

Human capital measurement: country experiences and international initiatives

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1. Introduction

1. Measuring human capital can serve a number of purposes, e.g. to better understand what drives economic growth, to assess the long-term sustainability of a country's development path, and to measure the output and productivity of the education sector. Moreover, recent discussions on 'beyond GDP' have led to growing attention to the distribution of human capital across households and individuals, and on the non-monetary benefits stemming from it.
2. Many researchers and organizations have taken steps to produce measures of human capital, relying on a variety of approaches. The diversity of the approaches to measuring human capital makes it hard to draw policy implications from comparisons of these measures within and across countries, and thus calls for efforts to develop consistent measures based on theoretically sound and practically feasible methodologies.
3. This chapter aims to make a review of the country experiences and international initiatives in the field of human capital measurement, with a view of identifying the trend emerging from these activities. In order to improve the quality of the existing popular measures of human capital, some of the remaining statistical and methodological challenges are discussed that should be addressed in the future.
4. The rest of the chapter is organized as follows. Section 2 provides an overview of the comprehensive domain of the concept of human capital. In Section 3, the subsequent implications for the measurement are discussed. Section 4 and Section 5 review the country experiences and international initiatives respectively, based on a recent questionnaire, and on literature survey of the leading activities in this field. Main issues and challenges remained are described in Section 6. Section 7 concludes.

2. Concept and definition

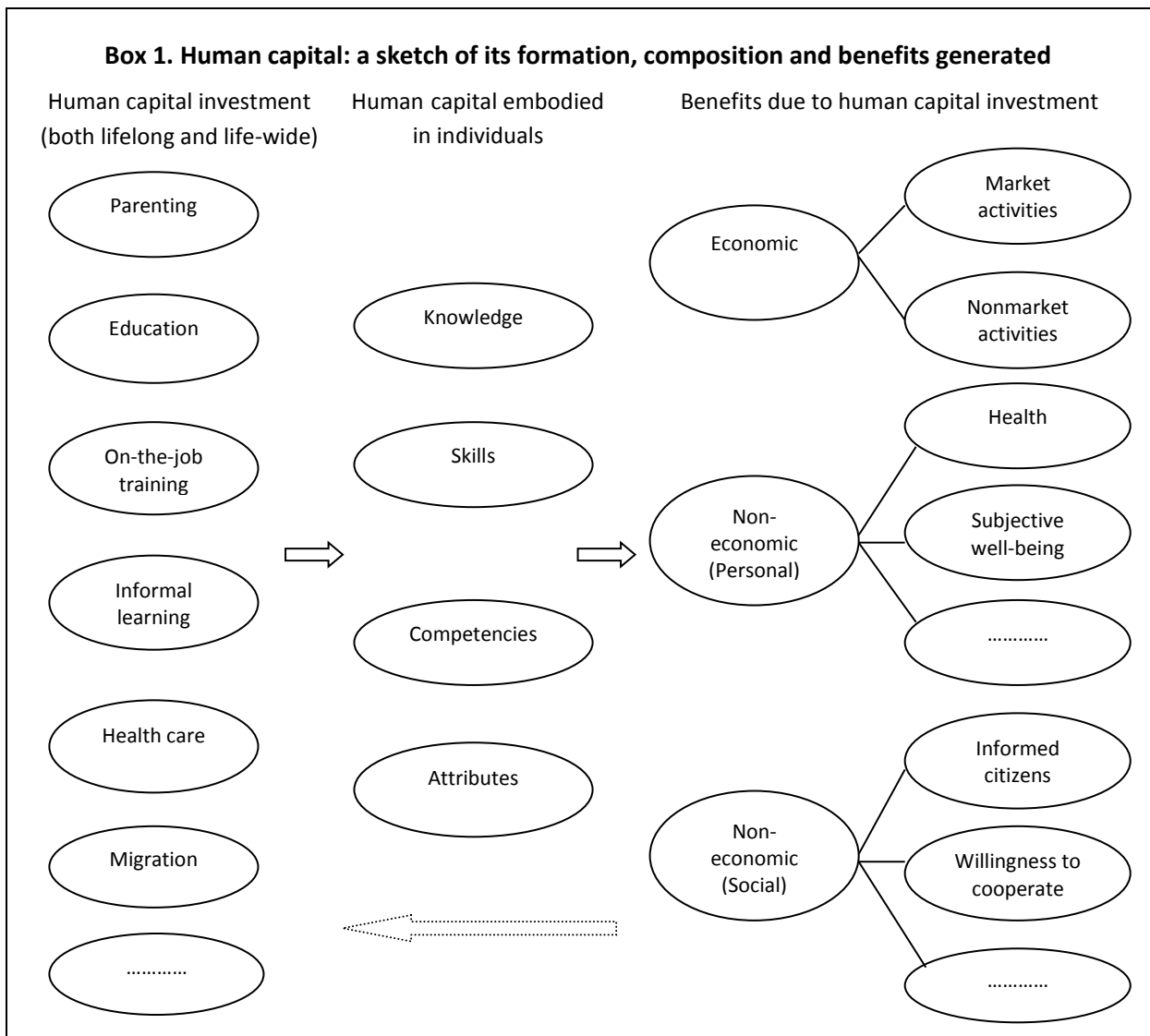
5. The concept of human capital has its roots in the history of economic thought, as reflected in Petty (1690), Smith (1776), Farr (1853), and Engel (1883), where human beings and their acquired abilities were considered on a par with traditional assets (e.g. land and fixed capital), as important components of national wealth.
6. Thanks to the seminal works by Schultz (1961), Becker (1964) and Mincer (1974), the human capital concept regained recognition in 1960s, and since then it has been regularly applied for

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addressing a variety of issues such as economic growth, education, on-the-job training, migration and social exclusion.

7. The definition of human capital varies in the literature, but the majority put stress on the economic returns in the form of higher earnings and economic growth. However, human capital investment delivers many other non-economic benefits as well (e.g. improved health status, enhanced personal well-being and greater social cohesion), which are viewed by many as being as important as, if not more important than, the economic benefits.
8. Recognizing both economic and non-economic aspects, the OECD proposed a broad definition of human capital as *'the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being'* (OECD, 2001). This definition has gradually obtained wide acceptance.
9. Box 1 displays a stylized drawing of the elements pertaining to the OECD definition, comprising the essential constituents that make up human capital, the numerous channels through which human capital is developed, and the diverse benefits that human capital delivers.



10. First, the overarching OECD definition incorporates various skills and competencies that are acquired through learning and experience, but may also include innate abilities. Some aspects of motivation and behavior, as well as the physical, emotional and mental health of individuals are also regarded as human capital within this broad definition (OECD, 2001).
11. The components of human capital reflect essentially its multi-faceted nature. For instance, they include both general and work-specific skills, as well as tacit and explicit ones. They cover not only the cognitive skills that were conventionally recognized but also non-cognitive skills such as intra- and inter-personal skills that have assumed an increasingly important role in modern societies.
12. Distinct from traditional fixed capital, almost all types of knowledge, skills, competencies and attributes are invisible. While fixed capital wears out through use, human capital typically grows through use and experience. However, both human and fixed capitals accumulate through investments while decline due to obsolescence, although not in the same manner.³
13. Second, human capital can be accumulated through many channels that may be characterized as both *lifelong*, in terms of learning from birth to death, and *life-wide*, in terms of learning at various occasions, including families (through parenting), schools (through formal and informal education), workplaces (through on-the-job training and work practice) and even daily life (through informal learning, anywhere and anytime).
14. Human capital development is normally involved with private and public resources, as well as market and nonmarket inputs. A distinct feature of human capital investment is that almost all types of such investment require learning by individuals, an activity that is not only nonmarket, but also outside of the production boundary of the current System of National Accounts (SNA).⁴
15. The way human capital is developed also hinges upon a range of environmental factors, such as cultural backgrounds, social relationships, as well as political, legal and institutional arrangements. For instance, skill development takes place in many different stages of lifecycle, during which social capital (i.e. networks and norms) plays a critical role in fostering a culture of learning within a society (Coleman, 1990).
16. Health care is regarded as one type of human capital investment in Box 1, because health condition is one of the vital attributes that are encompassed by the broad notion of human capital.⁵ Moreover, a better health status normally enhances an individual's learning abilities and also job market performance, so that his/her embodied human capital can be utilized in a more efficient way.

³ For example, human capital depreciates due to lack of use, obsolescence of knowledge, population ageing and many other factors.

⁴ Because the activity of learning cannot be undertaken by anyone else than the person considered, it fails to meet the 'third party criterion' that defines the production boundary of the SNA.

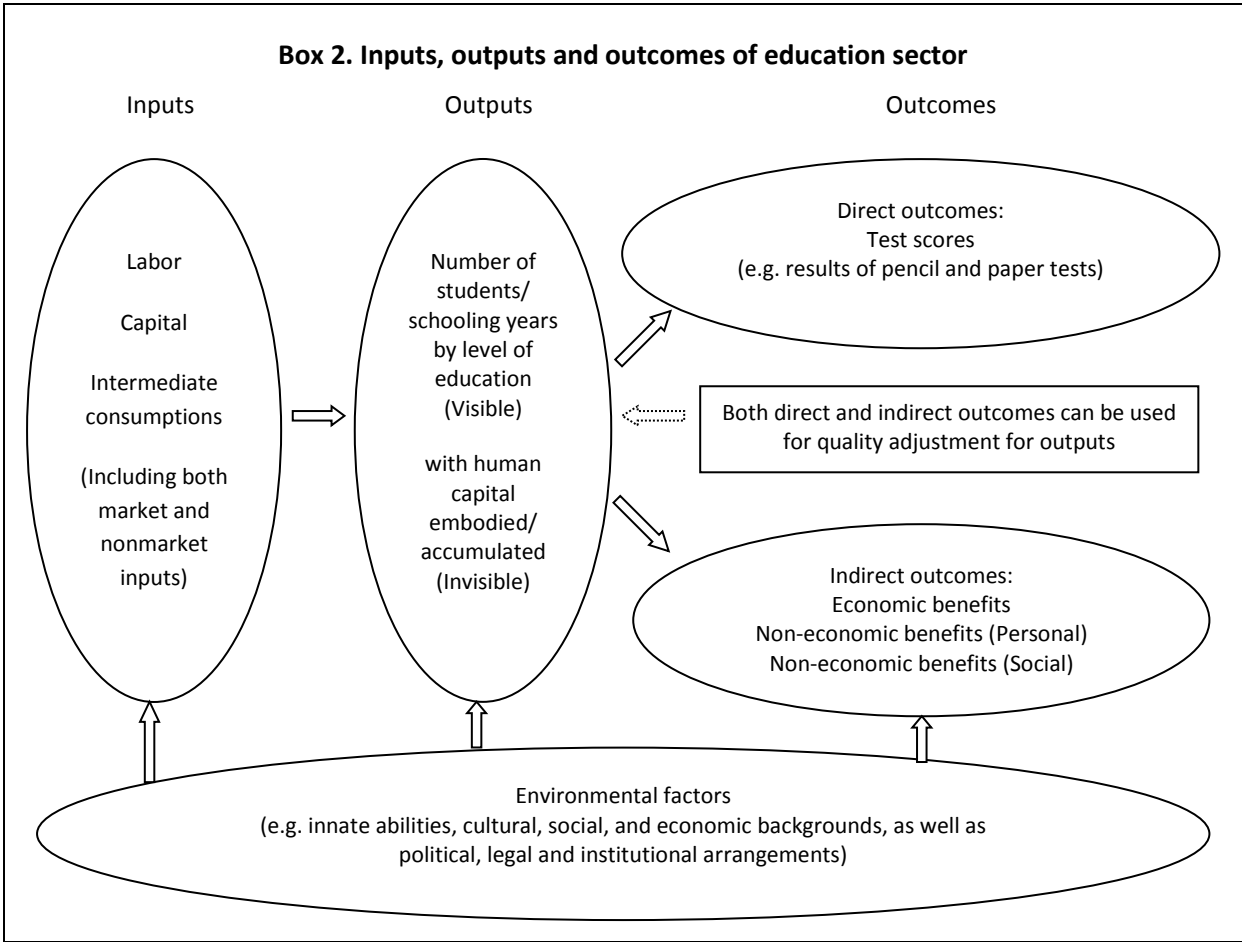
⁵ For example, Gary S. Becker viewed *education*, *on-the-job training* and **health** as components of human capital, all having consequences for earnings and economic productivity (Becker, 1993).

17. Human capital investment in any given country may also take the form of migration, with the immigration of skilled people representing an addition to the stock of human capital for the country of destination, and a depletion of human capital for the country of origin.
18. Third, human capital investment can generate both economic and non-economic benefits. Economic benefits include enhanced employability and, if employed, improved earnings and career prospects for individuals undertaking the investment; while non-economic benefits can take the form of productivity increases in performing nonmarket activities (e.g. household production) or of personal benefits that are not related to production (e.g. greater enjoyment of arts and culture, higher health status and subjective well-being).
19. The benefits can also spill over to other agents and even to society at large. For instance, at the firm level, higher productivity of some employees, due to higher education, may increase the performance of other workers and, hence, firms' profitability. At macro-economic level, recent evidence has highlighted the positive impact of human capital on economic growth. Further, these spill-over are not limited to economic returns, e.g. education may make people better citizens and better parents, leading to greater social cohesion.
20. Finally, as illustrated by the dotted arrow in Box 1, there also exist feedback effects, running from the benefits generated by human capital investment onto the investment itself. For example, workers with higher education are more likely to benefit from and thus be willing to pursue further education and training.
21. In addition, the feedback process may lead to a virtuous cycle where more education makes further learning even easier and faster, and thus more efficient. At the national level, there is a long-standing debate on the direction of causality between education and economic growth. Recent studies have demonstrated that the causality may operate in both directions, suggesting that a feedback loop may also operate at the macro level.

3. Implications for measurement

22. There are so many elements involved in and intertwined with the concept and definition of human capital that getting a full picture of every single element, of the causal links between each type of human capital investment and the corresponding benefits, and of the feedback loop among them, is quite complicated.
23. This implies that encompassing all the elements of Box 1 into a single measure of human capital is a daunting task, which could not be realistically accomplished in the foreseeable future. The most sensible approach is to address this task step by step.
24. A sensible way is to focus on a narrower range of elements, starting from those aspects characterized as of either lower conceptual challenges or greater data availability. For instance, most of the human capital definitions currently employed distinguish human beings themselves from the acquired abilities, and include only the latter within the domain.

- 25. Closely related to this choice, health status is often considered separately as another specific asset, i.e. health capital (e.g. Abraham and Mackie, 2005) because of its apparently distinct feature, and also due to practical difficulties such as how to distinguish health related expenditures between purposes for consumption and investment.
- 26. One frequently chosen option by many researchers and institutions is to focus on formal education as the main form of human capital investment; and on the economic returns accruing to individuals, as the main benefits due to human capital investment,⁶ even if the broader OECD definition is accepted as a useful reference point.⁷
- 27. Presently, there exist a number of different ways to measure human capital, even if the definition of human capital has been narrowed down to (formal) education only. Box 2 draws a picture about the inputs, outputs and outcomes of (formal) education sector. When treating the education sector as a production unit, its output should be considered as human capital investment rather than education services as stipulated by the SNA convention.



- 28. Although this notion has been widely recognized, to measure the output which is invisible is never an easy task. Some use the visible indicators, part of them quantitative (such as number

⁶ However, it does not imply that there are no other possible ways to move beyond this option.

⁷ More on this is in Section 4.

of students/average schooling years), the others qualitative (such as class size⁸, test scores) as proxies for human capital; these physical measures of human capital can be classified as one category labeled the indicators-based approach.

29. Another category of approaches to measuring human capital is monetary measures, which can be further divided as the cost-based, the income-based and the residual approaches. The cost-based approach measures human capital by looking at the stream of past investments undertaken by individuals, households, employers and governments (e.g. Shultz, 1961; Kendrick, 1976; Eisner, 1985).
30. This approach relies on information about all the inputs that are incurred when producing human capital. As shown in Box 2, these include market inputs such as monetary outlays by each of the agents mentioned above, but can also be extended to nonmarket inputs (e.g. the imputed value of the time devoted to education by students, their parents and volunteers).
31. By including nonmarket inputs, the cost-based approach differs from the way the output of education sector is currently measured in the SNA, although they are similar. Because many education services, the product of education sector as specified by the SNA, are provided by government, their values are measured based on the costs of market inputs into this sector.⁹
32. The income-based approach measures human capital by looking at the stream of future earnings that human capital investment generates over a person's lifetime (e.g. Weisbrod, 1961; Graham and Webb, 1979; Jorgenson and Fraumeni, 1989, 1992a, 1992b). In contrast with the cost-based approach which focuses on the input side, the income-based approach focuses on the outcomes of human capital investment.¹⁰
33. Note that a distinction is deliberately made in Box 2 between outputs and outcomes of the education sector. By using the jargon of national accounting, outputs refer closely to activities or processes that are within the production boundary of the SNA, i.e. the provision of education services, while outcomes are further away from this provision, with indirect outcomes being even further than direct outcomes.
34. Although the whole transition from inputs to outputs and further to outcomes are all subject to various environmental factors, it is argued that more and more environmental factors will play a part in the transition from outputs to outcomes. Thus, neither direct nor indirect outcomes are considered to be proper measures of the outputs of the education sector.
35. As a result, to measure the outputs of the education sector, the current SNA not only excludes many nonmarket inputs, but also sets the boundary of its measuring scope to the outputs only. However, information about either direct or indirect outcomes, in particular about the

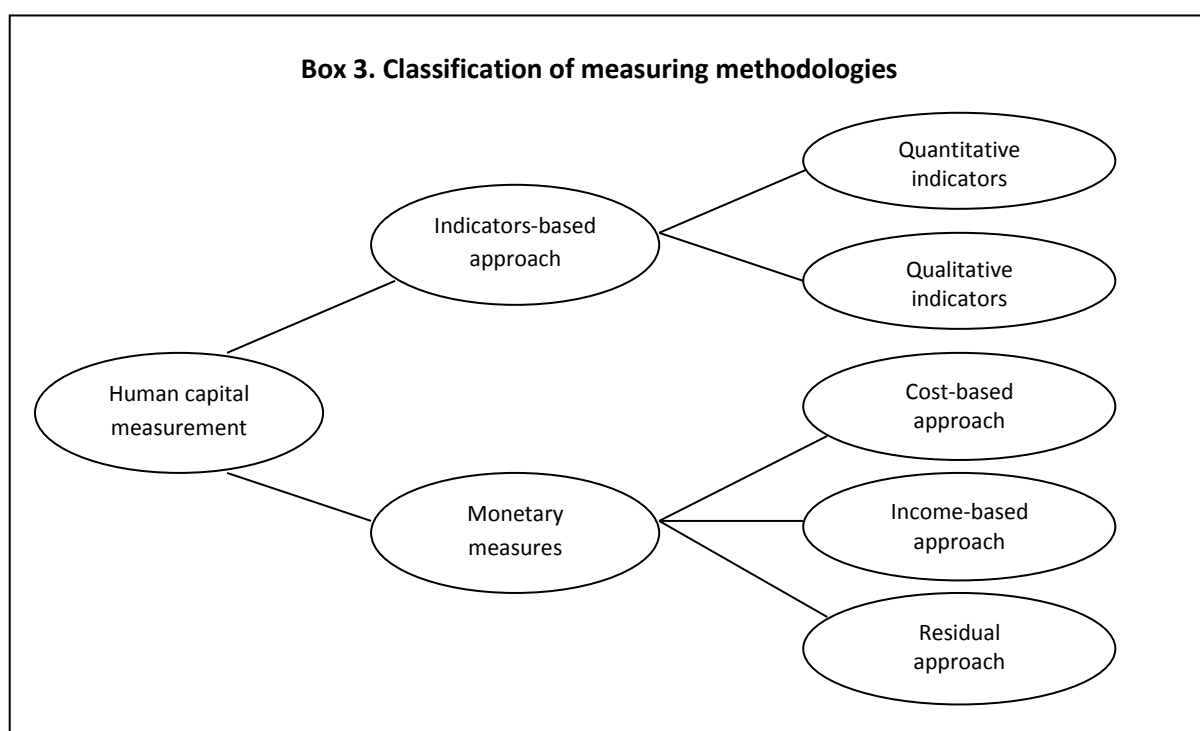
⁸ As qualitative information, class size can be used to explicitly quality-adjust the outputs of the education sector.

⁹ The market inputs include teachers' wages and salaries, the consumption of fixed capital, household expenditures for school fees and educational materials, etc.

¹⁰ While the outcomes from human capital investment are of many types (i.e. monetary and non-monetary, private and public), what is measured by the income-based approach is limited to the private monetary benefits that accrue to the person investing in human capital.

contribution of education services to these outcomes, can provide a tool for the explicit quality adjustment of the outputs, as indicated by the dotted arrow in Box 2.¹¹

36. Another monetary measure is the residual approach that is applied by the World Bank through its comprehensive wealth accounting. This approach measures human capital as the difference between the total wealth and the sum of produced and natural capitals (World Bank, 2006, 2011; Ruta and Hamilton, 2007; Ferreira and Hamilton, 2010).¹² A similar approach has also been applied by Statistics Norway (Greaker et al., 2005) at the country level.



37. All the different approaches as shown in Box 3¹³ have advantages and disadvantages.¹⁴ Depending upon the purpose, different approaches may therefore be used, either individually or jointly with others. However, given the importance of the SNA in official statistics and for economic analysis, monetary measures, in particular the cost-based and the income-based approaches, are most likely to be used to construct human capital measures based on an explicit accounting framework consistent with the SNA.

¹¹ Therefore, even if within the framework of the current SNA, the results generated from the qualitative indicators (e.g. test scores) as well as from the income-based approach (e.g. earnings differentials) can well be applied for this purpose.

¹² This difference is labeled by the World Bank as 'intangible assets', of which human capital is found to be the most important component (World Bank, 2006, 2011).

¹³ This typology as shown in Box 3 is not the only way to classify the various approaches. For instance, a distinction can also be made between parametric and non-parametric approaches to measuring human capital. The former involves econometric techniques (e.g. Kyriacou, 1991; Mulligan and Sala-i-Martin, 1995; Barro and Lee, 2010), while the latter usually does not.

¹⁴ More on this is in Section 4 and Section 5.

4. Country experiences

38. This section provides an overview of national practices in measuring human capital,¹⁵ with focus being put on the purpose, concept, methodology, and data sources applied, in a view to identifying the trend emerging from country experiences.
39. The overview starts with a summary of results from a recent survey questionnaire responded by the UNECE CES countries;¹⁶ then representative studies are reviewed.¹⁷

4.1 Results of the UNECE CES questionnaire on measuring human capital

40. Overall, out of the 70 CES countries, 46 answered the questionnaire, with 17 providing detailed answers.¹⁸ Highlights from countries' responses include the following:
- For most countries, the purpose of measuring human capital is multiple, including for education related policies, growth accounting/productivity analysis, national wealth accounting, satellite account construction, sustainability assessment, and measuring well-being and social progress.
 - Although some countries refer to the broad OECD definition of human capital, many countries prefer to use definitions that have narrower scope, tending to focus on the economic/productive dimension.
 - Data sources used are diverse, including survey data, administrative data, census data and others. Almost all data needed for making measures of human capital are available within the statistical system of each country.
 - Measuring human capital is carried out usually by either independent researchers or statisticians working with national statistical offices. Although most of the existing estimates are in the form of research results instead of official statistics, many countries measure human capital on a regular basis, most of them annually.
 - Only a few countries plan to construct satellite accounts for human capital in general and for education sector in particular. Likewise, very few countries have assessed the possibility and potential implications of incorporating measures of human capital into the SNA.

¹⁵ This brief overview, to a large extent, tends to be representative rather than exhaustive.

¹⁶ The UNECE CES (Conference of European Statisticians) questionnaire was designed by the OECD, and collected by both the OECD and the UNECE, with the purpose of providing an overview of what countries have done, are doing, and are planning to do in the field of human capital measurement. The questionnaire and answers to it are summarized in Boarini et al. (2012).

¹⁷ The residual approach will be discussed in Section 5 on international initiatives, because at the country level, there are just a few countries applying this approach (e.g. Norway, the Netherlands).

¹⁸ They are, among OECD countries, Austria, Canada, Finland, France, Germany, Israel, Italy, the Netherlands, New Zealand, Norway, Poland, Slovenia, the United Kingdom and the United States; and, among CES non-OECD countries, Liechtenstein, Romania and Ukraine.

- In terms of measuring methodologies, physical indicators and monetary measures are most often applied. Most countries choose only one single approach, and the majority of them rely on monetary measures only; while a few other countries choose multiple approaches.
- For many countries, conventional quantitative indicators are still used that are drawn from education statistics, such as population distribution by education category, average years of schooling, etc. Only a few countries collect qualitative indicators such as those undertaken by the PISA and PIAAC.¹⁹
- Among the monetary measures, the income-based approach is predominant over the cost-based and the residual approaches. The main reason provided for relying on the residual approach is its simplicity, despite its obvious absence of theoretical appealing.
- The main reasons for choosing the cost-based approach are data availability, applicability in the SNA, and no requirement of making assumptions about the future, while the main challenges are still the issues related to data availability. Some countries included in their estimates not just the costs incurred by educational institutions, but also expenditures by firms and private households. However, no countries have ever included nonmarket costs in their estimates of human capital based on the cost-based approach.
- The main reasons for using the income-based approach are its consistency with economic theory and with the way in which other assets (such as natural resources) are measured in the SNA. This approach is also considered to be well established and widely employed, and to be suitable for constructing a fully fledged human capital account with volumes, values and prices as basic elements. Issues related to the methodology and data availability, rather than the concept itself, are regarded as the main challenges for applying this approach. Partly due to data limitations, almost all countries having used the income-based approach limit their estimates to the working age population and to market activities only.

4.2 *Representative studies using the indicators-based approach*

41. Indicators that are often used as single proxies for human capital include adult literacy rates (e.g. Azariadis and Drazen, 1990; Romer, 1990), school enrolment ratios (e.g. Barro, 1991; Mankiw et al., 1992; Levine and Renelt, 1992), average years of schooling and other measures drawn from the distribution of population across various educational categories (e.g. Benhabib and Spiegel, 1994; Barro and Sala-i-Martin, 1995; Gundlach, 1995; Islam, 1995; O'Neill, 1995; Temple, 1999; Barro, 1997, 2001; Krueger and Lindahl, 2001).
42. A single physical indicator as a proxy for human capital, though simple, cannot on its own adequately measure the various dimensions of skills and competences (OECD, 2001), and sometimes even poorly specifies the relationship between education and the stock of human capital (Wößmann, 2003; Kokkinen, 2010).
43. Dashboard type indicators (e.g. *Education at a Glance*; Ederer et al., 2007, 2011) rely on a number of statistics that, though rich in information, lack a common metric, as a result, cannot

¹⁹ These refer to two OECD projects, i.e. the OECD Programme for International Student Assessment (PISA) and the OECD Programme for International Assessment of Adult Competencies (PIAAC)

be aggregated into an overall measure. This makes them less suitable for comprehensive comparisons of human capital across countries and over time. Further, indicator sets do not allow the comparison of the relative importance of different types of capital, i.e. produced, natural and human capitals (Stroombergen et al., 2002).

44. On the contrary, monetary measures combine many different aspects that contribute to human capital in a single metric. For example, estimates by the income-based approach allow comparing the importance of demography (the age and gender structure of the population), educational factors (the number of people with different levels of educational attainment, enrolment rates) and labor market factors (employment probabilities and earnings). Similarly, human capital estimates by the cost-based approach allow comparing the relative importance of the expenditures incurred by different sectors (public administration, households, and firms) and of market and nonmarket inputs.

4.3 *Representative studies using the cost-based approach*

45. The cost-based approach to measuring human capital is similar to the perpetual inventory method that is conventionally applied to measuring fixed capital, i.e. the stock of human capital is measured as the accumulated value of all the expenditures occurring to its formation, considered as human capital investment.
46. The cost-based approach is relatively easy to apply, at least when limited to market inputs, because of the ready availability of data on both public and private expenditures in formal education. The approach can also be extended to account for expenditures undertaken for on-the-job training.²⁰
47. However, this approach has been criticized on a conceptual ground as the value of human capital should be regarded as determined by demand and supply rather than solely by production costs (Kiker, 1966; Le et al., 2003).
48. Another problem with this approach is that it is hard, if not impossible, to distinguish expenditures between investment and consumption,²¹ thus estimates based on this approach rely virtually on arbitrarily allocating spending between these two categories in practice.
49. Challenges are also involved with the choice of the price indices used to deflate historical expenditures in order to construct a stock value based on the perpetual inventory method. Moreover, the depreciation rate, which matters a great deal when constructing the stock of human capital based on this method, is usually set arbitrarily in practice.
50. Overall, this approach ignores a fundamental feature of the process of education, i.e. the lengthy gestation period between the current outlays for educational inputs and the

²⁰ This point holds if the skills accumulated through on-the-job training can be separately treated as one specific type of human capital, distinct from that due to formal education.

²¹ For instance, during the period of taking education, part of household expenditures is used for paying students' food and clothes, which could serve both consumption and investment purposes.

emergence of human capital embodied in more competent people (Jorgenson and Fraumeni, 1989, 1992a).

51. The most well-known application of the cost-based approach is provided by Kendrick (1976) for the United States. Kendrick's estimates are more inclusive than most other applications of this approach, as they include the cost of child rearing, spending on education and other expenditures considered as having educational value.
52. In addition to these expenditures, Kendrick also includes the opportunity cost of student time, i.e. earnings forgone by students when studying. Following the same approach, Eisner (1978, 1985, 1988, 1989) estimated the value of human capital in the United States through a number of modifications to the US national income accounts.
53. Both Eisner and Kendrick included in their estimates of human capital formation the opportunity cost of students' time while in school, as well as the actual costs of education undertaken by both households (e.g. costs for tuition and educational materials) and governments (e.g. costs for salaries and investments of educational institutions). However, unlike Kendrick, Eisner excluded the costs of child-rearing from the investment in human capital.
54. To resolve the investment-consumption dichotomy, Kendrick included in human capital investments all household expenditures related to child rearing up to the age of 14, as well as half of household expenditures on health and safety, while considering the other half as consumption. Due to a lack of empirical evidences for choosing depreciation rates, Kendrick used a modified double declining-balance method, while Eisner used straight-line depreciation.
55. The cost-based approach is also applied in Germany (Ewerhart, 2001, 2003), the Netherlands (Rooijen-Horsten et al., 2007, 2008), and Finland (Kokkinen, 2008, 2010). Statistics Canada also plans to apply the cost-based approach, together with the income-based approach already employed, in order to reconcile the estimates from the two approaches.

4.4 Representative studies using the income-based approach

56. One of the main conclusions from the questionnaire responses is that several countries are currently applying variants of the income-based approach. This approach has been used for measuring human capital at least since the 1960s (e.g. Weisbrod, 1961). However, it was the seminal works by Jorgenson and Fraumeni (1989, 1992a, 1992b) that spawned interests in measuring human capital by applying the lifetime income approach (also called the Jorgenson-Fraumeni approach).
57. The lifetime income approach measures human capital as the present value of the expected future labor incomes that could be generated over the lifetime of the people currently living. By bringing together the influence of a broad range of factors (demography, mortality, education and labor market aspects), this approach allows comparing the relative importance of these factors and drawing useful policy implications from the estimates.

58. By focusing on the earning power of each person, this approach values human capital at market prices, under the assumption that market prices are good signals of the value of human capital services that result from the interaction of demand and supply in the labor market.
59. One clear advantage of this approach is that its extension naturally leads to an accounting system that includes values, volumes, and prices as basic elements, which opens the way to the construction of a sequence of accounts that are similar to those used for produced capital within the SNA (Fraumeni, 2009). This is the main reason that the lifetime income approach is considered as of more capacity to hold promise to embrace human capital into the SNA in the future.
60. However, this approach is not immune from drawbacks. For instance, to calculate expected future earnings, some subjective judgments are necessarily made about the discount rate, real income growth rate, etc. There are also reasons to argue that labor market does not always function in a perfect way, implying that the wage rate typically used as a proxy for earning power is not always equal to the marginal value of a particular type of human capital.
61. Moreover, differences in wages may not truly reflect differences in earning power in some cases where trade unions may command a premium wage for their members and where real wages may fall in economic recessions.
62. Table 1 presents a list of national studies that have applied this approach to measuring human capital.²² As shown in Table 1, data availability varies across national studies. For many countries, the data needed for applying the income-based approach are compiled by the researcher, with a number of assumptions made during the data construction process.
63. In part due to this, and differently from the original studies by Jorgenson and Fraumeni, most of the national studies listed in Table 1 focused on the working age population (typically based on exogenous age thresholds, e.g. 16 and 65) instead of the whole population, and on market activities only.
64. These limitations reflect a pragmatic way to sidestep a number of conceptual and data issues that arise when applying the full Jorgenson-Fraumeni approach. Incorporating nonmarket activities into human capital estimates remains controversial²³ and focusing on working age population is also considered more relevant for measuring a country's productive capacity (Wei, 2004; Gu and Wong, 2008; Grecker and Liu, 2008).
65. Methodological modifications to the Jorgenson-Fraumeni approach were also made in some national studies. For example, to smooth the business cycle effects that affects the Jorgenson-

²² The list in Table 1 is meant to highlight the broad range of countries (13) for which these estimates exist, rather than being exhaustive of the full range of studies based on this approach.

²³ For example, evaluating nonmarket activities involves much imputation which should be avoided as much as possible following the tradition of the SNA. Extending the production boundary to incorporate nonmarket activities (such as cooking, cleaning and other household unpaid services) will blur the distinction between employment and unemployment, while these terms have been clearly defined, widely accepted and frequently used for long time.

Fraumeni approach (which relies exclusively on current cross-sectional information), Wei (2008) applied a cohort-based estimation to simulate future earnings.²⁴

Table 1. An overview of selected national studies applying income-based approach

Examples of national studies	Country	Motivation	Time range	Main data sources	Population covered	Market/ Nonmarket activities
Jorgenson and Fraumeni (1989, 1992a, 1992b)	United States	New systems of national accounts, Output of education sector	1948-1984, 1947-1987	Rich data based on decades of research	Age 0-75	Both
Ahloth et al. (1997)	Sweden	Output of education sector	1967, 1973, 1980, 1990	Level of living surveys	Age 0-75	Both
Ervik et al. (2003)	Norway	Output of higher education sector	1995	Register data	Age 20-64	Market only
Wei (2004, 2008)	Australia	Incorporating human capital into the SNA (Stock/Flow)	1981-2001	Census data	Age 18 (25)-65, labor force/whole population	Market only
Le et al. (2006)	New Zealand	Measuring human capital (Stock)	1981-2001	Census data	Age 18-64	Market only
Gundimeda et al. (2006)	India	Accounting for human capital formation	1993-2001	Surveys of employment and unemployment, Census of population	Age 15-60	Market only
Gu and Wong (2008)	Canada	Human capital contribution to national wealth account	1970-2007	Census /labour force survey	Age 15-74	Market only
Liu and Greaker (2009)	Norway	Measuring human capital (Stock)	2006	Register data	Age 15(16)-67(74), labor force/ whole population	Market only
Christian (2010)	United States	Measuring human capital (Stock/Investment)	1994-2006	Rich data	Age 0-80	Both
Coremberg (2010)	Argentina	Measuring human capital (Stock)/Output of education sector	1997, 2001, 2004	Household permanent survey	Age 15-65	Market only
Li et al. (2010)	China	Measuring human capital (Stock)	1985-2007	Household survey/Health and nutrition survey	Urban/rural, Age 0-60 (55 for female)	Market only
Jones and Chiripanhura (2010)	United Kingdom	Measuring human capital (Stock)	2001-2009	Labor force survey	Age 16-64	Market only
Istat (2013)	Italy	Measuring human capital (Stock)	2008	Various surveys	Age 15-64	Both

²⁴ For more detailed discussions on the technical issues, besides the conceptual, methodological and data issues, in national studies that applied the lifetime income approach to measuring human capital, see Liu (2012).

66. Results from national studies suggest that the estimated value of the stock of human capital is substantially larger than that of conventional produced capital, even when measures of the former are restricted to market activities. Measures of the stock of human capital based on the income-based approach tend also to exceed those based on the cost-based approach, a pattern that may reflect the fact that the former approach implicitly attributes the impact of on-the-job training and work experiences to formal education, while the latter effectively ignore the nonmarket inputs in practice.²⁵
67. The estimated value of the output of education sector by the income-based approach is also higher than the gross fixed capital formation traditionally measured in the SNA.²⁶ Therefore, considering educational expenditures as investment rather than consumption would significantly change our understanding of the extent of capital formation in any given year.
68. The estimated value of human capital by the lifetime income approach are sensitive to the choice of key parameters, i.e. the real annual growth of labor income that is assumed to prevail in the future, and the rate used to discount future earnings. However, the growth of human capital and its distribution across different groups of people are less sensitive.

5. International initiatives

69. Developing comparable measures of human capital has been pursued by both independent researchers and international organizations. One famous example of the research in this field is represented by Barro and Lee (1993, 1996, 2001, 2010, 2013) for constructing an international dataset of educational attainment, school years and schooling quality as proxies for human capital, based on census and survey information compiled by UNESCO and other sources.
70. This indicators-based approach has also been taken by several international organizations. For instance, apart from works on constructing sustainable development indices (UNECE, 2009), the UN publishes Human Development Index (HDI), which combines measures of average achievements in a country in three basic dimensions of human development, i.e. health, education and knowledge, and standards of living.²⁷
71. The OECD has a long tradition in developing both conceptual and methodological framework in the field of human capital measurement, which is reflected by a series of publications (e.g. OECD, 1994, 1996, 1998, 2001; Keeley, 2007).²⁸ Using the indicators-based approach, the OECD

²⁵ For more discussions on the possible explanations about the large divergence of the human capital estimates between the cost-based and the income-based approaches, please refer to Abraham (2010).

²⁶ As discussed in Section 2 (also see Box 2), according to the SNA convention, the output of education sector is measured as the sum of market inputs into this sector.

²⁷ The 2012 Human Development Report includes two measures of education and knowledge, namely school attainment, expressed in terms of the number of years of schooling, and school-life expectancy. More information is available at <http://hdr.undp.org/en/>.

²⁸ Other relevant streams of recent OECD on human capital are the 'Social Outcomes of Learning project', the OECD Skills Strategy; work on intangible assets undertaken as part of the OECD work on New Sources of Growth; and the OECD Better Life Initiative. For more on these streams of work see the information on the

also collects and disseminates a large range of physical indicators that are published in one of its flagship publications, i.e. *Education at a Glance*.

72. Recently, two OECD projects have attracted increasing attention in the international arena, i.e. the PISA, which tests 15-16 year olds students for their cognitive skills in terms of reading, mathematics, science and problem solving; and the PIAAC, which tests adults for their competencies in terms of literacy, numeracy and ability to solve problems in technology-rich environments.²⁹
73. As discussed in Section 4, information drawn from the indicators-based approach is not possible to be aggregated into an overall measure, nor is it easily integrated into a consistent accounting framework with which most of national accountants are familiar.³⁰
74. Although large-scale international projects such as the PISA and PIAAC can generate important information suitable for policy-taking and decision making, like all surveys, they are subject to survey and test limitations (e.g. with respect to sample size, range of variables included, country coverage, etc.).³¹ However, as shown in Box 2, the test scores from the PISA and PIAAC may well be used to quality-adjust the volume output of education sector, even if within the framework of the current SNA.
75. One international example of monetary measures of human capital is represented by the World Bank's comprehensive wealth accounts, which include estimates of human capital, for more than 120 countries over the decade from 1995 to 2005.
76. As introduced in Section 3, the World Bank applied the residual approach to measure the stock of human capital as the difference between the total discounted value of each country's future consumption flows (as a proxy for total wealth) and the sum of the tangible components of that wealth, i.e. produced capital and the market-component of natural capital (World Bank, 2006, 2011; Ruta and Hamilton, 2007; Ferreira and Hamilton, 2010).
77. While the residual approach can be applied to a large number of countries based on less-demanding statistical information, it has limits. First, by taking as its starting point the discounted value of future consumption flows, it obviously ignores the nonmarket benefits of

following websites:

http://www.oecd.org/document/9/0,3746,en_2649_39263294_33706505_1_1_1_1,00.html

<http://www.oecd.org/dataoecd/58/28/47769132.pdf> <http://www.oecd.org/dataoecd/60/40/46349020.pdf>

http://www.oecd.org/document/0/0,3746,en_2649_201185_47837376_1_1_1_1,00.html.

²⁹ For more information on PISA and PIAAC, please visit the following websites:

http://www.pisa.oecd.org/pages/0,2987,en_32252351_32235731_1_1_1_1_1,00.html;

http://www.oecd.org/document/35/0,3746,en_2649_201185_40277475_1_1_1_1,00.html.

³⁰ This point is also relevant when considering differences between parametric and non-parametric approaches to measuring human capital. Parametric approaches are frequently used in academic research; however, since they rely on econometric techniques, different assumptions and model specifications, even based on the same dataset, will typically lead to different estimates. On the contrary, non-parametric approaches avoid these problems and are more akin to the tools typically used by National Statistical Offices and other producers of human capital statistics.

³¹ More important, since these large-scale programs are resource-demanding in terms of both money and time required to implement, administer, process, analyze and report, they are typically undertaken with low frequency.

various capital stocks. Second, this measure is affected by measurement errors in all the terms entering the accounting identities, resulting in potential biases in the final estimates of human capital. Third, the approach cannot explain what drives the observed change of human capital over time, thus offering less valuable information for policy intervention.

78. To identify the common methodology and data requirements for building human capital accounts, the OECD launched a project in 2009, trying to build monetary estimates of human capital for international and inter-temporal comparisons. Results from this project, summarized in Liu (2011), show the feasibility of applying the lifetime income approach for comparative analysis, by means of data that are currently available within the OECD statistical system.
79. In 2012, the UN published its first 'Inclusive Wealth Report' which presented estimates of inclusive wealth (the sum of manufactured, human and natural capital) for 20 countries (UN-IHDP, UNEP, 2012). In this report, human capital is captured by measuring the population's educational attainment and the additional compensation over time of this training.³²

Table 2. Country rankings of human capital measured by different approaches

	PISA Science 2006	PIIAC Literacy 2011-2	PIAAC Numeracy 2011-2	PIAAC Problem- solving in Tech-rich Environments 2011-2	Barro-Lee Average Educational Attainment 2005	Jorgenson- Fraumeni Human Capital per Capita 2006 ¹	World Bank Intangible Capital 2005
AGES	15	16-65	16-65	16-65	15-64	15-64	All Ages
Australia	3	3	5	4	7	9	6
Canada	4	5	6	5	3	4	7
China					17	18	17
Denmark	10	8	3	3	14	8	2
France	9	11	10		11	7	9
Great Britain	5	7	8	6	16	2	8
India					18	17	18
Israel					8	13	4
Italy	14	13	12		12	14	11
Japan	2	1	1	6	6	6	13
Netherlands	6	2	2	1	9	10	5
New Zealand	1				2	12	3
Norway	12	4	3	2	4	3	1
Poland	11	10	9	10	15	15	14
Romania					10	16	15
South Korea	7	5	7	9	5	5	12
Spain	13	12	13		13	11	10
United States	8	9	11	8	1	1	16

Notes:

1. The J-F figures for Australia and India are for 2001; those for Denmark are for 2002.
2. The ages covered for China include ages 16 through 55 for females and 16 through 59 for males.
3. The ages covered for India include ages 15 through 60.

³² Basically, the approach applied in this 2012 report is also income-based, but it is different from the original Jorgenson-Fraumeni approach.

80. Table 2 provides country rankings in terms of human capital that are measured based on different approaches by international activities. Information in Columns 2 to 5 is derived from the OECD PISA and PIAAC projects (Schleicher, 2007; OECD, 2013), while that in Column 6 is based on Barro and Lee (2013). Although all these measures of human capital are generated by the indicators-based approach, the former are qualitative indicators, while the latter are quantitative ones.
81. Information in Column 7 in Table 2 is based on Liu (2014) except that for China and India. The estimates for China are taken from Li (2013), while those for India are drawn from Gundimedea et al. (2006); all the relevant estimates of human capital are measured by the lifetime income approach. The figures in the last column are computed based on World Bank estimates (2011) which took the residual approach to measuring human capital.
82. The main message from Table 2 is that the country rankings of human capital are different across different measuring approaches. The diversity of the estimates makes it difficult to draw useful policy implications, and thus calls for efforts to develop more consistent measures based on more promising approaches.
83. Although the bulk of the residual in the World Bank's wealth accounts is considered to be human capital, the residual itself actually encompasses anything that is unaccounted for. To further account for the residual which is around 80 per cent of total wealth for high-income OECD countries (World Bank, 2011), a joint work between the World Bank and the OECD was carried out (Hamilton and Liu, 2014).
84. By incorporating the direct measures of human capital based on the lifetime income approach into the World Bank's wealth accounts for the selected countries,³³ the unexplained 'residual of residual' reduces to an average of 25 per cent of total wealth.³⁴
85. Recently, during the preparation process for the forthcoming UN *Inclusive Wealth Report 2014*, a research project is launched with the purpose of comparing different approaches to measuring human capital, with the lifetime income approach incorporated as one of the main approaches to measuring human capital for international comparisons.

6. Remaining challenges

86. Despite the emerging international trend that an increasing number of countries have applied, or are planning to apply, the income-based approach to measuring human capital, several issues and challenges remain and are worth being discussed.

³³ The selected countries are: Canada, France, Israel, Italy, Korea, the Netherlands, New Zealand, Norway, Poland, Romania, Spain, the United Kingdom, and the United States. Except Romania, all other countries are OECD members.

³⁴ Although it includes measuring errors (such as ignored nonmarket benefits) and other things, the main part of the 25 per cent of total wealth that is unaccounted for as the 'residual of residual', is arguably the 'stock equivalent' of total factor productivity, i.e. the value of assets such as institutional quality and social capital that augment the capacity of produced, natural, and human capital to support a stream of consumption into the future (Hamilton and Liu, 2014).

6.1 *Data issues*

87. The data needed by the income-based approach are currently either not available for some countries or are not in a form suitable for direct use. Based on the OECD experience (Liu, 2011), several issues stand out:
- First, the quality and sources of earnings' data cross-classified by different characteristics of workers vary significantly across countries. Data may refer to different earnings concepts (hourly and weekly earnings in most cases, annual and monthly earnings for some countries) and may include different elements of the remuneration packages of workers. In some cases, data on earnings refer only to the main job while in other countries they may also cover secondary jobs and other remunerated activities. Finally, earnings data for different countries typically refer to different categories of educational attainment, and may be collected as either point estimates or in the form of earnings brackets.
 - Second, despite the great progress accomplished in collecting harmonised educational statistics, there remain issues with the quality of data on school enrolment and graduation rates, as definitions and classifications are not always comparable across countries, due for instance to differences in educational systems and in ways of counting students (e.g. students who repeat the year, students who graduate for a second time, etc.).
 - Third, human capital estimates would ideally require data on survival rates broken down by education.³⁵ While some national estimates exist, and they highlight large mortality differentials by socio-economic characteristics, these breakdowns are not available for all countries and they are rarely comparable across countries. Moreover, mortality statistics by educational level are not compiled through common standards across OECD countries, and in several countries they simply do not exist (OECD et al., 2011).
88. More generally, constructing estimates of human capital based on the income-based approach requires that data from a range of sources – e.g. earnings statistics, population census, labor force surveys, mortality records – are integrated and harmonized to meet the requirements of human capital accounting. There are still challenges ahead in this regard.

6.2 *Methodological difficulties*

89. Currently, most human capital estimates rely on the assumption that cross-sectional earnings are good predictors of future cohorts' earnings. However there are ample evidences that cohort effects are typically large.³⁶ This suggests that it would be appropriate to use longitudinal earnings data that disentangle age and cohort effects, and make it possible to account for cohort-specific factors.

³⁵ Data on survival rates by age and education is constructed by Barro and Lee (2010).

³⁶ One implication of the cohort effects is that a person born in the twenty-first century may expect different income flows in the future than a person born in the 1990s.

90. Likewise, it would be important to separate wage premium due to educational attainment from those due to on-the-job training and other firms' characteristics, as failure to do so may lead to overstate the educational contribution to human capital. With respect to labor market indicators (e.g. employment rates and earnings), it is also important to separate business cycles effects that distort comparisons (e.g. by depressing earnings or employment rates for different categories of workers during a recession).
91. A further difficulty when applying the lifetime income approach relates to the choice of some of the key parameters required by the method, such as the expected real growth of labor income in the future, the discount rate and the price deflators used for temporal and country-comparisons. While assumptions on these parameters are currently left to the discretion of researchers, their choice would ideally require further theoretical and empirical backup.³⁷
92. Another challenge for developing monetary measures of human capital is represented by the large discrepancies between estimates of human capital by the income-based and the costs-based approaches. These discrepancies should be better understood and reconciled. One way to address this challenge would be to apply the two approaches simultaneously, which would offer an opportunity to identify the main factors accounting for the differences and to reconcile the two methods.

7. Concluding remarks

93. The concept of human capital has many dimensions, implying that its measurement has to be undertaken step by step in practice. Currently, many countries are using the definitions of human capital that focus on the productive capacity of individuals, and restrict the measurement to formal education and the economic returns accruing to individuals, even if the broader OECD definition is accepted as a reference point.
94. Starting from this narrower focus, human capital measurement initially aimed to develop summary indicators as simple proxies for human capital. While the data requirements are limited, so is the scope of these proxies. In recent years, developing monetary measures of human capital in a systematic way has received increasing interest from independent researchers, national statistical offices and international organizations.
95. All the approaches to measuring human capital reviewed in this chapter have strengths and weaknesses. However, the monetary measures generated from the cost-based and income-based approaches should arguably have a core status. Because these measures are more comparable with those for traditional capital covered by the SNA, while the construction of the latter is one of the main tasks of national statistical offices.
96. From country experiences and international initiatives in the field of human capital measurement, an international trend is emerging, i.e. the lifetime income approach has been

³⁷ Similar challenges confront the cost-based approach with respect to the choice of depreciation rates and price deflators.

attracting more and more attention. Estimates based on this approach can be used to assess the relative contribution of a range of factors (demographic, education and labor market) to the evolution of human capital, facilitating the corresponding policy interventions.

97. Recent international experience also suggests the feasibility of producing this type of measures based on the information that is already available within the national and international statistical systems (e.g. Liu, 2011). However, the scope for improvements in terms of consistency and comparability of the underlying data remains significant. Therefore, works should be pursued for continuing the compilation and harmonization of the data needed for human capital accounting.
98. There are also rooms for improvement on the detailed methodological choices applied by the lifetime income approach for human capital measurement. For instance, to control the cohort effects, business cycles effects and to separate wage premiums among different factors, more studies should be carried out, possibly based on new sources of data. Researches are also encouraged about how to choose the key parameters required by applying this approach.
99. To address the divergence between estimates applying the cost-based and the income-based approaches, satellite accounts could be employed for such purpose, as they would allow linking stock and flow measures of human capital in a full-fledged accounting system which is consistent with the rest of the SNA.³⁸
100. Presently, there are more estimates of the stock of than the investment in human capital; studies that directly link the stock and flow in a systematic way are just a few (e.g. Jorgenson and Fraumeni, 1989; Wei, 2008; Gu and Wong, 2010a). To reach an integrated and consistent human capital account, the construction of both stock and flow accounts should also be encouraged.
101. Up to date the monetary measures of human capital based on the lifetime income approach have been primarily used for national wealth accounting (e.g. Gu and Wong, 2008), for measuring the output of education sector (e.g. Ervik et al., 2003), for identifying the driving forces behind the evolution of human capital (e.g. Liu, 2011), and for addressing issues related to well-being and quality of life (e.g. OECD, 2011).
102. However, it is not easy to find concrete applications of human capital estimates used for the purpose of growth accounting, especially, within the standard growth accounting framework such as that applied in the EU KLEMS project (O'Mahony and Timmer, 2009). How to link such estimates with the standard growth accounting framework is still challenging.
103. Nonetheless, efforts have been made to use the estimates by the lifetime income approach to quality-adjust the output, so that an output-based estimate of the volume of the education sector can be derived (Gu and Wong, 2010b; see also Box 2), making it possible to establish a productivity measure based on independently estimated inputs and outputs (see Schreyer, 2010).

³⁸ More details on the rationale and feasibility of developing human capital satellite accounts can be found in Boarini et al. (2012).

104. Currently, the lifetime income approach has been applied for countries with relatively richer data. However, for the purpose of international comparisons, some kind of streamlined approach should be developed for those countries in which the needed data is not available. Although there exist a few studies (e.g. Fraumeni 2009; Hamilton, 2013), more research along this line is very much welcomed.

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