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Issues paper

Data processing, hosting and related activities

(Cloud computing)

(ISIC 63.11)

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Introduction

The Voorburg group discussed ISIC 6311 'Data processing, hosting and related activities' with emphasis on cloud computing for the first time at the meeting in Rome, Italy (2018). There were mini-presentations on SPPI from Finland, Poland and Israel. Mexico, Sweden and the U.S. were responsible for the output part of the session. Austria had the lead of the session with Germany as discussant.

This service sector is highly innovative. Cloud computing represents a fast changing, growing and continuously improving technology. In addition, the complexity of several services in the b2b area complicates the work of statisticians. It seems that concentration of this industry will increasing in the future. A big challenge is quality adjustment.

As discussed at the Voorburg group meeting in Rome and suggested by the Voorburg group co-chairs, it was agreed that an issues paper should be prepared for this year's meeting in Paris, France (2019). The focus is on the background and any issues that were brought up last year. Themes of specific interest are classification, terminology, inconsistent treatment across NSOs and outstanding questions about domestic or international characterization of transactions for multinational enterprises. This paper represents an issues paper in the format of a sector paper, included are notes where specific industry information is not available.

1. Descriptions and characteristics of the industry

1.1 Definition of the industry

ISIC class 6311 'Data processing, hosting and related activities' comprises a remarkable range of different services. There are traditional services like provision of infrastructure for hosting, web hosting, application service provisioning, general time-share provision of mainframe facilities to clients, complete processing of data supplied by clients or provision of data entry services. NSOs (National Statistical Offices) are engaged in the research of these services over an extended period.

Recent research from the Voorburg group has analysed challenges for the measurement of turnover/output and SPPI concerning the digital economy. ICT (Information and Communications Technology) Services: Data processing, hosting and related activities; web portals are within SNA (System of National Accounts) production boundary. It is a digital enabling industry where transactions are digitally delivered. Products shell be considered as digital services. Producers of the institutional sector are corporations and RoW (Rest of the World). Users of the institutional sector are corporations, households, government, NPISH (Non-profit institutions serving households) and RoW.

Nowadays, cloud computing services become increasingly important in this industry. Companies do not require the management of on-premises. Examples are applications, runtime or virtualization. Prominent services that use a cloud are email, back office, database, CRM (Customer Relationship Management), BI (Business Intelligence) or HRM (Human Resource Management)/HCM (Human Capital Management) activities. The degree of outsourcing depends on the needs of consumers.[1]

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[1] See also: Mini-presentation from the U.S., Figure 1, Page 9.

Industry classification

Table 1: Main industrial classifications for data processing, hosting and related activities

Industry classification	Title
ISIC class 6311 and NACE class 6311	Data processing, hosting and related activities
NAICS industry 518210 and NAICS Mexico Subsector 518	Data processing, hosting, and related services Electronic data processing, hosting, and other related services

Product classification

Table 2: Main product classifications for data processing, hosting and related activitities

Product classification	Title
CPC 83151 83152 83159 83633 and CPA 63.11.11 63.11.12 63.11.13 63.11.19 63.11.20 NAPCS 7014250000 7014250003 7014250006 7012028000 7014275000 7014275006 7014275009 7014300000 7014300003 7014300006 7014300009	 Website hosting services Application service provisioning Other hosting and IT infrastructure provisioning services Sale of Internet advertising space (except on commission) Data processing services Web hosting services Application service provisioning Other hosting and IT infrastructure provisioning services Advertising space or time in Internet Web site hosting services Web site hosting services without integration of related applications Web site hosting services with integration of related applications Web site design and development services Application service provisioning, including cloud services Application service provisioning with integration services Application service provisioning without integration services Business process management services Financial business process management services Human resources business process management services Supply-chain business process management services

7014300012	Customer relations business process management services
7014300015	Vertical markets business process management services
7014300018	Other business process management services
7014325000	Collocation services
7014350000	Data storage services, including remote backup, storage of computer data, and cloud services
7014375000	Data management services
and	
NAPCS Mexico	
The following are principals:	Design and applications development
	Provision of information technologies (it) infrastructure and lodging
	Business process management
	Information technology infrastructure management
	Technical support on information technology
	Processing information and documents
	Continuous internet access
	Design and development of web sites and databases
	Design, development and integration of computer systems
	Design and development of networks

Classification issues

Most SPPI surveys are based on classifications where the main activity determines the allocation of enterprises. Data processing, hosting and related activities may be secondary services offered by enterprises elsewhere classified. For example, such services can be found in ISIC codes 582 'Software publishing' and 620 'Computer programming, consultancy and related activities'.

There are also other issues related to secondary activities. NSOs must ensure that companies report all their secondary activities. Legal frame is important for this concern. If the focus is on the main activity only statisticians will not be able to survey these activities in a right way.

The respective industry and product classifications provide a good and detailed description of traditional services from this industry. Data processing, hosting and related activities are rather complex, rapidly changing services and therefore more difficult to classify on a product level. Cloud computing services are not yet explicitly defined in classifications. There is a need to work on updating classification systems and develop guidelines for digital transaction measurement.[2]

Cloud service customers get easily access to the services via a web browser. Consumers are enterprises and households. All these services are used by enterprises, whereas households are mostly interested in SaaS.

Three important categories of cloud computing[3] services are:

- Software as a Service (Saas) includes: End-user applications (e.g. Web-based email applications)

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[2] Barrera, E.; Bravo, R.; Cecconi, C.; Garneau, M. B. and Murphy, J. (2018), Page 11, 12.
[3] For more information on cloud computing see chapter: Further cloud computing details besides classification.

- Platform as a Service (Paas) includes: Manage data and application resources for the development of applications (e.g. Cloud computing platforms from Google and Microsoft)

- Infrastructure as a Service (IaaS) includes: Use of IT-infrastructure like server, networks or data storage space (e.g. AWS (Amazon Web Services) for Netflix)

The ISO (International Organization for Standardization) standard from 2014 defines SaaS as a 'cloud service category in which the cloud capabilities type provided to the cloud service customer is an application capabilities type'.

Table 3: Software as a Service (SaaS)

Software as a Service (SaaS)	CPA 58.2 (Software publishing services) CPA 58.29.40 On-line software	Eurostat Task Force "Price and volume measures for service activities" Finland (Mini-presentation on SPPI 2018)
	CPA 63.11.13 Application service provisioning	Finland (Mini-presentation on SPPI 2018)

The classification of SaaS may depend on the rights relating to the software. The activity could be classified to publishing activities if the cloud provider has copyrights for the software. Otherwise CPA code 63.11.13 'Application service provisioning' can be chosen.

Table 4: Platform as a Service (PaaS)

Platform as a Service (PaaS)	CPA 62.01 Computer programming services	Finland (Mini-presentation on SPPI 2018
	CPA 63.11 Data processing, hosting and related services	Finland (Mini-presentation on SPPI 2018)

The assignment to computer programming services or data processing, hosting and related services may depend on the specific platform and user needs. The focus can lie on programming activities or on an environment with available developed tools for creating new online applications.

Table 5: Infrastructure as a Service (IaaS)

Infrastructure as a Service (IaaS)	CPA 63.11.1 Data processing, hosting, application services and other IT infrastructure provisioning services	Finland (Mini-presentation on SPPI 2018) Meeting notes

According to the findings of last year's discussion, IaaS can be assigned relatively unambiguously to data processing, hosting, application services and other IT infrastructure provisioning services. The consumers may use their own software. The focus is on providing

the infrastructure, not the software only, despite the fact that IaaS providers also bundle software.

The complexity of such services is mentioned in the following example from Byrne, D.; Corrado, C. and Sichel, D. (March 2017, Page 12-14). Compute product (IaaS category), renting a virtual machine (PC or server) from AWS, and this product is priced in terms of dollars per hour. The use of a virtual machine here is known as an 'instance'.

- Different regions offering the service

- Wide range of configurations, from 2009 to 2016, AWS offered 55 different configurations of virtual machines

- Each configuration has specified characteristics in terms of the power of the processor, the amount of RAM and the amount of disk space allocated

- Customers can choose between Linux or Windows operating system

- 'On-demand' instances, which can be purchased at any time with no commitment; 'Reserved' instances, for which a customer pays in advance for a set volume of instances whether or not the instances are used

- Spot market for instances

- Quantity discounts to heavier users

- Revision of instance types, quality adjustment is needed

- No quantity data available, regressions are unweighted

The Voorburg group members in Rome agreed that classifications for data processing, hosting and related activities (cloud computing) would require a revision regularly at shorter intervals. NSOs need to cooperate with experts and enterprises of the branch. A lot of research was already done by different initiatives. For example, the European cloud computing strategy closely examines key areas in the field of cloud computing. Of particular interest are standards and specifications that help to classify these services with practical relevance.

The classification of streaming services depends on the rights relating to the content. This is similar to the suggestions for SaaS and IaaS. If the streaming enterprise only provides infrastructure for hosting streaming content, the activity should be classified to data processing, hosting and related activities. There are different classification possibilities for companies which have the control over the streaming content.

Table 6: Streaming services

Streaming services	ISIC 6311 Data processing, hosting and related services CPC 83159 Other hosting and IT infrastructure provisioning services	Finland (Mini-presentation on SPPI 2018 U.S. (Mini-presentation on Output 2018)
	Elsewhere in the information sector	U.S. (Mini-presentation on Output 2018) Finland (Mini-presentation on SPPI 2018)

Further cloud computing details besides classification issues

The ISO standard from 2014 defines cloud computing as a 'paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand. The cloud computing paradigm is composed of key characteristics, cloud computing roles and activities, cloud capabilities types and cloud service categories, cloud deployment models and cloud computing cross cutting aspects'.[4]

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. The abstraction layer consists of the software deployed across the physical layer, which manifests the essential cloud characteristics. According to the U.S. NIST (National Institute of Standards and Technology) definition, the abstraction layer sits above the physical layer. Server, storage and network components are hardware resources that are necessary to provide cloud computing services.[5]

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[4] ISO/IEC 17788 (2014), Page 4.
[5] NIST SP 800-145 (2011). Page 2.

The following table shows different cloud computing deployment types.

Table 7: Cloud computing deployment models[6]

Cloud deployment type	Features	Benefits
Public	For use by multiple organisations (tenants) on a shared basis and hosted and managed by a third-party service provider. Computing resources accessed as external services, instead of as products purchased, installed and managed within the organisation.	Ability to rapidly sale the allocation of computing resources to match fluctuations in business demand. Utility-based pricing. Potentially, large economies of scale.
Private	For exclusive use by a single organisation and typically controlled, managed and hosted in private data centres. The hosting and operation may be outsourced to a third-party service provider, but a private cloud remains for the exclusive use of one organisation.	Considered the most secure option, but with reduced potential for economies of scale and productivity gains available through multi-tenant options.
Hybrid	Both private and public cloud models are adopted by a single organisation.	Allows for multiple deployment methods to meet specific business/agency needs.

For the U.S. market, the following table presents important product lines generated revenue in NAICS 518210, Data processing, hosting, and related services for the 2012 Economic Census (in order of priority).

Table 8: Important product lines (U.S. mini presentation, Table 3, Page 5)

Product Line Description
Application service provisioning, with or without integration of related services
Business process management services, including financial, human resources, supply-chain, customer relations, and vertical markets management
Business process management services - financial
Other business process management services
Website hosting services, with or without integration of related services

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[6] Deloitte (2016), Page 24.

Website hosting, with integration of related services
Data management services
Information technology (IT) technical support services
All other receipts

Examples of leading EU based private cloud service providers by European market share are: T-Systems (Germany), Atos (France), Capgemini, BT GS, and Orange BS.

The top five European-based public cloud providers by European market share are:

- SAP (Germany): The main focus is on SaaS applications for CRM and ERM (Enterprise Resource Management). It is also the world's largest vendor of business management software, including ERM, CRM and SCM (Supply Chain Management).

- T-Systems (Germany): The main focus is on providing private cloud services, but they also provide a virtual private cloud.

- SmartFocus (France/UK): It is a provider of SaaS services for email, social and mobile marketing.

- Unit4 (Netherlands): It is a vendor of business applications, for example financial management software suite.

- Cegid (France): It is a vendor of business applications who also offers SaaS applications (for example accounting services).[7]

1.2 Market conditions and constraints

The following figures (if not mentioned other sources) are based on the U.S. mini presentation and Eurostat database (European Union - 28).

In the U.S., the importance of the data processing, hosting and related activities service sector increased in the past. Compared to the information sector, revenues rose from 6% (2007) to 9% (2012). Industry revenues grew further. Growth rates of revenues were 7,9% (2015) and 10,3% (2016). In Europe, the share of this industry on the information sector was 57,4% (2012) and 56,7% (2014). Contrary to the U.S., 2016 compared to 2015, a slight decrease in revenues or gross premiums written was observable. The importance of data processing, hosting and related activities and the whole economy is quite small, but the lower level of classification has to be considered.
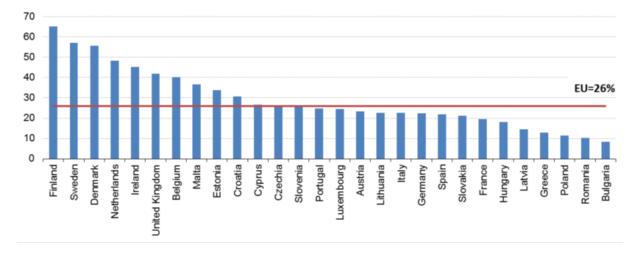
In Israel, ISIC 6311 'Data processing, hosting and related activities' has an average revenue growth rate of 10% every year from 2014 to 2017. Mexico showed in 2014 an increase of real-term industry revenues by more than 60% compared to 2004.

According to the report 'ICT usage in enterprises in 2018', 26% of European enterprises with at least 10 persons employed purchased cloud computing services. Large enterprises use cloud computing services more than small ones. The growth of cloud computing (between

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[7] Deloitte (2016), Chapter 3.1.3 Cloud providers: key players in Europe.

2014 and 2018) is higher in large enterprises. SME (Small and medium sized enterprises) are more sensitive by using this new technology.

Graphic 1: Use of cloud computing services by enterprises in the EU member states, 2018 (% of enterprises)[8]

The Eurostat newsrelease 193/2018 sets out that cloud computing services show higher growth rates than in recent years. Cloud computing usage grew rapidly over the last few years, as in 2014 it stood at 19% and in 2016 at 21%.

The growth of the cloud computing industry is considered verified. Studies from researchers showed an upward trend in the past. Many studies mentioned this strong growth of cloud services, but there is a wide range of the estimates. Reasons for the growth of cloud services are reduced costs and greater flexibility.

In official statistics data processing, hosting and related activities are mixed with cloud computing services. Detailed data from vendors of traditional hosting business services and private cloud services are rarely available. Moreover, it is not ensured which proportion of cloud activities are outside of data processing, hosting and related activities. Another limitation could be the already discussed problem of surveying secondary activities.

Several studies highlighted that cloud computing growth is below its potential. Consumers of cloud services are uncertain about their data in the cloud. It is important that data protection is ensured. This is also true for a change of the service provider. Customers often were confronted by disclosure of personal data in the past. Another issue is data transferred to third parties. Consumers are concerned to whom their personal data is forwarded, especially in the context of multinational enterprises. There are many other factors which could impede higher growth rates for cloud computing, for example:

- Barriers to cross-border online activity

- Insufficient technical infrastructure

- Wrong or missing regulatory conditions (Innovation, investment, fair competition and a level playing field)

- High costs of data location requirements

- Little knowledge among current and perspective users[9]

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[8] Eurostat, eurostat newsrelease 193/2018.

Different regulations within European countries make it difficult for companies to trade their services. SMEs are particularly concerned with this issue because they have not the possibilities (human and capital resources) that larger companies have. Another problem is the time lag in adopting new emerging services (e.g. cloud computing) to national and international laws. There are different initiatives from the EU.[10]

Costs for building and running a cloud computing business play an important role in this service sector. Companies reinvest revenues and generating hereby high investment rates. Sweden mentioned this topic at the last Voorburg group meeting. Value added can be negative due to high expansion costs.

In general, gains from major digital innovations were concentrated in a relatively short period.[11] There will be further constant changes in the cloud computing industry with a fairly quickly flattening effect. The question rises when the peak is reached.

In the U.S., the number of establishments declined from 2007 to 2012. It is argued that a continuous trend of consolidation among the industry's largest businesses happened. In Europe, establishments increased slightly in the period 2012 till 2016.

The U.S. stated that rules for this industry are on a moderate level today. It is expected that regulation will increasing over time. The same trend seems to apply for the EU. One example are rules concerning the protection of personal data.

The concentration of the U.S. data processing, hosting and related services industry has changed in recent years. In 2012, the shares of the largest firms were on a lower level.

Table 9: Concentration of NAICS industry 51821 in U.S. in 2012

Firms concentration	Revenue of largest firms as percent of total revenue (%)
All firms	100
4 largest firms	15,9
8 largest firms	22,6
20 largest firms	32,8
50 largest firms	45,3

The degree of concentration within the current industry situation is high. According to a study mentioned in the U.S. mini presentation, the top 4 U.S. companies providing cloud infrastructure services (IaaS and PaaS) had a collective market share of more than 50% in the 2nd quarter of 2017.

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[9] Deloitte (2016), Chapter 2.3 Digital Single Market Strategy and 3.2.2 Barriers to adoption of cloud computing in Europe.
[10] Deloitte (2016), Page 13.
[11] IMF (2018), Page 18.

Table 10 shows the concentration of the European NACE 631 'Data processing, hosting and related activities; web portals' industry. Some limitations must be considered for the figures in 2016. Web portals are included and some data is confidential. In Europe, the industry concentration is not high. 198 companies (with 250 persons employed or more) had a bit more than half of the turnover share in comparison to the companies with persons employed from 2 to 249. Number of enterprises and number of employees are also presented in this table.

Table 10: Concentration of NACE industry 631 in Europe (European Union - 28) in 2016

Persons employed - number	Number of enterprises	Number of employees	Turnover or gross premiums written - million euro
250 persons employed or more	198	120 694	39 213 (2015) 2016 confidential
From 50 to 249 persons employed	949	98 206	16 252,5
From 20 to 49 persons employed	1 545	48 432	6 732,3 (2015) 2016 confidential
From 2 to 9 persons employed	31 701	111 013	8 231,6

In Europe, the situation for cloud computing is similar to the U.S. The top 25 public cloud vendors are responsible for more than 97% of the total revenues. The 17 U.S. headquartered providers have a share of 83%. The top 5 European based private cloud service providers are responsible for nearly 50% of the overall revenues.[12] One problem is mentioned in the European study concerning the results of private cloud services. Vendors are reluctant to provide separate results for their traditional hosting business and private cloud services.

1.3 Specific characteristics of the industry

Cloud computing is a relatively new and growing service. Consumers change their behavior from on-site facilities to cloud services. Such services are also intermediate inputs in the production process of services.

Many providers of cloud computing services are global enterprises and the provider and the user of the cloud service can easily be located in different countries. Cross border transactions are challenging for statisticians. It is a complex task measuring and ensuring coherence of transactions between the ultimate owner of the cloud computing infrastructure, the unit where the infrastructure is located, and the end-user.[13]

In order to identify actual measurement challenges with cloud computing, various service offerings have to be considered (for example on a contract basis, rates or fees, projects, etc.). The indirect value of activities is another specific characteristic of this industry. Cloud providers do not always charge a direct value for their services. Especially in the b2c area

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[12] Deloitte (2016), Chapter 3.1.3 Cloud providers: key players in Europe.
[13] OECD (2019), S. 132.

(e.g. storage and email services) customers get services mostly up to a certain limit free of charge. In this paper there are examples of different cloud computing services and how they are transacted.

Basic investigation is required for bundled cloud computing services. The U.S. will consider new questions to their surveys. Which products are being bundled and how frequently they are transacted together? Such results are important as basis for future surveys.

2. Turnover/output measurement

2.1 General framework

Economic censuses and sampling surveys are suitable for surveying turnover/output. In the mini presentations different frequencies (e.g. monthly, quarterly, annually or every five years) were mentioned for such surveys. Scorecard details show the periodicity for countries that currently calculate and publish indexes for this industry (ISIC or other industrial classification basis).

- 2 every 5 years

- 17 annually

- 6 quarterly

- 6 monthly

Turnover/output data is usually used for annual industry accounts, including GDP by industry and annual input-output accounts, input-output tables, update industry and product index weights, services industry labor productivity, cost measures and other macroeconomic indicators. Indices are calculated for variables like income, personnel employed, expenses, salaries or productivity. Each census and survey has its own characteristics, for example classification code, sample framework, -size, -scheme, geographic coverage or variables collected.

2.2 Measurement issues

The measurement of turnover/output for data processing, hosting and related activities gets complicated when turnover is generated by different establishments at different points in time. Multinational companies often run many data centers all over the world. At the Voorburg meeting in Rome it was assumed that the improvement of latency is a driving force for setting up new data centers. The start of these discussions was launched there in 2018.

It is uncertain whether enterprises record the turnover on establishment level. The U.S. mini presentation indicates that this does not happen in most cases. One solution could be the allocation of turnover to establishments based on the proportion of total company payroll at each location. Since the marginal labor production cost associated with these activities is frequently quite small, this allocation by payroll may not be logical as mentioned from the U.S.

Alternative sources of information could be administrative tax records, social security or data from regulatory institutions.

2.3 Description of methods for measurement

Almost all countries reported that they are collecting turnover/output data on a regular basis. For Europe, these results are expected due to regulations which oblige European countries to collect SBS and STS data. Regarding the timing no favoured freuency could be observed.

Common sampling methods are stratified simple random sampling, PPS (Probability Proportional to Size) sampling, judicious sampling or combinations of those methods.

In the U.S., new samples are drawn every 5 years with updates during the period. The sampling frame is identical for quarterly, annual services surveys and economic census. Estimates are computed for totals, ratios, percent contribution estimates and trends.

Two imputation categories were mentioned in the mini presentation from the U.S. First, values derived by logical edits. In a logical edit, the replacement is derived from other reported values. Second, values derived from statistical modeling. Replacement values derived from statistical models apply historic trends or industry averages.

3. Measurement of SPPI

3.1 General framework

European SPPIs for information services are usually published on higher aggregate levels. In Finland, the SPPI for CPA 63 'Information services' has been published since 2005. It is compiled on a product basis. SPPIs in Poland and Austria (ISIC/NACE 63 'Information service activities' and ISIC/NACE 631 'Data processing, hosting and related activities; web portals') are compiled and disseminated at the industry level.

There are two main reasons for the publication of higher aggregate levels. First, the European legislation does not require lower level indices. Growing cost pressure is on NSOs which simply cannot afford more detailed statistics. Second, the survey of more detailed level indices is complicated because there is a lack of information concerning service products and/or new service products in the data processing, hosting and related activities industry (e.g. cloud computing). But this is not only true for the information service sector.

The European SPPIs often include b2all prices. There is rarely no splitting of b2b (business to business), b2c (business to consumers) or others. Future requirements might change this for SPPIs in Europe. FRIBS (a new Framework Regulation Intergrating Business Statistics) prescribes rules for b2b and b2c indices. Another breakdown could be into domestic and exported services.

Different periodicities are common for SPPIs. Scorecard details show the periodicity for countries that currently calculate and publish indexes for this industry (ISIC or other industrial classification basis).

- 1 annually

- 14 quarterly

- 5 monthly

SPPIs for information services are usually used for example as deflators in the SNA (System of National Accounts), ISP (Index of Services Production) or TIO (Trend Indicator of Output).

3.2 Measurement issues

Business register and business service statistics are regularly the sampling frame for SPPIs. Information on service products and enterprises in this branch suffer from some restrictions. Limitations could be the lack of detailed product level data or simply missing data. Cloud computing is one example for missing data. Detailed product level data is actually only available for tradtional data processing, hosting and related services. The situation will improving considerably in the near future because NSOs are going to collect more data on product level. This information is important for classification and weighting of companies and their services.

Common sampling methods are PPS (Probability Proportional to Size) sampling, judicious sampling (purposively) or combinations of both.

Current cloud computing information and services often have to be selected in co-operation with data providers due to the lack of data on product level detail in classifications.

Turnover information on lower level weights of indices can stem from enterprises and their breakdown by service groups. Other sources are business registers and business service statistics. Sometimes trade associations provide detailed weight information. Upper level weights can be obtained from the SNA supply and use tables.

SPPIs are often calculated using the Laspeyres price index formula. Missing prices have to be imputed for index calculations. In Finland, missing prices of service products are imputed my means of other corresponding products of the price development in the service group. This method assumes the same price development for missing and corresponding products in the service group. If possible, new service products are chosen for permanently missing services.

Quality adjustment is challenging for ICT and high-tech products. Two points should be emphasized here. It is a resource-intensive task and procedures need frequent updating. Explicit quality adjustment procedures are used for similar services and products.[14] Further investigation is needed for data processing, hosting and related activities as well as cloud computing services.

3.3 Description of pricing methods and criteria for choosing the method

Price determining factors

There are a large number of price determining factors in this industry. These factors are much easier to follow in other service industries (e.g. cleaning services). High technology services with their inherent complexity make it a challenge to identify and determine the price determining factors in a correct manner.

Some important price determining factors in the cloud computing industry[15]:

- Number of users
- Computer storage capacity (gigabytes)
- Computer connection speed
- Processor speed of the server
- Amount of memory used
- Level of service/uptime

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[14] Deloitte (2016), Page 18, 19.
[15] Mini-presentation from the U.S.

- Number of transactions to be processed
- Sophistication of technology needed
- Disaster recovery plan/server back-up
- Amount of data being transferred
- Storage space (physical space to store clients hardware)
- Network/server redundancy
- Multi-tenant or single tenant architecture (shared or dedicated server)
- Price floors/ceilings written into contract
- Implementation fees (includes training)
- Penalty fees
- Customization/optional features

Latency is a price effective component and could also be a driving factor for pricing. In the UK there were no data centers till 2015. Now data centers emerge on the market and effects of latency can be reduced for the future. There is a quality change of the services in addition to a possible price effect.

Finland mentioned in its mini presentation also specific price determining factors for the cloud computing industry. For example, the type of technical equipment from the cloud providers or the lease period of resources from the service provider play an important role for the prices.

The Voorburg group members discussed further price determining factors at the last meeting in Rome. Processing performed overnight is cheaper than processing during the workday. One NSO observed that over the weekend processing is available even more cheaply.

Pricing methods

Data processing, hosting and related activities are complex services. As mentioned already in this paper a wide range of services, service packages and pricing schemes are offered by enterprises of this industry. Various pricing methods could be best options.

Direct use of prices of repeated services is an appropriate pricing method. It is also suitable for cloud services. The same service product will be observed in successive survey periods even though enterprises have their own pricing schemes.

Some providers offer only customized business solutions to their clients. Each service contract is then negotiated individually. Contract pricing can be used for such transactions.

Hourly charge-out rates are possible for data processing, hosting and related activities, but this pricing method is not suitable for cloud computing. Poland also uses the unit value method. Hedonic pricing models seem to be suitable for this service sector, but there are no experiences with this method.

The following table shows some basis pricing mechanisms in the cloud services industry.

Table 11: Basic pricing mechanisms in the cloud services industry

Pricing mechanism	Price
Fees based on time or usage	e.g. Price per hour of application usage, Price per GB of storage
Hyprid form	e.g. Price per month combined with price per hour after a certain limit of the service
Flat fee (Subscription)	e.g. Price per month to access the service

Hybrid forms are popular in this service sector. Some services are free of charge up to a certain limit. Hosting or cloud services providers also use single flat fees for their service packages. Service packages can be available in standardized or customized form. List prices are not preferred. Especially for b2b services, enterprises are negotiating prices. In some cases list prices (e.g. b2c price per GB of storage) may be the best option. Normally, clients have to pay on a monthly or annual basis.

It is important that recommended pricing methods become available for different cloud computing service categories (SaaS, PaaS and IaaS).

Three examples of pricing methods can be found in the U.S. mini presentation. The following table contains the result of a selected transaction to be priced. This product is priced in terms of dollars per hour.

Table 12: Fees based on time and usage, example of a compute product

Service	Units	Unit of measure	Rate	Total charge
Small instance	900	hr	$0.017	$15.30
15 TB/hr memory usage	56	hr	$0.473	$26.49
Data transfer out	50	TB	$0.222	$11.10
Data transfer in	150	TB	$0.079	$11.85
IP addresses	19	address	$1.297	$24.64
			Total	$89.38

The starting point is the selection of a representative bill or record of service features for a client. Instance is here equal to one physical or virtual server or 'license'. 15/TB/hr memory usage is chosen. Data transfer from cloud to internet may be based on tiered pricing. In this

transaction 50 TB Data transfer out and 150 TB Data transfer in are chosen for the price survey. IP addresses amount to 19. The rate is computed as monthly average rate. Monthly average rates are preferred according to the U.S. mini presentation because discounting and 'free' services can be captured. Discounts are very common in the b2b area, especially when the volume of orders is large.

4. Evaluation of measurement

Finland mentioned that more detailed breakdowns of information services SPPI would be useful for deflation and other use. European indices are often published on a high aggregation level only. Countries may compute lower level indices, but do not publish them.

Surveys could differ in timing. SPPIs are usually produced on a quarterly basis, whereas ISP and TIO may be computed on a monthly basis. Quarterly data can be transformed to monthly data with the linear interpolation method. Common extrapolation methods for prediction of the latest missing data are the ARIMA model, AR model and carrying forward the value of the previous quarter.

Poland mentioned in its mini presentation that subsidiaries of multinational enterprises provide their services also to affiliated units. Intergroup transactions are not free market services. Such companies can not provide precise data on the prices because they have only information on the costs. The question is whether the costs should be monitored as an alternative for the SPPI survey.

Imported/exported services were discussed at the last Voorburg group meeting in Rome. For example, a data center in country A (owned by a company in country B) shows generated or allocated revenues. Should it be treated as an import of a service? This must be reviewed carfully and it is necessary to observe where the revenues are being booked or reflected.

Turnover/output statistics in Mexico are well aligned with SNA requirements. Mexico asks companies for quarterly data on the value and volume of services. This allows the calculation of an experimental implicit price index.

5. International progress

The situation regarding data availability on output and prices is quite similar. Both variables are well covered in ISIC 6311 'Data processing, hosting and related activities', only 3 of 25 respondents did not have coverage for both turnover and prices. According to the scorecard details 23 out of 25 countries are collecting industry-level turnover data. Four countries are having turnover details. 20 out of 25 countries are calculating industry-level prices. Three countries are having PPI details (one country soon).

Summary of main conclusions

The experiences are partly limited in the data processing, hosting and related activities industry. NSOs were concentrated on traditional services for some time. Currently, statisticians need cloud computing information on turnover/output and prices.

All examined industry classifications are similar in their structure with nearly identical content. Product classifications offer a good and detailed description of traditional data processing, hosting and related activities. Cloud computing services should be explicitly defined in classifications.

The cloud computing industry has shown strong growth rates in recent years, but there is a wide range of estimates in research studies. Official statistics do not provide differentiations between cloud computing and traditional data processing, hosting and related activities. NSOs need information on the distribution and development of both service groups.

Turnover statistics and SPPIs on product level are not available in many countries. Based on experiences gained so far, turnover has to be explored in more detail.

- Turnover at the industry level includes turnover from companies that carry out data processing, hosting and related activities in combination with secondary activities

- Turnover at the industry level excludes turnover from companies that carry out data processing, hosting and related activities as secondary activities

In order to get a realistic picture of this industry, it would be necessary to collect data on turnover from all companies carrying out data processing, hosting and related activities.

Data processing, hosting and related activities are usually complex services. Customers can choose from a big range of service offers with many pricing schemes. Bundled services are very common in this industry. Different pricing methods should be considered for surveying SPPIs. It is important to take a look at pricing methods for main cloud computing categories (SaaS, PaaS and IaaS) in the future.

The characterization (domestic or international) of transactions for multinational companies is another important issue. Global enterprises offer cloud services in different countries. They have established data centers and local subsidiaries all over the world. It is important to know the different units (supply and demand side) and how they interact together. This helps to answer questions about imported/exported services or intergroup transactions/free market services.

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