Are GDP and Productivity Measures Up to the Challenges of the Digital Economy?

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ABSTRACT

Recent years have seen a rapid emergence of disruptive technologies with new forms of intermediation, service provision and consumption, with digitalization being a common characteristic. These include new platforms that facilitate peer-to-peer transactions, such as AirBnB and Uber, new activities such as crowd sourcing, a growing category of the 'occasional self-employed' and prevalence of 'free' media services, funded by advertising and 'Big data'. Against a backdrop of slowing rates of measured productivity growth, this has raised questions about the conceptual basis of GDP, and whether current compilation methods are adequate. This article frames the discussion under an umbrella of the Digitalized Economy, covering also statistical challenges where digitalization is a complicating feature such as the measurement of international transactions and knowledge-based assets. It delineates between conceptual and compilation issues and highlights areas where further investigations are merited. The overall conclusion is that, on balance, the accounting framework for GDP looks to be up to the challenges posed by digitalization. Many practical measurement issues remain, however, in particular concerning price changes and where digitalization meets internationalization.

"The digital economy now permeates countless aspects of the world economy, impacting sectors as varied as banking, retail, energy, transportation, education, publishing, media or health. Information and Communication Technologies (ICTs) are transforming the ways social interactions and personal relationships are conducted, with fixed, mobile and broadcast networks converging, and devices and objects increasingly connected to form the Internet of Things." (OECD, 2015a:11)

THE DIGITAL ECONOMY[2] is everywhere and is continuously redefining and transforming the way we work and indeed live. But there are increasing concerns that, as ubiquitous as it is, it is in large part absent from our statistics. The advent of new digital innovations was expected to spark a new wave of productivity growth, similar to those seen in the past, e.g. as a result of electrification, and the ICT wave in the 1990s, but this has not yet materialised, raising a number of questions. Some of these relate to better understanding the role that these new technologies play in fostering productivity and economic growth, such as

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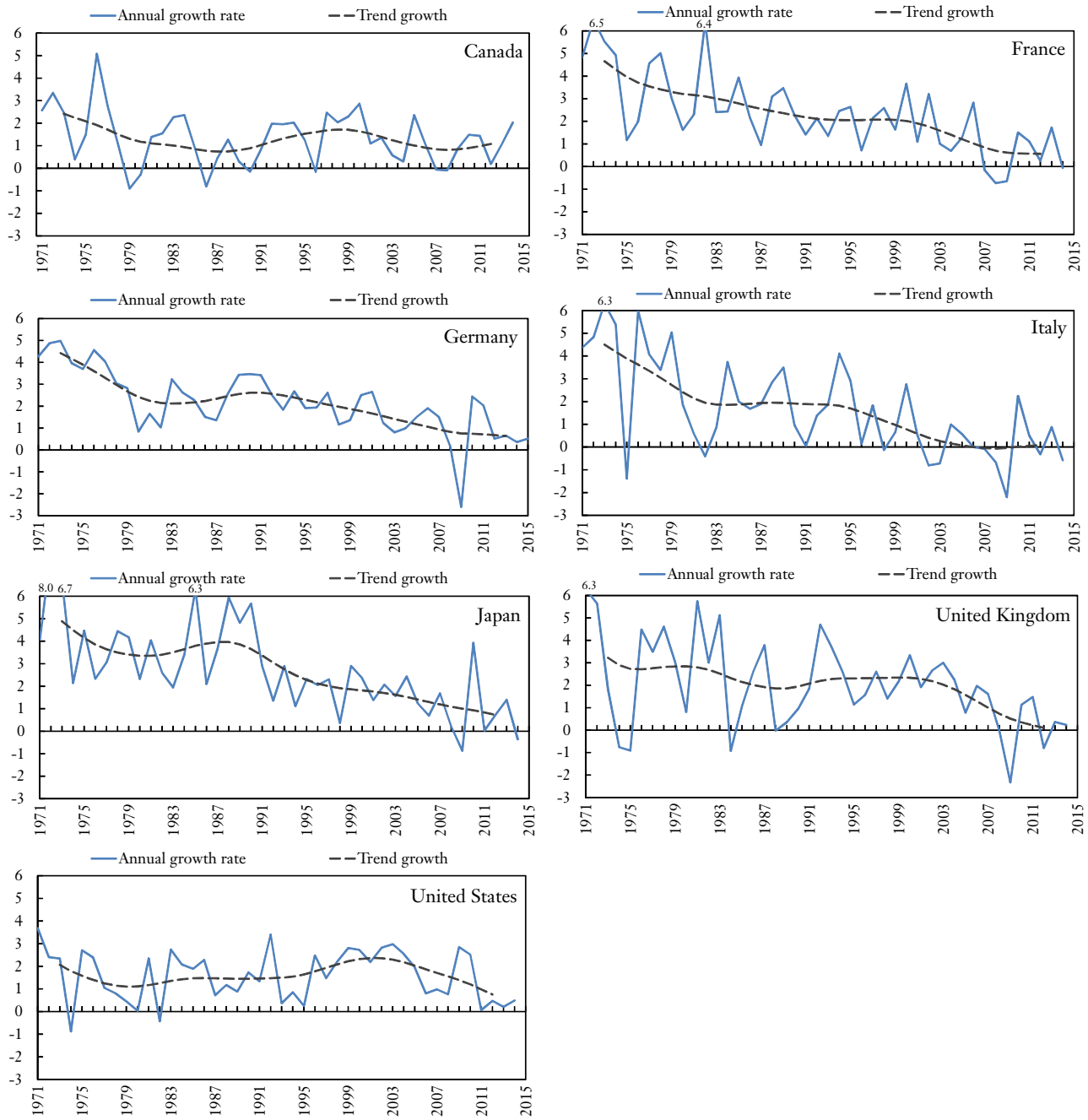
2 For the purpose at hand we use the terms 'digital economy' and 'digitalized economy' interchangeably.

Chart 1: Trend Labour Productivity Growth in G7 Countries

Total Economy, Percentage Change at Annual Rate



Note: Labour productivity is annual GDP per hour worker; trend estimates are derived using an HP-filter. See OECD (2016) Annex G for details.
Source: OECD (2016) *Compendium of Productivity Indicators*.

whether potential benefits are lagged, and the mechanisms and policy levers that can be pulled on to ensure that maximum benefits can be extracted. But many, and increasingly so, relate to measurement.

These concerns are of course understandable. The scale and pace of digitalization impacts not only the way in which businesses operate but also the way in which consumers engage with businesses and with each other. For businesses,

digitalization provides scope for improvements in production processes and access to new markets, but digitalization itself has also spawned many new businesses, and ways of doing business, whilst also providing significant scope for profit shifting across international borders. And digitalization has also impacted the role of the consumer, with households increasingly engaging in intermediation services that blur the divide between pure consumption and participative production.

This paper attempts to address the multitude of measurement issues raised by digitalization. Before beginning, however, it is useful to briefly frame the discussion in the context of the productivity slowdown that has to some extent precipitated the heightened spotlight on measurement.

The productivity slowdown observed in recent years has occurred at a time of rapid technological change, increasing participation of firms and countries in global value chains, and rising education levels in the labour force, all of which are generally associated with higher productivity growth. These seemingly contradictory facts have revived the debate on whether the productivity slowdown is a transitional phenomenon, longer-term condition, or indeed a function of mismeasurement. Whilst this puzzle remains true, it is important to note that the slowdown is not a recent phenomenon and indeed predates both the crisis and the current technological wave characterized by the digitalized economy (Chart 1). Of course this does not necessarily mean that mismeasurement is not an issue, rather it indicates that at best it cannot be singled out as the sole culprit (Byrne, Fernald and Reinsdorf, 2016). The remainder of this paper investigates the scope for mismeasurement looking individually at a range of transactions that characterize the digitalized economy.

New Forms of Intermediation of Peer-to-Peer Services

Although there is as yet no single definition of the digitalized economy there is at least a broad consensus that one of its manifestations is peer-to-peer (consumer-to-consumer) transactions facilitated by web-based intermediaries in the corporate sector. Perhaps the best known examples are Uber and AirBnB but others such as e-Bay have provided similar intermediation services for considerably longer.

Despite its novelty, giving rise to a new lexicon ('sharing economy', 'Uberisation', etc.), it is important to recognize that the underlying transactions that are the bread and butter of the sharing economy are in and of themselves not new. Households have long engaged in peer-to-peer transactions such as the provision of dwelling rental services, the provision of taxi services (often unlicensed), and the sale of second hand (and indeed new) goods (e.g. via garage sales and classified adverts). And GDP, at least conceptually, captures all of the related transactions and value-added created.

What is different about today's digitalized economy is the scale of these transactions. For instance, AirBnB now has a market capitalization close to that of Hilton Worldwide, and larger than that of other global hotel companies such as Marriott (Davidson, 2015). Such developments are driven by (1) the opportunities provided by web-based intermediaries to reduce entry barriers for households as service providers, increase market size, and minimize risks (both for the providers and the producers of the related services), and (2) the explosion in computing power and access to broadband that has facilitated consumer access.

> *"Between 2012 and 2013, smartphone adoption in OECD countries grew by 30 per cent, reaching a high of 73 per cent in Korea and an average of almost 50 per cent in 2013. Individuals use their smartphones*

for an increasing variety of activities with increasing intensity, including activities traditionally carried out on a computer, such as browsing the Internet, emailing or accessing a social network. More sophisticated activities, including online banking, mobile purchases and job search, are also experiencing fast growth. Many of these activities are carried out on dedicated mobile apps. Popular travel, mobility and retail apps have all made a recent appearance, pointing to the growing effect of digital services delivered via mobile apps on traditional sectors" (OECD 2015a:54).

The question therefore is not whether the conceptual accounting framework for GDP includes these transactions, but whether the compilation practices currently employed to measure peer-to-peer transactions, and which were designed to measure low-scale, relatively insignificant sums, are sufficiently robust to accurately measure them today.

Many of the characteristics of the 'sharing' economy, as described above, are common to informal economy transactions, i.e. transactions between unincorporated enterprises. But one aspect that differs concerns the role of the intermediary. The first question, therefore, is whether the current tools available to statistical offices can accurately capture the intermediation fees charged by the new digital intermediaries. To the extent that the intermediaries (at least those with not insignificant revenues) are registered in the national territory, and therefore in scope for traditional business surveys, the answer must be that their activity is likely to be captured in the accounts along with other registered entities. Where the entities are not registered in the national territory, so that the transactions between households and the intermediary are cross border, other complications (not unique to the sharing economy) may arise (as discussed below).

The more pertinent question therefore concerns the role of households as producers and in particular whether the current compilation methods adequately capture the underlying value-added produced, where this may be the case. Four generalized modes of peer-to-peer transactions, differentiated by the underlying activity of the sharing economy, are considered below. A fifth mode relating to business-to-business and business-to-consumer transactions is also considered.

Dwelling Services

The extent to which statistical information systems are able to accurately measure the scale of market transactions in dwelling services between households is difficult to say. Certainly in most countries the provision of such services is often accompanied by a requirement to register the related income for tax purposes. For long-term lettings, especially those facilitated by letting agencies, there is not likely to be a significant degree of under-recording, however this may not be the case for short-term occasional lettings. Prior to the advent of specialized (digital) intermediaries these infrequent lettings are likely to have been relatively small in scale and may not have been recorded exhaustively; indeed in some countries legislation permits tax-free letting services beneath a certain threshold. The advent of AirBnB has almost certainly increased the scale of these activities but there are two important factors to consider in assessing their impact on GDP.

The first and perhaps most important concerns the imputation already included in the national accounts for dwelling services (owner-occupied rent). These estimates assume that owner occupiers occupy their homes full-time, so, in theory, any unrecorded activity from short-term market lettings, such as those that typify AirBnB-type transactions, will at least in part be covered by the imputation for owner-

occupied rent. Some value of output will go amiss, however, as short-term rentals are likely to fetch a higher value than the longer-term rental values[3] that underlie the estimates for owner-occupied housing. These differences will reflect additional mark-ups including charges in return for the use of fixtures and fittings (e.g. furniture, Wi-Fi access) and associated labour input. More evidence is needed to gauge the importance of these mark-ups.

The second relates to the administrative nature of the intermediaries themselves and the scope they provide to improve measurement. As noted above, prior to the widespread use of registered intermediaries, the scale of infrequent short-term lettings is not likely to have been significant, but at the same time not likely to have been recorded, especially where the transactions did not involve an intermediary. But registration via intermediaries in and of itself is likely to increase the propensity for individuals to declare income to the tax authorities, especially in countries where VAT or a consumption tax is applied. AirBnB invoices, for example, include the name and address of the household engaged in letting services. Moreover the intermediaries themselves are also likely to have to declare their turnover, either directly for corporation tax, VAT and consumption tax[4] purposes or indirectly for occupancy or tourist tax purposes.[5]

It will be important for countries, and in particular those with data-sharing arrangements with the tax authorities, to make use of this source of information to develop estimates of any additional value of dwelling services that may arise in conjunction with new forms of transactions. At the same time, national accountants should be careful to avoid any double-counting of activity already included in imputed rent.

Business and Transportation Services

One important feature of the sharing economy is the role of intermediaries in bringing together unincorporated service providers (typically the self-employed) and households (consumers). The best known example is Uberpop but there are many other (and increasingly so) operators in this market, such as TaskRabbit that are helping to provide scalability and market access for the self-employed across a range of activities.

Again, the underlying activities in and of themselves are not new, and have been traditionally captured using the numerous approaches related to the informal and non-observed economy. Typically, for unincorporated units (e.g. those below administrative thresholds), this has meant using labour force surveys that capture the income of the self-employed and also secondary activities of employees. Often these estimates are augmented (validated) with expenditure estimates provided by household expenditure surveys used in supply-use tables. But where the activities involve an agreement between the two parties to engage in a cash transaction that avoids the payment of tax, notably VAT, it is unlikely that the activity will be recorded in GDP at all, short of explicit rule of thumb adjustments made to capture the activity. However, partly offsetting this, at least for productivity measures, is the likeli-

3 These are estimated as the equivalent of a longer-term rental of similar size and quality or by applying a user cost approach that captures the value of capital services. In addition the increased ease with which new digital intermediaries facilitate letting may have encouraged owners of unoccupied properties, held purely as investment vehicles and which may not have been captured in estimates of imputed-rent, to put these on the rental market, although this activity is not expected to be significant.

4 AirBnB charges VAT on its service fees for customers from the European Union, Switzerland, Norway, Iceland, and South Africa and Japanese consumption tax for customers from Japan.

5 For example AirBnB directly collects an occupancy tax in Amsterdam, San Francisco and Portland.

hood that the associated labour input will also be unrecorded.

The emergence of a wide host of intermediary service providers that link consumers to producers, coupled with increased and widespread broadband access, is likely to have significantly increased the scale of these activities by, typically, the 'occasionally self-employed'. This requires an examination of new approaches to measurement. Labour force surveys may continue to provide a useful vehicle for measuring these activities but they can only ever present an approximate approach and given the potential (and still uncertain) scale of these activities it may be necessary to identify complementary sources.

However, as was the case for dwelling services, although the intermediaries themselves may have increased the size of a long-standing measurement problem they may also provide a solution. This is because their turnover will reflect the underlying activities conducted, and additional administrative information may also be available relating to hours worked and sector of activity. It may be feasible to use data collected by intermediary service providers to improve the estimates of activities of unincorporated enterprises providing transportation services.

One additional complication presented by the growth in these activities concerns the nature of the underlying goods used to provide the services. The most important concerns motor vehicles used to provide occasional taxi-services, which raises issues concerning the delineation of consumer durables and gross fixed capital investment (dealt with below).

Distribution Services

A third important platform of the sharing economy relates to the intermediaries (such as e-Bay) bringing together buyers and sellers of goods (typically second hand but also new). Where these transactions concern unincorporated enterprises (below an administrative threshold) and households, in most countries, the standing assumption is that the distribution margin (in practice the value-added) is negligible or indeed zero. So, for example, if a household sells a second hand car via private listings to another household, the transaction will generate no recorded value-added by the household. If the activity relates to the buying and selling of a new good (and again for small scale activities) it is also unlikely that any value-added will be recorded.

Once again, the increased scale of transactions facilitated by digitalization may require a different approach to measurement. However, to some extent, there is a natural barrier of sorts to the size of the problem. For those unincorporated enterprises able to achieve scalability there is an increased likelihood of registering their activity for tax purposes, especially if they cross the VAT registration threshold and almost certainly if their customer base expands to corporations. For all other unincorporated enterprises, the assumption remains that transactions for each unit are not likely to be significant. The convention of not recording any value-added in these cases continues to appear reasonable.

This in practice produces the same results as transactions through intermediaries such as Freecycle (a non-profit institution linking households together to acquire, for free, second hand goods).

Financial Intermediation Services

Crowdfunding and the more narrowly defined peer-to-peer lending have emerged as not insignificant new sources of alternative financing in recent years. The latter refers specifically to intermediaries providing, in essence, liquidity transformation services, linking creditors and borrowers, while the former captures in addition broader forms of financing that typically reflect

equity-based stakes, or other explicit rewards, for creditors (again typically through an intermediary, and so share characteristics with venture capital vehicles).

Again, notwithstanding issues relating to cross-border trade, the value-added of the intermediaries, typically captured through explicit fees, will at least in theory be captured in GDP. It is important to note, however, that whilst these fees are a return for the liquidity transformation services provided by the P2P intermediaries, they are not the same thing as Financial Intermediation Services Indirectly Measured (FISIM), because (a) the transactions are explicit, with the gains (e.g. interest received relative to reference rates) from the intermediation services (after commission fees) accruing to the creditors (and often borrowers), and (b) the intermediaries are not classified as financial intermediaries with deposits and/or loans (the convention used in the 2008 SNA to determine the scope of financial intermediaries providing FISIM services). The conclusion from the above is that activities by P2P intermediaries are, in principle, fully accounted for in the 2008 SNA.

There is, however, another question related to the scope of FISIM and its limitation to banks that may require further deliberation as part of the 2008 SNA Research Agenda (United Nations, 2008). In practice creditors and borrowers use P2P transactions to seek higher returns (for creditors) and access to finance and often lower rates of borrowing compared to those the same borrowers would be offered by banks. This suggests that part of the FISIM activity provided by banks may, under P2P transactions, instead be provided by creditors (and potentially borrowers). In this case, households[6] would be engaging in a productive service by providing liquidity, transforming maturities and accepting risks.[7]

At the same time it has to be recognised that banks also provide a whole host of other services (convenience services such as offering safe deposits, the use of cash machines, accounting services, etc.) that are not provided by P2P intermediaries, and so FISIM services provided by banks would in any case be higher.

It is important to recall that this is not the first time the scope of FISIM has been under consideration. The recent Inter-Secretariat Working Group on the National Accounts (IWGNA)[8] Task Force on FISIM recognised that the scope of financial intermediaries providing FISIM services warranted further investigation, while the earlier OECD Financial Services Task Force also recognised the possibility that FISIM could in practice be provided in respect to other financial instruments and by non-financial institutions, but it also recognised that measuring the activity in a comparable way across countries, institutions and instruments would not be practicable, particularly in the context of equity, reflecting the difficulty in separating a FISIM component from holding gains and losses.

It is perhaps premature to call for a re-opening of discussions on the institutional boundary of FISIM but, as a first step, an improved understanding of the size of P2P lending across countries, at least relative to conventional lending, appears to be warranted even if current estimates suggest that numbers are still small. For example Price Waterhouse Coopers estimates P2P turnover (reflecting the commission and

6 Diewert (2014) considers also the financial services provided by non-financial firms.

7 By the same token, the activity of money lenders – highly relevant in developing economies – would be recognised as production.

8 The ISWGNA includes the statistical arms of the OECD, United Nations Statistics Division, Eurostat, the IMF and the World Bank.

not the underlying lending flows) in 2013 at $163 million in the United States.[9]

Other Intermediaries

Digital intermediaries are not of course only concerned with household-to-household transactions. Many intermediaries are engaged in linking producers to consumers, where at least one party is a corporation. Notwithstanding potential cross-border complications (discussed below), these, in isolation, present little conceptual or measurement difficulties. The appearance of new, web-based intermediaries in the corporate sector, merely results in a shift of intermediation revenues and value-added from traditional providers (such as a travel agent) to web-based providers (such as Booking.com), and as long as the institutions are recorded in administrative registers (as they would almost certainly be for large-scale players and those that engage in transactions with other corporations) their activities should be recorded in the national accounts. Note that the amounts involved here are the margins or service fees charged for the intermediation, not the value of the transacted service itself (such as the accommodation fees for hotel rooms or private accommodation rentals).

Consumers as Producers: Blurring the Production Boundary

The pervasiveness of internet access by households has helped to blur the traditional borderlines between household production for market purposes, own account production, consumption, and leisure. Increasingly households are involved in intermediation that would previously have been the almost exclusive preserve of a dedicated intermediary. In other words, households are increasingly engaged in activities that would previously have been included in GDP.

Perhaps the best example is the use of internet search engines or travel websites to book flights and holidays, previously the preserve of a dedicated travel agent. But there are many other examples that merit consideration under this broad umbrella where market production blurs with non-market activity: self-check in at airports, self-service at supermarkets, cash withdrawal machines and on-line banking to name but a few.

These innovations have all helped to transform the way consumers engage with businesses and brought with them associated benefits but they also involve greater participation on the part of consumers, and indeed involvement in activities that used to be part of the production process.[10] Because the involvement of the consumer displaces traditional activity, the question is whether this increased 'displacing' participation should be included in GDP, one of the main arguments being that GDP would be higher, for example, when a travel agent acts as an intermediary to conduct the search compared to when the individual conducts the search his/herself.

By convention the simple answer is no, and so current estimates of GDP, as defined, are not affected by the inability to record these participatory activities. Moreover the issue relating to lower/higher GDP depending on whether the consumer conducts the activity or not is neither new nor without precedent. There has been a

9 Value-added in the U.S. Finance and Insurance industry is around 1.2 trillion USD, so the PWC estimate is the equivalent of about 0.14 per cent.

10 However it is important to recognise that prior to digitalization, consumers were not entirely detached from the production process, either. They would still have to look at the proposals for example made by the travel agent and wait in long queues to cash in cheques or withdraw money, so one could make an argument that in some cases digitalization has decreased the participation of consumers in the production process (at least in terms of time spent).

long standing critique that many services provided by households for their own consumption (cooking, cleaning, baby-sitting, shopping) could in theory be provided by a third-party and so should be included in the production boundary, if only to avoid introducing temporal and cross-country distortions that might arise when higher disposable income allows households to purchase these services rather than produce them themselves.

But these have not been included, partly on the grounds that they would create other distortions to GDP (through the inclusion of a significant non-market activity) that would render GDP almost meaningless as a measure of economic activity and a tool for policy making, and partly because of the valuation difficulties involved.[11,12] Indeed the national accounting framework provides scope for only one type of service produced on own-account for own-consumption in the production boundary (owner-occupied housing services). Instead the approach and response of the national accounts community has typically been to encourage the development of satellite accounts that capture these non-market household services as a tool to provide improved insights into material well-being and a complementary view of GDP.

Although the scale of 'digitalized' participation activities is likely to be significantly less than those for other non-market services outside the production boundary, the inclusion of estimates would remain distortive and would still require a subjective view on the price of the activity. Moreover their incorporation would certainly precipitate the inclusion of a whole range of non-market activities, such as those described above, but also many others such as assembly (e.g. furniture), decorating, or transportation.

That is not to say, however, that this resolves all of the problems (and one particular issue concerning the role of consumers in the provision of 'free' services is discussed below). The increased participation of consumers in activities suggests that there may have been quality changes in the final services provided, requiring a careful consideration of the implications on price measures and hence on volume estimates of GDP (also discussed below).

Consumer Durables and Investment

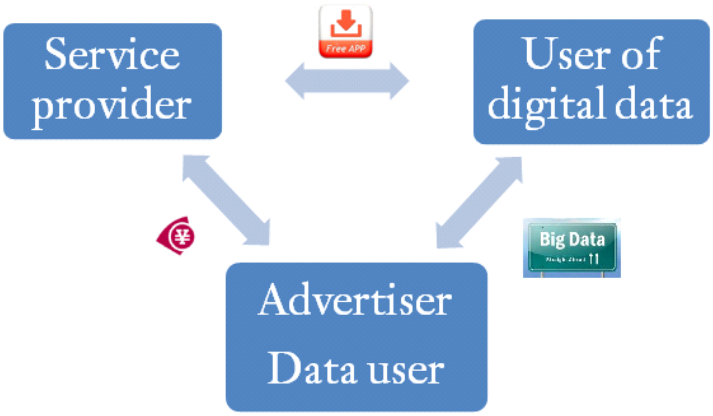
As noted above the sharing economy has seen an increased participation of unincorporated enterprises (households) in informal activities. This brings with it questions related to the delineation of dual use consumer durables and gross fixed capital formation.

The System of National Accounts does not provide prescriptive guidance on when durables should or should not be included as investment when they are used both for own-use and also in production by unincorporated enterprises. As such it is not clear whether current national compilation systems use the same qualifying criteria and, therefore, are necessarily able to capture increased investment that may have taken place from those individuals choosing to benefit from the increased market access provided by intermediaries such as Uber. A reclassification of consumer durables as investment does not affect GDP but has a direct bearing on measures of capital, and by implication, multifactor productivity. A better understanding of how countries make the relevant distinction and the source information used would clearly be welcome in order to assess the potential impact on productivity measures.

11 Note too that the valuation could be based on replacement or opportunity costs, which can lead to significant differences in the estimate.

12 See also Ahmad and Koh (2011) and Schreyer and Diewert (2014).

Figure 1: Free Products and Triangular Transactions



Free and Subsidized Consumer Products

Free digital products for consumers are frequently put forward as examples of output or consumer welfare that goes unnoticed in GDP figures. Such products include free apps for smartphones or tablets and free search capacity provided by websites such as Google. For instance, Brynjolfsson and McAffee (2014:108) argue that

> *"[…] There is a huge layer of the economy unseen in the official data, and for that matter, unaccounted for in the income statements and balance sheets of most companies. […] the trends in the official statistics not only underestimate our bounty, but in the second machine age they have also become increasingly misleading."*

To frame this discussion, it is important to note that the provision of free services by corporations to households is not a new phenomenon. Households have long been accustomed, for example, to receiving free media services (television and radio) financed implicitly via advertising. Indeed supermarkets often sell loss-leader products to attract customers and to build market share and banks often provide teaser rates and inducements to attract borrowers and lenders. The 2008 SNA Research Agenda (United Nations, 2008, Appendix 4.16) recognised that the provision of free products by corporations required further consideration:

> *"In the SNA, no final consumption is recorded for corporations because corporations are not considered to be final users of goods and services, except for capital products which, with the exception of valuables, are acquired for the purpose of production. However, large corporations often undertake sponsorship of cultural and sporting events. To date, the SNA regards the payments involved as a form of advertising but it could be argued that they are a form of individual consumption and could be treated as final consumption expenditure of corporations and social transfers in kind to households..."*

In this sense, digitalization has merely increased the scale of free or subsidised products and perhaps accelerated the need to proceed with this particular SNA Research Agenda item. But digitalization has brought with it another complexity, relating to the mode of financing. Whereas in the past the financing model was driven by advertising revenues or an attempt to create brand awareness, today's models are also increasingly financed by the acquisition of Big Data (on consumer preferences, characteristics and spending patterns). These two modes of 'finance' are considered in turn below.

Financing via Advertising

Financing via advertising involves a triangular set-up between the service provider, consumer and advertiser (Figure 1). The free (or subsidised) product is put at the disposition of the consumer and financed by advertising services for which there is an explicit transaction between the service provider and the advertising company. Assuming, for simplicity, that the services are provided for free, the sales generated by the service provider correspond to the value

of advertising services. Implicitly, therefore, the value of the free service provided to the consumer can be equated with the value of the corresponding advertising services.

Because there is no explicit payment by the consumer there is an argument that GDP is underestimated by the value of the free services received. Certainly GDP would be lower compared to the counterfactual, where advertising revenues are not used to subsidise the service. But this, to some extent overlooks the fact that, under the 'free' model, the consumer does indirectly pay through the higher prices paid for advertised products (as the firms paying for the advertising recoup their costs).[13] In which case, other things being equal, overall GDP would be equal in both cases; the only difference being different consumption patterns of consumers in the two cases.

The argument set out in the SNA Research Agenda[14] however points to the possibility of an alternative treatment that would increase GDP through (new) final consumption of corporations (with corresponding social transfers in kind increasing actual final consumption of households).

Nakamura and Soloveichik (2015) put forward a different (albeit similar) proposal (of particular interest because it provides estimates) that equates the time spent by households watching advertisements as an act of production, for which they are paid by the advertising firm, and in turn pay for the (previously free) services to the service provider. Consequentially, under this proposal, no explicit transaction would be recorded between the service provider and the firm paying for the advertising service, and both GDP and household consumption would be higher.

The authors impute a value of production by unincorporated household enterprises equal to the value of advertising receipts and use data on advertising expenditure for different media, along with an estimated price index, to gauge the quantitative impact of recording household production in this way on real GDP growth. Across about 80 countries, the imputed services consumed by households grew considerably faster (at 6.7 per cent per year) than overall GDP in

13 In earlier discussions on the scope of GDP, some (Kuznets (1948), Haberler and Hagen (1946) and Hicks (1948)) argued that government production should be treated as an intermediate product, as the value of services provided for free and financed by taxes was already reflected in the (higher) value of final products, and so their inclusion as general government final consumption led to double-counting. This view, as is now known, was not supported, the main argument (Gilbert et al. 1948) being that the collective services provided by government are not an element in businesses' cost and are consequently not reflected in the value of their output, unless one presumes an unrealistic identity between the services provided by government and the value of taxes that producers pay (see also Vanoli, 2005). The different treatment of free products provided by government and businesses was an important catalyst for the inclusion of the subject on the 2008 Research Agenda. But the analogy is limited. If, for example, government subsequently chose to charge households for individual services, all other things being equal, household final consumption would increase, offsetting the decrease in government final consumption, while gross value-added (GVA, GDP in basic prices) would be unaffected (but not necessarily GDP at market prices, which would depend on whether taxes on products, such as VAT, were in turn reduced). Similarly if media providers chose to charge consumers for their media services, rather than finance them indirectly via advertising, GVA would also remain unchanged. The media provider would continue to record the same level of value-added as would that of the firm that previously paid for advertising services (who would no longer be consuming intermediate services provided by the media company but whose gross output would in turn fall as the brand premium on output should also fall). This suggests that the recording of free products to households as consumption by government but not by businesses is not inconsistent. The same outcome would not, however, arise if the accounts already included an imputation for free media services. In this case overall value-added would be lower by the amount of the imputation. An interesting footnote, not central to the discussions at hand, is that GVA would not necessarily be unchanged were collective services provided by government charged for directly rather than financed via taxes if business were also made to incur some of these costs directly as intermediate consumption.

14 Another and similar accounting possibility is to impute a current transfer to households that they in turn use to purchase the media services.

real terms, although as they note, because of the relatively low share of advertising-supported entertainment in GDP the imputation has a negligible impact on GDP growth.

> "*However, advertising-supported entertainment accounts for less than 0.5 per cent of nominal GDP. Because advertising-supported entertainment is such a small share of the economy, its 4 per cent faster real growth rate only raises overall growth rates by 0.018 per cent per year" (Nakamura and Soloveichik, 2015:14).*

It is also interesting to observe that the nominal GDP share estimated by the authors has been remarkably stable over the last three decades, indicating that the exclusion of an imputation for advertisement-financed free services does not create a systematic downward bias in real GDP growth.

That being said, it is also important to recognise that the proposal is not without its own complications. The premise that households provide services to firms by participating in the production of advertising services perhaps stretches the third-party criterion of the accounting framework to its limits, as ultimately the effect is to engage in an activity that in the main increases their own propensity to consume the advertised products (and only indirectly has a third party effect if the households then engage in convincing others to buy the goods).

In addition it is useful to frame the proposal in the context of long-standing considerations relating to the possible inclusion of brands as produced assets in the accounting framework; proxied via expenditures on advertising. Whilst the Nakamura and Soloveichik proposal generates the same GDP as the option set out in the SNA Research Agenda proposal, this would not be the case if advertising expenditures were subsequently recorded as investment.[15]

Moreover, the Nakamura-Soloveichik proposal necessarily ignores the captive nature of households in this process of production and the fact that they have little control of the price charged for their services, which ultimately is determined by the service provider. But, under the proposal, the service provider is recorded as invisible in this process and is recorded only as providing services to households and not advertising services to other firms. This can lead to significant interpretative problems, not least for productivity. For example the model used by one service provider (say a television company) may be to show adverts every 15 minutes, for which it charges a lower price compared to another television company that shows the same programme only with adverts every hour (which is likely to attract more viewers and so a higher advertising price). In equilibrium, all other things being equal, the revenue for both firms would be the same but the hours 'worked' by one set of viewers would be considerably higher.

This, in turn, raises further complications pertaining to the actual valuation of the imputed flows of consumption, income and production.

15 Assuming that the SNA Research Agenda proposal as detailed on page 1 was accepted, GDP would be unaffected if advertising expenditures were subsequently treated as investment, as corporations' 'final consumption' would instead be recorded as investment. However if the Nakamura and Soloveichik proposal was accepted, GDP would be higher (again) if advertising expenditures were subsequently treated as investment, as the 'advertising services' provided by households and purchased by firms would then be recorded as investment by the firms purchasing these services, but the imputation for the free media services received by households (equivalent in value to the advertising services provided) would still be recorded as household final consumption. In other words if the value of the free services provided by media companies (and the value of services provided by households) was equal to X, the Nakamura and Soloveichik proposal would increase GDP by X. If in the future the SNA chose to recognise 'brands' as a produced asset (measured by the costs of production – namely advertising costs), GDP would rise again by X. So, relative to the 2008 SNA position, a combination of the Nakamura-Soloveichik proposal and recognition to treat brands as production capital would increase GDP by X+X.

The accounting proposals typically assume that the value of the 'free' products equals the observed value of advertising services. This is a matter of debate. Conceptually speaking, the valuation via advertisement is a producer valuation that may or may not correspond to a valuation by the consumer. When there are explicit transactions, theory suggests that the observed (equilibrium) price reflects both the marginal valuation of the consumer and the marginal cost of the producer. In the case at hand, nothing guarantees that this equality holds and one could indeed imagine a user value imputation different from the producer value. Apart from the rather complicated accounting arrangements necessary for such an approach, there is the important question of how to measure the unobserved user value. A shadow price would be required that reflects the consumer's marginal utility from spending an extra hour or minute producing the respective advertising services. This might be estimated through the opportunity cost of time spent, such as foregone earnings. There is an important literature on valuing leisure and household production that may provide guidance.[16]

Whatever the precise measurement of shadow prices, it is clear that consumer valuation should not attempt to measure total consumer welfare arising from the use of free digital products, just as the value of traditional market products is not a measure of consumer welfare.[17] Measures of the total value of consumer welfare such as consumer surplus are at odds with the conceptual basis of measuring GDP and income, let alone any welfare measure that goes beyond consumption and encompasses quality-of-life dimensions. There is no question about the importance of such measures and the OECD's work in this area[18] is but one example. However, measuring production and income is a different objective from measuring welfare. In addition, some elements of consumer welfare are automatically present when price indices that embrace a consumer perspective are used for measuring real GDP (see below).

Financing via Data...and Databases

The second avenue for the financing of free digital products is collecting and commercially exploiting the vast amounts of data generated by users of digital products. In many ways, this financing model resembles the advertising model: there is an implicit transaction between consumers (who provide data) and producers (who provide digital services for 'free' in return). A third party may or may not be involved. Economically speaking, the service provider finances its free services by building up a digital asset (volumes of data) that is subsequently used in the production of data services.

Although not explicitly spelled out in the SNA Research Agenda, which deals with advertising modes of finance, the model proposed there could also be applied here, resulting in GDP increasing. However (unlike the advertising model) the analogy is slightly more complicated here as there is no obvious proxy to establish the value of the services provided for free.

One approach could be to consider the new additional investment added to the database (owned by the service provider or a third party). But this is also problematic as, in practice, for reasons described below, the System of National Accounts only records, as investment, expenditures related to the digitalization of the data and not the inherent value of the data itself. Ultimately, it is the intrinsic value of the data that

16 For estimates in OECD countries see Ahmad and Koh (2011), Fraumeni (2008) and Landefeld, Fraumeni and Vojtech (2005). For a recent theoretical treatment, see Schreyer and Diewert (2014).

17 See Schreyer (2016) for a discussion of GDP and welfare.

18 For a discussion of OECD work on well-being, see OECD (2011a, 2013a, 2015b) and Boarini *et al.* (2015).

captures the exchange between the consumer and the producer. Moreover this presupposes that the whole is equal to the sum of the parts, in other words that the sum of individual pieces of data provided by households is equivalent to the totality of that data in a single dataset.

Where a third party is involved that pays the digital services provider to collect data on its behalf, it could be possible to use the associated payments it makes to the digital services provider to acquire the data as a suitable proxy but where no third party is involved this would again be problematic. An alternative approach, where no third party is involved, would be to estimate the increase in the market value of the database (including the embodied data and after adjusting for price effects and depreciation) and use this as the proxy. However, from a practical perspective this would be onerous as it would require an estimate for all digital services providers (as it would not be possible to determine a priori whether they collected data for their own intermediate use).

However even if it were possible to derive meaningful estimates there is a risk that, in imputing these values, the national accounts inadvertently opens the door to the capitalization of knowledge (and by extension human capital). It was, at least in part, to avoid this that the SNA recommends that only the costs of physical maintenance and construction of databases are included as produced capital, rather than the earnings potential of the data embedded in the database itself.

In all probability the market value of databases is likely to be significantly greater than a valuation according to the Perpetual Inventory Method (PIM), which values capital stocks using past investment (adjusted for depreciation and retirement). Indeed it is likely that it is only when databases are sold in their entirety (including the market value of the data embodied in them) that the full value of databases will be recorded in the accounts (as goodwill, i.e. not contributing to GDP).

Creating an analogy with the Nakamura and Soloveichik proposal presents additional problems as not all provisions of data by households (the corollary of consumers watching adverts) result in free goods or services being provided in exchange; supermarkets for example are increasingly engaged in the creation of Big Data without there being any explicit exchange (free or subsidised products) being made in return to consumers. The analogy therefore would lead to an imputed exchange being made for some provisions of data and none in others; in much the same way that consumers are exposed to advertising in a multitude of ways without there necessarily being an explicit exchange in return.

In summary, while it is clear that digitalization has increased the wedge between metrics of production and welfare, reinforcing the case for supplementing GDP and income with other indicators, it does not follow, particularly given the multitude of practical challenges presented and the conceptual considerations of capitalizing knowledge, that welfare measures should replace measures of production.

However, the arguments for an imputation should not necessarily be dismissed on the grounds that they are impractical nor because they open the door to capitalization of knowledge. The 2008 SNA Research Agenda already advocates further work to explore this issue, but its remit is unnecessarily limited to advertising modes of finance. The scope should be extended to consider data modes of financing and the consequential impacts any recommendations could have on the valuation of databases and knowledge more generally.

Free Assets Produced by Households

The provision of free services to consumers is not the only area where 'free' is in and of itself an

issue for the accounts. Conceptual difficulties also emerge when considering the creation of 'public goods' using labour provided for free, and where financing is typically only provided by donations (as opposed to paid services for the use of the goods, whether directly as fees or indirectly via other forms of financing e.g. advertising). Wikipedia and Linux are two well-known examples.

It is beyond contention that these have provided significant benefits for consumers and a case can be made that time spent on these activities includes an element of production but it is also clear that, within the current accounting framework at least, the services they provide as well as the work involved in their creation (correctly) do not enter into GDP.

This is not to say that they do not have value per se nor that they are excluded from the production boundary, as they clearly have value to users and can play an important role in the production process, but because production is free, by extension so too is the value of the assets.

Note that assets that have not been produced freely (at zero cost) but are available for free are included in the accounts and balance sheets.[19] For market producers, on the grounds that they create additional spillovers, such as brand awareness and increased likelihood of payment for premium services. For government, on the grounds that they deliver public benefits, with the value equivalent to the associated costs of production. Where the associated costs of production are zero therefore, as is largely the case with Wikipedia and Linux, it follows that these will not be included in the valuation of the final asset. In addition and perhaps most importantly, the very nature of the assets is that there is a collective 'global' ownership of the assets[20] meaning that it would not be possible, in any case, to record the assets on the balance sheets of any individual country.

That being said a better understanding of the economic benefits (and impact) through satellite accounts, in particular to households, but also to businesses (who may reduce recorded investment costs through the use of freely available software) would be welcome; not least to assess the potential consequences on estimates of multi-factor productivity that occur when paid for software is substituted by free software.

Cross-Border Flows of Intellectual Property and Knowledge-Based Assets

The 2008 SNA recognises five categories of intellectual property assets:

i. Research and development;

ii. Mineral exploration and evaluation;

iii. Computer software and databases;

iv. Entertainment, literary and artistic originals; and

v. Other IPPs.

With the exception of mineral exploration and evaluation, IPPs are subject to substantial international trade. As is clear from the OECD's work on base erosion profit shifting, intellectual property products have increased the ability of

19 The OECD Handbook on Deriving Capital Measures of Intellectual Property Products (OECD, 2009) says the following with regards to free intellectual property products: "Occasionally market producers make their originals available for free before the end of their physical and economic service life. But the fact that the IPPs are made freely available does not of itself exclude the IPPs from being recorded as assets. As long as the original producer still expects to obtain economic benefits from the IPP an asset remains." Other complications arise in conjunction with government owned assets for free use and are described there as well.

20 A comparison can be drawn with the SNA treatment of the atmosphere and the corresponding work of the OECD/Eurostat Task Force on the Treatment of Emission Permits in the National Accounts. Paragraph 46 says 'The decision not to consider the atmosphere as an asset in the 2008 SNA is consistent with the underlying philosophy of economic assets in the accounts. No value can meaningfully be placed on it in a national accounting sense, and crucially it is a common property resource that cannot be identified with a single owning entity, apart from at best, humanity in general'.

Table 1: Classification of Knowledge Based Assets

Computerized information (knowledge stored in programmes	Innovative property (research and development assets)	Economic competencies (human and organization capital)
Software*, databases*	Scientific R&D*, mineral exploration*, artistic originals*, financial product innovation, design, R&D in social sciences and humanities	Branding (advertising, marketing), training, organizational structure

* Contains assets currently capitalized in the official measure of investment.
Source: Corrado, Hulten and Sichel (2005).

firms to shift the registration (legal ownership) of their IPPs from one (high-tax) jurisdiction to another (low-tax), and as a consequence also shift the underlying value added created by these assets.

The international statistics community, starting with the OECD Task Force on R&D and subsequently UNECE Task Forces on Globalisation in the National Accounts and Global Production, have for a number of years strived to introduce clarity here, with a key focus on attempting to ensure alignment with the principles of economic ownership (i.e. who runs the risks and receives the rewards) but the current situation remains a work-in-progress with all Task Forces calling for further work to be conducted.

Unlike many of the issues raised above, the issue here is not necessarily that the related flows (payments and receipts) from the use of the assets are not recorded in the accounts – the issue is whether the flows necessarily align with national accounts concepts of economic ownership, rather than legal ownership.[21] One factor that has meant that current estimates are likely to default to legal ownership in practice reflects the fact that taxes are paid and recorded on the basis of legal ownership, and adjustments that relocate assets to the territory of the economic owner actually using them in production would result in further imputations of somewhat incongruous cross-border taxes.

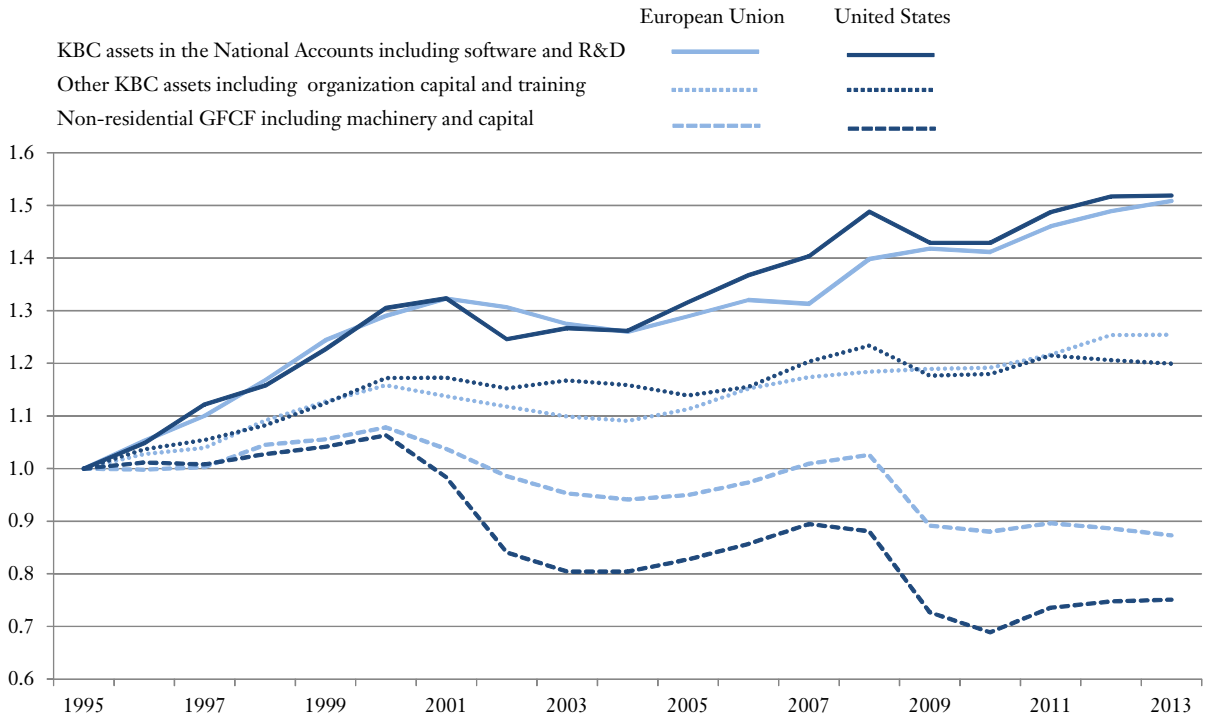
This means that current estimates, and comparability, of GDP across countries will be affected, although, to some extent, this is partly mitigated by balance of payments income flows (and so GNI) which will counter-balance these inconsistencies (although not in entirety nor necessarily in the same year, as profits can be 'parked' in the country where legal ownership of the IPP is established).

But this is not of course the only problematic outcome, productivity estimates may also be affected, and not only because value-added may be incorrectly allocated to any particular country but because the 'transferred' IPP generating the recorded value-added may not always be captured in cross-border international trade statistics. This may mean that the balance sheets (especially when estimated using PIM) in one country may be too high and in another too low. Further work is needed across countries to ensure that there is an underlying consistency between assets on the balance sheets, used for productivity analysis, and output. One important avenue for exploration would be through the development of accounts that break down national accounts estimates by activity (value added, expenditures and sales of IPP assets and services), and producing corresponding estimates of productivity, capital-labour shares, and primary income (payments and receipts) for the following three categories of firms: foreign affil-

21 The 2008 SNA (United Nations, 2008, paragraph 3.21) distinguishes between legal owner ('the institutional unit entitled in law […] to claim the benefits associated with the entities') and economic owner ('the institutional unit entitled to claim the benefits associated with the entities […] by virtue of accepting the associated risks'). Often, legal and economic owner coincide but not necessarily so.

Chart 2: Knowledge Intensity of Business Investment, Selected EU Economies and the United States, 1995-2013

Business Sector Investment by Type of Asset, Percentage of Gross Value Added, 1995=1.0



Source: OECD calculations based on INTAN-Invest data, www.intan-invest.net and OECD, *Structural Analysis (STAN) Database, http://oe.cd/stan,* June 2015. For added descriptions, see OECD (2015c) *Science, Technology and Innovation Scoreboard*.

iates, domestically owned firms with affiliates abroad, and other domestically owned firms.

This problem – a disconnect between capital stock estimates and recorded GDP, and hence productivity estimates - is exacerbated when the scope of digitalized assets is expanded, as many have argued. The most commonly used classification (of a broad scope of what has become known as knowledge-based assets) was developed by Corrado, Hulten and Sichel (2005). Table 1, which provides a description of those assets, shows that some of the assets are currently included in the 2008 SNA but many are not. Moreover, estimates suggest that the growth of knowledge-based assets (both those included in the SNA and those that are not) have typically, and significantly, outpaced growth in tangible assets (Chart 2).

However, where these estimates have been used in productivity analysis they typically assume that the knowledge based assets recorded in a given country are only used in production in that country (and often overlook the fact that the assets may in fact have been shifted offshore), but the assets themselves (even if they have not been shifted offshore), in particular brands owned by multinationals and organisational capital, can be used in practice to generate value added across a number of countries. This is likely to mean that productivity estimates will in turn be affected.

As was the case for assets already included in the SNA, reconciling the underlying asset with the flows of value added is non-trivial. Because of profit shifting (and parking of profits), investigations of intra-firm primary income flows will not necessarily provide the solution. In the

absence of profit shifting one could reallocate income flows related to the use of the underlying assets as value added generated in the territory of the parent company. This results in, all other things being equal, higher labour productivity figures in those countries with positive net receipts from knowledge based assets and lower labour productivity in those with negative net receipts.

The recommendations made above for intellectual property products apply equally to those knowledge based assets currently outside of the SNA asset boundary. But one immediate recommendation is for some caution in interpreting the productivity results that emerge from extending the asset boundary without adjusting for the cross-border use of the underlying assets.

E-commerce

The OECD's Guide to Measuring the Information Society (OECD, 2011b) defines e-commerce transactions as "the sale or purchase of goods or services, conducted over computer networks by methods specifically designed for the purpose of receiving or placing of orders." It is important to note, under this definition, that the goods or services are ordered by these methods, but the payment and the ultimate delivery of the goods or services do not have to be conducted online.

For transactions occurring within the economy and where at least one party is a registered enterprise, there is no particular reason to believe that e-commerce transactions present any greater difficulty for GDP measurement than transactions conducted using other modes. As noted above e-commerce transactions between households may present some difficulties but despite the growth in this activity in recent years it is only in rare circumstances (when in all likelihood the household will appear as a registered enterprise) that value added is likely to be underestimated, and so the problem is negligible, particularly when one factors in the balancing and validation process that supply-use tables embody.

Where problems may occur concerns cross border e-commerce of services, discussed in more detail below. Also, problems may exist for goods transactions. In many countries customs statistics only record imports of goods above a certain value. In theory therefore, and in the absence of complementary data sources, the assumption is that the supply-use balancing process is able to capture these 'missing' imports. But to what extent this is true is difficult to say. The OECD Statistics Directorate has recently begun an exercise to compare merchandise trade flows with comparable goods measures recorded in the national accounts, which should be able to provide some indication on whether these gaps have grown in recent years, as might be expected given the growth in cross-border e-commerce purchases. Nevertheless, work is on-going (see below) to explore additional data sources that may help capture these flows, chiefly through postal records and credit card transactions.

That being said, because most of the value of e-commerce goods transactions will be B2B and large scale, cross-border e-commerce goods transactions are not expected to create significant measurement errors in GDP.

It is difficult, however, to be as confident when it comes to cross-border e-commerce services transactions (such as streaming and downloading), as data is generally scarce (and where there is the added complication of illegal downloads).

UNCTAD, the Universal Postal Union, and the WTO have recently set up a Technical Group, including the OECD, to better measure e-commerce transactions, and it is hoped that this will deliver improvements in measurement and an indication of the scale of the current measurement problem.

Prices and Volumes

The sections above have all focused on the possible (mis)measurement effects of digitalization on current price measures of value added and GDP. But digitalization also creates significant challenges for prices, and hence volume-based measures of GDP and productivity. As was the case for current price measures, many of these challenges are not new, and are merely exacerbated by digitalization.

One challenge is customization that is enabled by digitalization. With products (in particular services but increasingly also goods) becoming more unique, price comparisons that control for quality differences become more complicated. The Eurostat-OECD Methodological Guide for Developing Producer Price Indices for Services (OECD 2014) provides detailed advice on this issue by product, highlighting a number of approaches that could be used for measuring price changes in specialized products (contract pricing, model pricing, component pricing, hedonic methods) but the fact remains that accurately measuring quality changes remains challenging. However, it is perhaps important to put the issue of 'customization' into its appropriate context when considering volume measures of GDP. Notwithstanding issues raised by the substitutability of products (see below), the objective is to measure price changes, not the price level of the product. Consequently, proxy estimates that employ comparable price changes over comparable (non-customized) products may limit the scope of potential errors on volume estimates.

A notable characteristic of digitalization relates to the multiplicity of 'pricing models'. The Bean Review (paragraph 3.15) observes:

> *"The pricing model for many internet and mobile services is one where a basic version is available for free with an enhanced version available to paying subscribers (the so-called 'freemium' model). Moreover, where a service is financed through a subscription, the subsequent use of the service is unlimited (i.e. there is a fixed cost for access but a zero marginal cost of use). This implies that the monetary transaction, even when recorded, fails to reflect the volume of digital product consumed; in effect, the price per unit is not observed."*

The implication here is that the volume of consumption may be under, or indeed over, stated. This is indeed the case if the unit of the service provided, and hence price measurement, is simply defined as 'one access to a digital service', regardless of the quantity of contents available and potentially downloadable by the subscriber. However, standard procedures of quality adjustment of price indices would in principle readily account for say a doubling of the offered contents in a streaming service by registering a corresponding drop in prices.

Moreover it is important to put the issue of product (quantity) paid for and product (quantity) consumed into some context because it is not new. The average consumer for example will often purchase goods (typically food) that they may not eventually consume, especially when supermarkets create incentives (e.g. three for the price of two). But it is clear that the accounts correctly record the purchases and not the actual consumption. The same can be said for digitalized products. In other words, whether a consumer downloads 10 movies rather than 5 from their unlimited subscription does not matter for GDP estimates (although this is another matter when considering consumer surplus).

As noted above an important feature of digitalization is in its creation of new business models. The Bean Review (2016:94) examines the case of accommodation services and conjectures that there may be a downward bias to volume measures:

> *"Gross value added from the accommodation services [provided by AirBnB] are*

currently deflated by the Services Producer Price Index (SPPI) and the Consumer Price Index (CPI). Both indices contain hotel prices but not Airbnb prices. Some analysis from 2013 suggests that renting an entire flat through Airbnb was 20 per cent cheaper than renting a hotel room, whereas renting a single room within an Airbnb host's home was almost 50 per cent cheaper. Moreover, an Airbnb rental is arguably superior to a hotel room due to the variety of choice, access to a kitchen, etc. Consequently, the failure to reflect the price of Airbnb rentals in the price deflator for accommodation services suggests that the value added generated by that sector may be underestimated, even assuming that Airbnb nominal expenditures are fully captured through surveys (which is a strong assumption)."

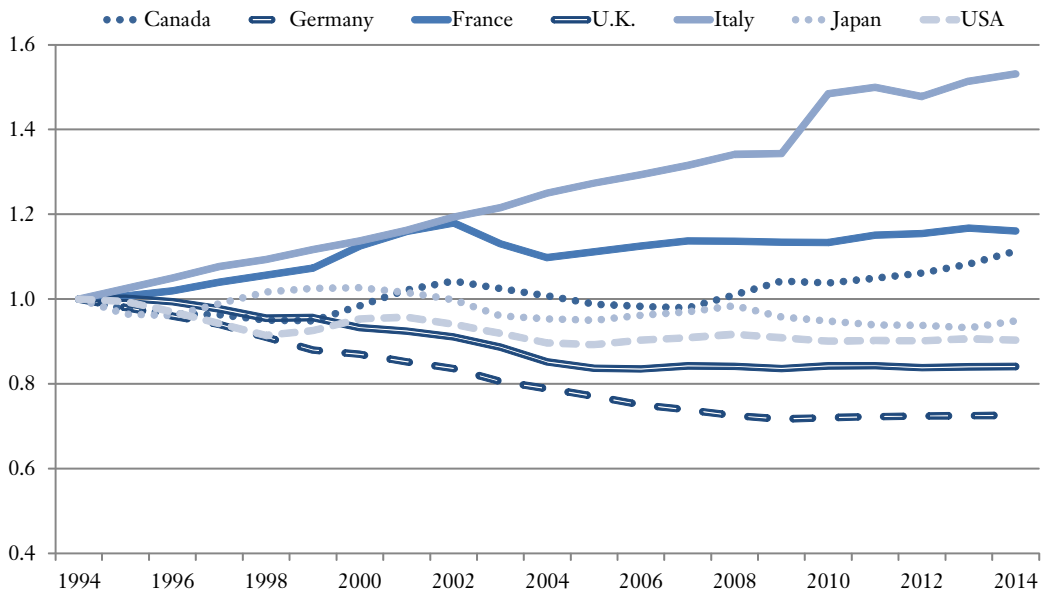
The underlying assumption made in the Bean Report is that AirBnB rooms are of higher quality than comparable hotel rooms. So the use of a price index that only refers to hotel rooms will fail to capture the switch to cheaper AirBnB rooms and underestimate the total volume of accommodation services. But the assumption of superior quality of AirBnB rooms is not without contention[22] nor is the presupposition that the two ways of providing accommodation services should be treated as a single product.[23]

Getting quality change and switching between products right may very well be the greatest challenge presented by digitalization as it is not, of course, limited to AirBnB nor indeed to new business models per se. The internet has had a democratizing effect that has reduced the space between buyers and producers, in the process piloting consumers towards cheaper suppliers and producers of goods and services, even within the same country. This reduces, other things being equal, recorded consumption for a given basket of products. But conventional price indices may not be able to capture this substitution effect, similar to the well-known outlet bias problem (assuming of course that quality is unchanged, which as highlighted above is not necessarily a given). Naturally, this may also have implications for the slowing productivity measures in the face of digitalization. Further investigations to determine how current price indices capture this potential bias, and indeed whether the substitution in and of itself should

22 Whether accommodation services provided through internet platforms are of superior quality is, at least, a point of discussion. Indeed, AirBnB provides a granular choice in terms of the location of accommodation services but whether, for a given location, the quality of accommodation is superior to the quality offered by a comparable commercial supplier is not clear. OECD (2014:178ff) provide an overview of the pricing methods for accommodation services. Price indices for accommodation services are rather complex and generally control for quality change in commercial provision of accommodation services. If commercial service quality trends upwards (as would be the case with rising room size or greater choice through food and beverage services; room service; banquet and catering services; telephone services; internet access; laundry services; parking facilities; etc.) this may not be representative of quality change in privately provided services and thus partly or entirely compensate for a possible downward bias from greater choice of locations.

23 The SNA (paragraph 15.66) states "differences in quality may be attributable to differences in the physical characteristics of the goods or services concerned and be easily recognized, but not all differences in quality are of this kind. Goods or services delivered in different locations, or at different times, such as seasonal fruits and vegetables, must be treated as different qualities even if they are otherwise physically identical. The conditions of sale, or circumstances or environment in which the goods or services are supplied or delivered can make an important contribution to differences in quality.... The same goods or services sold by different kinds of retailers, such as local shops, specialist shops, department stores or supermarkets may have to be treated as different qualities." Paragraph 15.67 states: "It is generally assumed in economic analysis that whenever a difference in price is found between two goods and services that appear to be physically identical there must be some other factor, such as location, timing or conditions of sale, that is introducing a difference in quality. Otherwise, it can be argued that the difference could not persist, as rational purchasers would always buy lower priced items and no sales would take place at higher prices."

Chart 3: Price Indices for Software Investment, Selected OECD Countries, 1994=1



Source: OECD Productivity Database, March 2016.

necessarily be captured as a price or a quality change, are necessary.

But these are not the only issues raised by digitalization. Long-standing challenges remain in some of the more mature problem areas, such as software for example, where the evidence points to significant differences across countries in measurement approaches.

Nor is this issue necessarily limited to software. Similar divergent movements might also be expected in other areas, such as ICT equipment[24] and research and development deflators. And other classic issues relating to quality versus price also remain in large part unresolved; notably the quality changes implied by increased consumer participation in intermediation activities, such as self-service supermarkets, all of which require further consideration.

However, as in other cases noted above, although digitalization has increased the size of the problem it may also be part of the solution. There is considerable scope to complement traditional methods of price measurement with new data sources and data-gathering techniques, including scanner data and web-scraping, which provide capacity to collect large samples of prices at high frequency – weekly or even daily. With a higher frequency of price collection, the turnover of models between periods of price collection is reduced, making it easier to match models[25] between consecutive periods, and so improve the ability to control for quality change. In addition this can help to reduce the size of of the well-known 'new goods bias' where prices of newly introduced models fall quickly in the period immediately following their introduction.

Hitherto, when prices are collected and resampled infrequently (every month, quarter or year), but the model change is rapid, additional methods of quality adjustment have had to be invoked, including often complex hedonic pricing methods.[26] The evidence suggests that more

24 See, for instance, Byrne and Corrado (2015).

25 Matching models is an established method to compare prices while controlling for quality change.

timely collection using digitalized sources can provide robust, and more efficient, alternatives.

A good example is Cavallo and Rigobon (2016:19) in reference to MIT's Billion Prices Project. The authors point out that "Online prices offer a simple solution to this [new goods] problem by providing a large number of uncensored price spells for all models on sale at any point in time. With this type of data, a simple index using overlapping qualities can closely approximate official indexes that use complex hedonic quality-adjustment methods." They demonstrate the capacity of high-frequency online price collection for dealing with quality change by showing monthly inflation rates for televisions in the U.S. market that closely approximate the results of the hedonic price index constructed by the U.S. Bureau of Labor Statistics.

Conclusions

On balance the accounting framework used for GDP looks to be up to the challenges posed by digitalization. Certainly from a conceptual perspective GDP does not look to be deficient. Indeed where conceptual issues do arise, these have been flagged up as actions within the 2008 SNA Research Agenda, or are of limited significance to overall GDP.

At the same time however it is also clear that in many areas, that affect both GDP and productivity, practical measurement remains a challenge – not least in the context of cross-border flows such as intra-firm flows of intellectual property and e-commerce transactions, where work is on-going.

In many of the areas where measurement is problematic, the underlying issue is not new. What is new is the scale of the problem. With new intermediaries and new modes of doing business increasing the size of more informal (sharing economy) transactions between households, conventional methods, which have hitherto provided rough estimates for these flows, may no longer be appropriate. However the very cause of the increased size of the problem (the new intermediaries) may also be a source of the solution, in that they provide potential access to new administrative data that records what were previously largely invisible (non-observed) transactions.

But this is not the case for all measurement challenges. The measurement of price change and in particular the distinction between quality and price change, which is both a practical and conceptual consideration, require increased and concerted efforts, not least because of the anecdotal and real evidence that points to widespread differences across countries. However, notwithstanding the conceptual challenges posed, by participative production for example, again, digitalization, and its scope to provide more frequent data collections, may itself provide part of the solution.

At the same time, it is clear (notably from the discussions on free services, the increasing participation of households in the production process, and prices) that digitalization brings further into focus the fact that GDP is a measure of production and not a measure of welfare or consumer surplus. This reinforces the need to complement GDP with other indicators that capture well-being.

Perhaps the most pertinent conclusion that can be drawn is the need for more evidence on current country practices in dealing with the issues raised above as well as empirical estimates of some of the phenomena at hand. This will allow researchers to gauge the size of current

26 See ILO et al. (2004). Boskin et al. (1996) brought the quality adjustment issue to the fore as the largest single element in the estimated bias of the U.S. CPI. A body of literature evolved in regards to the quality adjustment of high-tech products, aptly overviewed and assessed by Triplett (2006).

challenges and to develop more targeted best-practice recommendations.

As a follow up to this article the OECD will circulate a dedicated questionnaire shaped along the lines of the issues raised above as a first step in an overall strategy that could lead to more concrete practical guidance. This will also provide a vehicle to set out the groundwork for more elaborate discussions on some of the conceptual challenges raised, including considerations on whether, and if so how complementary measures (e.g. satellite accounts) could be developed that better identify the consumer surplus gained through digitalization.

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