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How can we measure the economy in the digital era?

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- Juha Itkonen
  Economist

The impact of digitalisation is not fully reflected in economic statistics. Even though the commonly used economic metrics such as GDP are still relevant in assessing the state of the economy, the production of statistics should be developed to better measure the digital economy. Because of digitalisation, GDP may have understated output growth, even though measurement errors alone do not explain the exceptionally weak developments in recent years, nor do they eliminate the key challenges for the Finnish economy. Digital technology has, however, improved our well-being in ways that are difficult to measure in money.

Is digitalisation visible everywhere except in economic statistics?

Digitalisation is transforming the economy and society in a number of ways. The widespread introduction of information and communication technology (ICT) in the various sectors of the economy is reshaping production methods and structures and creating new goods and services. Digitalisation is potentially one of the most significant drivers of productivity and economic growth now and in the future.[1]

Digitalisation is reflected in many ways in the day-to-day lives of individuals and entrepreneurs, but in the national accounts the effects seem to have remained smaller

1. Brynjolfsson – McAfee (2014) and Pohjola (2014).

than expected. The popularity of the Internet and of mobile devices has increased rapidly in recent years, and their speed and efficiency have multiplied in a short period of time. Companies have begun to reorganise production processes as new technology has progressively offered more efficient operating methods. Digital technology has spawned a large variety of new business activities and services.

Despite the above, economic and productivity growth as measured by GDP seems to have slowed globally.[2] Over the longer term, productivity growth generated by technological progress is the key factor in increasing living standards and also an important factor in supporting well-being. The question about the importance of digitalisation to growth has divided economists into pessimists and optimists. The pessimists point to statistics and argue that the best applications of ICT have already been seen and that new advances are largely restricted to entertainment and communications. The optimists, in turn, believe that artificial intelligence and robots will revolutionise society in many ways and that the change is already visible. They point out that statistics do not tell the whole story. Digitalisation has created many new challenges for measuring the economy, and it is probable that the change is not fully reflected in the statistics.

Can traditional economic statistics capture developments in an increasingly digitalised economy? Will GDP, the commonly used metric for monitoring the state of the economy, still be a sufficient measure in the future, too? These questions have attracted much attention in recent years, and many national statistical authorities and international organisations such as the OECD and the IMF have begun to review the appropriateness and up-to-dateness of economic metrics. At the end of 2016, the Bank of Finland and Statistics Finland also set up a joint working group to analyse the measurement challenges brought by digitalisation. The working group's findings are summarised below. A more extensive report will be published in autumn 2017.

What is GDP intended to measure?

When assessing different economic metrics, it is important to bear in mind what each indicator is intended to capture. When we talk about measurement errors, it is necessary to specify in in relation to what a metric is biased. Similarly, it is important to clarify what exactly an unbiased indicator would measure.

No single metric can exhaustively answer all questions under all conditions; several indicators are typically needed to capture the different aspects of the phenomenon observed. In assessing the challenges created by digitalisation, it is therefore necessary to distinguish problems related to a measure's appropriateness from problems related to its accuracy. An appropriate measure is suited for a specified purpose and yields answers to the questions presented. An accurate measure, in turn, captures precisely and unbiasedly the phenomenon it is intended to measure according to its definition.

Gross domestic product (GDP) measures domestic production and is the most commonly used metric for the size and development of a national economy. Production refers to the

2. E.g. Adler et al. (2017).

process of using work, capital and intermediate goods as inputs in order to generate goods and services.

GDP is part of the national accounts, which is an extensive and internationally harmonised statistical system for measurement of an economy. GDP can be computed in national accounts in three conceptually consistent ways. Firstly, GDP measures the value added produced by various economic activities in the economy. Secondly, it measures the income (e.g. compensation of employees and capital income) generated by production. Thirdly, GDP measures the monetary market value of goods and services intended for final use. To put it simply, the three definitions of GDP can be put together by stating that products can be consumed in the same quantity as they have been produced, and income is generated in the same amount as production.

GDP is not a measure of general well-being, even though it is often interpreted as such. GDP is, however, strongly intertwined with many factors essential to well-being and is therefore an important component in assessing well-being.[3] GDP does not attempt to capture income or wealth differences, the range of goods, consumption of natural resources, the state of the environment, sustainability of economic growth, population health, criminality nor possible increases in leisure time, even though these matter to the well-being of individuals.[4]

GDP per capita measures the average value of goods and services available for people. When GDP is divided by the size of the population, it can be used as a measure of the economic standard of living. In such use, standard of living is to be interpreted relatively restrictedly. GDP is suited for e.g. cross-country comparisons of living standards, as long as differences in price levels are taken into account. This article also examines other factors that should be considered in cross-country comparisons of living standards.

The suitability of GDP as a measure of material living standards is somewhat limited by the fact that some of the activities producing economic value are not counted in statistics. In national accounts, production does not include (apart from some few exceptions) own-account production of services by households or free digital services. GDP does not include e.g. cleaning of one's own home or writing a blog post. Production also excludes free goods of nature (clean air) or growth of natural resources without labour input (growth of natural forests). Estimating a monetary value for such items would be uncertain, laborious and in many cases impossible.

As a compromise between reliability and coverage, national accounts exclude many items that would practically weaken statistical comparability and accuracy, even though they could in principle be included in the accounts. Deficiencies in the coverage of national accounts can, however, be supplemented and elaborated with satellite accounts aimed at estimating activities falling outside the scope of official national accounts using comparable concepts and methods. Statistics Finland, for example, has produced satellite accounts for household production (2006), tourism (2007) and culture (2014).

3. Pohjola (2013) and Jones – Klenow (2016).
4. Stiglitz et al. (2009) and Prime Minister's Office (2011).

GDP is generally used as a measure of economic growth. In order to assess production developments by comparing GDP figures over different periods, one must also be able to measure price developments. In nominal GDP (GDP at current prices, GDP value), the produced goods are valued according to the prices of the respective time period. Nominal GDP can grow when the general price level rises, i.e. as a result of inflation, even if the quantity of goods and services produced in the economy does not increase nor their quality improve. Real GDP (GDP at constant prices, GDP volume), in turn, measures growth in the value of production not attributable to higher prices. In other words, it aims at measuring growth in the quality and quantity of production. Changes in the quality and quantity of goods can often not be observed directly. Instead, we have to conclude these changes from changes in the value of GDP by eliminating the impact of price changes.

What should be included in GDP?

Digitalisation impacts economic output in several ways, but not all the effects are necessarily fully reflected in GDP. If digitalisation leads to a significant share of output not being recorded in national accounts, statistics may give a misleading picture of the volume and structure of economic activity.

The statistics may miss many new goods that have been created as a result of technological advances. For example, free products such as open-source software are not counted, even though corresponding proprietary software is recorded in GDP valued at its market price.

The characteristics of old goods can also change so that the goods are either excluded from the statistics or subsequently included in them. In the case of travel agencies, for example, GDP has contracted, since an increasing number of consumers plan and book their trips by themselves. On the other hand, various digital apps make it easier to delegate a variety of household chores such as cleaning to external service providers, in which case these chores are added to the statistics.

In the national accounts, the production boundary determines when an activity carried out for the production of goods and services is included in the statistics. Own-account production of services by households is excluded from the national accounts, apart from a few exceptions. The distinction between recorded and unrecorded production is in many respects based on the practical preconditions for the compilation of statistics. For example, determining the market value of housework or free digital services is difficult and often open to a range of interpretations. Incorporation of imputed estimates in the statistics could weaken their reliability or usability.

The estimate of economic growth could be biased if a significant share of production evolves in a way that it moves in or outside the production boundary of the national accounts. From an economic perspective, it is therefore justified to also consider an extended concept of output that would include the production of goods falling outside the official production boundary. Such an extended GDP would not suffer from the bias caused by the narrowness of the production boundary.

Indeed, the national accounts have been supplemented with satellite accounts as described earlier. These estimate the economic significance of production that falls outside the production boundary. However, it is not meaningful to include absolutely all goods-producing activities in such a metric. For example, it is not necessary to consider hobbies as production even if they generate some sort of products. From the perspective of estimating the condition and development of the economy, measurement can be restricted to activities that can, in principle, be delegated to someone else without a major change in the result. For example, the satellite account for household production aims at estimating the monetary value of housework (cleaning, cooking etc.) on the basis of time use statistics. In 2006, inclusion of household production in GDP was estimated to boost GDP by 39%.

However, is not always relevant to broaden the concept of GDP. GDP can be used to reflect the funding base of the public sector, i.e. economic activity that could, in principle, be used to gather income for the funding of public expenditure. For this purpose, the official production boundary is more suitable. Taxes can be levied more easily on e.g. cleaning services purchased by households (included in GDP) than on cleaning of one's own home (not included in GDP).

GDP can understate the actual scope of production also when services previously regarded as production become free due to digitalisation and are therefore no longer recorded in the national accounts. For instance, the previously common printed encyclopaedias were reflected in the national accounts as production and consumption, but their sales declined sharply with the popularity of Wikipedia and other web-based data sources. Hence, from the consumer's perspective, a corresponding product is still available, even though in GDP the change is reflected as economic contraction as a result of lower consumption of encyclopaedias.

Unrecorded production is also a factor when assessing the relative size of different economic industries and sectors. Measurement issues with digitalisation are particularly heightened in ICT-related service sectors that produce a large range of free digital services. It is therefore possible that the ICT sector is considerably more important to the economy than the statistics suggest.

For instance, the added value for consumers from social media is not directly captured by the statistics. Free services financed via advertising, such as blogs, are only captured via advertisement-related cash flows. In the national accounts, a blog writer's output equals the writer's advertising revenue, but at the same time the money spent on advertising is an input of the company that advertises, i.e. intermediate consumption. In GDP, these items offset each other. Advertisement-financed free services increase GDP only if they boost consumption of the advertised products without decreasing other consumption. The impact of free services on GDP is therefore modest, nor does it take into account the actual service produced for consumers, i.e. the blog itself that, as a free product, does not have an easily measured monetary value.

Similar measurement problems have also been evident prior to digitalisation, maybe even more extensively than at present. For example, the value for consumers from advertisement-financed radio and television channels or free newspapers has not been, and is not, directly observable.

Measurement of price developments creates challenges for the measurement of economic growth

The real growth rate of the economy is largely determined on the basis of estimates of developments in nominal GDP and prices. In order to measure the economic growth rate correctly, one must also be able to measure the value and prices of output sufficiently accurately. The most significant challenges in measuring economic growth relate to the measurement of price developments.

Estimating the rise in the general level of prices, i.e. inflation, is a precondition for a reasonable comparison of monetary variables at different points in time. Price indices are needed to separate, in changes in nominal measures, the impact of a rise in prices from actual real economic factors. For most items, real GDP growth must be calculated by excluding the effect of price changes from nominal GDP growth. There are a variety of price indices for different purposes: the consumer price index measures changes in prices of goods consumed by households, while the producer price index measures changes in prices of outputs and intermediate goods. There are also specific price indices for imports and exports.

The measurement challenges associated with price indices have long been known.[5] Key factors causing measurement errors include problems with the measurement of consumption shares of goods, substitution bias related to the index formula, new goods, quality bias and sampling bias. These factors are discussed in more detail below.

A price index is based on a basket of goods that describes the distribution of consumption or production across various goods. The consumer price index (CPI), for example, is based on a goods basket in which the weight assigned to each product corresponds to its share in household consumption expenditure. Calculating a relevant price index requires that the content of the goods basket has been chosen and the weight structure has been measured correctly. The earlier mentioned measurement problems related to the structure of the economy are therefore also reflected in price indices.

An economically meaningful CPI corresponds as accurately as possible to a cost-of-living index that measures the relative amount of money required for the achievement of an equal utility level at different points in time. The cost-of-living index shows how much more nominal income is needed in the current year – after changes in prices, quality and goods selection – to buy a goods basket that provides the same utility level as the previous year's goods basket. Hence, the cost-of-living index makes it possible to calculate to what extent growth in nominal income has generated utility to customers.

A cost-of-living index so defined differs from a fixed-weight CPI because consumers can react to price changes by adjusting the consumption shares of goods and thereby improve their position. The difference between these indices is called substitution bias. In practice, it is difficult to compute a cost-of-living index, as this would require the estimation of consumers' willingness to pay (reservation prices). A similar phenomenon

5. E.g. Boskin et al. (1998), Hausman (2003), Statistics Finland (2016).

is also related to producers' activity since they, too, can adjust the structure of inputs and outputs in the event of changes in producer prices.

The variety of new goods created as a result of digitalisation pose a significant challenge. New goods should be taken into account in price indices because they enable the consumer to achieve the same utility level at a smaller cost. Even though the prices of old goods do not change and consumers' nominal income does not increase, the existence of new products improves the position of consumers. An estimate based on detailed consumption data shows that new products cause a 0.8 percentage point upward bias in the CPI in the United States. The estimate is subject to a number of reservations, but it indicates the importance and potential scale of new goods.[6]

New free digital services should also be taken into account in price indices the same way as new goods. An estimate based on consumption and time use data suggests that the consumer surplus generated by use of the Internet was about 2–3% relative to median income in the United States in 2005.[7] This estimate, too, is subject to many reservations and is at best indicative. It should be noted that the use of the Internet and mobile devices, in particular, has increased considerably since 2005.[8]

It is also problematic that new goods are included in the sample of the price index with a time lag, and therefore changes are not initially reflected in the development of the index. This problem is alleviated by the fact that, initially, the weight of new goods is often small in the basket, and thus their effect on the index is minor. However, if there are large changes in prices and a rapid growth in consumption share, the effect could also be reflected in the overall index. The introduction of a chain index formula in the CPI and other price indices of the national accounts has helped mitigate this problem.

Price indices aim ultimately at measuring 'pure' price developments, i.e. keeping the quality of goods and services constant. In other words, the purpose is to compare, over different time periods, the prices of goods that are equal in terms of their quality and other characteristics. If a price increase of e.g. a new computer model is solely due to the increase in quality, an index that measures pure price developments should not rise. From the economic theory perspective, the purpose is to find for price comparisons perfect substitutes that would offer the same utility for the customer.

It is challenging to hold the quality of many goods and particularly services constant, if it is not possible to find goods that are fully comparable or observe similarities at different points in time. For example, car and computer models change rapidly and the characteristics of the various models differ. Similarly, services are often tailored so that they are not fully comparable, and it may be difficult to see the quality differences. With digitalisation, production processes become more flexible and logistics more efficient, which makes it even easier to expand and tailor the selection of goods and services.

Digitalisation has changed the character of many products from goods to services. For example, in addition to compact discs, consumers can now also subscribe to streaming

6. Broda – Weinstein (2010).
7. Goolsbee – Klenow (2006).
8. Brynjolfsson – Oh (2012) and Syverson (2017).

services and access a vast music library instead of individual albums. If CDs and streaming services are interpreted as separate products, the digital transformation is not directly reflected in the price index for traditional CDs. Future changes in subscription prices of streaming services are reflected in the index only after the services have been added to the goods basket of the index.

The selection of outlets and companies in the price index sample may cause bias if the price levels or price developments between outlets differ, the sample is not sufficiently representative or consumption shares between outlets have not been estimated correctly. The increasing popularity of online shopping (and also of discount stores) in recent decades has presumably caused an upward bias in price indices. New cheaper shopping venues entering the markets do not directly cause a decline in the CPI; instead, the products of these businesses are eventually included in the goods basket (somewhat similarly to new goods).

These measurement challenges are reflected in economic growth estimates. Analytically, it can be shown that the observed growth rate of real GDP deviates from the growth rate of GDP extended by unobserved output, if developments in nominal GDP or price indices are measured wrongly or the growth rate of unobserved GDP deviates from the growth rate of observed GDP. Even though some production is not counted in the statistics, this does not necessarily cause a bias in the GDP growth figure.

Measurement errors related to real GDP matter less when monitoring economic cycles than when assessing long-term trends.[9] The perception of cyclical conditions is largely based on changes in the growth rate of GDP. If the measurement bias is constant, i.e. independent of cyclical conditions, the phases of economic cycles are still observable as long as the bias is taken into account in the trend growth rate. If, however, the magnitude of the bias changes, this can lead to erroneous conclusions about economic conditions. Studies show that new goods are created more (in net terms, while there is also product destruction) during economic expansions, and therefore the measurement bias is in this respect procyclical.[10] Hence, the impact of cyclical fluctuations on well-being may be stronger than measured.

We should pay more attention to digitalisation

It is not a simple or easy task to build an overall picture of a national economy. Challenges related to the measurement of the economy have always been considerable. Digitalisation is reshaping the economy and society in a number of ways, which creates new challenges to those who produce and interpret statistical data.

The current system of national accounts and its concepts and measures are largely relevant and accurate in capturing economic output, income formation and consumption. The bulk of output can be measured appropriately.[11] With the progress of digitalisation, however, the economic structure is increasingly focused on products for

9. E.g. Feldstein (2017).
10. Broda – Weinstein (2010).
11. Groshen et al. (2017).

which it is difficult to estimate changes in quantity, quality and price. Classifications of economic activities and goods are ill suited to assessing the digital structural change, since ICT has already become part of almost every aspect of economic activity, just as electricity in the past. As part of ongoing statistical development, however, more attention should be devoted to digitalisation.

Developments in well-being should be assessed on the basis of diverse metrics. There is, however, a strong connection between measures depicting the economy and developments in well-being. It is possible that this connection will weaken to some extent with technological advances, since the impact of digitalisation on higher living standards is not fully reflected in economic statistics. It is not appropriate to assess welfare developments solely on the basis of economic metrics, nor should we do so without them. Besides GDP, the national accounts also include other measures that capture overall economic developments (such as net domestic product and national income). The usability of these measures has heightened further.

The economic literature does not provide a commonly agreed method for estimating the magnitude of the measurement bias stemming from digitalisation. Nor was there an adequately comprehensive and profound estimate available of the change in the magnitude of measurement errors caused by digitalisation at the time of writing this article. The general view among researchers would seem to be that it is impossible to give a precise estimate of the measurement biases related to various metrics, although more is known about their direction. A comprehensive assessment of individual phenomena related to digitalisation can show the probable direction of measurement biases and reveal which factors are of sufficient magnitude to impact the overall picture of the economy.

Free services, quality changes and global intellectual capital are perhaps the most significant challenges associated with the measurement of digitalisation. Free services increase consumer well-being but are largely excluded from economic statistics. Quality improvement in ICT devices and services is very challenging, and measurement errors may accumulate over time. Movements in global intellectual capital can cause huge level shifts in GDP and the related key figures.

Measurement errors probably explain some of the exceptional economic phenomena of the past decade, such as slower productivity growth, but cannot be regarded as the sole reason behind them. Discussion on the magnitude of measurement errors is still ongoing.

We should note, however, that measurement errors do not fundamentally change the view on public sector sustainability or cost-competitiveness. Economic growth that is not reflected in monetary market transactions does not boost the tax base. Unmeasured gains from digitalisation, such as free digital services, do not help to correct public sector deficits. In principle, we could assume that measurement errors are similar in competitor countries and do not therefore alter Finland's relative position.

When facing new measurement challenges, we should not draw the conclusion that the statistics would be less valuable and meaningful in supporting decision-making. On the contrary, because of the rapid technological transformation, it is even more important to

get reliable information on the condition of the economy and changes in economic structures. However, maintaining economic statistics relevant in a changing world requires ongoing development. Digitalisation also brings new tools to the production of statistics, and we should make use of these tools. Information is crucial for the functioning of the economy and the well-being of the public.

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Tags

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Authors

Juha Itkonen
Economist
firstname.lastname(at)bof.fi