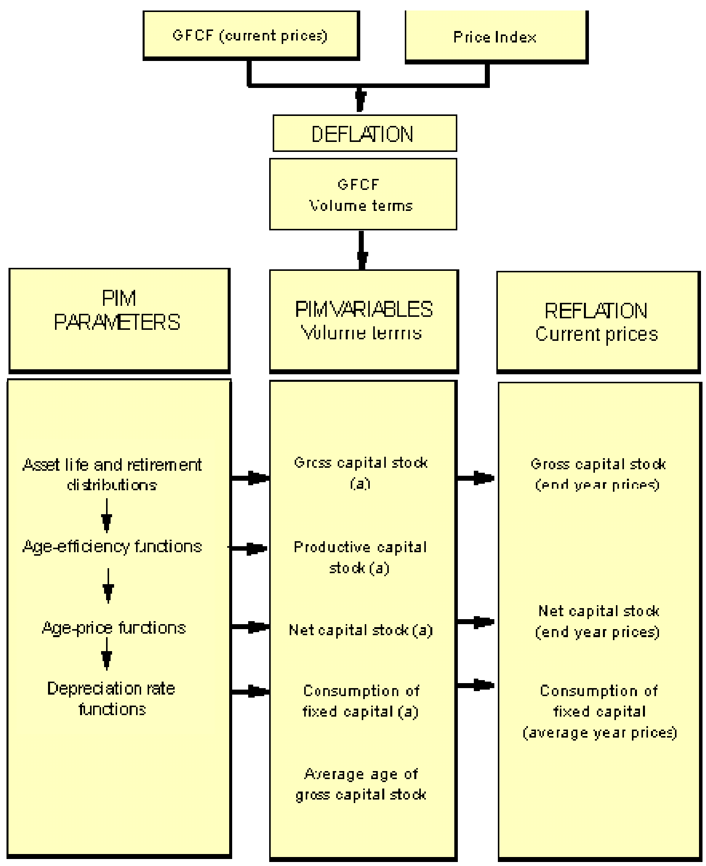
The alternative to using a PIM to derive capital stock estimates is to use direct measurement. However, there are significant drawbacks with this approach, mainly associated with the paucity of data that are available. For estimates of net capital stocks, there are simply insufficient observations of the second-hand value of assets, given that only a small proportion of assets are actively traded in second-hand markets. While the accounts of businesses typically contain – in the balance sheets – estimates of the ‘written down’ values of assets, the depreciation estimates underlying these values are typically inconsistent with the calculation of consumption for fixed capital in the national accounts. This is because accountants’ measures of depreciation are often based on simple ‘rules’, such as straight-line depreciation. Studies have shown that these methods are often a poor representation of the actual consumption of fixed capital. Another common problem is that book estimates of depreciation, and consequently asset values, are often based on historical cost, whereas the national accounts requires estimates based on current values. Thirdly, the asset lives chosen for estimating depreciation may be artificially shortened, for tax purposes for example.

Turning to the productive dimension of capital, the situation in terms of availability of direct data is possibly even worse. Few businesses have, as a matter of course, comprehensive estimates of productive capital stock or of the capital services generated by their assets. While it is possible to observe the values of capital services from the rentals of assets, for most types of assets the market for operational leasing is typically very small relative to the total stock of the asset or even non-existent.

However, the PIM also has drawbacks as an approach. There are two main drawbacks. First, very long time series are needed for the two key inputs – GFCF estimates and the associate price indexes. In fact, input information is generally required for all periods back until the period when the oldest-aged asset was new. Many assets, particularly buildings and structures, can have asset lives that can be measured in decades and in some cases even in hundreds of years. Few countries have input series covering the periods that would ideally be required. The alternative is to chose a distant point for which input series are available, with the point chosen by either assuming the capital stock at that point in time was negligible or using a 'jumping off' capital stock estimates that may have been derived as the result of some historical study.

The second drawback of the PIM approach is that it is heavily dependent on the assumptions used. Experience in Australia has shown that even relatively minor changes in assumptions can have significant impacts on the capital stock estimates generated, particularly those relating to the productivity dimension. So while contact with businesses may not be a feasible way to measure capital stock estimates directly, such contacts can often be a valuable source for establishing or testing the assumptions underlying the PIM.

The steps involved in applying the PIM are summarised in the diagram below:



(a) Expressed in the average prices of the reference year

Another useful output of the PIM is the average age of the gross capital stock at the end of each year, which can be used to show the extent to which an economy's capital stock is aging, or becoming younger, over time.

PIM assumptions

The key assumptions underlying the PIM relate to:

- mean asset lives;
- asset life distributions;
- the age-efficiency profile;
- the discount rate.

It should be recalled that as a consequence of the capital theory that underlies the Australian PIM, the age-price (depreciation) profile is derived from the age-efficiency profile, using the discount rate, and as such no explicit assumptions about this profile are required. However, the derived age-price results may be usefully tested against whatever information on the values of second hand assets is available, because significant differences could suggest concerns about the age-efficiency assumption.

In Australia, six data sources are used to derive mean asset lives:

- implicit tax lives;
- weighted prescribed tax lives;
- asset lives used by businesses to calculate depreciation for their own purposes;
- survival rates for vehicles in the motor vehicle fleet derived from the motor vehicle census;
- technical information on the operating lives of various types of machinery from manufactures' specifications;
- asset life estimates from other comparable overseas countries.

Judgment is used to meld the various data sources to determine the average asset life for each type of capital equipment. A concern is the extent to which asset lives for a particular type of asset may change over time. Generally, unless reasonable evidence is available indicating the contrary, asset lives are kept constant over time.

Within particular types of assets, variations in lives will occur because of different rates of use, maintenance, etc. Because of the lack of recent empirical evidence, asset life distribution curves developed by Winfrey[3] are generally used. Although the Winfrey study is old, it is empirically based. For a few intangible fixed asset types, other asset live distributions, based on asset specific information, are used.

Likewise, there is a lack of empirical data about the shape of age-efficiency functions, so the choice is a matter of judgement. The ABS has generally chosen to use hyperbolic functions,

[3] Winfrey R, *Statistical Analysis of Industrial Property Retirements*, Iowa State College of Agricultural and mechanic Arts, 1938.

which is the same approach as that used by the US Bureau of Labour Statistics (BLS). In a hyperbolic function, the efficiency of an asset declines by small amounts at first, with the rate of decline increasing as the asset ages.

For discount rates, the ABS has chosen a real rate of 4%, the same as that used by the BLS and which approximates the average real 10 year Australian Government bond rate.

A more comprehensive description of the ABS's PIM is available in *Australian National Accounts: Concepts Sources and Methods* (Cat. No. 5216.0) (2000), available on the ABS website www.abs.gov.au.

Prospects for collaboration to improve compilation

Australia is clearly not alone in its desire to compile high quality, comprehensive capital stock estimates in an integrated framework, and increasingly countries are interested in ensuring that the wealth and productivity dimensions of capital are compiled in a consistent and coherent fashion. In line with this, and given the complexities associated with capital stock measurement, there are a range of areas in which countries might collaborate:

- refining the capital theory on which the capital stock estimates are based;
- 'best practice' in the construction of PIMS;
- work on developing and testing the assumptions underlying the PIM, particularly those that are based on old studies and/or lack a robust empirical framework;
- understanding the application of the PIM to the new asset types in the SNA, such as R&D assets;
- sharing experience in direct measurement of capital stocks, where such measurement may complement the PIM or replace certain elements;
- working with accounting standards bodies to improve the quality of businesses' capital stock estimates from the perspective of economic statistics.

Up until now, the forum for international work on capital measurement issues has been the Canberra Group[4]. The original Canberra Group developed the aforementioned *Measuring Capital* Manual. Canberra 2 has been active in addressing issues associated with updating the SNA, including the capitalisation of R&D. It is also actively involved in progressing the research issues identified in *Measuring Capital* and there is an advanced draft of a revised edition of the Manual. Notwithstanding this, however, there remains plenty of work to be done on aspects of measuring capital that could benefit from continued international collaboration. To progress some of these issues might require studies of significant magnitudes, and countries should be encouraged to invest in such studies and to share findings. While the Canberra Group has proven to be a reasonably effective mechanism for progressing capital issues – particularly in its bringing together of capital theoreticians and national accounts practitioners – it is a part-time, self selected group and consideration should be given to ensuring that the full range of countries is involved.

[4] The OECD is currently providing secretariat services for the Group, and Group meeting are normally chaired by an ABS representative.

A related issue is the need to understand the implications for capital measurement in developing countries that lack the sophisticated statistical capability of countries such as Australia.

Issues for discussion

The following issues are suggested for discussion:

- the measurement of capital stocks is challenging. On the one hand, direct measurement is very difficult due to a paucity of observable data. On the other hand, using models such as the PIM have the drawback of being dependent on assumptions. The ABS has taken the approach that it is better to provide 'approximate answers to the right questions', rather than to avoid measurement. Our view is that statistical agencies are best placed to develop credible, transparent models that will stand up to scrutiny, partly because much of the data required to derive the estimates will generally only be available to statistical offices. Another reason for statistical offices undertaking the measurement is that capital stock estimates are required for a comprehensive set of national accounts, which is generally the domain of statistical offices. The issue of the how statistical offices should approach this type of work may merit discussion;
- the paper outlines the broad approach adopted by the ABS in constructing capital stock estimates, which is based on an integrated theory of the wealth and productivity dimensions of capital. Is such an integrated approach supported, and is theoretical basis underlying the ABS approach seen as appropriate?
- the paper suggests some possible areas for international collaboration. Have the key areas been identified? What are the highest priority areas?
- the Canberra Group has played a major role in addressing capital stock measurement issues. Given that there remains a range of issues on which further work may be required, what should be the future of the Group? While it is considered that the Group has been reasonably effective in its work to date, should changes be made to the Group's operation to further enhance its effectiveness?

3. Capital measurement in the Netherlands

Invited paper by Mark de Haan, Dirk van den Bergen and Myriam van Rooijen-Horsten, Statistics Netherlands

Introduction

At Statistics Netherlands the development of productivity statistics has been given key priority. The latest national accounts revision entailed two improvements leading to better productivity measurement. First, labour volume data based on full time job equivalents were replaced by hours worked. Labour volume data are being compiled in a system of labour accounts that is fully consistent with the national accounts.

Second, capital measurement was substantially improved. The Perpetual Inventory Method (PIM) as now applied at Statistics Netherlands provides a consistent set of statistics on consumption of fixed capital, capital wealth stocks, productive capital stocks and capital services (i.e. the value of capital inputs into production). A first experimental set of productivity calculations at the level of industry branches, excluding non-market services, was carried out last year.

There are good reasons why capital measurement should be extended beyond the current SNA asset boundary. The innovative capacity and profit opportunities of firms are increasingly determined by information technologies, scientific knowledge, brand building and organisational skills. National accountants are challenged to keep record of these new forms of intangible capital, not only in the context of measuring wealth stocks but also in relation to productivity measurement. Intangible capital is considered an important source of productivity growth (cf. Van Ark, 2007, Corrado et al., 2006).

This year Statistics Netherlands will carry out a feasibility study on the measurement of a wider range intangible assets and their contribution to productivity growth. This study will follow research by Corrado et al. (2006)

This paper reviews the current state of the art of capital measurement at Statistics Netherlands. The next section of this paper discusses the newly designed PIM as recently introduced by Statistics Netherlands. Section 3 discusses the main features of research and experimental development (R&D) investment and capital stocks calculations in the R&D satellite account of the Netherlands. It is foreseen that the revised SNA will recommend the capitalization of R&D. This section picks up the main issues addressed by the Canberra II Group on the practical implications of capitalizing R&D.

This year Statistics Netherlands will carry out a feasilibity study on the measurement of a wider range intangible assets and their contribution to productivity growth. This study will follow the findings of Corrado et al. (2006). Section 5 winds up sums up directions for future work at Statistics Netherlands.

Capital measurement

The OECD (2001) handbook on Measuring Capital provides a useful methodological framework for compiling macroeconomic statistics on consumption of fixed capital, wealth capital stocks and capital services. The handbook explains the interrelationships between each of these statistics and recommends their compilation to be carried out on the basis of one conceptual framework. Statistics Netherlands followed these OECD recommendations when revising the PIM system. A more detailed technical description is provided by Van den Bergen et al. (2005).

Gross capital stocks

A substantial amount of work involved the reconstruction of investment time series in current and constant (*t*-1) prices from the year 1953 onwards. The time series were constructed at the level of 57 industry branches, 20 asset types and 18 institutional (sub)sectors. For the starting year 1952 a gross capital stock was derived from an inventory of capital stock that was still in operation after the Second World War (Korn and Van der Weide, 1960). Supplementary assumptions were made about its age structure.

Special attention was given to the price indexes applied for (pre-packaged) computer software and computer hardware. Price indexes collected by Statistics Netherlands appeared to be unsatisfactory for two main reasons. Firstly, imports are not well covered. This is a serious omission since larger parts of pre-packaged software and computer hardware purchases in the Netherlands originate from imports. Secondly, no adequate adjustments are being made for quality changes. Alternatively, price statistics from the US Bureau of Economic Analysis and the US Bureau of Labour Statistics were adopted. Since the influence of exchange rates on computer and software prices in Europe are uncertain, no corrections have been made for US dollar-Euro exchange rate changes.

The Dutch PIM runs off with compiling gross capital stocks on the basis of estimated discard functions. These gross capital stocks represent the replacement values of all fixed assets still used in production at a given moment in time. Replacement valuation means that all asset vintages are valued according to currently prevailing market prices of new assets.

For the manufacturing industry Statistics Netherlands has in addition to the annual investment survey two supplementary data sources available to estimate capital stocks. These are directly observed capital stock benchmarks and discard surveys. Both sources are based on identical classifications of assets and industries. The combined use of these sources leads to average service lives estimates and discard patterns for the combination of various asset types and manufacturing industry branches. In the Netherlands a first research on service lives was carried out by Meinen et al. (1998). An update of this research led to more detailed and more precise estimates.

Weibull distribution functions were derived from calculated discard fractions. These discard fractions were translated into survival rates. These, by definition, declining survival rates generally lead to robust estimates of the average service lives and mortality distribution patterns. In certain cases the estimates were found to be rather high indicating that likely some discards were missed by the Survey. A drawback of the method used is that missing observations on large discards in a certain year may substantially influence estimated service lives and mortality distribution patterns.

Incidental information on directly observed capital stocks were also available for crude oil and natural gas mining (ISIC-11) and the water distribution industry (41). Car register information was used for determining the service lives of road transport equipment. Service lives of airplanes were derived from company records of Dutch airline companies. The survival functions of assets in other industry branches were in some cases borrowed from those found in the manufacturing industry. In other cases results were slightly modified when existing evidence gave reason to assume diverging service lives from those observed in the manufacturing industry.

Productive capital stocks

A next step in the PIM is the compilation of so-called productive capital stocks. These are particularly useful for productivity measurement. Productive stocks reflect the level of capital services assets are expected to generate. The productive capacity of assets is postulated with the help of so-called age-efficiency profiles. It is assumed that the age-efficiencies of most assets decline over their service lives as a result of wear and tear. The total productive capital stock of a particular asset type is derived from aggregating assets of various vintages according to their transformation into efficiency units.

The usually declining level of capital services an asset is able to produce over its entire service live is reflected by the asset's age efficiency profile. Empirical information on the shape of age-efficiency profiles is scarcely available. In most cases assumptions were made about the age-efficiency patterns of various asset types. Regarding their general shape two assumptions can be made. A geometric profile is used by Statistics Canada. This profile assumes the largest absolute declines in service levels at the beginning of an asset's service life. At the Australian Bureau of Statistics and the US Bureau of Labour Statistics a hyperbolic profile is used, assuming that the largest absolute declines occur at the end of an asset's service life. Without the availability of any empirical evidence for the Netherlands, a hyperbolic profile is considered the most plausible one.

Hyperbolic age-efficiency profiles were postulated with the help of a so-called Winfrey function (OECD, 2001, par. 6.75). The β parameter in this function determines the initial efficiency losses at the beginning of an asset's services lives. The β parameter may vary between 0 and 1. A value of 1 indicates a constant level performance, also referred to as a 'one-horse-shay'. We selected a β value of 0.5 for asset types like machinery and installations and transport equipment, a value of 0.75 for industrial buildings and dwellings and a value of 1.0 for computers, software and other intangible fixed assets.

The average age-efficiency profile of a group of (identical) assets is obtained by weighting the age-efficiency profiles, which are dependent on the service life of the asset, with the mortality distribution function. The so acquired average age-efficiency profile is usually more or less geometric, even though the individual assets have a hyperbolic age-efficiency profile.

Wealth stocks

The net capital stock represents the expected actual market value of the complete stock of fixed assets used in production. Since most capital goods are sparsely traded on second hand markets, asset market values are approximated on the basis of net present value calculations of current and future rentals a capital good is expected to generate during its remaining service life. These rentals are assumed to be equal to the amount of capital services the asset can generate. An asset's expected flow of current and future capital services is postulated on the basis of its expected remaining service life and its age-efficiency profile.

The newly estimated service lives of assets are on average a bit shorter than those used before the national accounts revision. Shorter service lives result in higher depreciation levels and lower wealth stocks. However, in total the new method leads to depreciation levels that are about 5.5 percent lower than those according to the former straight-line depreciation method. At the same time the estimated net capital stock levels are about 7.5 percent higher. So the new depreciation calculations provide on average lower depreciation rates than the former straight-line depreciation method. This changed method more than offsets the effect of shorter observed service lives.

Return to capital

The value of capital services represents the costs of owning and using assets in a given period of time and should approximate their rental prices (if existing). The periodic user costs of capital include the depreciation of fixed assets, possible holding gains or losses, a return to capital and specific taxes levied on asset ownership.

With regard to the return to capital and exogenously or endogenously determined rate can be used. The gross operating surplus is by definition entirely allocated to capital inputs when using endogenous rates of return to capital. Exogenously determined rates of return will in most cases lead to a new residual in the income generation account, being that part of value added that remains unallocated to either capital or labour inputs. This new 'balancing item' could be either positive or negative.

The interpretation that could be given to this new balancing item, currently not acknowledged in the SNA, is that companies in certain years may earn real profits or losses. Otherwise it may identify (partly) capital income that remains unallocated due to the incomplete coverage of assets in the accounts. The increasing importance of intangible assets, as for example illustrated by high amounts of goodwill paid for company take-overs, indicates that a substantial amount of capital remains uncovered in balance sheets.

So far a default exogenous rate of 4 percent has been used in the valuation of capital services. No attention has yet been given to risk premiums that may contribute to diverging rates of return between industry branches.

Summary of results

Table 1 provides an overview of constant price changes in volume capital stock estimates for the Netherlands. The table illustrates the substantial volume growth of information technology appliances in production. Computer hardware capital stocks increased dramatically between 1980 and 2005. The increase in software is also substantial, but after 2000 computer software increased moderately.

It is important to emphasize that the volume increase of computer hardware and software is partly counterbalanced by very large price declines. Current value shares in the total capital stock of computer hardware and software increased therefore much slower. In the year 2005, both computer hardware and software had only a 0.7 percent share of the capital stock. The bulk of the capital stock consists of dwellings and other buildings and structures. Together they make up 84 percent of the total capital stock in 2005.

Table 1. Volume change of the Dutch net capital stock, 2000 = 100

	1980	1985	1990	1995	2000	2005
Dwellings	60.1	67.8	77.5	87.7	100	111.7
Non-residential buildings	78.4	80.5	87.2	93.8	100	104.8
Civil engineering works	85.9	89.1	91.6	95.2	100	105.1
Passenger cars and other vehicles	47.4	50.9	67.5	72.7	100	104.3
Trains and trams	53.2	67.0	70.5	100.2	100	134.1
Ships	95.7	109.6	106.1	98.3	100	90.0
Aircraft	51.5	74.6	86.5	117.1	100	93.1
Computer hardware	0.5	2.8	8.8	21.1	100	247.7
Machinery and equipment	58.9	65.4	78.1	86.4	100	99.5
Cultivated assets	64.0	70.3	76.3	86.1	100	105.3
Other tangible fixed assets	52.4	55.2	72.8	77.5	100	109.5
Computer software	4.1	11.4	28.3	40.5	100	107.8
Other intangible fixed assets	30.7	48.7	75.6	78.1	100	88.2
Total capital stock	64.8	71.0	80.0	88.3	100	107.9

Knowledge capital creation by research and development

The international Frascati guidelines (OECD, 2001) are a good point of reference for the definition of R&D and the knowledge assets resulting from R&D. In the Dutch R&D satellite account data from the annual R&D survey are translated to an economy wide representation of R&D supply and use including international trade of R&D services (De Haan & Van Rooijen-Horsten, 2004).

R&D is expected to play a fundamental role in the competitiveness of firms by delivering blueprints for product or process innovations. Knowledge gained from R&D may lead to separately identifiable, and principally exchangeable entities. Exclusive ownership rights can be enforced by way of legal protection, by way of secrecy or having access to complementary human capital needed to provide the knowledge asset its competitive edge. These are important preconditions for codified scientific knowledge to comply with the general SNA definition of an asset.

The capitalisation of R&D expenditure in the SNA is therefore an important step forward. However there are a number of conceptual issues that need further attention before national accounts statistics on R&D investment and capital stocks can be compiled in a meaningful way.

Freely available R&D

It is important to define the conditions under which R&D actually leads to the creation of an asset in the SNA sense. Aspden (2003) indicates that potentially all research provides, one way or another, a service over longer periods of time, either through higher levels of productivity or simply by satisfying people's curiosity. Therefore he advocates a generic capitalisation of R&D, including both private R&D and R&D carried out in the public domain. Following this line of thinking, knowledge capital would principally not depreciate since it will never stop providing beneficial services to society.

There is however one major obstacle. Knowledge freely disseminated in the public domain misses any form of ownership. This is a decisive factor in the SNA definition of an asset. Although the government can be identified as the financer and performer of R&D, it is not necessarily true that governments also own this public knowledge. The comparison, made by some, with public infrastructure is unjustified. Usually roads are legally owned by either governments or private institutions. The government could at any point in time decide to sell a road to a private party or to start levying access fees. This is simply impossible for knowledge once this is made freely accessible to the public. At that moment ownership ceases to exist.

There is one important reason why R&D may lead to the creation of an asset in the SNA sense. Due to exclusive access to knowledge obtained by R&D, the owner may exert a certain level of market power. The service of a knowledge asset decays together with the inevitable loss in monopolistic power the owner will experience over time. This inevitable loss in market power will ultimately terminate the service life of a knowledge asset. Also sharing of knowledge incurs an opportunity cost since it delimits the monopolistic power of the initial owner. This opportunity cost does not exist in the case of freely accessible knowledge. Freely accessible knowledge is therefore a free good. In conclusion, exclusive ownership maintains to be a decisive precondition for knowledge to be accepted as an asset in the SNA sense.

The discussion then boils down to how the exclusive ownership of knowledge assets is understood. Legal enforcement of ownership by way of patenting is in our minds not a necessary condition. Exclusive ownership can also be obtained by way of secrecy or by having exclusive access to the complementary tacit knowledge. Usually the main purpose of R&D performed or funded by companies is to increase a firm´s competitiveness. Since most of the returns of this R&D are expected to go to the investor, private R&D will usually lead to assets in the SNA sense.

Measuring R&D trade

R&D import and export data may be derived from survey information about R&D financed by foreign entities (apart from foreign government funding) and reversely, domestically financed R&D carried out in other countries. It should be kept in mind that most R&D surveys do not explicitly ask for actual (foreign) R&D sales and purchases. This type of information would certainly improve R&D surveys for national accounting purposes. Also most R&D surveys are directed to R&D performers. This may lead to under reporting of R&D imports if large amounts of R&D are obtained by non-performers from non-domestic producers. However, in the Netherlands this underreporting is probably of minor significance.

Results from the Dutch R&D survey[1] illustrate that the Netherlands is a net exporter of R&D services. This may indicate that the Netherlands enjoy beneficial conditions for carrying out R&D. However, the spill over effects of this R&D are likely to occur outside the Netherlands.

An attempt was made to investigate whether data from the Dutch R&D survey correctly reflect the international trade of R&D flows, especially with regard to multinational companies. In the Netherlands eight multinationals are responsible for approximately 50 percent of the Dutch gross expenditure on R&D. Comparing the number of employees of these companies working in the Netherlands as a proportion of total worldwide employees with the number of R&D employees in the Netherlands as a proportion of worldwide R&D employees indicates that R&D performance of these companies is concentrated in the Netherlands. For total of these companies, 11 percent of total personnel worldwide and 44 percent of R&D personnel worldwide is employed in the Netherlands (1999).

[1] Assuming the questions on R&D financed by foreign entities and reversely, domestically financed R&D carried out abroad, accurately reflect R&D export and import.

This apparent concentration of R&D activities in the Netherlands indicates that these multinationals are likely to transfer certain amounts of R&D services to foreign company divisions. Remarkably however, only two out of 8 multinationals report substantial amounts of R&D export whereas the other 6 report zero R&D export or a very small amounts.

These results seem to indicate that R&D transfers to the rest of the world are underreported in the survey. It may be that R&D is being transferred between different company divisions without any financial compensation. These unobserved transfers in kind really hamper a robust measurement of R&D investment and capital stock in small and open economies like the Netherlands. One may conclude that R&D surveys should include questions about on whose behalf (domestic versus foreign) R&D is undertaken. Similarly, questions could be added about whether access to knowledge has been obtained from R&D carried out by other (foreign) company divisions. In the Netherlands consultations will be carried out on short notice to investigate whether officials of these multinational companies are able to respond to such questions.

R&D and computer software overlap

Data from the Netherlands indicate that R&D devoted to software development can be substantial. Mantler & Peleg (2003) identify two kinds of possible R&D-software overlaps. First, R&D may be performed with the aim of developing a software original. Second, the development of software may be part of a R&D project. Mantler & Peleg argue that "…in the case of R&D on software, as in other cases where assets are being produced using R&D, there are in fact two products, a) an asset – the software – that can be used repeatedly in production, and b) R&D that is a product in itself, whether regarded as an asset or as intermediate consumption".

The Frascati guidelines (cf. par's 135 and further) indicate that certain software development projects may entirely fall under the Frascati definition of R&D. "For a software development to be classified as R&D, its completion must be dependent on a scientific and/or technological advance, and the aim of the project must be the systematic resolution of a scientific and/or technological uncertainty", and, "The nature of software development is such as to make identifying its R&D component, if any, difficult".

R&D that is entirely devoted to the creation of a new software original may constitute an inseparable part of a production process generating a software original. Since in most cases software and R&D assets are valued by summing up their production costs, it seems unwanted to sum up in such cases production costs twice: first as a software asset and second as an R&D asset. The most straightforward recommendation that could be made for these cases is that all R&D with the specific goal of developing a software original should be identified as software and not as R&D. This is also in line with the present recording of software in the SNA-1993.

In case the R&D concerns basic or applied research of a more general nature that could be of use in several software development projects, it would be meaningful to identify this R&D output (and the resulting knowledge asset) separately from software. When the development of software is an inseparable part of an R&D project (not resulting in the development of a software original), this software should not be identified as a separate asset. The costs of this software development should be an integral part of the R&D project. In case software is being developed as a supplementary tool, the accounting recommendations of Mantler & Peleg should be adopted. That is, when the developed software can be identified as an independent multipurpose software tool, this software should be defined as a separate asset, and the consumption of fixed capital of this software should be part of the production costs of the R&D output.

Other intangible fixed assets

At this moment, the standard national accounts of the Netherlands cover the following intangible asset categories: computer software, mineral exploration and entertainment, literary and artistic originals. In addition satellite accounts are annually being compiled for R&D.

Corrado et al. (2006) indicate that business capital stocks are increasingly dominated by a much wider range of intangible assets. The work of Corrado et al. provides concrete directions in which intangible capital measurement can be expanded. In addition to those intangible asset types covered in the Dutch national (satellite) accounts, they identify intangible assets such as non-scientific R&D, brand equity and firm-specific training of personnel. Their estimates suggest that these, up to now, mostly uncounted intangibles may have an appreciable effect on GDP levels, investment rates and labour productivity levels.

The main criterion on which Corrado et al. base their expanded capital measurement is that any use of resources that reduces current consumption in order to increase it in the future qualifies as an investment. They argue that most business expenditures aimed at enhancing the value of a firm and improving its products, including human capital development and R&D should be recorded as intangible capital in national accounting systems. However, since according to SNA guidelines education expenditure is still not recorded as investment in human capital, there are apparently additional criteria playing a role in the SNA definition of assets. These are discussed for each newly proposed asset category.

Job training

Although firm specific training primarily improves the human capital of employees, it can reasonably be argued that a company would not pay for it unless it expects a return on investment. Since the expected returns on company training will usually last several years, expenditure on firm specific training meets at this point the criterion of an asset. Also innovations will probably fail without sufficiently skilled employees. This means for example that the creation of knowledge assets will usually not lead to rising profits unless access is guaranteed to the complementary human capital.

However it is questionable to what extent a firm really exercises ownership rights over the created knowledge embodied in its personnel. A trained employee may choose at any point in time to leave the company for another job. However companies may demand compensation from recently trained employees when leaving shortly after being trained. In this way the benefits of job training are expected to be largely captured by the employer. This may be seen as some sort of ownership.

In summary, although it is hard to recognize job training as a separately identifiable and exchangeable asset, job training usually provides income for several years, and therefore meets an important criterion of an asset. However, it seems difficult to argue why job training is, and other education expenditure is not, part of investment.

Non-scientific (R&D) innovations

Up to now official statistics have focussed mainly on technological product and process innovations (cf. Oslo manual for data collection on technological innovation, OESO, 1996). Not much is known about non-technical innovations in particularly the services industries. Corrado et al. restrict their estimates in this area to expenditure on developing new motion picture films and other forms of entertainment. However, in the Dutch national accounts this category of expenditure is, following SNA 93 guidelines, already recorded as investment in entertainment, literary and artistic originals.

Expectedly, the host of innovations related to new service business concepts is not captured in official innovation statistics. Most innovations in the services industries have both technical and non-technical dimensions (Van Ark, 2007). The technical dimension is dominated by new applications of information and communication technology. Information technology can be regarded as an important facilitator of most innovations in services. Yet, expenditure on information technology, computer hardware, software and communication equipment, is already captured as investment in the main stream national accounts. This is also the case in the Netherlands.

The non-technical dimensions distinguished by Van Ark entail new service concepts (e.g. call centres), new client interfaces (e.g. e-commerce) and new delivery concepts (e.g. home shopping, electronic banking). Further investigation is needed to identify which non-technical investment expenditure contributes to these forms of new commercial and financial services design. One may expect that job training plays an important role in non-scientific innovations as well.

Marketing assets

Expenditure on marketing and advertising may contribute to the value of brand names. In many businesses establishing solid brand names is an important precondition for commercial success. Although brand names are not recognised as assets in the SNA, the value of brand names will usually add to a company's goodwill. One conceptual problem concerns how marketing spending is related to brand building. Corrado et al. refer to empirical evidence from which they conclude that only 60 percent of advertising expenditure contributes over longer periods of time to the value of brand names. So when estimating investment in brand names, it seems important to separate spending with expected long lasting effects from other spending on advertising such as personnel ads.

Future work

As argued in this paper there are good reasons why capital measurement should be extended beyond the present and future SNA asset boundaries. The innovative capacity and profit opportunities of firms are increasingly determined by information technologies, scientific knowledge, brand building and organisational skills. However, it is questionable whether all these new categories of intangible assets can be introduced independently in the core National accounts. R&D deliver the blueprints for new production or product technologies. In that sense R&D carries similar 'tangible' properties as for example a computer software code. They both represent codified knowledge. This makes R&D quite similar to computer software and perhaps other regular types of assets.

This property seems absent in intangible asset types such as brand building, non-technical innovations and improvement of organisational skills. Although expenditures on these forms of capital are likely to enhance the value of firms, they cannot easily be identified as separate entries on balance sheets. As opposed to most R&D assets, it is probably difficult, if possible at all, to sell them as separate entities. In other words, it is more difficult to perceive them as separately identifiable and exchangeable assets than is the case with most R&D. Within the core national accounts this property of exchangeability may be considered an important precondition for capitalization. However, a broader concept of intangible capital can very well be explored in satellite accounts.

In the Netherlands improvements in capital measurement started within the SNA asset boundary. At this moment in the Dutch national accounts annual capital stock estimates of SNA-type fixed assets cover the period from 1952 onwards. Anticipating the upcoming SNA revision, research on R&D capital has been started. Time series of R&D gross fixed capital formation and capital stocks from 1970 onwards will soon be completed. However it is important to stress that capital and productivity measurement at Statistics Netherlands are still under construction.

Following Corrado et al. this year a feasibility study will be carried out on measuring a broader range of intangible fixed assets such as firm specific training, non-technical innovations and brand names. This work will be carried out as extension of our knowledge satellite accounts.

In addition, it is expected that this year balance sheets will be compiled for inventories and non-produced assets such as land and subsoil assets (especially natural gas). For the purpose of productivity analysis these stocks will be classified by industry branch and institutional sectors.

A next step will be introducing these new capital stock measures in multifactor productivity statistics. Multi-factor productivity can be seen as a measure of our ignorance. It represents that part of output growth that can not be explained by the growth in the inputs of production. When more types of assets services are included as inputs in productivity measures, usually a bigger part of output growth is explained. Furthermore, productivity measurement provides direct estimations of impacts of each of these assets on output growth. Including these new assets in productivity statistics is expectedly leading to a better understanding of the drivers of economic growth.

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4. The capital boundary in the 1993 SNA, Rev.1 – challenges for national statistical offices

Invited paper by Pierre Sollberger, Philippe Stauffer and Ruth Meier, Federal Statistical Office of Switzerland

Executive summary

The aim of this paper is to describe the main challenges that national statistical offices face when they want to implement the changes in the capital boundary proposed in the current revision of the system of National Accounts (SNA 1993). The challenges are illustrated with the example of Research and Development (R&D). The proposal made by the international community is to consider these expenditures as investments (gross fixed capital formation (GFCF)). Estimates were made for the first time for Switzerland. The paper documents the various stages of the implementation process and presents provisional results for the period 1990-2004. For the Swiss Federal Statistical Office (FSO), these results represent only a first step, the ultimate goal being the full integration of the conceptual changes proposed by the international community in the national accounts. The exercise shows the difficulties of the whole process and stresses the following points for discussion:

- some countries are pioneers in the R&D capitalization, but most of members of OECD are only followers. Thus a manual and a guide of best practices are needed but are they sufficient to insure a wide diffusion of knowledge and skills of this new theme?
- how to insure in the R&D framework the homogeneity of measures on an international level? National statistical offices are facing a dilemma: Measuring the complex reality of their economy versus applying a more standardized and simplified methodology allowing international comparisons. How these two objectives can be balanced?

Finally, the use of an R&D satellite account is a right way to work out the new methodologies. Nevertheless, the real aim is its full integration in the national accounts. Is this aim completely agreed by all countries? If it is not the case, how can we convince them?

Introduction: can user needs, the statistical burden and the quest for perfection ever be balanced?

Statistical offices are a breed of a special kind: payrolls and research tend to be financed mainly by the taxpayer, demands for data are increasing in all fields of analyses and parliaments are often deaf to pleas for more funding. Moreover, production processes have to be planned years in advance while financial support is provided on an annual basis. Finally, data should always be up to date with current social, economic or political issues, regardless of the difficulties inherent to the collection process.

Besides, major efforts are made by the international community to set rules by which statistics must abide in order to have a given quality. Time and human power are also devoted to provide harmonized results. At the same time, national users feel that attention should focus mainly on their statistical needs. Finally, data providers resist what they perceive as an ever-increasing and never-ending statistical burden. Response rates sometimes decline, and statistical offices consider steps to implement their surveys into a binding legal framework.

Statistical offices are therefore quite a unique specie, and their directors have to come up with institutional, legal, methodological and technical solutions. Simplifying options are limited, but worth exploring, as they can help in the balancing exercise between statistical perfection, user needs and provider reservations. In this context, standardized methodologies, harmonized statistics and coordinated revisions are major inputs provided by international organizations. This international support –however precious it may be- is nevertheless not sufficient to square the situation. Two additional options are also investigated by statistical offices: on the one hand, production processes are scrutinized and initiatives are launched to integrate processes and outputs more systematically. This provides a horizontal framework which, by nature, is applicable across most fields of official statistics. On the other hand existing data is reshuffled so as to widen its use to new fields of analysis. Here, the thrush is more of a vertical nature, addressing issues which are related, but not identical.

This paper was written with this last element in mind. The option is important, as statistical structures can never integrate all needs, let alone needs which were not voiced at the initial, conceptual stage. The world would be a gloomy planet if statistical shortcomings of existing data were systematically used as an excuse not to investigate new issues. Statistical offices don't live in a perfect world, and perfection thus is an illusion. At the very least, existing data should be used as proxies and tested. Based on the results of the investigations, initiatives can be launched to collect additional information and/or the conceptual framework can be reorganized.

The revision process of the SNA 1993 came up with various proposals which widen the capital boundary. The most important elements are the integration of Research and development (R&D), of originals and copies, of databases, of patented entities, and of purchased goodwill. While arguments for the integration of these elements into the capital boundary are sound and convincing, statistical offices are faced with the challenge of the implementation in the context sketched above. This paper argues that first estimates based on existing data are possible, but also that recommendations of "best-practices" and in-depth assessments with partners are indeed not only welcome but a necessity. The document will focus on the issue of R&D, as statistical data is partly available in Switzerland.

A last point should be mentioned here: all data provided in this document is provisional and has not yet an official character. The Conference of European Statisticians (CES) actually gave the impulse for first estimates in this field of work, which is new to the FSO. Results will therefore be revised, and inputs of the experts at the conference are most welcome.

The use of existing data: the example of R&D expenditures and their capitalization

As indicated in the previous section, using existing data is a first step in the process of setting up new statistical information. Obviously a major prerequisite is that data was collected on a systematic and coordinated basis in the past. In this context, R&D is a good example that illustrates not only of what can be done, but also the challenges which statistical offices face when they want to implement the proposals put forward in the revision of the SNA 1993. As a reminder, the revised SNA 1993 proposes that R&D should be capitalized, that is that it should be considered as a part of gross fixed capital formation (GFCF) and not an element of intermediate consumption.

In this context, R&D benefits from two elements:

- R&D surveys were launched many years ago, which implies that methods are robust, results have been scrutinized, and international comparability is rather good.
- "Capitalization" is not a strange planet which still needs to be explored, but a world where many studies were conducted in the past. The capitalization process of R&D thus benefits from the accumulated experience. While various methods are indeed possible (econometrics for example) to set up a capital stock, international practice suggests that the Perpetual Inventory Method (PIM) is a good vehicle. Experiences collected in the non-financial capital stock make it possible to identify the elements which are needed, namely basically data about GFCF, parameters for mortality functions, information about lifetime and finally a set of deflators.

Ingredients are thus available for a first try. Two points can be made at this point: first, during the consultation of the recommendations of the SNA revision process, some countries voiced reservations regarding the difficulties of working with accounting and survey-based data. These concerns will not be dealt with here. The document rather focuses on bridging difficulties between existing data and the framework of national accounts. Another point is the difficulties of working with data which are not collected on a yearly basis. As a matter of fact, in Switzerland, R&D surveys of private enterprises are made every fourth year, and no estimates were provided for the intermediate period. Thus, in order to deal with the lack of data, hypotheses have to be made to "bridge" the years of the surveys. These do have significant impacts on results. Thus, in the next two subsections, difficulties and hypotheses chosen for the estimation of R&D capital stock in Switzerland are not only presented, but the impacts of the different hypotheses are also discussed.

Challenges for first estimates of gross fixed capital formation: the case of "freely available R&D", the pitfalls of interpolations and the construction of long time series

To estimate a capital stock with the help of the PIM, the first step is to obtain GFCF in R&D. Primary data used comes from data collected according to the prescriptions of the Frascati Manual (FM). In this manual, an important aggregate is gross domestic expenditures on R&D

(GERD). This aggregate constitutes the starting point of the calculations. However, three hurdles must then be overcome.

Criterions for distinguishing R&D activities are not the same between the FM and the SNA. Actually, we may refer to Salem & Sidiqqi (2006, p. 8) when they state: "The precise range of activities or expenditures that constitute R&D capital is one of the key conceptual issues". Adjustments to the results collected according to the FM are thus needed.

In the recommendation put forward to the international community, only R&D expenditure that is sold or that is expected to bring a benefit in the future to its owner can be included within the asset boundary. This raises the question of R&D which brings no economic benefit discernable at the time of its completion and the issue of R&D provided by government.

As stated before, R&D surveys are not conducted on a yearly basis in Switzerland. The problem of interpolation must still be overcome.

Adjustments to the FM results are not detailed here, as they don't constitute the main focus of the research. Appendix 1 gives the architecture of these adjustments for the interested reader. The two last points need further developments and are dealt with in the following parts.

The issue of R&D which does not generate economic benefits

The definition and delimitation of R&D is an important issue. Various options are possible. On the one hand, in the FM, R&D activities are defined as a creative work undertaken on a systematic basis in order to increase the stock of knowledge (OECD, 2002). On the other hand, in the 1993 SNA, the definition of an economic asset if an entity functioning as a store of value from which economic benefits may be derived by their owners by holding them or using them over a period of time. One can see that the impact on the productivity of an economic process of an R&D activity is not a selecting criterion of the FM, while it is a central concern in the logic of the SNA.

This conceptual difference is extremely important. With the SNA's criterion, most of basic R&D activities should not be included in GFCF, as it is not possible to link these activities to productivity improvements. Consequently, it was argued in the SNA revision process that R&D "made freely available to the public" should not be capitalized. The main argument is that knowledge produced by this R&D activity does not provide any competitive advantage to its owner. This is due to the fact that knowledge is provided freely to the public. Such an activity should thus not be considered as an asset in the economic sense (de Haan & Rooijen-Horston, 2004).

In 2005, the Advisory Expert Group on National Accounts (AEG), which is a central actor in the revision process of the SNA, came up with the following wording for a solution: "In principle, freely available R&D should not be included as capital formation but in practice it may not be possible to exclude it. The assumption is that including freely available R&D would not lead to significant error." In the ensuing discussions, the questions of the definition of "freely available R&D" and of the magnitude of the phenomena were raised. To answer these questions, Aspden (2006b) came up with the following solution:

- basic research expenditures of government and higher education institutions should be excluded;
- parts of the R&D expenditures of private non-profit institutions should also be excluded.

In both cases, the argument is that there is no strategy in place to capture future economic benefits.

In parallel, Aspden proposes to take into account basic research of business enterprises. As a matter of fact, these units expect future incomes derived from this basic research, even if the results are published or made available to a wider audience. Aspden also proposes to include applied research and experimental development realized by the government and by higher education institutions, because he considers that these activities are undertaken with the intention of obtaining specific benefits for the R&D performers. His proposition has generated many responses and the debate is not closed (Aspden 2006c).

To answer the question about the magnitude of freely available R&D, Aspden published the (unweighted) average of R&D expenditure across 29 countries, by institutional sector and by type of R&D. Findings show that aggregated basic research of Government and higher education institutions represents almost 18% of the total R&D expenditures. Nevertheless, as stressed by the author, substantial variations between countries lie behind the average.

Aspden's proposals were used as a guideline for the calculations made in Switzerland. Total R&D expenditures and the "adjusted" R&D expenditure (i.e. freely available R&D) were tested in various scenarios in order to estimate their impact on Swiss R&D capitalization. Results are presented and commented in part 2.3 below.

Interpolated data and long time series

Primary data for the GFCF in R&D can be found in various surveys, focusing on business enterprises, on government and on higher education institutions. The Swiss federal statistical office was confronted with two problems:

- data is not available on a yearly basis;
- surveys are not coordinated. As a matter of fact, in Switzerland, R&D expenditures are covered every four years for business enterprises, every two years for the government, and every year (but unpublished) for higher education institutions. The R&D expenditures of private non-profit institutions are estimated every four years.

The PIM needs annual GFCF in order to estimate R&D capital stock. Interpolations must thus be made, in order to obtain coherent and reliable series of data. The interpolation was made in two steps. In a first phase, the R&D expenditures were interpolated by institutional sectors (private enterprises, government, etc.). The next move was to interpolate expenditures by type of research, for each institutional sector.

In order to interpolate the various periods, the growth rate of an indicator was used. It was constrained in the sense that the average annual growth rates of the indicator were adjusted in order to correspond to the average annual growth rate of R&D expenditure measured during the analyzed period (for more details about the interpolation of data, see appendix 2). The indicator variable is Gross Domestic product (GDP) at current prices, with a positive lag of one year. The lag mirrors the anticipations of the various economic actors regarding economic growth. One should point out the fact that this is a rather strong assumption, as it means that we consider that the R&D expenditures pattern is linked with the GDP growth rate of the following year. Further research will be launched at the FSO to test alternatives to this indicator, but results presented below were conducted on the basis of this assumption.

With the help of interpolation, R&D GFCF can be estimated on an annual basis. A question remains, namely the availability of long time series. It is a well-known characteristic of the PIM that long time series are needed. In Switzerland, coherent R&D expenditures are available since 1981. Surveys were conducted earlier, but the conceptual framework was different. Thus, it is impossible to link the data of earlier periods to the present time series. Consequently, availability of R&D capital stock estimation is limited in time.

Well-known concepts for a new dimension: the choice of mortality functions, lifetimes and deflators of R&D

As such, the PIM is a well-known process. The concept is mature and many researchers use this method. However, the standard process can generate some critical interrogations in the R&D framework. Some parameters such as lifetimes, mortality functions or deflators can impact significantly on final results and must be assessed with caution.

Mortality functions

In Switzerland, due to the lack of data, there is currently no differentiation of mortality function between industries. Thus, all GFCF use the same mortality function. A bell-shaped distribution estimated by a log-normal density function was chosen. This choice is justified by the fact that the Swiss non-financial capital stock uses a log-normal distribution for every category of fixed asset (Rais & Sollberger, 2006). For that reason, to insure coherence between R&D and the other fixed assets in the national account framework, the same density function is used in the case of R&D expenditures.

Lifetime

In order to measure a capital stock with the PIM, service lifetimes must be estimated, which is quite a daunting task in the case of R&D. As pointed out by De Haan et al. (2006), there are only few empirical analyses on this theme. In the various studies, annual depreciation rates go from 11% to 25%, corresponding to an average service life ranging from 5 to 10 years. For example, the BEA (Bureau of Economic Analysis) uses a depreciation rate of 15% in its primary scenario (Okubo et al., 2006), which corresponds to a lifetime of about 7 years. The Australian Bureau of Statistics (ABS) uses a median lifetime of 9 years. In a study published in 1996, Nadiri and Prucha already realized such comparisons. Depreciation rates were set within the framework of a factor demand model, and the results are consistent with studies with an average survival time of approximately 7 years.

These examples illustrate the difficulty to estimate average or median lifetimes for R&D GFCF. There is a real necessity that analysts continue empirical researches and improve knowledge in this area, as lifetimes have a tremendous impact on the level of the R&D capital stock. That is why, in the next subsection, hypotheses on lifetimes are tested, illustrating the impacts of two different lifetimes on the stock of the Swiss R&D capital. The two lifetime used for the scenario are based on the paper of De Haan et al. (2006), with a duration of 5 and 10 years. A more extended duration could be investigated; however, due to a lack of historical data in Switzerland, it is quite impossible – at present – to realize a third scenario involving a longer lifetime.

Deflators of R&D

Capital stocks are usually estimated on the basis of GFCF at constant prices. Most of the time, R&D data is at current prices. Therefore, deflators are needed to get to GFCF at constant prices.

The optimal solution is to calculate special R&D deflators based on weights and prices that are specific to R&D. Nevertheless, the complexity of the task and its cost make this exercise hardly achievable. In the absence of a full set of R&D deflators, the use of the implicit GDP deflator is tolerable (OECD, 2002). The GDP deflator provides an approximate measure of the average real "opportunity cost" of carrying out the R&D.

However, as mentioned in the FM : "In general, over the long term, it is reasonable to suppose that the implicit GDP deflator (output) would tend to increase less rapidly than a "true" R&D deflator (input) because of productivity increases." The FM thus recommends using a more common approach by using weights derived from R&D surveys combined with proxy prices. Unfortunately, in Switzerland as in many other countries, there is no data that can be used to construct a specific R&D deflator. Therefore, the implicit GDP deflator was used for the results presented in the next subsection.

Setting the scenarios for analysis, or how capital stock fluctuates depending on the assumptions

As seen before, R&D capitalization requires strong assumptions to close the gaps linked to the lack of information. We decided to focus on two major assumptions and to cross each other in order to obtain four scenarios. A benchmark is then realized in order to analyze how capital stocks fluctuate depending on the assumptions.

Scenarios

The first dimension used for the definition of the scenarios is the extension of the capital boundary of R&D. One may choose between a large and a limited option. The first option considers all R&D expenditures to estimate the R&D capital stock while the second one excludes freely available R&D.

The second dimension is the lifetime of R&D "output". As it is not yet a mature subject and more research will be conducted in the future, two lifetimes were selected for the creation of the scenarios, namely 5 and 10 years.

By crossing the two main assumptions, we have the following scenario matrix:

Table 1 Scenario matrix

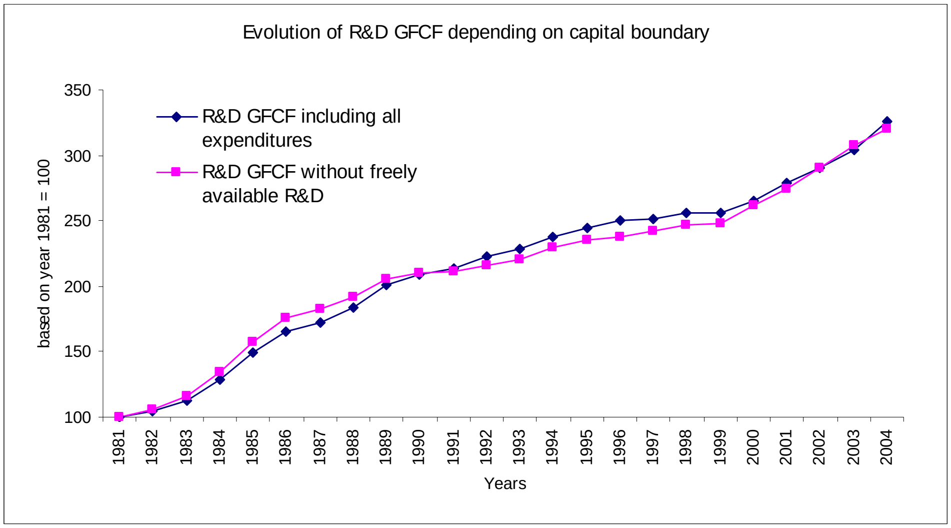
	Including all R&D expenditures	**Excluding freely available R&D**
Lifetime = 5 years	Scenario 1	Scenario 2
Lifetime = 10 years	Scenario 3	Scenario 4

Scenario 0 is the initial situation, that is the results before considering R&D expenditures in the Swiss non-financial capital stock.

Findings and comments

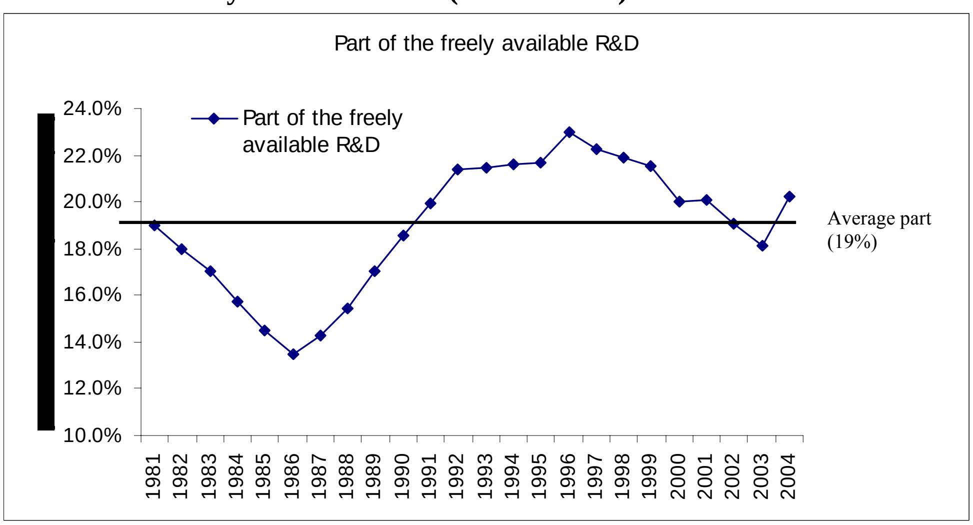
In a first step, estimates of R&D GFCF are made with and without the freely available R&D. Evolutions are illustrated in figure 1 below. The two series have been indexed on the year 1981 = 100.

Figure 1 Evolution of R&D GFCF (source: SFO)



On average, basic research which can be excluded represents about 19% of total of R&D expenditures. This result is very similar to the findings of Aspden (2006b) mentioned above. Quite logically, series including all R&D expenditures are the highest.

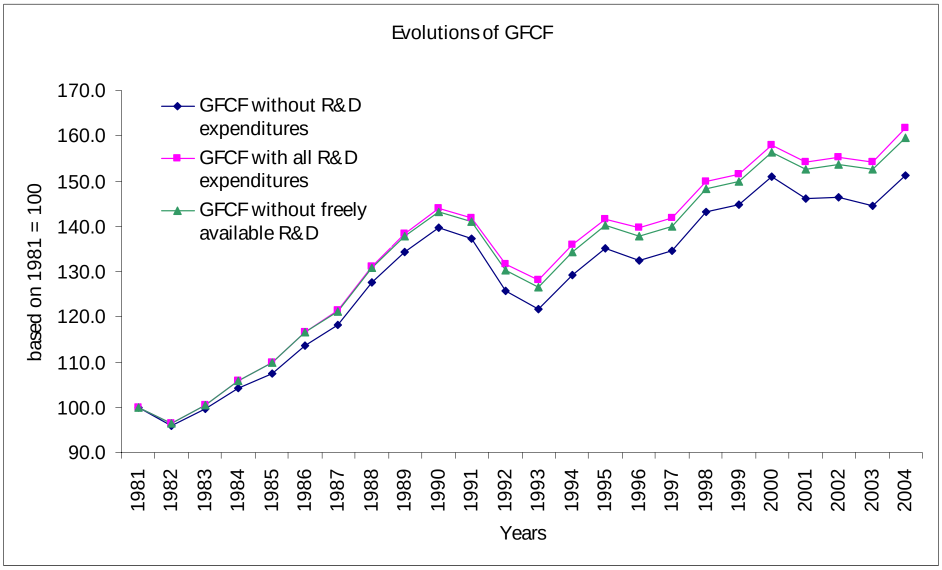
Figure 2 Part of the freely available R&D (source: SFO)



In the first half of the 1980s, the part of freely available R&D declined steadily from 19.0% to 13.5%. This was followed by a continuous increase from 1986 to 1996, the latter being the maximum reached so far (23.0% of Total R&D). The last years are more stable, with a spread of freely available R&D varying between 18.0% and 22.0% of total R&D.

When the two new series are included in the initial GFCF data (figure 3), the profile changes over time. As a matter of fact, the aggregate with the R&D is more dynamic than the traditional aggregate of the National accounts.

Figure 3 Evolutions of GFCF depending on scenarios (source: SFO)



These differences have direct impacts on the evolution of the amount of the capital stock. As shown in the following table (table 2), fluctuations of capital stock vary depending on the scenario.

Table 2 Swiss non-financial capital stock depending on scenarios, index based on scenario 0 of the studied year.

Year	Scenario 0	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2001	100.0	102.6	102.0	104.8	103.8
2002	100.0	102.6	102.1	104.8	103.8
2003	100.0	102.6	102.1	104.9	103.9
2004	100.0	102.7	102.2	105.0	104.0

The impact of R&D capitalization on the Swiss non-financial stock is thus significant. With a lifetime of 5 years (scenario 1 &2), the impact on capital stock for the year 2001 is comprised between 2.0% and 2.6% depending on the inclusion or not of freely available R&D. Considering a lifetime of 10 years (scenarios 3 & 4), for the same year, the impact almost doubles, with an increase of the capital stock comprised between 3.8% and 4.8%. The impacts on the Swiss capital stock are more marked for scenarios 3 & 4 because of the intrinsic characteristics of the PIM, based on an accumulation of GFCF. These impacts cumulate slowly over time, with a total impact for the year 2004 ranging between 2.2% and 2.7% for scenarios 1 & 2 and between 4.0% and 5.0% for scenarios 3 & 4. These increases are mainly due to the fact that R&D GFCF grow more rapidly than GFCF of other categories of asset.

As could be expected, growth rates of capital stock were affected by inclusion of R&D GFCF. The question now is if the evolution of capital stock changes significantly depending on the scenario.

Table 3 Annual growth rate of the Swiss non-financial capital stock depending on scenarios

Year	Scenario 0	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2002	1.98%	2.00%	2.02%	2.02%	2.02%
2003	1.78%	1.83%	1.84%	1.84%	1.84%
2004	1.85%	1.92%	1.91%	1.93%	1.92%

Table 3 shows that there are no huge changes in the evolution of the annual growth rates. Still, it is interesting to observe that the inclusion of R&D has a systematically positive impact on the evolution of the total capital stock. That means that R&D GFCF grows faster than the other type of categories, thus increasing annual growth rates.

To have the full picture, the contributions of each scenario to the capital stock growth rate are assessed (table 4).

Table 4 Contributions to the capital stock growth rate depending on scenarios

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2002	0.08%	0.08%	0.13%	0.11%
2003	0.09%	0.09%	0.14%	0.13%
2004	0.12%	0.10%	0.17%	0.14%

While its contribution is not really impressive, R&D capitalization contributes positively to the growth of the Swiss non-financial capital stock. Besides, it seems fair to say that R&D will play a growing role in the evolution of the capital stock. Table 4 shows that the contribution of each scenario is increasing with time. Hence, it may not be surprising that R&D contributions will increase in the near future.

The landscape, the road, and the bumps: main provisional conclusions

Henry Kissinger said: “If you don't know where you are going, every road will get you nowhere”. Fortunately, in the case of R&D capitalization, researchers know where they are going. Even if the road is already set in a well-known landscape called System of National

Accounts, the way is still thorny and bumpy. In this chapter, provisional conclusions will be discussed, and the methodological and conceptual bumps which spread over the road leading to the R&D capital stock will be analyzed.

Methodological challenges: from the problem of interpolation to the estimation of deflators

The previous chapter showed the pitfalls which had to be overcome in order to present first estimates for Switzerland. Among the various problems which were discussed, data availability is central. Even when it is possible to obtain time series which are sufficiently long for R&D expenditures, data provided by surveys are often conducted every second, third or even fourth year. To use the PIM, GFCF for every year is needed. Therefore, there is a necessity to interpolate data in order to estimate R&D capital stock.

For the current exercise, R&D expenditures have been interpolated with the help of GDP as indicator, with a positive lag of one year between the variation of GFCF and the one of GDP. The underlying assumption is based on a neo-classical approach. However, this choice is debatable. Is GDP the best indicator to interpolate R&D expenditure? It is difficult to answer the question. In Switzerland, research is under way to evaluate alternative indicators like for example the evolution of the number of patents.

Besides, one must keep in mind that data was calibrated in order to fulfill the requirements of the System of National accounts. While a number of papers was already published on this subject, most notably on the bridge tables, it is important to remember that this kind of adjustments can become complex. A harmonized process should be elaborated and widely published to help statistical offices to face this problem.

Finally, another recurring methodological problem mentioned by various studies is the production of a deflator. It appears that only few countries have appropriate R&D deflators. A large number of countries have proxies like the implicit deflator of GDP. In this context, one must keep in mind the warning of the Frascati Manual namely that, over the long term, the implicit GDP deflator increases less rapidly than appropriate R&D deflators. Even if this “B-solution” is acceptable for the moment, measures have to be taken in order to estimate properly a set of R&D deflators.

Conceptual issues: from capital boundary to lifetime and mortality functions

Besides methodological problems, the analyst is faced with conceptual issues. The first one is the problem of the capital boundary, or more precisely, the issue of “freely available” R&D. There is a rather broad consensus that R&D which cannot be protected by property rights should not be considered as an economic asset. Still, it is not easy to define “freely available R&D”. Basic research undertaken by government and private non-profit institutions is an option chosen by many, but it is not the only one. In addition, it is quite difficult to estimate the part of the

R&D expenditures of the private non-profit institutions which has to be included in the process of capitalization.

Other important conceptual issue is the choice of the density function with the PIM. Weibull or log-normal density distributions are often used to estimate the mortality function of a specific vintage of a capital asset. These choices are often justified by operational reasons and less frequently by scientific motives. Recommendations agreed upon by a majority of states would be welcome for countries which have no information whatsoever.

As seen above, lifetimes greatly influence the level of capital stocks. Nevertheless, only few empirical studies have been made to provide inputs. Results are currently converging to an interval comprised between 5 and 15 years. Nevertheless, as shown in this paper, fluctuations generated by lifetime are really significant and more efforts should be make to acquire knowledge about R&D lifetime.

Finally, a persistent difficulty is the question of historical data series. Repeated observations are needed to set up an approximation of the capital of a fixed asset. The issue may be more important for R&D than for other asset categories, as this type of expenditures has not a really long history in statistical terms. Consequently, it is quite difficult to take into account R&D in the capital over a long period.

The future lies ahead

When the 1993 SNA was drafted, the idea to consider R&D expenditure as a gross fixed capital formation was already in many minds. Methodological and conceptual issues then stalled the inclusion, and R&D was integrated only as intermediate consumption, thus as an item which diminishes value-added.

Nowadays, a convergence of opinions leads to the acceptance of the capitalization of R&D. While difficulties and uncertainties should not be underestimated, breakthroughs were achieved and various countries recently published first estimates of an R&D capital stock.

It is now time to define, to explain and to agree on R&D capitalization in the framework of the system of national accounts. Of course, it is too early to include R&D capital stock directly in the national accounts, but a process should be launched in order to find data and work out pragmatic solutions.

How to find a smoother road with a satellite map

The road is still long up to a complete integration of R&D capitalization in the system of the national accounts. Methodologies are not yet consolidated and tested on a grand scale, and satellite accounts seem to be appropriate tools for testing the solidity of hypothesis which are needed to set up such a construct.

As outlined by Okubo et al. (2006): “While this satellite account does not affect national official measures of GDP, it provides an opportunity to work out new methodologies that may be incorporated into the accounts in the futures.”

The realization of a R&D satellite account is one of the main short term objectives for the Swiss federal statistical office. This paper can actually be considered as the first step in the implementation process.

Conclusions: of the importance of a manual and the key role of OECD

The previous sections show that Switzerland has used instruments developed elsewhere to cope with data shortcomings and methodological difficulties. Many countries face the same situation, and the danger now seems to be that statistical offices develop tailor-made solutions only on the basis of national concerns. This might lead to heterogeneous solutions if assumptions were to differ. In order to realize international comparisons, it is crucial to know assumptions on which the work was carried out.

In order to insure minimal coherence, a manual should be published describing the major concepts with the main recommendations, and describing “best practices”. In this context, the OECD seems to be the perfect “editor” and work is under way to provide statistical offices with guidelines. By operationalizing the concepts, the OECD would actively participate to a better understanding of the concepts related to the capitalization of R&D expenditures. Such a manual would help to disseminate concepts and improve knowledge, skills could become more specific and surveys could be reshuffled to cover the various needs of the users. By helping producers and users of statistical information to find a common ground, the OECDE would act again as a facilitator and provide the international community with resources which are central to the mission of statistical offices, namely efficiency of processes, integrity of data and comparability of results.

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APPENDIX

Appendix I: From GERD of the Frascati Manual to the R&D FBCF of the National Accounts

Data from derived of the Gross Expenditures in Research and Development (GERD) provided by the Frascati Manual (FM) and data relative to the R&D output defined by the System of national accounts (SNA 93) are not directly comparable. Based a process sketched by Peleg (2006), data from the Frascati Manual would need the following adjustments in order to be "SNA compatible":

GERD (from FM)
+ acquisition of R&D used as input in R&D production
+ depreciation of capital goods owned by R&D producers and used in R&D production
+ net operating surplus contained in R&D output measured at basic prices
+ other taxes less other subsidies on production
- capital expenditures
= R&D output by SNA 93 definition.

Appendix II: Interpolation of R&D expenditures

In Switzerland, R&D expenditures of private businesses are recorded every four years. In order to interpolate data for the lacking three years, a growth rate of another indicator variable is used with a constraint. The constraint is that the average annual growth rate of the indicator variable must be adjusted in order to correspond to the average annual growth rate of R&D expenditure measured during the analyzed period. This is done by the following formula:

$$RD_{h,i} = RD_h \times \sqrt[n]{x^i} \times \frac{S_{h,i}}{S_h \times \sqrt[n]{Z^i}}$$

Where,

$RD_{h,i}$ is the amount of expenditures in R&D of the i^{th} year after the observed year h,

RD_h is the amount of expenditures in R&D for the first observed year.

$\sqrt[n]{x} = \sqrt[n]{\frac{RD_{h+1}}{RD_h}}$ is the average annual growth rate of R&D expenditures between two observed years (there are *n* years between these two observations),

$S_{h,i}$ is the indicator variable – available each year – of the i^{th} year after the observed year h,

$\sqrt[n]{Z} = \sqrt[n]{\frac{S_{h+1}}{S_h}}$ is the average annual growth rate of the indicator variable between the two observed years relative to R&D survey.

The indicator variable used to interpolate R&D data is Gross Domestic Product (GDP), with a positive lag of one year. That is to say that to estimate the annual growth rate of R&D expenditures of the year t, the annual growth rate of GDP of the year t+1 has been used. This choice can be explained by the fact that enterprises decide to invest or not, by anticipating the forecasted evolution of the demand (neo-classical approach of the investment theory).

5. Capitalisation of research and development expenditure: points of view and experiences in the European Union

Invited paper by Gallo Gueye and Francis Malherbe, Eurostat

Introduction

Research and development has been one of the major topics of the revision of the United Nations System of National Accounts. As a result of the work of the Canberra II Group in particular, it was proposed to include research and development expenditure as gross fixed capital formation. This innovation in relation to the current system would have a substantial impact on national accounts, since, according to the estimates of Danish national accountants, for example, capitalisation of research and development expenditure would lead to an increase of around 3% in gross domestic product. Initially, this proposed change in the United Nations 1993 System of National Accounts (SNA 1993) was opposed by many European countries for essentially practical reasons, but also for theoretical reasons. A compromise has finally been found, however. It has been acknowledged that R&D expenditure has the characteristics of investment and that the long-term aim must be to record this expenditure as fixed capital formation in the core national accounts. However, the quality of the data must first be tested in a satellite account, so as to ensure a high level of reliability, before achieving the long-term aim of capitalisation.

R&D is treated in the current system as intermediate consumption, i.e. as current expenditure benefiting production for the current period only. This of course runs counter to the very nature of R&D, the aim of which is to improve production for future periods. The current treatment is justified in the SNA 1993 Manual by considerations of an essentially practical nature: other activities such as staff training and market research also allow benefits to be gained in the longer term. In order to be able to classify R&D as investment expenditure, there would have to be precise criteria for distinguishing it from the other activities. In addition, it would have to be possible to identify and classify the assets produced, value them in an economically meaningful way and establish their rate of depreciation over time.

The experts of the Canberra II Group and of the AEG felt that considerable progress had been achieved as regards knowledge of R&D activities, with the result that most countries were now able to overcome those difficulties that led them to oppose the move to treat R&D expenditure as fixed capital formation. It is true that their decision was also influenced by the desire to give greater weight to an activity that has an ever increasing importance in modern economies. There was also considerable pressure from economists to move towards capitalisation of R&D expenditure. Indeed, without knowing what services are generated by the knowledge capital accumulated through R&D, it is impossible to measure the impact of R&D on growth and thus lay the foundations of policies in this area on objective bases.

European points of view

The experts' optimism is shared by few European national accountants. The European position was expressed officially at the meeting of the Statistical Programme Committee of the Member States of the European Union and put forward as part of the SNA review. The majority of the European national accountants consider that the obstacles to the capitalisation of R&D expenditure presented in the current SNA are not yet solved in their countries. Moreover, they have raised new objections of a more conceptual nature. For example, the Danish national accountants point out that, in the revised SNA, production costs will have to include capital services and therefore, in particular, capital services generated by the current stocks of knowledge accumulated through R&D, since new research is generally based on the results of previous research. So, even if it were possible to measure these stocks and related capital services accurately, would it really be possible to attribute some or all of these costs to new research on an objective basis in order for this research to be taken into account in valuing the related production? It is difficult to deny the relevance of such a remark even if it is still possible to play down its importance.

Let us now return to the various obstacles mentioned by the SNA, so that we can determine to what extent they can be considered to have been overcome by the European countries. The first difficulty, the need to be able to distinguish R&D from other activities such as training or market research, still exists in the different countries, even if the situation varies from one country to the next. Suffice to say that this problem already exists in the current system, the main difference being that confusion between two activities (e.g. research and training) does not have any impact on GDP in the current system, whereas it would have in a system where R&D expenditure was considered to be an investment.

The second obstacle is the difficulty in identifying and classifying the assets produced. This is a new problem that does not exist in the current system and only the experience of the countries will really be able to respond to it. It should be noted, however, that, if we can conceive that R&D products protected by patents will be sufficiently well known for correct identification and classification, we can also predict that there will be huge problems in identifying and classifying R&D products not covered by patents. If this is not the case, at the very least, we can say that it is actually an additional difficulty, since, here again, if an identification error has only minor consequences in the current system, it would have a major impact in a system where R&D were capitalised. Valuing assets resulting from research depends largely on the characteristics of the assets themselves, such as their expected life; consequently, a classification error has an impact on how assets are valued.

The third problem concerns the need to be able to value the assets produced by research in a relevant way. In this area, ideally we would apply the general principles of the SNA and value the assets produced at market prices. However, it is difficult to adopt this approach in practice, as the price of these assets is only available on an exceptional basis. Although this may be the case when these assets are protected by a patent with regularly tracked prices, such favourable situations are rare in practice. Consequently, the only possible valuation methods are more often than not those involving a perpetual inventory, whereby the stocks of capital are built up again from entries made up by the fixed gross capital formation, disposals and revaluations. It is clear that such valuations are particularly difficult, largely on account of the wide range of research products, which are never standardised products.

These valuation difficulties can be grouped together in several categories. The first, already mentioned, relates to the difficulty in identifying and classifying the product. The second concerns the need to value correctly the gross fixed capital formation for the different types of research expenditure, taking account of all the imputations necessary, e.g. capital services of the stock of current knowledge. The third is connected to the difficulty in estimating, on an objective basis, the mortality tables and expected lives of the R&D products. This last point is particularly important, as it is difficult to imagine being able to have effective measures to establish this information other than on a totally exceptional basis. In practice, it will only be possible to estimate mortality and expected lives on the basis of hypotheses or, at best, expert opinions. Indeed, the estimation of the level of knowledge capital accumulated will depend largely on these hypotheses. A fourth difficulty lies in the availability of long series, which are vital for implementing the perpetual inventory methods. A fifth problem concerns the need for deflators to apply the perpetual inventory method to R&D expenditure, when it is virtually impossible to obtain price indices of R&D services owing to the fact that they are not standardised.

All of these problems persist in most if not all of the countries and we must therefore support the countries that are concerned about the difficulties of implementing rules on the capitalisation of R&D expenditure. At the same time, Eurostat cannot ignore the arguments of economists and policy-makers who wish to have reliable data on an area that has such strategic importance for the future of European economies. Eurostat has therefore decided to support a compromise solution that will allow experience to be built up before achieving the long-term objective of capitalisation. Accordingly, R&D will not be capitalised in the core national accounts but will first be presented in satellite accounts.

Such a compromise solution may appear to provide little satisfaction to some people, given that it puts off the final decision, but, in the absence of any kind of consensus, it was difficult to settle on either option. In fact, what we have here is a problem that is all too familiar to national accountants. We are faced with a phenomenon that clearly needs to be measured, but the measurement methods actually available are not sufficient to measure it accurately and, in all likelihood, never will be. As a result, a valuation can only be made on the basis of hypotheses, which by their very nature are debatable, and thus with little accuracy, difficult to measure in any case. We are therefore faced with the following question: would it be better to make a very rough estimate than no estimate at all, knowing that, in the case of the latter, we often return to estimating at a zero value when it is certain that this is not true? If we use a very rough estimate, do we not run the risk of misleading users, since, even if forewarned, they will have no other choice but to use the estimates proposed by the national accountants? On the other hand, if we reject this estimate, are we not damaging the macroeconomic quality of the accounts? It is only with experience that we will we be able to decide on more objective criteria. In any event, the methods and estimates must be comparable at European level and this is a major constraint that will have to be respected by the R&D satellite accounts.

The development of satellite accounts

The development of R&D satellite accounts represents a major aim and a major challenge at European level. This project will enable Member States to prepare estimates that will be integrated in their core national accounts, but only when a high level of reliability has been achieved.

According to the information currently available, only two countries of the European Union, namely the Netherlands and Denmark, are currently developing R&D satellite accounts. This situation may appear to be worrying in the light of the introduction of the compromise reached for the SNA update, but it may actually represent an opportunity. First, the other Member States will be able to take advantage of the experience gained by these two countries and, second, it will certainly be easier to develop common methods for all of the Member States, since the vast majority of them will not be bound by any existing method, which means that it will be possible to achieve a satisfactory level of results comparability more quickly.

It will be possible to provide a solid statistical basis for the development of harmonised European R&D satellite accounts, since, under Commission Regulation (EC) No 753/2004 of 22 April 2004, all European Union countries must gather statistical information in the field of research and development. The Regulation lays down that Member States must obtain the necessary data using a combination of different sources, such as sample surveys, administrative data sources or other data sources. The emphasis is placed on comparability at international level, since the Regulation clearly specifies that the statistical areas it covers are based on harmonised concepts and definitions set out in the latest versions of the Frascati and Canberra manuals. The Member States must transmit their data in a standardised format to Eurostat, which is responsible for checking the quality of the data.

Eurostat is deeply committed to promoting the development of R&D satellite accounts in the European Union. To this end, it will hold talks with the various national statistical institutes to determine what the satellite accounts should be. Eurostat plans to set up a task force on this subject in which all volunteer countries will be able to participate. This will be a long and complex undertaking, since the data currently collected are insufficient for the comprehensive preparation of R&D satellite accounts. In particular, at present, there are no reliable data on the expected life of the results of R&D studies and, thus, without information on these expected lives, perpetual inventory methods cannot be used to evaluate the accumulated knowledge capital. A collective decision will therefore have to be made on which hypotheses are acceptable and on what form should be taken by the base needed to extend data collection to other data.

The possible development of new Community provisions requires major testing in advance and an impact study focusing on the consequences of the new rules on national accounts, the reliability of estimates and the additional resources that may be needed by the national statistical institutes to implement the new requirements. In this area, it is important to remember the specificity of the European Union. Whereas for most other countries national accounts are primarily an instrument of economic analysis to be used by decision-makers and are therefore mainly of a technical nature, in the EU they are one of the bases of the common policies of the Community and have a legally binding nature for the Member States. This specificity is not without consequences for the development of national accounts. Indeed, Community legal acts must be able to be applied in all Member States in the same way and must therefore be founded on indisputable objective bases.

The fair application of European law therefore means that the estimates required must be clearly identified and discussed and validated jointly by all Member States. An incorrect estimate in one country may have repercussions for the other countries, particularly in financial terms, e.g. the estimate of gross national income is used to distribute the fourth own resource between Member States. The counterpart to this fairness is the need to find a consensus.

With regard to the development of R&D satellite accounts, Eurostat will emphasise this collective approach, as it believes that it is the only approach capable of ensuring that the Community provisions are applied fairly, and that comparing experiences leads to a better understanding of the phenomena and therefore to the possibility of providing a better basis for the estimates needed to compile national accounts.

6. Measuring capital stocks in Korea

Supporting paper by Sangjin Park, Korea National Statistical Office

Introduction

Capital stocks are essential in measuring the results of economic development at a given time. They show basic information for establishing national development policies, and also provide material for formulating the national balance sheet. The Korea Statistical Office (KNSO) has released statistics from the Korea National Wealth Survey (KNWS) four times. Even though this direct survey contained an increased amount of information by region, industry, institute and type of asset, its cost was too much in terms of the large budget required and in terms of efficiency. Several researchers have estimated capital stocks according to their own interests. For this reason, the KNSO set up a plan to estimate annual capital stocks. Finally, the KNSO decided to release the last ten years of capital stocks at the end of this year. This paper provides an overview of what the KNSO has been doing and the applied methodology.

Korea national wealth survey

The last KNWS was conducted as of 31 December 1997, following the first Survey in 1968, the second in 1977 and the third in 1987. The survey covered all sectors, including general government, incorporated and unincorporated establishments, non-profit institutions, and households. Information was collected on tangible fixed assets, inventory by region and by industry, and consumer durables and semi-durables. Almost 25,000 incorporated establishments, and 60,000 unincorporated establishments were sampled in the last survey, along with 5,000 households.

History of the estimation on capital stocks in KNSO

In December of 1999, the KNSO decided not to conduct the KNWS but instead, to estimate capital stocks annually. From 2000 to 2002, the KNSO conducted the retirement surveys and contracted with some experts to find the retirement function by type of fixed assets and then estimate produced tangible and intangible fixed assets. From 2003 to 2004, the KNSO estimated land, forestry, software and produced tangible fixed assets using more detailed data sources. In 2005, the KNSO contracted with experts to estimate inventories and subsoil assets. From 2006, the KNSO has maintained a Task Force Team with the Bank of KOREA (BOK) that makes the gross fixed capital formation in the Korea System of National Accounts (KSNA) and plans to make the national balance sheet. The Task Force team has held the meetings and discussed all aspects related to capital stocks in ‘93 SNA every month.

To date, the KNSO has expanded internally the asset's coverage to non-produced tangible assets such as subsoil assets and forestry. In addition, it has tried to improve the accuracy of the estimates through cooperation with related ministries or institutes, exports, and so on.

Measurement method

The KNSO uses the Perpetual Inventory Method (PIM) which involves the accumulation of past capital formation over its estimated service life. For the PIM, the KNSO uses the 1997 KNWS results as the initial benchmark estimates of tangible fixed assets, consumer durables and inventories, and Winfrey function which is a result from the retirement survey for the assets. To obtain the net capital stocks, the KNSO usually uses the geometric depreciation for tangible fixed assets and straight-line depreciation for intangible fixed assets.

Since the 1997 KNWS results are used as the initial estimates, it is important to improve the consistency between the survey's results and gross capital formation. In 2004, the BOK completed the rebasing of the KSNA to the reference year of 2000 and the implementation of '93 SNA recommendations. Afterwards, the KNSO reclassified the 1997 KNWS results in accordance with the flow data in the KSNA again.

For example, consumer durables in the 1997 KNWS have been reclassified by the Classification of Individual Consumption According to Purpose (COICOP), since durable goods follow this classification in the final consumption expenditure of households.

Entertainment, literary or artistic originals contain movie film originals, literary works and music recordings. For produced intangible fixed assets, the KNSO uses the PIM with gross intangible fixed capital formation extending back over its service life.

Land assets are estimated by multiplying average land price per unit by land area. In the case of forestry the quantity of trees (cubic meters) and price per volume are used while Hoskold's method is used for subsoil assets.

Classification by type of asset

The KNSO covers consumer durables as a memorandum item and capital stocks related to "non-financial assets" as defined in the '93 SNA except valuables, water resources and non-produced intangible assets due to data deficits. The classification by type of asset is as follows:

- produced assets: tangible fixed assets, intangible fixed assets and inventories;
- non-produced tangible assets: Land, forestry and subsoil assets;
- consumer durables in the final consumption expenditure of households.

Even compiling capital stocks by more detailed asset classifications (see Table 1), the KNSO will publish the statistics less detailed than Table 1.

Classification by institutional sector

The KNSO identifies four institutional sectors, including general government, financial corporations, non-financial corporations, and households, and doesn't distinguish non-profit institutions serving households separately from households.

Classification by kind of activity

For most kinds of analytic studies, capital stocks and flows will need to be classified according to kind of activity. So the KNSO divides produced tangible fixed assets into thirteen different kinds of economic activity in accordance with the capital flows.

Table 1 Type of detailed asset

<table>
<tr><th colspan="2">Assets</th><th>Detailed Assets</th></tr>
<tr><td rowspan="3">Produced assets</td><td>Tangible fixed assets</td><td>Residential buildings, Non-residential buildings, Other construction, Transport equipment, Other machinery and equipment</td></tr>
<tr><td>Intangible fixed assets</td><td>Mineral exploration, Computer software, Entertainment, literary or artistic originals</td></tr>
<tr><td>Inventories</td><td>Materials and supplies, Work-in-progress, Finished goods, Goods for Sale</td></tr>
<tr><td rowspan="3">Non-produced tangible assets</td><td>Land</td><td>By region, By land category</td></tr>
<tr><td>Forestry</td><td>By forest physiognomy, by tree age-class</td></tr>
<tr><td>Subsoil assets</td><td>Metallic mineral (includes natural gas), Non-metallic mineral</td></tr>
<tr><td colspan="2">Consumer durables</td><td>Furniture, Household appliances, Transport, Audio-visual equipment, Other</td></tr>
</table>

CHAPTER III: MEASUREMENT OF HUMAN CAPITAL

1. Summary of the session

The session was organised by Mr. Brian Pink (Australia). Mr. Oystein Olsen (Norway) served as the discussant. The session was based on invited papers by Australia, Italy, and the United States.

The session dealt with the measurement of human capital and the role of national statistical offices in this process. Different measurement approaches were presented and their strengths and weaknesses analysed. In principle, three different strategies in measuring human capital can be considered: to develop databases on human capital for research and analysis, to develop methods for output measures in the government sector within the framework of national accounts, or to integrate fully human capital measures in national accounts. The latter is, however, not feasible at the current stage.

In the discussion, the following points were made:

- there are many difficulties related to the measurement of human capital. An appropriate strategy might be to undertake experimental calculations of human capital to gain further experience;
- releasing experimental estimates that are of a low quality can undermine the users' trust in official statistics. An alternative solution could be to create micro-simulation databases or models that enable users to make their own estimates and to analyse the impact of possible policy interventions on human capital;
- measuring the output of education from the output side, rather than the input side, would be a natural step forward; it is linked to the work that statistical offices are already undertaking to improve measurement of the output of government sector;
- human capital can be considered a multi-dimensional concept and different indicators can be used to show the different dimensions of the concept; these can go further than educational attainment, including assessment of learning outcomes, cognitive skills, etc.;
- the use of human capital should also be taken into account, e.g., the human capital of unemployed persons is not utilised within the SNA production boundary;
- it is questionable whether future earnings can be equated with formal education and whether it is a reasonable proxy for the output of the education sector;
- particular care should be taken when implementing the approaches that assume a strong relation between education and wages; the wage differentials do not reflect only educational differences;
- clarifying the policy issues to be addressed by the concept of human capital will help to improve its measurement.

In conclusion to the session on human capital, the session organiser highlighted the following points:

- statisticians are in the early stages of work in this area and are trying to reach a commonality of views on why and how to measure the human capital; it is a difficult area from both conceptual and practical measurement perspectives and a considerable amount of experimental work needs to be undertaken to make substantive progress;
- however, human capital is an increasingly important area for policymakers that deserves ongoing attention by statisticians as an emerging priority.

2. Measuring Australia's human capital development: the role of post-school education and the impact of population ageing

Invited paper by Hui Wei, Australian Bureau of Statistics

Introduction

As perhaps the most important asset of a country, human capital is a key concept in economic analysis and policy discourse. It is relevant for addressing questions such as what are the returns to education, how can a country enhance the productive capacity of its workforce, what is the likely impact of an ageing population on economic growth. At present, systematic measures of human capital are available for very few countries. This presents researchers and policy makers with a dilemma: how are we to understand the role of human capital for the economic and social progress if we do not have agreement on how to measure it? It is the responsibility of national statistical agencies to inform debates and decision making processes. What is their role in supporting the measurement of human capital as a part of official statistics?

The under-development of measures of human capital as official statistics arises from several factors. First there needs to be agreement on the concept. To what extent should non-economic aspects of human capital be incorporated and what theoretical and practical challenges does this pose? Despite many years of effort by generations of economists, there is still some way to go before we have a consensus on how the economic dimension of human capital should be measured. Should this measurement be undertaken in a national accounting context? Human capital is harder to measure than physical capital as it has to be measured by indirect means. How might national statistics agencies set about reaching agreement on a broad approach to measuring human capital? What are the conceptual and methodological challenges they need to overcome. Finally, this work requires expertise, knowledge and skills in numerous fields including the system of national accounts, productivity/economic growth, labour/education economics. Should we official statistical agencies invest in this work out of our limited resources?

In response to increasing demand for statistics related to the measurement of human resource in Australia, the Australian Bureau of Statistics (ABS) has started on a research program on the measurement of human capital. To make our task more manageable, we are dealing only with the 'economic' component of human capital. This does not imply that the 'non-economic' aspects are not important. So far this project has produced systematic but experimental estimates of the size of human capital stock, the formation of human capital by education and working experience (both gross and net).[1]

[1] See Wei, H (2004) and Wei, H (forthcoming).

Given the measurement methods available in the relevant literature, we have chosen the Jorgenson-Fraumeni lifetime labour income approach (Jorgenson, D and B. Fraumeni, 1989) as the basis of our accounting framework for human capital, with some modifications. This method measures the stock of human capital as the discounted present value of expected lifetime labour market income. In accounting for factors contributing to the growth of the human capital stock over time, we focus attention on the roles of post-school education and increased working experience for young workers. In accounting for factors causing the depletion of the existing human capital stock, we estimate the impact of population ageing on the availability of human resource for undertaking market labour activities. In so doing, we also take into account the growth of human productive capacity over time. In valuing the magnitudes of these human capital flows, we use per capita lifetime labour incomes and its changes over time as the valuation basis.

Population ageing is an important economic issue facing developed countries, generating many studies and debates. The analysis of population ageing and policy initiatives for dealing with it require the availability of relevant statistics. Our measurement framework of human capital contributes to this by providing quantitative assessment of the impact of population ageing on human capital development. Our estimates show that since the early 1990s, the human capital stock in Australia has been depreciating at an accelerated rate due to population ageing, and this trend has been counterbalanced by increasing investment in education and training. Our measurement framework could be also used for evaluating to what extent the accelerating depletion of human capital stock caused by population ageing could be alleviated by encouraging older people to stay in the workforce longer, in particular for those with advanced human capital skills. This framework could be used for comparing relative effectiveness of various policy solutions in dollar terms.

In compiling these measures of human capital development for Australia, we have encountered numerous theoretical and practical issues and challenges. By discussing these issues and presenting our experimental estimates of human capital stock and flows, we hope that this paper could draw attention to the measurement issues of human capital and generate robust debates about how and what to do in putting human capital into the domain of official statistics.

Measurement scope

Human capital can be defined in various ways, depending on the issues at hand. Human capital can be broadly defined as the productive capacity embodied in individuals. This definition is adopted by a recent report of the World Bank (2006, p.89). A person's productive capacity is related to a variety of factors, such as knowledge and skills, physical and mental conditions, life experience and attitude. As the 'knowledge and skills' is the most important determinant in a person's productive capacity, human capital can be also defined as the knowledge and skills embodied in individuals. This is the definition adopted by the OECD (1998, p.9).

The ‘knowledge and skills’ definition focuses attention on the contribution of education and training to a person’s human capital formation. This is more in line with the conventional approach of the human capital theory, formulated by Schultz (1961) and Becker (1964) in the early 1960s. Some other authors extend the concept of human capital to consider the roles of health and other factors in a person’s human capital formation. Ideally, all major factors that facilitate the formation and enhancement of productive capacities of human beings should be considered in developing comprehensive measurement of human capital. However, from a practical point of view, knowledge and skills are relatively easier to measure. In addition, there exist rich data sources on variables that could serve as proxies of knowledge and skills, such as educational attainment and labour market earnings. Due to these considerations, we adopt ‘the knowledge and skills’ definition of human capital in our research program on the measurement of human capital.

Human capital (knowledge and skills) can be accumulated in various forms: education, working experience, innate ability, etc. Even within the category of education, it includes formal schooling activities including compulsory primary and secondary education, post-school education such as universities and vocational training institutions. It also includes informal education in the form of learning within family and early childhood settings and self studies. It would be a daunting task to include all these factors in the measurement of human capital in one go. To make our job more manageable, we focus attention on post-school education and working experience, two major contributors in human capital formation and the central themes of an enormous outpouring of literature in labour and growth economic studies.

Human capital (knowledge and skills) can be broadly categorized into two kinds: the baseline knowledge and skills, and advanced knowledge and skills. This categorization is similar to that used in the World Bank report which divides human capital into raw labour and skilled labour (World Bank, 2006, p.88). Our research work focuses on the growth of advanced knowledge and skills, defined as those acquired through formal post-school studies including universities degrees and vocational training programs.

Human capital plays an important role in market activities as well as in non-market activities. Education does not only have positive effect on labour productivity and hence on labour market earnings, it also helps improve the overall ability to undertake non-market activities and enrich personal lives. These non-economic returns to education are no less important as the impact on market labour activities and the economic success of both individuals and nations. Accordingly, human capital can be either defined as “…relevant to economic activities (OECD 1998, p 9)”, or as “…facilitate the creation of personal, social and economic well-being (OECD 2001, p18).” Since the ABS research work focuses on the role of human capital in enhancing the economic performance, the market dimension of human capital is adopted in our research program at this stage. In valuing the human capital produced by education, we exclude these non-economic benefits in projecting lifetime labour incomes, because human capital in non-market activities is harder to measure, and is subject to more controversies.

Human capital, embodied knowledge and skills, has multiple dimensions. Conceptually, human capital skills can be categorized into three broad kinds: generic skills, firm-specific skills and task specific skills. Ideally, measures of human capital should capture these three dimensions. At present, we use educational attainment as a measure of generic skills. Information on the occupation and industry could capture firm-specific skills. At this stage though, we do not have systematic data about the distribution of human capital across different industries.

As far as working experience is concerned, we do not have direct observations on this important aspect of human capital. We use age as a proxy for measuring working experience. As we will show later in this paper that ageing has both positive and negative impact on human capital formation. This study attempts to measure the impact of population ageing on human capital development in Australia.

Methodology

Our methodology is based on the Jorgenson-Fraumeni lifetime labour income approach. Unlike the standard financial method, which calculates present value of a capital project by discounting the cash flows in each period to the present and adding up to obtain the present value of the investment, Jorgenson and Fraumeni simplifies this procedure by a backward recursion. It is assumed that all individuals retire at age 75 and have no labour income and therefore zero human capital. For individuals at other ages, their lifetime labour incomes are equal to their current incomes plus the present values of lifetime labour incomes of those with one year older. For example, an individual's lifetime labour income at age 74 is his current labour income only because he will retire next period. For an individual at age 73 his lifetime labour income is his current labour income plus the lifetime labour income of the preceding 74 year old person, adjusted by income growth and survival factors. By working backward in this way for all possible combinations of sex and education level, all individuals' lifetime labour incomes can be derived.

Within the Jorgenson and Fraumeni human capital accounting framework, all individuals in an economy are cross-classified by sex/educational attainment/age, and the stock of human capital is obtained by multiplying lifetime labour incomes by the corresponding number of persons in each sex/education/age category and aggregating across these sex/education/age groups. The change in human capital stock from period to period is viewed as the sum of human capital formation, net of depreciation and revaluation. Human capital formation itself comes from population growth (both new babies and immigration) and increments to lifetime incomes due to investment in formal education. Depreciation on human capital arises from ageing, deaths and emigration. Net human capital formation is the difference between gross formation and depreciation. Revaluation on human capital comes from changes in lifetime labour incomes over time for each age/sex/education groups.

One important advantage associated with the Jorgenson-Fraumeni approach is its ability to account for the effect on human capital formation of current schooling activities – that is, it can account for additional human capital embodied in those individuals who are still participating in formal education and who anticipate improved employment and income prospects as a result. In addition, the Jorgenson-Fraumeni approach can be used to measure option values generated by undertaking additional schooling activities, in particular basic school education.[2] The concept of option value, which is defined as the potential for possibly greater returns associated with completing certain educational levels, has received increasing attention in the recent return-to education literature.[3]

In applying the Jorgenson-Fraumeni approach to the Australia data, we have made several modifications. One of the major concerns with the Jorgenson and Fraumeni approach is that estimation of lifetime labour incomes based on current cross-sectional information is subject to short-term business cycle effects: it tends to under-estimate lifetime labour incomes in recession years and over-estimate in booming years. To remove biases caused by business cycle effects associated with estimates of lifetime labour incomes based on current cross-section data, we use repeated cross-section data from the 1981-2001 Australian Census, which combine all years of the census data to follow each sex/education/age cohort over its life cycle.

There are many other forms of returns to human capital, such as the values created in unpaid household production, and potentially, leisure. How to value non-market labour activities is a contentious issue. Jorgenson and Fraumeni adopt the concept of full income including non-market income as well as market income. The non-market income is based on imputations to leisure time. The after-tax wage rates are used to impute the incomes of leisure time. This choice attracts understandable criticism. For example, is it appropriate to value a PhD holder's work in the garden at a higher rate than that for someone who only completed secondary education? In order to avoid these complications, the estimates of human capital in our study are confined to market labour activities. The valuation of non-market activities is beyond the scope of our present study.

The Jorgenson and Fraumeni's accounting framework covers all individuals in the population. Our study is confined to the working age population aged 18-65 years. Like many economic growth and productivity studies, we are concerned with the growth and development of human capital embodied in the working age population. Therefore, only post-secondary education is accounted as investment in human capital formation.[4] Accordingly, other factors causing changes in the human capital stock, such as additions of turning-working-age persons and immigrates to the working-age population, are treated as other volume changes, equivalent to the category 'Other changes in assets account' in the SNA93.

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[2] For applying the Jorgenson-Fraumeni lifetime income approach to measure option values generated by secondary education, see Wei, H (2007).

[3] For a brief literature survey on this topic, see Heckman, J.J., Lochner, L.j., and Todd, P.E., (2005).

[4] Hill (2003) makes the similar recommendation in his proposed accounting system for human capital.

The Jorgenson and Fraumeni's accounting system only considers formal education in its estimates of investment in human capital that enhances individuals' skills and knowledge, with the component of on-the-job training being mixed with its estimation of depreciation on human capital. The standard human capital theory also emphasizes the role of on- the-job training in human capital formation. This study provides separate estimates of investment due to working experience.

The Jorgenson and Fraumeni's measurement system of human capital accumulation account is based on the rich data base on market labour activities. In contrast, our study uses the full Australian Census data for the period 1981 - 2001. As there is no direct information on labour earnings in the Census data, our research has to use the Census income variable, which contains all sources of incomes, as a proxy of labour earnings. In the lack of information on hours worked in the Census data for pre 2001 period, our study makes no attempt to separate hourly labour compensation and hours worked in the measurement of total labour earnings. Further more, our study is based on the aggregate level without occupation/industry details.

Main findings

Applying the modified Jorgenson-Fraumeni method, described in the preceding section, to the Australian Census data for 1981, 1986, 1991, 1996 and 2001, we produce five snapshots of age-earnings profiles for four broad categories of educational attainment for both men and women over this twenty year period. Combining these age-earnings profiles together, we derive per capita measures of lifetime labour market incomes for each age/sex/education cohort, and applies these per capita measures to the number of people in the corresponding cohort. By aggregating across all cohorts, we obtain the estimates of the human capital stock for Australia.

Table 1 The stock of human capital for Australia: 1981-2001 (millions of 2001 dollars)

		1981	1986	1991	1996	2001
Male	Higher Degree	42,917	52,562	92,185	127,009	161,362
	Bachelor Degree	244,123	315,558	448,212	607,439	733,190
	Skilled Labour	840,709	943,680	1,039,949	1,143,195	1,259,752
	Unqualified	1,540,987	1,685,260	1,889,659	1,950,974	1,957,450
	Sub Total	2,668,736	2,997,060	3,470,005	3,828,618	4,111,754
Female	Higher Degree	9,485	14,002	30,389	55,730	90,579
	Bachelor Degree	106,458	160,347	305,251	489,443	663,789
	Skilled Labour	349,437	420,986	429,201	488,993	553,664
	Unqualified	1,251,790	1,353,062	1,569,421	1,623,914	1,616,411
	Sub Total	1,717,170	1,948,398	2,334,262	2,658,080	2,924,442
Total		4,385,906	4,945,457	5,804,266	6,486,698	7,036,196

Table 1 presents the experimental estimates of the human capital stock for Australia in 2001 constant dollars. Two patterns are noticeable from these figures. First, the stock of human capital in Australia has increased by 60 per cent between 1981 and 2001, characterized by sharply rising share of aggregate human capital attributable to more educated workers. Second, increases in the more highly qualified components of human capital have been much faster for women than for men. For example, the value of female higher degree holders' human capital has increased nearly ten-fold during the twenty year period. The human capital of men with higher degrees has nearly quadrupled over the same period. The value of female bachelor degree holders' human capital is over six times higher in 2001 than 1981, while during the same period the corresponding value for men has tripled.

Table 2 presents the experimental estimates of human capital accumulation account in 2001 dollars. In contrast to the original Jorgenson and Fraumeni's accumulation account for human capital, which measures human capital formation as comprising of all types of education and demographic changes as well, our modified accumulation account focuses attention on the contribution of post-school education and working experience to the growth of human capital stock, with demographic changes being treated as other volume changes. In a broad sense, depreciation on human capital is a measure of the impact of population ageing on the availability of human capital skills for labour market activities (as persons become older, they have less working life for using human capital in the labour market).

Some brief explanatory notes for Table 2 are provided below. The numbers in the opening balance are taken from the subtotals in Table 1. The investment in post-school education, measured as incremental increases to lifetime labour incomes due to additional schooling activities, includes schooling activities for bachelor, higher degree and vocational studies. To match the definition of investment in human capital, depreciation is defined as deletions of additional lifetime labour incomes of those individuals with post school education due to their ageing. The investment in working experience is measured as incremental increases in lifetime labour incomes to those with additional years of working experience. The key assumption underlying such estimation is that increases in labour earnings as people get older are attributable to on-the-job training.

Depreciation of on-the-job investment is measured similarly as in the case of investment in education. The item 'Persons Turning Working Age' measures the additions to the existing human capital stock from the under-working age sub-population of the previous accounting period that have joined the workforce in the current accounting period, as the base level education group. The growth of human capital beyond the base level for this group of population during the current accounting period is accounted in the category of investment in post-school education. The item 'Ageing of the Base Level Human Capital' measures deletions of lifetime labour incomes of all individuals (including those with post school education attainments) as unskilled labour (depletions of the corresponding additional human capital skills are covered in the depreciation estimates for the investment in education and experience factor categories). The item 'Revaluation' measures the changes in real lifetime labour incomes over time (holding age as constant). As there is no sufficient information to derive estimates of emigrants, the item 'Omissions &Errors' includes the deletions of the human capital stock caused by emigration.

More details and associated caveats are provided in the forthcoming ABS research paper on the measurement of human capital flows.

Table 2 Human capital accumulation accounts (millions of 2001 dollars)

	1981–86	*1986–91*	*1991–96*	*1996-2001*
MALE				
Opening Balance	2,668,736	2,997,060	3,470,005	3,828,618
Investment in Education				
Investment in post-school education	62,060	81,564	103,468	102,938
Depreciation on post-school investment	-31,687	-34,465	-46,942	-61,551
Net formation by post-school investment	30,373	47,099	56,526	41,388
Experience Factor				
Gross on-the-job investment	319,201	300,113	277,664	251,974
Depreciation on the job investment	-47,128	-47,547	-47,055	-49,897
Net on-the-job investment	272,073	252,565	230,608	202,077
Persons Turning Working Age	485,721	554,633	534,861	549,963
Ageing of Base Level Human Capital	-584,722	-632,549	-670,121	-689,796
Immigrants	136,760	208,898	155,619	184,047
Revaluation	76,679	131,589	151,234	120,925
Omissions & Errors (including emigrants)	-88,561	-89,290	-100,114	-125,467
Changes in Human Capital Stock	328,323	472,945	358,613	283,136
Closing Balance	**2,997,060**	**3,470,005**	**3,828,618**	**4,111,754**
FEMALE				
Opening Balance	1,717,170	1,948,398	2,334,262	2,658,080
Investment in Education				
Investment in post-school education	37,593	63,876	87,765	90,750
Depreciation on post-school investment	-11,713	-14,312	-20,911	-31,295
Net formation by post-school investment	25,880	49,564	66,854	59,455
Experience Factor				
Gross on-the-job investment	123,785	110,013	140,482	145,821
Depreciation on the job investment	-19,635	-20,520	-25,380	-29,225
Net on-the-job investment	104,150	89,492	115,102	116,596
Persons Turning Working Age	340,898	404,026	394,857	410,493
Ageing of Base Level Human Capital	-334,273	-369,916	-451,445	-493,475
Immigrants	90,999	145,939	120,448	136,928
Revaluation	55,078	113,785	128,765	89,715
Omissions & Errors (including emigrants)	-51,504	-47,026	-50,762	-53,351
Changes in Human Capital Stock	231,228	385,864	323,818	266,362
Closing Balance	**1,948,398**	**2,334,262**	**2,658,080**	**2,924,442**

The preliminary findings from the flow accounting exercise paint a mixed picture for Australian human capital development over the last two decades. The figures show that the gross human capital formation by investment in post-school education has grown at a rapid pace: its contribution to the growth of human capital stock rose from 19% for men and 16% for women during the early 1980s, to 36% for men and 34% for women in the period 1996–2001. However, the magnitudes of depreciation also have trended upwards strongly since the first half of 1990s, which significantly have slowed down the growth of human capital stock. As a result, the growth of net human capital formation slowed down significantly. This phenomenon essentially reflects the impact of population ageing on long-term growth prospect of human resources available for sustainable economic growth and development.

Impact of population ageing

The ultimate cause of depreciation on human capital is finite work life. As people get older, they have less working periods available for market activities. The estimates of depreciation are measures of the impact of population ageing on the stock of human resources in the economy in dollar terms. This depreciation can be examined through a number of components in Table 2: ageing of base level human capital; depreciation on the investment in post school education; and depreciation of on-the-job investment. Ageing of the base level human capital is, to some extent, compensated for by persons turning working age. As can be see from Table 2, the net effect of these is negative and the gap between the two is increasing over time. It is more pronounced for males than females. Indeed for females the increased labour force participation of women during the 1980s as more women combined work with family responsibilities meant that contribution to human capital growth of young women turning working age exceeded the loss due to ageing. However by the 1990s the pattern for women was similar to males. As can be seen also from Table 2, the growth of human capital has slowed down since 1991, from $473bn to $283bn in 2001 for males and from $386bn to $266bn for females. Both depreciation on the investment in post school education and on-the-job investment are contributing to this.

It has long been recognised that human capital is an important source of long-term economic growth. Our figures show that population ageing is reducing the net growth of human capital. To counter the impact this may have on long-term economic growth various solutions and policy options might be contemplated. Our measurement framework could be used for quantifying the effects of these policy choices on the size of human capital stock. For example, it could help answer the following questions: What is the necessary percentage increase in the labour force participation rate to counteract the impact of population ageing in the short term? To what extent the increase in productivity through investment in education and training could compensate the depletion of human resources caused by population ageing?

Challenges and future development

The systematic measurement of human capital presents difficult challenges for an official statistical agency like the ABS. Conceptually, there are various tough decisions, choices and assumptions that have to be made. These include issues related to evaluation of non-market activities, ability biases, influences of institutional factors on determination of wage rates and so on. From the practical point of view, the job is equally challenging. It is a daunting task to reconcile inconsistencies between various data sources. Probably the fundamental challenging issue is the fact that source data does not directly measure human capital and has to be manipulated to do so, sometime in less than ideal ways.

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3. The measurement of human capital, also with reference to elderly population

Invited paper by Luigi Biggeri, ISTAT, Italy

Introduction

The development of human capital is a strategic resource and, therefore, a key priority for the development of social cohesion and competitiveness in the knowledge society. Actually, at least since the 1960s, human capital has played a key role in economic research, being used to explain people's behaviour both in the field of education, labour market and, above all, in the field of the theories of economic development and growth where human capital is considered as the main economic resource of a given society with equal or more importance than physical capital. This is the reason why it is fundamental to have proper indicators to measure the level and variation (development) of the human capital of a given population or part of it. These measures could then be used to make National Accounts estimates, comparisons over time, comparisons both at international, national and regional level as well as to analyse the impact of human capital on competitiveness and economic growth.

However, despite the growing attention, the concept of human capital has been given many different definitions by several authors without reaching a completely and commonly-shared theoretical basis. Above all, many problems have arisen concerning its measurement, due to its multi-dimensional nature and the micro or macro levels of analysis. As a result, empirical measures and analyses are not much developed as yet.

In order to identify possible operative definitions of the statistical indicators to measure the level and development of human capital, we deem it useful to recall, in brief, theories, concepts and definitions of human capital, generally stated at various levels and to set out the main proposals put forward for measuring and analysing it. Special focus on the human capital of elderly population will be given.

Theories, concepts and some types of analyses of human capital: the multifaced aspects

The theory of human capital worked out at the beginning of the 1960s by Schultz, (1961), Mincer (1958 and 1970) and Becker (1962 and 1964) has considerably developed in various directions which cannot be summed up here.

The theory – or rather the theories – on human capital have provided, however, scientific justification of two facts: for each individual, the level (or stock) and development (or changes) of human capital bring about a different level and development of an individual's earnings and income (the same goes for families); for economy, as a whole, they bring about the country's level and its economic growth (the same goes for enterprises).

Thus, from a microeconomic point of view, the human capital of an individual is one of the main factors influencing success in the employment sector. It is pivotal to invest in training since it gives people better access to employment, besides the chances for career advancement and improvements in their professional and salary (economic) conditions.

From the macroeconomic point of view, the country's competitive capacity and its production system depend on the accumulation rate and the investments in physical capital, as well as on the investments in human capital and on the knowledge embodied in it.

In the light of the positive effects that investments in education and training have on labour productivity for a country, the human capital is as crucial as the economic growth, just like progress in technology. Recent theories on human capital emphasize that also the quality of work affects the production process and economic growth. In fact, physical capital is made up of goods, which, in turn, are the result of human work. Hence, technology constitutes the real economic potential of the resources available, that is, simply human knowledge applied to production. Therefore, the higher the quality of work allowing for the creation of technology and its correct use, the greater the process of development.

And lastly, since investments in human capital should also positively affect health, crime and social cohesion, the social impact of human capital development is deemed to be even more relevant than the impact - measured in economic terms - on productivity.

Measurement experiences referring to the theories on human capital at the individual level have been developed since the 1960s, when Becker (1964) realised that rational individuals compare the costs and benefits associated with the gaining of human capital. In the case of perfect information, individuals invest in their own human capital when the marginal benefit of an investment (additional earning in its working life) exceeds the marginal costs of the investment itself. In this framework, the theory of human capital aims at examining how a single worker chooses to allocate his/her time to training of human capital (through schooling or training on the job) and job, in view of maximizing the income expected from the use of this capital. In this context, the so-called Mincer Equation (named after Mincer's work in 1970) allows for estimating the rate of return to schooling/education starting from a cross-sectional analysis of incomes in a representative population sample. This is one of the most often used indicators in economy, where individual wage is a function of individual variables, such as the years of schooling and working experience. As a general rule, the higher the human capital of individuals, the higher their incomes and the better their ways of living. If human capital is to be defined as the skills that individuals keep or develop through either education or vocational training and supply on the labour market in exchange for being paid, wage differentials are the way in which the market boosts the workers' human capital. Wage differentials provide a measure of the current financial benefits that an individual has to invest in continuing to study in a given country and, at the same time, contribute to determine the system of benefits enabling people to choose the proper investment in human capital.

Definitions and measures of human capital

The above-mentioned analyses do not provide a measure of human capital. Furthermore using a single indicator (e.g. the educational attainment) as a proxy turns out to be inadequate or even misleading.

There are several definitions of human capital at various levels (individual, family, enterprise, country). However, in our context it seems to be useful to refer to the general definition of human capital quoted in a well-known OECD paper issued in 2001 (OECD, 2001), i.e. "the knowledge, skills and competencies, attributes embodied in individuals that facilitate the creation of personal, social and economic well-being". This is clearly a definition that refers to the manifold features of human capital and to the factors influencing its level and evolution.

In fact, human capital is determined by and increases with formal education and training, as well as with other forms of learning stemming from social networks. On the one hand, education meant as gaining knowledge, skills and competencies is the key factor influencing human capital. On the other hand, many other specific and contextual factors can influence the development of human capital both at the level of an individual and of a group of individuals (e.g. enterprises, territorial areas, a country as a whole). Moreover, learning permeates individual life, occurs throughout a lifetime and does not concentrate only on formal education or training. Learning takes place within a family or with peers, at the work place, during informal learning in everyday life or through civic engagement. For example, the level of local economic development can affect the development of the human capital of people living in those places. Some of the authors have also underlined that the cultural environment in which learning takes place is of the utmost importance. Undoubtedly, there is a mutual relationship between human and social capital, the latter being understood as an endowment of relational goods (i.e. networks and social relationships).

In conclusion, the influence of information must not be neglected. In modern societies, the enhancement of human capital education has to be accompanied by a constant and adequate information flow; therefore the access to information is also a strategic factor for the development of human capital.

For this reason, publications by international organizations (in particular UN, OECD and Eurostat) contain a lot of information about the most important indicators of human capital. In recent years, some of them have been included in the structural indicators upon which Europe relies to measure economic and social development as laid down in the Lisbon strategy and its successive revision.

Alternative and more qualified methodological approaches have recently been introduced (in particular by OECD). They rely on individual competencies and on surveys (e.g. PISA and IALS) which, unfortunately, measure only some of the aspects of skills and competencies and are subject to the limits inherent to these kinds of sample surveys carried out in different institutional and social contexts in various countries. Many of the most recent analyses on human capital in various countries are based on the results of these different indicators, since there is not a single indicator.

Actually, as Dagum highlighted (1996 and 2000), human capital is a latent variable (i.e. it cannot be measured directly). It depends on several factors and represents the abilities of an individual (family or country) to generate income. In order to obtain a single and valid indicator, estimates have to focus on these abilities. A new methodology is being proposed. In compliance with economic theories, it would allow to quantify human capital at the household and individual levels in a given social framework as a multidimensional set which is not observable (non-observable composite variable). The set is generated from investments in education and direct training on the job that are important enough to cause an increase in working abilities that can be measured by an increase in the income gained and the wealth accumulated by an individual over his/her lifetime. In this regard, some experiments have been carried out using data from a sample survey on household income to get an estimate of the household human capital (Dagum, Vittadini, Costa, Lovaglio, 2003).

As a general rule, the concept of human capital and the corresponding indicators have been almost exclusively applied to evaluate the possible contribution of an individual or a group of individuals to the economy of a community. More recently, it has been suggested to use the concept of human capital also to measure the differential effect - in terms of labour and/or income - coming from investments in education, for special segments of educational paths. This implies that the definition be target-oriented and namely: "a non-observable variable obtained through an ad-hoc combination of a set of indicators concerning the result of investments in education, in terms of working ability". The indicators reflecting these effects can not necessarily be expressed in monetary terms .It is obvious that the operational definition is relevant because it links the object to be assessed to the objective conditions in which the very phenomenon occurs. It is still an emerging research sector, but it is really very promising.

In the end, other measures concerning human capital draw attention to the economic assessment of investments in human capital, which aims at analysing how financial and human resources employed in educational training contribute to the enhancement of the economic output as a whole, or the value of an enterprise, in particular cases. Among the experiences of measurement in this field, Human Resource Accounts systems are worth mentioning. Since the 1980s, they have been introduced in many Northern European countries to assess the impact of human capital on economic growth (Flamholtz, 1986). At present, the importance on a macroeconomic level of a modern system of accounts for human capital is being increasingly acknowledged (a special session of the seminar is devoted to this subject). Less widespread is the awareness of the strategic role played by the systems of accounts of knowledge, information and competencies at the entrepreneurial level as well as from a macroeconomic viewpoint. Yet, the weight of delays in research on human capital and educational economy depends also on the perception of how adequate the basic models and concepts of this subject matter are. From the point of view of tools for analysis and measurement, we are experiencing a phase of deep re-thinking, criticism and development, and from an application point of view the objective is to estimate the performance rates of the different levels and types of the above-mentioned education and training (Antonelli, 2001 and 2003).

A simplified framework to define indicators to measure and conduct analyses on human capital

As it stems from the above-mentioned definitions, and in particular from the OECD definition, by its very nature the concept of human capital is multidimensional and involves objective and/or subjective components, together with aspects that can be largely different: general and specific, silent or encoded, gained through learning or experience or rather coming from innate abilities. As a consequence, it is hard to set adequate measures (indicators) for the various aspects and, above all, to obtain a single synthetic measure. Moreover, there are different measures and analyses depending on the reference level (individual or a country) and on the goal set.

In order to define adequate operational statistical indicators, it is important in our opinion to start from the micro level (individuals), and to shift then to different aggregate levels (families, groups of population, enterprises, country, etc.), describing the problems that should be solved at different levels. In any case, estimates must refer both to the level (stock) and development (flows) of the human capital.

For an **individual**, human capital can be measured referring to the following four elements (Gori, 2006): Cognitive skills (Basic, Advanced, Specialised); Non Cognitive skills (Concentration, Compliance, Punctuality, Cooperation, Persistence, Sociability, Networking, Leadership, etc.); Attainment (Years of schooling, Certificates); Other (genetic background, IQ, economic and social contest, etc.).

Observations:

- the cognitive skills should be separated into generic skills (such as problem solving, communication and the ability to work in teams; the latter is also a non-cognitive skill) and specific skills (theoretical knowledge, knowledge of methods, etc.); the first can be defined as general academic skills, while the second as field specific skills;
- the management skills (planning, coordinating and organising, leadership, creativity, etc.) are considered both generic cognitive skills and non-cognitive skills;
- the non-cognitive skills are not usually considered as measures of human capital;

- as for the attainment, it is important to consider both formal and informal training; that is, the cognitive and non-cognitive skills achieved on the job and during life by lifelong learning and social networks;
- it is necessary to distinguish between attainment (how far you go in school or college), the indicator commonly used to evaluate human capital, and achievement (what you have learned, which can be obtained through any valid measurement); it is more important to measure the quality of the training (school) than the number of years spent at school;
- skill formation is a dynamic process: therefore, it is important to consider the life cycle of an individual; that is the human capital usually increases over time; in order to measure it, the achievement performed during the entire school and work life has to be studied and evaluated.

At aggregate level, obviously the estimation of human capital is obtained summing up the individual evaluations, but various problems have to be solved.

Observations:

- it is necessary to distinguish between potential human capital (supply side) from actually employed human capital (demand side);
- in order to understand the differences between the two above-mentioned configurations, the supply-demand matching process of human capital must be investigated and the link between them identified, i.e. how the different types of potential human capital are used and how the training process differs from the experiences requested by the demand;
- the evaluation of human capital turnover, accumulated and destroyed, is very important;
- valid estimates, comparisons over time and, above all, adequate comparisons among different groups of populations (or countries) depend on the composition of the populations, that is on the availability of separate estimates for homogeneous sub-populations (sub-aggregates); therefore, it is necessary to classify individuals taking into account various variables, like: gender, age, citizenship, living area, and so on;
- the classifications of population by age and citizenship are particularly important; in fact, since the skill formation is a dynamic process, the analysis of the comparisons of human capital between two populations must be made using the analysis by cohorts (longitudinal analysis); this is important also to evaluate policy's impact; moreover, separate estimates for the human capital of immigrants are necessary, because they account for an additional net improvement of human capital for the host country.

The measure and analysis of human capital for the elderly population

With reference to the aging of all populations, in particular the ones of European countries, due to the decreasing birth rate and lengthening of average life expectancy, there is a need to focus on measuring elderly population capital. Actually, the aging process brings about - or can lead to - the lengthening of working life.

When dealing with measurement of the human capital of adult or elderly population, it is even more difficult to find adequate indicators that can properly represent its potential human capital, especially when the measures are used to make comparisons among different populations. This is due to two reasons: first, the comparison is made between individuals in the same age groups but belonging to cohorts which are completely different in quantity and educational attainment (young people (generations) in a population are more educated though belong to smaller cohorts). Secondly, usually the indicator considers only the formal education attainment, and in any case it is difficult to include the human capital enhancement - stemming from professional or lifelong training - that elderly cohorts have achieved.

Some data concerning the Italian population can serve as a good example to illustrate this problem and, accordingly, the needs for proper measures and analyses. Data on the Italian population show a deep educational gap between young generations having higher education levels similar to the average in Europe, and older generations whose education levels are far distant from the average in Europe. Moreover, there could be considerably deep differences between cohorts.

Data in Table 1 refer to percentage of high-school and university graduates over the total population in adult and elderly age classes, as observed in the Labour Force Survey. Series allow comparisons between the percentage of people with high education attainment in the 40-44 and 65-69 age classes for 1977 and 2003. From Table 1, the following considerations arise and refer to the two different approaches:

Analysis by age

- The proportion of people with high education attainment among people aged 40-44 has risen from 10,8% in 1977 to 48,6% in 2003; whereas, the same proportion has risen from 4,4% to 14,5% among people aged 65-69. Therefore, the increase is higher in the younger people and in particular among women.
- The proportion of high-school and university graduates out of the total population in the 40-44 and 65-69 age classes for 1977 (it is higher for the younger by 2,5 times) is much closer than in 2003 (where the percent is higher for the younger by 3,3 times).

Analysis by cohort

- The levels of high-school and university graduates in the cohorts aged 40-44 in 1977 have further increased throughout the following 25-26 years and in 2003 they account for 1/3 higher.
- Therefore, the education attained by people aged 40-44 in 2003 is expected to increase further in the following 25 years and in 2028 the percent of high-school and university graduates among people aged 65-69 will be higher by 50%.

Table 1 Percent of high-school and university graduates in some age groups out of the overall population in the same age group by sex– years 1977 and 2003

	1977			2003		
	Men	Women	Total	Men	Women	Total
40-44	13,3	8,3	10,8	48,2	49,0	48,6
…						
65-69	6,3	2,7	4,4	17,8	11,7	14,5

Source: Labor Force Survey and demographic statistics

These results give a useful hint to debate over the opportunity to carry out analyses by generation or by cohort when making international comparisons and comparisons over time. They can also be used to measure the progress achieved in education in one cohort as opposed to another or among especially significant cohorts, as well as to measure the effect of the progressive decrease in the younger and more educated cohorts due to the decline in births.

Final remarks

Much work has been done referring to theory, definitions and measurement of the human capital. However, the international and national statistical offices have still to make strong efforts to set adequate indicators and methods of estimation to get proper and valid indirect measures of human capital. They have also to promote the development of panel databases to conduct valid analyses according to some of the approaches mentioned in the paper.

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4. Measuring the education output of government using a human capital approach: what might estimates show?

Invited paper by Barbara M. Fraumeni, University of Southern Maine, the Muskie School of Public Service[1], and the National Bureau of Economic Research, United States

Introduction

Most European statistical agencies are developing new measures of government output to comply with the European System of Accounts (ESA). ESA 1995 [Eurostat 1995] calls for direct volume measures for most government output, including education, instead of input-based measures.

Difficulties with implementing direct volume measures by the Office for National Statistics of the United Kingdom led to the Atkinson Review [Atkinson, 2005]. A number of conference sessions, full conferences, and consultations have been held over the past couple of years to develop and improve the direct volume measures for government output with considerable time devoted to the topic by both statistical agencies and private researchers. These efforts are likely to continue well into the future as there are significant measurement problems associated with developing the new output estimates.

This paper concludes that a human capital approach to measuring the education output of government is highly likely to be fruitful. Growth rates from the human capital approach would be used to estimate the volume of government education output. The discussion in this paper will center on feasibility and whether a human capital approach is likely to provide estimates that are significantly different from approaches primarily driven by enrollment growth rates.

Last summer Dale Jorgenson, Barbara Fraumeni, and Michael Christian began a research project to extend and revise the Jorgenson-Fraumeni (J-F) investment in education estimates for the United States (1992a, 1992b). A preliminary report on the first stages of this project was presented at an OECD/ONS/Government of Norway workshop in London in the Fall.[2]

The original J-F project was a massive project which took some 5-10 years to complete. The length of time was in part due to the time involved in conceptualizing and implementing new methodology, but it was also due to the size of the data collection effort. A number of investigators were involved in preparing inputs to the estimates, most notably Chinloy, Gollop and Ho, who constructed a labor data base on wages, hours worked, and employees by age and

[1] The research assistance of Marc Hitchcock of the Muskie School on the J-F-C project is gratefully acknowledged.
[2] See Fraumeni, 2006. The posted paper at http://www.oecd.org/dataoecd/1/60/37460216.pdf outlined the human capital methodology, which is described in the appendix to this paper. The verbal presentation focused on the subject of this paper.

education categories. The J-F human capital estimates were constructed by single year of age and education. Realistically such an effort cannot be supported on an on-going basis.

Accordingly, the J-F-C project is asking the question: Can robust estimates be constructed with a blend of categorical data from the labor data base maintained by Ho and information on enrollment and population by single year of age and grade enrolled or highest education level completed?

Even this less ambitious project entails producing a large data set; the largest J-F-C database has over 120,000 observations spread out over 45 years with about 25 variables associated with each observation. However, the Ho labor data base, the main foundation for the J-F-C project, is the data base constructed for the EU-KLEMS data base, which was released for public use on March 15th.[3] The public release does not release the full Ho labor database for a variety of reasons, but nonetheless the full set of data could possibly continue to be used by at least some researchers. The databases for other countries probably are less encompassing, but each could represent a starting point for construction of a human capital set of accounts.

If a human capital approach is to be adopted by statistical agencies, it must require relatively few resources and little time to update the government output time series. Initial development costs might be higher than other approaches, but with luck the efforts of private researchers such as J-F-C would significantly reduce start-up costs.

The original J-F human capital research on investment in education produced results from 1948-1986. The current J-F-C project will produce results from 1960 (the start of the Ho data underlying EU-KLEMS) to a recent year, say 2005. Initially as was true for J-F, J-F-C will focus on the aggregate output of both private and public education. Eventually a subproject will focus on how to isolate the impact of public education on lifetime earnings in order to measure government education output. This is an important step that needs to be taken, but one that logically follows demonstration of the feasibility of constructing the human capital set of accounts with substantially less data than the original J-F project in an amount of time that is manageable for a statistical agency.

General methodology

Government education output is frequently measured by the number of students attending public schools. Quality adjustments may be made, for example to reflect test scores, and other distinctions may be made, for example for the cost of different programs by discipline. These adjustments tend to be very small or relatively ad-hoc because of the lack of data to implement more refined approaches.[4]

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[3] See the homepage of the EU KLEMS project at http://www.euklems.net/ for further information.

[4] For an example of quality-adjustment of enrollment numbers, see Christian 2006.

The J-F human capital approach quantifies the impact of education on lifetime income to determine investment in education, which is by definition the output of education. The Atkinson Report recognized the potential merit of this approach, calling for the consideration of "an adjustment to reflect the value of education for future earnings" [Atkinson, Recommendation 9.3 p. 135].

J-F estimated the impact of formal education on lifetime income for the non-institutional population of the United States. The first step was to estimate expected lifetime income for all individuals by year of birth, calendar year of estimate, sex, single years of age from birth (0) through 75+, and single year of education from 1st grade through completing at least one year of graduate school. Investment in education is the incremental effect on lifetime income of completing one more year of education and is registered at the point the additional year of education is completed. All paid and unpaid activities are valued except for maintenance, which includes sleep and personal care. Unpaid non-market activities, except for investment in education and investment in new births, are valued using an opportunity cost approach. Total opportunity cost for these unpaid activities is time multiplied by the market wage that could have been earned by an individual in the same age, sex, and education category by year. Market time is directly valued by the wages earned.

Expectations about years lived, enrollment, and labor force patterns including hours worked, and relative wages come from information about older individuals alive in a particular year. For example, the probability that someone completes another year of school in 1981 who is a sixteen-year-old male high-school sophomore in 1980 comes from the completion rate of seventeen-year-old male high-school juniors in 1980. Similarly, the probability that a forty-year old female in 1980 with a college degree will work (and how many hours) in 1981 comes from forty-one year old females in 1980 with a college degree. Accordingly, only contemporaneous information is needed with one exception. Future wages must be determined using a real rate of growth of wages.

All future income is discounted. Finally, lifetime incomes are calculated by a backwards recursion, starting with age 74, which is the oldest age before retirement.

The Appendix gives equations for the specific methodology employed by J-F-C, which parallels the J-F methodology. The differences in methodology compared to the J-F methodology relate to the use of categorical, rather than single year of age or education, data to significantly reduce data demands.

Analysis of expected results

In the United States investment in education volume growth rates will be driven by two distinct trends. These trends occur in two sub periods which are approximately the same as the two sub periods analyzed in this paper. The first sub period: 1960-1986, is the later period covered in the original J-F study. The second sub period: 1987-2004, included years which are to be added to the original J-F study by the J-F-C study.[5]

Because in most cases adjustments to enrollments or other quantity indicators are small, the actual J-F growth rate results and the expected J-F-C growth rate results are compared to enrollment growth rates. Using enrollments as a proxy for education output assumes that every grade of education contributes the same to education output and that education output (per grade) has not changed over time.

The following table compares the annual growth rate for enrollments to the annual growth rates from J-F in constant dollars (volumes).

Table 1		
Growth Rates	**Enrollments**	**Investment in Education (constant$)**
1960-1986 (J-F)	**.6%**	**2.7%**
1986-2004 (J-F-C)	**1.2%**	**?**

A question mark appears in the J-F-C row as the project has not yet been completed. Use of J-F investment in education growth rates would make a very significant difference in the education output series. Although the growth rates would be different if only market lifetime income were estimated; the magnitude of the differences with enrollment growth rates would be in the same ballpark.

Looking at the trends in 1960-1986 versus 1986-2004 gives a strong indication of what number might replace the '?' when the J-F-C project is completed. The trend stories, which are illustrated in the next table, both relate to college.

Table 2		
Growth Rates	**Enrollment Growth Rates**	**Wage Gap** **College to Other Levels**
1960-1986 **J-F**	**4.6%** **(.6%)**	**Decreases often, but also increases**
1986-2004 **J-F-C**	**1.8%** **(1.2%)**	**Increases substantially**

[5] These periods were chosen because they could be analyzed without completing the J-F-C project and because the break year: 1986, corresponds roughly to the trend break year.

The top enrollment growth rate numbers are annual growth rates for college enrollments. The growth rates below are the overall enrollment growth rates repeated from the table above.

In the first period: 1960-1986, the college enrollment growth rate is almost eight times the overall school enrollment growth rate. In the later period: 1986-2004, although the college enrollment growth rate is still significantly higher than the overall school enrollment growth rate, the magnitude of the difference is much smaller than in the earlier period. Clearly, the driver of the investment in education growth rates is the high growth rates in college enrollments. College-educated individuals earn significantly higher lifetime income than those with less education because of the higher wages they receive. Accordingly, high college enrollment growth rates impact on investment in education in two ways: through higher wages and through higher overall enrollment rates.

The last column of the table looks at the trends in the wage gap between college educated individuals and those with less education. The average wage per hour data used to estimate the wage gap trends comes from the Ho labor database. In the first period: 1960-1986, the trends in wage gaps are mixed; in some cases the gap is narrowing, in other cases it is increasing. [6] In the second period: 1986-2004, the gap is always increasing.

Accordingly, my expectation is that the investment in education growth rates will continue to be substantially higher than the overall school enrollment growth rates, but that the reason for the difference will change. The main 'driver' of the difference will be the increasing wage gap rather than the substantially higher college enrollment rates.

Other issues

The other issues that need to be confronted to complete a simplified system to measure government education output are of two types. First, what problems do categorical data represent? Second, what has to be done to make the switch from all formal education output to government only education output?

Two education categories seem to be problematic. First, since students commonly spend a number of years in graduate education, some further research has to be conducted to handle the category of more than college. How many years of graduate education do students complete? How long does it take them to complete each year? To some extent a similar problem occurs at the undergraduate level as the evidence is that more students are taking more than 4 years to complete 4 years of college.

[6] As can be seen from the Appendix, the education categories changed in 1992. For descriptive purposes, using the categories for 1992 and before, two reference points were used: more than college and a college degree. These were compared to the wages per hour of those with less education: college degree in one comparison; plus always those with college, but without a college degree; a high-school degree; high-school, but without a high-school degree; and up to eight years of primary school completed.

Second, wages paid to individuals who have not completed more than eight years of primary education may depend upon whether they have been educated to the point that they can read, write, and perform basic arithmetic. If the numbers of individuals who have less than eight years of education completed is very small, this issue could be ignored.

To make the switch from estimating the output of all formal education to just government provided education, the most important issue is attribution to government schools or to other inputs. Trends in time students and parents spend in the education process should be removed from investment in education growth rates.[7] Social capital impacts should also be excluded, which include neighborhood, cultural, and family influences.

Conclusion

Evidence presented in this paper shows that using a human capital approach to estimating government education output growth rates for the United States could have a significant impact on government education output estimates. To the extent that enrollment and wage gap patterns for other countries show similar trends, similar results would be expected. A human capital approach is superior to a simple enrollment approach as it captures a number of factors not reflected in counts. Education is one of the largest government expenditure categories; accordingly it is important to pay particular attention to its measurement. Education not only benefits the individual being educated; it also leads to higher rates of growth for the economy as a whole due to the higher productivity of a skilled workforce.

[7] It is certainly possible that schools inspire students to involve themselves to a greater extent in learning; accordingly the division between school and individual inputs is unclear.

APPENDIX

The following text describes in more detail the methodology being employed for the estimates being developed. The format of the description is similar to the format of the appendix to Jorgenson-Fraumeni (1992b).

Dimensions of the data

Years: 1960-2004
By Sex: Male and Female

Categories:

Age	
1	16-17
2	18-24
3	25-34
4	35-44
5	45-54
6	55-64
7	65-74
8	75+

Education (1960-1992) based on years of school

1	Less than HS
2	Some high school
3	High school grad
4	Some college
5	College grad
6	More than college

Education (1992-2000) based on highest level achieved

1	8th grade or less
2	grades 9-12 no diploma
3	high school grad
4	some college no degree, associate degree
5	BA, BS
6	More than BA or BS

When the variable is enrollment or investment in education, the education categories refer to level of enrollment instead of years enrolled or highest level achieved.

Level of enrollment for all years	
1	Grade 1-8
2	High school years 1-3
3	High school year 4
4	College year 1-3
5	College year 4
6	Graduate school

In the following equations, when the variables are categorical as opposed to by single year of age and education, capital letters are used. For example, a variable with an "A" dimension is an age category variable; a variable with an "a" dimension is a by single year of age variable. Enrollment is referred to as "ENR" when it is an enrollment category variable; it is referred to as "enr" when it is a by single year of education level enrolled variable. Otherwise education is referred to by "E" (categorical) or "e" by single number of years in school or by single year of highest level of education achieved.

The single years of age are for a = 0,1,2,…75, 75+. The single years of education are:

Education = e	Enrollment or Investment in Education
1	Not enrolled
2	Grade 1
3	Grade 2
4	Grade 3
5	Grade 4
6	Grade 5
7	Grade 6
8	Grade 7
9	Grade 8
10	High school 1
11	High school 2
12	High school 3
13	High school 4
14	College 1
15	College 2
16	College 3
17	College 4
18	College 5+

Variables

The input variables required for estimates of the output of the educational sector by year, unless otherwise indicated, are denoted as follows. Variables are in current (nominal) dollars, are per person in the population unless otherwise noted, and are categorical unless otherwise noted by small letter dimensions and description.

Cmp(s,A,E) – hourly compensation, gross of taxes on labor income.
Emp(s,A,E) – number of employees.
Hrs(s,A,E) – hours worked per week.
Pop(s,a,e) – population by single year of age and education.
R – (1 + real rate of growth on labor income)/(1 + discount rate)
Senr(s,a,enr) – enrollments by single year of age and single year of level enrolled.
Sr(birthyear, s,a) – probability of survival, specific to the year of birth
Tax – Average tax rate on labor income
Taxam – Average marginal tax rate on labor income

Intermediate stage variables estimated from the above variables include:
Hrstot(s,A,E) – hours worked per week summed across all employees in the category.
Pop(s,A,E) – population.
Senr(s,A,ENR) – enrollments.
Ymi(s,a,e) – yearly market income by single year of age and education.
Ymi(s,A,E) – yearly market income.
Ymitot(s,A,E) – yearly market income summed across all employees in the category.
Ynmi(s,a.e) – yearly non-market income by single year of age and education.
Ynmi(s,A,E) – yearly non-market income.

Output variables include:
Life(s,a,e) – lifetime income by single year of age and education.
Mi(s,a,e) – market lifetime income by single year of age and education.
Nmi(s,a,e) – non-market lifetime income by single year of age and education
Si(s,a,enr) – Investment in education by single year of age and single year of level enrolled.

Life stages equations

There are five stages of life in the J-F human capital model of investment in education. Since calculations proceed by starting with those aged 75, the stages of life are being listed in reverse.

Stage 5: retirement, age 75+
ymi(s,a,e)=ynmi(s,a,e)=mi(s,a,e)=nmi(s,a,e) = 0

Stage 4: work only, age 35-74

ymi(s,a,e)=ymitot(s,A,E)/pop(s,A,E)*(1-tax)
ynmi(s,a,e)=[14*7*52-hrstot(s,A,E))/pop(s,A,E)]
cmp(s,A,E)(1-taxam)
mi(s,a,e)=ymi(s,a,e)+sr(s,older)*mi(s,older,e)*R
nmi(s,a,e)=ynmi(s,a,e)+sr(s,older)*nmi(s,older,e)*R

Stage 3: work and school, age 16-34
ymi(s,a,e)=ymitot(s,A,E)/pop(s,A,E)*(1-tax)
ynmi(s,a,e)=[14*7*52-hrstot(s,A,E)/pop(s,A,E)-1300*senr(s,A,ENR)]*cmp(s,A,E)
*(1-taxam)
mi(s,a,e)=ymi(s,a,e)+[senr(s,a,enr)*sr(s,older)*mi(s,older,school)
+(1-senr(s,a,enr))*sr(s,older)*mi(s,older,e)]*R
nmi(s,a,e)=ynmi(s,a,e)+[senr(s,a,enr)*sr(s,older)*nmi(s,older,school)
+(1-senr(s,a,enr))*sr(s,older)*nmi(s,older,e)]*R

Stage 2: school only, age 5-15
ymi(s,a,e)=ynmi(s,a,e)=0
mi(s,a,e)=[senr(s,a,enr)*sr(s,older)*mi(s,older,school)+(1-senr(s,a,enr))*sr(s,older)*mi(s,older,e)]*R
nmi(s,a,e)=[senr(s,a,enr)*sr(s,older)*nmi(s,older,school)+(1-senr(s,a,enr))*sr(s,older)*nmi(s,older,e)]*R

Stage 1: no school or work, age 0-4
ymi(s,a,e)=ynmi(s,a,e)=0
mi(s,a,e)= sr(s,older)*mi(s,older,e)*R
nmi(s,a,e)= sr(s,older)*nmi(s,older,e)*R

Summary estimates

life(s,a,e)=mi(s,a,e)+nmi(s,a,e), where life is lifetime income, both market and non-market, per capital, total population
si(s,a,e)=senr(s,a,enr)*(life(s,older,e)-life(s,older,e-1))
If you are enrolled in a particular grade, and complete it when you are one year older, you get the lifetime income of someone who is one year older and who has completed that grade.

Volume (constant$) variables for each of the output variables are estimated with a translog (Divisia/Tornqvist) index.

Weights in nominal $s	Quantities
Si	Enrolled students
Mi	Population
Nmi	Population
Life	Population

A variety of other volume (constant$) indexes could be constructed, such as for yearly market income and depreciation of human capital.

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CHAPTER IV: MEASUREMENT OF SOCIAL CAPITAL

1. Summary of the session

The session was organised by Mr. Joe Grice (ONS, United Kingdom). Mr. Michel Glaude (Eurostat) served as the discussant. The session was based on invited papers by Finland, the United Kingdom, and the OECD.

The Conference looked at different definitions of social capital and identified future challenges for official statistics in its measurement. Social capital is a new concept and is used in different contexts in statistical offices, such as social cohesion, neighbourhood statistics, housing and community policies, societal wellbeing, etc. It is also considered to be one of the pillars of sustainable development. Some of the future challenges include how to develop data collections in a cost-effective manner and how to analyse the data, for example, in relation to the productivity gains of social capital.

In the discussion, the following points were made:

- while social capital is a difficult concept, it has a great potential for policy makers and society as a whole. The key challenge for national statistical offices is still to determine the purpose and implications of the social capital within the context of official statistics;
- there are several definitions of the concept of social capital; they usually include dimensions such as networks, shared norms and values, cohesion, and trust among groups;
- the questions of governance and institutional effectiveness could be considered as part of social capital;
- social capital constitutes a kind of asset that provides value-added to individuals and societies, although it may not form part of what is usually considered ”capital” in the economic sense;
- the role and functioning of the governmental sector and the importance of informal networks differ widely between countries due to the cultural context. Such issues would have to be taken into account in the development of statistical measures;
- indicators of social capital might be included in the framework of societal well-being. However, the objective measurement of social capital should be distinguished from the measurement of subjective well-being;
- it was suggested to explore the possibilities for indirect measures of social capital; one example mentioned was transaction costs. High transaction costs may occur in low trust societies because of the high cost of ensuring the rule of law;
- the nature of the concept of social capital and related aggregation and weighting problems may support a multi-dimensional approach rather than a single indicator approach.

In conclusion to the session on social capital, the session organiser highlighted the following points:

- the difficulty in defining social capital from a statistical viewpoint is recognized. Clarification is needed as to what statistical value can be derived from the concept of social capital and for which purposes it can be applied. The concept has a much wider application than simply as a factor of production;
- the goal at this stage is not to harmonise the concept but to have a common understanding of its possible definitions and uses;
- countries are encouraged to share experiences in the different uses of the concept and cost-effective data collection methods. Continuation of work in this area is very important.

2. Social capital – ways ahead and ways blocked in national assessment and international comparisons

Invited paper Laura Iisakka, Statistics Finland, and Jussi Simpura, National Research and Development Center for Social Welfare and Health, Helsinki, Finland

Summary

Social capital appears for many as a promising candidate to improve the explanation for differences in economic and social development between regions and nations. In order to be fully used for such purposes, social capital needs to become assessed on national or regional level in an internationally or inter-regionally comparable way. Attempts to proceed to this direction have been many, but achievements scarce. This paper discusses national experience from Finland, and some international comparison, with the purpose of determining the state of the art: where can we see promising avenues and where the ways seem to be blocked for internationally comparable assessment of the volume of social capital?

Introduction: the economic roots of the sociological concept of social capital

Social capital is one of the new or supplementary forms of capital (together with natural capital) which do not yet fit to framework of national accounts. For the organisers of this CES seminar, "a fundamental question in this context is to what extent these new forms of capital can be quantified in money values. Or are there other ways of in which these capital stocks and the changes therein can be measured in a meaningful way?" This review on measurement of social capital will show some ways to proceed, and will claim that some other ways are blocked, when measuring social capital as capital.

The basis for the interest in the concept of social capital lies in comparisons, with sociological overtones and economic undertones. The classic of the field, Robert Putnam's (1993) work on differences between northern and southern Italy, already focuses on the role of social capital in explaining regional differences in economic and social development. Much of the interest in social capital in the economic research relates to similar issues. Social capital is one of the alternatives to explain the unexplained or residual variation in economic development between countries or regions (e.g. Hjerppe 1998, 2003; Woolcock, 2000). In order to be a useful concept in such effort, social capital should be measurable in comparable ways over time, between countries, and preferably also in terms of volume and not only in terms of trends. Briefly, it should be possible to assess social capital as capital. In the simplest formulation, social capital is like an economically invisible material that keeps societies internally together and smoothes its action, thus improving its economic and social performance.

Social capital as capital: two opposite camps

In the course of time since Putnam's first works, the enthusiasm around social capital has risen more among social scientists than among economists. In the latter camp, serious suspicions have been presented on the use of the concept. It has been claimed, among other critical remarks, that the term should be abandoned altogether, and in particular the capital metaphor is misleading. For instance, Quibria (2003, 7) quotes Kenneth Arrow (2000), one of the great old men, saying that social capital hardly fulfils three basic requirements for anything to be called capital: "(i) capital has a time dimension, (ii) it requires deliberate sacrifice of the present for future benefit and (iii) it is ´alienable´ - that is, its ownership can be transferred from one person to another.

Quibria, in his critique, quotes also some proponents of the concept of social capital who admit that social capital may not actually be capital. As an example, Ostrom, (2000, quoted by Quibria (2003) in footnote 12 on p. 8) mentions four important differences between social capital and other forms of capital: "First, social capital does not wear out with use – on the contrary, it erodes from lack of use. Second, it is not easy to see or measure. Third, it is hard to through external (for example donor) intervention. Finally, national and regional government institutions strongly affect the level and type of social capital available to individuals to pursue long-term development efforts."

In the economic camp, more understanding to the notion of social capital has been shown within regional economics (see e.g. Westlund and Bolton 2003). It is not self-evident why this is so. Measurement of social capital is not easier on sub-national regional level than on national or international level, and the conceptual problems quoted above remain on the regional level as well. It may be that regional economic analysis in smaller regions allows more ways to assess various forms of intangible capital (see the next paragraph) than is possible to use on national or international analysis, and therefore also the residual containing social capital could be analyzed in more detail.

Another relevant strain in the economic debate of the last few years is the discussion on extending the notion of capital into aspects of wealth and sustainable development by the World Bank (Where is the Wealth of Nations, 2006; see also Hamilton and Ruta 2006), social capital has been mentioned, although mostly bypassing. Hamilton and Ruta (2006), interestingly, find out that what they call intangible capital has a majority share of all capital, and that share is highest in the economically most advanced countries. Intangible capital includes human capital, governance, institutional effectiveness and all other capitals not mentioned elsewhere. The last group, all other capitals, includes social capital. As for the method of assessment, Hamilton and Ruta mention the method of "difference" for all forms of intangible capital[1]. This method does not include direct measurement of the volume of capital and changes therein for any forms of

[1] The method of difference seems to refer to a kind of comparative analysis of the residual economic development that cannot be explained by more measurable form of capital. The method aims at releaving the role of various alternative explanatory factors.

intangible capital. It remains to be discussed elsewhere whether governance and institutional effectiveness are a form of social capital (as many proponents of the concept would suggest) or not.

In the sociological camp, the deficiencies of social capital as capital are readily admitted (see e.g. Engeström 2001), but they are not necessarily seen as obstacles for the advance of the use of the concept. It may be that whereas empirical economists are often obsessed with the measurement of the volume of social capital and changes therein, sociologists do not need such a volume-type concept nor its measurement. Even overall indices of social capital, without the purpose of determining the total volume, are more often found within economic research than within sociological research.

Indeed, regional economics seems to be the promised land for the empirical study of social capital. Impressive and detailed empirical works, resulting in some variant of a total index of social capital, can be found, for instance, on Italy (the multivariate analysis by Sabatini (2005)) and U.S. (e.g. Rupashinga et al. (2006) who continue down to the county level in their analysis).

Assessing social capital on national level: ways ahead

Our national experience of assessing social capital in Finland also originates from concerns of economic theory: the theory of endogenous growth (Hjerppe 1998, 2003) and its applications in regional economics (Alanen and Pelkonen 2000). The pioneer figure in the Finnish national debate on social capital, Dr. Reino Hjerppe, very much emphasised the usefulness of the concept of social capital in economic analysis. Later, however, most of the research interest and political concerns around social capital has concerned sociological issues like trust, or political efforts like the support to people's participation in civic action.

Statistics Finland has published a statistical review *Social Capital in Finland* last year (2006). The articles in this publication review international measurements and statistical frameworks to find and extract indicators of social capital that can be obtained by using existing Statistics Finland's data sources. In measuring social capital it is important to consider not only the characteristics of social capital, but also its presumed outcomes as have been done in this report. The articles in the publication examine the key features of social capital, such as trust, participation, voluntary work, social interaction and reciprocity. Some special themes are also considered: whether the use of communication media adds to social capital and whether a correlation can be seen between perceived health and social capital. The articles also talk about social capital in workplace communities, enterprises' network relations and collective labour agreements.

Existing statistical datasets provide a useful tool for studying social capital, even though they have not been collected for the measurement of this concept. For example they give an opportunity to make comparisons over time. However systematic comparisons are not always possible because different datasets are updated at different intervals. Further, a broad and comprehensive analysis is not usually possible on the basis of just one dataset, but one must use different datasets simultaneously. Using existing datasets gives also opportunity to compare social capital in different countries and regions although it does not make for easy international comparisons. Analyses that integrate different materials combine usually different indicators and also questions that are worded differently in different countries.

Social capital measurement is usually based on examining different indicators that represent social capital's key components like has been done in Statistics Finland, as well as in Australia (Aspects of Social Capital, 2006) or in Canada (PRI's reports, 2005a,b,c). It has not been possible to measure the total volume of social capital in Finland yet. This is the situation also in other countries.

There is a common need to find out more about the multidimensional nature of social capital. It is not satisfactory to examine just a single dimension of the concept and consider it as representative of the concept as a whole, and analyze its effect on the economic performance. Actually, during the spring 2007, Australian Bureau of Statistics (ABS) is trying to establish whether social capital can be seen as a multidimensional concept, or a set of discrete phenomena drawn together under a 'social capital' umbrella label. This is part of the need to create a way to measure total volume of social capital in different countries which is still missing in the measure of social capital.

What would be the ways ahead in national assessment of social capital? Ideally, a special survey focusing on social capital and repeated with a few years' intervals would be a nice instrument for many. The problem is that there is no golden standard for assessing social capital. Another problem is, of course, that national statistical institutions and other data-collecting organisations are already overloaded with data-collection tasks. And the same goes for the respondents: declining response rates almost everywhere do not call for new data collection. The alternative is to rely on existing data from other, different sources. This is what has been done in Finland and some other countries a few times. And this is also the approach used in the detailed regional analyses mentioned above (Rupashinga et al 2006, Sabatini 2005). For a few years to come, this kind of secondary analysis is the most likely course to improve national assessment of social capital.

International comparisons of social capital: ways blocked?

There seems to be an implicit assumption in the assessment of social capital that it has some universal features that work uniformly in most countries and most cultures. Existing international or major regional comparisons cover countries from the same cultural circle (Anglo-American countries) or regions within the same country (e.g. Putnam's classic comparison between northern and southern Italy, or between the states of the U.S.).

One issue in particular seems to be problematic. That is the role of local or community civic action. Again implicitly, the Anglo-American proponents of social capital stress the importance of local community and the decisive role of voluntary civic action (implicitly, as against government-inspired action). This may be indeed a problem if some countries (like most Nordic countries) see state and government not as an obstacle but as an opportunity for civic action. "We are the state" could be a Nordic slogan, as regulatory and financial support by the government is an essential element in almost all civic action there. The government is predominantly something good, not something bad for civic action in the Nordic countries. How, then, could this kind of attitude towards civic action be included in the non-governmental voluntarism underlying the Anglo-American concept of social capital? Against this background, it is a bit paradoxical that Putnam, in his comparison between the U.S. states found that the most important single explanatory variable for differences in the volume[2] of social capital was the share of people of Scandinavian origin in the population of the states.

Real international comparisons of the volume of social capital are rare. Patulny (2004) used the World Values Survey and Multinational Time Use Surveys to find out what kind of differences in social capital exist between different social policy or welfare regimes (social democratic, liberal and corporatist). The focus was on the so called bridging social capital. In Patulny's (2004, 5) formulation, "Bridging is based on an emotional process whereby trust is generalised and oriented through social norms towards generalised 'others' we don't know very well". His research question was how the welfare regime may be involved in determining the volume of social capital. He did not develop a measure for the volume of social capital but constructed four variables to describe bridging social capital: trust, voluntary membership, volunteering activity and socialising activity. To the surprise of some proponents of social capital, strong government involvement (like in the social democratic welfare regime) did not erode bridging social capital. Patulny suggests in his conclusions that trends in bridging social capital are influenced both by the welfare regime type and, "importantly, welfare regime re-structuring".

Iisakka (2004) also used the World Values Survey data in the study comparing the level of social capital in different countries. The aim of the study was to investigate whether there are differences in the level of social capital between countries where income differentials are high, average and low. Social capital was measured using the following measures: generalised trust, trust in different institutions and participation in associations. According to the results social capital differed between these countries. Social capital was highest in the Nordic countries where income differentials were the lowest but against the hypothesis, the level of social capital wasn't lowest in countries where income differentials were highest. Against this background it can be said that also cultural factors have a significant role in measuring social capital. For instance, formal networks have bigger role in the USA than in Spain where informal networks, such as family, friends and relatives, are more important than participation in formal groups.

The fact that multi-national comparable data sets like the World Value Survey have been used for measurement of social capital does not exclude the possibility that the variables in

[2] The volume that Putnam describes is not volume in the economic sense but rather a kind of proxy of such an economic volume of capital.

survey data sets may be culturally incomparable. Take, for instance, the key issue of civic participation. In a country where government organisations have much of the same functions that civic organisations somewhere else, any survey question on volunteering in that country has a completely different contextualization compared with any other country where non-governmental action has upper hand. Therefore, even the technically most identical surveys cannot guarantee comparability in measurement of social capital, as many of its dimensions are culturally determined. This is a much overlooked issue in almost all comparative survey work, and it is extremely acute when measuring social capital.

Despite all the doubts presented above, many proponents of the concept of social capital have continued work to establish universal cross-cultural frameworks for measuring social capital. Among them, the World Bank is the most prominent one. Its work to develop an instrument (a questionnaire) for measuring social capital focuses on developing countries, and even there, mostly on measuring on the level of a local community or region (see e.g. Grootaert et al 2004). Indeed, it is admitted in the report describing the social capital questionnaire in detail, that "the tools needed to measure social capital at the level of households or individuals are very different from those needed to measure social capital at the country level" (Grootaert et al 2004, p. 5). It remains unclear what the experts at the World Bank would expect from a country-level measure of social capital.

Questions for future work in developing statistics on social capital

Our conclusion is rather pessimistic when thinking about the prospects of measuring the volume of social capital in a way that would be comparable over time in national assessment, and comparable between nations.

At the national level, various dimensions of social capital can certainly be measured by survey data and other types of data about social networks, civic action and participation. Technically and to some extent theoretically it might be possible to use multivariate approaches, if one has an extensive multivariate data set at hand. This is seldom the case, when using data that has been collected from various sources, both from registers and from sample surveys. The examples from the regional analyses in Italy (Sabatini 2005) and the United States (Rupashinga et al 2006) suggest that either giant surveys or use of mixed data may be the most promising way forward. Collecting regional data like those used in Italy and the United States is a laborious effort, in particular when repeated from one year to another. Of course, the problem that social capital at a community level is not necessarily a sum of social capitals on individual, household or lower, sub-community levels, is problematic whenever aggregating from regions to national figures.

In international comparisons, the problems are even more complicated due to cultural variation in the concepts of networks, trust and reciprocity, for instance. In addition, the problem that social capital may be more a property of a collective unit, like nation or regional and local communities, is even more strongly present in international comparisons than in national assessment. It may be that the experts of the Word Bank may have this problem in mind when making their remark that country-level measures require different tools from those applied on traditional regional and local analyses.

With increasing number of national reports on social capital, it may become possible to go deeper in the problems of international comparisons. So far, such reports have been too few and from culturally all too similar countries for really critical comparisons. Also serious attempts to assess the volume of social capital at national level have been rare. It may happen that this situation will be improved within a few years to come, and then it is time to return to the question

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3. From measuring social capital to measuring societal well-being: some early thoughts from the United Kingdom

Invited paper by Paul Allin, Office for National Statistics, United Kingdom

Abstract

Social policy interest within the United Kingdom has recognised the importance of social capital (the pattern and intensity of networks among people and the shared values which arise from those networks) and that greater interaction between people generates a greater sense of community spirit. There has been particularly strong interest in measuring social capital as part of neighbourhood renewal and other social inclusion policy agendas. Under Office for National Statistics' (ONS) Neighbourhood Statistics System (NeSS), this broadened into a set of indicators covering community well-being and the social environment. But even that only addresses part of the big picture of societal well-being. ONS is now starting to explore how to measure, analyse and report on societal well-being, embracing and building on social capital and other concepts. This work is still at an early stage in the United Kingdom. The way forward is likely to be to analyse and report on existing indicators, while developing a framework (ideally internationally agreed) for more robust tracking of societal well-being over time and between locations. ONS is also exploring the development of satellite accounts as a way of stepping beyond economic well-being as measured in the national accounts. However, the point of departure for societal well-being is to gain greater understanding of what we already measure as social capital and other social phenomena, and how this contributes to societal well-being.

Social capital

Social policy makers and commentators in the United Kingdom, as elsewhere, recognise social capital as the pattern and intensity of networks among people, and the shared values which arise from those networks. Greater interaction between people generates a greater sense of community spirit, which is desirable. There has been particularly strong interest in measuring social capital as part of neighbourhood renewal and other social inclusion policy agendas. Research has shown that higher levels of social capital are associated with desirable outcomes like better health, higher educational achievement, better employment outcomes, and lower crime rates. In other words, people with extensive networks are more likely to be "housed, healthy, hired and happy" (ref 1). All of these outcomes are generally valued by policy-makers and community members alike.

Definitions of social capital vary, but the main aspects include citizenship, 'neighbourliness', social networks and civic participation. The definition used by ONS, taken from the Organisation for Economic Co-operation and Development (OECD), is "networks together with shared norms, values and understandings that facilitate co-operation within or among groups" (ref 2). Formal and informal networks are central to the concept of social capital. They are defined as the personal relationships which are accumulated when people interact with each other in families, workplaces, neighbourhoods, local associations, faith groups, internet chat rooms, common interest groups, and a range of informal and formal meeting places (ref 3). The plethora of potential networks to which each of us does or could belong is bewildering.

To measure social capital by using the network as the unit of study is a daunting if not impossible task. Instead, social capital is usually measured through surveys of individuals. Respondents are asked a range of questions that cover a variety of issues. They commonly focus on:

- levels of trust - for example, whether individuals trust their neighbours and whether they consider their neighbourhood a place where people help each other;
- membership - for example, how many clubs, societies or social groups individuals belong to;
- networks and how much social contact individuals have in their lives - for example, how often individuals see family and friends.

Neighbourhood statistics

One way of looking at the geography of social capital would be to measure the social capital of a representative sample of individuals within distinct geographical areas and summarise the results for the sample overall. These summary measures could be compared between areas in which social capital surveys are undertaken, but are unlikely to be available for the country as a whole. To have a national survey of social capital that gave reliable results in each community would require considerable resources. Surveys of social capital have therefore tended to be seen either as measures of the national, aggregate position, apart from when surveys have been undertaken within particular local areas, as part of a programme of regeneration or urban renewal for example.

ONS's Neighbourhood Statistics System (http://www.neighbourhood.statistics.gov.uk/dissemination) (NeSS) takes a different approach. It compiles data that are available in each local area, so that a consistent set of indicators and data items are available. These are used within a local area, to profile it and to track changes over time, and to allow comparisons between areas within larger aggregates. The components of NeSS are a mix of measures for the area (e.g. population turnover) and for individuals within the area (e.g. average level of satisfaction with public services). We group indicators into domains, including one covering community well-being/social environment. The indicators in this domain refer to:

- general satisfaction of residents with their local authority and with street cleanliness ('best value performance indicators' survey data);
- satisfaction of local authority tenants with opportunities for participation;
- numbers of communal establishments and of residents in communal establishments;

- self-reported health measures (general health and long-term illness);
- provision of unpaid care;
- population change over 1982-2002;
- population turnover rates;
- migration into area over previous 12 months;
- road accidents in area.

It is not the intention of this paper to evaluate these indicators as measures of social capital. The choice of indicators is driven by the deconstruction of the concept of social capital into things that can be measured at a local level. More pragmatically, the choice of indicators is often dictated by the availability of indicators of suitable quality.

Societal well-being

Societal well-being increasingly features in public policy debate. However, societal well-being is not easily defined or measured. We understand it to refer to the overall well-being of the nation as a whole, embracing economic well-being, the health of the nation, the stock of human capital, and much more.

There appear to be two main approaches to the measurement of societal well-being beyond per capita GDP. The first of these we might characterise as the life-satisfaction/happiness approach. This, like social capital, focuses on the individual. It seeks to measure the perception that people have of their own well-being. The second approach might be called, drawing on development economics, the 'capability approach'. This looks more at collective measures of the quality of life, such as health, education, housing, and participation in social life. While the first approach draws mainly on survey-based data of happiness and life-satisfaction, the second approach appears to give rise to an ever-increasing number of indicators. These include, among many other contenders, the OECD and Eurostat social indicators.

It is regularly noted that no framework for measuring societal well-being exists, unlike the system of national accounts. One factor may well be that there is no common currency with which to measure the many different dimensions of societal well-being. Quality-adjusted years of life may work in the health and social care context, but it is difficult to operationalise this across other aspects of well-being. Consistency over time is an important feature. Changes in societal well-being might intuitively be rather slow to take effect. On the other hand, there might be some changes that reflect a paradigm shift in attitudes or outcomes. In either case, we need measures that allow changes to be determined with confidence. The analogy with measuring turning points in the economy is interesting: might we find social indicators that lead, lag or are coincident with turning points in societal well-being?

In a recent OECD paper reviewing societal well-being, Boarini et al (ref 4) conclude that:

- within the national accounts, other and possibly better measures than GDP per head exist (e.g. net national product, net income). However, these are less widely available and, where they are available, they do not change the picture given by comparing GDP per head over time or between countries;
- illustrative calculations to extend the national accounts similarly do not alter the rankings of GDP per head between countries, However, extending the national accounts does show a different time profile in well-being to that shown by GDP per head;
- similarly, levels of most of the specific indicators of social conditions are significantly correlated to GDP per head across OECD countries, while changes over time are not. A composite index based on these indicators points to significant difference in performance relative to GDP per head in around half of OECD countries, whatever the weights used in the index;
- survey-based data on happiness and life-satisfaction across OECD countries are only weakly related to levels of GDP per head. Research on these subjective measures suggests that several distinct factors – such as joblessness, family and community ties – contribute to overall life-satisfaction and their influence cannot be reduced to a single dimension of economic resources.

The authors' summary is that "measures of economic growth remain critical for any assessment of well-being but they need to be complemented with measures of other dimensions of well-being. How best to integrate these different measures is an open question. One approach is to take measures of economic resources as a starting point and then introduce a series of corrections to incorporate other arguments, but internationally-agreed standards on how to value these various non-market factors have yet to be developed. A different approach is to use various non-monetary indicators alongside conventional measures of economic resources: while still lacking a coherent conceptual and statistical framework, these indicators provide information that is relevant for the assessment of well-being".

Over the years there have been developments seeking to provide their own framework, sometimes within a limited domain rather than for societal well-being overall. These include Stone's social accounting matrices and, more recently, the launch of various satellite accounts around the national accounts (including for the environment, the household economy, tourism and health accounts).

Concluding remarks

Without seeking to devalue the measurement of social capital, it is perhaps inevitable that interest in the measurement of economic and social phenomena moves relentlessly onwards. Within the United Kingdom we are now starting to explore how to measure, analyse and report on societal well-being. It is still early days. We have no results to present or any specific proposals to share. We feel the way forward is likely to be to analyse and report on existing indicators within the context of societal well-being. This data-driven approach has served us well in producing Neighbourhood Statistics for the United Kingdom. It is in the well-developed United Kingdom tradition of 'secondary analysis', extracting further insights from data that were collected for specific purposes and avoiding, at least initially, the expense of designing, testing and implementing new statistical instruments.

Working pragmatically with existing data is unlikely to be sufficient, especially for something as important as societal well-being. So, we recognise also the need to develop a framework for societal well-being. Ideally this should be on the basis of international agreement, for more robust tracking of societal well-being over time and between locations. This could provide further impetus to the development of satellite accounts in future and, for various reasons, we are exploring the potential of satellite accounts.

However, the point of departure for us – and the key theme of this paper - is to gain greater understanding of what we are already measuring as social capital and how this contributes to societal well-being. Our goal is the wider concept of societal well-being, embracing and building on social capital. In this respect we are catching up with Cote and Healy (ref 2) and others who have already recognised the role of human and social capital in economic growth and more widely in the well-being of nations.

The challenge is to deliver relevant, robust, meaningful and timely measures of societal well-being, and to do so cost-effectively. An early aim will be to understand why we should measure societal well-being, so that we can test the usefulness of measures that we produce. The divergence between measures of well-being (particularly life-satisfaction and happiness) and trends in per-capita GDP has been highlighted. The reasons for this are not well understood, so nor are the policy options that might be appropriate. We need to understand the process more clearly, so that we can identify who needs to know about the state of societal well-being and what they can do to improve it.

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4. Social capital: measurement and meaning

Invited paper by Organization for Economic Co-operation and Development (OECD)
Paper presented by Enrico Giovannini

Introduction

OECD work on social capital (SC) began some years ago with work which culminated in 2001 in the publication of *The Wellbeing of Nations*. This set out the case for extending the analysis of the role of human capital in economic performance, so that the role of networks, norms and values in growth and social cohesion would also be included. Since then, there has been some continuing discussion of how far SC can be measured and operationalised within OECD. For example, in November 2004, in the context of the first OECD World Forum on "Statistics, Knowledge and Policy", a session was organised to discuss different approaches followed by some national statistical offices to the measurement of SC.

More recently, some work has been done within the Statistics Directorate on wellbeing/progress and within the Education Directorate on the links between education and civic and social engagement (CSE - encompassing many of the features of SC), including the possible development of indicators on CSE – see www.oecd.org/edu/socialoutcomes/symposium and a forthcoming publication *Understanding the Social Outcomes of Learning* (CERI 2007). Moreover, in the context of the OECD-ECE-Eurostat working group on sustainable development the issue of social capital is under discussion.

To avoid duplications with other papers and reviews, this paper mainly deals with the relationship between human and social capital, but of course the issues are broader than this.

Social capital as capital – a metaphor?

The emergence of social capital and other forms of capital has been chronicled many times. These extensions of the uses of the term have sparked continuing debate amongst a range of disciplines, about how tightly 'capital' is to be defined. Roughly speaking, a continuum can be seen as running from a view of capital as a purely economic term that can strictly be applied to physical and financial resources, to a very loose approach that allows it to be attached to more or less anything which can be thought of as an asset of some kind and/or yields some kind of return or added value. Human capital comes closer to physical capital in terms of the acceptance of it in mainstream economics and the number of points of logical coherence that it has in common with physical capital. The point at which the line between a literal and a metaphorical application of the term is to be drawn varies enormously; so does the weight that might legitimately be attached to any analysis involving the term.

Assuming for the moment that the concept of SC is not immediately disqualified on the grounds of an illegitimate use of the term 'capital', there are at least three reasons why its use might be seen as potentially valuable in relation to both economic and social policies:

- it broadens the range of inputs to be considered in the processes which generate wealth and wellbeing;
- it broadens the range of outputs to be used in measuring wealth and wellbeing;
- it encourages a more dynamic approach , so that the interactions between different forms of capital are included. This is of course also a disadvantage in so far as it makes the measurement process more complicated.

"Capital" has a number of dimensions under which SC can encourage reflection and analysis, whether or not it is treated primarily as a metaphor. These also pose measurement challenges – which may or may not be considered too difficult for regular data-gathering purposes.

- *Stocks*: physical capital is tangible and relatively straightforward to value. Human capital is harder to assess, let alone value; the usual approach to measurement is to use the levels of qualification achieved, or, even more crudely, the duration of education by years of schooling. If social capital is about relationships, the notion of a stock of relationships is not very coherent. On the other hand, some components, such as the level of trust within a community, have over time strengths and weaknesses that might reasonably be referred to as stocks. The stocks issue raises questions about decay. This is important in the light of growing interest in the notion of sustainability. Physical plant is written off, though at very varying rates of depreciation. In relation to human capital the notion of a half-life, borrowed from physics, has some currency, with shortening half-lives indicating the rapidity of technological and other change and the need for constant updating. In respect of SC, there is the striking reversal of the usual pattern, with SC thought of as increasing rather than decreasing through usage, and conversely declining through non-usage.
- *Ownership*: the owner of physical capital can sell it or give it away if they cannot find a buyer. Human capital is obviously different. People may pass on skills to others, and do so for money. But they do not thereby lose ownership of the skills – even though their value may be in some small measure diminished because of reduced scarcity. It is illegal to sell ownership of qualifications, precisely because they are awarded to an individual in respect of knowledge or skills acquired by that particular person. Social capital is different again. A crude and individualised interpretation of SC measures it in terms of personal contacts – the size of one's address book. But norms and networks are not owned, but subscribed to. People cannot hand over their social capital to someone else, whether or not money is involved. Social capital could be thought of as primarily a collective asset. It inheres in relationships, which requires at least two agents to be involved. Because of this inherent quality social capital is not alienable; those involved cannot even collectively decide to rescind ownership and pass it on to some other set of

people. This does not conform to the traditional economic model in which a cooperative or a state can decide to sell off its assets.

- *Returns*: human capital generates both private and public returns, though demonstrating it conclusively is still surprisingly difficult. It enables individuals to gain higher-paid jobs. It enables a company, and by extension a nation, to compete successfully on the economic front. It also appears to generate social returns in the form, for example, of improved health, which benefits both the individuals concerned and the wider collectively. Social capital likewise brings benefits to individuals and more broadly to communities and publics. It enables human capital to be realised, as the networks involved give access to employment opportunities. But SC is also itself a return, something to be valued in its own right.
- *Distribution*: finally, the distribution of capital in its different forms is a major issue. There can be significantly different levels of social capital across groups, with differential returns. A high concentration of social capital in one group can change the value associated with it, from positive to negative, at least potentially, because the benefits it generates for insiders are outweighed by negative externalities. This is why the social capital of a whole community needs 'bridging' as well as 'bonding' components, i.e. relationships outwards as well as inwards to other members of the group.

These are not just intellectually interesting issues to consider. In particular, they point to how the effectiveness of human capital depends on the presence of social capital, so that skills and competences can be deployed and valued. The interaction between different forms of capital – multiplicative rather than additive – is a key feature. In terms of methodology, the acceptance of human capital as a major factor in economic growth will have run through some of the same issues before gaining acceptance as an essential tool of economic and social policy analysis, albeit one with still many very rough edges. As *The Wellbeing of Nations* argued, the notion of human capital has needed to be expanded and refined over time. Its measurement remains very imperfect; but no one doubts its relevance and applicability. It may be that SC is now following a similar trajectory, but with more complexities.

Measurement for what?

The above discussion raises the issue of the purposes of measurement. From the OECD angle particularly, the great advantage of human capital has been its fruitfulness in expanding the analysis of reasons why some economies perform more successfully than others. Could the same be true of SC? The answer to this depends very largely on what models people operate with for approaching the analysis of economic and social performance. Putting it very crudely, if the search is for discrete independent variables which can be inserted into regression (or other) analyses to explain particular levels of performance, or differences in levels of performance, then 'social capital' as a concept is often likely to be both ill-specified and misleading.

If, on the other hand, the aim is to open up complex issues where multiple interactions are seen as inevitable, and different interpretations of these interactions as similarly inevitable and even desirable, then SC may be a far better guide to sound analysis and valid policy prescription. Bringing SC into the debate complicates matters rather than simplifying them. It does not supply a neat new tool of the same kind as previous tools but higher calibre, but entails a more multidimensional approach to analysis. But of course there will be no single figure answer to give as an end product of the analytical work, and this weakens its impact in the hurly-burly of short-term political decision-making.

The answer to questions about the measurability and utility of SC will depend in part on what the models are of the use of evidence in policy-making, and the definition of evidence itself. This is an issue which is currently gaining – or regaining – particular salience, at least in the education sphere. The legitimacy of much of what passes for evidence is being increasingly challenged, by different stakeholders in different ways. The range of information available has grown hugely, but the problem of assuring the quality of the information has also grown. And there is some fierce methodological warfare between those who would prefer a single hierarchy of evidence, with randomised control trials (RCTs) at the apex and those who have a more pluralistic view[1]. All of this means that the reliability of measures and the feasibility of data-gathering are only two of the factors which go into the overall debate on the utility of SC.

Levels and context

What is the appropriate unit of analysis? Can we assess the volume/effects of SC for an entire nation, or can it only be done at more local or neighbourhood level? The problem of aggregation has been frequently pointed out; it is compounded by the interaction between SC at different levels. In 2005 Halpern argued that intervention can operate at three levels:

- micro or individual level, through support for families, mentoring schemes, volunteering;
- meso or community level: promoting vibrant local government, building community-based asset schemes, building networks between firms, employees and community, and using ICT to strengthen neighbour interaction;
- macro or society level: promoting citizenship education, developing community credit schemes that reward volunteering, and developing genuine shared moral discourse to encourage mutual responsibility.

He goes on to draw up a quite complex 3-dimensional diagram for mapping different forms of SC to these different levels. Conceptually this is very helpful. However it does not necessarily make the task of specifying and gathering data clearer, especially when, as Halpern himself recognises, the interaction between these different levels is extremely significant.

[1] This is to put the issue in polarised terms, which is arguably not helpful – i.e. there are supporters of RCTs who would also argue for pluralist approaches.

That said, some broad comparisons have been made at national level, especially within Europe. The Statistics Finland paper does a good job in summarising some of the issues involved, and the concluding sentence of its section on the topic is suitably sceptical: “ It remains unclear what the experts at the World Bank would expect from a country-level measure of social capital.” However some inter-country patterns can be discerned with reasonable plausibility. In 2006, Adam examined the World Values Survey, the European Values Survey and the European Social Survey: although he is sceptical about the Values surveys, nevertheless he concludes that there are four groups of countries discernible, especially the two at the extremes (high SC: Nordics plus Netherlands; low SC: many East Europe plus some Mediterranean). It is not clear that this is doing much more than confirming common sense, but Adam rightly stresses that triangulation, combining different types of data, is a very important target to aim for.

Awareness of context is always important in comparative work, but perhaps particularly so in relation to SC. This applies to the cultural or ideological attitudes displayed towards the concept. These range from the enthusiasm shown in at least some academic and policy quarters in the US to a quite widespread hostility in France. This latter stems from the general identification of social capital with ‘communautarisme’, which to French people of very different political persuasions signals an erosion of republican traditions of solidarity.

Context also covers perceptions of the state and its effect on SC. In some contexts, SC is seen as in some sense an alternative to or a counterweight to state provision, most obviously in the role of the voluntary sector. The state can be seen as the inhibitor of SC; conversely SC can be seen as some kind of safeguard against the inadequacies or even dominance of government. In others, notably in Scandinavian countries, the relationship is more of a positive sum game, with state and voluntary sectors seen as complementing each other; state support for citizens’ study circles is an example. Specification of the significance and impact of SC therefore depends on how the role of the state is defined and analysed, at different levels. SC may be a substitute or compensation for inadequate government; a challenge to the authority of government; or a positive complement – or, of course, a mixture of these.

Do labels matter?

In one sense, it does not matter whether or not the term ‘social capital’ is actually used, as long as the phenomena it refers to are adequately specified. But it may matter considerably, in at least two contrasting senses. First, on the positive side: SC may be a way of bringing together quite diverse elements which are nevertheless closely interrelated, such that analysis of one of them cannot be adequately undertaken without the others being taken into account. This is the thrust of the arguments linking human and social capital. Using SC compels analysts and policy-makers to look at issues more in the round, and therefore, arguably, more realistically.

On the other side, it may be that lumping these different elements – trust, civic activity, political participation, network engagement, - together under a single heading is not just conceptually clumsy but misleading, because it encourages analyses which attempt to cover too much. Here holistic approach meets analytical edge. It may be that the way out of this is to look rigorously at what is meant by a multi-dimensional approach; and also to bring into play the notion of iterative triangulation: not only the use of multiple data types and sources, but their use over time in an iterative way, so that results and implications are continuously checked and refined.

SC and productivity: gender and migration

An example of how SC can be meaningful in an assessment of investment and productivity is provided by considering changes in the gender patterns of human capital accumulation. In almost every OECD country women are overtaking men in educational achievement, at every level and in almost every subject. It is a hugely striking trend. SC has a double significance here. First, in contributing in part to an explanation: the norms which girls exhibit in their peer groups tend to favour school work and value achievement, so that the female groups help each other to succeed, raising young female human capital levels much faster than male. However this does not always translate into returns, at least not in salary terms. Why not? In part because male social networks continue to operate, reducing meritocratic allocation of higher-paying jobs. Females lack the linking social capital needed to take them upwards in the hieararchy, and the result is a sub-optimal allocation of qualified personnel.

The explanatory power of SC is evident, though in the former case at least it could more simply be called peer group effects. However the measurement issues are formidable, at least when it comes to any form of national indices.

The same issues arise, in different degrees, with other sub-optimal forms of HC allocation. Another example is where skilled or highly skilled people migrate but cannot get their skills recognised. This may happen formally or informally. Sometimes it may be for good reason, where the skills do not have the same application in a different cultural context. But sometimes it will be because the individuals lack the necessary social capital to enable them to know about and exploit job opportunities. Understanding productivity is likely to be enhanced by analyses which include SC.

Conclusion

System complexity is a challenge which can be accepted, or ducked on the grounds that it is not susceptible to some of the most powerful current tools of analysis. Social capital can at the very least help us to focus on the interaction between different forms of capital, in order to build a more realistic and robust framework for a complex world. This need not stop the search for better individual measures or indices for social progress. It may mean, though, that the most potent contribution of SC is to the quality of the dialogue on what is meant by social progress, rather than as a single coherent conceptual tool.

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