Paper

Free services in the Netherlands

Martin van Elp,
Nicky Kuijpers,
Nino Mushkudiani

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Explanation of symbols

Empty cell	Figure not applicable
.	Figure is unknown, insufficiently reliable or confidential
*	Provisional figure
**	Revised provisional figure
–	(between two numbers) inclusive
0 (0.0)	Less than half of unit concerned
2022–2023	2022 to 2023 inclusive
2022/2023	Average for 2022 up to and including 2023
2022/'23	Crop year, financial year, school year, etc., beginning in 2022 and ending in 2023
2020/'21–2022/'23	Crop year, etc., 2020/'21 to 2022/'23 inclusive

Because of rounding, some totals may not correspond to the sum of the separate cells.
Revised figures are not marked as such.

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1. Introduction

The rise of the digital economy in recent years has greatly affected our daily lives. It has impacted our personal wellbeing by providing us with new services, goods, and sources of information. It also caused structural changes in many sectors of the economy. These rapid changes to the economy have led to concerns among economists: considering these large-scale developments, are we still measuring the size of the economy correctly? This question has often been related to the productivity puzzle, the unexplained decline in productivity growth ever since the financial crisis of 2008/2009. As the measurement of productivity growth depends on the national accounts, a possible explanation for declining productivity growth could be mismeasurement in these national accounts because of changes not captured in the existing framework.

A particular growing phenomenon that leads to potential measurement issues are *free services*. Free entertainment has been a conceptual problem for the national accounts since way before the digital age (e.g. Cremeans (1980)), but the digital revolution has led to a sharp increase in the size, value, and use of free services. Goods and services without a price are problematic in the national accounts framework because they cannot be readily measured in terms of value. While some free services do involve economic activity that is "visible" in market transactions, such as advertising costs of businesses, the consumer side of free services remains uncounted in GDP. Significant growth in the size and use of free services which is uncaptured in the national accounts could therefore potentially explain part of the decline in productivity growth.

In this report we aim to measure the size of free services in the Netherlands in a manner that is consistent with the national accounts framework. In order to do this we must first define what free services are, and examine in which ways they can be measured consistently with the SNA. We present a framework to identify free services, its suppliers and users, as well as the business models that could be used to produce these free services. Finally, we investigate whether there is a significant contribution of free services to the Dutch economy, and whether they significantly affect GDP.

This report is a continuation of the work in Van Elp & Mushkudiani (2019), where a first estimate of free services in the Dutch economy for the year 2015 was derived. In this report[2], we first perform sensitivity analyses to the estimation method employed in the previous report, changing several parameters and loosening assumptions. Secondly, more recent data is available and that allows us to make an estimate of the size of free services for the years 2015 through 2019.

Lastly, free services will also be measured using an alternative method which was not in the previous report, which we will call "free services margins". Free services margins are to represent the free services that have replaced paid-for goods and services, bridging the gap between observed quality-adjusted prices on the production side and perceived quality of total consumption on the consumer side. We present analyses applying this new method to the Netherlands.

The outline of the rest of this report is as follows. Chapter 2 starts with a broad overview of the literature on free services, as well as the different strands within this body of literature. In this

[2] A previous iteration of the work in this report was presented as 'Free services in the Netherlands' (Van Elp, Kuijpers, & Mushkudiani, 2022) at the IARIW conference in Luxemburg in 2022.

chapter we also present a framework in order to understand the different methods of measuring free services. Following, chapter 3 describes how we apply imputation of final consumption of businesses to estimate the size of free services in the Netherlands, and presents the results of this application. This chapter is an expansion and sensitivity analysis of the 2019 report. Chapter 4 proposes an alternative method to estimate free services, dubbed “free services margins”. The results of this method are also described in this chapter. Finally, chapter 5 concludes and discusses the findings.

2. Literature

Free services can be described as all services that are provided free of charge by households and companies (but not government) to households, companies and the government.[3] As this description is very broad, it can be unclear what exactly is a free service and what is not. Furthermore, there is no clear consensus on how the value and size of free services should be measured. This chapter aims to summarize these various aspects of free services based on the literature. First, the background of the literature on free services is discussed. We then provide a more in-depth evaluation of recent developments in two relevant strands of free services literature, namely the Consumer Surplus approach and the GDP approach. Finally, a framework is laid out for the measurement of free services, bringing together the various aspects of free services into tangible measurement methods and their relation to the national accounts. This framework serves as a base for the methods we apply in the following chapters.

2.1 Background

In the literature on measurement of free services we can distinguish two main strands of research. First is the Consumer Surplus approach, which measures the utility value of the free services provided to consumers. In order to perform such measurement one could employ for example choice experiments or surveys, with the intention of retrieving either willingness-to-pay measures or opportunity cost measures for certain goods and/or services. Another way to measure this is through time use data. The second approach attempts to include free services in the national accounts framework with the intention of measuring its effects on GDP. This strand of research is therefore also coined the GDP approach. There are several conceptual methods that can be employed to measure free services in the GDP approach. One could transfer parts of intermediate use to final consumption by businesses, impute viewership services by households consuming the free service, record data gathering costs as investments, or adjust prices of goods/services for their free characteristics. Regardless of the approach taken, measuring the value of free services in the economy is a challenging task, and both the Consumer Surplus approach as well as the GDP approach have their caveats.

As much of the literature on *free services,* and the measurement thereof, has already been explored in Van Elp & Mushkudiani (2019), we refer to that report for a thorough overview on the literature. The following sections focus on recent and novel additions, insights and research on both the Consumer Surplus approach and the GDP approach of free services measurement.

2.2 Consumer Surplus approach

There have been significant recent developments in the literature on the consumer surplus approach of free services measurement. Brynjolfsson, Collis and Eggers carried out massive online choice experiments in order to estimate the value of various digital goods, such as search engines, email, and social media, for consumers (2019). Rather than willingness-to-pay estimation, they evaluate the willingness to forgo instead, using actual incentive-compatible experiments. This ensures that the experiments accurately represent the real world preferences of the subjects. Evaluating the experiment results, they find that free digital goods and services have created large gains in well-being that are not reflected in conventional measures of GDP and

[3] This excludes ecosystem services that are 'free' as well. For the monetary valuation of ecosystem services for the Netherlands, see: https://www.cbs.nl/en-gb/background/2020/04/monetary-valuation-of-ecosystem-services-for-the-netherlands

productivity. In 2019, Brynjolfsson et al. build further upon the previously mentioned research and develop a new framework to provide estimates of welfare change, as well as real "GDP-B" growth, based on the values derived from the 2018 choice experiments. The "GDP-B" metric is an extended measure of GDP, which adds the utility benefits (in monetary units) of new and free goods to consumers to the GDP retrieved from the system of national accounts. They make an example estimation of the GDP-B measure, and find that including the welfare gains of just Facebook would have added between 0.05 and 0.11 percentage points to GDP-B growth in the US.

Hulten & Nakamura introduce a new concept to include free services in the measurement of GDP (2019). This concept incorporates a consumer choice technology into the traditional GDP concept of the national accounts framework. The method effectively falls in between consumer surplus approaches and GDP approaches, as it employs consumer utility in order to add a measure of free services to GDP as defined in the national accounts. However, since Hulten & Nakamura's resulting measure of GDP is a conceptual expansion of GDP as defined in the standard national accounts framework, we categorize the research as a consumer surplus approach rather than a GDP approach.

The idea of the paper is that there is a *consumption technology*, which transforms goods – measured in production prices – into consumption goods, from which the consumer subsequently generates utility. This utility however is not quantified within the national accounts framework. The concept is heavily based on Lancaster's consumer theory (1966). Employing the concept of a consumption technology allows us to express the difference between the price of goods, and the resulting well-being for consumers, in terms of monetary units.

To illustrate the theory, we can hypothesize the following example. Consider an app for mobile devices which allows drivers to make more efficient decisions in traffic. This app impacts the consumption technology, allowing the driver of the vehicle (the consumer) to generate more utility with the same good, in this case the car. It's important to note that neither the car itself, nor its price, actually change in this model. It is the *consumption technology* that changes over time, leading to a "consumption technology wedge" - a difference between the producer price and the experienced utility to consumers, which can be measured using choice experiments. The same concept can be applied to, for instance, websites that allow you to compare products or accommodations, and various other (similar) free services. In practice, the consumption technology theory can be used for free services measurement by inferring the utility functions from consumption or time use data, or choice experiments. The variable measured by this represents "costless consumption innovation". Measuring this costless consumption innovation (the shift in the consumption technology over time) allows us to then expand the standard GDP to an extended GDP (EGDP) by simply adding up their values. Hulten & Nakamura make a first estimate for this EDGP concept based on various pieces of consumer surplus approach research. They estimate that costless consumption innovation could expand U.S GDP by 100 billion up to a 1000 billion dollars. However, because their estimates are based mostly on individual products/services (such as Facebook), they are incomplete and should be interpreted with caution. Our alternative method "free services margins" in chapter 4 is conceptually similar to the method introduced by Hulten & Nakamura, but attempts to practically incorporate free services in the standard national accounts framework. In that chapter we will also show how this approach, with a consumption technology, can enter the supply and use tables.

While the aforementioned developments in consumer surplus approach research are important, in this report we approach free services exclusively from a national accounts point of view. Traditional consumer surplus approaches are not suitable to provide a value measurement of free services adhering to the current boundaries of the SNA for the following reasons. Firstly, the national accounts are based on market prices rather than utility values. This means that the resulting estimates from consumer surplus methods cannot be used in the current system of national accounts. Secondly, research aiming to quantify the (consumer utility) value of free services generally has to focus on the utility of a set of specific digital services, and is thus unable to capture all free services in their entirety. This difference in scope is problematic, as the goal should be to measure the entirety of free services in the system of national accounts. Anything less may suffer from underestimating the impact of free services on the economy.

2.3 GDP approach

In the GDP approach literature, since 2018, Byrne and Corrado introduced a method in which consumer digital goods and services are capitalized, and specifically augmented for the use and consumption of IT devices and subscription network access services (2020). They compare the accounting issue for "free" IT services to that of owner-occupied housing, arguing that the rapid growth of omitted services in both real and nominal terms warrants an imputation of these digital services. The value of the IT digital goods is determined by the intensity with which households use their IT capital to consume digital content (time use data), while the volume depends on the quality of the IT capital (network speeds for example). The complementarity between device use and network use allows them to develop a quality-adjusted price measure for the network access services already present in GDP. Doing so, they find that consumer digital services contribute nearly 0.6 percentage points per year to GDP growth from 2007 to 2017 in the US. Furthermore, they estimate that consumer welfare has also been enhanced by up to 1775 dollars per connected user from 2004 to 2017. We could summarize the Byrne & Corrado method as performing quality adjustment on the price of telecommunications services using time use data. The free services margins method presented in Section 4 also uses time use data to estimate consumption that is "missing" from paid-for goods.

While neither Hulten & Nakamura's method nor Byrne & Corrado's method are able to explain the entirety of the productivity puzzle, it is clear that a sizable portion of the economy is in fact not captured in current GDP measures when it comes to free services.

2.4 Measuring Free Services

2.4.1 Framework

In this section we lay out a general framework for free services, starting with the definition of free services, free service structures and business models, their relation with the SNA and the current approach of including free services in the national accounts. Given each of these elements in the framework, new approaches for including free services in the national accounts are then formulated. This framework is based on the framework presented in van Elp and Mushkudiani (2019), which is in turn based on various parts of the free services literature. It should be noted that the framework does not consider any consumer welfare approaches, and is exclusively directed at measurement of free services through GDP approaches.

To lay out a framework for the measurement of free services, we must first define the concept itself. As stated above free services are **all services** that are provided free of charge by households and companies (but not government) to households, companies and the government.

Government services are excluded because they are already included in the current national accounts framework as consumption. Free services include a wide range of activities, such as watching television (partly free, viewers pay subscription fees but the programs are funded through advertisements), listening to radio that includes advertising, watching free videos on the internet on platforms like Youtube, downloading and playing free video games, downloading and using free applications on your smartphone, but also non-digital services such as spectating a free sports event. In return for these services, the household or company provides the producer of the service with either part of their personal information/data or advertising viewership.

When attempting to measure free services in the national accounts, it is important to consider the mechanisms through which these services are provided. As the majority of content is provided to consumers at little to no cost, something other than the provision of the service provides these businesses revenue. From the literature, we can identify the following categories of business models in producers of free services:

1. Financing via advertising
2. Marketing-driven models
3. Financing via data
4. "Ubiquity now, Revenue Later"-Business models using investments
5. Freemium
6. Charity and free assets produced by households

Each of these business models is incorporated in the current system of national accounts (SNA) differently:

Advertising supported media. In the SNA media expenditures are considered intermediate expenses in the production of the goods being advertised. SNA's current method only counts Television and Radio broadcasts, by government and non-profit institutions, in final consumption. The advertising expenditures are part of revenues and intermediate use.

Marketing driven. It is often not possible to explicitly measure marketing expenditures. Most marketing expenditures are part of intermediate use or wages (employees producing marketing content). Examples of free services through marketing are free brochures, creation of viral content, and free apps that allow for targeted promotions.

Financing via data. Purchase of data is part of revenues and intermediate use, though less visible than advertising. However, when large data transactions cannot be traced and matched with monetary transfers (which indeed do not always occur), they are not included in GDP. The research question here is how to include the value of the data in the SNA.[4] Similarly, a question is whether data depreciates or not, and if so to what extent.

"Ubiquity now, Revenue Later". For companies that use venture capital to provide free services, the expenditures will be accounted for, though a big part might not count as investments. The goal of these expenses often is to grow a market, gain market share and/or create barriers to entry.

[4] More on the value of data for the Netherlands (in Dutch): https://www.cbs.nl/nl-nl/longread/aanvullende-statistische-diensten/2020/de-waarde-van-data-2001-2017

Freemium. For the freemium business model, revenues obtained from premium versions are included in the SNA. However, the value of the free products themselves is hard to estimate. It could potentially be considered an investment. If businesses collect freemium user data and use these data for their premium product marketing research or for improving or updating premium products, the cost could also be seen as R&D. Like 'Ubiquity now, Revenue Later', firms operating under this business model attempt to grow a market and/or gain a bigger market share.

Charity and free assets produced by households. These free services are completely missing in the SNA. It is difficult to measure and valuate the use of Wikipedia for example, or open source software such as R. Though the consumption of paper encyclopaedias has clearly dropped because of Wikipedia. The free knowledge Wikipedia provides is available to everyone with an internet connection and its use will probably even lead to technological progress.

2.4.2 Current situation

This section will briefly summarize how free services are currently treated in the national accounts. For a more detailed explanation including a numeric example, refer to chapter 3 of van Elp and Mushkudiani (2019).

As mentioned in the previous section, different business models of businesses providing free services lead to different transactions in the SNA. However, they all have one aspect in common, which is that the transaction of the actual free service being consumed by the household is not accounted for. What we generally do identify are the costs of the business providing the free service, either as intermediate use or investments, as well as the revenue obtained through paid-for advertised products, marketed products, or data if applicable. The conceptual issue with this treatment is that in most cases expenditures associated with services provided free to households show up as intermediate use, not investments or consumption. This means that they do not lead to an increase in GDP, even though free services provide significant economic activity and value. Because the consumption side of free service transactions are missing, growth in the consumption of free services over time could lead to underestimation of the GDP, perhaps even partly explaining the productivity puzzle.

In the following chapter, an alternative method to treat free services in the national accounts is discussed, and subsequently carried out for the Dutch national accounts. This method aims to transfer free-services related intermediate use of businesses to final consumption by these businesses.

3. Final consumption of free services by businesses

This chapter presents the method to estimate the impact of free services in the Dutch national accounts using the imputation of final consumption by businesses. This is a GDP approach based on a proposal in Ahmad & Schreyer (2016). We will briefly introduce some background of this method and its implications, followed by a description of application of the method in our specific use case. Finally, the chapter ends with results from the application of final consumption of free services by businesses to the supply and use tables of the Netherlands for several years. These results are a sensitivity analysis of the results in van Elp and Mushkudiani (2019), and also provide results for more recent years.

3.1 Backgrounds

With the imputation of final consumption by businesses that replaces intermediate use we treat advertising, as well as other costs that lead to the creation of free services, as final consumption expenditure of corporations and social transfers in kind to households. The imputation of final consumption by businesses demands very little expansion of the existing SUT, and is as simple as transferring values from intermediate use to final consumption. The idea is that companies, through their intermediate inputs, pay for services that are provided for household consumption, for free. These services are hence not used to generate the outputs of the using economic sector, and are actually not just intermediate use. Instead, this portion of intermediate use is actually a mechanism that creates free services (in the example below, television entertainment) for consumers.

Figure 1 Soap – TV economy, advertising as individual consumption.

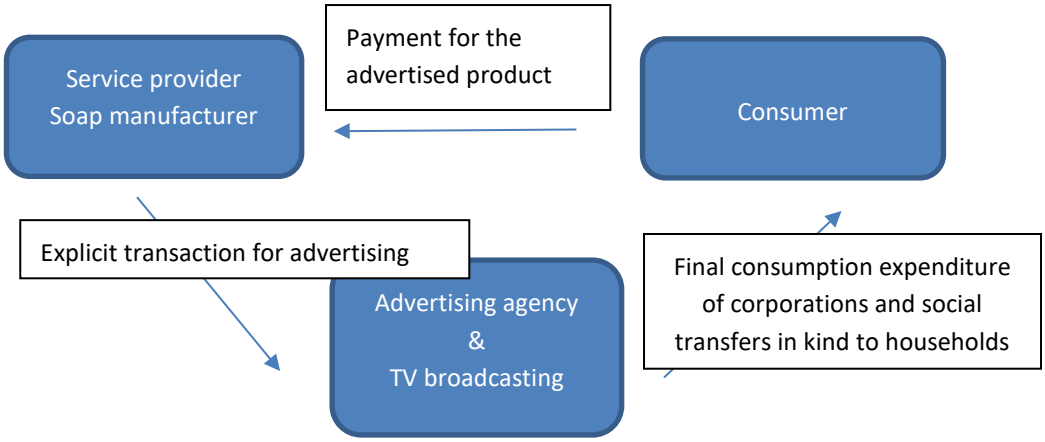


Figure 1 illustrates how the method accounts for transactions in a simple Soap-TV economy, which is an example of the advertising supported media business model. In this example, the final consumption by corporations that goes to consumers as a free service is passed on by the advertising agency. That is the display time and space that the advertising agency bought for a consumer and practically gave away as a free gift. For this transaction we then create a new entry in final consumption.

– This approach is relatively easy to implement, as it requires very little expansion of the existing supply and use tables, but merely transfers values from intermediate use to final consumption (of businesses). The data requirements, besides the SUT, is information about the proportion

of intermediate use (of advertising/marketing) that does not lead to the provision of the free service but covers other expenses like that of sales agents.

Table 1, below, presents consolidated supply- and use tables for this expanded Soap-TV economy. The difference is:

- The advertising agency now buys two types of display time from the TV broadcasting company.
- It still buys display time (20 million) as an intermediate input. These are the costs of the advertising department and administration at the TV broadcasting company.
- In addition, it buys display time (30 million) that is gifted to households as free entertainment. For this amount actors, screenwriters and other creatives have been working to offer the entertainment to households.
- This 30 million of entertainment display time is recorded as final consumption by businesses, raising GDP through the expenditure approach by the same amount. As a consequence value added increases, raising both the production and income approach of GDP.

Table 1 Extended Soap-TV economy

Supply

	Soap manufacturing	Advertising	TV broadcasting	Imports	**Total**
Oils and Fats	.	.	.	100	**100**
Soap	50	.	.	30	**80**
Advertising	.	50	.	50	**100**
Display time	.	.	50	.	**50**
Total	**50**	**50**	**50**	**180**	

Use (Before)

	Intermediate use					
	Soap manufacturing	Advertising	TV broadcasting	Final consumption by households	Exports	**Total**
Oils and Fats	50	.	.	10	40	**100**
Soap	.	.	10	40	30	**80**
Advertising	50	.	.	.	50	**100**
Display time	.	50	.	.	.	**50**
Total	**100**	**50**	**10**	**50**	**120**	

Use (After)

	Intermediate use						
	Soap manufacturing	Advertising	TV broadcasting	Final consumption by households	**Final consumption by businesses***	Exports	**Total**
Oils and Fats	50	.	.	10	.	40	**100**
Soap	.	.	10	40	.	30	**80**
Advertising	50	.	.	.	.	50	**100**
Display time	.	20	.	.	30	.	**50**
Total	**100**	**20**	**10**	**50**	**30**	**120**	

There are some conceptual caveats to this approach, but for an experimental estimate, this suffices. As mentioned previously, besides the regular SUT, information on the proportion of intermediate use (of advertising/marketing etc.) that leads to the provision of the free service, and does not cover other expenses like that of sales agents, is required.

3.2 Method

In the previous section we conceptually described the imputation of final consumption by businesses approach (Ahmad & Schreyer, 2016). In this section we will estimate the contribution of free services to Dutch GDP using this method. The idea is to treat advertising, and other similar costs that lead to the creation of free services, as final consumption expenditure of corporations and social transfers in kind to households. This method was employed in van Elp & Mushkudiani (2019). In this report, we will elaborate on this method further, changing some parameters and varying some of the assumptions. Furthermore, the availability of more recent data from 2014 till 2019 allows us to present the results of this analysis for several years, and makes it possible to carry out a sensitivity analysis for both the results from the previous research (van Elp & Mushkudiani, 2019) and from the newly available data.

In order to impute final consumption of corporations as defined in the previous section, one must first determine which fraction of intermediate use is actually consumption by businesses of free services. We determine this fraction for each industry. In the Soap – TV economy this is the display time that is given to households for free as entertainment, valued at 30 million. Actors, screenwriters and other creatives have been working to offer the entertainment to households.

Equivalent to our previous research, we take the following steps to impute final consumption of businesses:

1 Define the fractions of intermediate use that is actually consumption by businesses of free services, which are then freely provided to consumers, using occupation data;
2 Use an industry by industry input-output table, so that we can apply the estimated fractions.

This method ignores the possibility that free services enter and leave the Netherlands through international trade, through international broadcasting or through Dutch citizens that live in the Netherlands and work abroad.

We must first estimate the fractions of production that are actually free services for each industry. These fractions are calculated based on employee wages and hours worked in each industry. We have selected the occupations that we assume mostly contribute to the production of free services. Free services reach consumers mainly through advertisements, which means that these occupations should be the main contributors to the production of free services. From quite a few career and job market websites we accumulate descriptions of occupations in the advertisement sector. Following our method, if we find designers working within the agriculture industry, we assume that they create websites for farmers or carry out other activities related to advertising or promotion. There may be some designers that change their profession, bought a farm or agricultural space and do not contribute to production of free services as designers within the agriculture industry. We assume however that such cases are very limited and at most lead to a small error.

Besides the selection of occupations closely related to advertising, which is the same subset of occupations used in van Elp and Mushkudiani (2019), we further extend the list with Software and Application developers. Free services are commonly provided in the form of apps or websites, which requires information technology on the back-end. Furthermore, Software and Application developers can also perform data analysis and collection, contributing to the provision of free services. However, IT occupations can also contribute to paid production and/or internal business IT structures. For example, a software developer in the insurance industry could work on in-house service that aids in determining risk profiles. For this reason, we estimate two extremes, one in which we do not include IT occupations at all and one in which we include the entirety of IT

occupations excluding the ones operating in the IT sector. These two extremes then give an indication of the lower and upper bound of the size of free services in the Dutch economy.

After combining the occupations from advertising with Software and Application developers we obtain a list which we assume all contribute to free services. We matched these lists with the occupations from the Dutch Labour Force Survey (LFS), which follow ISCO 08 classification.

The full list of selected occupations[5] that are assumed to generate free services are as follows:

Table 2 Selected occupations

Authors and linguists	Artistic and cultural associate professionals
Journalists	Sales, marketing and public relations professionals
Visual artists	Telecommunications and broadcasting technicians
Other creative and performing artists	Software and application developers
Graphic and product designers	

For the selected occupations of the Dutch labour force we want to estimate the total hours worked as well as the total wages obtained within each industry sector. The variables we require are therefore: occupation, hours worked, wages and industry of employment. We have two data sources that contain these variables: the Dutch Labour Force Survey (LFS), and employment registry data (ER). The LFS includes the variable occupation, and its survey weights allow us to estimate the occupation totals for the Dutch population. It is a rotating panel survey consisting of five waves, collecting information about labour of households and individuals. For our study we consider only individuals and not households. The employment registry (ER) includes the other variables we are interested in: employee wages, hours worked and the industry of employment. The ER is an administrative data set that combines information from different administrative sources, mainly from Tax authorities but also from the Centre for Work and Income (CWI) and the institute for employees insurances (in Dutch, Uitkeringsinstituut Werknemers Verzekeringen (UWV)). The ER consists of administrative information on working persons, households, jobs, benefits and pensions. It covers the entire Dutch population, including persons living abroad but working in the Netherlands or receiving a benefit or pension from a Dutch institution, with the exception of self-employed persons. Self-employed persons are not included in the ER. However, they are included in the LFS, which means that if we link these two sources on a micro level we will lose all self-employed persons from the LFS. There are also some other minor coverage issues between the two sources.

From the linked data we obtain estimates of the number of employees, wages earned, and hours worked on the aggregate level for all nine selected “free services occupations” within each industry. We employ aggregated estimates from the labour accounts for the total wages and total hours worked for each industry. The ratios of the wages and hours worked of individuals with the occupations that generate free services and the total wages and hours worked of individuals without regards to their occupations gives us the fractions we desire. These can then be applied to the input-output tables of the national accounts in order to retrieve an estimate of the size of free services per industry.

[5] Translated from the Statistics Netherlands classification for occupations, with reference to the titles of ISCO 2008.

For our analyses we have performed calculations for the years 2014 up until 2019. The data was linked in a complex manner. The ER is our main data source, and we link occupation data from the LFS to ER records. Since the LFS is a sample survey, a relatively small number of individuals can be linked. For this reason we link three years of the LFS to each year of ER. For example, for the year 2014 we have the ER data linked with the LFS respondents from 2013, 2014 and 2015. We assume that the occupations of the LFS respondents do not change over one year.

We now follow with a more detailed explanation of the linkage of data sources. Starting with the year 2013, we select the LFS respondents for this year that have one of the nine occupations of interest (Table). In total, there were 4269 of these persons. We then link these persons to the ER data of 2014. Only 3166 of the 4296 LFS respondents could be linked. This resulted in 38409 records of ER data for these 3166 persons. Observe that we have more than one record linked in the ER for each LFS person. Since the ER is a monthly register, a person with one job will have 12 records per year, a person with 2 jobs will have 24 records, etc. For these 3166 persons we now know the hours worked and wages in 2014 from the ER and the occupation from the LFS of 2014, which is assumed to be the same as in 2015.

Similarly, we linked the LFS respondents of the selected occupations of the consecutive years (from 2013 until 2020) with the ER data. We show all counts obtained from this linking in Table 3. If we evaluate the ER years from 2014 until 2019, we find that they each have three years of LFS data linked to it. For example for 2014 (in bold in Table) in total 38409 + 37569 + 42871 of the ER records are obtained from the LFS respondents linked from three different years: 2013, 2014 and 2015. For all of these individuals we know the wages and the hours worked in 2014, and the occupation they had in 2013, 2014 and 2015. In this way we increased the number of respondents in one year. Note again that we assume that the occupation of these respondents did not change over the previous or following year. The downside of this approach is that for each year we have an overlap of respondents, e.g. for both 2014 and 2015 in the ER data we consider the LFS respondents from 2014 and 2015.

Table 3 Number of respondents per year

LFS Year	LFS respondents	Persons found in ER	ER Year	Records in ER
2013	4269	3166	2012	0
			2013	0
			2014	**38409**
2014	4094	3150	2013	0
			2014	**37569**
			2015	36266
2015	4600	3757	**2014**	**42871**
			2015	42864
			2016	41912
2016	4509	3493	2015	41098
			2016	41179
			2017	40005
2017	4672	3655	2016	42125
			2017	42812
			2018	42232

LFS Year	LFS respondents	Persons found in ER	ER Year	Records in ER
2018	6112	4738	2017	55061
			2018	55417
			2019	54519
2019	5781	4422	2018	52401
			2019	53245
			2020	0
2020	6258	4638	2019	55262
			2020	0
			2021	0

The LFS includes the survey weights for each respondent. These weights serve for estimating the variable aggregates on the population level. We employ these weights to obtain the estimates of the total number of employees, the total wages earned, and the total hours worked for all selected "free services occupations" within each industry for the Dutch population.

In year 2014 we have $n_{2014} = 4094$ respondents with the selected occupations. Using the LFS year weights, we obtain that the estimate of the total number of persons in the Netherlands with these occupations in 2014 is 523691. From these 4094 persons only 3150 were found in the ER register. For these 3150 respondents we have the estimate of the total number of the selected occupations in the Netherlands in 2014 by using the LFS weight:

$$N_{2014}^{ER} = \sum_{selected\ occupations} w_{i,2014}^{LFS}$$

Here $w_{i,2014}^{LFS}$ is the LFS weight of the respondent i. These estimates for each year are given in the table below.

Year, *T*	2014	2015	2016	2017	2018	2019
Population totals, N_T^{ER}	376859	419796	401502	416094	459326	476810

Since we actually use three LFS years we need to correct the weight accordingly. Similarly, define by N_{2013}^{ER} and N_{2015}^{ER} the estimates for 2013 and 2015. We include 2013 and 2015 respondents in our data as if they were 2014 respondents. We therefore need to adjust the weights, because we will have tripled the number of these occupations otherwise.

$$w_{i,2013}^{1} = \frac{N_{2014}^{ER}}{N_{2013}^{ER} + N_{2014}^{ER} + N_{2015}^{ER}} * w_{i,2013}^{LFS}$$
$$w_{i,2014}^{1} = \frac{N_{2014}^{ER}}{N_{2013}^{ER} + N_{2014}^{ER} + N_{2015}^{ER}} * w_{i,2014}^{LFS}$$
$$w_{i,2015}^{1} = \frac{N_{2014}^{ER}}{N_{2013}^{ER} + N_{2014}^{ER} + N_{2015}^{ER}} * w_{i,2015}^{LFS}$$

If we add all of these weights we will have N_{2014}^{ER} persons with the selected occupations in 2014. The correction factor here is

$$corr_T^1 = \frac{N_T^{ER}}{N_{T-1}^{ER} + N_T^{ER} + N_{T+1}^{ER}}, \text{where T } = 2014, \dots, 2019.$$

The estimates of this factor are given in this table:

Year	2014	2015	2016	2017	2018	2019
Correction factor 1	0.326	0.353	0.327	0.327	0.340	0.337

When we linked our LFS respondents to ER data we lost quite a few respondents. We need to correct the weights also for these lost respondents:

$$w^2_{i,2014} = \frac{w^1_{i,2014}}{N^{ER}_{2014}} * N^{LFS}_{2014}$$

Here N^{LFS}_{2014} is the estimate of the total number of persons in the Netherlands with the selected occupation of all 2014 LFS respondents. This estimate can be calculated in a similar way as N^{ER}_{2014}. The second correction factor is then:

$$corr^2_T = \frac{N^{LFS}_T}{N^{ER}_T}, \text{where T } = 2014, \ldots, 2019.$$

The estimates of this factor are as follows:

Year	2014	2015	2016	2017	2018	2019
Correction factor 2	1.363	1.247	1.393	1.346	1.256	1.36925

Applying both of the aforementioned correction factors to the LFS weights we finally obtain the estimate for the total number of persons with the selected occupations in the Netherlands.

In the previous report, the value of free services was estimated under the assumption that each using industry consumes the exact same share of free services (based on the supplying industry). While this does not matter for the estimate on the total impact of free services, refining this assumption allows us to also evaluate which industries consume the most free services. To do this, we can employ national accounts data on the proportion of household consumption in the total size of each industry. The idea behind this is that industries in which household consumption plays a larger role are more likely to contain free services, as the target audience of free services tend to be consumers rather than businesses.[6] We can then model a relationship between the prevalence of consumption in an industry and the consumption of free services.

In order to determine which industries consume what amount of free services, we first estimate the proportion of final household consumption within each industry as a fraction of total use (between zero and one). This fraction is then rescaled linearly, where the industry with the lowest amount of household consumption has a weight of 0.33 while the industry with the largest amount of household consumption has a weight of 3. This rescaling is done to prevent extreme outliers on the tail ends of the distribution. Finally, the resulting consumption weights are included in the multiplication of the LFS share and intermediate use of an industry as follows.

$$free\ services_{s,u} = LFS\ shares_s \times intermediate\ use_{s,u} \times consumption\ weight_u$$

Where s is the supplying industry and u is the using industry. Finally, the resulting free services values for each supply-use industry combination are rescaled back to the pre-weighted industry totals, so that the total level of free services remains unaffected. This way only the distribution of free services among using industries is changed. This correction is displayed numerically for a small subset of industries in appendix A as an example.

[6] Businesses can theoretically be the recipient of free services as well. However, in this case their value ends up in intermediate use, and is thus not included in GDP.

The application of the wage/hours worked fractions at the industry level to the Dutch national accounts, and the resulting GDP figures, are discussed in the next section.

3.3 Results

To determine the contribution of free services to GDP we need the fractions as determined in the previous section:

- Fractions of hours worked by creators of free services and marketers in an industry.
- Fractions of wages by creators of free services and marketers in an industry.

By applying these fractions to the input-output table of the Dutch national accounts, we retrieve estimates of which parts of intermediate use, retrieved from industries that also produce free services, are actually consumption of free services. It is important to emphasize here that this approach is therefore **not** a sum-of-cost approach, as the fractions are applied to output of the supplying industries that end up as intermediate use by other industries.

We split this consumption of free services into three parts:

- Consumption by businesses of free services, excluding marketing and IT.
- Consumption by businesses of free services, IT.
- Consumption by businesses of free services, marketing.

This means we distinguish explicitly between marketing, IT and all other selected professions. As in van Elp and Mushkudiani (2019)[7], marketing is presented separately because free services created by marketing people arguably have a different nature from those by the other selected professions. The other professions lead (more directly) to services ready for consumption. Free services created by IT occupations (software developers) are included separately because their inclusion is novel, hence we want to assess the impact of these professions in more detail.

In the following sections, results will be displayed for the years 2015 up until 2019. 2014 has been omitted due to product and industry classifications being incompatible with the other years.

First, we look at the original Dutch GDP and its components for 2015 up until 2019 by employing the expenditures approach. Total GDP rose from 690 euros in 2015 to 813 billion euros in 2019. Consumption by households was 305 billion euro in 2015, and 44% of GDP. This proportion of household consumption drops slightly over time, to 43% in 2019.

[7] Appendix C has an overview of the evolution of our estimates over time. Besides improvements to our method, and the inclusion of IT professionals in response to feedback, the application of this research to the experimental Digital Supply and Use Tables (DSUT) for the Netherlands brought to light several issues with our earlier publications and research. For example government industries that do not have an operating surplus need special treatment In this method, which was omitted in 2019.

Table 4 Dutch GDP and its components, million euros, 2015-2019

Component	Value, 2015	Value, 2016	Value, 2017	Value, 2018	Value, 2019
Gross fixed capital formation	152,533	141,675	148,670	158,093	172,808
Final consumption, general government	172 354	174,680	179,491	188,611	200,134
Final consumption, households	305,372	310,430	321,600	335,773	347,622
Final consumption, NPISHs	5,444	5,611	5,661	5,787	5,925
Imports of services	(-) 165,668	(-) 135,848	(-) 147,337	(-) 160,522	(-) 161,176
Imports of goods	(-) 352,926	(-) 355,196	(-) 388,826	(-) 413,310	(-) 430,183
Exports of services	151,980	142,478	154,783	170,518	180,790
Exports of goods	418,373	420,899	460,770	484,921	490,287
Changes in inventories incl. valuables	2,546	3,446	3,334	4,116	6,848
Gross domestic product (GDP)	690,008	708,337	738,146	773,987	813,055

Free services are added to this GDP component table by applying the obtained LFS shares to each combination of supplying and using industry in the input-output tables, and transferring the obtained values to a new component, “Final consumption, businesses”. The shares used in the calculation are those of the supplying industry, as the activities of the selected occupations at the supplying industry are assumed to lead to the creation of free services paid for by the using industry. In addition, we assume that some industries do not produce free services.

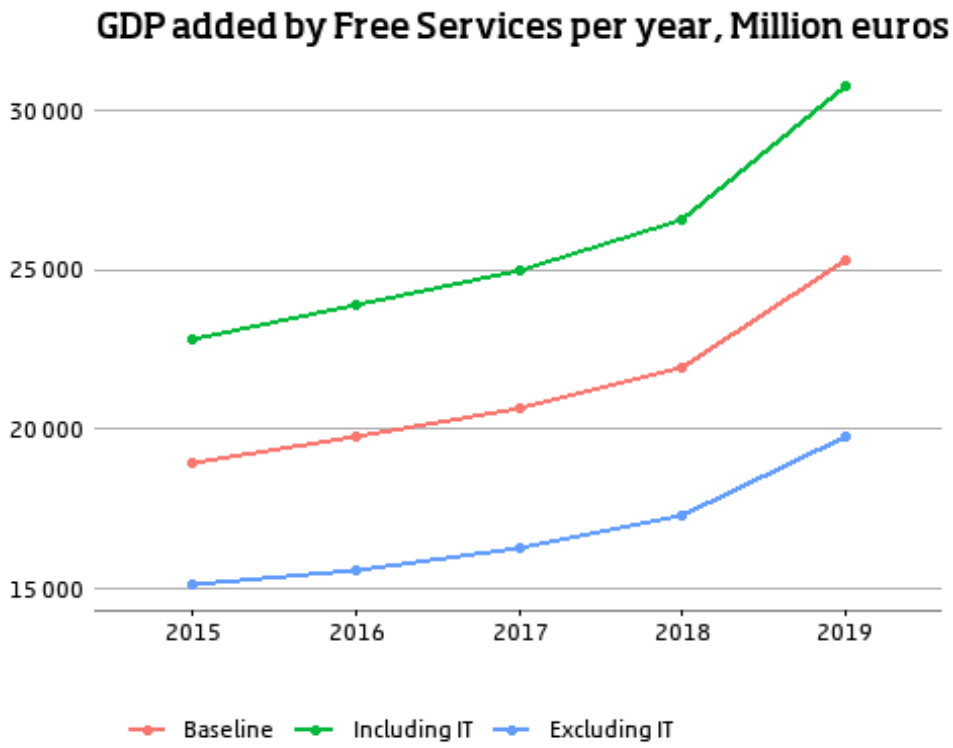
Firstly, industries considered not to produce free services are the publishing, marketing, and IT industries. The assumption here is that the selected occupations only generate paid-for outputs in these particular industries. Secondly, software developers in the banking sector are also excluded. This specific combination is a very large group of workers of which the majority is unlikely to produce free services. The banking industry is almost entirely digitalized nowadays, with many large software systems facilitating monetary transactions. We believe the employees developing, maintaining and supporting these systems should not be considered free services producers, as it is developed either for banks themselves or paid clients of the banks in question. Lastly, the entire industry “legal- and management advice” is excluded. This industry likely contains many IT and marketing specialists that register themselves as advisory firms, but in fact produce IT/marketing services. Including this would therefore lead to a significant overestimation of free services production, as these workers would not be included if they were (correctly) placed in their respective industries.

On top of the aforementioned exceptions, we additionally exclude the value of free services originating from inputs purchased by public services industries, such as public administration and government funded education. For these industries, production is assumed to be equal to the sum of costs. Theoretically, all inputs are therefore used to generate “regular” outputs rather than free services.

The LFS shares used in the following calculations are based on the salary of the free service producing occupations compared to the total salary in the respective sector, rather than the hours worked. The reason for this is twofold. First, salary is arguably the best indicator of productivity compared to the hours worked or the number of jobs, as employers take into account productivity when setting wages. Secondly, the estimates based on salary are the most conservative. LFS shares based on either the fraction of jobs or the fraction of hours worked are significantly larger, thus leading to larger free service estimates and a greater increase of GDP. The results employing salary shares can therefore be interpreted as a lower bound of the impact of free services. The finding that LFS shares are lower when employing salary shares implies that occupations that lead to free services in industries have a lower value added than other activities. This is not entirely unexpected, as the services in question are provided free of charge to households and businesses, rather than paid for.

Figure 2 indicates the value of free services that would be transferred from intermediate use to consumption by businesses for each year. This equates to the value that is added to GDP due to free services. In the figure we further distinguish between three scenarios for the size of free services. Estimates are displayed both excluding and including software developers (IT). As the true number of software developers (outside of the IT sectors) is likely somewhere between 0 and 100%, these two values can be seen as the lower and upper bound of the size of free services respectively. The baseline estimate displayed in the figure is the average of the bandwidth, and our preferred reference of the size of free services for each year.

Figure 2

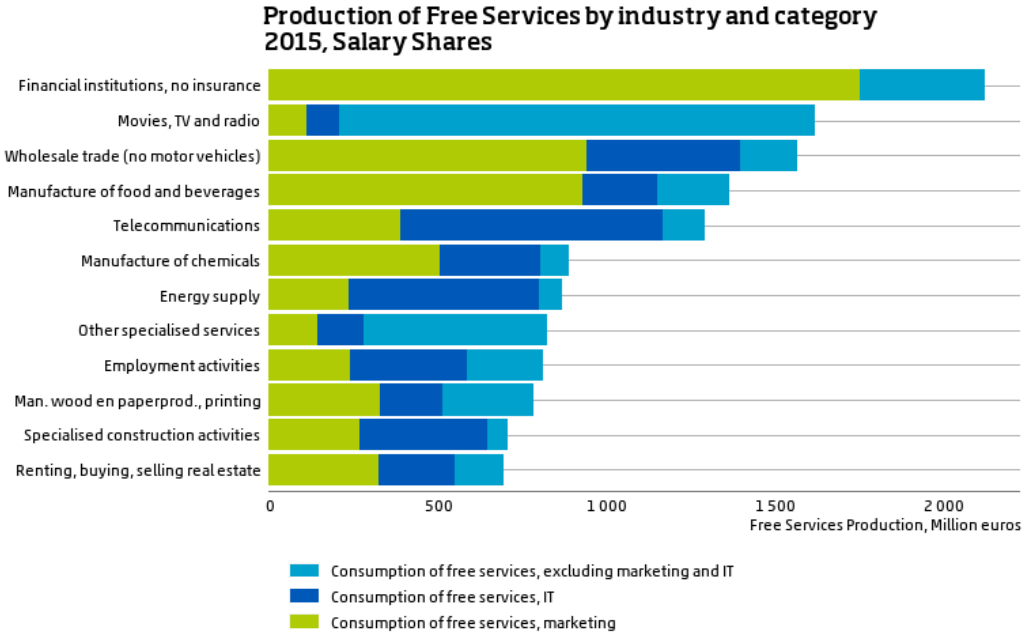


The findings indicate that the inclusion of IT occupations to the list of free service producing professions greatly impacts the estimated size of free services. Transferring intermediate use to consumption by businesses adds between 19.4 and 29.6 billion euros to GDP in 2015, depending on the inclusion of software developers. These values translates to an increase between 2.8% and

4.3% of GDP. For 2016, 2017, and 2018 this share remains roughly the same, ranging between ~2.7 and ~4.3% of GDP each year. Similarly, the inclusion of consumption by businesses therefore does not appear to affect year on year growth of GDP in current prices. In 2019 however, free services contribute between 3.0 and 4.7% of GDP, which indicates that the proportion of free services in the economy might be rising. The rise in the contribution of free services to GDP translates to an increase in between 0.3 and 0.5 percentage points of year-on-year GDP growth.

Exploring the resulting free services values in more detail, we can assess which industries produce the most free services. Figure 3 displays the 12 industries that contribute the most to the production of free services, in descending order. This production of free services is further divided into three categories, namely IT, marketing, and everything else. The biggest producer of free services are financial institutions (excluding insurance), the majority of which consists of marketing based free services. Movies, TV, and radio is the second largest producer, instead consisting almost exclusively of non-IT and non-marketing free services producers. Other large producers of free services are the wholesale trade, manufacture of food and beverages, telecommunications, and energy supply industries.

Figure 3



A significant advantage of this free services estimation method is that it employs the entire input-output matrix. This exhaustiveness allows us to perform a similar assessment to determine which industries are the largest consumers of free services. As mentioned in the previous paragraph, here we can loosen the assumption that the fraction of free services is the same for each using industry by modelling a relationship between the proportion of consumption in an industry and the consumption of free services in that industry. While it is difficult to determine an exact relationship, it is insightful to present different scenarios of the model. A preliminary application of such consumption correction to free services consumption per industry results in the following figures:

Figure 4

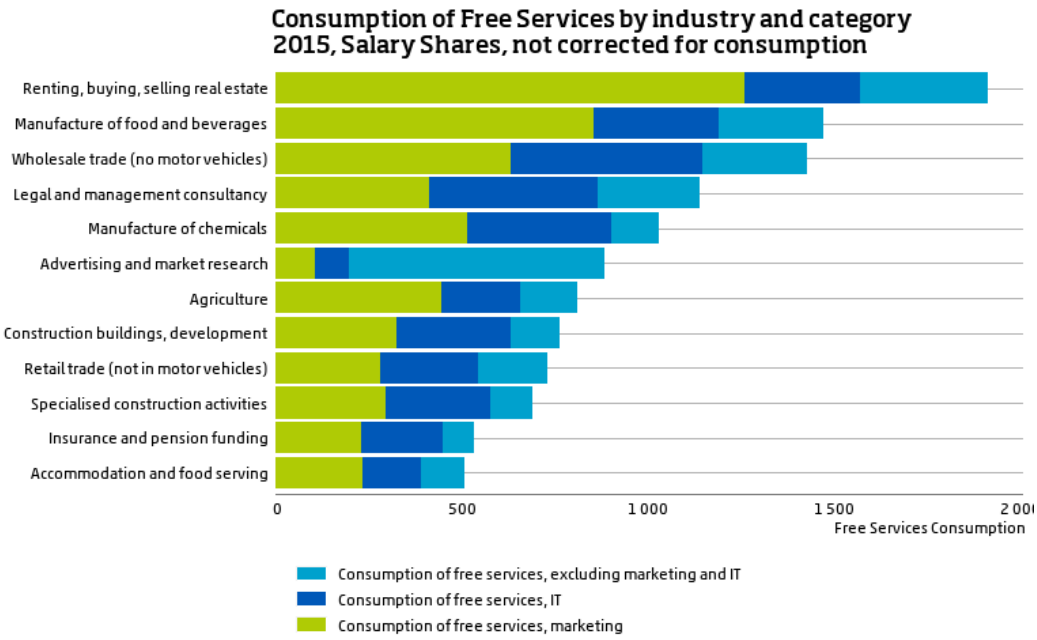


Figure 5

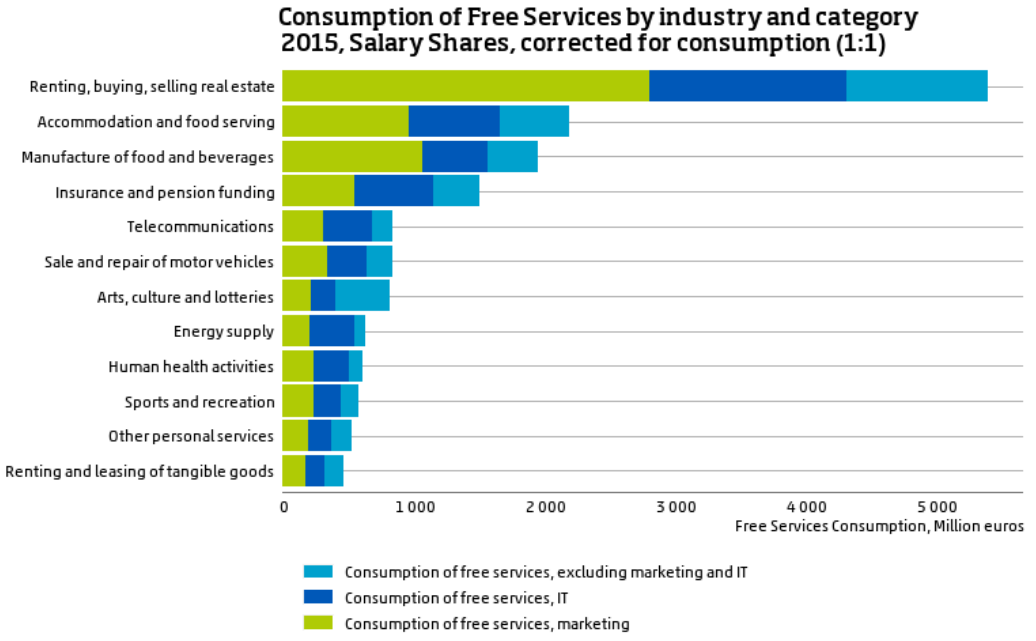
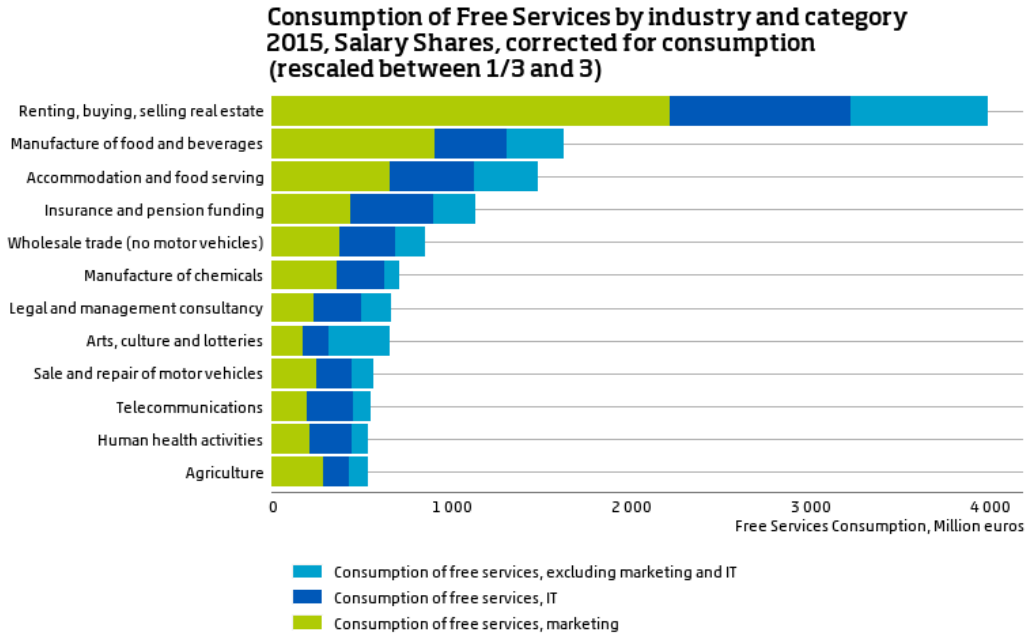


Figure 6



First, figure 4 presents the consumption of free services, per industry, per free service category, when assuming that each using industry uses the same proportion of free services. Figure 5 presents the consumption ranking instead modelling a one-to-one relationship between household consumption and consumption of free services. In this model, an industry in which the relative value of household consumption is five times larger than the average of all industries is weighed five times as heavily in the calculation of free services consumption. Finally, figure 6 presents a consumption ranking in which the consumption weights from the previous scenario (figure 5) are rescaled between 1/3rd and 3, so that extreme values are diminished. The resulting free service consumption per industry (per category) could therefore be considered a medium between figures 4 and figure 5.

The industry “renting, buying, selling real estate” appears to be the largest consumer of free services in all three specifications. This industry uses a large amount of inputs from several big industries, including the banking sector, which is the largest producer of free services. On top of this, it is heavily dominated by household consumption, thus the consumption of free services grows exponentially when correcting for this.

How does this reflect reality?
According to our analysis the "rental and trade of property" industry is the largest consumer of free services. How does that reflect reality?

This industry also encompasses "Imputed rents of owner-occupied dwellings", and that portion of the industry uses a lot of banking services in the form of FISIM (Financial Intermediation Services Indirectly Measured). Banks apparently employ many people in marketing and the idea is that these people in one way or another create free services.

Free services created by marketing people would mostly boil down to copy writing. For example, the creation of brochures and websites to describe attributes of banking services offered. This information is free for households. It also includes the creation of content for free apps and games, advertorials and alike.

Comparing the three figures we also find some significant differences. Both the hospitality and insurance sectors consume significantly more free services when correcting for household consumption. Conversely, good-producing industries, such as the agriculture and construction industries, consume much less free services in the corrected scenarios. Intuitively, the results of the consumption corrected scenarios seem to align more with the general knowledge of free service production and its business models.

4. Free services margins

This chapter presents a new method to deal with free services within the national accounts framework. In general, methods that extend the national accounts for free services consider a production approach, either by imputing production by households or by transferring intermediate use to final consumption by businesses. In contrast to these, the method we introduce here starts from the perspective of consumers. To analyse the robustness of estimates of the impact of free services, it is desirable to confront estimates coming from the producers' side with estimates coming from the consumers' side. That consumer surplus approaches do not fit in the national accounts, does not mean that the consumer perspective should be ignored.

Our objective is to focus on prices and volumes when thinking about free services, and not to expand the production boundary. An important downside of expanding the production boundary, in a standard fashion, would be that the size of the economy in current prices increases as well. In the case of free services, monetary values would be based on assumptions and subjectivity. Such imputation in current prices would create more problems than it solves for key policy questions, like monetary policy and government revenue, says the IMF staff report (2018). This objective also means we stay closer to a GDP approach.

To meet this objective, we propose the concept of free services margins to include free services in the national accounts. We start with some background knowledge necessary to understand the underpinnings of this proposed method. Then we explain the free services margins approach in detail, including the data needs. We end with the results from the application of free services margins to the supply and use tables of the Netherlands.

4.1 Backgrounds

4.1.1 Characteristics of goods and services create utility

Lancaster (1966) expanded standard consumer theory by considering the characteristics of goods and services as determining consumer choice, and resulting utility. He assumes "that consumption is an activity in which goods, singly or in combination, are inputs and in which the output is a collection of characteristics." According to this theory, goods do not give utility to consumers directly, but through their characteristics. Different goods can have similar characteristics in different quantities. Consumers can also consume bundles of goods, which can have other added characteristics as well. Individual preferences and prices, and changes in those, determine if and to what extent they are consumed.

Consumers in Lancaster's theory optimise their utility by combining activities, the consumption of a combination of goods, to achieve an efficient combination of characteristics. The frontier of options is given by a budget constraint and prices. If an activity drops in price, it will become more attractive and will be consumed more. A price increase will lower demand, up to the point where the activity is not undertaken anymore. In Lancaster's consumer theory a new product is, possibly with other goods, just a new activity which offers a new combination of characteristics. If this new resultant activity is sufficiently low in price, it will sell, and might even replace older activities.

This theory implies that free services, with their (perceived) low price, can replace paid-for services when they offer similar characteristics. This phenomenon seems to have happened to goods and services that serve activities around entertainment, information and leisure, such as

newspapers and books. Free services, combined with some hardware like a phone or computer, can provide similar characteristics to these services. As newspapers and books still exist, it seems free services are not a perfect substitute however.

To understand how prices and margins can reflect free services, the next section discusses what happens in the national accounts when a price becomes zero and how free services are similar to margins.

4.1.2 Using prices and margins to reflect free services

The national accounts aggregates are measured in current and constant prices to distinguish a change in quantity from a change in price (Lequiller & Blades, 2014).[8] When applied to free services this distinction can be taken to an extreme.

Such an extreme is a price drop to zero: a good or service becoming free. In practice this does not happen to individual goods sold by companies, but it does happen with taxes and subsidies that for example drop to a 0%-rate (i.e. disappear). For goods and services this would mean that in year T the value of the service shows up with a value of zero, but the value in constant prices will be non-zero. Table 5 describes this situation numerically.

Table 5 Example calculations of changes in volumes and prices of a service that drops in price to zero

Service, year T, in current prices	€ 0	
Service, year T, in constant prices	€ 12	
Service, year T-1, in current prices	€ 11	
Price change, year T	-100%	
Volume change, year T	9.1%	(12 / 11)
Value change, year T	-100%	

The above means that if in a specific year a paid-for service becomes free, it should still contribute to GDP in constant prices, provided that we follow the reasoning of Lancaster (1966) about consumption activities. This also means that a price of zero is not impossible in the national accounts, but that after 1 year the consumption of the good or service ("activity") disappears from the record. Arguably, a free service that replaces a paid-for service (or has similar "characteristics") should therefore be recorded as consumption of volume in constant prices in the year when the consumer switches from the paid-for service to the free service. By chain-linking these volumes the expansion (or contraction) of free services can be tracked over time.

Margins in the national accounts bridge the gap between the goods produced by industry (or imported) and the final product used by the consumer at home after buying it.[9] Between these two are often transportation costs and the earnings from wholesale and retail. Transportation, wholesale and retail add value to products by making goods (more easily) available to users.

Free services could also be seen as a quality augmentation of existing products, like laptops and smartphones. On the producer side these products are just the sum of its parts, the included

[8] An explanation of current and constant prices is in Appendix B.

[9] Trade and transport margins are produced by traders, mostly in retail and wholesale, and transporters. Contrary to most other services these margins are not consumed directly. "Instead, the national accounts register the consumption of retail and wholesale services as the trade margins included in the cost of the products bought." (Lequiller & Blades, 2014)

software, and licences. On the consumer side, these same devices are in large part about the access they provide to productivity, entertainment and information. Free services are therefore an important contributing factor to the value of these products for consumers. Free services margins could be the bridge between the goods produced by industry (or imported) and the final product used by the consumer at home. The next section will discuss this proposed method for free services in detail.

4.2 Method

Activities as defined by Lancaster (1966), a combination of goods and/or services that provide certain characteristics, do not exist in the national accounts. Only goods and services exist there. However, a reduction in the consumption of books does not necessarily mean that the activity of reading has been undertaken less. It could be that consumers read more free offerings. Over time this shift could increase because the free service gets better characteristics, like accessibility and availability. A slight augmentation to the supply and use table can correct for this.

The idea behind this augmentation to the supply and use table is that most free services are somehow delivered through other goods and services that people do buy. However, the quality adjustment of these goods and services does not (fully) take into consideration the (increased) access to free services. Quality adjustment of hardware very much focuses on the specifications,[10] and not on the opportunities they give access to.

To correct for this we propose the imputation of free services margins, bridging the gap between currently observed quality-adjusted prices and perceived quality of total consumption including the access to and use of free services. This proposal is novel, tries to limit the amount of imputations and focuses on quality adjustment through volumes.

Free services margins are implemented as follows:

- Current prices are zero (‘free’).
- The level in constant prices describes the consumption "lost" to free services, that support a consumption activity, by paid for goods and services.[11]
- In the supply and use table they are ideally allocated to specific goods (or activities following Lancaster (1966)), but can also be consumed directly by households.
- They are produced by free services providers (or imported).

This proposal has the following benefits:

- Utility-based approaches are criticized for being wildly divergent, and impossible to reference to another quantity. Constraining ourselves to the National Accounts framework does not have these disadvantages.
- No imputation of production by households, which is a concept that extends the production boundary.
- GDP in current prices is not adjusted in this approach. It does adjusts the GDP deflator, as advocated for by IMF (2018).

[10] See for example the quality adjustment for personal computers by the BLS: https://web.archive.org/web/20210502180835/https://www.bls.gov/cpi/factsheets/personal-computers.htm

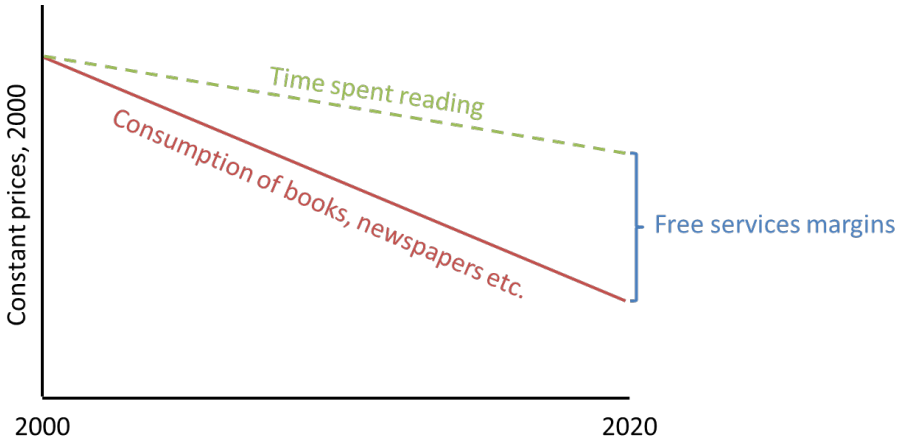
[11] The implicit assumption here is that free services always replace the use of some good or service. We think this an appropriate assumption for two reasons. First, following Lancaster (1966) consumption of goods and services support consumption activities, and although the inputs can be more or less novel, consumption activities (like eating, sleeping, traveling, leisure) are never really new. Second, there are only 24 hours in a day, so if people use more free services for activities they probably use something else less and/or do other activities less.

- Productivity can be allocated to the industry where free services are produced, instead of to the industry that happens to provide access or produces equipment.
- The approach is mostly consumption oriented, where measurement problems concerning production do not apply.

Comparatively little data is needed for a preliminary estimate. However, an estimate with little data does require more assumptions.

The concept of free services margins can be explained by the following figure. It shows consumption of books, newspapers etc. in constant prices. This consumption drops over time between 2000 and 2020. However, there is a separate line for time spent on reading. This also drops, but not as strongly as the consumption of books, newspapers etc. The core idea is that the difference between these lines is the consumption of free services, which are not accounted for in the current SNA. The difference as shown are the free services margins. And to emphasize, in current prices there would be no difference in surface for free services margins, because they have a price of zero.

Figure 7



To elaborate we will also show a numerical example of free services margins. The base case is the same economy as in Table 1, Chapter 3. The top left of table 6 represents this same economy, expressed in constant prices, after aggregating all producers and adding books to imports and consumption. Moreover the previous period (T-1) in current prices is shown on the right.

To introduce free services margins to the base case economy we add rows for production and consumption of free services margins. These rows are non-zero in constant prices (bottom left), but zero in current prices (bottom right). We assume that consumers have found an (additional) source for information/entertainment that replaces the consumption of books.

From the perspective of consumers their consumption has not dropped, as they have replaced books with watching a free TV show. This is represented by a row that says that consumers consume free services margins with a current price of 0 in period T (not shown) and a constant price of 5. This 5 corresponds with the volume drop in the consumption of books. In this example we could for example allocate the production of the free services margins to the TV broadcasting industry. The assumption then is that the replacement of books is produced there.

Adding free services margins to the base case economy in this manner increases GDP in volume, and keeps GDP in current prices equal. In this simplified economy the calculations are as follows. The size of the base case economy in T-1 is 40 (Consumption 50 + Balance of trade -10) and in T again 40 (Consumption 45 + Balance of trade -5). After adding free services we get 40 again for T-1, but now 45 for T (Consumption 50 + Balance of trade -5). The size of the economy in period T in current prices (not shown) is again 40, as free services margins have a price of 0.

Table 6 Adding free services to a base case economy

Supply T, constant prices (Before)

	Producers	Imports	Total
Soap	50	30	**80**
Advertising	50	50	**100**
Books	.	5	**5**
Display time	50	.	**50**
Total	**150**	**85**	

Supply T-1, current prices (Before)

	Producers	Imports	Total
Soap	50	30	**80**
Advertising	50	50	**100**
Books	.	10	**10**
Display time	50	.	**50**
Total	**150**	**90**	

Use T, constant prices (Before)

	Intermediate use: Producers	Final consumption	Exports	Total
Soap	10	40	30	**80**
Advertising	50	.	50	**100**
Books	.	5	.	**5**
Display time	50	.	.	**50**
Total	**110**	**45**	**80**	

Use T-1, current prices (Before)

	Intermediate use: Producers	Final consumption	Exports	Total
Soap	10	40	30	**80**
Advertising	50	.	50	**100**
Books	.	10	.	**10**
Display time	50	.	.	**50**
Total	**110**	**50**	**80**	

Supply T, constant prices (After)

	Producers	Imports	Total
Soap	50	30	**80**
Advertising	50	50	**100**
Books	.	5	**5**
Display time	50	.	**50**
Free services margins	5	.	**5**
Total	**155**	**85**	

Supply T-1, current prices (After)

	Producers	Imports	Total
Soap	50	30	**80**
Advertising	50	50	**100**
Books	.	10	**10**
Display time	50	.	**50**
Free services margins	.	.	**0**
Total	**150**	**90**	

Use T, constant (After)

	Intermediate use: Producers	Final consumption	Exports	Total
Soap	10	40	30	**80**
Advertising	50	.	50	**100**
Books	.	5	.	**5**
Display time	50	.	.	**50**
Free services margins	.	5	.	**5**
Total	**110**	**50**	**80**	

Use T-1, current prices (After)

	Intermediate use: Producers	Final consumption	Exports	Total
Soap	10	40	30	**80**
Advertising	50	.	50	**100**
Books	.	10	.	**10**
Display time	50	.	.	**50**
Free services margins	.	.	.	**0**
Total	**110**	**50**	**80**	

The results above are fictional to show the concept of free services margins. It shows that the inclusion of free services margins impacts the GDP deflator in a desirable manner and adjusts GDP in volume to account for the consumption (and production) of free services, while leaving GDP in current prices as it is.

After this stylized example, it is necessary to discuss the data needs of the method. For instance, data is required to support the assumption that consumers have replaced books with free services.

4.3 Data needs

To determine to what extent consumers replace goods and services with free services we need information to estimate what would have happened without free services. For this purpose, we can think of three indicators: time use surveys, population statistics, and (improbable) lower consumption volumes.

Time use surveys are the preferred source to learn about real consumption by households. The idea is that if consumers spend as much time reading now as they did ten years ago, that they should consume at least as much publishing goods as ten years ago. If this is not the case, this is an indication that the publishing goods have been replaced with free services. Conversely, if consumers have spent less time reading than before, and went on to watch more (streaming) television, a drop in the consumption of publishing goods is only expected. If we observe a drop in time spent on reading that coincides with a drop in the consumption of publishing goods, that falsifies the hypothesis that there was a shift to free services. The downside of time use surveys is that they are scarce, often only intermittently describing the time use of households.

A different source to determine the expected level of consumption is the use of population statistics. A bigger population is expected to consume more books, *ceteris paribus*. Obviously this a much weaker indicator, as any change in preferences (or shift along the preferences curve) is ignored. Moreover, the indicator becomes weaker as the distance in time between the population statistic and the shift to the free service grows.

In the following section we present the results from applying the free services margins method to the Netherlands, making the best of any information we have about time use and population.

4.4 Results

The implementation of the proposed method for free services margins for calculating Dutch GDP takes the following steps:

1. Collect series on time use, population and consumption, from publicly accessible sources.
2. Determine goods and services possibly affected by a shift to free services.
3. Select indicators from the time-use and population series for the goods and services affected by free services.
4. Calculate expected change in volume for the selected goods and services, when the shift to free services would be absent.
5. Calculate actual change in volume for the selected goods and services, in the presence of free services.
6. The difference in the expected and actual volume change are the level of free services margins in constant prices, for that good or service.
7. Calculate new GDP growth rate, including these free services margins.

The following sections will describe each of the aforementioned steps in detail.

4.4.1 Collect series on time use, population and consumption

In the first step we collect data series on time use, population, and consumption for the Netherlands. For the analysis, the following series are collected from Eurostat[12]:

[12] Using Eurostat series, instead of Statistics Netherlands series, makes comparison with and replication for other countries easier later on.

- Time spent, main activity only (tus_00age)
- Population (demo_pjan)
- Consumption, national accounts (nama_10_co3_p3)
- Item weights, HICP (prc_hicp_inw)

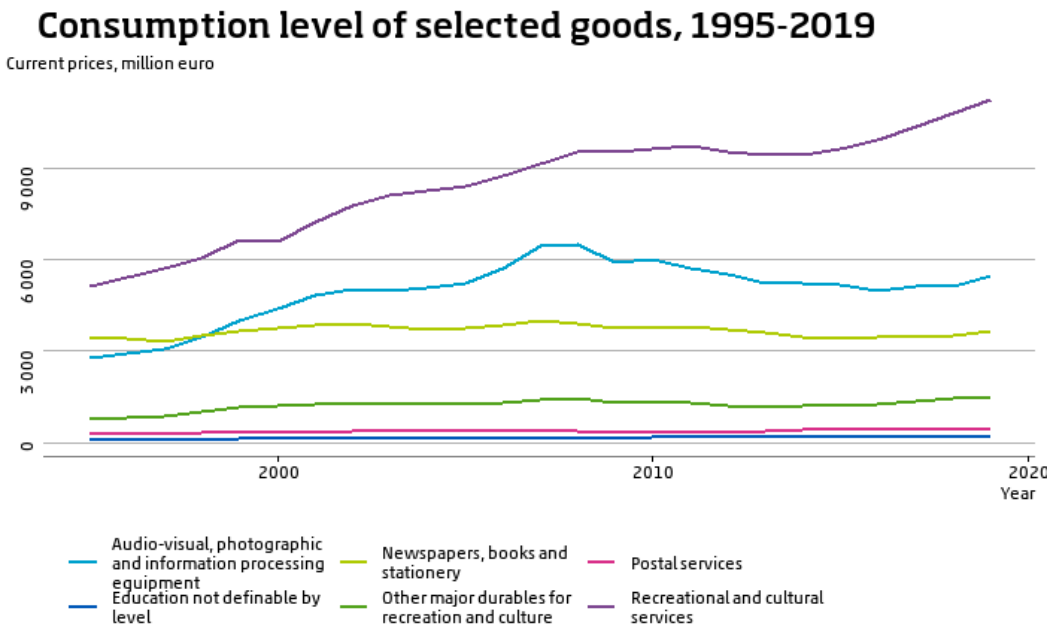
4.4.2 Determine goods and services possibly affected by a shift to free services.

We then determine the goods and services that are possibly affected by a shift to free services. From the goods and services present in the national accounts, this initial selection[13] is as follows:

Goods and services
Postal services
Audio-visual, photographic and information processing equipment
Other major durables for recreation and culture
Recreational and cultural services
Newspapers, books and stationery
Education not definable by level

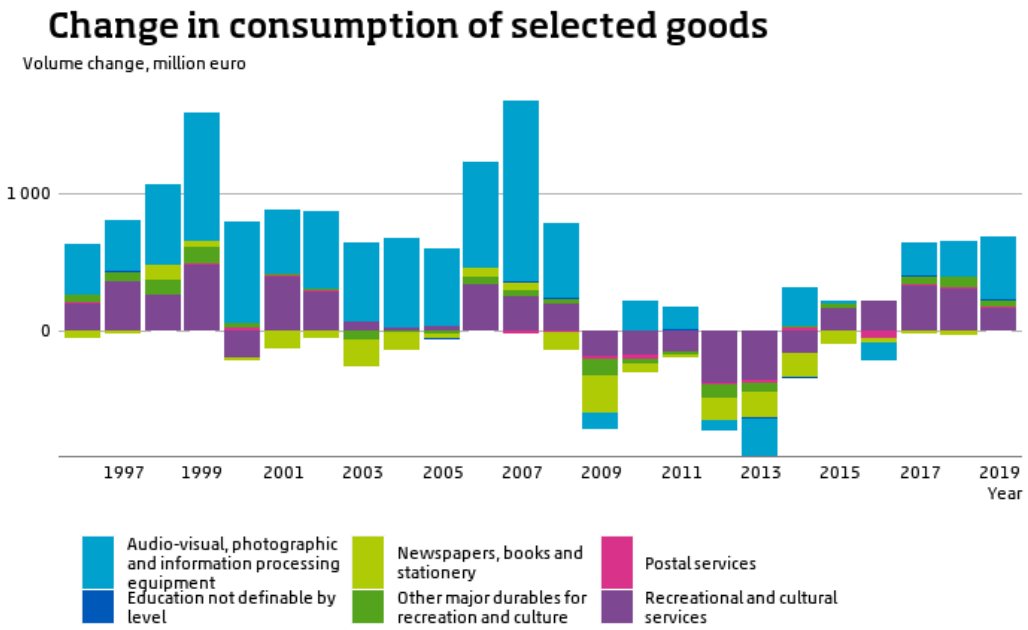
Figure 8 presents the level of consumption over time for this selection of goods and services, while Figure 9 presents the change in consumption for each year. Some of the selected goods show a positive growth in current prices, while others are stable or even at a lower in level in 2019 than in 1995. Quite a few of the selected goods and services show negative volume growth rates for many years.

Figure 8



[13] This selection is preliminary to show the feasibility of this approach. Future work should settle on an exhaustive selection with broad support among the statistical community.

Figure 9



Goods and services that are available in the harmonised index of consumer prices (HICP) are more detailed than those present in the national accounts. A relevant selection of these goods and services is the following:

Items	
Postal services	Books
Internet access provision services	Fiction books
Software	Educational text books
Pre-recorded recording media	Other non-fiction books
Games, toys and hobbies	Binding services and E-book downloads
Games and hobbies	Newspapers and periodicals
Cultural services	Newspapers
Cinemas, theatres, concerts	Magazines and periodicals
Museums, libraries, zoological gardens	Education not definable by level
Television and radio licence fees, subscriptions	

The weights of the HICP are set for a good consumer price index, and are therefore not a perfect substitute for the national accounts. However, because of its higher granularity, the HICP does provide additional insight in the consumption over time of specific goods and services that may have been replaced by free services. The HICP weights of books, newspapers and periodicals appear to have dropped significantly since 1996. Furthermore, games, toys and hobbies do not seem to move much in terms of HICP weights. Contrarily, cultural services are very volatile. Goods and services that support free time study (educational text books and education not definable by level) have not moved in weight for the last ten years.

4.4.3 Indicators for affected goods and services

In order to derive indicators for goods and services affected by free services, we now employ time use data. For the Netherlands, this data is only available for the year 2010 in the Eurostat database. There is a different dataset from Statistics Netherlands itself that contains time use information from around 2000.[14] However, this data is not necessarily consistent with the data from 2010, and therefore disregarded in the analysis.

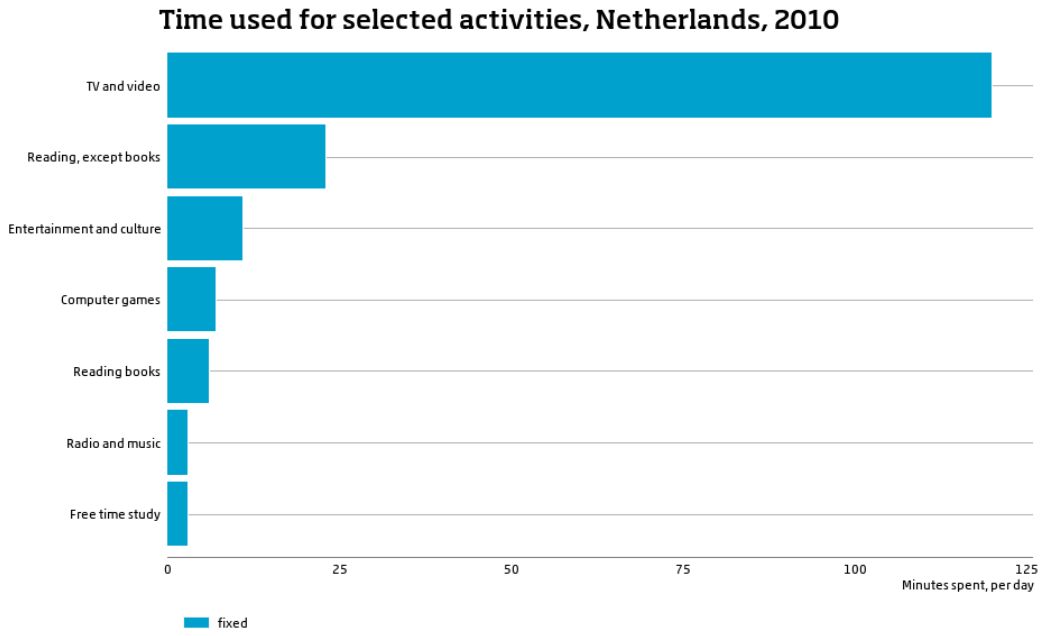
First, a set of activities that might be affected or related to free services are selected from all the activities available in the time use data. These activities are as follows:

Activities
Free time study
Entertainment and culture
Computer games
Reading, except books
Reading books
TV and video
Radio and music

From these selected activities, TV and video are dominant in time use, see Figure 10. Especially TV could well give access to free services. These could for example be TV shows that offer entertainment or information and that are funded by advertising and/or product placement. Furthermore, reading is also a significant activity. Evaluating time use data for other European countries for the same year, a similar picture arises, with TV and video dominating, followed by reading.

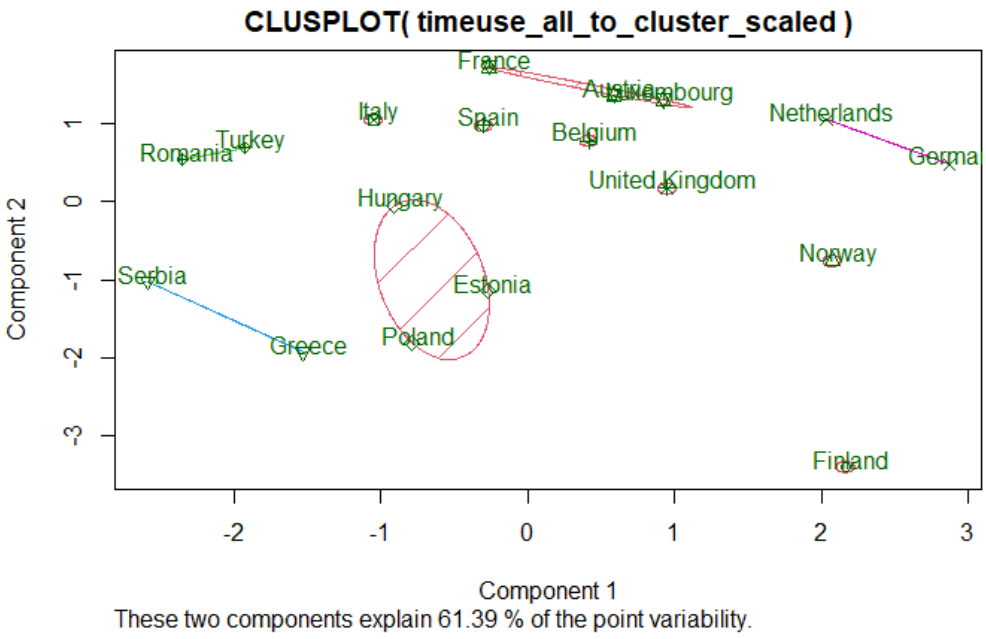
[14] In fact, the time use survey used for the 2010 numbers in the Eurostat database are from a Statistics Netherlands publication from 2011. This same survey was repeated in 2016, but without the accompanying tables in the Statistics Netherlands database. A straightforward comparison between 2011 (2010) and 2016 for this project was therefore impossible. Lastly, going back to the microdata was unfeasible as well.

Figure 10



From this group of countries, we investigate which are most similar to the Netherlands. When clustering the data into 11 groups, exclusively Germany is in the same cluster as the Netherlands, see Figure 11. As we lack data over time for the Netherlands, we will therefore assume that time use developments in the Netherlands will be similar to those in Germany in the following parts of the analysis.

Figure 11

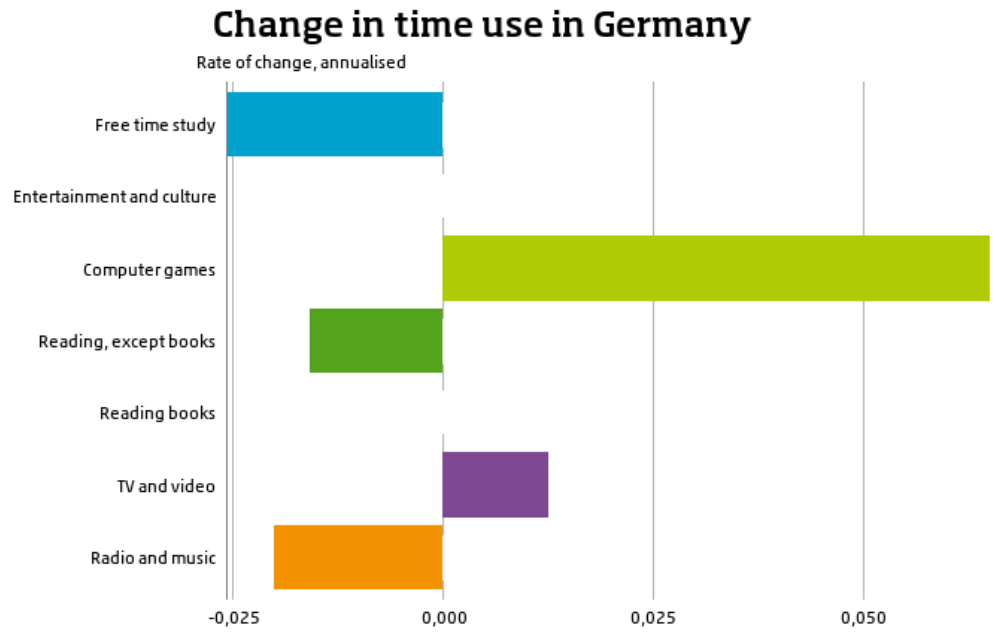


Besides time use data, another potential indicator for the expected change in volume of goods and services is population growth. Although a weak indicator by itself, volume growth for the Netherlands is expected to be around 0.5% each year, just because the population grows each year.

Unlike the Netherlands, other European countries have multiple entries in the Eurostat tables for time use[15], which allows us to calculate the growth rate of each activity. Doing this, we learn that *computer games* have become much more popular to spend time on between the 2000s and 2010s. *Radio and music*, and *reading except books* have lost popularity. In about half the countries, *reading books* actually increased in time spent.

As time spent on leisure in the Netherlands in 2010 seemed most similar to Germany, we evaluate the developments there more closely. In Germany we also find that time spent on computer games increased, while most other selected activities decreased in time use (the exception being TV and video). These developments will be used as indicators in the following part of the analysis.

Figure 12



4.4.4 Expected change in volume

To establish the expected change in volume of the consumption of goods in the Netherlands for the period 2000-2015, the volume change of the corresponding consumption activities is determined. This change is driven by both population growth and changes in time use. For population growth, the change between 2000 and 2015 is used. For changes in time use the annualized change in time use for Germany is raised to the power of 15 (fifteen years). The resulting total change in consumption activities across 2000-2015 is shown in the table below. Computer games have clearly become much more popular, while free time study is undertaken much less, despite a bigger population. Activities that did not see a change in time use, like reading books, are still expected to have grown, because of population growth.

[15] Data collection period of the 15 European countries participating in HETUS wave 2000: 1998-1999: France 1999-2000: Estonia, Finland 2000-2001: Slovenia, Sweden, United Kingdom, Norway 2001-2002: Bulgaria, Germany 2002-2003: Spain, Italy 2003: Latvia, Lithuania 2003-2004: Poland 2005-2006: Belgium Data collection period of the 18 European countries participating in HETUS wave 2010: 2008-2009: Italy, Austria 2009-2010: Estonia, Spain, France, Hungary, Finland 2010-2011: Romania, Norway, Serbia 2011-2012: Netherlands 2012-2013: Belgium, Germany, Poland 2013-2014: Greece 2014-2015: United Kingdom, Luxembourg, Turkey

Activity	Change in time use	Total change, incl. population growth
Free time study	0.676	0.720
Entertainment and culture	1.000	1.065
Computer games	2.573	2.742
Reading, except books	0.787	0.838
Reading books	1.000	1.065
TV and video	1.205	1.284
Radio and music	0.738	0.786

To calculate expected volume changes for goods, the subset of activities is linked to goods as distinguished in the HICP, which results in the following table:

Activity	Consumption good	Expected change
Free time study	Educational text books	0.720
Free time study	Education not definable by level	0.720
Entertainment and culture	Cultural services	1.065
Computer games	Games, toys and hobbies	2.742
Reading, except books	Newspapers and periodicals	0.838
Reading books	Books	1.065
Reading books	Fiction books	1.065
TV and video	Television and radio license fees, subscriptions	1.284
Radio and music	Pre-recorded recording media	0.786

There are still several problems with this table. Some of the goods in the HICP only contain weights from 2010 onwards. Arguably the activities 'TV and video' and' Radio and music' have a more mixed link with the consumption of TV and radio license fees and subscriptions, and with pre-recorded recording media. In the next sections these combinations of activities and goods will therefore be discarded.

What results after discarding the aforementioned problem cases is the following table. The next section will go on to establish the level of free services that have replaced each of these four goods.

Activity	Consumption good	Expected change
Entertainment and culture	Cultural services	1.065
Computer games	Games, toys and hobbies	2.742
Reading, except books	Newspapers and periodicals	0.838
Reading books	Books	1.065

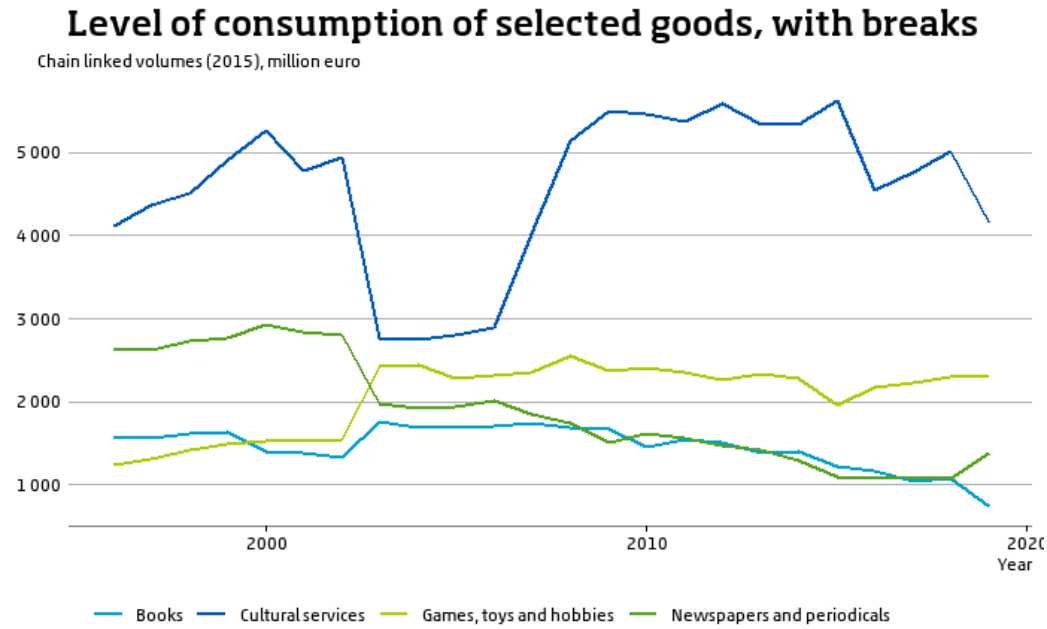
4.4.5 Actual change in volume

To get the actual change in volume of the goods selected in the previous section, a more granular picture of consumption is required than is available from the national accounts. In this section the weights from the HICP are employed to make the consumption table more granular,

by calculating the share of a good in an aggregate that is present in the national accounts consumption table.

By applying the weights from the HICP to the consumption in chain linked volumes (2015), the following trends emerge. Firstly, the HICP weights have clear breaks that might need to be repaired.[16] For cultural services it seems that the two breaks counterweight each other. Furthermore, the level of 'Games, toys and hobbies' seems to be underestimated before 2003. In 2003 a break is also observed for 'Books', and 'Newspapers and periodicals'. There also appears to be another break in 2019, however, that is beyond the scope of this analysis for now.

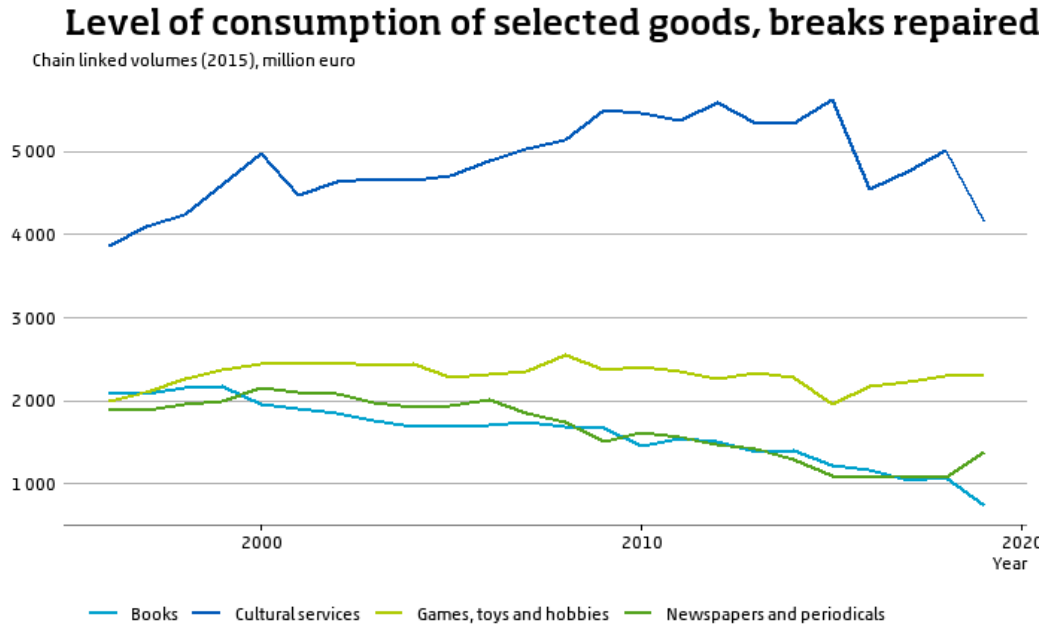
Figure 13



To correct for the aforementioned breaks, the break between 2002 and 2003 for each of the three goods is calculated and subsequently added to the shares of the preceding year. Additional corrections are also made for the other breaks in Cultural services.

[16] The weights for the HICP are based on the national accounts since 2003. Before they were based on a household survey. That change in source explains the breaks around 2003. Moreover, the HICP weights are determined once, when the reporting period is estimated. Future (benchmark) revisions of the national accounts are not reflected in past HICP weights. So, the other breaks after 2003 are caused by (big) revisions of the national accounts which only show up in new periods of the HICP weights, although the national accounts itself are continuous.

Figure 14



After these corrections it is possible to make a table similar to the expected change, which shows the actual change in volume for all four selected goods between 2000 and 2015.

Consumption good	Actual change
Games, toys and hobbies	0.798
Cultural services	1.128
Newspapers and periodicals	0.508
Books	0.630

4.4.6 Confrontation of expected and actual change in volume

To determine the level of free services margins between 2000 and 2015, it is now possible to calculate the difference between the expected and actual change in volume of the four selected goods. This results in the following table.

Consumption good	Actual change	Expected change	Base 2000	Actual 2015	Expected 2015	Difference
Games, toys and hobbies	0.798	2.742	2445	1952	6702	4751
Cultural services	1.128	1.065	4984	5620	5309	-311
Newspapers and periodicals	0.508	0.838	2165	1099	1815	716
Books	0.630	1.065	1953	1231	2081	850

The calculated difference indicates that especially games must be consumed through free services rather than being paid for. Moreover, the decline in the consumption volume of books and newspapers also seems to be explained by replacement, as actual consumption is lower than expected consumption. Consumers are therefore assumed to have found free alternatives. When consumers would exchange books with streaming a TV show, that is expected to be reflected in the time spent on reading and watching TV. And that is not the case in the data. We only see a drop in the consumption of books, but time spent on reading books has not dropped.

Besides positive differences, implying an increase in free services, we see one negative difference for cultural services. The consumption of cultural services has risen more than expected. It could be that in the case of cultural services people have switched from free alternatives to more paid for cultural services.

4.4.7 New growth rates in volume

Translating these findings to an estimation of GDP is a stretch, but this section nonetheless attempts to do so for completeness' sake. Over the 15 years that were analysed, the volume of consumption that has been missed for the four goods in question combined is estimated to be 6005 million in 2015 euros. Translated to consumption growth, this leads to a difference between the observed growth of 0.42% per year, and expected growth of 0.551% per year. The difference between these two growth rates, 0.131 percentage points per year, is non-negligible given the original level of consumption growth per year.

However, it should be noted that although consumption growth would have been significantly higher, GDP growth would be less affected. There are two reasons for this. First, the total level of GDP is obviously higher than just the level of consumption, with consumption making up roughly 45% of GDP. Because of this, yearly GDP growth would have only been 0.059 percentage points higher. Furthermore, the Netherlands is most likely a net importer of free services (margins) as well, for example when it comes to social networks and online entertainment. If this is indeed the case, these net imports would result in a an even lower impact of free services on GDP growth.

4.4.8 Sensitivity analysis with two alternative countries

To see how the results are influenced by choosing the developments in Germany as representative for the Netherlands, we will repeat the same analysis for Belgium and the United Kingdom. The table beneath shows the results of this sensitivity analysis.

	Difference		
Consumption good	**Germany**	**Belgium**	**United Kingdom**
Games, toys and hobbies	4751	653	6500
Cultural services	-311	5298	505
Newspapers and periodicals	716	291	355
Books	850	265	850
Total (4 consumption goods)	**6005**	**6507**	**8210**

Clearly the results for using the United Kingdom are very similar to those for Germany in the main analysis. The results for Belgium do differ significantly. This is driven by different developments in time use. In Germany (and the United Kingdom) the time spent on computer games has increased strongly, whereas in Belgium time spent on entertainment and culture saw growth instead.

Regardless, if the difference between expected and actual consumption for these four goods is summed, we consistently get a number of 6 billion (Germany) and slightly higher. The choice of representative country has therefore not strongly affected the results of the free services margins method.

5. Conclusion and Discussion

Even though “free services” are free for consumers at the moment of consumption, we still pay for these services one way or another: looking at advertisements, giving access to our personal data, or through other ways. In a perfect world we would have all business data available, e.g. on foreign or national investments, on marketing and advertising part of businesses, on the value of personal data and so on. In that perfect world we would not have trouble reconciling all this information, and measurement of the value of “free services” would be rather straightforward. As we do not have this information nor knowledge, we have to wriggle our way through with the data that is available to us to estimate the size of free services. In this paper we estimate the size of free services in the Netherlands using two different approaches. Both approaches are embedded within the national accounts framework.

The first approach is the imputation of final consumption by businesses that replaces intermediate use. This method is a continuation of the work in Van Elp & Mushkudiani (2019). We treat advertising, as well as other similar costs made when creating free services, as final consumption expenditure of corporations and social transfers in kind to households. The idea is that companies, through their intermediate inputs, pay for services that are provided for household consumption, for free. These services are hence not used to generate the outputs of the using economic sector, and are therefore not intermediate use. Instead, this portion of intermediate use is actually a mechanism that creates free services for consumers. We estimate the fractions of production that are actually free services for each industry, based on employee wages and hours worked in each industry. We have selected the occupations that, we assume, mostly contribute to the production of free services. Free services reach consumers mainly through advertisements, which means that these occupations should be the main contributors to the production of free services. And as we use fractions of production, or output, this also means our approach assigns more value to free services than a pure sum-of-cost approach would do.

Finally, we investigate whether there is a significant contribution of free services to the Dutch economy, and whether they significantly affect GDP. We estimate the size of free services to be between 2.8-4.7% of current GDP for the years 2015 through 2019. We also carried out sensitivity analyses for these results.

Imputing final consumption by businesses to include free services in the system of national accounts has several advantages. First, it requires relatively little data to estimate. Second, the transformation of supply and use tables is straightforward and undemanding. However, expanding supply and use tables with an additional column specifying final consumption by businesses is a concept that raises discussion. Traditionally, businesses are considered unable to consume goods and services. While changing this is advantageous in allowing free services to be measured and included in the supply and use tables, it is also a deviation from the traditional line of thinking.

The second approach we applied are the novel free services margins. The experimental application of free services margins shows that consumption growth would be significantly higher when correcting for the consumption volume lost because of free services. This result is reached by analysing just four relevant goods. GDP growth would also be affected, but less significantly.

Firstly, because GDP includes more than just consumption, and secondly because the Netherlands is most likely a net importer of free services.

Another lesson is that in an increasingly intangible economy (Haskel & Westlake, 2017), statistical agencies should measure more intangibles, such as time use. This is necessary to keep policymakers informed on what truly happens in the economy. Extending the national accounts to account for free services is possible, but only if the amount of guesswork can be reduced. Despite a lack of (detailed) data, the experimental results for free services margins provide novel information that is valuable. Firstly, it shows what could be achieved with this method with better availability of time use data. Secondly, the results indicate that the consumption of computer games in particular seems to be underestimated by the current national accounts. Moreover, as only four goods could be analysed, the end result of an increase in the consumption growth rate by about 30 percent after correction for free services is yet another indication that the national accounts are missing something significant.

The significance of these results do not imply that free services should enter the core of the national accounts just yet. Clearly, the weaknesses of the preceding analyses are manifold and not easily solved. However, the statistical community and policy makers should also be reluctant to take consumption growth from the national accounts at face value. Free services are currently not accounted for, and that matters.

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Appendix A Free Services Consumption Correction

Supplying Industry	Original Use	Final Household Consumption (Using Industry)	Total Use (Using Industry)	Fraction of Use that is Household Consumption
Manufacture of coke and petroleum	Employment activities	6	21823	0.000275
Construction buildings, development	Employment activities	6	21823	0.000275
Manufacture of coke and petroleum	Telecommunications	6110	15426	0.396085
Construction buildings, development	Telecommunications	6110	15426	0.396085
Manufacture of coke and petroleum	Insurance and pension funding	15982	21447	0.745186
Construction buildings, development	Insurance and pension funding	15982	21447	0.745186

Consumption Fraction (Rescaled between 1/3 and 3)	Uncorrected value of Free Services	Corrected value of Free Services[17]	Rescale factor of Supplying industry[18]	Corrected and rescaled value of Free Services[19]
0.334317	0.433898	0.14506	1.45477	0.211028
0.334317	0.002261	0.000756	0.578651	0.000437
1.750732	0.017356	0.030386	1.45477	0.044204
1.750732	0.092694	0.162282	0.578651	0.093905
3	0.329763	0.989288	1.45477	1.439186
3	0.009043	0.02713	0.578651	0.015699

[17] Rescaled Consumption Fraction * Uncorrected value of Free Services

[18] Total Corrected value of Free Services of Supplying Industry / Total Uncorrected value of Free Services of Supplying Industry

[19] Rescale factor of Supplying industry * Corrected value of Free Services

Appendix B Current and constant prices

The national accounts aggregates are measured in current and constant prices to distinguish a change in quantity from a change in price (Lequiller & Blades, 2014). A change in price is the relative difference between the current and constant prices of the current period, whereas a change in quantity is the difference between the constant prices of the current period and the current prices of the previous period. Example calculations for these changes are presented in table 7.

Table 7 Example calculations of changes in GDP in current and constant prices

GDP, year T, in current prices	€ 10,500	
GDP, year T, in constant prices	€ 10,300	
GDP, year T-1, in current prices	€ 10,000	
Price change, year T	1.9%	(10,500 / 10,300)
Volume change, year T	3.0%	(10,300 / 10,000)
Value change, year T	5.0%	(10,500 / 10,000)

In the national accounts, the change in volume is measured. However, volume includes more than just the raw quantities. Prices are also adjusted for quality: a better television sold this year contributes to a positive volume change when compared to a worse television sold last year. Although in both years one unit is sold, we would still see a change in volume because of the higher quality in this year. When GDP growth is mentioned in the news, it generally concerns the change of GDP in volume.

The above calculations can also be written as the following equation (Lequiller & Blades, 2014):

[1 + (Growth rate of GDP in volume/100)] =
[1 + (Growth rate of GDP at current prices/100)] /
[1 + (Growth rate of the GDP deflator/100)]

"[S]tarting with GDP growth at current prices, one 'deflates' (i.e. divides) this by the price indicator (the GDP deflator) to obtain the volume indicator (GDP volume)." (Lequiller & Blades, 2014)

A good example of services that drop in price, but contribute (often) positively to GDP growth are communication services. Users of these services can often call, message, or download more and more at the same or even lower rates than the year before. Table 2 presents an example of this scenario.

Table 8 Example calculations of changes in volumes and prices of a single service

Internet subscription, year T, in current prices	€ 10	
Internet subscription, year T, in constant prices	€ 12	
Internet subscription, year T-1, in current prices	€ 11	
Price change, year T	-16.7%	(10 / 12)
Volume change, year T	9.1%	(12 / 11)
Value change, year T	-9.1%	(10 / 11)

Appendix C Evolution of experimental estimates

As is the nature of experimental estimates ours for free services have changed over time. In this appendix we try to clarify these changes in our estimates. The table beneath gives a summary of our estimates for different years and reports.

Table 9 Evolution of experimental estimates for Free services, billion euro, current prices

	Occupations	2015	2018	2019
First estimate (2019)	**No IT**	20.9		
IARIW paper (2022)	**No IT**	19.4	21.4	24.7
	50% IT	24.5	27.2	31.6
DSUT (2022)	**50% IT**		22.7	26.3
This report (2023)	**No IT**	15.1	17.3	19.8
	50% IT	19.0	21.9	25.3

In 2019 we published our first estimates, for 2015. We gave estimates for fractions of production to transfer to free services based on jobs, hours, and wages. We decided that the results based on wages seemed most plausible. The final estimate, based on wages, was 20.9 billion euro back then.

In the meantime we have updated to later waves of the labour force survey and combined this with employment registry data. Moreover we have shown that the weights applied to the labour force survey for the purpose of free services can be improved. These revisions and the improved method can explain up to about a hundred million of the difference, between our estimate now and in 2019.

Moreover, in this report we have added the whole IT industry to the group of industries not producing free services. The reason is that we now include IT professionals as producers of free services. In 2019 we considered that writers do not produce free services when they work for a publisher. Likewise IT professionals should not produce free services in the IT industry as IT is the core monetary output of that industry. Our implementation means that writers and other 'free services' occupations also no longer generate free services in the IT industry. This blanket exclusion of the whole IT industry should explain most of the remaining difference between our first estimate and the IARIW paper. In future research we should make a matrix of industries and occupations that determines which combinations of occupation and industry do not produce free services.

Another issue arose when we added our free services method to the experimental Digital Supply and Use Tables that Statistics Netherlands makes (DSUT, 2022). A transfer of intermediate use to final consumption by businesses creates an operating surplus, that is gifted to households in kind. However, several industries cannot have an operating surplus like government, education and financial holding companies. These industries for example use a sum of cost approach and their production is already consumed. In any case transferring their intermediate use to final consumption is either impossible and/or should not make a difference for consumption in aggregate. But our calculations in 2019 and in the IARIW paper did not

properly account for this conceptual issue. This improvement to our method explains most of the difference between this report and the earliest estimates.

Lastly, we discovered minor issues with the results in the most recent experimental Digital Supply and Use Tables because of how the input-output tables were constructed and applied in that report. This would explain about half a billion euro between DSUT (2022) and this report. Which would still leave a few hundred euro of unexplained difference between this report and the implementation of free services in DSUT (2022). A reason for this remaining difference could be the different levels of detail in the DSUT and the calculations underpinning this report. This is for future research.