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Guide on Measuring Human Capital



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Guide on Measuring Human Capital

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Note

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Preface

The idea of viewing individuals' knowledge and abilities as an asset—as human capital—can be traced back to the 18th century. But human capital is intangible and hard to define, so in spite of its long history it has remained a challenge to measure. Understanding and quantifying human capital is becoming increasingly necessary for policymakers to better understand what drives economic growth and the functioning of labour markets, to assess the long-term sustainability of a country's development path, and to measure the output and productivity performance of the educational sector.

In view of this growing demand, in 2013 the Conference of European Statisticians (CES) established a Task Force on measuring human capital. The objective of the Task Force was to pursue the conceptual development of human capital measurement, with a particular focus on developing experimental human capital satellite accounts. The Task Force was asked to develop guidelines and compile best practices to help countries construct experimental satellite accounts for human capital based on common methodologies.

This publication is the result of the work of the Task Force. It has been reviewed by countries through consultations carried out among CES members and relevant organizations in February-March 2016. Given the importance of measuring human capital for the global statistical community, the United Nations Statistics Division carried out a global consultation among all United Nations Member States in July-August 2016. In October 2016, the CES Bureau endorsed the Guide.

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Acronyms

ABS	Australian Bureau of Statistics
BEA	Bureau for Economic Analysis
BLS	Bureau of Labor Statistics
CSNA	Canadian System of National Accounts
CBS	Central Bureau for Statistics
CPC	Central Product Classification
COICOP	Classification of Individual Consumption According to Purpose
COFOG	Classification of the Functions of Government
COPNI	Classification of the Purposes of Non-Profit Institutions Serving Households
CES	Conference of European Statisticians
CPI	Consumer Price Index
CVT	Continuing Vocational Training
CVTS	Continuing Vocational Training Survey
CPS	Current Population Survey
EP	Education services and products
XPIs	Export price indices
FA	Financing Agents
FTE's	Full time equivalent jobs
GFCF	Gross Fixed Capital Formation
MPIs	Import price indices
IWR	Inclusive Wealth Report
ISCED	International Standard Classification of Education
ISIC	International Standard Industrial Classification of All Economic Activities
J-F	Jorgenson-Fraumeni
NEA	National Education Account
NSIs	National statistical institutes
NPISH	Non-profit institutions serving households
OECD	Organisation for Economic Co-operation and Envelopment
PIM	Perpetual Inventory Method
PPI	Producer Price Index
PIAAC	Programme for International Assessment of Adult Competencies
PISA	Programme for International Student Assessment
PPP	Purchasing power parity
R&D	Research and Development
SAE	Satellite Account for Education and Training
SNA	System of National Accounts
UNU-IHDP	UN University's International Human Dimension Programme
UOE	UNESCO, OECD, Eurostat
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization

1. Introduction

1.1. Why this Guide?

1. Understanding human capital is of significant interest to policymakers. Statistics on human capital may help to understand the drivers of economic growth and the functioning of the labour market, as well as to assess the long-term sustainability of a country's development path.
2. Based on the outcome of a Conference of European Statisticians (CES) seminar in 2011 and the recommendations in the subsequent stock-taking report, CES established the Task Force on Measuring Human Capital in 2013. Its objective is to pursue the conceptual development of human capital measurement, with priority on developing experimental human capital satellite accounts. In addition, the stock-taking report recommended that further work should be carried out in the following areas: investigating the discrepancies between the cost-based and income-based approach; improving the quality of data collected internationally; and pursuing work to estimate the non-economic returns to human capital.

1.2. Importance and policy relevance

3. Measuring the stock of human capital can serve many purposes, i.e. 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 performance of the educational sector. While all these perspectives emphasize the importance of measuring the total stock of human capital, more recent discussions on 'beyond GDP' have led to growing attention being paid to the distribution of human capital across households and individuals, and on the non-monetary benefits stemming from it.
4. Maximizing current income and consumption in a context of limited resources will not assure the sustainability of a country's development path. Sustainable development, in its inter-generational dimension, is usually understood as requiring that an unchanged stock of capital per capita (including human capital) be passed on to the next generation (UNECE, 2009).
5. To produce meaningful measures of the total capital stock of each country, measures of each of its components are needed. Because of its role in economic accounting, the metric typically used to measure the different types of capital is that of 'money'. Devising a robust methodology for the monetary valuation of the stock of human capital is especially important as a number of studies have suggested that human capital, measured in this way, is by far the most important component of the total capital stock in most advanced economies (e.g. Greaker et al, 2005; Gu and Wong, 2008; World Bank, 2006, 2011).
6. Not only the total stock of human capital but also its evolution over time provides important information for monitoring sustainability. For instance, measures of changes in human capital due to demographic factors such as population ageing, may provide an early warning of the risk that the accumulation of human capital may not be sustainable over time. This would allow pre-emptive policies aimed at encouraging alternative forms of investment, to offset the decline in the total capital stock due to ageing.
7. Recent reflections on the limits of GDP as a welfare measure (e.g. Stiglitz et al 2009; OECD, 2011; and various EU initiatives) have underscored that people's material conditions

(i.e. their economic well-being) are determined not only by current income and consumption but also by the assets they own – e.g. housing property, financial assets and also, importantly, human capital. All these assets generate income streams over their lifetime and provide a buffer against sudden shocks. This individual perspective suggests that, beyond looking at the total stock of a country's human capital, measures of how this capital is distributed are also important.

8. The concept of people's well-being stretches beyond its material side, to encompass a variety of non-monetary dimensions which, together, define people's quality of life. This broader perspective has implications for the measurement of human capital as it highlights that, in addition to its economic returns, investment in human capital can generate other benefits that will improve individuals' well-being. These 'non-economic' benefits can include the improved health conditions that are generally associated to higher education and which may enhance not just an individual's productivity and earnings but also his/her subjective well-being (Dolan et al, 2008). Furthermore, these non-economic benefits are not restricted to individuals, but can extend to the society at large. For example, education may lead to better-informed citizens, more tolerant of social and cultural diversity and more willing to actively take part in a modern democratic society.

9. While some of these non-economic benefits of education are captured through the monetary measures of human capital that are reviewed in this guide (e.g. the longer life expectancy of more educated individuals), this is not the case for most other benefits. Moreover, the formation of human capital itself may be affected by activities that enhance health conditions as well as family and community well-being. This, again, also has implications for human capital measurement.

1.3. Overview of the Guide

10. The Guide discusses the concept of human capital, methodological and implementation issues, and challenges related to valuing human capital. The Guide provides recommendations aimed at producing estimates that are as consistent as possible with national accounting concepts and comparable across economies. However, the Guide does not recommend the inclusion of human capital in the central framework of the SNA as more research is needed. The Guide suggests starting with the development of a satellite account for education and training. The Guide continues by encouraging the development of a human capital satellite account, and provides an example showing how integration of human capital might influence the sequences of accounts. Finally, the Guide provides additional examples of how human capital has been measured in selected country-specific contexts, the type of data used and a comparison of these estimates across countries.

1.3.1. Chapter 2: Concepts and definitions

11. This chapter provides a generic overview of the concept of human capital. It discusses what is meant when referring to human capital, how is it defined, and does the stock of human capital capture only future economic benefits from investing in the development of knowledge and skills? It also discusses issues related to encapsulating non-economic returns such as better health. However, it is noted that for this Guide the concept and related valuation of human capital will, for the most part, be based only on the economic returns.

12. The chapter gives a presentation of what the international standards for compiling national accounts, the System of National Accounts 2008 (2008 SNA), says about human capital. SNA states that expenditures on education and staff training should not be considered as a form of investments in human capital. The concept of human capital is thus not part of the ‘asset boundary’ of the 2008 SNA. However, on the SNA research agenda (Annex 4 of the 2008 SNA), it is mentioned that human capital is an issue that needs further consideration. This Guide can be looked upon as providing input to these considerations and discussions.

13. Discussion about the economic benefits from human capital and the concomitant principles for the valuation of stocks of human capital, the process that leads to the creation of human capital, in more technical terms the ‘production process’ of human capital, and the elements leading to the accumulation and depreciation of the human capital stock, are covered in the chapter. All of this is first and foremost intended to provide a conceptual framework for, or a way of thinking about, human capital. It is presented in a way that is as much as possible in line with the basic underlying principles of the SNA, albeit that the presented framework clearly goes beyond the current international standards. Two options that could be considered are:

- i. to look upon the relevant activities in the sector paying for the produced services as producing a capital output, and subsequently transferring these outputs, via capital transfers, to households;
- ii. to look upon the relevant activities in the sector paying for the produced services as producing a non-capital output that is transferred to the households where it is used as intermediate consumption into the production process of households producing their own human capital.

14. Finally, chapter 2 concludes with some further thoughts about the inclusion of non-economic returns. Different from other topics addressed in the chapter, the issue of including non-economic returns will not be further elaborated in this Guide.

1.3.2. Chapter 3: Methodological issues

15. This chapter looks in more detail at the methodological challenges related to the measurement of human capital. In particular, it looks at the theoretical basis for the cost of production and lifetime income approaches to estimating human capital and the challenges in implementing them. It also discusses briefly how these approaches can be complemented by a third approach, the indicators approach, to provide a more complete picture of what is happening.

16. Regarding measurement of human capital there are a number of considerations that are common to more than one approach outlined in the Guide – the scope of the estimates, the heterogeneity of human capital and the aggregation of human capital. Only economic returns that accrue to individual persons having acquired human capital are taken into consideration. No spillover effects will be assessed, not because they are not important, but measurement of them is not yet well established and lacking sufficient practical examples.

17. The Guide only considers human capital formed from education and job-related training. In general, the quantity of human capital is considered to be represented by two commonly adopted indicators: educational attainment and job-related training. Human capital skills are generally distinguished into two kinds: general-purpose skills and firm-specific

skills. The empirical literature on the measurement of human capital has focused on general-purpose skills, partly because these are easier to measure.

18. There are challenges surrounding the heterogeneity of human capital in the economy outside the scope of the study. Workers differ in their human capital skills, suggesting heterogeneity of human capital in the economy. The assumption that workers with the same category of productive characteristics have the same level of human capital skills may be problematic. In terms of education, for example, a worker with the same level of educational attainment may have a different level of human capital from his peers in the same category of productive characteristics, due to differences in schooling quality. While some methods are available for adjusting for quality differences, it is difficult to do so consistently in a cross-section and over time.

19. The final key challenge common to all approaches is aggregation. Aggregation is one of the most contentious issues in capital theory, and this also applies to human capital. Measures of human capital focus on individuals' human capital and aggregate them to arrive at the population measure. This ignores spillovers between workers so that the whole may be more than the sum of the parts.

1.3.3. Chapter 4: Implementation and measurement issues

20. This chapter aims to be a practical implementation guide for national statistical offices compiling human capital estimates. It discusses issues in implementation and measurement for each of the three approaches described in chapter 3. As stated earlier, the framework of this Guide is confined to economic returns, formal education and job-related training, and the working age population. This chapter adds to this a focus on internationally comparable measurement and data. Recommendations are made for the extent of implementation and data sources in order to arrive at internationally comparable estimates of human capital¹.

21. If capital markets were perfect, the cost-based and lifetime income-based approaches would generate similar estimates (Le et al, 2003). In practice, the lifetime income-based method gives a substantially higher estimate than the cost-based method (Abraham, 2010). However, it is not essential that the cost based and lifetime income based approaches match when accounting for human capital within an SNA framework. The two methods start from rather similar conceptual perspectives; the main difference is in the measurement, leading to differences in estimates. The lifetime income method starts from income data on individuals by level of education, and the cost based method from the source of expenditures. Countries do not need to make a choice between the two approaches, both have advantages and disadvantages. Policy makers and researchers may get much information from both approaches. Further, indicators on human capital can serve as a complement or even as a benchmark (e.g. test scores) in analysis of investments in and stocks of human capital. For instance, one may link proportions of students enrolled by gender, age and education level to expenditures data in an analysis of data constructed in satellite accounts for education and training and for human capital.

22. Chapter 3 describes the theory, and chapter 4 shows the (im)possibilities of estimation. We need to be pragmatic on various estimation issues, e.g. on labour participation, retirement

¹ As is often the case when developing new statistics, input may be needed from a variety of agencies and institutions depending on the organization of official statistics in each country. Coordinating efforts across agencies can be an important factor in the success of any complex project such as measuring human capital.

ages, migration, and discount rates. Each country estimating human capital should conduct sensitivity analyses to show the impact of the various assumptions and alternative data sources.

1.3.4. **Chapter 5: Satellite account for education and training**

23. Given the aim of linking human capital estimates to the System of National Accounts (SNA), a first step could be the development of a Satellite Account for Education and Training. The construction of such a satellite account is relatively straight forward as most of the cost data are already available in national statistical institutes (NSIs). Such a satellite account can in itself present an important analytical tool for supporting analysis and policy-making decisions and, in addition, can provide a foundation for enhanced human capital studies at the international level.

24. This chapter presents the setup of a satellite account for education (SAE), covering both formal and non-formal education², including training able to supplement the SNA core system and using data that are already largely available in the core accounts of SNA. The proposed scheme includes a set of main tables and other supplementary tables. It should include detailed information on financial transactions, thus being able to distinguish between who is producing and who is financing the total expenditure on education services.

25. The SAE extends the production boundary of the SNA only slightly to recognize ancillary training activities as own account production of training. The idea is to provide policy makers with more detailed data on the expenditures on education, and the financing of these expenditures. The expenditure data can be linked to other indicators on human capital such as proportions of students enrolled by gender, age and education level. Supplementary tables, such as employment broken down by educational attainment and industry are recommended. In this respect, it can be noted that labour is the most important factor of production, which means that such analysis is crucial for the enhanced study of multifactor productivity.

1.3.5. **Chapter 6: Human capital: Going beyond the system of national accounts**

26. This chapter moves to treating expenditures on education and training as investments rather than current expenses. This requires changes to a number of accounts within the SNA depending on which of the options presented in chapter 2 are used. In chapter 6, a proposed treatment is demonstrated through the use of a satellite account for human capital. This satellite account provides an example of how economic aggregates such as gross domestic product, investment, consumption, saving and national net worth would change when

² Learning activities differ in their degree of formality. On the one end of the spectrum lies the hierarchically structured formal education system, where individuals belonging to a defined clientele register and enrol, and students follow a defined curriculum and are awarded a certificate upon successful completion. On the other end of the spectrum lies entirely informal learning that happens spontaneously as part of day-to-day life, with family, friends, and neighbours, or through engagement with the media or libraries, for instance. While this spectrum forms a continuum, the mentioned ideal types of formal and informal education are customarily complemented with a single category falling in-between, namely non-formal education. This encompasses learning activities, such as voluntary classes organized by community groups, that exhibit some characteristics of formal education, such as a set time and place and defined learning objectives, but may lack others, such as recognized certification.

expenses related to human capital are classified as investment rather than as current expenditures (see also paragraph 13).

27. Using the structure of the SNA to integrate skills and knowledge as a form of capital, the satellite account presents additional information on the link between human capital and economic performance, while simultaneously retaining the core strengths of SNA estimates. The size of investment in human capital provides an assessment of the role of skills and knowledge acquired through education and training in economic and productivity growth. It can be compared with other types of investment such as investment in machinery and equipment, buildings and structures and research and development to provide an examination of their relative importance for economic growth. Total capital stock estimates in the expanded balance sheet provide information on the evolution of total capital stock and the sustainability of development in an economy. The saving estimates that are adjusted to include saving in the form of human capital provide a richer view of saving by households and governments.

28. Consistent with the Guide, chapter 6 focuses on formal education and formal training. Including investment in human capital in the SNA raises a number of challenges. Among the most pressing are how to structure the treatment of human capital investment through the sequence of accounts³ in the SNA, the choice of an appropriate methodology for volume estimates of human capital investment, the choice of an appropriate depreciation rate for human capital, and a reconciliation of alternative methods for estimating the human capital stock and the underlying investments.

29. The chapter explores the effect of measuring human capital on the SNA using both the income- and cost-based approaches. The income-based approach produces a larger estimate for the human capital investment than that implied by the cost-based estimate.

1.3.6. Chapter 7: Human capital country studies

30. There are a large number of country specific human capital studies, some of which look at several countries and others which focus on one country. This chapter surveys a representative sample of them. A country ranking table is presented in the main body of this chapter. It includes 10 rankings by six different types of human capital measures: Programme for International Student Assessment (PISA), Programme for International Assessment of Adult Competencies (PIAAC), Barro-Lee, Inclusive Wealth Report (IWR), Jorgenson-Fraumeni (J-F), and World Bank. Only J-F human capital measures have been previously described in this Guide; accordingly, the other human capital measures are briefly described in this chapter.

31. There is a clear trade-off between the scope of the data needed for a measure, the sophistication of the measure, and the number of countries for which estimates currently exist. For example, the IWR (UNU-IHDP and UNEP 2014) measure which uses country averages exists for 140 countries, while J-F which uses detailed country information exists for some 20 countries.

³ This will depend on the option chosen for presenting the production of human capital.

1.3.7. Chapter 8: Recommendations and future work

32. This chapter gives an overview of the main recommendations in the Guide and suggestions for future work. The Guide shows that it is feasible to construct human capital satellite accounts. It provides an example of constructing such a satellite account, which shows the impact of human capital on the values of GDP, investment, consumption, savings and net wealth. The Guide also provides guidance on how statistical agencies can address a number of challenges for the construction of a human capital satellite account.

33. The recommendations in this Guide are a first attempt to come up with an estimate and a recording of the role of human capital in a way that is aligned with the principles of the national accounts. Estimates can either be initiated by developing a satellite account on education, or achieved by going beyond the present SNA by fully integrating estimates of human capital. Because of both data constraints and methodological issues, the Guide recommends, as a first step, to develop a satellite account for education and training. The objective of such a satellite account is to distinguish and provide breakdowns of the various expenditures on training and education, including the identification of the financing arrangements for these expenditures.

34. The three additional avenues for further work identified in the stock-taking report provided to the CES were: investigating the discrepancies between the cost-based and income-based approach; improving the quality of data collected internationally; and developing techniques for the estimation of the non-economic returns to human capital. The Task Force reiterates the recommendation that future work is needed in these three areas.

35. The Task Force also suggests establishing and maintaining a centralized international list (e.g. hosted by UNECE) of country studies on human capital. In addition, a collaborative production by some countries of internationally-comparable satellite accounts for education and training, based on the Guide's recommendations, is encouraged. Application of the proposed approach to several countries with a range of different economic conditions would permit a useful comparison exercise. With sufficient additional experience and coordinated with corresponding work developed by UNESCO, a complete compliance guide for a Satellite Account for Education and Training might be developed.

2. Concepts and definitions

2.1. Introduction

36. This chapter provides a generic overview of the concept of human capital. What exactly do we mean when we are referring to human capital? How is it defined? Does the stock of human capital capture only future economic benefits from investing in the development of knowledge and skills? Or should it also encapsulate non-economic returns like better health? Section 2.2, containing a concise discussion of this issue, concludes that in this Guide the concept and related valuation of human capital will, for the most part, be limited to the economic returns.

37. Section 2.3 then goes on with a short discussion of what the international standard for compiling national accounts, the System of National Accounts 2008 (2008 SNA), has to say about human capital. In short, the present SNA states that expenditures on education and staff training should not be considered as a form of investments in human capital. The concept of human capital is thus not part of the ‘asset boundary’ of the 2008 SNA. On the other hand paragraph A.4.55 of the research agenda of the standard (annex 4) states that human capital is an issue that needs further consideration. This Guide can also be looked upon as providing substantial input to these considerations and discussions.

38. Section 2.4 subsequently discusses in somewhat more detail the economic benefits from human capital and the concomitant principles for the valuation of stocks of human capital (section 2.4.1), the process that leads to the creation of human capital, in more technical terms the ‘production process’ of human capital (section 2.4.2), and the elements leading to the accumulation and depreciation of the human capital stock (section 2.4.3). All of this is first and foremost intended to provide a conceptual framework for, or a way of thinking about, human capital. It is presented in a way that is as much as possible in line with the basic underlying principles of the SNA, albeit that the presented framework clearly does not align with the current international standards.

39. Section 2.5 concludes this chapter with some further thoughts about the inclusion of non-economic returns. In contrast with the topics addressed in section 2.4, the issue of including non-economic returns will not be further elaborated in this Guide.

2.2. Defining human capital

2.2.1. General definition

40. The origin of the human capital concept can be traced back to the work of Adam Smith in the 18th century. Smith underlined the importance of “the acquired and useful abilities of all the inhabitants or members of the society”; while an individual will incur costs to obtain such abilities, once acquired they stand as “a capital fixed and realised, as it were, in his person” (Smith, 1776).

41. The practical implications of the idea of treating individuals’ abilities as a kind of capital, i.e. as an asset, were not widely recognized until the 1960s, when economists began to incorporate such a notion into their work. This shift partly reflected the view that the concept of human capital could explain the large difference between the increase in the economic output of a country and that of the traditional inputs (land, labour, and capital

according to the SNA) entering its production. Some economists suggested that investment in human capital was probably the major explanation for this difference (e.g. Schultz, 1961).

42. There are many definitions of human capital used in the literature, but most of them stress the economic returns of human capital investment. Schultz (1961), for example, defined human capital as “acquired skills and knowledge”, to distinguish raw (unskilled) labour from skilled labour. Similarly, the Penguin Dictionary of Economics (1984) defined human capital as “the skills, capacities and abilities possessed by an individual which permit him to earn income”, a definition which emphasizes the improvement of people’s economic situation due to human capital investment. The World Bank (2006) similarly defined human capital as the productive capacity embodied in individuals, with special focus on its contribution to economic production.

43. As economies become more knowledge-based and globalized, the economic importance of human capital to both individual’s competitive advantage and to countries’ economic success become more significant than ever. However, as mentioned above, human capital investment delivers many other non-economic benefits as well, such as improved health status, enhanced personal well-being and greater social cohesion. These broader benefits are viewed by many authors as being as important as, if not larger than, the economic benefits in the form of higher earnings and economic growth.

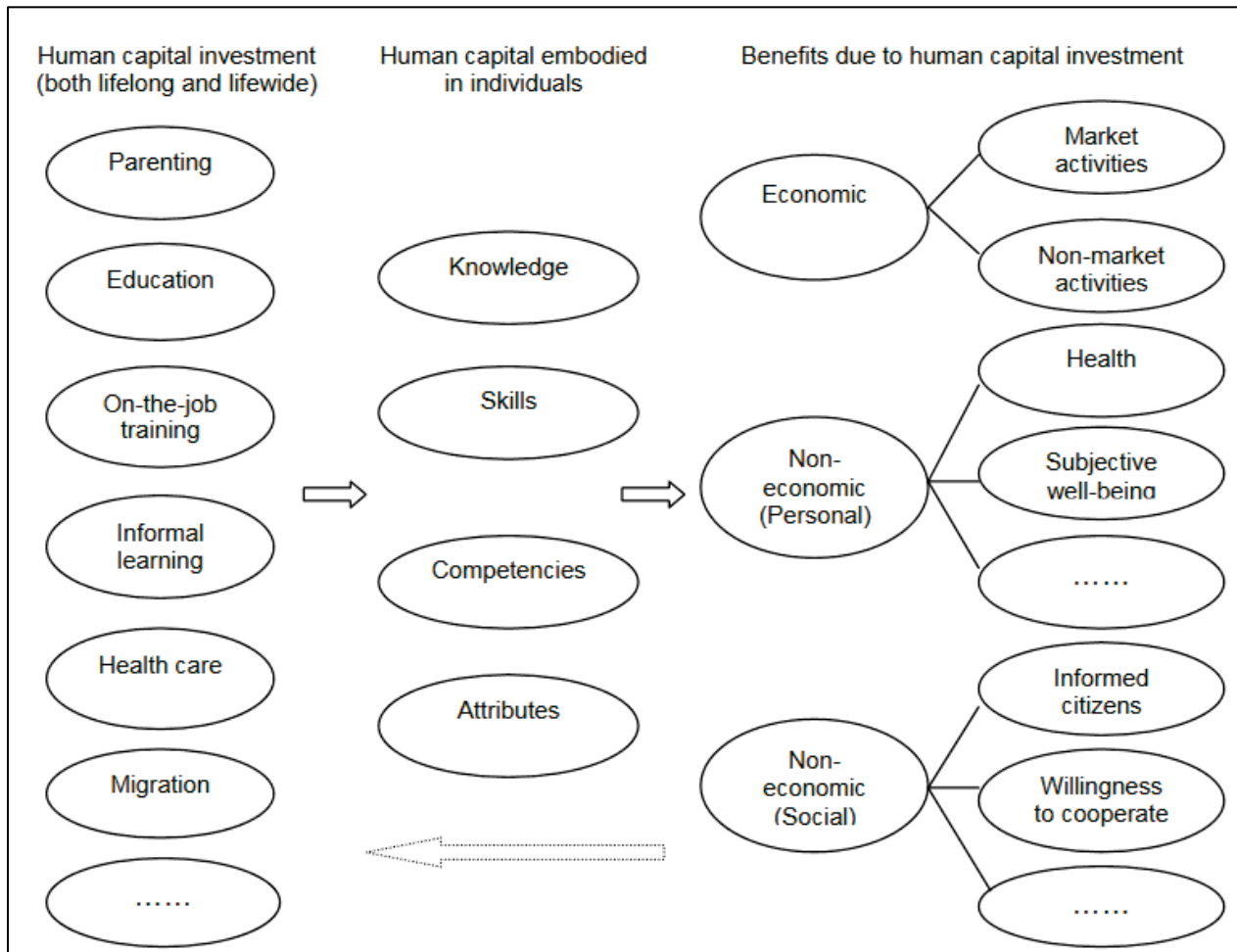
44. Acknowledging these broader benefits, the OECD gradually extended its definition of human capital. In an OECD report published in 1998, human capital was defined as “the knowledge, skills, competences and other attributes embodied in individuals that are relevant to economic activity” (OECD, 1998). A later report, however, defined 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). Box 2.1 provides a brief overview of the elements that are included in this broader definition of human capital according to the 2001 OECD report, displaying the various channels through which human capital is developed and the diverse benefits that it delivers.

45. The OECD definition is all-embracing. It incorporates various skills and competencies that are acquired through learning and experience but may also include innate abilities. Some aspects of motivation and behaviour, as well as the physical, emotional and mental health of individuals are also regarded as human capital in this broader definition (OECD, 2011).

46. The components of human capital proposed by the OECD reflect its multi-faceted nature. For instance, they include both general and work-specific skills, both tacit and explicit ones. They cover not only the cognitive skills that were conventionally recognized by research in this field but also non-cognitive skills such as intra- and inter-personal skills that have assumed an increasingly important role in modern societies.

Box 2.1

Human capital: a sketch of its formation, composition and benefits generated



2.2.2. Limiting the definition of human capital to economic returns

47. The SNA more and more recognizes the importance of including knowledge based capital in the national accounts statistics. However, unlike physical capital, all types of knowledge, skills, competencies and attributes are invisible. It should be clear from the start that this does not prevent them from being recognized as investments and capital accumulation in the system of national accounts. For example, the 1993 SNA already recognized intangible, knowledge related expenditures on (i) mineral exploration and evaluation; (ii) software and databases; and (iii) entertainment, literary and artistic originals, as investments, thus adding to the stock of productive capital. In the 2008 SNA, this has been further extended with expenditures on research and development. In addition, goodwill and marketing assets are to be included, but only when evidenced by transactions on the market, for example as part of a takeover of a corporation at a price which is higher than the intrinsic value, or net worth, of the corporation in question. Also other intangible assets, such as transferable leases, which may be traded as a separate item (think of sales of long term rental contracts of shopping spaces, and contracts with soccer players or other sportspersons), are only recorded when acquired on the market, although in practice the recording of these assets may contain significant gaps. More generally, human capital has certain characteristics in

common with the capital stock items included in the present asset boundary of the SNA: they accumulate through investments and they decline through use and obsolescence, although in different ways. For example, while the capital stock items typically recognized in the SNA will wear out through use, human capital typically grows through use and experience, while it depreciates due to lack of use, obsolescence of knowledge, population ageing and other factors.

48. In looking at human capital, this Guide will mainly deal with the narrower definition of human capital, in the sense that it will mainly focus on a valuation of the elements which are related to the economic returns. It will thus not consider the inclusion of any non-economic returns. Also various spill-over effects of human capital will not be taken into account, unless implicitly included as part of the estimation procedure. The main reason for this choice is related to the consistency with the present framework of national accounts, which basically is confined to the economic value of assets, and its use in economic activities. Going beyond the purely economic returns would also create various definitional and measurement issues, although it can be noted that in the research area attempts have been made to value human capital using an extended income definition including for example unpaid activities within households and leisure time (see e.g. Jorgenson and Fraumeni). Notwithstanding these research activities, it goes without saying that such an extension would multiply the measurement problems, leaving apart the significant additional, more conceptually related, issues in defining and delineating human capital and accordingly even further extending the production boundary of the present system of national accounts. As such, the recommendations in this Guide should be considered as a first attempt to come up with an estimate and a recording of the role of human capital which is relatively closely aligned to the basic underlying principles of national accounts. While the Guide describes the more moderate approach of developing a satellite account on education (see chapter 5), the Guide primarily describes what is needed to go beyond the present SNA by fully integrating the narrower definition of human capital with an example in chapter 6. Although the definition of human capital applied in this Guide is limited to the economic valuation, in a number of places some attention will be paid to non-economic returns as well.

2.3. Human capital and the 2008 SNA

49. The present international standard for the compilation of national accounts, the 2008 SNA, contain various references to human capital. In paragraph 1.54, the following is stated:

“It is often proposed that expenditures on staff training and education should be classified as gross fixed capital formation as a form of investment in human capital. The acquisition of knowledge, skills and qualifications increases the productive potential of the individuals concerned and is a source of future economic benefit to them. However, while knowledge, skills and qualifications are clearly assets in a broad sense of the term, they cannot be equated with fixed assets as understood in the SNA. They are acquired through learning, studying and practising, activities that cannot be undertaken by anyone else on behalf of the student and thus the acquisition of knowledge is not a process of production even though the instruction conveyed by education services is. The education services produced by schools, colleges, universities, etc. are thus treated as being consumed by students in the process of their acquiring knowledge and skills. This type of education is treated as final consumption. When training is given by an employer to enhance the effectiveness of staff, the costs are treated as intermediate consumption.”

50. In the above definition, the so-called ‘third-party’ criterion is used for not treating expenditures on education, etc. as investments in human capital, in the sense that the activities of learning, studying and practicing, and the subsequent accumulation of knowledge is embodied in a person and cannot be transferred to another person. As such these activities do not align to the so-called production boundary, human capital being an asset that is ‘produced’. This strict or rigorous application of the third party criterion is arguable. In practice, there may be other examples of services which cannot be separately sold on markets or which cannot be provided from one unit to another (see also paragraph 1.40 of the 2008 SNA, describing the production boundary). One example one could refer to is goodwill related to the past building up of brand names with a high reputation. Such capital may also be fully embodied, as an undistinguishable part of the relevant enterprise. Although in the present standards only purchased goodwill is recognized as being part of the asset boundary, these assets would probably be included as produced assets, if one could establish in practice a link to the process of producing these assets.

51. In paragraphs 2.34, 3.46 and 3.48, the 2008 SNA continues stating the following:

“The coverage of assets is limited to those assets which are subject to ownership rights and from which economic benefits may be derived by their owners by holding them or using them in an economic activity as defined in the SNA. Consumer durables, human capital and those natural resources that are not capable of bringing economic benefits to their owners are outside the scope of assets in the SNA.” (paragraph 2.34)

“The coverage of assets is limited to those assets used in economic activity and that are subject to ownership rights; thus for example, consumer durables and human capital, as well as natural resources that are not owned, are excluded.” (paragraph 3.46)

“Human capital is not treated by the SNA as an asset. It is difficult to envisage “ownership rights” in connection with people, and even if this were sidestepped, the question of valuation is not very tractable.” (paragraph 3.48)

52. The criterion of whether or not economic benefits can be derived from holding or using the assets in question looks slightly circular: as the predominant type of benefits, (additional) compensation of employees, is not recognized as being attached to the relevant assets, the assets are assumed not to bring any benefits at all. However, it is quite obvious that significant (extra) benefits are actually derived from investments in human capital. Also the criterion of ‘ownership’ is questionable. It goes without saying that one would not like to see ownership of people, but if one looks upon human capital as a separate entity, although embodied in a person, it does not seem problematic to view the relevant person owning human capital which clearly brings future economic benefits to him/her.

53. In summary, one could also argue that there is a slight inconsistency in the 2008 SNA when it comes to the non-recognition of human capital as part of investment and capital stock. On the one hand, it is excluded because of the third party criterion in defining the production boundary, basically raising the issue whether or not human capital is a ‘produced’ asset. On the other hand, in defining the asset boundary, there is no reference to a third party; when discussing this boundary, only criteria such as ownership rights and economic benefits being derived from the asset in question are being used. It is clear, however, that human capital differs from the usual types of capital in that it is fully embodied in persons, and as such is an entity that cannot be sold as a separate item on the market. To the defence of the 2008 SNA, one should also note that the treatment of human capital is considered as one of the items for the research agenda. As stated in paragraph A4.55:

“Human input is the major input in most production processes, and the value of that input is to a large extent dependent on the knowledge that humans bring to the production process. It is well recognized that an educated population is vital to economic well-being in most countries. Despite the fact that there are major conceptual and practical problems with identifying the value of an educated labour force, there are repeated requests to address this issue within the SNA framework.”

2.4. Recording and measuring human capital as an asset

2.4.1. Economic benefits from human capital

54. Box 2.1 suggests that human capital investment generates both economic and non-economic benefits, which can accrue to both the person undertaking the investment and to society at large. Economic returns accruing to the individual include enhanced employability and, if the person is employed, improved earnings and career prospects; while non-economic benefits can take the form of an increase in the person’s productivity in performing non-market activities (e.g. household production) or of personal benefits that are not related to production (e.g. greater enjoyment of arts and culture, better health status and subjective well-being).

55. The benefits of human capital investment can also spill-over to other agents. At the firm level, the higher productivity of some employees, due to their higher education and experience, may increase the performance of other workers and, hence, the firm’s profitability. At the macro-economic level, evidence has highlighted the positive impact of human capital on economic growth. Further, these spill-overs are not limited to economic returns: education may make people better citizens and better parents, leading to greater social cohesion.

56. Finally, as illustrated by the dotted arrow in box 2.1, there are also feedback effects, running from the benefits generated by human capital investment to the already created human capital stock thus further augmenting the level of stocks. For example, workers with higher educational attainment are more likely to benefit from further education and training. In addition, the feedback process may lead to a virtuous cycle where more education makes further learning 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. Various studies have shown that the causality may operate in both directions, suggesting that a feedback loop may also operate at the macro level.

57. As stated before, in this Guide, the concept of human capital is confined to the economic benefits that can be derived from the accumulation of embodied knowledge in a person. Basically, it is assumed that these benefits can be assessed by (increased) income levels, either through higher compensation of employees or through higher income from self-employment. In this respect, it can be implicitly assumed that some of the spill-over effects, such as the impact on the productivity of other workers, may actually be reflected in higher income levels.

58. Looking at the literature (see e.g. Liu, 2011), two methods are preferred in trying to arrive at an estimate of the value of human capital: either the ‘cost-based approach’ or the ‘lifetime income approach’. The latter approach is based on the net present value of the future benefits earned with the input of human capital. These benefits are usually based on labour income by different categories of age and educational attainment.

59. From a more theoretical point of view, the net present value estimate seems to be the most viable one, as it adds all future benefits that can be allocated to the relevant asset, thus replicating a market-equivalent valuation. Its measurement, however, requires quite a number of assumptions on the future development of the (active) population and the development in the level of economic benefits, it is also significantly affected by the discount rate that is applied. For that reason, a cost-based estimation is typically provided as an alternative method. According to this method, the investment costs for creating human capital are summed to obtain an estimate. These costs do not only relate to formal education, but also training and courses provided by the employer; time spent on learning and studying at home; and other expenditures on, for example, school books and other training material. However, one should be aware of the fact that this method also requires several assumptions, for example on the distinction between expenditures with a more current nature and expenditures which add to the capital stock of human capital. Also various assumptions are needed to measure and to value the unpaid activities. Furthermore, to arrive at a capital stock estimate, one needs to make additional assumptions on the service lives and the depreciation pattern of the relevant assets.

60. Usually, the estimates from the lifetime income approach are (substantially) higher than the ones using the cost-based approach. Various reasons may cause this difference, obviously one of them being that not all future labour income can actually be attributed to human capital. Another reason may be that part of human capital is actually not produced, but for example genetically inherited. For a more detailed overview, including the various pros and cons of the different valuation techniques, reference is made to chapter 3 of this Guide.

61. From a purely conceptual point of view, one can argue that in a setting of perfect competition, the cost-based approach ought to end up with an estimate which is equal to a valuation estimated using the lifetime income approach. In the ‘production process’ of human capital that is further elaborated in the following, the difference between the costs/inputs and the benefits/outputs are to be attributed to an operating surplus/mixed income resulting from investing in education, be it formal or informal. However, this issue should be addressed in more detail in future research.

2.4.2. The creation of human capital: a further elaboration of the production process

62. In addition to the central framework using the generally agreed concepts and definition, the 2008 SNA clearly recognizes the potential of having so-called satellite accounts. In a satellite framework, one has the option to go beyond recording strictly in line with the 2008 SNA central framework. The satellite account can take more modest steps away from the core concepts, definitions and classifications, by breaking down and regrouping the various transactions that are related to education, training, etc., and potentially by extending the production boundary for example for enterprise internal expenses on training and courses. This will be the subject of chapter 5. However, one could also go well beyond the current SNA definitions, and expand the asset boundary with human capital. This idea of treating human capital as a produced asset is used below as a way of presenting a conceptual framework of flows and stocks related to human capital. Doing so, the changes that need to be made to the core definitions are also discussed. In chapter 6, this conceptual framework is further elaborated as part of the presentation of a satellite account for human capital, showing changes in recording needed to integrate the concept of human capital in the sequence of accounts.

63. A very basic question in accounting for human capital as a produced asset concerns the way in which human capital is accumulated and becomes obsolete. Regarding the accumulation of human capital, one could look upon the creation of this embodied knowledge as a kind of ‘production process’ undertaken by individual persons, the product of which is the investment in human capital assets. Doing so, one could look upon the accumulation of knowledge according to the lifetime income approach as the measure for the output of creating human capital, whereas the cost approach focuses much more on the inputs needed to produce human capital.

64. The inputs into this production process of human capital would consist of the following:

- Formal education services, either paid by households or provided for free or at reduced prices by government and non-profit institutions serving households (NPISHs)
- Training provided or paid for by the employer
- Other expenditures on, for example, school books and other training material
- Time spent on learning and studying at home, etc.

65. Slightly problematic in this view of the ‘production of human capital’ is the fact that most of the production activity related to education and training occurs in economic units other than those which ultimately embody and ‘own’ the assets. Therefore, to be able to build up the assets in the sector of the persons who embody this knowledge and derive benefits from them, one would need to transfer the education and training outputs resulting from the activities in these other units (for a major part government, non-profit institutions serving households, and corporations) to the sector enjoying the benefits from these services. Two options that could be considered are⁴:

- i. to look upon the relevant activities in the sector paying for the produced services as producing a capital output, and subsequently transferring these outputs, via capital transfers, to the households;
- ii. to look upon the relevant activities in the sector paying for the produced services as producing a non-capital output that is transferred to the households where it is used as intermediate consumption into the production process of households producing their own human capital.

66. The above imputations are actually less far-reaching than one may think at first sight, as the relevant final expenditures by government and NPISHs are already recorded as social transfers in kind, and also as part of household actual final consumption (= final consumption expenditure plus goods and services provided to households by government and NPISH either free or at prices that are not economically significant). On the other hand, it should also be noted that in the case of training and courses which are internally provided by the employer the proposed recording will lead to an extension of the production boundary as a new output – training – will be recognized as part of the firm’s production. This new training output is, in all cases, transferred to the persons (households) receiving the training.

67. The next step would be to change the recording of expenditures on education made by households themselves, and as such included in household final consumption expenditure. In

⁴ Note that it is assumed here that all human capital is to be considered as a produced asset. One could also consider part of human capital as being non-produced and coming into existence by heritage or by increasing working experience. For reasons of simplicity, this option is not explored further in the Guide.

line with the notion of the creation of human capital as a production process within households, it seems more appropriate to consider the actual expenditures by households themselves as intermediate inputs to this process.

68. For arriving at the total output level of the ‘production’ of human capital, one has (again) two alternatives. Either to base the estimate on a cost based approach or use a lifetime income approach.

69. In the case of the cost approach, one can distinguish two variants: (i) one could include only those intermediate inputs described above, or (ii) one could also include a cost estimate of the time spent on learning and studying at home, e.g. through the attribution of a certain shadow price to one hour spent, which would also feed into the output (and the resulting value added and operating surplus/mixed income) of producing human capital. One would thus implicitly extend the production boundary, and value added levels, with unpaid activities related to studying.

70. The alternative to the cost based approach is to set the output level equal to the gross additions to human capital according to the lifetime income approach. In estimating the gross additions, one should not take into account the decreases in the level of human capital due to for example ageing, death and emigration. It should also be noted that increases of human capital due for example to immigration of people embodying human capital are to be accounted for separately, as this concerns an import of capital which is not the result of domestic production. On the other hand, emigration can be considered as exports of domestically produced human capital. Value added of producing human capital would amount to the difference between the gross creation of human capital in a year and the actual expenditures on intermediate inputs made, be it by government, non-profit institutions serving households, corporations or households themselves. Under this second alternative, one would thus implicitly assume that the resulting value added accounts for the production of human capital for own final use, by employing own activities such as learning and studying at home.

71. Looking back to the two options set out in paragraph 65 above, it should be noted that, the resulting extension of the production boundary according to the current international standard, the 2008 SNA, differs under the two options. Applying the second option would require more substantial imputations of output (and concomitant intermediate consumption). However, apart from which alternative is applied when valuing human capital (costs approach versus lifetime income approach), the imputations for value added and consequently the imputation for the value of the investment and stock for human capital are the same for both options.

72. If one would start to think about a full integration of human capital in the framework of national accounts, other considerations may need to be thought through as well. With the above imputations to record the production process, one is not yet there. One may need to reconsider the nature of compensation of employees. In line with the lifetime income approach, compensation of employees has become a form of compensation for putting human capital at the disposal of employers. As such the owners of human capital have become producers of human capital services which are sold to the employers. Such a far-reaching proposal, with very significant extensions to the production boundary (not only by the production of human capital, but also by looking at all or most of compensation of employees as a provision of services), would clearly constitute an overhaul of the present system of national accounts without precedent in the past 60-70 years of developments in the system of national accounts. A completely new interpretation of the economy would become apparent. It certainly will be very counterintuitive, having the present ‘economic story’ in mind. But

also a less far-reaching proposal, such as recording the expenditures on education as investments by the households being the economic owners of human capital, would constitute a major divisive line between past and present.

73. Given the above, including the concept of human capital in the central framework of national accounts, would be several steps too far. Instead, one could simply add a value of human capital to the central framework, as a non-produced asset. But this capital would then be totally disconnected from the rest of the system. Therefore, applying a satellite account approach seems to be the preferable option. As stated before, one can distinguish two basic alternatives. One could think of a more limited approach, a kind of satellite account for education, in which the various expenses, including in-house production of education services, are spelled out. Or one could try to develop a full-fledged satellite account for human capital, in which the various imputations described above are applied. These and other issues will be discussed in chapters 5 and 6 of this Guide.

2.4.3. Valuation, accumulation and depreciation of human capital

74. According to the 2008 SNA, every item on the balance sheet has to be valued "... as if it were acquired on the date to which the balance sheet relates. This implies that when they are exchanged on a market, assets and liabilities are to be valued using a set of prices that are current on the date to which the balance sheet relates and that refer to specific assets" (SNA 2008, paragraph 13.16). Doing so, one has to take into account that the value of a certain asset will decrease while ageing and having been more used/depleted, as a consequence of which the future benefits that can be derived from such an asset will decrease.

75. To adequately value assets using (equivalent) market prices, one would need prices from second-hand markets on which the items in question are regularly, actively and freely traded. This may be the case for e.g. cars and residential dwellings, but certainly not for most other non-financial assets. In the absence of market equivalent prices for the relevant assets, two alternatives are mentioned in the 2008 SNA:

- i. Net Present Value method: the value of an asset is approximated by the present, or discounted, value of future economic benefits expected from a given asset;
- ii. Perpetual Inventory Method (PIM): the value of the capital stock is approximated by accumulating and revaluing acquisitions less disposals of the type of asset in question over its lifetime and adjusted for changes such as depreciation and destruction, for example by natural disasters, etc.

76. Both methods should, in principle, provide the same results, in the sense that the net capital stock estimated by PIM should use so-called age-price profiles which approximate market prices, whereas market prices would in open, transparent and competitive markets be equal to the net present value of the future capital services that can be derived from the relevant asset.

77. In compiling national accounts, the PIM usually is the preferred method. The PIM resembles the current replacement cost method, often applied in business accounting. The stock of assets is set equal to the sum of past years' investments. Doing so, the assets acquired in past periods will need to be revaluated to current price levels, to arrive at the appropriate value. Also depreciation of the assets in place needs to be taken into account, to reflect the decrease in value due to the use of the relevant assets. Finally, one of course needs to account for the disposals of the relevant assets, either as a result of a sale or because the asset is scrapped at the end of its economic life cycle.

78. Using PIM, the accumulation of assets is equal to the new additions, investments in newly produced assets plus purchases (less disposals) of second-hand capital goods. The depreciation costs, or ‘consumption of fixed capital’ according to SNA-terminology, should include “... the decline, during the course of the accounting period, in the current value of the stock of fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage” (SNA 2008, paragraph 10.25). On the other hand, unforeseen elements, e.g. obsolescence due to unforeseen technological developments, are to be accounted for as “other changes in the volume of assets”, as a kind of revaluation. Depreciation can be measured by the decrease, between the beginning and the end of a certain period, in the net present value of the remaining sequence of expected future benefits. In the words of the 2008 SNA (paragraph 6.246):

“The value of a fixed asset to its owner at any point of time is determined by the present value of the future capital services (that is, the sum of the values of the stream of future rentals less operating costs discounted to the present period) that can be expected over its remaining service life. Consumption of fixed capital is measured by the decrease, between the beginning and the end of the current accounting period, in the present value of the remaining sequence of expected future benefits. The extent of the decrease will be influenced not only by the amount by which the efficiency of the asset may have declined during the current period but also by the shortening of its service life and the rate at which its economic efficiency declines over its remaining service life. The decrease is expressed in the average prices of the current period for an asset of exactly the same quality and should exclude holding gains and losses. When the flow of future benefits that determines the present values used to derive consumption of fixed capital is expressed in terms of flows that include an element of inflation, then the discount factor should be nominal. When the flows are expressed in terms of current period prices, then a real discount rate should be used. Either procedure results in a present value expressed in current period prices.”

79. As can be derived from the above paragraph, from a conceptual point of view, the value estimate using PIM in the case of the cost-approach should not differ from the one using the Net Present Value method in the case of the lifetime income approach. The same holds for the accumulation and depreciation patterns of human capital. In terms of the lifetime income approach, depreciation would equal the loss of one year of future benefits through ageing minus the winding down of the discount (the discount rate times the value of the asset). However, as said before, usually the cost approach will arrive at value estimates that are lower than the ones using the lifetime income approach. Possible reasons for this difference are the exclusion of certain cost elements, part of the human capital actually not being produced, or an overestimation of the value using the lifetime income approach.

80. To estimate the total capital stock (and depreciation), when using the PIM, the following data and assumptions, broken down by type of asset, are required:

- A sufficiently long time series of data on gross fixed capital formation (or investments) or a benchmark;
- A sufficiently long time series of volume or price indices;
- An estimate of the capital stock for a certain year in the past;
- Assumptions regarding the average service lives of the relevant assets;
- Assumptions regarding the depreciation function, or ‘age-price profile’, of the relevant assets;
- Assumptions regarding the mortality function, or ‘retirement function’, of the relevant assets.

81. More details on the general methodology and practices of measuring capital stocks can be found in the second edition of the OECD Manual ‘Measuring Capital’ (OECD, 2009).

82. On some occasions, the net present value method is also applied in national accounts. This is most certainly true for non-produced assets, such as natural resources. But also in case of, for example, intellectual property products, this may prove to be the most promising and viable method to arrive at a good approximation of the market-equivalent price of an asset. Using this method, the most critical elements of information are:

- Assumptions regarding the average (remaining) service lives of the relevant assets;
- An adequate forecast of the economic benefits that will be derived from the relevant assets.

83. In addition, as said before, the assumptions in relation to the discount rate are critical for the valuation of the capital stock.

84. Leaving aside the possibly non-produced part of human capital, the accumulation and depreciation of ‘produced’ human capital has certain resemblances with other non-financial assets in the system of national accounts. There are differences as well. Looking at the accumulation of assets, there is a clear similarity in the way the assets are built up by expenditures which have the character of investments. Different from the more traditional types of capital goods is the fact that a substantial part is related to unpaid activities which implicitly enter the production boundary. The latter, however, also has some resemblance with in-house production of, for example, literary originals, in which case an author is writing a book at home, although in this case the result clearly is a tradable ‘intellectual property product’.

85. Another difference with the more traditional form of fixed assets is that human capital is created over a very long period before it is actually put to use in economic activities and generating economic returns. In this respect, one should consider the investments in formal education, before entering the labour market, as a kind of work-in-progress, which is finalized at the end of the schooling period, and subsequently reclassified from work-in-progress to the fixed capital stock. This treatment is similar to large investment projects which take longer than a year. One could make this distinction between work-in-progress and finalized capital in the recording of the creation of human capital as well. It goes without saying, however, that this would further complicate the estimation procedures somewhat, not adding to the total value of asset accumulation. On the other hand, if one would like to make the distinction between ‘work-in-progress’ and capital stocks of human capital actually used in production, this could relatively easily be built into a system of measuring human capital.

86. Furthermore, due to the embodied nature of human capital, there cannot be any (negative) accumulation through purchases (or sales) of the asset of human capital as such. On the other hand, as stated before, one can consider (part of) compensation of employees as a form of compensation for the supply of human capital services. Finally, domestic stocks of human capital can be accumulated (or diminished) by immigration (or emigration) of people.

87. Looking at depreciation, the value of human capital will decrease by ageing, and the consequent shortening of the period up to retirement or death. This has clear similarities with the shortening of the remaining service life of more traditional assets. On the other hand, human capital is different in the sense that more classic ‘wear and tear’ through the use of assets, while eventually evident, often exhibits quite different patterns of change with use. As stated before, embodied knowledge may actually increase as a result of using it in practice, as a result of gaining more experience, etc. Or vice versa, the stock of human capital may depreciate quicker because of non-use, for example as a result of long-term unemployment.

Economic obsolescence of human capital may also be a quite important factor in accounting for depreciation, in case of shifts in the required knowledge and skills. To the extent that this obsolescence is ‘normal’, it is to be looked upon as depreciation.

88. Similar to more traditional capital stock items, there may be sudden shocks in the value of the stocks of human capital, which are to be viewed as so-called ‘other changes in the volume of assets’. These changes could be negative, for example as a consequence of unexpected economic changes which make a substantial part of the available human capital obsolete. It can also relate to positive shocks, for example the extension of the retirement age by way of changes in the relevant laws and regulations.

89. From a measurement perspective, the above would clearly require a rather perfect world of data. As this is not the actual practice, one will have to apply (rough) assumptions and guestimates to approximate the various elements in the conceptual framework. Looking at the cost-based approach, one would need sufficiently long time series of data on the expenditures (including estimates for the value of unpaid activities). Here, ‘sufficiently long’ means that one would like to have a consistent time series as long as possible, and preferably one that surpasses the service life of the relevant asset. In that case, the estimates of capital stock for more recent years would be based on actually measured data on gross fixed capital formation and/or the ‘rough estimates’ for the starting stock would have a relatively low weight. It may be clear that the availability of long time series may be quite demanding in the case of human capital which typically has a rather long service life.

90. The age at which the relevant asset is put out of service, because it has reached the end of its service life, is typically referred to as the ‘retirement’ of the asset. Usually, some kind of retirement or mortality function is assumed. This can be a ‘simultaneous exit’, i.e. all assets are retired at the moment when they reach the average service life of the asset in question. Other retirement patterns assume a certain bell-shaped function around the average age of retirement (see OECD 2009, section 13.2).

91. The depreciation function, or ‘age-price profile’, reflects the decrease in value of an asset during its service life. For human capital, this information typically is not available from directly observable market prices, assumptions will have to be made. Leaving apart the information on the service life, there are two basic possibilities. Either one directly assumes a certain age-price profile, for example a linearly-declining function, giving rise to constant absolute values of depreciation over an asset’s lifetime. Or one makes assumptions regarding the ‘age-efficiency profile’. The latter reflects the productive capacity of an asset over its service life. This information can then be used to construct an age-price profile. The geometric age-efficiency profile is the one most commonly used (for more details on different methodologies for individual assets and for cohorts of assets, including the pros and cons of these methods, reference is made again to the OECD Manual ‘Measuring Capital’). In estimating depreciation patterns in the case of PIM, one could also make use of the resulting depreciation function when applying the Net Present Value method.

2.5. Non-economic returns

92. Getting a full picture of each component encompassed by the broad OECD definition of human capital, of the causal links between each type of human capital investment, of the corresponding benefits and feedback loops among them, is quite complicated. Encompassing all the elements of box 2.1 into a single measure of the stock of human capital is a daunting task. The most sensible approach is to address this task step-by-step.

93. This Guide applies this principle of gradualism, by focusing on a narrower range of elements of human capital, starting from those aspects characterized by either lower conceptual challenges or greater data availability. The option pursued is to focus on the economic returns to the individual, as the main benefits due to human capital investment. Currently, many researchers and institutions are using definitions that focus on the productive capacity of individuals. Even when accepting the broader OECD definition as a useful reference point, most of the ongoing statistical work on measuring human capital takes formal education and the economic returns to individuals as points of departure.

94. The pragmatic approach advocated here has implications. For instance, focusing on economic returns implies that the health component of human capital will have to be dealt with separately from the education aspect of human capital. As a matter of fact, health status is sometimes considered as a specific kind of asset, i.e. as health capital (e.g. Abraham and Mackie, 2005). A framework for the systematic description of the financial flows associated with health care has been developed jointly by the OECD, Eurostat and World Health Organization (OECD et al, 2011). Treating health as a separate type of capital does not imply that health status is irrelevant for the measurement of the ‘educational’ capital explored here. However, it implies that the measure of the human capital stock described here will only reflect the impact of health care activities in improving people’s economic returns. Moreover, as stated before, the narrower focus on economic returns is also more in line with the current conceptual framework of defining and valuing assets in the system of national accounts.

95. Non-economic returns, or better to say non-monetary returns, relate to a whole range of benefits delivered by human capital investment. These broader benefits accrue to individuals privately but also to society at large. Private non-monetary benefits include better health status and higher longevity, civic awareness and participation, job quality and job satisfaction, social connections, subjective well-being and personal security. Public non-monetary benefits to society as a whole include higher productivity, lower social spending, higher public health and safety, and stronger social inclusion.

96. Measuring this wider range of benefits is certainly much more challenging. While the evidence on the importance of the non-monetary benefits is robust, it comes in the form of estimates showing that, when controlling for a number of other factors, education has a positive impact on these various components of well-being, i.e. higher educated individuals have higher probability of experiencing a positive well-being outcome. This means that well-being benefits to education are not quantified through a monetary metric. To include these benefits, it would be necessary to find appropriate prices for incorporating these benefits. Pricing methods for non-monetary outcomes exist (Abraham et al 2005, and Schreyer 2010), but they are far from being agreed upon as they require many arbitrary assumptions as well as a relatively large set of data. One pricing method that could be considered is a more sophisticated version of the income-based method, based on the incremental earnings brought by higher well-being (e.g. the higher salary due to higher health status, higher job satisfaction, higher subjective well-being). Another possibility would be to estimate private and public returns to education by applying the standard internal rates of returns methodology to non-monetary benefits (e.g. considering the lower medical expenditures that an individual or society at large incurs as a result of higher health status due to higher education).

3. Methodological issues

3.1. Introduction

97. This chapter will look in more detail at the methodological challenges related to the measurement of human capital using some of the approaches discussed in the previous chapter. In particular, it will look at the theoretical basis for the cost of production and lifetime income approaches to measuring human capital and the challenges in measuring these approaches. It will also consider how these approaches can be complemented by indicators to provide a more complete picture of what is happening.

98. When considering the measurement of human capital there are a number of considerations that are common to more than one approach outlined in this Guide – the scope of the estimates, the heterogeneity of human capital and the aggregation of human capital.

99. As outlined in chapter 2, material in this Guide focuses mainly on a narrow definition of human capital.

100. This Guide only considers the economic returns that accrue to individual persons from investments in human capital. That is to say, no spillover effects (positive externalities due to human capital investment) will be taken into account. This is not because the spillover effects are less important, but rather, because the measurement of them is more difficult, at least for the time being.

101. The elements valued are related to the economic returns (and not wider non-economic returns). One important innovation introduced by Jorgenson and Fraumeni is the imputed valuation of nonmarket labour activities from information on market labour activities. 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 nonmarket labour activities is a contentious issue and the data requirements are substantial.

102. This Guide only considers human capital in the form of formal education and work related training. In general, the Guide considers the quantity of human capital to be represented in two commonly adopted indicators: educational attainment and work related training. Human capital skills are generally grouped into two kinds: general-purpose skills and firm-specific skills. The empirical literature on the measurement of human capital has focused on general-purpose skills, partly because these are easier to measure. Human capital is formed in many diverse ways. In the form of formal education, students can acquire mathematical skills, language skills, and other generic cognitive skills. In the form of training, workers accumulate analytical abilities, computing abilities, negotiating abilities, supervising abilities, and so on.

103. There are challenges surrounding the heterogeneity of human capital in the economy outside the scope of the Guide. Workers differ in their human capital skills, suggesting heterogeneity of human capital in the economy. If there are m dimensions of human capital skills, and n levels in each skill dimension, the total number of different types of human capital in the economy is given by the product: $\prod_{i=1}^m n_i$, where $i=1$ to m and $j=1$ to n .

104. The assumption that workers in the same category of productive characteristics have the same level of human capital skills may be problematic. In terms of education, for example, a worker with the same level of educational attainment may have a different level of education capital from his peers in the same category of productive characteristics, due to

differences in schooling quality. If the quality of education experienced by workers is different, due to different education inputs (teacher quality, class size, pupil-teacher ratio, different days of per year schooling and different hours per day schooling), the quantity of education capital embodied in workers with the same educational attainment, but graduated from different educational institutions, will be different. While some methods are available for adjusting for quality differences, it is difficult to do so consistently in a cross-section and over time. Schreyer (2010) offers the example of quality adjustment through exam scores which are “the joint outcome of teaching, student effort, natural ability and the broader socio-economic environment”. If changes in test scores that are due to teaching only are observed and can be measured, estimates of the quality adjustment of education services can be obtained.

105. The final key challenge common to all approaches is aggregation. Aggregation and explicit homogeneity assumptions exist for all types of capital, but they are reflected in human capital in different ways than for physical and intangible capital. Aggregation is one of the most contentious issues in capital theory, and this also applies to human capital. Measures of human capital focus on individuals’ human capital and aggregate them to arrive at the population measure. Jones and Chiripanhura (2010) observe that “This ignores spillovers between workers so that the whole may be more than the sum of the parts”.

3.2. Methods and approaches to measuring human capital

106. As discussed in chapter 2, a number of approaches have been used to measure Human Capital. In general, these approaches can be split into direct and indirect approaches.

107. **Indirect approaches** estimate human capital residually. The World Bank has pioneered this approach (World Bank, 2006, 2011; Ruta and Hamilton, 2007). This approach is based on the assumption that the discounted value of the benefits that the capital stock will deliver over its life will be equal to the current monetary value of the capital asset. In the context of discussions on sustainable development, the total capital assets of each country may be thought of as generating a stream of benefits in the form of consumption goods in the future. Therefore, by taking the discounted value of the future consumption flows (taken as a proxy for total wealth), and subtracting from this amount the monetary value of those capital goods for which monetary estimates of their current stocks are readily available (i.e. produced capital, market value of a range of natural assets, and net foreign assets), may provide an indirect (i.e. residual) estimate of the value of those capital stocks for which no monetary value can be observed on the market.

108. While this indirect approach can be applied to a large number of countries based on limited statistical information, it has limits. First, it obviously ignores the non-market benefits of the 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 resulting estimates of human capital. Third, it cannot explain what drives the observed changes of the stock of human capital over time. Fourth, it is a measure of intangible capital, from which human capital cannot be derived on its own. It is therefore not an approach that is recommended by this Guide and will not be discussed further in this chapter. However, data requirements for the indirect approach are discussed briefly in the example at the end of chapter 4.

109. **Direct approaches** derive a measure of the stock of human capital from information on its various components. There are three direct approaches to measuring the stock of human capital:

- i. **The cost-based approach** - the value of the human capital stock is calculated as being the depreciated value of the stream of past investments, including investments coming from the individual, the family, employers and governments (e.g. Shultz, 1961; Kendrick, 1976; Eisner, 1985). This approach relies on information on all the costs that are incurred when producing the human capital and estimating the depreciation rate is an important element of this method. This method can also be extended to account for non-market expenditures (e.g. imputed values of the time devoted to education by both students and their parents).
- ii. **The lifetime income-based approach** - measures human capital by summing the discounted values of all future income streams that all individuals in the population expect to earn throughout their lifetime (e.g. Weisbrod, 1961; Graham and Webb, 1979; Jorgenson and Fraumeni, 1989, 1992a, 1992b; Inclusive Wealth Report 2012, 2014). In contrast with the cost-based approach, which focuses on the input side, the lifetime income-based approach measures the stock of human capital from the output side (although the output in this method is limited to the private monetary benefits that accrue to the person in which the human capital is embodied).
- iii. **The indicators-based approach** - estimates human capital based on educational output indicators. Several measures have been used in the literature - for example, adult literacy; school enrolment rates; and average years of schooling (e.g. OECD, 2007, 2011; Barro-Lee 2010, 2013). Unlike the others, this approach relies on several indicators that, though rich in information, lack a common metric.

110. Abraham (2010) identifies the cost-based approach and the lifetime income-based approach as analogous to the income and production sides of a national income and product account. They are not conflicting methodologies, as they have the same goal. In theory, estimates from the cost based approach should closely align to those from the lifetime income-based approach.

111. The System of National Accounts 2008 (2008 SNA) identifies three methods to value assets and liabilities. The first is to use observable market prices – however, human capital is not purchased or sold in the market and therefore this is not applicable. The alternative is either to approximate by accumulating and revaluing acquisitions less disposals of the asset over its lifetime and adjust for changes in consumption of fixed capital; or approximate the values using the present, or discounted, value of future economic benefits expected from a given asset. With good information and efficient markets, the values of the assets obtained from either of these two approaches should be approximately equal.

112. “However, unlike the two sides of a national income and product account, cost-based and income-based human capital accounts should not necessarily lead to identical results.” Christian (2011) There are a number of reasons for this; differences may come from inadequate source data and estimates (for example, not estimating forgone costs, see chapter 4, section 4.2.1), but also from the fact that underlying assumptions of perfect competition and foresight are not justified. An asset market, in reality, is characterised by many aspects of imperfection, such as imperfect competition, imperfect information and uncertainty.

113. Each of these direct approaches has its strengths and limitations. This chapter will start by discussing each of the direct approaches to measuring human capital in detail. It will also outline how these approaches can be used together within the framework described in chapter 2. The cost-based approach for example is most suited to value the various inputs in the production of human capital, while the lifetime income-based approach estimates the output of the production process and the total stock of human capital. However, both methods

provide an estimate of Gross Fixed Capital Formation (GFCF) in human capital and the resulting stock. In addition to the cost- and income-based monetary measures of human capital, indicator methods could also provide complementary information.

3.3. The cost-based approach

114. Empirical estimates of physical capital stocks are often derived by valuing assets at the cost of their production and aggregating vintages of the type of asset at a point in time, correcting for retirement of old assets and their decline in value (depreciation). This approach is called the Perpetual Inventory Method (PIM) and is explained further in the OECD manual (2009). The cost-based approach values the human capital stock as being the depreciated value of the amount invested in human capital adjusted to current prices. The method is popular because of the general availability of expenditure data on capital goods, and it is still a standard accounting practice in much financial and management reporting. In addition, the cost-based approach is in line with much of the valuation of economic capital in the 2008 SNA. When extending the capital concept to knowledge and skills the cost-based method is an obvious choice in valuing human capital.

115. The work of Mincer (1962) shows that informal, on-the-job training (for example shadowing more experienced colleagues) contains an implicit investment aspect, as workers accept lower wages to gain working experience. Indeed, human capital results not only from schooling and training, but also from general experience both at work and in leisure-time activities. But the expenditures related to informal on-the-job training are less likely to be readily available – the scope of this Guide is therefore restricted to formal investment in human capital (see chapter 4).

116. The cost-based approach has been adopted in a number of important landmark studies. Schultz (1960) was the first to make estimates of investment in human capital for the United States for the period 1900-1956 by using a cost method. Probably the most comprehensive estimates of human capital based on the cost method were made by Kendrick (1976).

117. Schultz considered the contribution of formal education to human capital formation (covering all three levels of education) and included estimates of opportunity costs involved in the human capital formation process. In doing so, he assumed that only students after eighth grade incurred foregone earnings in pursuing schooling activities.

118. In estimating rearing costs as part of human capital investment, Kendrick imputed investment values to cohorts of persons under-fourteen years of age, based on consumption values and other resources devoted to them. He defined the human rearing span as the period from birth to working age, which was somewhat arbitrarily set at fourteen. Increased consumption by children in a cohort implicitly allowed for quality changes in the production of a labour force. Those ‘quality’ changes in human investment output that were due to increased measured inputs in their production are incorporated in human capital formation. The stock of tangible human capital was measured by the accumulated costs of rearing children to age fourteen.

119. Kendrick defined the intangible investment in human capital as those made primarily to improve the productivity of the tangible human beings in which they are embodied. According to Kendrick, there were three dimensions of investments in intangible human capital: those used (1) to educate and train individuals; (2) to provide them with better health and safety; and (3) to improve labour allocation via job search and mobility. The education and training series covered not only expenditures on formal, informal education and

employee training, but also the foregone earnings of students of working age, which were the larger part of educational costs. One-half of the expenditures on medical, health, and safety objectives were treated as investment, with the other half treated as maintenance which does not increase future productive capacity. Mobility costs included job search and hiring, frictional unemployment, and migration costs.

120. This Guide recommends that foregone earnings while studying are included in the cost-based approach estimates of human capital. This extends the production boundary of SNA 2008. It is advisable to start by calculating the available actual expenses and subsequently provide the best possible estimate for the value of the time spent studying. Sourcing data may be challenging and countries should at first use national data sources and if not suitable, make use of international databases.

121. Net migration affects the 'stock' of human capital and as such should be taken into account in the estimates. Issues such as utilization of migrant human capital may have policy relevance for some countries but may be difficult to calculate. Underutilization could be a result of the non-recognition of foreign credentials by licensing bodies of various trades. Additionally, companies may demand educational prerequisites for particular jobs which will affect the types of immigrants and their career progressions (Reitz 2001). There are also limitations with the availability of data, for example it may be difficult to measure the number of migrants employed /unemployed.

122. The examples so far highlight one of the key difficulties of this approach - identifying which costs should be included and how they should be measured. Simply reclassifying all education and training expenditures as investment rather than consumption may not be correct. To the extent that individuals enjoy their courses or have their range of interests, tastes and activities extended, educational expenditures also provide some consumption benefits. Thus, the difficulty lies in determining which part of educational expenditure is investment spending and which part is consumption (see Schultz, 1961 and Shaffer, 1961 for a discussion).

123. This leads on to the inherent problem with Kendrick's estimation (and to a large extent with the cost based valuation method in general); that it might treat part of the expenditures on education for consumption as investments. In principle, investment is a clearly different concept from consumption. In reality, it is much harder to distinguish between expenditures for consumption and for investment. According to Schultz (1961), there are three classes of expenditures: expenditures that satisfy consumer preferences and in no way enhance the capabilities under discussion - these represent pure consumption; expenditures that enhance capabilities and do not satisfy any preferences underlying consumption - these represent pure investment; and expenditures that have both effects. He believes that most relevant activities clearly are in the third class, partly consumption and partly investment, which is why the task of identifying each component is so formidable and why the measurement of capital formation by expenditures is less suitable for human capital investment than for investment in physical goods.

124. Hill (2002) proposes a method by which human capital could be measured and treated in the SNA 2008. Hill's basic approach is similar to that of Kendrick's in the sense that both of them use direct expenditure plus opportunity costs to value human capital investment and stocks. But Hill is interested in the intangible intellectual component of human capital. He treats intellectual capital as an asset produced by the people acquiring the knowledge and skills. In the production of intellectual capital, output is defined as acquired knowledge and skills. The teaching or training services provided by educational and training establishments and the work of students and trainees are inputs to the production of intellectual capital. In

this way, students are viewed as working for themselves and they are self-employed. Hill suggests that the production of human capital by students should be treated in the same way as the household own dwelling production is treated in the SNA. Hill classifies the costs incurred in the production of human capital into three parts: (1) teaching and training service costs; (2) household services (such as electricity consumed for the purpose of study); and (3) the value of the student's work, which is measured by the opportunity cost (foregone earnings).

125. In addition to the challenge of the decision criteria used to split human resource expenditures into a consumption-flow component and an investment-flow component there is the challenge of the choice of depreciation rates for human capital. The choice of depreciation for measuring human capital is essentially arbitrary because of a lack of empirical evidence. However, calculating the depreciation rate is an important element of this method.

126. Like physical capital, human capital depreciates over time; however, the depreciation profile is unlikely to be the same. For example, physical capital depreciates faster in early years of life as a result of wear and tear and normal obsolescence. This is less likely to be the case for human capital, which in fact may appreciate in early years. The appreciation of human capital is often ignored in the literature, despite some empirical evidence (Mincer, 1958, 1974; Graham and Webb, 1979).

127. While human capital might depreciate due to erosion of skills due to ageing or illness (similar to physical capital) it might also depreciate due to insufficient use. De Grip and Van Loo (2002) categorize these two causes within technical obsolescence of human capital, which affect the skills of workers. This is distinguished from economic obsolescence of human capital, which affects the value of workers human capital. Examples of economic obsolescence include job-specific obsolescence due to technological and organizational change, sector specific obsolescence due to shifts in employment and firm specific skills obsolescence due to displacement.

128. This Guide now discusses age price and age efficiency profiles.

129. An age-efficiency profile for a single asset describes the time pattern of change in product efficiency as the asset ages. The age-efficiency function of a single asset reflects losses in efficiency due to wear and tear as well as certain effects on service lives. Whilst the age-efficiency function can take many shapes, the OECD Manual, 2009 focuses on linear, geometric and hyperbolic. The discussion in this chapter is limited to hyperbolic age-efficiency profiles.

130. Hyperbolic age-efficiency profiles typically show a form where assets lose little of their productive capacity during the early stages of their service lives but experience rapid loss of productive capacity towards the final stage of their service lives. A hyperbolic decline takes the form:

Equation 3.1

$$g_n(\text{hyperbolic}) = \frac{T-n}{T-b \cdot n}$$

131. Where $b \leq 1$ is a parameter that shapes the form of the function, n is an index for age that runs from zero (a new asset) to T , the retirement age of the asset.

132. This has been used by the Bureau for Labor Statistics (BLS) and Australian Bureau of Statistics (ABS), among others. The ABS assumed a certain hyperbolic function, setting

$b=0.5$ for machinery and equipment, and 0.75 for structures - the same values used by the BLS.

133. Age-price profiles, or depreciation profiles, focus on the loss in value of an asset due to physical deterioration (wear and tear), and due to normal obsolescence. Depreciation is a value concept, to be distinguished from quantity concepts such as the age-efficiency function that capture losses in an asset's productive efficiency.

134. Two common age-price profile methods used to calculate depreciation in the literature are the straight line method and the (modified) double declining balance method. A fuller explanation of depreciation calculations can be found in 'Measuring capital - OECD Manual 2009'. This section provides a brief overview.

135. In the straight-line method (Eisner, 1988) a constant proportion of the original human capital is assumed to become obsolete in each period. Given a service life, the age-price profile of the asset follows a pattern of linear decline.

136. The second method used to estimate depreciation is to use a geometric method in which depreciation is treated as non-linear. An example of a geometric method is the (modified) double declining balance method (Kendrick, 1976). The rationale behind this type of method is that physical capital depreciates faster in early years of life, so using the double declining balance method provides consistency across different types of capital.

137. This method is computationally simple; it was used in a large number of economic studies (see Jorgenson 1996 for a sample of influential papers) and was also gradually adopted by statistical agencies. Jorgensen updated estimates (as discussed in Jorgenson 1999) following additional work by the Bureau for Economic Analysis (BEA) (Fraumeni 1997) which used empirical results to develop asset specific geometric depreciation rates. More information is available in the OECD Manual, 2009.

138. Information from second-hand asset prices is sometimes used to estimate geometric rates econometrically. A specific adjustment is made to account for retirement patterns and for the fact that observed prices are only prices of surviving assets.

139. In the absence of econometric estimates of geometric depreciation rates, the depreciation rate, δ , has sometimes been estimated with the 'declining balance method' and on the basis of information about average service lives of a group of assets.

140. Hulten and Wykoff (1996) made a suggestion for converting an average service life of a cohort, T_A , into a depreciation rate. They proposed a two-step procedure based on the 'declining balance' formula, which is discussed further in the OECD Manual, 2009.

141. The real challenge is finding a rate of depreciation for human capital that is appropriate and linked to the theoretical basis of how human capital loses value over time. Chapter 4 recommends some implementation methods.

142. Grip and Van Loo (2002) also suggested ways in which the obsolescence of human capital could be measured using objective methods such as testing, subjective methods e.g. asking workers or their employers; workers' wages; and the probability of losing employment. All four measures have limitations. The last two indirect methods have the advantage that they measure the labour market effects of skills obsolescence that are the main concern of human capital obsolescence in a knowledge economy: lower productivity and lower labour market participation.

143. One of the key challenges of the cost-based approach is the choice of deflator used to deflate expenditures related to human capital investment over time.

144. Chapter 15 of the 2008 SNA discusses the main price indices available to derive volume measures in the national accounts: consumer price indices (CPIs), producer price indices (PPIs), export price indices (XPIs) and import price indices (MPIs). In the UK, and in line with guidance in 2008 SNA, the ONS uses price indices as deflators that match, as closely as possible, the values being deflated in terms of scope, valuation and timing. The price indices used will differ from country to country based on data availability.

145. However, for non-market individual services, in particular, health and education, 2008 SNA recommends the ‘output volume method’, - based on the calculation of a volume indicator of output using adequately weighted measures of output of the various categories of non-market goods and services produced.

146. For the cost approach, this Guide recommends using volume indexes based on output indicators, rather than price deflation of inputs, in order to arrive at volume measures of human capital. This is consistent with the way education service volumes are measured in national accounts. Gulong and Wu (2012) note that under the cost approach “the volume index of education output is calculated as a weighted sum of student enrolments using weights based on total expenditures per student as the unit price of education. Total expenditures include teacher salaries, intermediate inputs, and a capital consumption allowance.”

3.4. The lifetime income-based approach

147. The lifetime income-based approach, advocated by Jorgenson and Fraumeni (1989, 1992a, 1992b) measures the value of the total stock of human capital embodied in individuals as the sum of the discounted present value of all future income streams that all individuals in the population expect to earn throughout their lifetime. This method focuses on the expected return to investment and is therefore ‘forward-looking’ rather than the ‘backward-looking’ method using the historical costs of production for human capital.

148. The central assumption of the lifetime income-based approach is that labour is paid according to its marginal productivity. In the approach recommended in this Guide, it is also assumed that educational qualifications are the main driver of the returns to human capital. In practice, factors such as market power, trade unions, discrimination, etc. all affect wages. On-the-job training is implicitly included within the lifetime labour income approach (those with more experience get higher salaries).

149. The following discussion of the lifetime income-based approach modifies the original Jorgenson and Fraumeni ((1989), (1992a), (1992b)) method.

150. It excludes non-market activities – one important innovation introduced by Jorgenson and Fraumeni is the imputed valuation of nonmarket labour activities from information on market labour activities. 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 nonmarket labour activities is a contentious issue, and their inclusion makes comparison with physical capital stock measures more difficult. As discussed in chapter 2, the valuation of non-market activities is beyond the scope of this Guide. An example which includes non-market activities can be found in the annex to chapter 7.

151. Confinement to working age population – while Jorgenson and Fraumeni accounted for all individuals, this Guide suggest focusing on the working age population, mainly because of data limitations (see chapter 4, box 4.1). This is a somewhat arbitrary choice and, while not

crucial, it could easily be relaxed and extended to other age groups. There is no fixed upper age limit as this depends on the actual retirement age in a country.

152. Economic theory suggests that under competitive market conditions, the market price of an asset is related to the rental income that the asset is expected to earn through the following equation (the scrap value is ignored):

Equation 3.2

$$V_t = \sum_{\tau=1}^T \frac{f_{t+\tau-1}}{(1+\delta)^\tau}$$

where;

V_t is the real market value of an asset at the beginning of year t ,

f is the real rental income earned in each period,

T is the service life of an asset in years,

τ takes values of 1, 2, 3.... T ,

δ is the discount rate.

153. The corresponding equation for a human capital asset involves using earnings as the rental income and working life as the service life. Therefore, the real market value of an asset at the beginning of year t is the present value of lifetime income.

154. In most applications of this method, lifetime income is calculated for a representative individual in each classification category (i.e. by gender, age and educational attainment). A key assumption used here is that an individual of a given age, gender and educational level will, in year $t+1$, have the same labour income and other characteristics (e.g. employment rate, mortality rate, etc.) as those of a person who, in year t , is one year older but has otherwise the same characteristics (e.g. gender and educational level).

155. In general, there are different stages of the life cycle that can be distinguished in the measurement of lifetime income. The original Jorgenson and Fraumeni (J-F) approach applies five so-called 'stages of life' for the USA population:

Stage 1: No school or work, ages 0-4

Stage 2: School, but no work, ages 5-15

Stage 3: School and work, ages 16-34

Stage 4: Work only, 34-74

Stage 5: 74 and above.

156. For each of these stages the lifetime income of an individual can be computed as follows:

Stage 1: J-F assume that the lifetime income of these individuals is not affected by school enrolment and therefore their lifetime income is simply the discounted lifetime income of individuals a year older adjusted for income growth and survival probabilities.

Equation 3.3

$$mi_{y,s,a,e} = sr_{y,s,a+1} * mi_{y,s,a+1,e} \left(\frac{1+g}{1+r} \right)$$

Where $mi_{y,s,a,e}$ is the market lifetime income of an individual in a given year (y) at a given age (a), gender (s) and level of education (e); r is the discount rate; $sr_{y,s,a+1,e}$ is the probability of surviving an additional year for an individual in a given year (y) at a given

age (a), gender (s) and level of education (e); g is the yearly rate of income growth; and $mi_{y,s,a+1,e}$ is the market lifetime income of an individual a year older (a+1) in a given year for a given gender (s) and level of education (e).

Stage 2: We assume that these individuals cannot participate in the labour market, so the current average yearly earnings are set to zero. The human capital of this group takes into account the probability that people may improve their educational attainment multiplied by the income they are likely to earn given a change in their educational attainment. The lifetime income for this stage is:

Equation 3.4

$$mi_{y,s,a,e} = (senr_{y,s,a,e} * sr_{y,s,a+1} * mi_{y,s,a+1,e+1} + (1 - senr_{y,s,a,e})sr_{y,s,a+1} * mi_{y,s,a+1,e}) \left(\frac{1+g}{1+r} \right)$$

Where $senr_{y,s,a,e}$ is the school enrolment rate for an individual in a given year (y) at a given age (a), gender (s) and level of education (e).

Stage 3: We assume that these individuals can attend school as well as work. This group therefore have current earnings as part of the estimation ($ymi_{y,s,a,e}$). At the start of each period, the representative individual in the next year can either continue their work, holding the same educational level as before or they may have improved their educational attainment level and will thus receive a different income. Their lifetime income is estimated as:

Equation 3.5

$$mi_{y,s,a,e} = ymi_{y,s,a,e} + (senr_{y,s,a,e} * sr_{y,s,a+1} * mi_{y,s,a+1,e+1} + (1 - senr_{y,s,a,e})sr_{y,s,a+1} * mi_{y,s,a+1,e}) \left(\frac{1+g}{1+r} \right)$$

Where $ymi_{y,s,a,e}$ is the average yearly earnings of an individual in a given year (y) at a given age (a), gender (s) and level of education (e);

Stage 4: We assume that these individuals work but do not attend school, so the value of their lifetime income is the discounted sum of future labour income to the retirement age, where the educational attainment is held constant. The lifetime income of this group of individuals is equal to their current annual income, plus the lifetime income of an individual with the same characteristics but a year older, adjusted for the probability of surviving, the yearly rate of income growth and the discount rate.

Equation 3.6

$$mi_{y,s,a,e} = ymi_{y+1,s,a,e} + sr_{y,s,a+1} * mi_{y,s,a+1,e} \left(\frac{1+g}{1+r} \right)$$

Stage 5: We assume that all individuals 75 or over are retired, so that the value of their lifetime income is set to equal zero.

Equation 3.7

$$mi_{y,s,a,e} = \mathbf{0}$$

Where $a \geq 75$.

157. The adjustment to income for survival rates is a straight forward idea that an individual must be either alive or not alive in the next year. Therefore, their income in the next year is the expected value of the outcomes of these courses of action. The yearly rate of income growth is applied to reflect future increases in real incomes, and the discount rate is applied to determine the net present value.

158. The empirical implementation of the previous equations is based on backwards recursion and can be demonstrated by a simple numerical example. For example, in this approach, the lifetime income of a person in the final year of their ‘work only’ phase (i.e. one year before assumed default retirement which for this example we will assume to be 65) is simply their current labour income because their lifetime income at **age + 1** (age 65) is zero by construction. The lifetime income of a person aged one year below (aged 63) this is equal to his current labour income plus the present value of the lifetime income of a person in the final year of their ‘work only’ phase (aged 64), and so forth.

159. The lifetime income measures are applied to all individuals in each age/educational category to compute the human capital stock for each respective category. Summing up the stocks of human capital across all classified categories yields the estimate for the aggregate value of the human capital stock, given by:

Equation 3.8

$$HC = \sum_{age} \sum_{edu} LLI_{age}^{edu} N_{age}^{edu}$$

Where HC is the monetary value of the stock of human capital, LLI_{age}^{edu} is the present value of lifetime labour income for a representative individual in the corresponding age and educational attainment category and N_{age}^{edu} is the number of individuals in the corresponding age and educational attainment category.

160. This equation can be applied separately to both males and females to estimate the stock of human capital.

161. There are many examples in the literature which estimate human capital using versions of the Jorgenson-Fraumeni lifetime income approach. The methodology has been modified in some of these cases to reduce the data requirements, to deal with data availability constraints, and to reflect country-specific conditions. Chapter 4 will consider the implementation of this methodology in further detail, chapter 6 uses this method in estimating a satellite account and further examples using a lifetime income approach can be found in chapter 7 of this Guide.

162. In theory, income should reflect the expected return on human capital – which could also be considered as the total cost paid by the market. There are two ways of considering this, one is to consider the SNA definition of total compensation of employees, which includes wages and salaries and employer pension contributions, over the working life of employees. The second is to use the SNA definition of compensation of employees plus pension benefits over the employee’s whole life, ensuring that an adjustment is made to exclude employee pension contributions from the pension income stream.

163. The former approach aligns with existing SNA data sets and is much simpler to implement. Also, given the discussion earlier in the chapter which suggests that the population be limited to the working age population, the first approach is recommended.

164. In either case, it is recommended that the definition of income used be before both direct and indirect taxation and any other deductions such as student loan repayments. The income concept recommended in this chapter is the SNA concept of Compensation of Employees, adjusted for the income of the self-employed.

165. In estimating lifetime income using this methodology there are two challenges, both of which require practical assumptions to be made. The most important assumptions are as follows:

- The income growth that each person with a given set of characteristics may expect in the future (for projecting future annual incomes from the current annual income).
- The rate used to discount future earnings (for aggregating current and future annual incomes into lifetime incomes in present discounted value).

166. Both of these assumptions can have a significant impact on the size of human capital and therefore it is important to discuss the possible approaches. No matter how these assumptions are made, e.g. either through empirical observations or through theoretical reasoning, they are exogenous in nature.

167. The original Jorgenson-Fraumeni methodology used a growth rate of Harrod neutral productivity growth for the growth rate of real labour incomes and a long-run rate of return for the private sector of the economy for the real discount rate. Since then, several studies have used alternative rates.

168. The first alternative for the income growth rate is to consider labour productivity growth (or growth of gross value added per hour worked or per full-time equivalent). See for example Gu and Wong (2010). However, the labour productivity growth is partially related to physical capital deepening. So it might not be the best measure for the real income growth rate. An alternative is to measure it with the real earnings per labour volume unit, such as done by among others Liu (2011).

169. Measuring the discount rate is difficult, as it implies knowledge about the future. The discount rate reflects two elements. First, it represents the time value of income. This is the idea that money available now has more value than money in the future because it can generate interest or return. The time value of money can be measured by capital cost, e.g., an interest rate. But the discount rate also encompasses risk. This risk follows from the uncertainty about expected future income flows, which might be lower than expected. Hence the discount rate might be higher, namely the capital cost raised with a risk premium.

170. The Jorgenson-Fraumeni discount rate of 4.58 per cent, based on the long-run rate of return for the private sector of the US economy, has often been applied in empirical studies on the lifetime incomes in various countries. This rate is the estimated rate of return on long-term investments in the private sector of the USA in a part of the 20th century. However, as this is based on data in the private sector, from only the USA, and from a period before 1990, it may not be applicable to all countries in all time periods. Therefore other studies applied a 'less exact' variant, namely four per cent (see chapter 4 for reference).

171. An alternative is to consider real returns on long-term government bonds or other interest rates, such as the Central Bank lending rate which banks use when lending to each other. However, it should be noted that these alternatives are sensitive to policy decisions and economic crises (such as when central banks intervened in markets in 2008).

172. Finally, an alternative approach is to derive the discount rate using the Ramsey formula. The concept underlying this approach is different to that underlying the previous approaches. Here, rather than the long term private rate of return from the point of view of the individual, a social time preference rate is used as the bases for comparisons of utility across different points in time or different generations.

173. In their 2011 estimates, the World Bank used this approach to be consistent with the methodology underlying the separate wealth estimates for all countries. This approach is also consistent with discount rates used in governments when appraising investments (see for example HM Treasury (2003) ‘The Green Book: Appraisal and Evaluation in Central Government’).

174. The Ramsey formula calculates the discount rate as the social rate of return on investment, as follows:

Equation 3.9

$$r = \rho + \eta \left(\frac{\Delta c}{c} \right)$$

Where ρ is the pure rate of time preference, η is the elasticity of utility with respect to consumption, and $\left(\frac{\Delta c}{c} \right)$ is the rate of change in per capital consumption. Both ρ and η are difficult to quantify, however, based on existing estimates, the World Bank (2011) assumed ρ was equal to 1.5 and η was equal to 1.0.

175. Gu and Wong (2010) applied a mathematical decomposition of changes in the national human capital stock. It is preferable to measure the components directly with data. Wei (2008) constructed figures for Australia on the basis of direct measures of the components. The mathematical decomposition developed by Jorgenson and Fraumeni (1989) nevertheless gives a quick but sound indication of the contribution of each component to total change in the human capital stock. Gu and Wong (2010) supposed that the change of the human capital stock between periods t-1 and t can be decomposed to three components as follows:

Equation 3.10

$$\begin{aligned} HC^t - HC^{t-1} &= \sum_{s,e,a} h_{s,e,a}^t N_{s,e,a}^t - \sum_{s,e,a} h_{s,e,a}^{t-1} N_{s,e,a}^{t-1} \\ &= \sum_{s,e,a} h_{s,e,a}^t N_{s,e,a}^t - \sum_{s,e,a} h_{s,e,a}^t N_{s,e,a}^{t-1} + \sum_{s,e,a} (h_{s,e,a}^t - h_{s,e,a}^{t-1}) N_{s,e,a}^{t-1} \\ &= \left(\sum_{s,e,a} h_{s,e,a}^t N_{s,e,a}^t - \sum_{s,e,a} h_{s,e,a+1}^t sur_{a,a+1}^{t-1} N_{s,e,a}^{t-1} \right) \\ &\quad - \left(\sum_{s,e,a} h_{s,e,a}^t N_{s,e,a}^{t-1} - \sum_{s,e,a} h_{s,e,a+1}^t sur_{a,a+1}^{t-1} N_{s,e,a}^{t-1} \right) \\ &\quad + \sum_{s,e,a} (h_{s,e,a}^t - h_{s,e,a}^{t-1}) N_{s,e,a}^{t-1} \end{aligned}$$

where

- HC = national human capital stock
- N = number of individuals
- sur = survival rate
- h = human capital per capita or lifetime income.

176. The first term in the last expression is the gross investment in human capital, the second one is depreciation, and the third term is revaluation.

177. Gross investment can be decomposed further into two components: the lifetime income following from the increase of the population with those entering the population when they reach working-age (15 years of age), and the increase due to gross investment in education and immigration:

Equation 3.11

$$\sum_{s,e,a} h_{s,e,a}^t N_{s,e,a}^t - \sum_{s,e,a} h_{s,e,a+1}^t sur_{a,a+1}^{t-1} N_{s,e,a}^{t-1} = \sum_{s,e,a \in \{15\}} h_{s,e,a}^t N_{s,e,a}^t + \sum_{s,e,a \notin \{15\}} h_{s,e,a}^t (N_{s,e,a}^t - sur_{a-1,a}^{t-1} N_{s,e,a-1}^{t-1})$$

178. Depreciation can be decomposed into changes in lifetime incomes due to ageing of the population, and individuals quitting the population because of retirement, death or emigration:

Equation 3.12

$$\sum_{s,e,a} h_{s,e,a}^t N_{s,e,a}^{t-1} - \sum_{s,e,a} h_{s,e,a+1}^t sur_{a,a+1}^{t-1} N_{s,e,a}^{t-1} = \sum_{s,e,a} (h_{s,e,a}^t - h_{s,e,a+1}^t) sur_{a,a+1}^{t-1} N_{s,e,a}^{t-1} + \sum_{s,e,a} h_{s,e,a}^t (N_{s,e,a}^{t-1} - sur_{a,a+1}^{t-1} N_{s,e,a-1}^{t-1})$$

179. Note that the changes in lifetime incomes due to immigration are not decomposed separately from those due to gross investment in education. The same applies for depreciation because of retirement, emigration and death.

180. Revaluation is the changes of lifetime labour incomes (or ‘price’) for individuals with a given set of demographic characteristics due to short run changes in the labour market, not due to changes in embodied knowledge.

181. See chapter 4 for further discussion.

182. A variation of the lifetime income-based approach is presented by Mulligan and Sala-i-Martin (2000) who calculated an index measure of human capital. Specifically, they measure human capital as the total labour income per capita divided by the wage of the uneducated. The rationale for this method is that labour income incorporates not only the workers’ human capital but also the physical capital available to them, such that for a given level of human capital workers in regions with higher physical capital will tend to earn higher wages. Therefore, to obtain a ‘pure’ measure of human capital, the effect of physical capital should be taken into account. This method assumes that uneducated workers always have the same human capital, although they do not necessarily earn the same income.

183. As with the cost-based approach, deflating values to assess real changes over time can be difficult and estimates differ based on the price deflator used. (Christian 2011) discusses options for deflating stocks of human capital.

“In some cases, the human capital stock is deflated using a consumer or labour price index (Wei, 2004, 2008). Under this approach, changes in lifetime incomes relative to changes in prices remain after deflation. If human capital accounts purport to measure

human capital stocks and investments as quantities, this approach implies that changes in real lifetime incomes reflect changes in the quality of human capital within age, sex, and education levels. In other cases, the human capital stock is deflated using prices for human capital itself, eliminating changes in lifetime incomes and leaving a quantity index based entirely on the number and distribution of persons by age, sex, and education (Gu and Wong, 2010a; Christian, 2010). The quality of human capital within age, sex, and education level is implicitly presumed to be constant over time.”

184. Wei (2004) noted that whilst other deflators (such as the GDP deflator) were available, consumption is one of the main objectives of labour income.

185. Further discussion of assessing real changes of human capital stock over time are discussed in section 3.6, Volume indices.

3.5. The indicators-based approach

186. The indicators based approach estimates human capital based on educational output indicators. It is necessary to highlight here that the indicator approach is understood as referring to relatively simple indicators, which may not attempt to measure human capital directly. They are generally proxies that are more-or-less directly observable rather than model-based, and/or do not apply economic accounting principles (discounting, depreciation, interest rates). This therefore excludes costs and income which could also be understood as indicators.

187. Unlike the other two approaches discussed in detail in this chapter, this approach relies on several indicators that, though rich in information, lack a common metric therefore making them less suitable for other uses such as the assessment of the ‘sustainability’ of a development path, which requires comparing changes in the aggregate stock of human capital with the stocks of other types of assets.

188. The indicators-based approach was one of the first ways of attempting to compare human capital across countries. For example, French reflections on military inferiority to Germany/Prussia in the second half of the nineteenth century suggested lower literacy among French conscripts as one factor. This reflects the fact that the earliest available data tends to be on literacy (e.g. Church records, military conscripts, censuses).

189. The establishment of national education systems in the late nineteenth century led to increased availability of enrolment numbers. However, this was often not accompanied with matching age-specific population data which would have allowed ratios to be calculated.

190. At one time, it was common to compare absolute numbers of highly qualified individuals (for example engineers or engineering graduates) as an indicator of human capital and this is still occasionally done (for example when comparing the IT capacity of India and China).

191. This, however, has generally been replaced by the evolution of a standard core set of enrolment ratios and educational attainment indicators routinely collected in administrative registers and censuses/household surveys. Several measures have been used in the literature - for example, adult literacy; school enrolment rates; and average years of schooling (e.g. OECD 2007, 2011).

192. This method is based on the assumption that these indicators are closely related to investment in education and this is a key element in human capital formation. Human capital encompasses more dimensions but education is arguably the most important component.

193. The main limitation of these approaches is that they do not measure economic impact and cannot be integrated into a national income account. However, they may be added in supplementary tables (see chapter 5). Additionally, adult literacy rates miss most of human capital attained beyond the elementary level, such as numeracy, logical and analytical reasoning and scientific and technological knowledge. Thus, their use as proxies for human capital in developed countries is limited. More recently, there has been relatively widespread collection and dissemination of measures of skills and cognitive performance.

194. The measurement of human capital through indicators can be separated into two groups, indicators that represent the flow of investment (i.e. indicators for the process of generating ‘fresh’ human capital in young cohorts) and indicators of the state of human capital in the overall population. Indicators such as enrolment, attendance, pupil skills or test scores all fall into the category of flows indicators. Examples of stock indicators are literacy rates, years of schooling, formal attainment indicators and adult skills indicators. Whilst the two are separate, and indicators of flow should not be used directly as indicators of stock, one can attempt to calculate stocks from flows (for example through a perpetual inventory method).

195. Most recently, researchers have begun to bring together indicators of flows, stocks and quality into a dashboard. In particular, these dashboards are a combination of current school-based indicators (for example net enrolment/attendance ratios, completion ratios), population models with educational attainment and test scores. True integration of these elements is still lacking and an active area of research.

196. All of the indicators discussed thus far are frequently collected for monitoring purposes related to, but distinct from, measuring national human capital (for example, individual welfare, social equity and vulnerability, and performance monitoring of the education system) and therefore there are a number of challenges when using indicators to measure human capital.

197. First, the years of schooling measure fails to allow for the costs and returns of education varying at different levels. Thus, this measure incorrectly assumes that one year of schooling always raises human capital by an equal amount. For example, a worker with ten years of schooling is assumed to have ten times as much human capital as a worker with one year of schooling. This assumption is at odds with the empirical literature which has typically documented diminishing returns to education (Psacharopoulos, 1994).

198. Second, no allowance is made for differences in quality of education across time and location. Behrman and Birdsall (1983) found that neglecting quality of schooling biased estimates of returns to schooling. The quality of schooling can vary both across countries and within one country; overlooking quality is likely to create severe biases.

199. Third, this measure unrealistically assumes that workers of different education categories are perfect substitutes for each other as long as their years of schooling are equal.

200. Finally, comparability is difficult. This has partially been addressed by the International Standard Classification of Education (ISCED) but difficulties remain. For example, different classifications of similar qualifications and different formal qualifications for the same jobs (e.g. whether nursing requires a tertiary qualification). This is compounded by the fact ‘flow’ indicators are relatively sensitive to measurement issues, resulting in a steady change in definitions over time.

201. There is also a debate surrounding enrolment and attendance, where the two are not necessarily equal for a number of reasons. One of which is the possible incentives to mis-report enrolment. Other important factors include the timing and duration of household

survey fieldwork relative to the start of the school year, sampling errors, different coverage and mismatches between administrative data on enrolments and national population estimates. Enrolment rates are much more widely available and with longer time series than attendance rates. More information is available in the Education, Policy and Data Center publication (2007).

202. In addition to this, there are a number of measurement issues with using the indicator-based approach (see section 4.4).

203. As a result, while informative for a number of purposes, these indicators are less suitable for other uses such as the assessment of the ‘sustainability’ of a development path, which require comparing changes in the aggregate stock of human capital with those in the stocks of other types of assets. Such comparisons typically require a common monetary metric. However, they can be used in conjunction with other approaches and play a complementary role (this is discussed further in section 3.8).

3.6. Volume indices

204. Monetary estimates of human capital values based on both the cost-based approach and the lifetime income-based approach in current prices need to appropriately adjust for comparisons between countries and over time. For these comparisons, we also need to derive estimates of **human capital volumes**. This involves decomposing the changes of human capital at current prices into changes of price levels between two periods (or two countries) and changes of human capital volumes. This Guide recommends compiling both current (monetary) and constant (volume) measures of human capital.

205. In the literature, two approaches to measuring volume indices are used, either:

- Deriving volume estimates by dividing the human capital value by a price deflator. Jorgensen et al discussed this approach in calculating a human capital spatial volume to see differences between countries. This is discussed in further detail below.
- Directly constructing volume estimates and then deriving price by dividing the human capital value by the constructed volume index. Jorgensen et al discussed this approach in calculating a human capital temporal volume index, to compare stocks of human capital in real terms over time. This is discussed below.

206. The design of the lifetime income-based approach naturally leads to an accounting system that includes values, volumes and prices as basic elements. In contrast, the choice of price index to deflate past expenditures in the cost-based approach is challenging, as discussed in section 3.3.

207. A **temporal volume index** allows comparison of human capital in real terms over time. The 2008 SNA defines a volume index as ‘an average of the proportionate changes in the quantities of a specified set of goods or services between two periods of time’. The quantities compared over time must be those for homogeneous items and the resulting quantity changes for different goods and services must be weighted by their economic importance, as measured by their relative values in one or other, or both, periods.

208. There are many index number formulae differing from each other mainly in weights which they attach to the individual price or quantity relatives and the particular form of the average used, whether it is arithmetic, geometric, harmonic, etc. These alternative formulae,

their properties and relative merits, are outlined in detail in the Consumer Price Index (CPI) manual (2004) and Producer Price Index (PPI) manual (2004).

209. The most widely used index number formulae are the Laspeyres and Paasche indices (the former uses base period weights and the later current period weights), the Fisher index (a geometric average of the Laspeyres and Paasche indices) and the Törnqvist index (a weighted geometric average of its components).

210. The Törnqvist index method, the methodology which is highlighted in Jorgensen et al (2005), was used by Gang Liu (2011) to assess real changes in human capital stock over time. This approach has been applied in several national studies on human capital measurement (*e.g.* Gu and Wong 2010; Li et al 2010). The growth rate of the temporal volume index of human capital is calculated as the weighted sum of the growth rates of the number of individuals in different categories of the population (such as age, gender and educational attainment), using their shares of the nominal value of human capital as corresponding weights. In the estimates, the more detailed the categories of population, the more accurate the volume index. The level of categorization will be dependent on the information and data available to countries.

211. The CPI and PPI manuals provide in chapters 15, 16 and 17 an extensive account of the various approaches to choosing among index numbers. What is apparent from this extensive body of work is that the Fisher index is generally favoured; that superlative indices such as the Fisher and Törnqvist indices produce very similar results and can all be justified from the economic theoretical approach. The Törnqvist index is commonly used by productivity analysts as it is easy to understand in terms of sources or growth. The difference between superlative indices and the Laspeyres or Paasche indices, or their spread, is due to substitution bias.

212. For comparisons over several periods of time, the 2008 SNA recommends chain linking (*i.e.* where the change between periods 0 and 2 is derived indirectly from the change between period 0 and period 1, combined with that from period 1 and period 2).

213. Subject to data availability and access to components in which to construct the aforementioned volume indices, it is recommended that, consistent with 2008 SNA guidance:

- The preferred measure of year-to-year movements of human capital volume is a Fisher volume index; changes over longer periods being obtained by chaining, that is, by cumulating the year-to-year movements.
- The preferred measure for year-to-year price change for human capital is therefore, also a Fisher price index; price changes over long periods being obtained by chaining the year-to-year price movements, or implicitly by dividing the Fisher chain volume index by an index of the current value series.
- Chain indices that use Laspeyres volume indices to measure year-to-year movements in the volume of human capital and the associated implicit Paasche price indices to measure year-to-year price change provide acceptable alternatives to Fisher indices.

214. A **spatial volume index** allows comparison of human capital in real terms between different countries at a single point in time by adjusting for the different price levels for the same set of goods and services in different countries. The 2008 SNA outlines two possible ways of making such comparisons.

215. The first approach is to adjust national accounts values to a common currency using exchange rates. This has the advantage that the data are readily available and completely up

to date and is adequate if users need a ranking of a country's relative spending power on the world market. However, it is not adequate for comparisons of productivity and standards of living because it does not adjust for the differences in price levels between countries and thus does not give a measure of countries' relative sizes in volumes of goods and services.

216. The alternative and recommended approach is to use purchasing power parities (PPPs). These produce a reliable set of estimates of the levels of activity between countries, expressed in a common currency. A purchasing power parity is defined as the number of units of B's currency that are needed in B to purchase the same quantity of individual good or service as one unit of A's currency will purchase in A. Typically, a PPP for a country is expressed in terms of the currency of a base country, with the US dollar commonly being used. For international volume comparisons, the resulting monetary estimates cannot be used without adequately accounting for differences in purchasing power parities. PPPs are thus weighted averages of the relative prices, quoted in national currency, of comparable items between countries. Used as deflators, they enable cross-country comparisons. Given the limitations of the exchange rate approach outlined above, it is recommended that spatial comparisons use PPPs for education services. This is, again, subject to data availability. The national compilation of human capital estimates themselves do not, however, depend on the availability of PPP data. This only arises when making international comparisons of the levels of human capital.

3.7. Discussion of the different approaches

217. Each of the three main approaches covered in this chapter have their advantages and disadvantages. This section will outline some of the key advantages and disadvantages of each method.

218. A key advantage of both the lifetime income-based approach and the cost-based approach is that they combine different aspects that contribute to human capital in a single metric (money); this is not true of the indicators approach which results in a dashboard of indicators. A dashboard can however provide important information for policy and decision making, information which can be hidden by a single indicator of the stock. One example of such an approach is provided by the World Economic Forum's Human Capital Report.

219. The indicators-based approach is therefore different from the cost-based and lifetime income-based approaches. For the lifetime income-based and cost-based approaches the challenges lie in arriving at the figure, but once the estimates are made, they are easily comparable. With the indicator-based approach, even if the 'true' attainments were known exactly, they might still not be strictly comparable across space and time. Human capital using the indicator-based approach is therefore not amenable to being treated like other kinds of capital and compared on the same scale, or to directly calculating for example rates of return without going via costs and incomes conditional on attainment.

220. The cost-based approach is in line with the valuation of the majority of economic capital in the System of National Accounts which is estimated using a PIM method. It also provides an estimate of the resources invested in the education and other human capital related sectors, which can be useful for cost-benefit analyses.

221. The lifetime income-based approach however, is more consistent with economic theory and better represents the relationship with productive capacity needed for future production. Additionally, it uses income as a measure of returns to investment and therefore considers the value of human capital services as a result of the interplay of demand and supply of labour

markets. This is contrary to the cost-based approach which is only supply-side based. Both cost- and lifetime income-based approaches would have their place if human capital satellite accounts are developed (see chapters 5 and 6).

222. The use of the lifetime income-based approach also allows investment in human capital to be broken down into several components: investment from births, depreciation from deaths, investment from education, depreciation from ageing, and with investment from immigration and depreciation from emigration. See section 3.4 and Gu and Wong (2010).

223. The lifetime income-based approach also has the advantage that it allows outputs to be measured independently of inputs. In contrast the cost-based approach relies on the assumption that the value of inputs is equal to the value of outputs. Accordingly, using the lifetime income-based approach an estimate of productivity in the education sector can be made.

224. Additionally, the design of the lifetime income-based approach naturally leads to an accounting system that includes values, volumes and prices as basic elements. In contrast, the choice of price index to deflate past expenditures in the cost-based approach is challenging.

225. Both monetary approaches, however, rely on assumptions. The cost-based approach relies on an assumption regarding the rate of depreciation, which as discussed in the previous sections is difficult to determine. The central assumption of the lifetime income-based approach is that labour is paid according to its marginal productivity. In practice, factors such as market power, trade unions, discrimination, etc. all affect wages. The lifetime income-based approach is also sensitive to the choice of discount rate and the rate of growth of income and relies upon accurate data on earnings, life tables and employment rates.

226. As discussed earlier in this chapter, another drawback of these measures is that they focus on individual's human capital and aggregate them to arrive at the population measure. This ignores spillovers between workers so that the whole may be more than the sum of the parts.

227. The cost-based approach also fails to take account of the heterogeneity of individuals. As an illustration, consider two children one of whom is innately less able than the other. To the extent that it is more expensive to educate the less able child to a particular attainment level the cost-based approach will overestimate that child's human capital while underestimating the human capital of the more able child compared to the estimates for a normal (average) child. Similarly, differences in the quality of education providers are ignored in this method. For example, schools vary in their quality as do the teachers within schools. Hanushek and Kimko (2000) and Lavy (2002) found that after social background, the quality of teaching is the best predictor of how well students do in school. While many of these issues can theoretically be taken on board, in practice it is very difficult.

228. Some aspects of education aim to create 'skills for life' e.g. education attainment that enables individuals to enjoy leisure activities during and after their working life and these skills may appreciate or depreciate depending on use and wider factors.

3.8. Approaches in the Guide

229. "Abraham (2010) identifies the cost-based approach and the lifetime income-based approach as analogous to the income and production sides of a national income and product account but notes that, unlike the two sides of a national income and product account, cost-

based and lifetime income-based human capital accounts should not necessarily lead to identical results.” Christian (2011)

230. Within this, the cost-based approach is most suited to value the various inputs in the production of human capital, while the lifetime income-based approach estimates the output of the production process and the stock of human capital. When combined, the lifetime income-based and cost-based measures of human capital provide a measure of the rate of return to investment in human capital (productivity).

231. As outlined in chapter 2, the generation of human capital is regarded as a production process that is undertaken by individual persons taking formal education or training and courses; the product of this production activity is the investment in human capital assets, to be added to the human capital stock that is already embodied in the person. As such, both the conventional production and asset boundaries are extended.

232. However, rather than using the cost based approach and valuing the output based on the monetary amount spent on investment in human capital, the output can be estimated using the lifetime income-based approach, where the investment can be valued based on the lifetime earnings’ differential due to this investment in human capital.

233. Within this Guide, indicators of human capital can also play complementary roles in a number of areas. For example, flow and school system indicators could be used; e.g. using grade repetition rates to estimate ‘leakage’ in the transformation of education expenditure into human capital. Additionally, in both the cost and income based approaches, assumptions regarding mortality are required to depreciate investments and income streams. Indicators can be used to complement mortality assumptions adjusting them to be more representative for ‘embodied cost’ or future income. Indicators can also be used to provide some insight into the structure of human capital within the workforce, which could allow for a decomposition of human capital into volume and price components. Additionally, further work could be done using indicators to provide information on non-market factors of production, provide information for quality adjustments of produced human capital or provide input for monetary measures of human capital when applying an input approach.

234. These ideas are explored in more detail in later chapters of this Guide.

4. Implementation and measurement issues

4.1. Introduction

235. The current chapter describes how to implement the three methods described in chapter 3 to measure human capital: the cost-based method, the lifetime income-based method and the indicators approach. The implementation of an indirect approach, which covers more than human capital, is described in Annex A, Implementation of the indirect approach

236. As stated earlier, the measures of human capital proposed in this Guide are confined to market-based activity, formal education and job-related training, and the working age population. This chapter adds to this a focus on internationally comparable measurement and data, particularly from the OECD, UNECE and Eurostat.

237. Current methods and models for estimating human capital have been developed from the perspective of industrialized countries. Some elements of these approaches may therefore need adjustment in order to be adapted to the specific circumstances and data availability of developing countries.

238. Each of the next three sections (4.2 to 4.4) describes the operationalization of the method under consideration and the data required⁵ to estimate the variables or indicators. Recommendations are made for implementation and data in order to arrive at internationally comparable estimates of human capital. Section 4.5 sums up the main issues in implementation and measurement and some future research options.

4.2. Measurement with the cost-based method

4.2.1. Operationalization

239. As mentioned in chapter 3, Kendrick (1976) made comprehensive estimates of human capital based on the cost-based method. Kendrick measured tangible costs of child rearing and intangible costs of education, training, and medical, health and safety expenditures and mobility costs.

240. Kendrick measured, among other things, formal and informal costs of education and training. Informal costs of education measured in the original Kendrick method are, for instance, government expenditures on libraries, and individuals' expenditures on books and museums. Informal training is for example working experience and learning on the job. Following Becker (1964), the original method also distinguishes specific (to a particular job) and general (transferable) on-the-job training. However, all of this is less easily measured than formal education and training expenditures, and also requires various additional assumptions.

241. The Guide recommends implementation of a simplified version of the Kendrick method, partially driven by (the lack of) internationally comparable data but also by considerations of complexity and transparency. The recommended simplified Kendrick cost

⁵ As is often the case when developing new statistics, input may be needed from a variety of agencies and institutions depending on the organization of official statistics in each country. Coordinating efforts across agencies can be an important factor in the success of any complex project such as measuring human capital.

approach focuses on formal education and formal job-related training for the working age population.

242. The cost based approach starts from the perpetual inventory method (PIM). This PIM method calculates the human capital stock as the depreciated value of the monetary cost of the investment in human capital. The stock of type (i) at time (t) therefore is (see chapters 2 and 3 for theoretical discussion):

Equation 4.1

$$H_{(i,t)} = (1 - \delta_{H(i,t)}) * H_{(i,t-1)} + I_{H(i,t)}$$

where

H = human capital stock,
 I_H = gross investment in human capital, and
 δ_H = depreciation rate.

243. Focusing on formal education and training, the minimum data requirements for implementation of the PIM method are:

- a) Expenditures on formal (general and vocational) education and formal on-the-job training
- b) Opportunity costs for students in education and employees in training
- c) Depreciation rates related to the various investments in human capital.

244. Additionally, the following is needed:

- a) Initial human capital stocks
- b) Price or volume indices.

245. Expenditures on formal education and training are relatively easy to obtain, as data are readily available in various international databases. The other data components are the more challenging part of the implementation, as they are based on assumptions. The Guide recommends measurement methods for each component as described below.

A. Expenditures on formal education and formal job-related training

246. In most countries public and private spending on formal education is relatively well-documented. Spending by enterprises on job-related training programmes may also be quantified.

247. Expenditures on formal education can be divided into public expenditures by government and private expenditures by households and non-profit institutions serving households (NSPIH's). Public expenditures consist of direct expenditures (such as salaries of education personnel) and ancillary expenditures such as costs of education facilities and supplies of school materials. Private expenditures encompass direct expenditures (such as school tuition) and ancillary expenditures on, for instance, materials such as books, and school fees.

248. Expenditures on formal training by enterprises, government and NPISH consist of direct expenditures on training such as direct costs of courses and (internal) teachers or training personnel and ancillary expenditures, such as costs of travelling expenses and accommodation, and costs of materials.

B. Opportunity costs of students in education and employees in training

249. Students usually do not have a (full-time) job while they pursue education, and workers who attend a training course cannot work at the same time, thus there are opportunity costs. For students these costs are the earnings a student would have received if he/she had entered the workforce rather than education (adjusted for his/her actual income from, e.g., a part-time job⁶). For employers these costs are the time workers spend on training instead of working.

250. Estimates of the opportunity costs are usually the largest component of investment in human capital via education and training. Evidence shows that characteristics such as age, education level and gender affect foregone earnings for students. Furthermore, labour market conditions also have an impact. The higher the unemployment rate (lower demand for labour), the lower the foregone earnings. The same goes for the costs of training. Training costs depend on the type of training, occupation and/or industry under consideration.

251. There is still a debate on how to precisely measure opportunity costs, and there is a large range of estimated values. Moreover, opportunity costs are not always estimated in the cost based approach of measuring human capital investment, with some important exceptions, such as Schultz (1960). Not estimating opportunity costs may explain a large part of the difference in currently estimated values of human capital between the cost-based and lifetime income-based methods, as mentioned by Abraham (2010) (see also chapter 3, section 3.2).

252. This Guide recommends estimating the opportunity costs in human capital investment. The Guide recommends these costs be estimated as below.

Foregone income for students attending education

253. Foregone income of student cohorts (s,e,a) pursuing education at some level (e+1) are calculated as:

Equation 4.2

$$FCE_{e+1} = \sum_a \sum_e \sum_s ([mi_{y,s,a,e} - mi_{y,s,a,e}^{e+1}] * N_{s,e,a}^{e+1})$$

where

FCE_{e+1} = foregone income of education of all student cohorts (s,e,a) at level e+1.

$mi_{y,s,a,e}$ = average annual labour income in population cohort (s,e,a).

$mi_{y,s,a,e}^{e+1}$ = average annual labour income in student cohort (s,e,a).

$N_{s,e,a}^{e+1}$ = number of students pursuing the education programme at level e+1.

s = gender.

a = age.

e = education level attained.

$e+1$ = level of education programme in which the students are involved.

254. This method resembles that of Schultz (1960). The foregone income of students while on education at some level e+1 is calculated as the sum of incomes not earned by students because they attend school and do their homework. The implementation starts with a cost estimate for a typical student in a group or cohort (s,e,a). Students often work part time or a

⁶ Students may also receive non-market income, such as an education grant. However, as the lifetime income method applied here is related to market activities, such non-market income is not accounted for.

part of the year (during summer holidays, for instance). This earned income (estimated by the average student income in the cohort, $mi_{y,s,a,e}^{e+1}$) has to be subtracted from the average labour income in the population cohort (s,a,e) (estimated by $mi_{y,s,a,e}$). The latter is to be seen as a proxy for the income students would have earned if they had not pursued studies. The resulting foregone income for a typical student ($mi_{y,s,a,e} - mi_{y,s,a,e}^{e+1}$) is multiplied with the number of students in the cohort under consideration, assuming that a typical student's foregone earnings can be applied to all individual students in the cohort (s,e,a). Depending on data availability, a correction might be necessary for the employment rate (the higher unemployment, the lower foregone income) and the fraction of the year students are not working.⁷ The foregone income of all cohorts pursuing education level (e+1) are added up across all groups. The total of foregone income of education is the sum of all foregone income across all levels of education programmes⁸.

255. Depending on data availability, some additional data may have to be gathered, for instance, on the average labour income of students $mi_{y,s,a,e}^{e+1}$. Otherwise assumptions have to be made (e.g. the student's average labour income = 10 per cent of the average labour income in the population $mi_{y,s,a,e}$).

Costs of foregone work for employees in training

256. The costs of foregone work for workers attending training courses in a certain branch (b) are calculated as:

Equation 4.3

$$FCT_b = mi_y^b * h_T^b * N_T^b$$

where

FCT_b = cost of foregone work for training in branch (b).

mi_y^b = average annual labour income per employee in branch (b).

h_T^b = average proportion of hours in training in a year per employee in branch (b).

N_T^b = number of employees involved in training in branch (b).

257. The costs are estimated as the labour income costs of employee time in training. In the end the total cost of foregone work for training is calculated as the sum of costs in all branches.

258. The above model assumes that time spent in training is uncorrelated with wages paid, which will overstate these costs for employees in training if they are typically the lower-paid (less experienced) employees. Depending on data availability, these costs might therefore to be better calculated from detailed data broken down by characteristics, such as wage class, occupation class, age and gender. Such detailed data are not always available (see section 4.2.2).

C. Depreciation

259. Chapter 3 described some methods to calculate depreciation. In practice, the geometric depreciation rate is often favoured. Depending on the type of investment (education or

⁷ On the employment rate, see also section 4.3.1 on the operationalization of the lifetime income based method. The fraction of the year students are not working is a correction factor calculated as the number of weeks in a typical school year divided by the number of working weeks.

⁸ Aspects of these data are also required for the lifetime income method (see section 4.3)

training, broken down by level), different depreciation rates might be calculated. Then assumptions have to be made on the average service life of each type. See paragraphs 273 and 276 below for examples of previous studies. Based on these examples it is recommended that service lives are estimated as below. Note that it is actually assumed that the effect of general education or training is longer lasting than that of specific training. For instance, ICT is rapidly changing, and ICT-related training will therefore have only a short service life.

Average service lives for education

Equation 4.4

$$T_e = a^{ret} - a_e^{ent}$$

where

T_e = (average) service life after qualification for education at education level (e).

a^{ret} = retirement age (usually similar for all education levels within a country).

a_e^{ent} = age of entering the labour market after qualification at education level (e).

260. That is, the average service life depends on the (average) working life span between graduation with education level (e) and age of retirement. For instance, individuals graduating university usually enter the labour market at a later age (ranging between ages 22 to 28) than individuals with only basic education (ages 15 to 16). Hence the working life span for university graduates is shorter. Note that a^{ret} might be country specific or fixed at 65 (see box 4.1). Furthermore, adjustments might also be made for different population groups (e.g. men and women) for average periods of unemployment, part-time work or non-participation in the labour force.

Average service lives for training

Equation 4.5

$$T_b = (D_b - 1)$$

where

T_b = (average) service life in branch (b).

D_b = average job duration in branch (b).

261. The argumentation is that companies only reap benefits from their investment in employees as long as they remain within the company. This encompasses the implicit assumption that human capital skills developed at a former employer cannot be transferred to other companies if employees start a new job there. The measurement of such transferred human capital is rather complicated. Since data on job duration within single enterprises is generally not available, the service life depends on the average duration of jobs in the industry under consideration. Finally, it is assumed that training usually starts only after one year of employment.

D. Initial human capital stock

262. An initial capital stock estimate at ($t = 0$) is needed to calculate time series of the human capital stock. Such an initial capital stock estimate is necessarily based on some assumptions. There are a number of methods to calculate initial stocks for physical capital. One may calculate the initial human capital stock in a similar way, for instance as

Equation 4.6

$$HC_{i,t=0} = \frac{IHC_{i,t=0}}{(\delta_{HC} + g)}$$

where

$HC_{i,t=0}$ = initial human capital stock for human capital investment type (i).

$IHC_{i,t=0}$ = initial human capital investment for type (i).

δ_{HC} = average depreciation rate for human capital type (i) over period under consideration.

g = average rate of growth in human capital investment (i).

263. Assumptions have to be made on depreciation and asset lives. The method assumes that the economy is in steady state at time ($t = 0$), which may be doubtful for countries in transition or development.

264. An alternative is to apply an assumed human capital-output ratio (e.g., the average ratio in a certain time period):

Equation 4.7

$$HC_{i,t=0} = Y_{t=0} * \left(\frac{HC}{Y}\right)$$

where

$Y_{t=0}$ = GDP at time $t = 0$.

$\left(\frac{HC}{Y}\right)$ = human capital-output ratio (assumption).

E. Price index

265. As discussed in chapter 3 (section 3.6), the choice of price index to deflate past expenditures in the cost-based approach is challenging. Researchers may choose the price index method practised in the National Accounts for their own country, or another preferred method recommended by the international OECD handbook on price and volume measurement.

4.2.2. Data

266. Below we repeat the minimum required variables in the cost based method:

- a) Expenditures on formal education (by ISCED class) and on-the-job training (by sector)
- b) Opportunity costs for students in education and employees in training (by branch)
- c) Depreciation rates related to the various investments in human capital
- d) Initial human capital stocks
- e) Price or volume indices.

267. Most variables have to be measured with assumptions as described in section 4.2.1. Below we discuss the data and their sources more in detail. Here the focus is on internationally harmonized data.

A. Education and training expenditures

268. International data on expenditures on formal education are classified by education level according to the International Standard Classification of Education (ISCED), as defined by the United Nations Educational, Scientific and Cultural Organization (UNESCO). The most recent version is ISCED 2011, with levels 0 (early childhood education) to 8 (doctoral or equivalent). There are also data on non-ISCED education expenditures, ancillary expenditures and R&D services in education (see also chapter 5).

269. When applying these official education expenditures data, one should bear in mind the following. First, the boundaries between ISCED levels are sometimes rather vague. Countries determine the classification of their national education programmes into the ISCED. As national programmes significantly differ across countries, the precise classification may sometimes be difficult. Differences arise in the levels of the programmes, years of schooling per programme and the type of education (general versus vocational). On the latter issue (type of education), much is still unresolved. Vocational programmes do not always need to be of lower level than general education (and thereby human capital levels). Some countries have a strong tradition in vocational education (e.g. Germany and the UK). Vocational education is also sometimes interwoven with training on the job (practising). We refer to CEDEFOP (2014) for elaboration on vocational training.

270. Data availability for on-the-job training is very limited. Existing data on expenditures on formal training are broken down by sector according to the ISIC. The data are not classified by education level. Some indication on the human capital content of training might be derived from data on vocational training surveys, which provide indicators on how much employees have attended training in the past, and which occupations these employees have.

Table 4.1
International data sources for education and training expenditures

Organization	Database	Website *	Datasets
Eurostat	Education and training	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Education and training	Education: → Education finance: <i>Expenditures on education</i> <i>Expenditures of/on public and private educational institutions</i> Training: → Participation in education and training → Continuing Vocational Training in Enterprises <i>Costs of CVT courses</i>
OECD	Education Database	http://www.oecd-ilibrary.org/statistics → OECD Education Statistics → Education Database	<i>Expenditure by funding source and transaction type</i> <i>Expenditure by nature and resource category</i>

*Arrows indicate successive levels in the website navigation hierarchy.

B. Opportunity costs in education and training

International data sources for foregone income of students pursuing education

271. As mentioned in section 4.2.1, the crucial data for the operationalization of foregone incomes of students are also used as input in the calculation of lifetime income: enrolment, labour income and the employment rate. We refer to section 4.3.2 for the data sources.

Training

272. We need data on labour incomes (by branch), hours in training and the number of employees involved in training.

Table 4.2
International data sources for costs of foregone work while on training

Organization	Database	Website *	Datasets
Eurostat	Labour market	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Labour market (labour)	<i>Earnings</i>
	Education and training	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Participation in education and training → Continuing Vocational Training in Enterprises	<i>Participation in vocational training</i> <i>Time spent in CVT courses</i>
OECD	Earnings	http://www.oecd-ilibrary.org/statistics → OECD Employment and labour market statistics	<i>Earnings</i>
UNECE	Wages	http://w3.unece.org/PXWeb/en → Economy → Labour force and wages	<i>Gross Average Monthly Wages by Country and Year</i>

*Arrows indicate successive levels in the website navigation hierarchy.

C. Depreciation

273. As mentioned in section 2.1, illustrations from practice may clarify how depreciation rates and service lives are estimated within the framework of the cost-based method.

Education

274. Kokkinen (2010) estimated human capital for Finland in the period 1910-2000 with the PIM method. For each type of education, he calculated a geometric depreciation rate. The long run retirement age was fixed at 65, and (historically determined) graduation ages depend

on the type and level of education. The average age for entering the labour market with basic education was set to 16, with upper secondary education to 19 and with university education to 28. This implies average service lives for the mentioned types of education of 49, 46 and 37 years, respectively. The depreciation rates were established by using the declining balance formula: 5 per cent depreciation for basic education, 5.5 per cent for upper secondary and 7.5 per cent for university education, giving the respective declining balance rates 2.45 per cent, 2.73 per cent and 2.8 per cent, falling in the range between 2 and 3, as reported by Baldwin et al (2007). For professional and vocational education, Kokkinen fixed three different ages of entering the labour market in three subsequent periods (the ages differ because of historical system changes in this type of education). Also using the declining balance formula in accordance with the service lives of 47, 46 and 45 years, the depreciation rates for this type of education were set to 6 per cent, 6.1 per cent and 6.2 per cent.

International data on graduation age by education level and retirement ages

275. Graduation ages can be derived from school duration by education level. We refer to section 4.3.2 for data sources on school duration.

276. Retirement may be fixed at age 65 as international data usually end with this age. However, if data are available, countries may also apply their own country-specific retirement age, for purposes of analysis (see box 4.1).⁹

Training

277. Van Rooijen-Horsten et al (2008) estimated service lives for firm-specific human capital in different industries. These service lives were applied to calculate geometric depreciation rates for each industry separately. The service life depends on the average duration of jobs in the industry under consideration, and it is assumed that training starts only after one year of employment. Hence an average service life of firm specific human capital is equal to the average duration of jobs less 1 year. This resulted in service lives ranging between 7 to 13 years in 10 different sectors. In the cases where no data are available, one may assume average service lives for training of 5 to 10 years.

Table 4.3

International data on average job tenure

Organization	Database	Website*	Datasets
OECD	Employment Database, average job tenure	http://www.oecd-ilibrary.org/statistics → OECD Employment and labour market statistics → Labour market statistics	<i>Employment by job tenure intervals: average tenure</i>

* Arrows indicate successive levels in the website navigation hierarchy.

⁹ See for an overview of country-specific retirement ages, http://en.wikipedia.org/wiki/Retirement_age

D. Initial human capital stocks

278. The necessary data follow from the application of the method chosen.

E. Price index

279. The necessary data follow from the application of the method and index formula chosen.

Box 4.1

Defining the 'population'

Implementation requires that the population involved be defined. This Guide recommends to base measures on the working age population for reasons of international comparability and data constraints. Then two issues arise, namely the age bounds of the working age population and the human capital of the unemployed and non-labour force within the working age population.

The population is usually bounded to ages 15 to 65 years, mainly because international data are restricted to these ages. On top of that, there are still debates on measuring the human capital of children and the elderly. The size of the population and the associated human capital increases by entry of new individuals of age 15 and immigrants (being part of gross investment, see section 4.3.1). It decreases due to depreciation, retirement, death and emigration. Individuals leave the population at age 65. Hence it is implicitly assumed that individuals retire at age 65.

One should note that there are some conceptual and practical problems with such a fixed retirement age. The 'working age' actually varies across countries, as entry ages and retirement ages differ. Whereas ages of entry to the working age population do not vary much, retirement ages do, however. In a number of countries (e.g. the USA) it is already fairly common to retire only at later ages. A number of other countries (e.g. Germany and the Netherlands) have recently decided that the official retirement age for current young cohorts will be different from the current one, based on increasing life expectancy. There are also proposals to make the timing of retirement much more flexible, depending on the individual under consideration. The international differences in retirement ages and its impact on the size of the human capital stock (and flows) may be part of a sensitivity or economic analysis on international differences in human capital. Current data on retirement of individuals at ages 65 or older can be taken into account if these data are available in the country under consideration. The data issue on future retirement ages can be overcome by 'stretching' observed age schedules into the future. The assumed evolution of retirement ages could be attached to increasing life expectancy, in line with the relevant policy proposals.

The second issue in the definition of the population is the measurement of the human capital of the unemployed and the non-labour force (within the working age population). Reasons to include the non-labour force and unemployed individuals are the following. First, it is not always clearly defined in the data who belongs to the labour force and who does not. There is not always a clear distinction in the data between employed and short term unemployed individuals, the short and long term unemployed, and long term unemployed individuals and the non-labour force. For instance, short term unemployed individuals quickly leave and re-enter jobs, often within in one year. Second, it is conceivable that there are individuals in the non-labour force or the unemployed labour force who actually have or accumulate human capital. Unemployed individuals are willing to work by definition, even the long term unemployed, and they are usually qualified for work. Even some individuals in the non-labour force may want to work but are not able to access work, such as women who are raising their children. There are also individuals in the non-labour force

who are actually accumulating human capital by attending education or participate in other activities such as volunteering for example which may develop human capital.

In the light of these arguments, it is legitimate to include the inactive population in the human capital stock. Nevertheless, there may arise problems with this approach. The above goes for a static analysis, but in a dynamic setting, it is then more difficult to interpret an increasing labour force participation.

To sum up, in international comparisons it is recommended to apply the working age span of 15 to 65 years, but countries which have a different retirement age (and data) may decide to apply this for purposes of within-country analyses and sensitivity analyses. Further it is recommended to include all individuals within the working age population, regardless whether they are employed or not. It is furthermore recommended that the employed include employees as well as self-employed individuals.

4.3. Measurement with the lifetime income-based method

4.3.1. Operationalization

Estimating the human capital stock

280. We start with the standard Jorgenson and Fraumeni (J-F) model as described in chapter 3 (equations 3.3 to 3.7).¹⁰ As mentioned earlier, estimates of human capital for children up to 15 years of age and of the elderly retired from the labour market are still under debate. Part of their human capital is generated by non-market human capital investments. But if one focuses on market activity only, then one can estimate lifetime income for those under 16 as the present value of their expected income during their whole life. Such estimates for the young may reflect what may come in the future, when these children grow up and enter the labour market. This is done in empirical studies on e.g. the USA (Jorgenson and Fraumeni (1989)). Whether one decides to estimate the human capital of children depends on the purpose of the analysis under consideration, and its target audience, such as policy makers.

281. In international comparisons of human capital, however, it is common to compare human capital stocks of the working age population only. Then there are two stages of the J-F model for which estimates are made: the work-and-study stage and the work-only stage (respectively 3 and 4, see equations 3.5 and 3.6 in chapter 3). The starting and ending ages of these stages is determined by data availability. International data on the working age population usually start from age 15 and end with age 65. Entering the 'working age population' at age 15 does not imply the individual will actually be working. Data end at age 65 mainly because of limitations in internationally comparable data, and do not imply actual retirement. Retirement ages differ across countries. Countries may have data on age groups beyond 65 at their disposal and decide to apply these data (for a discussion see box 4.1).

282. The age boundary between Stages 3 and 4 is also determined by availability of data. International data on enrolment rates are only available for ages up to somewhere between 34 and 41 years, depending on the data under consideration. The retirement age is usually fixed

¹⁰ This standard application does not explicitly model job related training; this issue is discussed at the end of this section.

at 65, but countries may choose to apply their own, country-specific, retirement age, depending on the purposes of analysis (within-country or international), and data availability.

283. In implementation of equations 3.5 and 3.6, the human capital or lifetime income of a representative individual is equal to the sum of current labour income plus the present value of his or her future lifetime incomes.¹¹ The current labour income is usually estimated as the average labour income in a population cohort with similar sex, education level and age (s,e,a). This income is adjusted for the probability of employment, estimated by the employment rate. The future lifetime incomes are estimated as the average labour incomes of other cohorts of older ages and similar or higher education levels. These incomes are adjusted for the probability of survival of cohort (s,e,a), the overall real income growth, a discount rate; and in the 'work and study' stage, also for the probability of qualification for a higher education level (proxied by the enrolment rate).

284. Implementation shows some additional data may be needed on study duration to qualify for a higher education level, if this study programme is longer than one year (assuming the data of the other variables (e.g. income and employment) are on annual basis). Further, practical applications often make assumptions about the following due to data availability:

- a) Individuals can only enrol in a higher educational level than the one they have already completed.
- b) No further enrolment is allowed for people having already achieved the highest educational level.
- c) Students enrolled in educational institutions requiring more than one year to complete are assumed to be evenly distributed across the total study-period. This is equivalent to saying that, during each school-year, the same proportion of all students will complete the study. There are no internationally comparable data on the distribution of students.¹²
- d) No delaying, quitting or skipping is allowed during the whole study period.

285. A standard but fundamental application is that of synthetic cohorts. That is, an individual of age (a) and education level (e) (and gender (s)) is assumed to have in year (t+1) the same (adjusted) labour income and other characteristics (e.g. enrolment rate, employment rate, survival rate etc.) as an individual who is one year older in year (t) but has otherwise the same characteristics. This is because of the type of (international) data available, namely cross-sectional data for contemporaneous cohorts rather than longitudinal data following the same people over time (Liu, 2011). The cohort effect is limited by the fact that relative wages are taken from other contemporaneous cohorts. Wages for a whole cohort can go up or down relative to other cohorts, but relative wages within a cohort are constant across cohorts as there is a constant assumed real rate of growth for all members of a cohort that never varies by year.

286. In the end, the total national human capital stock is calculated as the sum of human capital of all individuals. The important assumption here is that the estimated lifetime income

¹¹ Liu and Greaker (2008) applied microeconomic data with information on employment, earnings and enrolment for all individuals across all ages in the population (of Norway). This led to a different model with one equation for students who may have a (part time) job, and one equation for workers who only pursue studies. (in this model and with these data, workers may or may not pursuing studies, both cases are possible)

¹² Given that we are conditioning on age, there will probably be cases where this is not true. For instance, in the US, an 18-year-old enrolled in college is most likely to be in his or her first year. Researchers may test their data given what they know about a country's education system. It might be that the assumption is incorrect but ultimately has a small effect on the aggregate stock of human capital.

of the representative individual in a group can be attached to all individuals in the same group. Then the individual human capital stocks are added up across all groups.

Decomposing changes in the human capital stock

287. Component changes in the human capital stock might be estimated directly or decomposed mathematically with, for instance, the method of Gu and Wong (2010) or Jorgenson and Fraumeni (1989). In this approach, the annual change in the human capital stock consist of the following components (see chapter 3, section 3.4, for the formal presentation):

- a) gross investment: change in lifetime incomes due to education, lifetime incomes for individuals reaching working age (15), and immigration.
- b) depreciation: changes in lifetime income due to ageing of the working age population (decreasing working life spans), lifetime incomes of individuals quitting the population because of retirement, death or emigration.
- c) revaluation: changes in lifetime incomes (or ‘price’) for individuals with a given set of characteristics, due to short run changes in the labour market nothing to do with changes in embodied knowledge.

288. The main component of the gross investment is the change in lifetime incomes due to education. This reflects improvement of existing human capital, increasing its productive capacity. However, part of this capacity is reduced due to ageing, i.e. depreciation. Young adults and immigrants are new human capital ‘assets’ which add to the human capital stock, while individuals who quit the population under consideration (because of retirement, death or emigration) reduce the stock. Due to lack of data, it is usually not possible to disentangle migration from the other changes (see section 4.3.2).

289. Note that there is an important difference between physical and human capital: human capital can appreciate due to among other things working experience or on-the-job training (see chapters 2 and 3). In the above model of Gu and Wong (2010), this appreciation is implicitly interwoven in the gross investment component. Because of lack of data, it is difficult to disentangle changes from on-the-job training from other investment (formal education).

290. The decomposition of changes in the human capital stock is implemented after the calculation of the human capital stocks of the various cohorts (s,e,a). The data necessary for decomposition are available from these first calculations (per capita human capital stocks, numbers of individuals and survival rates, all variables split by cohort).

Job-related training in the J-F model

291. In the standard application of J-F model, the data on investments in human capital consist of formal education. Job-related training is not modelled separately. However, the lifetime incomes as calculated with the J-F model and formal education data in the foregoing actually encompasses effects from formal job-related training and work experience.

292. For policy purposes, it would be interesting to analyze the separate income effect due on-the-job training. Unfortunately, there is no information to calculate this effect. A complication is the interaction between various types of investment. Higher educated individuals tend to invest more in on-the-job training, though one might expect the correlation not be one-to-one. The outcome (higher lifetime incomes) will be the result of these investments and the interaction between these investments.

293. Wei (2008) calculated separate estimates of lifetime income changes as a result of working experience in Australia. He estimated this by discounted wage differences between age groups. This Guide considers ‘working experience’ as an informal investment not directly measurable (in contrast to formal on-the-job training).

294. Countries are encouraged to conduct further research on the separate income effects of on-the-job training and formal education. Additional data for expenditures on on-the-job training will be necessary.

4.3.2. Data

295. From the previous section, it is clear that the data to estimate lifetime incomes should include:

- a) population and educational attainment
- b) student population and enrolment
- c) school duration
- d) labour force and employment
- e) labour incomes
- f) survival rates
- g) income growth rate and discount rate
- h) volume index
- i) migration (optional)
- j) training (optional).

296. Where appropriate, data should ideally be cross-classified by gender, age and the highest level of educational attainment achieved. In practice, the current availability and type of data necessitates important assumptions to be made. Before discussing data and sources in detail, some general comments can be made. The international data required to calculate lifetime incomes are usually not complete, and additional assumptions have to be made to construct a database. There are four main issues:

297. The preferred method uses data broken down by gender, age and education level at the same time. But often international data are often broken down by gender and age, but not by education level. Sometimes it is assumed that data by gender and age apply to all individuals with that particular gender and age, regardless of the education level of these individuals (such as the survival rate). In other cases, by applying assumptions, additional statistical information (e.g. the distribution of education levels) is linked to data broken down by gender and age (such as earnings). Sometimes data on education have to be linked to data on population, employment and labour incomes. Imputations might sometimes be at hand in cases where there are no data for subpopulations (for an example for the USA, see Christian, 2011). In the future, one might consider break downs by other characteristics, such as occupation, economic sector and/or location.

298. Ideally one would like to have detailed single data (single ages, education levels, enrolment rates etc.). However, internationally comparable data often are for groups, e.g. age groups instead of single ages (Fraumeni, 2009). To solve this problem, it is usually assumed that category characteristics can be applied to all individuals in the category under consideration.

299. Real cohort data would be preferable to estimate the future earnings of various groups of people. Cyclical or structural changes may occur in the future causing future incomes to be lower or higher. Wei (2008) for instance, applied real cohort data for Australia to calculate

moving averages of incomes. But in international databases, such time series information is lacking, and therefore synthetic cohort data have to be applied. In such cases contemporaneous data of subpopulations with another age and education level is applied as a proxy for the own population with that other age and education level, to ‘predict’ lifetime incomes. That is, cohorts in the current year are assumed to be a good proxy for the future labour market behaviour and incomes of the current population.

300. Finally, the lack and poor quality of underlying data remain a continuing issue. For instance, as Liu (2011) noted, despite the great progress accomplished in collecting harmonized 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.). Further, the quality of data (if available) on education and earnings vary across countries. As far as possible, one may improve the current data by using statistical information from other sources. Sometimes one might smooth or impute data. For instance, if there is a lack of survey data for certain subpopulations, then one may impute the missing data. Or there may be volatility in the data, for instance in annual incomes. One might prefer to smooth such data in order to adjust for outliers or white noise. However, Christian (2014) found that smoothing data did not have a substantive effect on the results, by comparing results from smoothed data with results from unsmoothed data in a large data set. Finally, if microeconomic data are applied, this may lead to weighting issues.

A. Educational attainment

301. Population data broken down by age, gender and educational attainment are available in international databases. The ISCED described in section 4.2.2 forms the basis for the classification of educational attainment. Currently most data are classified according to ISCED 97, and to a lesser extent ISCED 2011. One should note that the quality of the data according to ISCED levels varies across countries. The classification of country specific education programmes into the ISCED is not always smooth. Sometimes a country specific programme is difficult to classify into the ISCED and countries make their own adjustments. For instance, some ISCED codes are missing in many countries, and some countries combine two or more codes together (Liu, 2011).

302. For instance, Liu (2011) applied the OECD Education database in estimating lifetime incomes of various countries. These data are largely based on national Labour Force Surveys. For most countries, these data are available by gender, educational level and 5-year age groups for people between age 15 and 64. Liu (2011) made some adjustments to the data on number of people by educational attainment. First, he linked the data on the working age population by educational attainment to the levels (by gender and 5-year age groups) available within the OECD Demographic Database. This would improve the coherence between the educational and demographic data underlying the estimates. Further he used national data on the population by gender and individual year of age to interpolate across different educational categories. In this way he constructed new data by single year of age from the available data on 5-year age groups.

Table 4.4
International data sources on educational attainment

Organization	Database	Website*	Datasets
Eurostat	Education and training	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Education and training → Education attainment level and outcomes of education	<i>Education attainment level</i>
OECD	Education Database	http://www.oecd-ilibrary.org/statistics → OECD Education Statistics → Education Database	<i>Graduates by age</i>
UNECE	Education	http://w3.unece.org/PXWeb/en/ → Population and gender → Education	<i>Educational attainment by level of education, age and sex</i>
Barro-Lee	Educational Attainment Dataset	http://www.barrolee.com/	<i>Educational attainment</i>

*Arrows indicate successive levels in the website navigation hierarchy.

B. Enrolment

303. Data on the number of students by gender and age are available at, for instance, OECD and Eurostat. These data are by single year of age up to 29 (OECD) or 34 (Eurostat), by 5-year age groups, 30-34 (OECD) and 35-39 (OECD and Eurostat), and by one group for all people aged 40 and above, enrolled in different educational levels classified according to ISCED 97. With these data on the number of students in each educational category, assumptions on transition patterns (see box 4.1) and school duration (see further below) and data on the number of people by their highest educational attainment, one can calculate school enrolment rates.

304. One may assume that the enrolment rate for each single year within the 5-year age groups (30-34 and 35-39) is the same as that for the corresponding age group. Further, one must decide what to do with the aggregated data on students aged 40 and above. For simplicity, Liu (2011) computed school enrolment rates up to age 40. However, many countries have witnessed in recent years a quite significant increase in the number of people of aged 40 and older attending schools for further education. In constructing data by single

age, the strong assumption would be that all single ages within this group have similar enrolment rates.

305. Researchers estimating lifetime incomes should analyze their enrolment data to decide on how to apply it. There are various assumptions in the J-F method leading to investigation of the data: Students with some qualification (e) can only study at a higher level (\bar{e}). Further, students do not drop out, skip or have a delay in study. Finally, students are assumed to be evenly distributed within the group studying for qualification for the education level under consideration.

306. However, each ISCED level (particularly 3 and above) is sufficiently broad that it encompasses various heterogeneous education programmes, with different graduation ages. First, within each level, there are programmes with different orientations. Of particular importance is the distinction between vocational and general programmes. Human capital formation may not only be about increasing general knowledge levels but also about matching of supply and demand for vocational graduates on the labour market. Second, within each level, there are programmes at different sublevels. This is not equivalent to the difference between vocational and general education programmes.

307. Ideally one would like to have detailed statistics on sublevels and orientation of education. This is even more relevant because differences in human capital stocks are probably mainly the result of differences in the higher educated part of the population. Currently, most individuals in Western countries have attained at least a secondary education. Wei (2008) therefore focuses on estimation of human capital formation due to post-secondary education programmes, and considers all other individuals as a basic stock of human capital. Further, increasingly more adults continue in education (lifelong learning). Some of these students may already have been qualified for ISCED 97 level 6. They attend education programmes to strengthen their position on the labour market.

Box 4.2

Transition scheme in ISCED 97

Liu (2011) derived a transition scheme in ISCED 97 in order to apply this to the OECD data underlying his estimates of lifetime incomes of various countries. Liu (2011) applied the following ISCED levels to determine which levels or fields qualify for the labour market.

- 0: Pre-primary education
- 1: Primary education or first stage of basic education
- 2: Lower secondary or second stage of basic education
 - 2A: provide direct access to Level 3 in a sequence which would ultimately lead to entrance to 3A or 3B
 - 2B: provide direct access to 3C
 - 2C: leads to direct access to labour market at the end of this level
- 3: Upper secondary education
 - 3A: provide direct access to 5A
 - 3B: provide direct access to 5B
 - 3C: lead directly to labour market or to Level 4 or other Level 3 programs.
- 4: Post-secondary non-tertiary education
 - 4A: prepared for entry to Level 5
 - 4B: direct labour market entry.
- 5: First stage of tertiary education
 - 5A: theoretically based research and preparatory courses of history, philosophy, mathematics, etc., or giving access to professions with high skills requirements such as medicine, dentistry, architecture, etc.
 - 5B: programs that are practical/technical/occupationally specific.
- 6: Second stage of tertiary education.

This leads to the transition scheme as depicted by Liu (2011):

Transition Pattern in ISCED 97

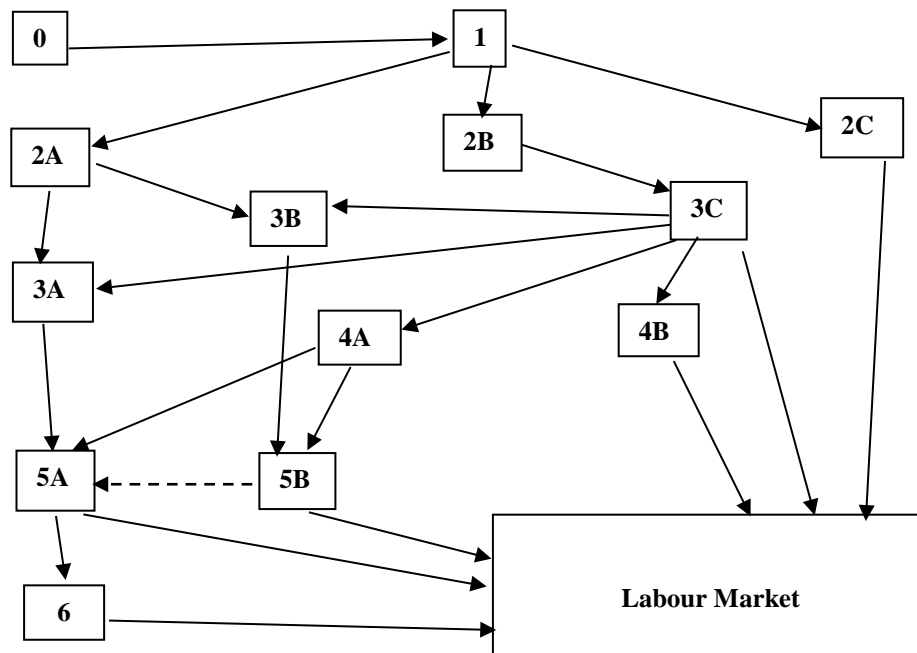


Table 4.5
International data sources on enrolment

Organization	Database	Website*	Datasets
Eurostat	Education and training	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Education and training → Participation in education and training	<i>Pupils and students - enrolments</i>
OECD	Education Database, enrolment	http://www.oecd-ilibrary.org/statistics → OECD Education Statistics → Education Database	<i>Students enrolled by age</i>
UNECE	Education	http://w3.unece.org/PXWeb/en/ → Population and gender → Education	<i>Enrolment ratio at secondary level by sex</i> <i>Upper and post-secondary students by sex</i> <i>Tertiary students by field of study, type of programme and sex</i>

*Arrows indicate successive levels in the website navigation hierarchy.

C. School duration

308. Education programmes differ considerably across countries, not only in content but also in length. Country information on study duration for each educational level is collected by the UNESCO's Institute for Statistics, the OECD and Eurostat for over 60 countries worldwide. This database provides information on school duration from 1999 onwards, although data are not always available for all years. Note that the duration (and entry age) figures in this database are purely *de jure*, not *de facto*. Further, one might use the durations implied by the age ranges used by the UNESCO Institute for Statistics for the calculation of net enrolment ratios in countries not included in the duration database.

309. If no country-specific data are available, then an alternative is to assume that the international average study duration within each ISCED level and type applies. The ISCED classification provides a standard in which national programmes are classified, depending on factors like duration of programmes, typical starting ages, programme orientation (general/vocational/pre-vocational) etc.

Table 4.6
International data sources on school duration

Organization	Database	Website*	Datasets
UNESCO	Education	http://data.uis.unesco.org/ → Education → System	<i>Duration by level of education</i>

*Arrows indicate successive levels in the website navigation hierarchy.

D. Employment

310. Within the working age population, the Guide distinguishes between the non-labour force and the labour force, and the employed and unemployed. The labour force should include the self-employed. While there may be discussion on whether the non-labour force and the unemployed contribute to the productive capacity of the economy, many recent studies applying the lifetime income approach calculate the human capital stock to include the non-labour force and unemployed as a part of the national human capital stock (see box 4.1).

311. Employment rates are calculated as the ratio of the number of employed persons to the total population by gender, age and educational attainment. Data on employment are readily available from international databases. The labour force surveys are currently the main data source on employment. Sometimes there are no data broken down by education level and assumptions and imputation are necessary. For instance, data by age groups may be broken down into single years.

Table 4.7
International data sources for employment

Organization	Database	Website*	Datasets
Eurostat	Labour Force Survey	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Labour market (labour) → Employment and unemployment (Labour Force Survey)	<i>LFS series – detailed annual survey results</i>
OECD	Labour force statistics	http://www.oecd-ilibrary.org/statistics → OECD Employment and Labour Market Statistics → Labour force statistics http://www.oecd-ilibrary.org/statistics → Indicator: Employment	<i>Population and labour force</i> <i>Employment by educational level (only from 2012 onwards)</i>
UNECE	Labour force and wages	http://w3.unece.org/PXWeb/en/ → Economy → Labour force and wages	<i>Population and employment by Country, Variable and Year</i>

*Arrows indicate successive levels in the website navigation hierarchy.

E. Labour incomes

312. As discussed in chapter 3, labour income should preferably be measured by labour compensation, as this reflects the value of human capital in the labour market. If not available, then wages and salaries could be used. One might apply labour compensation of employees as a proxy for the labour income of the self-employed (if there are no income data for the self-employed, but data on numbers of self-employed individuals are available). Labour income is usually estimated as the average labour compensation (per capita) of a cohort (s,e,a), and this average income is applied to all individuals in the cohort or other cohorts with other ages and education levels. Labour compensation or wage and salaries data are usually on an annual basis.

313. Definitions, quality and sources of earnings data broken down by personal characteristics vary significantly across countries (Liu, 2011). Issues that may arise are:

- a) Variation in original data source (labour force survey, household income survey or other)
- b) Different frequencies (hourly, weekly, monthly, annual)
- c) Variation in covering different elements of the remuneration packages of workers
- d) Covering only earnings from the main job, or also earnings from secondary jobs and other activities
- e) Differences in treatment of part-time and full-time work, and students holding a paid job
- f) Differences in classification of educational attainment
- g) Collected as either point estimates or in the form of earnings brackets
- h) Sometimes complete lack of earnings data by education level.

314. Depending on the data available different approaches and adjustments may be necessary. For instance, Rensman (2013) applied labour compensation (wages plus employers' social contributions) for employees and the self-employed for the Netherlands. However, Liu (2011) applied data on annual earnings by gender, age groups and educational attainment from the OECD Education database. As these data differ in definition of earnings across countries, he applied ratios between the earnings for different educational categories to the series 'wages and salaries' per employee from the OECD Annual National Accounts. This led to estimates of annual earnings by gender, age and educational levels that are consistent with SNA totals.¹³

¹³ Liu (2011) made two further adjustments: estimated earnings by single year of age, and imputed annual earnings consistent with educational levels in educational attainment data.

Table 4.8
International data sources for earnings

Organization	Database	Website*	Datasets
Eurostat	Earnings	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Labour market (labour)	<i>Earnings</i>
OECD	Earnings	http://www.oecd-ilibrary.org/statistics → OECD Employment and Labour Market Statistics	<i>Earnings</i>
UNECE	Labour force and wages	http://w3.unece.org/PXWeb/en/ → Economy → Labour force and wages	<i>Gross Average Monthly Wages by Country and Year</i>

* Arrows indicate successive levels in the website navigation hierarchy.

F. Survival rates

315. The survival rate is the conditional probability that a person who is alive in year (t) will also be living in year (t+1). Data on survival rates are usually broken down by gender and age, but not by education level. Survival rates by educational level are not compiled using common standards across OECD countries, and in several countries they simply do not exist. It is therefore usually assumed that a survival rate applies for all people of a given age and gender, regardless of the level of education.

316. Several studies show that people with higher educational attainment also have longer life-expectancy and higher survival rates. These individuals usually have, for instance, a healthier lifestyle (e.g. doing more exercise, having a healthier diet), better working and living conditions, and greater access to quality health-care (Liu, 2011). Figures from Eurostat and OECD Health at a Glance show clear differences in life expectancy between groups with different education levels (the gaps being particularly large in Central and Eastern Europe).¹⁴

317. Given these clear indications of differences in life expectancy across education levels, it is recommended to explore and estimate data on death, life expectancy and survival. Eurostat has started with deaths and life expectancy statistics by age, gender and educational attainment, but not for all countries yet and only for a recent period. Some individual countries already have survival tables by educational level, but have not published them yet

¹⁴ See OECD Health at a Glance 2015, Figure 3.5, Gap in life expectancy at age 30 by sex and education level, 2012 (or nearest year).

(such as the Netherlands). Further, there are some more detailed data available from the international Human Mortality Database. Eventually, one may apply an indirect estimation method to calculate survival rates by educational attainment (see for instance Luy 2012 and Luy et al 2011).

Table 4.9

International data sources on mortality and life expectancy

Organization	Database	Website*	Datasets
Eurostat	Mortality	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Demography and migration	<i>Mortality, life expectancy</i>
OECD	Health status	http://www.oecd-ilibrary.org/statistics → OECD Health Statistics → Health status	<i>Mortality, life expectancy</i>
Human Mortality Database	Human mortality	http://www.mortality.org	<i>Human Mortality Database</i>

* Arrows indicate successive levels in the website navigation hierarchy.

G. Income growth rate and discount rate

318. In the lifetime income approach, an income growth rate and a discount rate have to be set. The income growth rate accounts for growth of future (annual) incomes, and the discount rate discounts future values to a present value. Both rates are fixed exogenously, and debate continues on the choice of the value of the rates, as shown by chapter 3. Additionally, in implementation, one may ask whether (one or both of) these rates should be country-specific. Should they vary over time or not? Should they vary across sectors or not? Sensitivity analyses have shown that the level of the growth and discount rates affects the estimated level of the human capital stock, but that the rate of growth for the human capital stock remains largely invariant to such changes in the economic growth and discount rates. Among others Fraumeni (2011), Christian (2011), Abraham (2010), and Gu and Wong (2010) elaborate on the choice and impact of growth and discount rates.

319. In order to enhance international comparability and to enable cross-country comparisons, this Guide recommends the following:

- a) The **income growth rate** should be adjusted for inflation, and be country specific. It is preferably based on the real labour compensation per hour worked or per person (averaged over a longer time period). The rate should reflect gross income growth.

- b) The **discount rate** is also a real rate, and is preferably a standard international discount rate of 4% to enhance international comparability. This 4 per cent discount rate is already used for many countries. It had been applied by Jorgenson and Fraumeni in their original publication (Jorgenson and Fraumeni, 1989). In an update of the 1989 paper, Christian (2011) also uses 4 per cent. Moreover, this rate is also applied in recent literature on deferred tuition fees (see e.g. Vandenberghe and Debande, 2007).

320. Data preferably come from internationally harmonized databases, in particular from the Labour Accounts (compensation and hours worked of employees). The deflator may be the PPP (in international comparisons), or the consumer price index or labour price index (in within-country analyses).

321. Countries should be explicit on the growth and discount rates they have applied, and provide the necessary metadata.

H. Volume index

322. As is discussed in chapter 3, there are a number of methods for a temporal volume index. The preferred one is applying the Fisher volume index which is common in national accounting. For longer periods chaining is recommended. A second method, often applied in productivity analyses, is the Törnqvist volume index as in for example Liu (2011) and Gu and Wong (2010).

323. The preferred spatial volume index is based on purchasing power parities (PPP), as explained in chapter 3. If no PPPs are available, the exchange rate may be applied.

324. Countries should be explicit on the volume indices they have applied.

I. Migration (optional)

325. In order to account for changes in the human capital stock, data on immigration and emigration by gender, age and education level would be desirable. In some countries, such as the USA and Australia immigration flows are historically important. Furthermore, there are data indicating that increasingly the more highly educated have a preference to migrate to richer OECD countries (Arslan et al, 2014; OECD, 2012).

326. Unfortunately, internationally comparable data on migration broken down by education level are not or scarcely available. Also there are no or hardly any data on details, such as longitudinal data or whether it is a short or long stay (think of students moving for only (a part of) a year). This lack of data is the main reason for applying a mathematical decomposition as the one developed by Gu and Wong (2010), with which migration is not separable from other types of gross investment and depreciation (see chapter 3).¹⁵

327. Migration flow data would be preferred to stock data as a data source. This is because the stock of foreign-born individuals by education level does not tell how much of the human capital was actually imported or exported. Unfortunately, cross-country migration flows by gender, age and education level are hardly available, even for Western countries. There is also a data problem on emigrants who disappear from the scope of national census and surveys. Such data tends to be from administrative sources (although the UK has a survey with educational breakdowns of migrants). National statistical offices might decide to apply administrative data for their own country if these are available.

¹⁵ Kendrick (1976) also struggled with the lack of data on migration. He therefore made assumptions on the income of immigrants.

328. Data on the stock of migrants by education level can be addressed using foreign-born persons in censuses or surveys (e.g. household surveys or labour force surveys). A particularly good resource for EU countries is the Eurostat Census Hub, which allows bespoke tabulation of census data. For OECD and other UNECE countries, some data on educational attainment is available. The Census Hub and OECD database allow breakdowns of the population by place of birth, duration of stay/year of arrival, and gender, in addition to the educational breakdowns. The place of birth variable is useful because it is unchanging, and so avoids the problems associated with citizenship breakdowns, on account of the possibility that migrants change their citizenship after migrating. The duration of stay/year of arrival variables might be relevant to linking stocks of migrants with flows, although there is still a measurement issue about when migrants obtain their qualifications (before or after migration). Foreign students who enrolled and completed their education but do not remain in the country are not picked up in migration data as they have student visas, but their presence might result in an overstatement of human capital for those still enrolled in school. One should also note that since migrants tend to be young adults at the time of migration, the loss of their human capital to mortality is greatly overestimated if they are assumed to have the same age structure as the overall population. A final fundamental problem is that the utilization of human capital of immigrants might be suboptimal.

329. With assumptions regarding the stock data, researchers might calculate changes in the number of migrants (i.e. crude estimations of migration flows) by education level. One may apply pragmatic solutions such as using the average education level in the country of origin or using the average education level in the country of destination. This might be applied to estimate the income of immigrants.

Table 4.10
International data sources on migration

Organization	Database	Website *	Datasets
Eurostat	International migration	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Population → Demography	<i>International migration</i>
	Education	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Education and training → Education (indicators – non-finance)	<i>Mobility of students in Europe</i>
OECD	International migration	http://www.oecd-ilibrary.org/statistics → OECD International Migration Statistics	<i>International migration</i>
UNECE	Migration	http://w3.unece.org/PXWeb/en/ → Population and gender → Migration	<i>Migration</i>

*Arrows indicate successive levels in the website navigation hierarchy.

J. Training (optional)

330. As mentioned earlier, there are data on training activity and costs available from the Continuing Vocational Training Survey (CVTS).

Table 4.11
International data sources on training

Organization	Database	Website*	Datasets
Eurostat	Education and training	http://ec.europa.eu/eurostat/data/database → Databases by theme → Population and social conditions → Education and training → Participation in education and training	<i>Continuing Vocational Training in Enterprises</i>

*Arrows indicate successive levels in the website navigation hierarchy.

4.4. Measurement with the indicators approach

331. Indicators are the starting point for measurement according to the cost and lifetime income approaches described in section 4.2 and 4.3. Collection of data on indicators is relatively easy compared to the data calculations for the two monetary measures. Even countries with limited data availability and/or a limited statistical system have data for the raw educational attainment distribution at their disposal. Countries with more sophisticated data can publish more indicators such as the (distribution of) mean years of schooling and test scores.

332. As is the case with the data for the cost based and lifetime income based approaches, the quality of measurement remains challenging. For instance, ensuring full coverage is difficult, particularly for unrecognized private schools and home schooling in official data. Additionally, indicators that are ratios are sensitive to errors in population estimates. There is also the issue of age misreporting, and the potential for distortion through observing age in whole years in survey data. Education attainment measurement is more straightforward in principle, although there remains the issue of comparability. In addition, this approach amounts to a retrospective question for older cohorts and is therefore prone to misreporting. Finally, as with all surveys, there is the possibility that questionnaire design is biased by assumptions. For example, the omission of a 'no education' category in industrialized countries because that category ought to be zero.

333. Chapter 7 mentions some well-known international publications of indicators: the Barro-Lee data on average educational attainment, Education at a Glance of the OECD, and PISA and PIAAC. Part of the indicators in these publications are quantity measures, others are quality indicators, and some can be considered as quantity or quality measures.

334. The issue at hand is which indicators we would like to measure for a satellite account of human capital. First, we need quantity indicators as an input in the calculations of monetary measures, particularly the lifetime income method. Second, for purposes of analysis, indicators can serve as a benchmark or complement of the monetary measures.

335. The minimally required input indicators in calculations are:

Cost based approach:

- a) Total population distribution by (broad) age and gender, and education level
- b) Average schooling years by education level, to calculate working life spans (depreciation)

Lifetime income approach, all preferably distributed by age, gender and education level:

- a) Population and educational attainment
- b) Student population and enrolment
- c) School duration
- d) Labour force and employment
- e) Labour incomes
- f) Survival rates.

Indicators as benchmark or complement:

- a) Test scores from PISA and PIAAC, for analysis on quality of human capital or outcomes of education
- b) Indicators on retirement ages, part-time work and/or working hours, for analysis of the impact of increase in retirement age, male/female participation and/or international differences in hours worked
- c) Data broken down by sector, region, occupation etc., for analysis on distribution in human capital between different population groups.

International data sources

336. International data on all these indicators can be found in data sources for the variables described in section 4.2 and 4.3. Where not available, own country data may be applied.

4.5. Concluding remarks

337. If capital markets were perfect, the cost-based and lifetime income-based methods would generate similar estimates (Le et al, 2003). In practice, the lifetime income-based method gives a substantially higher estimate than the cost-based method (Abraham, 2010). However, it is not essential that the cost based and lifetime income based approaches match when accounting for human capital within an SNA framework. The two methods start from rather similar conceptual perspectives;¹⁶ the main difference is in the measurement, leading to differences in estimates. The lifetime income method starts from education data on individuals, and the cost-based method from the sources of expenditures. Countries do not need to make a choice between the two approaches, both have advantages and disadvantages. Policy makers and researchers may get much information from both approaches. Further, indicators on human capital can serve as a complement or even as a benchmark (e.g. test scores) in analysis of investments in and stocks of human capital. For instance, one may link proportions of students enrolled by gender, age and education level to expenditures data in an analysis of data constructed in satellite accounts for education and human capital (see chapters 5 and 6).

338. The analysis on the development of human capital would benefit from new international data broken down by gender, age and particularly the education level. Particularly desired are breakdowns for survival rates, migration and training. Further, the

¹⁶ Both approaches see human capital as an asset.

quality of existing data on for instance educational attainment, enrolment and earnings should be improved further. Finally a number of essential choices have to be made, namely on the price and volume index, rate of depreciation, discount rate and income growth rate. Further, there are various issues still to be discussed and eventually measured. One of these issues is the distinction between general and vocational schooling. In a further refinement, distinction by sector or occupation would be interesting for analysis.¹⁷

339. Chapter 3 described the theory, and chapter 4 shows the (im)possibilities of estimation. We need to be pragmatic on various estimation issues, e.g. on labour participation, retirement ages, migration, and discount rates. Each country estimating human capital should conduct sensitivity analyses to show the impact of the various assumptions and alternative data sources.

340. With our knowledge on theory (chapters 2 and 3) and measurement issues (chapter 4) we now turn to chapters 5 and 6 on the development of satellite accounts for education and human capital.

¹⁷ See chapter 7 for a review of some human capital studies that provide examples of how to address some of these issues.

Annex A. Implementation of the indirect approach

341. As described in chapter 3, the indirect approach estimates human capital residually. The World Bank pioneered this approach (World Bank, 2006, 2011; Ruta and Hamilton, 2007). The World Bank calculated the discounted value of the future consumption flows (a proxy for total wealth), and subtracted from this the monetary value of those capital goods for which monetary estimates of their current stocks are available (produced capital, a range of natural assets, and net foreign assets).

342. From this a residual appears. This residual represents the value of those capital stocks for which no monetary value can be observed on the market. This includes raw labour, human capital, social capital and other factors such as the quality of institutions. Though the indirect approach is relatively easily to be applied for many countries because data are readily available, it is clear that a human capital estimate cannot be derived from the residual.

343. Minimum data requirements for the indirect approach are:

- a) Time series on consumption (and growth rate of consumption);
- b) Assumption that consumption growth is constant;
- c) Assumption on pure rate of time preference (assumed to be 1.5 per cent);
- d) Assumption on elasticity of utility with respect to consumption (assumed to be 1);
- e) Data on tangible capital (physical and natural capital) and net foreign assets.

344. If the residual is to be analyzed to find the role of human capital (see World Bank, 2006, for an example of such an analysis), the minimum data are:

- a) An indicator for human capital, e.g. average years of schooling.
- b) A proxy for social capital, e.g. an index on rule of law.

5. Satellite account for education and training

5.1. Introduction

345. When considering extensions to the National Accounts such as with human capital, a natural starting point is the compilation of a satellite account. The satellite account approach is described in the System of National Accounts 2008 (2008 SNA). The basic form of a satellite account simply rearranges elements of the standard national accounts and introduces complementary information and detail. However, satellite accounts can also be used to explore estimates that go beyond the framework of the national accounts such as extensions of the scope, expanding the production boundary, alternative concepts and changes in classifications or experimental methodologies such as those explored in chapter 6 of this Guide.

346. The 2008 SNA (paragraph 1.54) states “It is often proposed that expenditures on staff training and education should be classified as gross fixed capital formation as a form of investment in human capital.” See further discussion in chapter 2 (starting with paragraph 40). The development of a Satellite Account for Education and Training (SAE) focusing on the expenditure on education and training seems therefore a logical first step in developing estimates of human capital, but without changing the asset boundary in the National Accounts. The satellite account for education and training can in itself be an important analytical tool for supporting decision making; however, a complete study of human capital requires in addition the construction of a satellite account for human capital. This second step is described in chapter 6 and requires considerable extension of the SNA production and asset boundaries, and additional methodological development.

347. In this chapter the setup of a SAE is discussed. The SAE will largely be based on monetary data already available from the national accounts, but will provide a more detailed description and assessment of the production activities that contribute to the creation of human capital, and of the financing agents. To broaden the analysis beyond the monetary data, the relatively rich statistics already collected on education in many countries, will be presented in supplementary tables to SAE, see section 5.5. UNESCO Institute for Statistics (UIS) and UNESCO International Institute for Education and planning (IIEP) have developed and piloted a National Education Accounts system (NEA) that is based on the principles of satellite accounts in 2008 SNA. Methodological guidelines to help countries implementing the NEA will be developed. It is recommended to follow this work closely in order to harmonize to the extent possible the SAE and NEA.

348. Expenditure on both formal and non-formal education, including in-house training (own account) in enterprises, will be covered in the SAE¹⁸. The satellite account takes a modest step away from the core concepts in the National Accounts, definitions and classifications, by breaking down and regrouping the various transactions that are related to education, training, etc. UNESCO has developed the International Standard Classification of Education (ISCED) which can provide a consistent basis for breaking down aggregate national accounts information on education and training into more detailed levels that will be useful for the study of human capital¹⁹. The SAE largely respects the current production

¹⁸ The SAE discussed in this chapter includes a broader set of non-formal education than the Guide recommends for use in estimating a human capital satellite account.

¹⁹ European accounts require additional detail based on ISCED since the introduction of ESA 2010.

boundary of the national accounts, although slightly expands it to include the output from enterprise internal expenses on in-house training (own account training). The conceptual development of the SAE, in the absence of specific guidelines by the SNA or ESA 2010, make reference to previous studies carried out at the international level (Quintela, 2007; Di Veroli, Tartamella, 2010; Jeljoul, Dalous, Brière, 2011; Bos, 2011; Baldassarini, Righi, 2012; Tronti, 2012), to the methodological guidelines developed by UNESCO, OECD, Eurostat (hereafter UOE) in UOE Data Collection on Education Systems, Volume 1 Manual Concepts, Definitions and Classifications (UNESCO, OECD, Eurostat, 2013) and, finally, to the experience building other Satellite Accounts - like the SERIEE Environmental Protection Expenditure Accounts - Compilation Guide (Eurostat, 2002) and the System of Health Accounts (OECD, Eurostat, WHO, 2011). The key variables considered and the products, the producers and the financing agents selected to build the SAE are described in sections 5.2 and 5.3.

349. The proposed satellite account includes a set of main tables and supplementary tables, discussed respectively in sections 5.4 and 5.5. The main tables are a table based on the Supply and Use Framework and tables based on the Resources and Uses account which are extended slightly to show detail for the transactions related to education and training outputs. The proposed table layouts constitute the encouraged level of detail for the SAE; nevertheless, depending on country circumstances, one could opt for alternative and/or more detailed breakdowns. The SAE provides information on who is financing and producing education services and on the amount of investment supporting the relevant activities by institutional sector. A summary of this is given in table 5.2 showing the link between the financing agents and the producers of education services and goods. The Resources and Uses Tables also provide information on the main uses (intermediate consumption, final consumption, export of educational services). They include information on transactions in sufficient detail to distinguish between the expenditures, the production and the financing of education and training.

350. The concepts and methods of the System of National Accounts provide a quantitative description of the economic activity related to education and training in the national economy, and therefore determine its importance and its relationships with other sectors. Consequently, having access to the value of output by type of education product allows the identification of valuable information such as: i) how education/training is used in the national economy, i.e. who benefits; ii) the relative importance of the actual financing agents and education producers, i.e. who finances education with how much and where does the funding go; iii) the proportion of education and training financed by individuals, enterprises and government; iv) at what ISCED levels major resources are allocated, i.e. what are the funds being spent on; v) the relationships with the rest of the world and, possibly, the balance of the benefits for students or domestic producers in the country of origin or abroad. Additionally, the SAE provide the main building blocks for cost-based estimates of the stock of human capital, and information relevant for education and remuneration policies, i.e. unit costs. It thus can provide a valuable dataset for academics to advance research on measuring human capital.

5.2. Key variables of the Satellite Account for Education and Training

351. The SAE describes the educational system first and foremost from an expenditure perspective. There should be a clear link to available data in the National Accounts. In the National Accounts the current expenditure on education refers to final consumption

expenditures, either by households as out of pocket payments, by government, or by non-profit institutions. In addition, direct and indirect expenses in enterprises on education and training should be added. Direct expenses in enterprises consist of purchases of education services which is part of intermediate consumption, and indirect expenses on in-house training. The latter, which is also intermediate consumption in the SNA, is here recognized as a separate output which slightly expands the production boundary, without changing GDP. How to estimate own account training in enterprises is discussed in section 4.2 of chapter 4, and will mainly consist of personnel costs (salaries).

352. The total current expenditures will be equal to the supply (production and imports) of education goods and services. The supply and use tables from the National Accounts can be used to identify the current expenditures and also which education services are provided by whom (providing units), As such, it introduces breakdowns of the various expenses related to human capital formation by type of product, or the various levels and types of (formal and non-formal) education.

353. Expenditures on gross fixed capital formation in the education system play a crucial role in the provision of education services by maintaining or expanding production capacity. However, this must be clearly distinguished from the current expenditures on education, and one should be careful not to add up the two types of expenses. It should also be noted that consumption of fixed capital in education is already included in the current production costs. It is, however, of interest to show expenditures on investment in the education industry in the tables, and the Guide recommends that this is included.

354. Expenses related to the following activities are considered:

A. Core Activities (current expenditure):

- formal education at education institutions (both market and non-market);
- formal vocational training at vocational education institutions;
- other personal and cultural activities (e.g. language schools, driving schools, dance schools);

B. Other expenditures (current expenditure):

- continuing vocational training (CVT) courses (external or internal) and other forms of CVT²⁰;
- ancillary expenditures (e.g., school transport, textbooks and other expenditures on equipment directly used in education etc.)²¹;

C. Other expenditures (capital expenditure):

- research and development (R&D) in education (in National Accounts this is part of gross fixed capital formation)
- expenses on gross fixed capital formation other than R&D.

355. It is recommended that activities in both lists A and B above be covered in the SAE as current expenditure on education but, due to data limitations in some countries particularly relating to group B, it may not be possible to include some or all of these. If the latter is the case, it is recommended that NSIs consider expanding data collection in these domains.

²⁰ Planned periods of training/instruction/practical experience; job rotation; exchanges with other enterprises; Learning or Quality Circles; Self-learning; Instruction at conferences, workshops, seminars etc.

²¹ There is room for discussion on what expenditure to define relevant for education in the SAE. Others could be also considered, as, for instance, lodging, meals, health services or welfare services for students.

356. All the (public and private) education costs of educational/vocational training institutions, enterprises and individuals are considered. The transactions associated with these expenditures are accounted for on an accrual basis²² in order to be in line with the relevant SNA-principles for the time of recording. The Guide recommends that current expenditures considered include:

- A. Final consumption expenditures on education in government and non-profit institutions relate to group 09 of the Classification of the Functions of Government (COFOG) and group 04 of the Classification of the Purposes of Non-Profit Institutions Serving Households (COPNI), see table 5.1. This will cover all non-market production except the expenses paid directly from the households (out of pocket payments). Non-market output is conventionally valued by the total production costs, including consumption of fixed capital, plus net taxes (2008 SNA 6.94). The final consumption expenditure will also cover other social transfers in kind beyond education goods and services, for example free school transport, delivered directly to individual households (2008 SNA 3.83).
- B. Direct consumption expenditures by households for goods and services purchased from educational institutions: i) COICOP group 10 covers costs for educational services, ii) goods which are requested for participation in the programmes and which are therefore imposed on the student either directly or indirectly by the educational institutions (school uniforms, books requested for instruction, athletic equipment, materials for arts lessons, etc.; ii) costs for educational goods which are not required by institutions, but which students and households choose to buy in support of their study in the programmes (additional books or computer, learning software to be used at home) (can be found in different COICOP groups, see table 5.1); iii) costs for outside school tuition to support the participation in educational programmes; iv) costs for non-formal training programs and for private language lessons or other courses²³, and school passenger transport which the household pay out of own pocket (minor part of COFOG 07).

5.3. Identification of the products, producers and financial agents

357. The presentation of education services and products (EP) to be considered in the SAE is consistent with the International Standard Industrial Classification of All Economic Activities (ISIC rev.4), the Central Product Classification (CPC version 2.1), and the guidelines adopted by UNESCO, OECD and Eurostat for the collection of financial data on education (UNESCO, OECD, Eurostat, 2013). The producing units (public/private educational units, administrative offices, non-formal educational centres, etc.) are providing educational activities/products (teaching activities, general administration, ancillary services), and these should be broken down by level of education based on ISCED 2011 (see table 5.1 for more detail). This Guide encourages the compilation and presentation of data at the lowest level of ISCED as possible, but as a starting point a minimum would be:

- Education Product 1 (EP1) - ISCED 0-1 (pre-primary/primary education)²⁴;

²² Differently from the UOE financial data collection, where figures are on cash basis (UNESCO, OECD, Eurostat, 2013).

²³ Differently from the UOE statistics (UNESCO, OECD, Eurostat, 2013).

²⁴ Child-care costs provided by the schools of pre-primary and primary education are excluded.

- Education Product 2 (EP2) - ISCED 2-4 (secondary education);
- Education Product 3 (EP3) - ISCED 5-8 (higher education);
- Education Product 4 (EP4) - Non ISCED education²⁵.

358. The expenditures and activities reported in table 5.1 present a fairly detailed picture of the education sector, with some exceptions:

- the item ‘administrative services’ is only distinguished in COFOG and consequently a breakdown of these expenditures by ISCED level can only be made for general government;
- several items within ancillary expenditures are only partially related to education (i.e. transport). This is true for both the relevant items in the Central Product Classification (CPC version 2.1) and the Classification of Individual Consumption According to Purpose (COICOP). For the items not entirely related to education, other monetary data sources (Household Budget Survey or administrative sources, i.e., Ministry of Education) or non-monetary information (number of students) can help in refining the estimates.

359. In developing this Guide, it has become evident that the international statistical classifications currently used by the SNA often do not identify with sufficient accuracy education products. Future work should include efforts to improve the detail in classifications regarding education costs/products.

²⁵ It includes the vocational training courses giving a degree (after varying years of instruction), educational support, training courses within the business sector, permanent adult education courses, recreational and vocational rehabilitation services for persons with disabilities or the unemployed, the cost of private language lessons or courses for leisure time (this is not the same as in UOE financial accounts).

Table 5.1
SAE Education Products and correspondence with CPC ver.2.1, ISIC rev.4, COFOG, COPNI, COICOP

	CPC ver.2.1	ISIC rev.4	COFOG	COPNI	COICOP
Education Products (EP)					
Education Product 1 (ISCED 0 -1)	921 Pre-primary education services	851 Pre-primary and primary education	09.1 Pre-primary and primary education	04.1 Pre-primary and primary education	10.1.0 Pre-primary and primary education
	922 Primary education services				
Education Product 2 (ISCED 2-4)	923 Secondary education services	852 Secondary education	09.2 Secondary education	04.2 Secondary education	10.2.0 Secondary education
Education Product 3 (ISCED 5-8)	924 Post-secondary non-tertiary education services	8530 Higher education	09.3 Post-secondary non-tertiary education	04.3 Post-secondary non-tertiary education	10.3.0 Post-secondary non-tertiary education
	925 Tertiary education services		09.4 Tertiary education	04.4 Tertiary education	10.4.0 Tertiary education
Education Product 4 (Non ISCED Education, including training of employees by their employers)	9291 Other education and training services	854 Other education	09.5 Education not definable by level	04.5 Education not definable by level	10.5.0 Education not definable by level
	92919 Other education and training services, n.e.c.	854 Other education	09.8 Education n.e.c. (CS)	04.7 Other educational services	
	92919 Other education and training services, n.e.c.	8549 Other education n.e.c.			07.2.4 Driving lessons
	92912 Sports and recreation education services	8541 Sports and recreation education		03.1.0 Recreational and sporting services	09.4.1 Recreational and sporting services
	92911 Cultural education services	8542 Cultural education		03.2.0 Cultural services	09.4.2 Cultural services
	9292 Educational support services	855 Educational support activities			

	CPC ver.2.1	ISIC rev.4	COFOG	COPNI	COICOP
	93411 Vocational rehabilitation services for persons with disabilities	881 Social work activities without accommodation for the elderly and disabled		05.1.0 Social protection services	12.4.0 Social protection
	93412 Vocational rehabilitation services for unemployed persons	889 Other social work activities without accommodation			
Other education costs; to be allocated to EP1 to EP4					
Admin. services	91121 Public administrative services related to education	8412 Regulation of the activities of providing health care, education, cultural services and other social services, excluding social security	09.6 Subsidiary services to education		
Ancillary expenditures	88520 Plastic product manufacturing services	2220 Manufacture of plastics products			
	452 Computing machinery and parts and accessories thereof	2620 Manufacture of computers and peripheral equipment			09.1.3 Information processing equipment
	35120 Artists', students' or signboard painters' colours, modifying tints, amusement colours and the like / 3891 Pens, pencils, stamps, typewriter or similar ribbons, ink-pads and similar articles / 38961 Paintings, drawings and pastels; original engravings, prints and lithographs; original sculptures and statuary	2022 Manufacture of paints, varnishes and similar coatings, printing ink and mastics / 3290 Other manufacturing n.e.c.			09.5.4 Stationery and drawing materials

CPC ver.2.1	ISIC rev.4	COFOG	COPNI	COICOP
61284 Wholesale trade services on a fee or contract basis, of computers and packaged software / 61285 Wholesale trade services on a fee or contract basis, of electronic and telecommunications equipment and parts	4651 Wholesale of computers, computer peripheral equipment and software			
62551 Retail trade services on a fee or contract basis, of books, newspapers, magazines and stationery	4741 Retail sale of computers, peripheral units, software and telecommunications equipment in specialized stores			
32210 Educational textbooks, in print / 32291 Professional, technical and scholarly books	5811 Book publishing			09.5.1 Books
47821 General business productivity and home use applications, packaged published software used in the home for entertainment, reference or educational purposes - word processors, spreadsheets, simple databases; graphics applications; project management software, computer-based training software, reference and home education software, etc.) / 47811 Operating systems, packaged	5820 Software publishing			

CPC ver.2.1	ISIC rev.4	COFOG	COPNI	COICOP
64119 Other land transportation services of passengers, n.e.c./ 64114 Local special-purpose scheduled road transport services of passengers (transportation services of pupils by school bus between their homes and school and between schools)	4922 Other passenger land transport			07.3.1 Passenger transport by railway / 07.3.2 Passenger transport by road

360. The Financing Agents (FA) of education and training, broken down by institutional sector, are presented in table 5.2 cross classified by major groupings of producers and products. In some cases, no transaction may exist or one may not be able to identify the relevant transactions due to data limitations. For example, it may be the case that the Balance of Payments does not provide sufficient detail to allow a breakdown by product for the 'rest of the world'.

Table 5.2
Transactions between financing agents and producers of education and training

Financing agent		Producer								
		General Government				Corporations and NPISH				Rest of the world
		Products								
		(EP1)	(EP2)	(EP3)	(EP4)	(EP1)	(EP2)	(EP3)	(EP 4)	(EP1-EP5)
Central/State Government	S.1311 – S.1312	X	X	X	X	X	X	X	X	X
Local Government	S.1313	X	X	X	X	X	X	X	X	X (*)
Financial/Non-Financial corporations	S.11 - S.12	X	X	X	X (*)	-	-	X	X	X (*)
NPISH	S.15	X	X	X	X (*)	X	X	X	X	-
Households	S.14	X	X	X	X	X	X	X	X	X
Rest of the world	S.2	X (*)	X (*)	X	X (*)	X (*)	X (*)	X	X (*)	-

* Cells likely to have small or non-identified flows

5.4. The main tables of the SAE

361. The first table of the SAE is a supply and use table with additional detail on education and training as shown figure 5.1. The top part of figure 5.1 presents the output of the education industry, broken down by type of producer (market or non-market producers). Output of education and training produced in-house may also be recorded in the columns of the other industries. In the rows, education and training services are broken down into much more detail than is usually the case in a generic supply and use framework. The bottom part of figure 5.1 shows the various uses (intermediate consumption, final consumption, export) of the education and training services by education level. As compared to the usual use table, it is proposed to have a more detailed breakdown of labour input by level of education, thus showing the demand for the various types of labour and making possible an analysis of developments in the relevant labour market segments and also an analysis of (future) mismatches in demand and supply of labour. It is also crucial information for the enhanced study of multifactor productivity, which could help to integrate an evaluation of both the input and the output of the education process with the calculation of monetary returns to human capital by gender, age and educational attainment cohort. Finally, it is also proposed to include a line for gross fixed capital formation by industry.

Figure 5.1
Supply and use table

SUPPLY	Output by Industry (ISIC rev.4)											Total output (at base prices)	Imports (f.o.b.)	Taxes less subsidies on products	Total supply at purchaser's prices			
	Agriculture, forestry and fishery	Manufacturing and other industry	Construction	Trade, transport, accommodation and food	Information and communication	Finance and insurance	Real estate activities	Business services	Education services							Human health and social work	Other services	
									Total	Market producers	Non-market producers							
Agriculture, forestry and fishery																		
Manufacturing products																		
Construction products																		
Trade, transport, accommodation and food																		
Finance and insurance																		
Real estate																		
Business services																		
Total																		
<i>EPI (ISCED 0-1)</i>																		
<i>EP2 (ISCED 2-3)</i>																		
<i>EP3 (ISCED 4-8)</i>																		
<i>EP4 (Non formal education/training, including training of employees by their employers)</i>																		
Education services																		
Human health and social work																		
Other services																		
Total output																		
<i>Market output</i>																		
<i>Non-market output</i>																		

362. The second main table of the SAE is the Resources/Uses Table (figure 5.2) which shows the uses (costs) and the resources (income) of the institutional units producing education and training services. The relevant institutional units are grouped together into the institutional sectors in which they are classified: general government, financial/non-financial corporations, non-profit institutions serving households, households or the rest of the world. The classification of uses and resources by institutional sector is particularly interesting in identifying the different roles of each sector in producing education and training, and the way in which this is financed. Of particular importance is the development of information by level of education.

363. In the *Resources Table*, both current and capital transfers usually constitute a significant part of income/financing. The estimation of 'current transfers' from financing agents requires the attribution of public revenues to specific functions performed by government (education products). 'Capital transfers' consist of particular transfers (donations and other forms of occasional transfers) affecting the accumulation of non-financial assets of the receivers. 'Income from sales' is a characteristic of market producers, but non-market institutions (General government and NPISHs) can also have significant sales (e.g., for ancillary products or partial payments for education services provided). 'Other incomes' relate to, for example, (net) receipts of interest and dividends on financial investments. In the *Uses Table*, the rows show the various cost elements and the use of and investment in capital related to producing education and training services.

364. A second Resources/Uses Table, providing alternative detail is added (figure 5.3). It maintains the same row structure as figure 5.2 but the columns present a breakdown of producers by educational product type. The goal of figure 5.3 is to arrive at information to assess to which education product the resources from Financing Agents are allocated. Moreover, it is possible to identify the uses of the resources made by the producers of each education product. Ideally, it is possible to think about a classification that includes at the same time institutional sector and type of educational product, but it may prove to be very difficult to split each economic flow in such detail.

365. The compilation of the tables is a complex task, because of both the difficulty in identifying the most appropriate data sources for the costs incurred by the producers for each education product and the exact allocation of the transfers/payments made by the financing agents as the various sources often use different classifications that have to be made consistent. In this respect, the estimation of current transfers/contributions from government may prove to be quite problematic, as it requires the attribution of public expenditures to specific functions performed by government. In the absence of detailed figures, a common practical solution is to assume that the government's financing of its own produced education is equal to the production of public education itself. It should be noted that, without this assumption, it is almost impossible to arrive at a consistent recording of the various transactions (Di Veroli, Tartamella, 2010).

Figure 5.2
Resources/uses table of the sector by institution producing education

	Central/State Government (S.1311)	Local Government (S.1313)	Financial/Non- financial corporations (S.11/S.12)	NPISHs (S.15)	TOTAL
RESOURCES					
Current transfer from financing agents (FA)					
- <i>Central/State Government</i> (S.1311/S.1312)					
- <i>Local Government</i> (S.1313)					
- <i>Financial/Non-financial corporations</i> (S.11/S.12)					
- <i>NPISHs</i> (S.15)					
- <i>Households</i> (S.14)					
- <i>Rest of the world</i> (S.2)					
Income from sales					
Capital transfers from financing agents (FA)					
- <i>Central/State Government</i> (S.1311/S.1312)					
- <i>Local Government</i> (S.1313)					
- <i>Financial/Non-financial corporations</i> (S.11/S.12)					
- <i>NPISHs</i> (S.15)					
- <i>Households</i> (S.14)					
- <i>Rest of the world</i> (S.2)					
Other incomes (from capital, insurance, rents)					
USES					
Intermediate consumption					
Compensation of employees					
Wages and salaries					
Employers' social contributions					
Taxes on production and imports					
Less Subsidies					
Consumption of fixed capital					
Total current expenditure/output					
Gross fixed capital formation					

Figure 5.3
Resources/uses table of the sector by product

	Formal Education/training - Total (EP1-EP3)				Non formal education/training (including training of employees by their employers) (EP4)	TOTAL
	<i>EP1</i> (ISCED 0 - 1)	<i>EP2</i> (ISCED 2 - 3)	<i>EP3</i> (ISCED 4- 8)	Total (EP1-EP3)		
RESOURCES						
Current transfer from financing agents (FA)						
- <i>Central/State Government</i> (S.1311/S.1312)						
- <i>Local Government</i> (S.1313)						
- <i>Financial/Non-financial corporations</i> (S.11/S.12)						
- <i>NPISHs</i> (S.15)						
- <i>Households</i> (S.14)						
- <i>Rest of the world</i> (S.2)						
Income from sales						
Capital transfers from financing agents (FA)						
- <i>Central/State Government</i> (S.1311/S.1312)						
- <i>Local Government</i> (S.1313)						
- <i>Financial/Non-financial corporations</i> (S.11/S.12)						
- <i>NPISHs</i> (S.15)						
- <i>Households</i> (S.14)						
- <i>Rest of the world</i> (S.2)						
Other incomes (from capital, insurance, rents)						
USES						
Intermediate consumption						
Compensation of employees						
Wages and salaries						
Employers' social contributions						
Taxes on production and imports						
Less Subsidies						
Consumption of fixed capital						
Total current expenditure/output						
Gross fixed capital formation						

5.5. The supplementary tables of the SAE

366. The information provided by the SAE is completed by Supplementary Tables (figures 5.4-5.6) covering non-monetary data, as suggested for satellite accounts in 2008 SNA. Figure 5.4 provides information on the resident population, broken down by sex, age group and educational attainment.

Figure 5.4

Table for supplementary information on population

	Education Attainment				
	Age group	ISCED 0-1	ISCED 2-4	ISCED 5-8	Total
Resident population	Total				
	<i>Total</i>				
	<i>0-14</i>				
<i>Male</i>	<i>15-34</i>				
	<i>35-64</i>				
	<i>65 and over</i>				
	<i>Total</i>				
	<i>0-14</i>				
<i>Female</i>	<i>15-34</i>				
	<i>35-64</i>				
	<i>65 and over</i>				

367. The supplementary tables in figure 5.5 and figure 5.6 show, respectively, the number of students (broken down by sex and by level of education) and the number of adults in continuing vocational training, in permanent education or in other types of non-formal education (broken down by sex, age group). These data may provide the possibility to estimate the yearly per capita cost of a typical student and the total costs needed to achieve a certain level of qualification. Data on the number of teachers is also included.

Figure 5.5
Table for supplementary information on students and teachers

	Level of education				Total
	ISCED 0-1	ISCED 2-4	ISCED 5-8	NON ISCED	
Number of students					
<i>Male</i>					
<i>Female</i>					
Average costs and fees (per pupil/student)					
Number of teachers					

Figure 5.6
Table for supplementary information on adults in continuing vocational training and on permanent education

	Age group		Total
	15-34	35-64	
Number of people in on-the-job training			
<i>Male</i>			
<i>Female</i>			
Costs and fees per person			
Number of adult in permanent education			
<i>Males</i>			
<i>Females</i>			
Average costs and fees (per person)			
Number of teachers			

5.6. Conclusion

368. The Guide recommends countries, as a first step, develop a satellite account for education and training. The objective of such a satellite account is to distinguish and provide breakdowns of the various expenditures on training and education, including showing the financing arrangements for these expenditures. The proposal introduces a slight extension of the production boundary as it recommends recognizing the output from the internal expenditures on education and training by employers. There are still challenges requiring further work. In developing this Guide, it has for example become evident that the international statistical classifications currently used by the SNA often do not identify with sufficient accuracy education products. Future work should include efforts to improve the detail in classifications regarding education costs/products.

369. Collaboration between countries in testing the methodology and quality of data is recommended. In this work one should also try to harmonize with the methodological guidelines set up in the National Education Account framework from UNESCO.

6. Human capital satellite account: an example for Canada

6.1. Introduction

370. Human capital can be defined as the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being (OECD, 2001, chapter 1). It can be acquired through education and training and provides individuals with both economic and non-economic benefits. Currently, the entries in the System of National Accounts (SNA) that reflect human capital expenditures are treated as current expenses. They are consumption expenditures for households, governments and non-profit institutions serving households (NPISH); and current expenditures, be it intermediate consumption or compensation of employees, for corporations.

371. This chapter moves to treating expenditures on education and training as investments rather than current expenses. This requires changes to a number of accounts within the SNA, and there exist alternative methods for doing so. Here, a treatment is demonstrated through the use of a satellite account for human capital. This satellite account provides an example of how economic aggregates such as gross domestic product, investment, consumption, saving and national net worth will change when expenditures related to human capital result in output that is accumulated as part of investment rather than result in current consumption.

372. The human capital satellite account in this chapter goes beyond the current SNA by fully integrating human capital. A more moderate approach is the education and training satellite account presented in chapter 5. The education and training satellite accounts focuses on the output and inputs of education and training activities in the expanded supply and use tables of the SNA.

373. Using the structure of the SNA to integrate skills and knowledge as a form of capital, the satellite account presents additional information on the link between human capital and economic performance, while simultaneously retaining the core strengths of SNA estimates. The size of investment in human capital provides an assessment of the role of skills and knowledge acquired through education and training in economic and productivity growth. It can be compared with other types of investment such as investment in machinery and equipment, structures and research and development to provide an improved understanding of their relative importance for economic growth. Total capital stock estimates in the expanded balance sheet provide information on the evolution of national wealth and the sustainability of development in an economy.²⁶

374. Empirical estimates in the human capital satellite accounts are based on human capital investments made in Canada that are recorded in the Canadian System of National Account (CSNA) or derived from the survey and administrative-data collection systems that form the source data for the CSNA. Throughout the chapter, the concepts employed are drawn from the SNA, but the data are based on the aggregates reported in the CSNA.

375. Consistent with the Guide, this chapter focuses on formal education and formal training. These are the areas where the data provide robust estimates; but the analysis could

²⁶ The concept of expenditures on education being an investment and the existence of human capital as a form of wealth have been familiar in economics for at least 50 years (e.g., Schultz 1961; and Becker 1964). Goldin (2001) noted that the modern concept of the wealth of nations and the concept of capital embodied in people emerged in the early twentieth century.

be expanded to include other types of human capital investment such as the costs of child rearing, informal training, investment in health, and the addition and subtraction of human capital due to migration.

376. Including investment in human capital in the SNA raises a number of challenges. Among the most pressing are where the asset is produced, how to structure the treatment of human capital investment through the sequence of accounts in the SNA, the choice of an appropriate price deflator for human capital investment, the choice of an appropriate depreciation rate for human capital, and a reconciliation of alternative methods for estimating the human capital stock and investment.²⁷

377. This chapter follows the Guide and structures the treatment of human capital through the sequence of accounts in the SNA. It follows the two methods in chapter 2 for integration, but also expands on the assumptions used and acknowledges that alternative treatments are possible. In some instances, such as the choice of a depreciation rate for human capital or the choice for a price deflator, the chapter provides an assessment of the issues and then proceeds to demonstrate the impact of a particular approach. Importantly, not all options or alternatives are fully elaborated. Rather, using those approaches that correspond most closely with the data sources available for the CSNA, the chapter demonstrates the effect of placing human capital into the sequence of accounts in the SNA based on the options presented in this Guide.

378. The remainder of the chapter is organized as follows. Section 6.2 briefly outlines major approaches for estimating the value of human capital for inclusion in a human capital satellite account. A comprehensive discussion of the various approaches is presented in chapters 3 and 4 of the Guide. Section 6.3 treats human capital as a produced asset and characterizes the production process for human capital. The choice among alternative views on the production of human capital turns out to be key for the development of a human capital satellite account. Section 6.4 presents the integration of human capital in the SNA when human capital is estimated using the cost-based approach. Section 6.5 presents the integration and additional changes to the sequence of accounts when human capital is estimated using the income-based approach. It also indicates where the extra value of investment found under the income approach can be attached to particular variables. Compared to the cost approach, the income approach values do not correspond as closely with the concepts and recommendations of the SNA 2008, and are only presented in a more aggregated form. Sections 6.6 and 6.7 present an experimental human capital satellite account for Canada. The estimates for Canada are suggestive of the magnitudes of the changes to the national accounts when education and training are treated as investments. Section 6.8 concludes.

6.2. Measurement of human capital for a satellite account

379. To incorporate human capital into the SNA, the monetary value of human capital investment and human capital stock need to be estimated. This Guide recommends two approaches to do so. They are the cost-based approach (e.g. Kendrick 1976) and the income-based approach (e.g. Jorgenson and Fraumeni 1989, 1992a and 1992b)²⁸. Kendrick (1976) estimated investment in human capital as total expenditures on education, training, health and child rearing. After applying the appropriate deflator, the cost-based approach produces an

²⁷ Chapters 2, 3 and 4 provided a comprehensive discussion of the issues associated with the measurement of human capital.

²⁸ Chapters 2 and 3 provide more detailed descriptions of these approaches.

estimate of human capital investment in constant dollars which can be accumulated to derive a human capital stock using the perpetual inventory method. A major advantage in using the cost of production approach is its ability to delineate what the investment streams are.²⁹

380. In contrast, Jorgenson and Fraumeni (1989, 1992a and 1992b) adopt an income-based approach and estimate the investment in human capital using estimates for expected lifetime income.³⁰ Under this approach, assumptions about the progress of lifetime income are applied to the age and education characteristics of a population.³¹

381. In the income-based approach, the present discounted value of individual's lifetime income provides an estimate of human capital stock, and the gross increase in lifetime income from education and training provides an estimate of investment in education and training. The advantage of this approach is that it directly measures the concept that is being sought—the present discounted value of lifetime earnings from human capital. However, in doing so, it is more difficult to delineate what sources of investment underlie the estimates. Some types of investments, such as schooling, can be more easily examined; however, the effect of experience, on the job training or natural ability is not as readily identified.

382. Both cost-based and income based approaches are used to value assets in the SNA when market prices are unavailable. For example, the income-based approach is used to value sub-soil asserts while the cost-based approach is used to value R&D intangible assets in the SNA.

383. Previous studies found that the two approaches yield quite different estimates of human capital investment and stock (Gu and Wong for Canada, 2014, Jorgenson and Fraumeni for the U.S. 1989). The difference between the two approaches can be traced to the difference between the rate of return to education and the discount rate used in the income based approach, and to difficulties in separating the increase in compensation of employees from the effect of education as opposed to from the effect of training, physical capital, and technological progress (Abraham, 2010), or simply genetically inherited intelligence. The difference between the two estimates can also be partly attributed to costs not included in the cost-based estimates of education such as the costs of child rearing or in some cases the foregone earnings of students.

6.3. Human capital as a produced asset

6.3.1. Measuring human capital, education and training

384. The human capital satellite account focuses on expenditures for formal education and formal training. Education and training can be paid for by all sectors of the economy with the

²⁹ The cost-based approach also has the appeal that it can be readily extended to additional potential sources of human capital, such as health and safety, labour mobility, and rearing children to working age. But those expenditures often include both consumption and investment components. It is a major challenge for the cost-based approach to determine the part of those expenditures that represents investment.

³⁰ Fraumeni, Christian and Samuels (2015) updated the estimates for the U.S. in Jorgenson and Fraumeni to more recent years.

³¹ In addition to the cost- and income-based approaches for estimating human capital stock, the indicators approach is also commonly used (chapter 3). The indicators of human capital investment that are derived from that approach – school enrolment, adult literacy and the average years of schooling – are not estimates in monetary value and therefore cannot be integrated with the SNA.

share for each sector varying across economies. Table 6.1 presents the types of expenditures on education and training that will be capitalized in a human capital satellite account.

385. The expenditures on formal education consist of direct costs and indirect costs. The direct costs of education include the wage and salaries of teachers, the consumption of fixed capital, intermediate consumption, and in cases of market producers, operating surplus of private schools. The indirect costs of education are an imputation for the time use of working age students.

386. The expenditures on formal job-related training include direct costs to the sectors providing instruction, plus the compensation of the workers during the periods when they are not producing. The direct costs include the wage and salary costs of in-house trainers and outside trainers, tuition reimbursements, materials and fixed capital inputs.

6.3.2. Placing human capital into the SNA 2008

387. The treatment of human capital investment through the sequence of accounts in the SNA requires assumptions about the production process of human capital. Following chapter 2, there are two alternative views for the production of human capital that are considered here.

388. First, human capital can be viewed as output produced in the household sector. To produce human capital, the household sector uses intermediate inputs for the creation or production of human capital, either paid for by households or provided by the NPISHs, enterprises or government. Under this model, the relevant sectors create intermediate input for human capital by combining direct and indirect inputs. The intermediate input for human capital is recorded as an output which is used by households as an intermediate input in the human capital creation process. It is important to note that the output now labelled intermediate input for human capital is a combination of new outputs, such as own account training, and existing outputs that are re-classified, such as formal education. The inputs into the household production process also include student time and direct purchases of education services by households. This option is chosen in Liu (2015) to develop a human capital satellite account.

389. When investment in human capital is viewed as output produced in the household sector, the intermediate input for human capital from the sectors undertaking direct and indirect training and education is transferred to the household sector, with a concomitant recording of a current transfer in kind.

390. Second, human capital can be viewed as output produced in the sectors that undertake expenses for education and training³². Under this view, human capital creation is a diverse process that takes place in all resident sectors, and the model employed for valuing human capital investment assumes that sectors use their inputs to directly create human capital. Under this model, households combine student time with direct purchases of human capital items to form human capital in the household sector, while the relevant sectors making the expenditures on education and training combine inputs based on their direct and indirect

³² Under one type of example, investment in education is viewed as the output produced in the education sector in the extended national accounts that are proposed by Jorgenson and Fraumeni (1989, 1992a and 1992b). The inputs to the education sector include labour costs for teachers and administrative staff, capital input, intermediate inputs, and foregone earnings of students. The output of the education sector is defined as the effect of education on the level of knowledge, skills, and competencies of students.

expenses to produce human capital investments as an output of their respective sectors. When investment in human capital is viewed as the output produced in the sectors that undertake education and training, the human capital produced outside of the household sector is subsequently transferred to the household sector with a concomitant capital transfer in kind³³.

391. In both cases, the relevant expenditures, be it in the form of intermediate consumption or investments, the full recording of human capital in the proposed satellite account requires that the household sector controls and reaps primary economic benefits from human capital. Thus, human capital must be recorded in the household sector capital account to reflect the ownership of the asset. The fact that the human capital asset is found exclusively on the household balance sheet means that the charge for the consumption of fixed capital is also only found in the household sector accounts.

392. The choice between the two views on production of human capital does not affect gross saving, net saving or gross fixed capital formation at the national level. But it affects their measurement at the sector level. The impact on gross saving plus capital transfers, which is the entry against which gross fixed capital formation is compared when calculating net lending, is the same for both types of transfer. As a result, differences occur in gross and net disposable income levels, net saving levels, net saving rates and gross saving rates due to the type of production model assumed and the type of transfer employed.

6.4. Human capital satellite account: cost-based approach

393. This section presents two structures for a human capital satellite account when human capital is estimated using the cost-based approach. The human capital satellite account includes an expansion of the current accounts, the capital account and the wealth account to include human capital investment or human capital stock as explicit entries. The current accounts include the production account, the distribution of income account and the use of income account. The capital account records the net accumulation of non-financial assets and liabilities. The current and capital accounts produce main aggregates such as GDP, national income, gross saving and gross fixed capital formation that are used to evaluate economic performance. These accounts are produced for five major sectors: households, non-profit institutions serving households, corporations, general governments, and the rest of the world.

394. To assess the effect of treating education and training as investment, this section first summarizes the changes to current and capital accounts at the national level. These changes are shown in column 4 of tables 6.3 and 6.4. Subsequently, the changes to current and capital accounts for domestic sectors are discussed. Transactions with non-residents, as recorded in the rest of the world accounts, are not considered. Throughout the discussion, changes to flows and stocks are presented.

6.4.1. Current and capital accounts at the national level

395. When expenditures on human capital are treated as investment, it will increase the overall level of GDP and national income by the imputed labour compensation of students

³³ The capital transfer would be assumed to be a form of a grant whereby funds are allocated to households for the explicit purpose of knowledge creation.

plus the costs of training in the corporate sector³⁴. It will change the composition of GDP (Column 5, table 6.2). Gross fixed capital formation increases by the sum of education costs and training costs, while consumption decreases by the value of education consumption for the government, NPISH and households sectors from their reclassification to investment.

396. The expanded current and capital accounts also change the composition of national income. Mixed income increases by the imputed labour compensation of students, while gross operating surplus increases by the costs of training in the business sector.

397. To understand these overall changes to GDP and national income, it is useful to look at various types of human capital investments separately, how they are treated in the current SNA and how this recording needs to be modified when they are treated as investment. Those various types of human capital expenditures include the direct costs of education, the indirect costs of education, the costs of training in the non-market sectors (government and NPISHs), and the costs of training in the corporate sector.

398. The non-market output of education by the government and NPISH sectors and education expenditures of households are included in the SNA as final consumption expenditures. These will be treated as capital formation in a human capital satellite account. This will not affect gross domestic product but will change the structure of GDP from consumption to capital formation. It has no effect on national income or the composition of national income.

399. The indirect cost of education represents foregone earnings for working-age students and it measures what would have been earned if the students were not attending school (Becker 1964). In contrast to the output from the direct costs of education which are included as current consumption in the SNA, indirect costs of education are not included in the SNA, and the output they generate adds to GDP. GDP and gross investment both increase by the amount equal to the imputed foregone labour compensation of working age students. National income and mixed income increases by the same amount, while there is no change to gross operating surplus.

400. The adjustments related to training expenditures in a human capital satellite account differ between the corporate sectors and the non-market sectors. This is a result of the difference in the measurement of output in the current SNA. In the current SNA, output of the corporate sectors is measured by the market value of goods and services produced, while the output of the non-market sectors is measured by the costs of inputs that are used to produce output. The additional training output in a human capital satellite account is valued at costs for both sectors.

401. In a human capital satellite account, direct costs (purchases as well as costs for in-house training staff) plus the compensation of workers on training in the corporate sector are combined to produce a newly recognized training output. As these training costs are currently attributed to the costs of non-training output, the recognition of these costs as production costs for a separate training output raises the operating surplus for the non-training output. As a result, value added will increase by the costs of training in the corporate sector.

402. For the non-market sectors, the value of input costs is used to measure the value of output. As the value of input costs does not change, the overall value of output in the non-market sectors does not change in a human capital satellite account. The recognition of training as a separate output results in these costs no longer contributing to the value of other

³⁴ Some of the training may actually be provided by unincorporated enterprises. For ease of exposition, in the remainder of this chapter, only the corporate sector will be referred to.

outputs for these sectors and thus the other outputs fall in value by an amount equal to the increase in training output, as a consequence of which there will be no change to GDP because of the capitalization of training expenditures in the non-market sectors.

403. There is no imputed rental income for human capital stock in the human capital satellite account proposed in this Guide. The compensation of employees represents the return on human capital employed in the current SNA. This treatment is not consistent with the current SNA, where the return on capital typically ends up in gross operating surplus and mixed income, typically broken down into net operating surplus and consumption of fixed capital³⁵. In this case, the compensation of employees is gross of the consumption of human capital.

404. To be consistent with the treatment of gross operating surplus and mixed income, the compensation of employees in a human capital satellite account can now be divided into net compensation of employees and consumption of human capital. For compensation of employees, consumption of human capital is deducted from gross national income to arrive at net national income estimates. The consumption of human capital represents that portion of gross income which must be invested to maintain its productive capacity.

6.4.2. Current and capital accounts at the sector level – household production

405. The changes to sector accounts differ between the two options for presenting human capital production. Table 6.2 summarizes the changes to the sector accounts when human capital is assumed to be produced in the household sector. Table 6.3 summarizes the changes to the sector accounts when human capital is assumed to be produced in the sectors paying the relevant expenses.

406. When human capital is viewed as output of the household sector (table 6.2), the education and training output produced by the corporate and non-market sectors are transferred to the household sector to be used in intermediate consumption, with a concomitant current transfer in kind. These inputs are combined with other direct purchases of education and training goods and services by households as well as student time to produce human capital in the household sector. The imputation for student time is recorded as household output and results in an increase in mixed income in the household sector.

407. The output of the corporate sector is increased by the value of education and training output, which is the sum of all costs of training in the sector. This value is added to the gross output and gross operating surplus of the corporate sector. The output of education currently recorded as final consumption in the government and NPISH sectors is moved from non-market to market output while training output is recognized as a separate output of these sectors based on costs.

408. As result of these changes, disposable income in the household sector increases by the value of additional output generated in the household sector with the creation of human capital.

409. The disposable income of the government and NPISH sectors decrease by the expenditures on education and training that are transferred to the household sector via current transfers. The disposable income of corporations is not affected as the current transfers in kind are compensated by an increase in income from the treatment of training expenditures as a separate output.

³⁵ The inconsistency has been noted by Kendrick (1976).

410. Final consumption in the use of income account must also be adjusted. Consumption in the household sector decreases by the amount of personal direct education expenditures that are reclassified as intermediate input for human capital. Final consumption in the government and NPISHs sectors decreases by their expenditures on education and training that are transferred to the household sector.

411. Gross saving and gross fixed capital formation are also affected. Gross saving in the household sector rises by total investment in human capital, which is now recorded as a household output. Gross fixed capital formation in the household capital account increases by the same amount. As gross saving in the household sector increases by the value of total human capital investment, the net lending/net borrowing balancing item does not change. There are no changes to the capital accounts in the other sectors.

412. Lastly, treating expenditures on education and training as investment has a significant effect on wealth as shown in the national balance sheet. The balance sheet records the stock of assets (financial and non-financial) and liabilities at the end of a period as a result of saving and borrowing, investment and lending, revaluations and other changes in the volume (e.g. discovery of natural resources) of assets. Net worth is the balancing item that equals the difference between assets and liabilities. Balance sheets are presented for the major sectors of the economy (general government, NPISH, household, corporations), for the economy as a whole as well as for the rest of the world.

413. On the national balance sheet, a new entry for human capital is included in the household sector. This raises household wealth and household net worth by the value of human capital, with an identical adjustment at the national level. All other sectors are unaffected.

6.4.3. Current and capital accounts at the sector level – human capital production in all sectors

414. Under the view that human capital is produced in the sectors paying the expenses for education and training activities, the satellite account in this chapter follows the conceptual framework presented in chapter 2, and assumes that a capital transfer in kind is used as the counterpart transaction for the subsequent allocation of human capital to the household sector. Table 6.3 summarizes the changes to the sector accounts under this alternative.³⁶

415. Human capital is assumed to be created directly in the sectors undertaking education and training expenses. In this case, the change in the value of output (now defined as human capital) for the corporate and non-market sectors is the same as in the previous option and the changes to value added and gross operating surplus increases as before. However, as human capital formation is assumed to occur within the sectors undertaking the expenses, the gross saving of these sectors must increase by the value of outputs of the human capital investment.

416. This additional saving is then used to support the capital transfers to the household sector and the resulting increase to GFCF that is recorded in the household capital account.

417. Under this approach, the changes to the household sector in the production account are less dramatic as the only changes come from the addition of imputed labour compensation for student time and the redefinition of final household consumption of education from

³⁶ In this chapter, the focus is on corporation and government expenditures. An extension could include human capital transfers due to migration. This is not done here, but would only necessitate that an additional asset be included in the capital transfers already shown in the non-resident sector account.

consumption to intermediate consumption used to produce human capital. However, there are dramatic changes to the use of income account. Of particular importance is the disassociation that occurs between the disposable income and the savings used to invest in human capital and the charge for the consumption of human capital. The saving occurs within those sectors that undertake expenditures while the charge for the consumption of human capital is deducted from compensation of employees.

418. The adjustments to the national balance sheet are identical to the previous example as the two approaches lead to the same value of human capital investment being booked in the household sector.

6.5. Human capital satellite account: income-based approach

419. This section outlines the changes to the human capital satellite account when human capital is estimated using the income-based approach. The gross flow of investment under the income-based approach is larger than that from the cost-based approach, and the difference between the two approaches represents the extra value of human capital investment that will be added into the satellite account over and above that already discussed.

420. As was noted in earlier chapters, the income-based investment estimates may include a number of household input flows, such as parent time, that are not included in the flows recognized under the cost based approach. Equally, it is possible that the values for flows based on the summation of costs, such as education, may under-estimate the value of the output. This would occur if, for example, governments provided the services at less than market cost. Consequently, it is not clear how to allocate the additional value across sectors at this time.

421. Therefore, the framework for integrating the income-based human capital estimates into the satellite account only adds the additional value of investment from the income approach to aggregate variables. As there is insufficient information at present to allocate the difference to certain activities performed by households themselves (thus ending up in mixed income) or to gross operating surplus the additional value is attributed to a gross mixed income/operating surplus variable (see tables 6.2 and 6.3).

422. When the extra value of human capital investment is included, estimates of income and expenditure in the current and capital accounts increase to reflect the extra value of human capital investment derived from the income-based human capital estimate. The extra value of human capital investment in education and training is added to investment from the cost-based approach, which raises GDP, national income and mixed income/operating surplus when integrated into the SNA framework. Gross saving and gross fixed capital formation also rise by the same amount. The consumption of fixed capital will also increase to reflect the higher levels of human capital stock.

423. Total wealth and national net worth in the national balance sheet increase by an additional amount that is equal to the difference between human capital stock estimated from the income-based and cost-based approaches. As noted above, the stock of human capital from the income approach provides an all-inclusive measure that includes the accumulation of human capital stock from education and training as well as increasing experience, birth, migration, health and other types of activities that may affect the income from labour of individuals. It is a direct measure of the value of human capital in the production process.

6.6. Integration of the cost-based estimate of human capital in the CSNA

424. This section presents estimates of investment in education and training in Canada and illustrates the effect of treating education and training expenses as investments on gross domestic product, national income, saving, investment and total wealth. The section focuses on the estimates of human capital investment and capital stock based on the cost-based approach. The effects of the income-based estimates will be presented in the next section. The section starts with the current price estimates of investment in human capital. Those estimates are then deflated to obtain investment in constant prices, which are accumulated to derive capital stock estimates. The capital stock estimates are subsequently re-inflated to present current price estimates for the human capital stock.

425. In a human capital satellite account, the changes will be made to the accounts for all sectors that include corporate, government, household and NPISH sectors. However, the example of human capital satellite account in this section will exclude the NPISH sector as the costs of education and training are not readily available for the NPISH sector in Canada.

6.6.1. Human capital investment

426. The integration of human capital in the SNA starts with the estimate of human capital expenditures of various types, including direct and indirect costs of education and training by sector.

427. The indirect costs of education represent the foregone earning of students. It is estimated by the number of hours that a student spends in school in a year times the hourly labour compensation of employees of the same age, education, and gender. The hours that a student spends in school is obtained from the Survey of Labor and Income Dynamics.³⁷ A distinction is made between part time and full time students. On average, a full time student spends about 1000 hours a year in the school, while a part time student spends about 230 hours in the school. The number of hours in the school also differs by the type of school attended.³⁸

428. The direct costs of formal education include household expenditures on education and government consumption expenditures on education. Those direct expenditures are reported in the final demand tables of the supply/use tables of CSNA. The classification of consumption expenditures in the final demand tables is based on the Classification of Individual Consumption according to Purposes (COICOP) of the United Nations Statistics Division. As such, those expenditures cover education services only and do not include educational materials such as books and stationary, or accommodation services that are reported elsewhere in the final demand tables.

429. The indirect costs of training are estimated from the Adult Education and Training Survey. The indirect costs of training per worker are estimated as average hours spent on training times the average hourly labour compensation per employee. The average hours spent on training per employee are estimated as the participation rate in job related training for an employee times average duration for the training in a year. The incidence and duration of adults' participation in job-related formal training are estimated from the Adult Training

³⁷ Statistics Canada IMDB 3889.

³⁸ Assuming that a student spends 40 weeks in a year, 5 days a week, and 5 hours a day in a school, the total hours the student attends a school is 1000 hours a year

and Education Survey (Statistics Canada, 2007). In 2008, the participation rate for job-related training is 0.357 for a worker and the average duration of training is 49 hours. The indirect costs of training in terms of foregone earnings for 2008 are estimated to be 500 dollars per worker.³⁹

430. The direct costs of training are not available from the Adult Education and Training Survey. The empirical evidence shows that the direct costs tend to be higher than the indirect costs. For example, O'Mahony (2012) found that the direct costs of training are about 30 per cent higher than the indirect costs of training in the EU countries. For the U.K. the ratio of direct costs to indirect costs is close to 2. For Canada, the Conference Board of Canada finds that the direct costs of training are about 811 dollars per worker for 2008, which is 63 per cent higher than the indirect costs (500 dollars) (Conference Board of Canada, 2012). This ratio is used to estimate direct costs of training. The average direct and indirect costs of training per worker are multiplied by the number of workers to derive total costs of formal training for the corporate and non-corporate sectors.⁴⁰

431. The estimates for this chapter do not take into account the difference in training participation and average duration of training across different types of employees (education, age and industry). The training participation and the average duration of training by type of employee can be obtained from the Adult Training Survey and those data can be used to derive more accurate estimates of training costs.

432. The current price value of investment in education and training must be decomposed into a price component and a volume component when investment is included in the national accounts. A natural choice of the price deflator for human capital investment is hourly labour compensation, adjusted to take into account the changes in the composition of hours worked towards more educated and more experienced workers. This composition-adjusted hourly labour compensation assumes that the average hourly labour compensation changes due to the shifts toward more educated workers and more experienced workers is counted as a change in the volume of human capital investment.

433. The composition-adjusted hourly labour compensation assumes that there are no differences in the quality of human capital within a type of employee. To account for the within-type changes in human capital quality, a hedonic method has been proposed and used in previous studies (Schreyer 2010, Diewert, 2011, Gu and Wong 2014 and Fraumeni et al 2008). To the extent that education expenditures reflect improvements in education quality as measured by changes in class size, the number of experienced teachers, and the outcomes of education (test scores), they should be counted as increases in the volume of human capital investment rather than as increases in the price of human capital investment.

434. The deflator for human capital can be also estimated indirectly as the nominal values of human capital investment and stock divided by the direct volume output measure of human capital investment and capital stock, where the direct volume output measure of human capital investment and capital stock are estimated as the number of individuals (students and workers) weighted across different types of individuals (e.g. education level experiences) using weights based on nominal investment or nominal capital stock for those various types (Schreyer 2012).

³⁹ The indirect costs of training per worker in 2008 equal the participation rate of training (0.359) times the average duration of training (49 hours) and average labour compensation per hour for employed workers (28 dollars per hour).

⁴⁰ It is assumed that the indirect cost of training per worker is same between paid workers and self-employed workers.

435. The consumer price index is an alternative which has been employed in previous empirical studies (Wei, 2004). The choice of CPI for the price deflator of human capital investment assumes that real hourly compensation (nominal labour compensation deflated by the CPI) represents increases in the volume of human capital. The idea that the increase in real earnings represents the increase in the quantity of human capital can be found in Shultz (1961) and is used in empirical studies on the estimation of the human capital accumulation from education and experience based on the Mincerian wage equation.

436. Human capital stocks are derived by accumulating investment net of depreciation. Empirical studies often assume that human capital follows a geometric depreciation pattern, and the depreciation rate for training investment tends to be higher than the depreciation rates for education investment. For example, Corrado et al (2009) assume a 40 per cent depreciation rate for job-related training, as a part of their measure of intangible capital for the United States, while O'Mahony (2012) assumes the depreciation rate of training capital is 25 per cent for her measurement of training capital for European countries. The Investment in Intangible Asset Survey launched by the Office of National Statistics in the UK provides the expected service life of investment in six categories of intangible assets: employer funded training, software, research and development (R&D), reputation and branding, design, and corporation process improvement. The survey finds 2.7 years of service life for training, reputation and branding, which implies a high depreciation rate for that capital (Awano et al, 2010).

437. Research also finds that the depreciation for education is lower than the depreciation for training. The depreciation rate estimates for education investment from Groot (1998) range from 4 per cent for the United States to 11-17 per cent for EU countries. Similarly, Mincer and Polachek (1974) and Heckman (1976) estimated the depreciation rates for human capital to be between 0.2 to 4.7 per cent. In the case of Canada, estimates from Gu and Wong (2010) show that the depreciation rate for human capital from the income-based approach is about 3 per cent, which is lower than the depreciation rates assumed for the cost-based approach.

438. The current price value of investment in education and training must be decomposed into a price component and a volume component when investment is included in the national accounts. As discussed in chapter 3, alternative choices exist. For this chapter, the CPI is used to deflate investment in education and training. It is assumed that human capital has a geometric depreciation pattern where the depreciation rate for training capital is 25 per cent and the depreciation rate for education is 4 per cent⁴¹.

439. Tables 6.5 and 6.6 present the total costs of education and training in Canada for the years 1981, 1990, 2000, 2010. The earnings foregone represents a significant portion of the costs of education and its importance increased over time with the share of students enrolled in post-secondary education as earning opportunities increased over time. For the period 1981 to 2010, the share of foregone earnings in total costs of education increased from 25 per cent to 65 per cent⁴².

⁴¹ This corresponds to about 40 years of average working life of an individual with double declining balance rate.

⁴² The investment in education in Canada was similar to that in EU countries but investment in training in Canada is lower than that in EU countries. O'Mahony (2012) found that the ratio of investment in education to GDP was 5% in EU countries for the period 2003-2007 and the ratio of investment in training to GDP was about 1.6% in EU countries.

6.6.2. National accounts with human capital investment

440. Table 6.6 presents the economic accounts at the national level when costs of education and training are treated as investment. The capitalization of expenditures on education and training has a significant effect on the level of national income and gross domestic product which now includes the imputed labour compensation of students and the costs of training in the corporate sector. National income increases by 201.6 billion dollars which is 12.4 per cent over the official estimate in 2010. The increase in national income is a result of 95.2 per cent increase in mixed income and 3.8 per cent increase in gross operating surplus. GDP increases by the same amount, 201.6 billion dollars, which represents a 12.1 per cent increase over the official estimate in 2010.

441. The capitalization of education and training expenditures also significantly changes the composition of GDP. Gross fixed capital formation is 76 per cent higher than the official estimate in 2010 once it is expanded to include investment in education and training. Final consumption declines by 7.2 per cent as a result of the reclassification from final consumption to investment of household expenditures on education and government expenditures on education and training.

6.6.3. Sector accounts and total wealth with human capital investment

442. The effects of capitalizing expenditures on education and training on income, consumption, gross saving by sectors are shown in tables 6.7, 6.8 and 6.9. The results are presented based on the option whereby human capital is produced in the household sector. It is important to note that the household current account in table 6.7 is presented on a gross basis. If it is presented on net basis, the consumption of human capital would have to be deducted from the estimates of gross household income and gross household saving to arrive at the estimates of net household income and net household saving.

443. In the household sector accounts, the adjusted disposable income for the household sector is 283.1 billion dollars, or 28.2 per cent, higher than the official estimate in 2010. This comes from the addition of the own-account production of human capital (minus the previous household direct expenditures which have been reclassified to intermediate consumption). This is equivalent to the imputed labour compensation plus the transfers of education and training output from other sectors to the household sector.

444. Final consumption declines by 13.0 billion dollars, or 1.4 per cent, in 2010 for the household sector as household direct expenditures on education are re-classified to investment. Gross saving and gross fixed capital formation increased by 296.0 billion dollars, which is the total cost-based expenditures on education and training derived for this chapter. As a result, gross saving in the household sector more than quadruples while gross fixed capital formation in the household sector more than triples in 2010.

445. Table 6.8 presents the corporate sector account. It shows an increase in corporate primary income from the additional output related to the expenditures on training and an equal increase in current transfers to the household sector. The net effect is that there are no changes to disposable income, gross fixed capital formation and gross saving in the corporate sector.

446. Table 6.9 presents the sector account for the government sector. It shows a decline in government disposable income and government consumption by an amount that is equal to government expenditures on education and training as the outputs are transferred to the

household sector. There are no changes to gross fixed capital formation and gross saving in the government sector.

447. Table 6.10 presents estimates for total wealth that include the human capital stock. The human capital stock is about 50 per cent of the non-human capital stock in 2010. The ratio of human capital stock to non-human capital increased from about 40 per cent to 50 per cent for the period 1990 to 2010.

6.7. Integration of the income-based estimate of human capital in the CSNA

448. This section presents the estimates of human capital investment and stock for Canada using the income-based approach and examines the impact of including those estimates in the Canadian System of National Accounts. When human capital investment and stock are estimated using the income-based approach, including human capital investment in the CSNA is found to have a large and significant impact on gross domestic product, gross investment, saving and total wealth.

449. The estimates of human capital investment and the human capital stock are obtained from Gu and Wong (2010, 2014). Gu and Wong (2010) estimated the human capital stock for the Canadian working-age population. The estimate provides an estimate of human capital stock that results from all activities that increase the future earnings of individuals. Those investment activities include education, training, net migration, rearing of children and investment in health.

450. Gu and Wong (2010) subsequently decomposed the change in the aggregate human capital stock of the working age population into investment in human capital, depreciation and revaluation of human capital. Investment in human capital in a period is the sum of the changes in lifetime incomes because of education, initial lifetime incomes for the individuals who reached working age and immigration to Canada. Depreciation of human capital is the sum of changes in lifetime labour compensation because of ageing for all individuals who remain in the working age population and lifetime labour compensation of all individuals who die or emigrate. Revaluation of human capital is the sum of changes in lifetime labour compensation from period to period for individuals with a given set of demographic characteristics—gender, education and age.

451. The human capital stock estimates are often restricted to the stock of the working age population. However, to construct an estimate of human capital investment from education that includes primary, secondary and post-secondary education, human capital stock estimates should be constructed for the entire population. Gu and Wong (2014) therefore extended the human capital stock of the working age population in Gu and Wong (2010) to include individuals aged 6 to 14, and estimated the investment in education as the changes in the lifetime labour compensation arising from all levels of education.

452. Table 6.11 presents the changes to GDP and gross investment when the income-based estimate of investment in education and training is included in the national accounts. In the table, investment in education and training estimated using the income-based approach is compared to investment in education and training estimated using the cost-based approach.

453. Investment in education as measured by the increase in the lifetime labour compensation due to education is much larger than the costs of education. In 2005, gross investment in education is 489.7 billion dollars when estimated using the income-based approach, while gross investment in education is 206.4 billion dollars when estimated using

the cost-based approach. The difference between the two is the ‘rental income’ from investing in human capital.

454. GDP is adjusted to include expenditures on training in the corporate sector, imputed labour compensation of students and rental income from human capital. The adjusted nominal GDP estimate is about 30 per cent higher than the official GDP estimate in the current CSNA.

455. Gross investment in education and training when education investment is estimated using the income-based approach is about 1.5 times the investment in non-human capital in 2005. Including investment in human capital in the CSNA almost doubled total investment in Canada in 2005.

456. As stated before, the total non-financial wealth is adjusted to include human capital. Gu and Wong (2010) find that the human capital stock of the working age population is about 16,189 billion dollars in 2007. For that year, non-human capital stock is 5,526 billion dollars. Human capital stock is thus three times the non-human capital stock in 2007. The ratio of human capital stock to non-human capital declined from 1990 to 2007. Total human capital stock was about four times the non-human capital stock in 1990.

6.8. Conclusion

457. This chapter presented a human capital satellite account that integrates monetary measures of human capital investment into the structure of the System of National Accounts (SNA). It describes the series of adjustments that must be made throughout the SNA when expenditures on education and training are treated as investment.

458. The chapter explores the effect of measuring human capital on the SNA using the income- and cost-based approaches. The income-based approach is employed in empirical studies of human capital, and produces a larger estimate for the human capital investment than that implied by the cost-based estimate. When the income-based approach is used to estimate human capital, the scope of the income and expenditure sides of the GDP accounts have to be broadened to account for the difference between the income and cost estimates of human capital investment.

459. When the cost-based approach is used to estimate human capital, the capitalization of expenditures on education and training is shown to have a significant effect on gross domestic product, national income, gross investment, saving and total wealth. In 2010, GDP would increase by 10 per cent and capital formation by 76 per cent, while total final consumption would decline by seven per cent.

460. The effect is much larger when the income-based approach is used as a result of the difference between income-based and cost-estimates of education investment. In 2005, GDP would increase by 30 per cent, and capital formation by 150 per cent, while final consumption of households, NPISH and government would decrease by seven per cent.

461. The chapter has focused on formal education and training. These are areas where the data provide robust estimates, but the analysis can be expanded to include other types of investment that include the costs of child rearing, informal training, investment in health, and the addition and subtraction of human capital due to migration.

462. This chapter shows that it is feasible to construct human capital satellite accounts. However, there are a number of challenges that statistical agencies must overcome for the construction of such a satellite account. Among the most pressing are how to structure the

treatment of human capital investment through the sequence of accounts in the SNA, the choice of an appropriate price deflator for human capital investment, the choice of an appropriate depreciation rate for human capital, and a reconciliation of alternative methods for estimating the human capital stock and investment. Accurate estimates of total costs of education and training are often lacking and represent an additional challenge.

Annex B. Tables

Table 6.1
Abbreviations used in tables 6.2 and 6.3

Sectors	Costs of education			Costs of training
	Direct	Indirect	Total	Total
Market sector/corporations	...	...	...	OJT ^C
Non-market sector		...		
Governments	E ^G (D)	...	...	OJT ^G
NPISH	E ^N (D)	...	...	OJT ^N
Households	E ^H (D)	E ^H (I)	E ^H	...*

* The training cost of unincorporated businesses have been included with corporations, above.

Where

E^G (D): Government direct education expenditures

E^N (D): NPISH direct education expenditures

E^H (D): Household direct education expenditures

E^H (I): Household indirect education expenditures

E^H : Total Household education expenditures

OJT^C: Total job related training cost – corporations

OJT^G: Total job related training cost – governments

OJT^N: Total job related training cost – NPISH

MHC^C: Intermediate inputs for human capital produced in the corporate sector

MHC^N: Intermediate inputs for human capital produced in the NPISH sector

MHC^G: Intermediate inputs for human capital produced in the government sector

HC: Human capital investment – cost based approach

VHI: Extra value of human capital from the income-based approach

Table 6.2
Changes to sector accounts when human capital is produced in the household sector

Items	Households	NPISHs	Corporations	Government	Total Economy	Additional changes from Income approach
Production account						
<i>Resources</i>						
Output	+HC (= MHC ^N + MHC ^C + MHC ^G + EH(D) + EH(I))		+MHC ^C (=OJT ^C)		+ MHC ^C + HC	+VHI
--Market outputs		+MHC ^N (= OJT ^G + E ^N (D))		+MHC ^G (= OJT ^G + E ^G (D))		
--Non-market outputs		-OJT ^N -E ^N (D)		-OJT ^G -E ^G (D)		
<i>Uses</i>						
Intermediate Consumption	+E ^H (D) +MHC ^N +MHC ^C +MHC ^G				+E ^H (D)+MHC ^N +MHC ^C +MHC ^G	
Value-added/GDP	+E ^H (I)		+MHC ^C (=OJT ^C)		+MHC ^C (=OJT ^C) +E ^H (I)	+VHI
Generation of income account						
<i>Resources</i>						
Value-added	+E ^H (I)		+MHC ^C (=OJT ^C)		+ MHC ^C +E ^H (I)	+VHI
<i>Uses</i>						
Compensation of employees						
Gross mixed income	+E ^H (I)				+E ^H (I)	
Gross operating surplus			+MHC ^C (=OJT ^C)		+MHC ^C (=OJT ^C)	
Gross mixed income/operating surplus⁴³						+VHI

⁴³ As noted in the chapter, there is insufficient information at this point to split VHI between mixed income and surplus.

Items	Households	NPISHs	Corporations	Government	Total Economy	Additional changes from Income approach
<u>Redistribution of income account</u>						
<i>Resources</i>						
Gross mixed income	+E ^H (I)				+E ^H (I)	
Gross operating surplus			+MHC ^C		+MHC ^C	
Current transfer receivable	+MHC ^N +MHC ^C +MHC ^G				+MHC ^N +MHC ^C +MHC ^G	
<u>Gross mixed income/operating surplus</u>						+VHI
<i>Uses</i>						
Current transfer payable		+MHC ^N	+MHC ^C	+MHC ^G	+MHC ^N +MHC ^C +MHC ^G	
Disposable income, gross	+MHC ^N +MHC ^C +MHC ^G +E ^H (I)	-MHC ^N		-MHC ^G	+MHC ^C +E ^H (I)	+VHI
Consumption of fixed capital	-CFC ^{HC}					
Disposable income, net	+MHC ^N +MHC ^C +MHC ^G +E ^H (I) -CFC ^{HC}	-MHC ^N	-MHC ^C	-MHC ^G	+MHC ^C +E ^H (I) -CFC ^{HC}	+VHI
<u>Use of income account</u>						
<i>Resources</i>						
Disposable income, gross	+MHC ^N +MHC ^C +MHC ^G +E ^H (I)	-MHC ^N	-MHC ^C	-MHC ^G	+MHC ^C +E ^H (I)	+VHI
<i>Uses</i>						
Final Consumption	-E ^H (D)	-OJT ^N -E ^N (D)		-OJT ^G -E ^N (D)	-OJT ^N -OJT ^G -E(D)	
Gross saving	+E ^H (D) +MHC ^N +MHC ^C +MHC ^G +E ^H (I)				+E ^H (D) +MHC ^N +MHC ^C +MHC ^G +E ^H (I)	+VHI

Items	Households	NPISHs	Corporations	Government	Total Economy	Additional changes from Income approach
Consumption of fixed capital	$-CFC^{HC}$					
Net saving	$+E^H(D)$ $+MHC^N$ $+MHC^C$ $+MHC^G$ $+E^H(I)$ $-CFC^{HC}$				$+E^H(D)$ $+MHC^N$ $+MHC^C$ $+MHC^G$ $+E^H(I)$ $-CFC^{HC}$	+VHI
Capital account						
<i>Resources</i>						
Gross saving	$+E^H(D)$ $+MHC^N$ $+MHC^C$ $+MHC^G$ $+E^H(I)$				$+E^H(D)$ $+MHC^N$ $+MHC^C$ $+MHC^G$ $+E^H(I)$	+VHI
Capital transfers						
<i>Uses</i>						
Gross fixed capital formation	$+HC = +E^H(D)$ $+MHC^N$ $+MHC^C$ $+MHC^G$ $+E^H(I)$				$+HC = +E^H(D)$ $+MHC^N$ $+MHC^C$ $+MHC^G$ $+E^H(I)$	+VHI
Net lending/net borrowing						

Table 6.3
Changes to sector accounts when human capital is produced in the sectors undertaking education and training and a capital transfer mechanism is used.

Items	Households	NPISHs	Corporations	Government	Total Economy	Additional changes from Income approach
Production account						
<i>Resources</i>						
Output	+HC ^H (=E ^H (D) +E ^H (I))		+HC ^C (=OJT ^C)		+HC ^C +E ^H (I)	+VHI
--Market outputs		+MHC ^N (=OJT ^N +E ^N (D))		+MHC ^G (=OJT ^G +E ^G (D))		
--Non-market outputs		-OJT ^N -E ^N (D)		-OJT ^G -E ^G (D)		
<i>Uses</i>						
Intermediate consumption	+E ^H (D)				+E ^H (D)	
Value-added/GDP	+E ^H (I)		+HC ^C =OJT ^C		+HC ^C +E ^H (I)	+VHI
Generation of income account						
<i>Resources</i>						
Value-added	+E ^H (I)		+HC ^C =OJT ^C		+HC ^C +E ^H (I)	+VHI
<i>Uses</i>						
Gross mixed income	+E ^H (I)				+E ^H (I)	
Gross operating surplus			+HC ^C =OJT ^C		+HC ^C	
Gross mixed income/operating surplus⁴⁴						+VHI
Redistribution of income account						
<i>Resources</i>						
Gross mixed income	+E ^H (I)				+E ^H (I)	

⁴⁴ As noted in the chapter, there is insufficient information at this point to split VHI between mixed income and surplus.

Items	Households	NPISHs	Corporations	Government	Total Economy	Additional changes from Income approach
Gross operating surplus			+ HC ^C = OJT ^C		+ HC ^C	
<u>Gross mixed income/operating surplus</u>						+VHI
Current transfer						
<i>Uses</i>						
Current transfer						
Disposable income, gross	+E ^H (I)		+ HC ^C = OJT ^C		+ HC ^C +E ^H (I)	+VHI
Consumption of fixed capital	-CFC ^{HC}					
Disposable income, net	+E ^H (I) -CFC ^{HC}		+ HC ^C = OJT ^C - CFC ^{HC}		+ HC ^C +E ^H (I) -CFC ^{HC}	+VHI
<u>Use of income account</u>						
<i>Resources</i>						
Disposable income, gross	+E ^H (I)		+HC ^C		+ HC ^C +E ^H (I)	+VHI
<i>Uses</i>						
Final Consumption	- E ^H (D)	-E ^N (D) - OJT ^N		-E ^G (D) - OJT ^G	-E(D) - OJT ^N - OJT ^G	
Gross saving	+HC ^H (=E ^H (D) +E ^H (I))	+HC ^N (=OJT ^N +E ^N (D))	+HC ^C (=OJT ^C)	+HC ^G (=OJT ^G +E ^G (D))	+HC ^H + HC ^N + HC ^C + HC ^G	+VHI
Consumption of fixed capital	-CFC ^{HC}					
Net saving	+HC ^H (=E ^H (D) +E ^H (I)) -CFC ^{HC}	+HC ^N (=OJT ^N +E ^N (D))	+HC ^C (=OJT ^C)	+HC ^G (=OJT ^G +E ^G (D))	+HC ^H + HC ^N + HC ^C + HC ^G -CFC ^{HC}	+VHI
<u>Capital account</u>						
<i>Resources</i>						
Gross saving	+HC ^H (=E ^H (D))	+HC ^N (=OJT ^N)	+HC ^C (=OJT ^C)	+HC ^G (=OJT ^G)	+HC ^H + HC ^N	+VHI

Items	Households	NPISHs	Corporations	Government	Total Economy	Additional changes from Income approach
	$+E^H(I)$	$+E^N(D)$	$+E^C(D)$	$+E^G(D)$	$+HC^C$ $+HC^G$	
<i>Capital transfers</i>						
-Payable		$+HC^N$	$+HC^{CI}$	$+HC^N$	$+HC^N$ $+HC^C$ $+HC^G$	
-Receivable	$+HC^N$ $+HC^C$ $+HC^G$				$+HC^N$ $+HC^C$ $+HC^G$	
<i>Uses</i>						
Gross fixed capital formation	$+HC = +E^H(D)$ $+MHC^N$ $+MHC^C$ $+MHC^G$ $+E^H(I)$				$+HC =$ $E^H(D)$ $+MHC^N$ $+MHC^C$ $+MHC^G$ $+E^H(I)$	$+VHI$
<i>Net lending/net borrowing</i>						

Table 6.4
Costs of education and training, (billions of current dollars)

	1981	1990	2000	2010
Total costs of education and training	35.5	81.4	123.5	296.0
<i>Total costs of education</i>	29.9	70.7	107.7	272.2
direct costs by households	1.5	3.6	7.6	13.0
direct costs by governments	20.4	37.8	46.7	75.2
earnings foregone	8.0	29.3	53.4	184.0
<i>Total costs of training</i>	5.7	10.7	15.8	23.8
by business sector	4.2	7.9	12.1	17.6
by governments	1.5	2.8	3.7	6.3

Table 6.5
Costs of education and training as percent of GDP

	1981	1990	2000	2010
Total costs of education and training	9.7	11.8	11.2	17.8
<i>Total costs of education</i>	8.1	10.2	9.8	16.4
direct costs by households	0.4	0.5	0.7	0.8
direct costs by governments	5.6	5.5	4.3	4.5
earnings foregone	2.2	4.2	4.9	11.1
<i>Total costs of training</i>	1.5	1.5	1.4	1.4
by the business sector	1.1	1.1	1.1	1.1
by governments	0.4	0.4	0.3	0.4

Table 6.6
Economic accounts of Canada in 2010, billions of current dollars

(Presentation based on the option where human capital is produced in the household sector.)

	Official	Adjusted	Abs. change	% change
<u>Generation of income account</u>				
<i>Resources</i>				
Value-added	1,662.8	1,864.4	201.6	12.1
<i>Uses</i>				
Compensation of employees	839.4	839.4		
Gross operating surplus	460.7	478.3	17.6	3.8
Gross mixed income	193.4	377.4	184.0	95.2
Taxes less subsidies on production	170.4	170.4		
Statistical discrepancy	-1.1	-1.1		
<u>Redistribution of income account</u>				
<i>Resources</i>				
National income, gross	1,630.5	1,832.1	201.6	12.4
<i>Uses</i>				
Net current transfer to non-residents	3.3	3.3		
National disposable income, gross	1,627.2	1,828.8	201.6	12.4
<u>Use of income account</u>				
<i>Resources</i>				
National disposable income, gross	1,627.2	1,828.8	201.6	12.4
<i>Uses</i>				
Consumption	1,305.1	1,210.7	-94.4	-7.2
Gross saving	322.1	618.1	296.0	91.9
<u>Capital account</u>				
<i>Resources</i>				
Gross saving	322.1	618.1	296.0	91.9
Plus: national net capital transfers	-0.1	-0.1		
<i>Uses</i>				
Capital formation, gross	388.1	684.1	296.0	76.3
Net lending/net borrowing	-65.0	-65.0		

Note: A blank in the cells represents no changes when human capital is included in the SNA. Value added/gross domestic product differs from gross national income as a result of net receivable from abroad in compensation of employees and property income, which can be shown in the primary distribution of income account.

Table 6.7
Household sector account in 2010, billions of current dollars

(Presentation based on the option where human capital is produced in the household sector.)

	Official	Adjusted	Abs. change	% change
<u>Redistribution of income account</u>				
<i>Resources</i>				
Household primary income, gross	1,125.4	1,309.4	184.0	16.4
Current transfer	167.8	266.9	99.0	59.0
<i>Uses</i>				
Current transfer	289.2	289.2		
Household disposable income, gross	1,004.0	1,287.1	283.1	28.2
<u>Use of income account</u>				
<i>Resources</i>				
Household disposable income	1,004.0	1,287.1	283.1	28.2
<i>Uses</i>				
Consumption	915.3	902.3	-13.0	-1.4
Gross saving	88.8	384.8	296.0	333.5
<u>Capital account</u>				
<i>Resources</i>				
Gross saving	88.8	384.8	296.0	333.5
Capital transfer	-2.0	-2.0		
<i>Uses</i>				
Capital formation, gross	134.5	430.5	296.0	220.1
Net lending/net borrowing	-47.7	-47.7		

Note: A blank in the cells represents no changes when human capital is included in the SNA.

Table 6.8
Corporate sector account in 2010, billions of current dollars

(Presentation based on the option where human capital is produced in the household sector.)

	Official	Adjusted	Abs. change	% change
<u>Redistribution of income account</u>				
<i>Resources</i>				
Corporate primary income, gross	290.2	307.8	17.6	6.1
Current transfer	0.6	0.6		
<i>Uses</i>				
Current transfer	58.4	76.0	17.6	30.1
Corporate disposable income, gross	232.4	232.4		
<u>Use of income account</u>				
<i>Resources</i>				
Corporate disposable income	232.4	232.4		
<i>Uses</i>				
Consumption				
Gross saving	232.4	232.4		
<u>Capital account</u>				
<i>Resources</i>				
Gross saving	232.4	232.4		
Capital transfer	3.8	3.8		
<i>Uses</i>				
Capital formation, gross	172.9	172.9		
Net lending/net borrowing	63.3	63.3		

Note: A blank in the cells represents no changes when human capital is included in the SNA.

Table 6.9
Government sector account in 2010, billions of current dollars

(Presentation based on the option where human capital is produced in the household sector.)

	Official	Adjusted	Abs. change	% change
<u>Redistribution of income account</u>				
<i>Resources</i>				
Government primary income, gross	213.5	213.5		
Current transfer	335.8	335.8		
<i>Uses</i>				
Current transfer	183.2	264.7	81.5	44.5
Government disposable income, gross	366.1	284.7	-81.5	-22.2
<u>Use of income account</u>				
<i>Resources</i>				
Government disposable income	366.1	284.7	-81.5	-22.2
<i>Uses</i>				
Consumption	366.3	284.9	-81.5	-22.2
Gross saving	-0.2	-0.2		
<u>Capital account</u>				
<i>Resources</i>				
Gross saving	-0.2	-0.2		
Capital transfer	-3.3	-3.3		
<i>Uses</i>				
Capital formation, gross	78.5	78.5		
Net lending/net borrowing	-81.9	-81.9		

Note: A blank in the cells represents no changes when human capital is included in the SNA.

Table 6.10
Total wealth in Canada, billions of current dollars

	1990	2000	2010
<u>Total capital stock</u>	3,081	4,849	9,336
<i>Non-human capital stock</i>	2,251	3,351	6,358
Residential structures	560	861	1,746
Non-residential structures	596	775	1,364
Machinery and equipment	180	272	312
Intellectual property products	49	93	191
Consumer durables	222	333	489
Inventories	142	187	232
Weapons systems	5	5	7
Land	497	825	2,017
<i>Human capital stock</i>	830	1,498	2,977
<u>Addendum</u>			
Ratio of human to nonhuman capital stock	0.37	0.45	0.47

Table 6.11

Income-based estimate of investment in education and training and changes to GDP in Canada, billions of current dollars

	1981	1990	2000	2005
Investment in human capital, income-based estimate	248.2	451.6	438.4	489.7
Investment in human capital, cost-based estimate	35.5	81.4	106.2	206.4
GOS/mixed income for human capital investment	212.6	370.2	332.2	283.3
Official GDP	366.6	690.8	1,001.8	1,410.7
GDP adjusted for cost estimate of investment in human capital	378.7	727.9	1,052.6	1,542.5
GDP adjusted for income estimate of investment in human capital	591.3	1,098.1	1,384.8	1,825.8
<u>Estimates as a ratio of official GDP</u>				
GDP adjusted for cost estimate of investment in human capital	1.03	1.05	1.05	1.09
GDP adjusted for income estimate of investment in human capital	1.61	1.59	1.38	1.29
Income estimate of investment in human capital	0.68	0.65	0.44	0.35
Cost estimate of investment in human capital	0.10	0.12	0.11	0.15

7. Human capital country studies

7.1. Introduction

463. There are a large number of country-specific human capital studies, some of which look at several countries and others which focus on one country. This chapter surveys a representative sample of them.

464. A country ranking table is presented in the main body of this chapter. It includes 10 rankings by six different types of human capital measures: Programme for International Student Assessment (PISA), Programme for International Assessment of Adult Competencies (PIAAC), Barro-Lee, Inclusive Wealth Report (IWR), Jorgenson-Fraumeni (J-F), and World Bank. Only J-F human capital measures have been previously described in this Guide; accordingly, the other human capital measures are briefly described in this chapter.

465. There is a clear trade-off between the scope of the data needed for a measure, the sophistication of the measure, and the number of countries for which estimates could exist. For example, the IWR (UNU-IHDP and UNEP 2014) measure which uses country averages exists for 140 countries, while J-F which uses detailed country information exists for some 20 countries.

466. The implementation of two monetary measures is described in examples at the end of this chapter: a cost-based firm-specific human capital measure by the Central Bureau for Statistics (CBS) (van Rooijen-Horsten et al 2003, van Rooijen-Horsten, van den Bergen, and Tanriseven, 2008 and van Rooijen-Horsten, van den Bergen, de Haan, et al 2008) and a lifetime income human capital measure by Christian (2010, 2014). The first is in the context of estimating intangible capital for the Netherlands; the second is in the context of estimating a modified Jorgenson-Fraumeni (J-F) measure for the United States.

7.2. Human capital measures

7.2.1. Barro-Lee

467. The Barro-Lee (2010, 2013) estimates of average educational attainment by age categories are popular because a large number of countries: 146, are covered. The Barro-Lee data set is probably the most widely used human capital proxy or indicator data set.

468. From Barro-Lee average formal education attainment is available, from age 15 through age 74, plus ages 75 and over, in five year age groups plus that for ages 75 and over, for a total of 13 groups, for total population and for females, and for every five years from 1950 through 2010. The associated population is also provided for each estimate.

469. Barro-Lee use a variety of techniques to fill in missing observations and educational attainment subcategories and to avoid mis-estimation of average years of schooling. They deal with four broad categories: No formal education, primary, secondary, and tertiary education. Primary and tertiary are further divided into complete and incomplete; secondary is further divided into lower secondary and upper secondary.

470. Most missing observations are filled in with backwards or forward extrapolation. In either case, educational attainment distribution of an age group is assumed to be the same as

that of 5 years earlier or later with an appropriate time lag. The net effect of these imputations is to hold an individual's educational attainment constant from age 25 through 64.

471. For individuals 65 years of age or older only, the probability of dying differs by educational attainment level.

7.2.2. OECD PISA and PIAAC

472. There are two international OECD sponsored tests whose results are often used as human capital indicators: PISA and PIAAC. PISA assesses student knowledge and skills and PIAAC assesses adult skills and their utilization.

473. This paper focuses on results from the 2006 PISA as all of the other human capital measures in the country ranking table, except for that from PIAAC, are from 2005 or 2006. In 2006, 57 countries and over 400 thousand students participated. Although in 2006, 2009, and 2012, at a minimum tests were offered in mathematics, science and reading, the 2006 PISA focused on science, the 2009 PISA focused on reading, and the 2012 PISA focused on mathematics. PISA testing also occurred in 2000 and 2003. In 2003 and 2012 tests were also offered in creative problem solving. In 2012, an optional test: financial literacy, was added.⁴⁵

474. PIAAC, a new OECD adult testing program, includes problem-solving and reading components. Twenty-four countries initially participated in 2012, with an additional nine countries being added in 2014.⁴⁶ About 125 thousand 16 to 65 year olds took this test in 2012. Results across countries and subnational entities varied widely, with the difference in the average score between the highest performing countries and the lowest performing countries amounting to more than five years of formal education.

7.2.3. World Bank

475. The World Bank's residual approach (2006, 2011) is implemented for over 120 countries. Total wealth is measured as the net present value of an assumed future consumption stream. The value of produced capital stocks, structures & equipment, is estimated with the perpetual inventory method. Natural capital is valued by taking the present value of resource rents. It includes non-renewable resources, cropland, pastureland, forested areas, and protected areas.

476. Intangible capital is equal to total wealth minus produced and natural capital. It is an aggregate which includes human capital, the infrastructure of the country, social capital, and the returns from net foreign financial assets. The World Bank concluded that in almost 85 per cent of the countries studied, intangible capital is the majority of total wealth.⁴⁷ The disadvantage of the World Bank's residual approach is that human capital is included in an aggregate.

⁴⁵ OECD (1999, 2003, 2007, undated)

⁴⁶ OECD (2013), p. 26.

⁴⁷ World Bank (2006) p. 28.

7.2.4. **Inclusive Wealth Report**

477. Human capital has been estimated using a lifetime income approach for a number of countries. A lifetime income approach, as the name implies, calculates human capital as a function of present and future income, discounted to the present. Some lifetime income methodologies allow for the possibility of individuals attaining more education in the future.

478. The more aggregate the data is, the more countries are covered. The Inclusive Wealth Report (IWR) Project of UN University's International Human Dimension Programme (UNU-IHDP) on Global Environmental Change and the UN's Environment Programme has constructed preliminary estimates for some 140 countries (Arrow et al 2010, 2012a, 2012b for methodology and UNU-IHDP and UNEP, 2014).

479. Human capital per person depends upon the average educational attainment in the country and the market rate of return to education, which is assumed equal to 8.5 per cent following Klenow and Rodríguez-Clare (2005). Human capital per person is multiplied by the total number of adults in the country to determine total human capital. The number of adults in the country is defined as the number of adults who are at least of an age equal to the number of years of average educational attainment in the country plus five. Average educational attainment is from Barro-Lee. As average educational attainment varies by country, the age of someone who is considered to be an adult varies significantly by country.

480. Total human capital is then multiplied by the shadow price of a unit of human capital. This price is set equal to the average real wage in the country to be received over the average number of working years remaining, discounted by 8.5 per cent. No allowance is made for increases in the educational attainment of workers who have remaining working years. Finally, human capital per capita is determined by dividing the resulting estimates by the total population of the country.

7.3. **Comparison of alternative human capital measures**

481. Depending upon what human capital measure is used, the country ranking can differ significantly, as table 7.1 illustrates. Analysts should carefully consider what human capital measure they use considering these differences. Understanding these differences requires an understanding of individual country's labour markets, education and taxation systems, and institutions.

482. The country ranking table is for the 18 countries which have in most cases 2006 J-F market human capital estimates and for which results are available in most cases for all of the other five types of measures estimates in either 2005 or 2006, with the exception of PIAAC (estimates for 2012).

Table 7.1
Country rankings – based on selected estimates

	PISA Science, Reading, Math 2006	PIAAC Literacy, Numeracy, Problem- solving in tech-rich environments 2011-2 ¹	Barro-Lee Average ed. attainment 2005	Inclusive Wealth Report per capita 2005 ²	Jorgenson-Fraumeni Human Capital per capita 2006 ³	World Bank Intangible Capital per capita 2005
Ages	15	16-65	15-64	all ages	15-64	all ages
Australia	4,4,6	3,5,4	7	9	9	10
Canada	1,2,3	5,6,5	3	5	4	7
China			17	18	18	17
Denmark	9,9,7	8,3,3	14	7	8	2
France	10,10,8	11,10,-	11	4	7	5
India			18	17	17	18
Israel	15,14,15		8	11	13	13
Italy	14,12,14	13,12,-	12	12	14	8
Japan	2,7,4	1,1,6	6	10	6	9
Netherlands	5,6,2	2,2,1	9	6	10	6
New Zealand	3,3,5		2	13	12	12
Norway	13,11,11	4,3,2	4	2	3	4
Poland	8,5,10	10,9,10	15	15	15	15
Romania			10	16	16	16
South Korea	6,1,1	5,7,9	5	14	5	14
Spain	12,13,12	12,13,-	13	8	11	11
United Kingdom	7,8,9	7,8,6	16	3	2	3
United States	11,-,13	9,11,8	1	1	1	1

¹The PIAAC survey was conducted in England and Northern Ireland, not in Wales or Scotland.

²The Inclusive Wealth Report numerator human capital is for the population that is old enough to have obtained the average level of education for the country while the population in the denominator is for the country as a whole. The rankings in the table are based upon Purchasing Power Parity adjusted estimates.

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

483. In this table, the three types of test for PISA are listed in the same column; the three types of tests for PIAAC are listed in the same column. In both cases, the rankings are listed in the same order as the testing types are listed in the heading. As is true for any column, if there are no results for any country, the corresponding row and column is blank. However, if some, but not all, of the PISA or PIAAC tests are not taken by residents of a particular country, a ‘-’ appears instead of a numerical entry. For example, residents of the United States took the science and mathematics test, but not the reading test. Accordingly, a ‘-’ appears as the middle entry in the U.S.– PISA column. Note that if standard errors are considered, the PISA and PIAAC rankings might differ.

484. Country rankings sometimes differ substantially across or within the PISA and PIAAC test rankings. Instances when PISA test rankings differ by at least five places occur for Japan, Poland, and South Korea. Instances when PIAAC test rankings differ by at least five places occur for Denmark and Japan. Instances when PISA rankings differ from PIAAC rankings by at least five places (from the lowest PISA or PIAAC test ranking to the highest PIAAC or PISA test ranking) occur for Canada, the Netherlands, Norway, South Korea, and the United States. Creating a combined ranking for PISA and PIAAC separately or across PISA and PIAAC would inevitably be the result of arbitrary weighting, presumably with equal weights.

485. Country rankings sometimes differ substantially across the four other types of human capital rankings. Instances when the rankings differ by at least five places occur for Denmark, France, Israel, Italy, New Zealand, Romania, South Korea, Spain, and the United Kingdom.

486. More importantly, country rankings sometimes differ substantially across the six types of human capital measures. The difference between the lowest PISA or PIAAC test ranking and the highest ranking among the other four types of measures is at least five places for all countries whose residents took either the PISA or the PIAAC test. Of the three countries whose residents did not take either the PISA or PIAAC tests (China, India, and Romania), there exists a difference of at least five places only for Romania. Ranking differences between the lowest PISA or PIAAC test ranking and the highest ranking among the other four types of measures are at least 10 for six countries: Denmark, New Zealand, Norway, South Korea, the United Kingdom, and the United States.

487. As the long list of substantial differences in the rankings illustrate, there is no question that which human capital measure is chosen can significantly influence the rankings.

7.4. Human capital country measures not listed in the table

7.4.1. Cost-based measures

488. Cost-based estimates have been constructed for at least three individual countries: Germany (Ewerhart, 2001, 2003), the Netherlands (Rooijen-Horsten, van den Bergen, and Tanriseven, 2008 and Rooijen-Horsten, van den Bergen, de Haan, et al, 2008) and Finland (Kokkinen, 2008) and for a sample of 22 countries (Squicciarini, Marcolin and Horvát 2015). The methodology and results from the Dutch study of firm-specific capital is discussed at the end of this chapter.

489. As noted in earlier chapters, cost-based measures could be constructed by a number of NSOs. The Canadian NSO indicated in an OECD survey that it plans to use a cost-based approach as well as other approaches to measure human capital in the future (Boarinni 2012, p.19).

490. Other lifetime income approaches include those of Istat (2013 and 2014) for Italy, Ervik et al (2003) for Norway, and Eisner (1980) and Haveman et al (2003) for the United States.

7.5. Conclusion

491. This chapter has described the substantial number of country specific human capital estimates available. The question is to what extent researchers will continue to provide such estimates and to what extent efforts across countries should be synchronized to allow for international comparisons.

492. In a recent survey of 70 Conference of European Statisticians countries NSO's, 46 replied; 17 of them provided detailed answers. Many of the existing human capital estimates by NSO's or by international organizations, such as the OECD or the World Bank, are in the form of research results. NSOs typically publish their estimates in their statistical publications. Many produce these estimates on a regular basis, often annually, but few consider them 'official statistics'. Only a few NSOs report that they plan to construct satellite accounts for human capital (Boarini et al 2012).

493. An important decision for the Human Capital Task Force is whether to recommend that countries or international organizations should devote additional resources to the measurement of human capital, and to what extent these efforts should be synchronized to facilitate cross-country comparisons, which would allow for a better understanding of country differences in human capital.

7.6. Examples

7.6.1. Cost-based estimates example

Rooijen-Horsten et al (2003), Rooijen-Horsten, van den Bergen, and Tanriseven (2008) and Rooijen-Horsten, van den Bergen, de Haan, et al (2008).

494. In two 2008 papers, Rooijen-Horsten and her co-authors measured intangible capital for the Netherlands following the methodology of Corrado, Hulten and Sichel (2004, 2005 and 2006) over the years 2001-2004. As part of their research, they estimated five components of firm-specific human capital using a cost-based approach:

- a) Purchases of 'market' education
- b) Travelling expenses and accommodation in connection with education
- c) Costs of (internal) teachers/ training personal
- d) Material expenses in connection with education
- e) Costs of forgone working hours (compensation of employees).

495. For all but three industries, the estimates were mainly derived from the Continuing Vocational Training Survey (CVTS), which is available every six years. The relevant years for this study were 1993, 1999, and 2005. Data sets were reconciled when questions or populations surveyed changed. As the survey includes firms with 10 employees or more, expenditures for firms with 5-9 employees were imputed. CVTS only covers courses/training that were attended by more than one participant at a time and that were held outside the direct working environment. Accordingly, on-the-job training and job rotation, as well as attending conferences were not included in the CVTS.

496. Volume indicators were used to interpolate between estimate years. Data for the volume indicators come from the Institute for Labour Studies. They include two-yearly proportions of employees having attended training sessions, yearly labour volume data from the national accounts and the six-year training hours per course participant from the CVTS. For the years 1990-1999, it was assumed that the number of training hours per course is constant. As a check, the interpolated series were inflated with an input-based price measure; extensions of the interpolated series favourably compared with the actual 1999 and 2005 data.

497. Limited information was available on firm-specific human capital for the period 1987-1995. Volume indicators again were used, for the period 1990-1995 they were derived from a combination of changes in the (two-yearly) proportion of employees having attended training and (yearly) labour volume data from the national accounts. For the period before 1990, volume indicators were derived from national accounts data on market education.

498. Note that the firm-specific market education figures differ from those in the national accounts because the CVTS and national accounts sources differ.

499. The following industries were not included in the CVTS:

- a) Public administration and social security
- b) Defence activities
- c) Subsidized education
- d) Health and social work activities.

500. For the public administration and social security industry, estimates depend on annual reports by the Ministry of the Interior and the police organization. Training expenditure per full time equivalent jobs (FTE's) is published in the annual reports of the police organization.

Training expenditures per FTE by ministry is published in the annual reports of the Ministry of the Interior. In the years in which these expenditures per FTE were unknown (1993-1998 for the police force and 1993- 2002 for the ministries), training expenditure per FTE was extrapolated based on industry wage costs in the national accounts. Total training expenditures were obtained by multiplying the training costs per FTE by the number of FTE's from the national accounts.

501. For military involved in defence activities, estimates depended on a 2006 annual report by the Ministry of Defence. Training expenditure per FTE in the years for which expenditures per FTE were unknown were extrapolated based on the labour costs per FTE in the industry defence activities in the national accounts. Total training expenditures were obtained by multiplying the training costs per military FTE by the number of FTE's from the national accounts. It was assumed that training expenditures per FTE for civilian defence activity workers were the same as those for employees in the public administration and social security industry. For both military and civilian workers, total training expenditures were obtained by multiplying the training costs per FTE by the number of FTE's from the national accounts.

502. For the subsidized education industry, estimates depend on a survey of continuing education expenditures during the 1994-5 school year. Employer-provided training expenditure for the year 1999 and 2005 was imputed based on CVTS data on growth of compensation of employees from 1993 to 1999 and from 1999 to 2005.

503. For workers involved in health and social work activities, estimates depend on a survey data on training expenditures for hospitals, nursing homes and municipal workers. It was assumed that the fraction of training expenditures in total production costs of these workers can be applied to production costs in other branches of the health and social work activity industry to determine other branches' training costs.

504. The authors provided unpublished underlying detail for the five categories of nominal firm-specific capital for the years 1987 through 2005. Total nominal purchases of firm-specific human capital over that time period increase on average about 2 per cent per year; purchases rise in most years.

505. The two largest firm-specific human capital categories were purchases of market education and costs of forgone working hours. The share of purchases of market education generally increased slowly from 1987 until 1998 (36 per cent to 40 per cent); costs of foregone working hours generally decreased slowly over the same time period (46 per cent to 43 per cent). After 1998, the share of purchases of market education stayed relatively constant and then decreased slightly to 38 per cent in 2005. At the same time, the share of costs of forgone education increased steadily to 47 per cent in 2005.

506. Between 1987 and 2005, travelling and accommodation expenses and material expenses were quite small and varied little as a share of firm-specific human capital expenses, with the former typically representing 3 per cent of the total and the latter 2 per cent of the total.

7.6.2. Lifetime income example

507. Christian (2010, 2014) estimated market and nonmarket human capital for the United States for the years 1998-2009 using a modified Jorgenson-Fraumeni (J-F) lifetime income approach.⁴⁸

508. Most of the data came from either the March or the October Current Population Survey (CPS). Data from the October school enrolment supplements to the CPS measured population and school enrolment; data from the March demographic supplements to the CPS measured wages and hours worked. The life tables of the Centers for Disease Control were the source for survival rates.

509. Human capital estimates were constructed for all individuals from age 0 through 80 and over. There were 19 educational attainment (or enrolment) levels, one more than J-F (1989): less than first grade (not enrolled), first grade through a four-year college or university undergraduate degree by year, one year of graduate school, and two or more years of graduate school.⁴⁹ Adjustments were made to the educational attainment variables using CPS questions available from 1998 forward to determine individual years of education, as educational attainment has been measured in the CPS since 1992 using qualifications earned rather than individual years of education (e.g., 'some college, but no degree' rather than 13, 14, or 15 years of education).

510. A new category was added to the J-F aggregates: Net investment value of residual population shifts that cannot be explained by the other four components.

511. The major difference between the human capital investments calculated by Christian and those by others, including J-F, is whether investment, notably investment in education, is measured as gross or net investment. According to Christian, there are two complimentary ways to describe the difficulty with gross investment in education. First, the impact of education, as it takes time, cannot be separated from the impact of ageing. Second, J-F gross investment in education calculations assumed that a student's probability of enrolling to school who did not enrol in school dropped to that of someone one year older, rather than to the probability of enrolling in school of someone who was not one year older. Christian discussed this point further and gave some numerical examples in Christian (2010).

512. The following discussion is based on estimates in Christian (2014) for 1998-2009.

513. The nominal share of market human capital in total human capital generally trends downward, from 32.0 per cent in 1998 to 30.6 per cent in 2009.

514. Two components of aggregate net human capital investment were always a positive contributor to human capital: births and education. Two components of aggregate net human capital investment were always a negative contributor to human capital: deaths and age. The residual was usually a positive contributor to human capital. Net human capital investment was set equal to the sum of births, education, deaths, age, and the residual. These sums were always positive for each of the three aggregates: total, market, and nonmarket net human capital investment.

⁴⁸ Equations are given and the basic data sources are described in Christian (2010). Changes in methodology and data compared to the 2010 research are described in Christian (2012). Chapter 3 gives the basic J-F market equations; the basic nonmarket equations are the same as the market equations except that the variable 'nmi' (nomarket lifetime income) is substituted for the variable 'mi' (market lifetime income).

⁴⁹ J-F highest educational attainment category is one or more years of graduate school and the oldest age group is 75

515. Births on average represented a slight majority of births plus education nominal net investment total, both for total and market human capital. On the other hand, births on average represented almost two-thirds of the births plus education nominal net investment nonmarket total.

516. With regards to the negative contributors to human capital: deaths and ageing, the negative contribution of ageing was always greater than the negative contribution of deaths. In absolute value terms, deaths were estimated to always be something less than 10 per cent of ageing in market net human capital investment; while this component was estimated to be typically something over 50 per cent of ageing in nonmarket net human capital investment, and over 20 per cent of ageing in total net human capital investment.

517. Each of the three real human capital aggregates trend upward over time, but the rate of growth did not monotonically increase. For the period as a whole, the rate of growth of real market human capital was .2 percentage points less than the rate of growth of real nonmarket human capital. The 1998-2009 rates of growth were .9 per cent, .8 per cent, and 1.0 per cent for total, market, and nonmarket real human capital, respectively.

518. Christian estimated market plus nonmarket human capital to be far larger than GDP, particularly as he included individuals from birth until age 80 or over. In nominal dollars, total human capital was just over 50 times GDP; nominal market human capital was about 16 times GDP, and nominal nonmarket human capital was about 35 times GDP.

8. Recommendations and further work

8.1. Recommendations

519. The stock-taking report provided to the Conference of European Statisticians (CES) seminar in 2011 from which this Guide arose recommended pursuing work in four areas, one of which was construction of experimental satellite accounts for human capital. The Guide shows that it is feasible to construct human capital satellite accounts. It provides an example of constructing such a satellite account, which shows the impact of human capital on the values of GDP, investment, consumption, savings and net wealth.

520. The Guide also provides guidance on how Statistical agencies can address a number of challenges for the construction of a human capital satellite account. The most pressing challenges include the following:

- a) The choice between alternative models of where human capital is produced,
- b) The treatment of human capital investment through the SNA sequence of accounts,
- c) Access to sufficiently comprehensive and detailed estimates of the costs of education and training,
- d) Selection of an appropriate methodology for volume estimates of human capital investment,
- e) Selection of an appropriate depreciation rate for human capital, and
- f) The reconciliation of alternative methods for estimating the human capital stock and investment.

521. The recommendations in this Guide are a first attempt to come up with an estimate and a recording of the role of human capital in a way that is aligned with the principles of the national accounts. Estimates can either be initiated by developing a satellite account on education, or achieved by going beyond the present SNA by fully integrating estimates of human capital.

522. Because of both data constraints and methodological issues, **the Guide recommends, as a first step, to develop a satellite account for education and training.** The objective of such a satellite account is to distinguish and provide breakdowns of the various expenditures on training and education, including the identification of the financing arrangements for these expenditures. The education satellite account proposal introduces a slight extension of the production boundary as it recommends recognizing the output from the internal expenditures on education and training by employers.

523. For estimating the value of human capital stock, the Guide recommends the use of either the ‘cost-based approach’ or the ‘lifetime income approach’ or both. While the two methods start from similar conceptual perspective, they generally result in estimates with quite different values; thus further examples for economies using both methods would provide additional data for analysing these differences.

524. The cost-based approach starts from the Perpetual Inventory Method (PIM) calculating the human capital stocks as the depreciated value of the monetary costs of the investment in human capital. The data requirements for implementing this method are expenditures on formal education and job-related training, foregone costs for students in education and employees in training, a depreciation rate related to the various investments in human capital. Data on initial human capital stocks and volume or price indices are needed as well.

Assumptions need to be made regarding the rate of depreciation, and the service lives and depreciation pattern of the relevant assets.

525. The lifetime income approach is based on the net present value of the future benefits earned from human capital. These benefits are usually based on labour income by different categories of age and educational attainment. The method requires detailed data on labour earnings, employed persons by sex, age, educational attainment and school duration, as well as survival rates, income growth and a discount rate.

526. From a theoretical point of view, the net present value estimate from the lifetime income approach is preferable, as it adds all future benefits that can be allocated to the relevant asset, thus replicating a market-equivalent valuation. Its measurement, however, requires quite a number of assumptions on the future development of the (active) population and the development in the level of economic benefits. It is also significantly affected by the discount rate that is applied. For that reason, a cost-based estimation is recommended as an alternative method.

527. From a purely conceptual point of view, one can argue that in a setting of perfect competition, the cost-based approach ought to result in an estimate which is equal to a valuation estimated using the lifetime income approach. Usually, the estimates from the lifetime income approach are substantially higher than the ones based on the cost-based approach. Various reasons may cause this difference, obviously one of them being that not all future labour income can actually be attributed to human capital.

528. The Human Capital Task Force encourages countries and international organizations to devote additional resources to the measurement of human capital. These efforts should be synchronized to facilitate cross-country comparisons, which would allow for a better understanding of country differences in human capital.

8.2. Further work

529. The three additional avenues for further work identified in the stock-taking report provided to the CES were: investigating the discrepancies between the cost-based and income-based approach; improving the quality of data collected internationally; and developing techniques for the estimation of the non-economic returns to human capital. The Task Force reiterates the recommendation that future work is needed in all these three areas.

530. Members of the Conference of European Statisticians, as well as all United Nations Member States and relevant international organizations, were consulted on the draft of this Guide and contributed suggestions for further work. Taking these suggestions into account, the Task Force recommends the following for future work.

8.2.1. General considerations

531. While the Guide shows how a satellite account may be used to present the production of human capital in the SNA, it does not address all the changes that would be needed for a full integration of human capital as a produced asset. More detailed conceptual consideration of issues such as compensation of employees are required to fully understand what integration of human capital into the framework of national accounts would mean in terms of reshaping our understanding of the economy.

8.2.2. Improving data quality and availability

532. It is recommended that the following aspects of data should be improved:

- a) The quality and availability of data needed for the lifetime income approach, including for example data on educational attainment, enrolment and earnings.
- b) The availability of data disaggregated by age, sex and educational level. This would be especially useful in the case of survival rates, migration and training. Breakdowns by other characteristics such as occupation, economic sector and location could be considered in the future.
- c) The level of detail of data on education costs and products in order to correspond to the international statistical classifications currently used by the SNA.

8.2.3. Areas where further research is needed

533. It is recommended that research should be conducted in the following areas:

- a) Research into why there is a difference between the cost-based and lifetime income-based estimates, including estimation of specific components explaining this difference. A number of reasons have been posited as explaining the difference, including the extent to which the setting deviates from perfect competition. Such research should be complemented by continued examination of how to deal with the data challenges posed by the lifetime income approach.
- b) Research into the role of health and the estimation of non-economic returns to human capital, which currently poses formidable definitional and measurement challenges
- c) Research into the impact of formal versus informal education (including self-education and on-the-job training) and an assessment of the data requirements and availability for expenditures on the latter.
- d) Elaboration on the distinction between and the measurement of general and vocational schooling, and as a further refinement, distinction by sector or occupation.
- e) Research on the estimation of and choice of volume and price measures, particularly for the cost-based approach.
- f) Undertaking sensitivity analysis to examine the impact of assumptions and of the choice of data sources on the resultant estimates of the level and growth of human capital. Such modelling exercises could also be used to assess the effects of variables such as quality of education, choice of subject, and country-specific factors such as the level of economic development. The results of such analysis could then lead to the provision of guidance on appropriate assumptions, choice of data and estimation techniques.

8.2.4. Proposed actions

534. The following actions are proposed:

- a) Establishing and maintaining a centralized international list (e.g. hosted by UNECE) of country studies on human capital.
- b) A collaborative production by some countries of internationally-comparable satellite accounts for education and training, based on the Guide's

recommendations. Application of the proposed approach to several countries with a range of different economic conditions would permit a useful comparison exercise. This work should be coordinated with UNESCO's programme of National Education Accounts. With sufficient additional experience, a complete compilation guide for a Satellite Account for Education and Training might be developed.

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The background of the page features a light blue color scheme with various financial and data-related graphics. On the left, there is a vertical bar chart with several bars of varying heights. In the center and right, there are line graphs with upward-trending arrows, suggesting growth or positive trends. Faintly visible are numerical values such as '1004.5', '002.2', '005.5', and '05.2'. A stylized white silhouette of a human head in profile is positioned on the right side, facing left. The overall aesthetic is clean and professional, typical of a technical or policy document.

Guide on Measuring Human Capital

The idea of viewing individuals' knowledge and abilities as an asset—as human capital—can be traced back to the 18th century. But human capital is hard to define and measure. Policymakers are calling for ways to understand and quantify human capital, in order to better understand what drives economic growth and the functioning of labour markets, to assess the long-term sustainability of a country's development path, and to measure the output and productivity performance of the educational sector. Devising a robust methodology for the monetary valuation of the stock of human capital is especially crucial as studies suggest that human capital is the most important component of the total capital stock in advanced economies.

This Guide on Measuring Human Capital discusses conceptual, methodological and implementation issues and challenges. The Guide shows how to estimate and record human capital in a way that is aligned with the principles of national accounts and that is comparable across economies.

The Guide proposes the development of a satellite account for education and training, and provides an example demonstrating the impact of human capital on the values of the gross domestic product, investment, consumption, savings and net wealth. The Guide provides additional examples of how human capital has been measured in selected country-specific contexts and compared across countries. The Guide also shows how statistical agencies can address the challenges of constructing a human capital satellite account.

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