

# Towards Wealth Accounting - Natural Capital within Comprehensive Wealth

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## Abstract

The aim of this paper is to provide an overview of wealth accounting, the conceptual basis of including natural capital into extended income and wealth accounts, and share ONS plans for improving the natural capital estimates within the comprehensive wealth framework. This paper provides an approach on developing UK wealth accounts by incorporating other capital areas – physical and human - and suggests an indicator to measure the sustainability of the UK's economy.

## Introduction

In December 2012, the Office for National Statistics (ONS) published a roadmap "[Accounting for the value of nature in the UK](#)" to incorporate natural capital into the UK Environmental Accounts. As part of the roadmap, ONS outlined a plan to improve the natural capital estimates within the framework of comprehensive wealth accounts – the so called "top-down approach", in order to provide an immediate overview of the value of natural capital within the UK.

The focus of this paper is to discuss the role of natural capital within the comprehensive wealth framework, the approach taken by the World Bank<sup>1</sup> and the Inclusive Wealth Report<sup>2</sup> to measure natural capital, and the approach that ONS plans to adopt to improve these estimates. Since this work is completed as part of the Measuring National Well-being Programme, it is important to understand how wealth is defined and what role it plays in determining the well-being of a nation. This paper starts with a brief discussion on the limitation of income accounts and introduces the concept of wealth accounting. It then provides an overview of two main wealth accounting approaches, comprehensive wealth<sup>3</sup> and inclusive wealth<sup>4</sup>, before discussing in detail how natural capital is calculated within these approaches and what approach the ONS plans to use in improving the natural capital estimates over time.

In the ONS consultation on "[Accounting for the value of nature in the UK](#)" in July 2012, ONS proposed that it would explore each of the capital areas – physical, natural, human and social and so on, – to render them closer to being fit for purpose into a wealth framework. Since the ONS already publishes produced and human capital estimates, in the penultimate section, this paper goes further by suggesting an approach on how these two capitals could be combined with natural capital to develop the first wealth accounts for the UK.

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<sup>1</sup> World Bank (The Changing Wealth of Nations, 2011; Where is the Wealth of Nations, 2006)

<sup>2</sup> The Inclusive Wealth Report, published in June 2012, is a joint collaboration between the United Nations University International Human Dimensions Programme and the United Nations Environment Programme

The final section suggests a proxy for sustainability – depletion adjusted net saving - as an indicator that aims to assess the UK economy's sustainability based on the concepts of extended national accounts. Depletion adjusted net saving measures the savings of the UK economy after taking into account depletion of natural resources.

## **System of National Accounts**

Over the last 50 years macro-economic policy has largely been based on information flowing from the System of National Accounts (SNA) framework. The SNA was introduced in 1953 as an international standard for measuring economic activity and it focused exclusively on measuring economic growth, in particular production in markets, for which prices were available. When the SNA was introduced, there was no need for better treatment of natural resources and the environment, as resources were considered abundant and the environment an inexhaustible sink. Since then, however, the world population and the world economy have grown significantly, which has put a stress on the natural environment.

A full articulation of the SNA includes many measures of economic activities, one of which is Gross Domestic Product (GDP), which has led to job creation and improved well-being for many people. While economic growth has produced many benefits – raising standards of living and improving quality of life across the world – it has also resulted in the depletion of natural resources and the degradation of ecosystems. There has been much debate over whether or not it is possible to achieve economic growth without unsustainably degrading the environment, and a growing realisation that economic growth at the current rate of depletion and degradation of environmental assets cannot continue indefinitely.

In an attempt to broaden the perspective of well-being beyond economic growth and income, the Human Development Index (HDI) was developed. The HDI added literacy and mortality to the equation of income; however, HDI was not a perfect measure to capture sustainability. Sagar and Najam (1998) suggested that for the HDI to capture the sustainability dimension of human development, it would need to incorporate some mechanism for accounting overexploitation of natural resources.

Neither GDP nor the HDI gave any indication of whether a country was on a sustainable path (Dasgupta, 2009). Therefore, it is not surprising to see a continuous degradation of natural capital due to these incomplete measures. Despite deficiencies in these measures, they continue to provide answers to many important questions such as monitoring economic activity. Changing emphasis does not mean dismissing GDP and production measures, but emphasising well-being is important because there appears to be an increasing gap between the information contained in aggregate GDP data and what counts for people's well-being.

There have been critiques since the early days of the SNA - some of the early welfare accounting proposals came from the 1960s; studies from Nordhaus and Tobin were in the early 1970s; and sustainability rationale for greener accounts is known from at least the late 1980s. One of the recent initiatives was the Commission on the Measurement of Economic Performance and Social Progress Report (Stiglitz et al. 2009), known as Stiglitz Report. The report identified the key dimensions of

well-being to include health, education, social connection, political voice, unpaid household work, and present and future condition of the environment. The Commission notes that “all these dimensions shape people’s well-being and yet many of them are missed by conventional income measures.” This could be because GDP only measures activity within ‘the market’; however, much of what maintains and enhances well-being occurs outside of the market. Therefore, the Commission argued that applying a broader definition of wealth, to include natural capital, social capital and human capital, could provide a better understanding of economic well-being.

However, the Commission argued that no single measure can summarise something as complex as the well-being of the members of society and any system of measurement must encompass a range of different measures. Pioneering studies such as those by Kenneth Arrow and others, and the World Bank have provided a framework that provides a single indicator to measure wealth and the changes in wealth over time. The concept of comprehensive wealth is important as having a present day estimate of this wealth signals our future prospects for well-being and prosperity. In turn, the way in which this wealth is changing over time indicates how these future prospects are altering. There are some limitations in the comprehensive wealth framework; however despite its limitation, Stiglitz, Sen and Fitoussi (2009) recommended comprehensive wealth as one useful indicator of economic performance.

## **What is wealth?**

Wealth could be defined in terms of an economy’s productive base, which comprises the entire range of capital assets to which people have access. Traditionally wealth has been defined as a stock of produced capital such as buildings, machinery, equipment and infrastructure. Economic theory tells us that there is a strong link between changes in wealth and the sustainability of development (World Bank, 2006). If a country is running down its assets, it is not on a sustainable path. For the link between changes in wealth and sustainability to hold, however, the notion of wealth must be truly comprehensive.

The publication *Where is the Wealth of Nations* (World Bank, 2006), *The Changing Wealth of Nations* (World Bank, 2011) and *The Inclusive Wealth Report* (2012) are initiatives that have expanded the definition of wealth by including different capitals into a wealth framework. These reports rely on an economic welfare model for their theoretical foundation and measure sustainability and well-being by measuring wealth instead of economic growth and income.

The World Bank (2006, 2011) extended the wealth measures by accounting for exhaustible resources, renewable resources and agricultural land. They also included intangible capital, which encompassed raw labour, human capital, social capital and the quality of institutions.

The Inclusive Wealth Report (2012) is based on theory developed by Arrow et al. (2012) in their paper *Sustainability and the Measurement of Wealth*. The paper provides a theoretical framework based on social welfare theory to address the multiple issues which sustainable development attempts to address. The paper expanded the definition of wealth by including ‘health’ and ‘time’ as

an asset. The Inclusive Wealth Report (IWR) treated health capital<sup>5</sup> separately from other forms of capital, as it argued that modest changes in health capital could outweigh any changes in the other three assets – produced, human and natural. The report also included ‘time’ as an asset and argued that a country enjoys an expansion of its productive base simply by waiting and, therefore, time should be included in a society’s productive base. Hence, the report defined wealth as the social worth of an economy’s assets that included reproducible capital; human capital; knowledge; natural capital; population; institutions; and time. However, it opens up an interesting discussion on how to measure these elements of wealth<sup>6</sup>.

## Approaches to calculate wealth

As discussed above, there are two broad approaches to calculate total wealth. It could either be measured by estimating the total wealth (top-down) and then breaking it down into various capitals. This is the World Bank approach adopted in *Where is the Wealth of Nations (2006)* and *The Changing Wealth of Nations (2011)*. The other approach is to add up all the individual capitals to estimate the total wealth (bottom-up), which is adopted in *The Inclusive Wealth Report (2012)*.

### 1) World Bank comprehensive wealth

The World Bank (2006, 2011)<sup>7</sup> estimated total wealth as:

Wealth = Produced capital + Natural capital + Intangible capital (human capital, social capital and quality of institutions)

Since it is challenging to measure wealth by summing observed or estimated values of various types of capitals, the World Bank estimated total wealth based on economic theory (Hamilton and Hartwick, 2005; World Bank, 2006). According to this theory, wealth is equal to the present value of future consumption, where consumption equals what is spent on market goods and services plus net investment in various types of capital. A time horizon of 25 years, which coincides roughly with human generations, was assumed throughout the calculation of wealth. For consumption purposes, a pure rate of time preference of 1.5%<sup>8</sup> - a rate that a rational consumer would use - was assumed. Since the focus was on sustainable development, a social discount rate of 4% was assumed.

The perpetual inventory method<sup>9</sup> was employed to estimate the value of produced capital; whereas, most natural capital were valued by taking the Net Present Value of future resources rents over an assumed lifetime. Intangible capital was calculated as a residual, the difference between total

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<sup>5</sup> IWR defines health capital as an increase in life expectancy that translates into an improvement in health. The value of health improvements is the value that people attach to the additional years of life that results from such improvements (Arrow et. al, 2012).

<sup>6</sup> See Hamilton and Solow (2012)

<sup>7</sup> For detailed methodology, please see “Where is the wealth of nations? (2006)”

<sup>8</sup> This rate was based on the Pearce and Ulph (1999) study

<sup>9</sup> It is the sum of additions, minus the subtractions, made over time to an initial stock

wealth and the sum of produced and natural capital. Since it includes all assets that are neither natural nor produced, the residual includes human capital, social capital and quality of institutions.

## **2) Inclusive Wealth Report**

The IWR, which is based on Arrow et al. (2012) methodology, presents a new metric known as the Inclusive Wealth Index (IWI) for evaluating progress in human well-being. Unlike the World Bank comprehensive wealth, where a major part of wealth was embedded in intangible capital, IWI computed the individual elements of wealth to estimate the total wealth and defined the IWI as:

Wealth (IWI) = Produced capital + Natural capital + Human capital

Health was treated separately from other capital forms as modest changes in health capital would outweigh any changes in the other three assets. Social capital was not calculated due to lack of empirical measures and the fact that it could affect the value of other forms of capital. The total wealth was calculated by adding up the social values of produced, natural and human capital. The capitals were then adjusted for changes in carbon damages, capital gains (time) and technology changes.

## **Natural capital within comprehensive wealth**

### **World Bank**

The World Bank reports comprehensive wealth accounts for 120 countries in *The Changing Wealth of Nation (2011)* and, due to lack of data, the accounts omitted several natural capitals. As a result, the value of natural capital was underestimated. Table 1 shows the natural capital that was included in the wealth accounts developed by the World Bank.

**Table 1: Natural Capital in the World Bank Comprehensive Wealth<sup>10</sup>**

Non-renewable resources	Non -Renewable resources	Renewable resources
Oil	Iron ore*	Protected area
Natural Gas	Lead*	Timber resources
Hard coal	Nickel*	Non-timber forest resources
Soft coal	Phosphate*	Crop land
Bauxite*	Tin*	Pasture land
Copper*	Silver*	
Gold*	Zinc*	

(\*) These 10 metals and minerals are published as total minerals

A few other assets, such as fisheries were excluded from natural capital; however, the value of these assets was implicitly included in the total wealth and ends up in intangible capital. Additional assets, such as water resources were missing altogether. The World Bank did not make any attempt to adjust the estimates of total wealth and different form of capitals for the value of externalities, for example, damages from pollution. However, damages from pollution were included in the genuine saving indicator that provides a broader indicator of sustainability by valuing changes in natural resources, environmental quality, and human capital, in addition to produced capital.

The ecosystem services, especially cultural and regulatory, were not valued and included in the natural capital as well as in the total wealth. Ecosystem services would only be picked up in total wealth if they fed into the production of consumption goods. Most of the provisioning services (with the exception of fisheries and some water services) were included explicitly in the wealth accounts in the form of agricultural land and forest land values that produce food, fibre, timber, non-timber forest products, and so on. The value of protected areas was calculated as a lower bound mainly due to data limitations. The value was also underestimated because it did not include other ecosystem services that protected areas may provide, such as tourism.

### **Inclusive Wealth Report**

The IWR focuses on quantifying components of natural capital that are primarily driven by those resources for which markets exist, since it is easier to obtain physical inventories and data on these stocks. Table 2 shows the natural capital that was included in IWR.

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<sup>10</sup> Source: The Changing Wealth of Nations (2011)

**Table 2: Natural Capital in the Inclusive Wealth Report<sup>11</sup>**

Non-renewable resources	Non -Renewable resources	Renewable resources
Oil	Lead*	Fisheries*
Natural Gas	Silver*	Timber resources
Coal	Nickel*	Non-timber forest resources
Copper*	Phosphate*	Crop land
Bauxite*	Tin*	Pasture land
Iron*	Zinc*	
Gold*		

(\*) The minerals and fisheries are not included into the UK natural capital figures.

The IWR also did not include ecosystem services in their estimates. However, Edward Barbier progressed this discussion further in this report by suggesting<sup>12</sup> that ecosystems and ecosystem services should be included as an important asset in an economy, and in principle, ecosystem services should be valued in a similar manner as any other form of wealth, regardless of whether a market exists or not.

## ONS approach to estimating UK natural capital

As part of the roadmap, the ONS outlined a plan to improve the natural capital estimates within the framework of comprehensive wealth accounts to provide an overview of the value of natural capital within the UK. ONS has published a limited number of monetary asset accounts as part of the UK Environmental Accounts, a 'satellite account' to the main National Accounts. Satellite accounts are extensions to the National Accounts that facilitate analysis of the wider impact of economic change. The key monetary environmental asset accounts that ONS has been producing is the monetary asset account for oil and gas reserves within the UK Continental Shelf. The methodology for UK oil & gas reserves was reviewed in 2012 and an updated monetary valuation of oil & gas is being published alongside this paper. ONS is also publishing the first monetary estimates of UK timber resources alongside this paper. Both UK oil & gas reserves and UK timber resources are developed in accordance with the [System of Economic and Environmental Accounts](#) (SEEA) Central Framework.

Both the World Bank and the IWR have provided estimates of natural capital in their wealth accounts; however, the methodology in these reports was quite different. The World Bank approach is consistent with the System of National Accounts (SNA) because it only looks at consumption; whereas, the definition of Arrow et al has a broader scope. In the roadmap, ONS outlined that it

<sup>11</sup> Source: Inclusive Wealth Report (2012). The IWR uses GTAP data for the resources they focus on. It is not clear how those data represent shadow scarcity values of natural resources

<sup>12</sup> Chapter 8: Edward B. Barbier

plans to publish initial estimates of UK natural capital by the end of 2013 with further improvements in 2014/15 in order to incorporate these estimates into the UK Environmental Accounts. The World Bank methodology to estimate natural capital is consistent with ONS methodology to value timber resources and oil & gas reserves. To make a quicker progress, ONS will use the World Bank approach to estimate its natural capital; however, it will further explore the IWR methodology as it has a wider scope in terms of measuring well-being.

ONS is planning to take the following approach to develop the natural capital estimates:

#### **2013/14**

- Develop the first UK natural capital estimates by the end of 2013/early 2014 using the World Bank data because of the broad consistency of the methodology with UK Continental Shelf oil & gas reserves and UK timber estimates developed by the ONS
- Wherever possible, improve the estimates with the data sources available in the UK
- Include additional components of natural capital into the estimates for which data are available but which are missing from the World Bank estimates.

#### **2014/15**

- Improve the natural capital valuation methodology to provide the best possible estimates for the UK
- Explore the IWR methodology to estimate the UK natural capital
- Explore the inclusion of ecosystem services into the natural capital estimates.

### **Wealth accounts**

As discussed in the introduction section, ONS already publishes produced and human capital estimates, and natural capital estimates could be combined with these two capitals to develop the first comprehensive wealth account for the UK.

The two approaches to developing comprehensive wealth accounts, which were discussed in the earlier sections, have shortcomings. For example, the World Bank approach does not include most ecosystem services in the total wealth that it estimates by calculating wealth as present value of future consumption. If this approach is adopted and ecosystem services are included in the natural capital, the total estimated wealth will not be consistent with the natural capital estimates within the same framework. This is because the benefits of some the ecosystem services are not part of the total estimated wealth in this approach.

On the other hand, if the IWR approach were adopted, due to lack of empirical measures on social capital, the total wealth would be underestimated. Even if social capital is estimated, it is not clear that by adding all capitals – produced, human, health and social – the total wealth will be over or understated. This is because this approach does not provide any information on the total wealth of a nation that is being estimated.



Although there are shortcomings in the both approaches, they provide a framework to develop comprehensive wealth accounts. In order to develop comprehensive wealth accounts for the UK, the World Bank approach provides a framework that could be adopted relatively quickly. This approach could be further improved in the UK context because the UK has published human capital estimates, which could be added directly into this framework instead of calculating it as a residual. The first UK comprehensive wealth accounts could be developed as:

*Wealth = Produced Capital + Human Capital + Natural Capital + Intangible Capital (where intangible capital is the social capital and quality of institution)*

However, if ecosystem services need to be included in the natural capital, the total wealth calculated in the above framework needs to be redefined to capture the benefits provided by the ecosystem services but not captured as consumption.

ONS is currently looking at the feasibility of developing estimates on social capital. If these are developed, this could be incorporated into the above framework and any residual - intangible capital - would be the total factor productivity.

The IWI provides a sound approach to add up all the capitals to calculate total wealth. However, more research is required on the capitals that need to be included in this framework.

## **Depletion adjusted net saving**

This final section suggests a proxy for sustainability – depletion adjusted net saving - as an indicator that aims to assess the UK economy’s sustainability based on the concepts of extended national accounts. This concept is based on the World Bank genuine saving indicator that provides a much broader indicator of sustainability by changes in natural resources, environmental quality, and human capital, in addition to the produced capital.

Standard national accounts measure the changes in a country’s wealth by focusing solely on produced assets. A country’s provision for the future is measured by its gross national savings, which represents the total amount of produced output that is not consumed. Gross national savings, however, can say little about sustainable development, since assets depreciate over time. The next step in measuring sustainability is to adjust net saving for the accumulation of other assets – human capital, the environment, and natural resources – that underpin development<sup>13</sup>.

This section introduces the concept of depletion adjusted net saving. It provides an indicator of sustainability by taking into account depletion of natural resources in addition to the traditional measure of changes in produced assets provided by net saving. The depletion in non-renewable resources is the extraction of natural resources; whereas, in renewable resources it is the difference between natural growth and extraction.

Depletion adjusted net saving could be calculated as:

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<sup>13</sup> World Bank (2006, 2011)

*Depletion adjusted net saving = Gross national saving – depreciation of fixed capital – depletion of natural resources*

ONS is currently developing environmental asset accounts and as part of these accounts, the depletion of natural resources might be captured. This could be incorporated into the above equation to measure depletion adjusted net saving. Positive net savings allow wealth to grow over time thus ensuring that future generations enjoy at least as many opportunities as current generations. Negative net saving implies that total wealth is in decline and policies leading to persistently negative savings are unsustainable.

Depletion adjusted net saving is at best a necessary, but not sufficient condition of sustainability, and overtime the aim should be to move from depletion adjusted net saving to degradation and depletion adjusted net saving. Damages from greenhouse gas emissions also have an impact on future well-being and on the sustainability of individual countries. The estimates of the shares of the stock of atmospheric CO<sub>2</sub> should also be formally incorporated into the above framework.

## References

- Arrow, K.J., P. Dasgupta, L.H. Goulder, K.J. Mumford, and K. Oleson (2012), 'Sustainability and the measurement of wealth', *Environment and Development Economics* 17(3): 317-353
- Duraiappah, A and P. Munoz (2012) 'Inclusive wealth: a tool for the United Nations', *Environment and Development Economics* 17(3): 362-367
- Hamilton, K. (2012), 'Comments on Arrow et al., "Sustainability and the measurement of wealth"', *Environment and Development Economics* 17(3): 356-361
- Khan, Jawed (2012), [Towards a Sustainable Environment – UK Natural Capital and Ecosystem, Economic Accounting](#), Office for National Statistics
- Office for National Statistics (2012), [Accounting for the value of nature in the UK](#)
- Najam and Sagar (1998), 'The Human Development Index: A Critical Review' *Ecological Economics*
- Natural Capital Committee (2013), [The State of Natural Capital](#)
- Nordhaus and Tobon (1972), 'Is Growth Obsolete?' National Bureau of Economic research
- Nordhaus, William; Kokkelenberg, Edward (1999) *Nature's Numbers: Expanding the National Economic Accounts to Include the Environment*
- Solow, R. (2012), 'An arrow in the Achilles' heel of sustainability and wealth accounting' *Environment and Development Economics* 17(3): 368-372
- UNEP (2012), 'Inclusive Wealth Report', Cambridge University Press
- United Nation, *Experimental Ecosystem Accounting and Extension and Application*  
<http://unstats.un.org/unsd/envaccounting/seearev/>
- World Bank (2011), 'The Changing Wealth of Nations', Washington, DC: World Bank
- World Bank (2006), 'Where is the Wealth of Nations?' Washington, DC: World Bank