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CONTENTS

ANALYSES

BOOK REVIEW

INFORMATION

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Journal of Statistika | Czech Statistical Office | Na padesátém 81 | 100 82 Prague 10 | Czech Republic
e-mail: statistika.journal@czso.cz | web: www.czso.cz/statistika_journal

Chains, Shops and Networks: Official Statistics and the Creation of Public Value

Asle Rolland[1] | *Statistics Norway, Oslo, Norway*

Abstract

The paper concerns official statistics, particularly as produced by the NSIs. Their contribution to the society is considered well captured by the concept of public value. Official statistics create value for the democracy as foundation for evidence-based politics. Democracies and autocracies alike need statistics to govern the public. Unique for the democracy is the need of statistics to govern the governors, for which the independence of the NSI is crucial. Three ways of creating public value are the value chain, the value shop and the value network. The chain is appropriate for the production, the shop for the interpretation and the network for the dissemination of statistics. Automation reduces the need to rely on the value chain as core business model. Thereto automation increases the statistical output, which in turn increases the need of shop and network activities. Replacing the chain with the shop as core model will elevate the NSIs from commodity producers to a processing industry.

Keywords

Public value, value creation, public interest, professional independence, official statistics, national statistical institutes

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INTRODUCTION

The topic of this paper is the contribution of official statistics to the welfare of the society. It is an ends-means paper with the end captured by the concept of public value and the means captured by the concepts of chains, shops and networks. Although in Europe the concept of official statistics usually refers to the statistical output of any state agency (SOU, 2012, p. 83) the concern of this paper is the main supplier of official statistics, the National Statistical Institute (NSI) or Office (NSO).

It is widely acknowledged that the NSIs are facing challenges. A panel discussion held at the 2013 Hong Kong World Statistical Conference addressed no less than nine of them (Penneck, 2014). The Bureau of the Conference of European Statisticians had then already, in 2010, set up a High-Level Group (HLG) for the Modernization of Statistical Production and Services. Particularly alarming is the pressure on the NSIs to satisfy increasing statistical demands within decreasing budgets (Smith, 2014). It implies that if they fail to improve their products and/or cut their costs sufficiently the NSIs will open a gap between demand and supply, to be filled by their currently marginal competitors. Widening the gap means sunrise for the competitors and sunset for the NSIs.

[1] The opinions expressed in this paper are those of the author and not necessarily those of Statistics Norway. E-mail: asle.rolland@getmail.no, phone: (+47)45004937.

The aim of this paper is to forestall such a development. It is based on the notion that competition should be met as an incentive to excel, in the innovative entrepreneurship spirit of William Baumol (1968; 2010), and not as a threat to be met with barriers to entry, as in the five forces model of Michael Porter (1980; 2008). It is thus written in the same spirit as the vision of the HLG. It acknowledges that "statistical organisations no longer have a monopoly on the means to inform society" in their field. "Others are starting to create outputs in competition with ours", and "we risk losing relevance". The NSIs "could react defensively" to this, and try to prevent market entry "by legislation etc." Instead, the HLG proposes "to actively pursue a course in which we use our strengths and resources" to provide the service that "give our stakeholders a clear perspective on what is happening in the world today".

1 PUBLIC VALUE

1.1 Value creation

The assertion of this paper is that the purpose of official statistics – and hence the objective of the NSI – is to produce public value in the sense introduced by the Harvard Kennedy School in Mark Moore's *Creating Public Value: Strategic Management in Government* (1995). There is concurrence between the concepts of Public Value (PV) and that of New Public Management (NPM), as they both concern the transfer of private sector logic to public sector operations. They cover, however, different aspects of that transfer, with the PV referring to the end and the NPM to the means.

The PV's point of departure was the assertion that just as the goal of private managers is to create private (economic) value, the goal of Government agencies is to create public (social) value. Compared superficially the managers of public non-profit organizations and of private for-profit enterprises appear to face exactly the same challenges. Thus "both private and public sector managers ought to be interested in getting the most out of the bundle of assets entrusted to them by figuring out the best use of the assets, and finding ways to produce their products and services or achieve their desired social results at the lowest possible costs" (Moore and Khagram, 2004, on which also the following summary is based). However, the presumption of similarity does not survive closer inspection. There are crucial differences, which Moore and Khagram group in three categories, (1) sources of revenue, (2) management discretion, and (3) performance measurement.

(1) Private and public organizations earn their revenues in substantially different ways. Private enterprises earn them from selling to customers in the product market. Frequently they need capital to get started, but even access to capital depends on trust in their ability to sell in the product market. Their principal sources of money are thus investors and consumers making individual investment and purchase choices. In contrast, Government agencies obtain both financial capital and operating revenues from the citizens in their role as taxpayers, with their elected representatives making collective choices on their behalf. The managers of Government agencies thus secure their resources not by selling products and services, "but by selling a story of public value creation to elected representatives of the people in legislatures and executive branch positions", the stories however presumably quite similar to those that managers of commercial enterprises sell to capital market investors in order to create private value. For Government agencies this implies that most "revenues come from executive branch recommendations that are then passed as legislative appropriations."

(2) "Government managers typically have much less discretion to define the purposes of their organizations, and the ways they intend to pursue those purposes." A major purpose of NPM is incidentally to increase their discretion; thus Haldor Byrkjeflot (2014) identified the issues at stake for Old Public Administration (OPA) and NPM as the following:

- OPA: "How to solve a given fixed assignment in a legally correct way",
- NPM: "How to create new results in an untraditional way without breaking the rules".

Nevertheless, Moore and Khagram argue that "government managers are both surrounded and thickly engaged by what we came to call their 'authorizing environment'", which "includes the large number and wide variety of people in particular positions who authorize them to take action, or appropriate money for them to use", as well as "call managers to account for their performance" and reward or punish them by continuing or withdrawing authorizations and money. Compared with private sector firms the public sector authorizers have "substantially more varied interests" that they expect the Government agency to cater for, all of them good purposes but not always possible to cater for simultaneously. Frequently the authorizing environment, in conflict with itself, is the "*only* source of funds" available for the public agency, while private sector enterprises have two sources, investors and customers, all acting independently of each other.

(3) Performance measurement is much more complicated for public agencies than for private enterprises. Above all, "government managers are missing one crucial piece of information that private sector managers have: the magnitude of the revenues earned by the sale of goods and services to willing customers." In order to compensate for this, "government managers have been forced to construct measures of value other than the revenues earned by sale", such as the "social outcomes", which may appear "years after the government has acted", in places "far removed from the government agency's current operations", or they try to measure customer or client satisfaction with their services, which however may not be the goal of the agency's activities, the goal rather being the achievement of the hard-to-measure social outcomes. Government agencies have therefore "often been forced back on to an unsatisfactory" alternative to measuring social outcome and customer satisfaction, "namely, the measurement of their concrete outputs and activities." Such measures are simple, inexpensive and quick enough "to allow top level managers to hold lower level managers accountable for their level of accomplishment", but "these assessments cannot ever be taken as reliable measures of the public value of what is produced."

1.2 The strategic triangle

The answer of Moore and Khagram to that challenge is the strategic triangle. It is assumed that in order to create public value the managers of Government agencies must be capable of providing satisfactory answers to three questions: (1) what is the important public value that the organization seeks to produce, (2) what sources of legitimacy and support authorize the organization's actions and provide the necessary resources to sustain its efforts to create that value, (3) what investments, innovations and other operational capabilities must be available – and made available by the supporters or the organization itself if they are missing – for the organization to deliver the desired results. Thus "the strategic problem for public managers" is to "imagine and articulate a vision of public value that can command legitimacy and support, and is operationally doable in the domain for which" the manager has "responsibility". Public value, legitimacy and support, and operational capabilities mutually reinforce each other.

1.3 The public value of official statistics

According to Moore and Khagram what constitutes the public value of official statistics will be "hotly contested". That is however exactly the point. It will clarify for the NSI what it is "trying to produce", and what results it "should feel accountable for achieving". The fact that values are contested makes it no less "important to establish a sense of purposefulness in management".

The strategy documents of European NSIs invariably open with statements of vision and mission. In 2011 the European Statistical System (ESS) opened the new version of its Code of Practice similarly (ESS, 2011).

"*The vision of the European Statistical System*. The European Statistical System will be a world leader in statistical information services and the most important information provider for the European Union and its Member States. Based on scientific principles and methods, the European Statistical System will

offer and continuously improve a programme of harmonised European statistics that constitutes an essential basis for democratic processes and progress in society.

The mission of the European Statistical System. We provide the European Union, the world and the public with independent high quality information on the economy and society on European, national and regional levels and make the information available to everyone for decision-making purposes, research and debate."

The vision and mission offer no demarcation line for the ESS. Inside its scope is everything. Outside is nothing. Apparently the aim of the ESS is to deliver a general interest public service similar to that of public service broadcasting (typically the BBC tells the story that it builds public value; BBC, 2004), albeit restricted to news that can be expressed in numbers. Just like private media outlets create private value for their owners by producing "all the news that's fit to sell" (Hamilton, 2004) the ESS intends to create public value for its owner, the public, by producing all the statistics it needs for decision-making, research and debate.

The practical task of the ESS, currently to conduct the European statistical programme for 2013–2017, tells a different story. Its objective 1 is to "provide statistical information, in a timely manner, to support the development, monitoring and evaluation of the policies of the Union". Its priority 1 is to "ensure statistical initiatives underpinning the development, implementation and monitoring of current Union policies" and to "provide statistical support for important requirements resulting from new Union policy initiatives". Its added value 1 is "ensuring that European statistics are focused on the information needed to design, implement, monitor and evaluate Union policies." It also "contributes to the effective use of resources" by "serving the needs of the wide range of users […] in a cost-effective manner without unnecessary duplication of effort", but that is in addition to its primary objective (EU, 2013).

Official statistics are public goods in the sense detected by Paul Samuelson (1954), that is, non-excludable and non-rival in consumption. The statistics produced by the ESS are intended to serve the European Union, but being non-rival in consumption their consumption by the EU does not reduce their availability for everyone else's consumption. The EU could make them excludable by restricting access, which would turn them into private goods, but prefers to deliver them as public goods in that sense too. They are thus made available by courtesy of the EU, which however obtains two advantages thereof: (1) the EU will rarely be taken by surprise, as decision-making, research and debate will based on its own statistics; (2) by re-using EU statistics a "wide range of users" will add value to them, and most of that value will also be available for everyone's consumption, including the EU.

As the primary objective of the European statistical programme is to serve the governing bodies of the European Union, the public – everyone else – is served as a residual category. The order of priority is the same in the United Nations fundamental principles of official statistics. Principle 1 opens with the assertion that "official statistics provide an indispensable element in the information system of a democratic society, serving the Government, the economy and the public with data about the economic, demographic, social and environmental situation." It ends with official statistics "that meet the test of practical utility" are made publicly available not because of their utility for the public, but "to honour citizens' entitlement to public information." Publication serves the open society of Karl Popper (1945). The statistics serve the Government.

The European statistical programme limits the scope of official statistics at European level. Inside the scope are statistics that concern the governing bodies of the European Union, the European Parliament and the Council. At national level the European programme limits the scope to statistics that concern the governing bodies of the State. However, even without the European programme the primary objective will be that of serving the Government. In this respect the vision and mission of the ESS as well as the fundamental principles of the UN merely state the existing empirical facts. Typically the Norwegian statistics act defines official statistics as follows: "Official statistics are statistics which are made available

to the public by Statistics Norway or another State agency" (SSB, 1989). The definition makes the statistics act a communications act. It identifies the senders (State agencies), the messages (statistics), and the receivers (the public). The definition does not prevent State agencies from serving general interest purposes, but it does make it likely that they will make publicly available the statistics they need to carry out their duties. Inside the scope will be statistics on their own performance, on the part of the public that they serve, and on the natural environment affected by that service. Outside the scope will be statistics on everything else.

Furthermore, the vision of the ESS and the fundamental principles of the UN link official statistics to the democracy. Official statistics are said to be essential for democratic processes (ESS) and indispensable for a democratic society (UN). However, serving the government is not sufficient to serve the democracy. Autocratic governments too are served by statistics; in fact the need for statistics must be a lot greater in autocracies with planned economy than in democracies with market economy. Thus another condition must be applied to statistics serving the government to serve the democracy: the government must be democratic. It is then the type of government that decides the democratic quality of the statistics, and not the statistics that decides the democratic quality of the government. If the government is democratic its official statistics are democratic too. If the government is autocratic its official statistics are autocratic too.

Making statistics publicly available provides the public with a means to control the government. Hence it adds a democratic feature even to the autocracy. Conversely, suppressing statistics that are embarrassing to the government adds an autocratic feature even to the democracy. Publicity as control is necessary for the democracy, but it is not sufficient.

In democracies and autocracies alike the State needs statistics to govern the public. What is unique for the democracy is the need of the public for statistics to govern the State. Hence the difference between a democratic and an autocratic service is the existence of official statistics serving the public. This is what makes official statistics democratic.

For the European statistical programme the public value of official statistics is that of providing evidence for evidence-based policymaking. Statistics "are no longer merely one source of information for policy-making purposes, but are now at the very heart of the decision-making processes. Evidence-based decision-making requires statistics that meet high-quality criteria linked to the specific purposes they are serving" (EU, 2013).

1.4 Independence

Most state agencies are likely to produce the statistics they need for their governance of the public (the society). They may produce it themselves, or commission the NSI to produce it for them. The NSI is however invariable a professionally independent institution. It is so according to the European "statistical law" (EU, 2009), as well as national statistical laws, e.g. the Norwegian statistics act. It is so according to the United Nations. The purpose of public institution's professional independence is to secure that it caters for the public interest. Ever since Kenneth Arrow published his impossibility theorem in 1951 it has been acknowledged that the public interest does not exist. But public interests exist. Some of them can be captured by the same statistics. Government and opposition, politicians and bureaucrats, representatives and voters may need knowledge of the same variables, despite having opposing interests related to the observed values. Other interest differences require separate statistics. Agenda-setting the statistical needs of one interest group will then be at the cost of another group with equally legitimate interests.

The value of independence must be to ensure that all stakeholders in a given policy area are properly represented in the statistical evidence underlying the decisions. This implies that the independent statistics producer must act paternalistically on behalf of interests that are not in position to order the statistics they need, typically because they are not organized. The State is the institution that is authorized to make orders on behalf of the unorganized public, but the State may have self-interests that deviate

from those of the public it serves. This is the problem of principal-agent theory, on which representative government is based. The democracy's solution is the repeated character of elections. Publicity is necessary for control, but in addition it must be possible to oust from office incumbents who do not deliver.

The role of the independent statistics producer is thus similar to that of an independent journalist. Neither of them can rely on the public demand for information. The public cannot express in advance what news it requires today. The producer must assume what will be in the public interest to uncover and cover, and let supply precede the demand. This is well captured by the HLG, which writes:

"Common wisdom states that you need to research the market for what it needs and then produce what is needed. That is not the way the automobile was born, or the 'smart phone'. The fact is that these artefacts were not needed at all; market research would not have revealed them as opportunities. What happened is that the presence of enabling technology and innovative thinking created a product that was at first only of any importance in the eyes of the innovators and their funders. They struggled considerably in early incarnations before the general public caught on."

Like journalistic news, statistical news must be credence goods, to be consumed by the public on faith. The news must contain what the producer thinks the public needs to know, with the implication that if the assumption is correct, the public becomes aware of its needs and wants, which in statistics will be unknown not least because so are the statistical means to express them. Hence the producers must have thorough and sophisticated knowledge of the society as it functions today and is likely to function tomorrow. The independent statistics producer must have the "ability to look at, identify, label, organize and understand the interrelationships between ideas, objects or events" (Forbes and Brown, 2012).

In order to cater for the statistical interests of all stakeholders it is not sufficient that the independent statistics producer enjoys negative freedom. It must also enjoy positive freedom, that is, freedom to act paternalistically on behalf of those unable to cater for their own interests. Its independence must encompass the two concepts of liberty (Berlin, 1969), freedom from interference and freedom to interfere. The positive (Republican) concept of liberty is clearly most controversial of the two, as it has a potential of abuse that hardly is present in the negative (Liberal) concept. Rather than acting benevolently the independent institution may use its positive freedom to cater for its own self-interest. The NSIs are themselves public bureaucracies, and as noted in the budget-maximizing model of public choice economist William Niskanen (1971): Bureaucrats are "not entirely motivated by the general welfare or the interests of the state", but also by "salary, perquisites of the office, public reputation, power, patronage, output of the bureau". When successful they have "substantially increased the budgets of the bureaus for which they were responsible". However, the alternative to positive freedom is to serve the organized stakeholders and leave the unorganized public unserved. Frequently that is equal to serving the society's production minorities (be it producers of goods or decisions), and neglecting its consumption majorities.

When granted positive freedom the independent statistics producer is empowered to set a statistical news agenda for its political masters. It enjoys the agenda-setting power of the news media, indeed frequently by using them or being used by them. For the stakeholders agenda-setting marks the difference between being considered and being neglected. They were put on the ladder to the political decisions of their concern. The steps that lead to a favourable outcome they must take themselves.

The European "statistical law" and the European statistical programme are based on producer independence as negative freedom. The statistics producers are guaranteed a professional autonomy similar to that of applied research: it is *research*, that is, to be carried out according to the professional standards of objectivity, neutrality and impartiality, without interference from stakeholders, but it is also *applied*, that is, answering the questions asked by the programme's masters, the European Parliament and the Council. The statistical outcome may contain surprises, but they will all be inside the agenda the masters have set. If the statistics producers in addition were enjoying positive freedom, the agenda itself would contain surprises.

2 CHAINS, SHOPS AND NETWORKS

The term "public value" has been criticized for overlapping terms such as "public goods", "public interest" or "public benefit". Intent to sort this out, John Alford and Janine O'Flynn (2009) argue it differs from these for three reasons: (1) it includes but is not limited to public goods, (2) it includes not only outputs but also outcomes, and (3) it encompasses what serves as merit goods for those enjoying it. The fourth conceptual advantage can be added: the terms draw attention to different topics. Public value draws attention to the topic of value creation, and hence to the different ways of creating value. Incidentally the values in question for the statistical agencies are economical as well as social, whilst many other State agencies limit their outcomes to the latter, which seems more overlapping with terms like public interest or public benefit.

The European statistics Code of Practice leaves the impression that value creation is not an issue for the ESS. The Code contains however a chapter entitled Statistical Processes. It consists of four principles introduced as follows: "European and other international standards, guidelines and good practices are fully observed in the processes used by the statistical authorities to organise, collect, process and disseminate European Statistics." The process outlined in the four principles is the value chain. The United Nations General Statistical Business Process Model (GSBPM), used by more than 50 statistical organizations worldwide (UNECE, 2013) is based on value chain logic. Following Porter the statistical agencies have no reason to look for alternatives either. In his influential bestseller *Competitive Advantage* (1985) Porter argues that the value-creation logic of the chain is valid for all industries.

The distinction between long-linked, intensive, and mediating organizational technologies detected by James Thompson (1967) suggests however that the chain is but one of three value creation configurations. Charles Stabell and Øystein Fjeldstad (1998) labelled them the value chain, the value shop and the value network. They differ not only in organizational technology, but also in value creation logic. The authors argue that firms rarely are pure instances of one primary technology and value creation logic. Therefore value chain analysis should be replaced with value configuration analysis embracing all three categories of value creation. For the NSIs the chain is appropriate for the production, the shop for the interpretation and the network for the dissemination of official statistics.

2.1 The value chain

Chains create value by transforming inputs into products. The primary technology is long-linked. Important for value creation is the adaptation of supply to demand. In order to secure stable production and optimal capacity utilization, the demand must be predictable and the production standardized. Porter identified five generic primary activity categories of the value chain: Inbound logistics, operations, outbound logistics, marketing and sales, and service. An ideal-typical example is assembly line manufacturing, immortalized by Charlie Chaplin in *Modern Times* (1936). The assembly line is designed to mass produce standard products at a low cost per unit by exploiting cost economies of scale. The chain is the value creation form of the factory.

The vision of the HLG is to meet the increasing challenge from competition by turning the NSIs into figures factories. "The production of statistics should be based on common and standardized processes, transforming raw data into statistical products according to generic and commonly accepted information concepts". The HLG views "this as the industrialisation and standardisation of statistics production", by which "each statistical organization" is turned into "a factory of statistical information. Together they form the 'official statistics industry'. Like any established industry, the production of official statistics should have its own industrial standards". Priority is given to cost reduction, which is considered necessary as a means to release resources needed to rejuvenate the product set. "The increased cost effectiveness represented by the modernisation of statistics should be realised by dividing the whole process in four phases:" (a) product design, (b) process design, (c) production: "the statistical process should be

executed by machines, with as little human intervention as possible, and with short turnaround times (close to real time should be possible) to minimise operational costs", and (d) analysis: "statistical subject-matter specialists should use outputs and intermediate results to publish articles and do research with advanced tools and as little human intervention as possible".

The value chain is ideal for the mass production of identical products ("one size fits all"). It keeps the production costs low, which makes the products available to many. It ensures that quality is defined as a property of the product itself, and measured objectively and statically as conformance to producer specifications (Walsh, 1991). Hence it ensures that the proper method for quality control is the peer review, whereby the ability to satisfy the requirements of other statistics producers is measured. The users too have a voice in the ESS Code of Practice, as the indicators of its principle 11 on relevance are the following: "Processes are in place to consult users, monitor the relevance and utility of existing statistics in meeting their needs, and consider their emerging needs and priorities"; "priority needs are being met and reflected in the work programme", and "user satisfaction is monitored on a regular basis and is systematically followed up". The ESS knows however independently of the users what standards the statistical output must conform to: relevance, accuracy and reliability, timeliness and punctuality, coherence and comparability, and accessibility and clarity. Peer review is sufficient to ascertain whether "processes are in place to consult users", and an affirmative answer sufficient to ascertain that the NSI delivers quality.

The value chain simplifies the management of the statistical agency. It enables the managers to employ transactional leadership, based on use of rewards and punishment to make the employees achieve the production targets set for the factory. It gives priority to control, immortalized by Karl Marx and Friedrich Engels in *The Communist Manifesto* (1848):

"Modern industry has converted the little workshop of the patriarchal master into the great factory of the industrial capitalist. Masses of labourers, crowded into the factory, are organized like soldiers. As privates of the industrial army they are placed under the command of a perfect hierarchy of officers and sergeants. Not only are they slaves of the bourgeois class, and of the bourgeois State; they are daily and hourly enslaved by the machine, by the overlooker, and, above all, by the individual bourgeois manufacturer himself."

The value chain keeps the costs of labour down. The HLG: "It is all about reducing the cost of the production process. Cost is defined as human labour, materials and duplication of efforts." Again *The Communist Manifesto*:

"The less the skill and exertion of strength implied in manual labour, in other words, the more modern industry becomes developed, the more is the labour of men superseded by that of women. Differences of age and sex have no longer any distinctive social validity for the working class. All are instruments of labour, more or less expensive to use, according to their age and sex."

However, industrialization is only one part of the HLG's vision. The other part is automation. The production of statistics is not to be executed by ever cheaper labour, but by machines. Contrary to the expectations of Marx and Engels the production staff will be reduced to a small number of well-paid experts to monitor the process and make repairs when necessary. The potential for this is likely to vary. Some statistical areas will probably continue being heavily dependent on expert judgments and human creativity for the production. However, if downsizing has irrevocable priority the inevitable solution is to liquidate statistics that are not suitable for automation.

It follows by logic that the virtues of mass production, standardized products at low price, are obtained by sacrificing individual customer needs. Immortal is Henry Ford's remark about the Model T: "Any customer can have a car painted any colour that he wants so long as it is black." Apparently the strategy of the HLG is to sell mass produced statistics to a consumer market forced by financial constraints to give low price priority over high utility.

However, official statistics are seldom retail commodities. Typically they are purchased by Governments and paid over the State Budget. Additional purchases are made industry associations rather than by individuals. The producers of official statistics are in the wholesale business. Their customers can afford paying for tailor-made quality.

In addition there is the risk involved in mass producing for an unpredictable demand. Currently that risk is so great that the HLG dares not set targets for the future, cp. its strategy:

"The SWOT analysis, allows the creation of a clear strategy, with a number of key actions to support the implementation of the HLG vision. A complicating factor is that future developments are uncertain because of the accelerating rate of change. This makes concrete long-term goals a near impossibility."

The risk is that the industry of official statistics makes heavy investments in production plants and the development of internationally standardized mass products that are no longer in demand when the industry is ready to start delivering.

Clearly there is a market for industrial mass production of statistics. For instance, the continuous audience measurement systems for broadcasting satisfy all the criteria listed in the vision of the HLG. They are standardized; executed by machines, deliver results close to real time, and so forth. They presuppose however that all stakeholders have expert knowledge of theory and methods, and are so familiar with the results that they hardly need to analyse them, but understand immediately what action they require. At the micro level they may not even have time to analyse them before new results demand their attention.

2.2 The value shop

Shops create value by solving customer problems. The shop is virtually the negation of the chain. While the chain relies on long-linked technology the shop relies on intensive technology. While the chain is organized to create value by delivering a standardized product the shop is organized to deliver a customized product, the solution to the problem. Customers may share problems, and the shop may detect problems its customers are unaware, but its primary activities are nevertheless problem-finding and acquisition, problem-solving, choice, execution and evaluation. The shop is the value creation form of the academic professions.

The quality concept of the value shop differs also from that of the value chain, as it is not focused on the product itself, but on the relationship of user and product. The concept is not objective and static as in the chain, but subjective and dynamic. Its emphasis is "the extent to which the product is fit for the purpose for which it is intended" (Walsh, 1991). Unlike quality as "conformance to specifications", which can be ascertained independently of and prior to purchase of the product, its fitness for its purpose cannot be ascertained independently of experience. Thus producer and consumer run greater risk: if the producer allows the consumer to experience the product prior to purchase the producer runs the risk of having solved the consumer's problem for free. If the consumer must purchase the product prior to experience the consumer runs the risk of buying a pig in a poke. It follows that the method to measure the quality of the shop's products cannot be peer reviews. Quality must be measured subjectively in terms of customer satisfaction and institutional reputation, which of course also is crucial for the recruitment of new customers. To this may be added objective measures e.g. of impact in terms of citations in journals and (political) documents.

Principle 1 of the ESS Code of Practice, professional independence, requires that the heads of the NSIs and of Eurostat "are of the highest professional calibre". The value shop requires that all employees of the NSIs "are of the highest professional calibre". Whilst the ideal employee of the value chain is an obedient labourer, the ideal employee of the value shop is a creative collaborator.

Amongst the NSIs (or NSOs) aware of that are Statistics New Zealand. In the already quoted article Sharleen Forbes and Denise Brown (2012) tell that "managers in Statistics New Zealand have consistently identified *conceptual thinking* as one of the skill gaps in their staff whenever they have been consulted about

staff training needs. Other desired attributes include intellectual rigour, critical thinking and a solution orientation". Fundamental is the "ability to look at, identify, label, organise and understand the interrelationships between ideas, objects or events". Conceptual thinking in an NSO (or NSI) is "considered to be an ability to take ideas that often emanate from political and policy discussion and translate them into objects (variables) measurable in the real world". To this ability must be added the importance of "good subject-matter knowledge". Forbes and Brown maintain that "NSOs need to recruit and place stronger conceptual thinkers into more conceptually demanding roles, and ensure that teams have a blend of skills", but argue also that "conceptual thinking can be learned", and outline "a possible training course for developing conceptual frameworks".

The value shop makes it more demanding to manage the statistical agency. It requires managers who are capable of transformational leadership, often referred to as the four I's: Idealized influence, inspirational motivation, individualized consideration and intellectual stimulation. The purpose of leadership is to release the creativity of the employees, who are empowered to make their own judgments and priorities. The task of the leader is to ensure that their interests coincide with those of the agency. The leader transforms two types of employee needs into service for the agency: their individual needs for freedom and self-assertion, and their collective needs to experience the work as meaningful and themselves as important for the organization.

The value shop is the answer to the main challenge detected by the HLG: the need to energize innovation and rejuvenate the product set. The HLG writes:

"We need to establish a culture for change. Among our most important assets are our human resources. That is were we keep our knowledge and our culture. In most organizations there is a good supply of forward-thinking people. The challenge is to unlock this potential. We should encourage an entrepreneurial attitude and look for ways to change the culture in our organizations where necessary."

The HLG also states that "innovation must be a management driven part of our core business". It is the responsibility of the leaders to "drive our workforce out of its comfort zone and try new ways of producing statistics". Managing organizational change is said to require the presence of four prerequisites: (a) willingness to change; "there must be enough trust and support for the strategy, vision and the leadership"; (b) ability to change, "leadership is again a critical factor" but the organization must have "on board" enough people with the right skills; (c) readiness for change, "because timing affects the level of support from the people that are involved", and (d) speed of change, a choice must be made "between evolution and revolution", and will "to some extent" be driven "by the increasing rate of change in the outside world".

The HLG may be interpreted to envisage change to be led top-down by the transactional boss, whose primary objective however is to keep things the same. It is transformational leadership that is leadership for change. Transformational leaders motivate and inspire their collaborators to innovation. Thereby the agency's capacity to innovate is enhanced, as there are more collaborators than leaders, and so is the willingness to change, as the collaborators will feel ownership of the innovations they promote. Top-down and bottom-up initiatives will merge into what serves the statistical agency best.

In the value shop work is carried out individually or in teams. Value chains are in contrast operated as virtual assembly lines. Each task presupposes the prior task and adds value to it. Automation reduces however the organizational difference between the shop and the chain. The experts who monitor the chain's automatic production process and make repairs may also work individually or in teams.

The value shop and the value chain have reciprocal statistical needs. The value shop needs statistics to solve customer problems. By stating "there is nothing as practical as a good theory" Kurt Lewin (1943) did not mean to make empirical evidence redundant. He referred to the fundamental value of theory for the investigation of practical problems. The value shop does not produce statistics. That is done in the value chain. The shop is using what the chain is producing. The value chain, on the other hand, does not solve customer problems. The value chain produces statistics. Without interpretation it produces masses of

figures for the cemetery of numbers, known as the Statistical Database or the StatBank. The value shop produces interpretations. "Causes trump statistics" Daniel Kahneman ascertained in *Thinking, Fast and Slow* (2012). "Statistical results with a causal interpretation have a stronger effect on our thinking than non-causal information". And beliefs trump causes. "Even compelling causal statistics will not change long-held beliefs or beliefs rooted in experience". This hierarchy, with descriptive statistics at the bottom, shows what evidence-based politics is up against.

2.3 The value network

Networks create value by linking customers together. The network relies therefore on mediating technology. A typical example is the telecom company. The company is not a value network but a provider of a networking service. For the customer, the value of the network depends on the other customers connected. The value therefore increases with the network's expansion. The primary activities are network promotion and contract management, service provisioning and infrastructure operation. Networks are managed as if they were clubs. Their owners get their income from connecting new customers, from connection fees, and from customers communicating.

In an article entitled "Safeguarding trust in statistics and the new statistical voice" Per Nymand-Andersen (2013) of the European Central Bank advocated "a new two-way statistical communication strategy". Nymand-Andersen argued "there is a growing gap between the current way statistics are stored in databases and the ways in which digital native professional users and citizens access and use statistics." In order to bridge the gap statistical agencies must break down monopoly thinking and realize that statistics are everywhere, causing a significant risk of information overload and making it increasingly difficult to find the right statistics. The internet is a form of network ideally designed for "many-to-many" communication; hence "collaborative platforms, combined with advances in visualisation and multimedia tools, are the way forward for presenting and communicating statistics across countries and sections of society." "The use of metadata and the tagging of statistics are increasing, defining the ways in which statistics can be found on the internet", and imperative for use is that statistics are actually found. "There is competitive advantage to be gained from at least being on the first page of results" found by research engines, and "the best way to ensure a top search ranking is to know how the company's search function works and join up with organizations which already have a high ranking in the field of statistics". Particularly effective is to build a community around statistics – a value network in Stabell and Fjeldstad's terminology. Nymand-Andersen writes: "The OECD has created several social networks focusing on issues such as progress, gender equality and children. In March 2013 these networks boasted over 90 000 unique visitors per month, 3 000 registered users and more than 60 active editors. […] It should be noted that 90% of these people do not work for the OECD, instead volunteering their time to contribute their knowledge of the subject."

The OECD has 34 member countries with a total population of 1.26 billion inhabitants. Clearly the members of the three communities are extremely exclusive minorities. Those who do not take part in the communities are however not excluded by anyone but themselves. Nymand-Andersen:

"Research into why users contribute to platforms such as Wikipedia reveals that they are more likely to contribute when (i) they are using the knowledge that they have, (ii) they gain recognition for their contributions and (iii) they feel that they are contributing to a project that serves the greater good, as the sum of all contributions will be something of global significance."

They contribute to the production of public value.

Networks may connect those who know the society and those who know its statistics. Unlike advisory boards intended to transfer knowledge one-way from the society to its statisticians in order to influence action, networks will transfer it two-ways in order to inspire action. Those who know the society will benefit from better knowledge of the vast amounts of statistics that the NSIs possess, and from better

understanding of its conformance to its specifications. The NSIs will benefit from better knowledge of the vast amounts of problems that need to be solved, and from better understanding of the statistics' fitness for their purposes.

CONCLUSION

A property of the value chain is its ability to make itself redundant as production model. This will happen to the extent the HLG succeeds in convincing the NSIs about the advantages of automated industrial production. Electronic utilization of electronic sources de-humanizes the whole process from data collection to statistical output. The GSBPM becomes obsolete.

An automated statistics industry will mass produce figures for a market where there is already an abundance of numbers and a deficit of attention. The users will increasingly need brokers to find and interpret the figures that are best fit for their purposes. The news media serve as brokers for the general public. Professional users rely on consulting firms. The public sector is a major consumer of consulting. The rule of thumb says that a consultant costs three times the wage of the position being covered.

The NSI is a State agency. The main professional user of official statistics is frequently another State agency. If the user institution lacks competence and capacity to find and interpret the figures that are best fit for its purposes, and the NSI merely provides figures, the user agency is forced to engage a consultancy as its broker. Rather than going straight from one State agency to the other official statistics will then have to make a detour into the private sector before it arrives at the target. That detour triples the costs of using official statistics for evidence-based politics. Not to mention the loss of democratic control. The consultancy is not accountable to the democracy but to its own profit-seeking shareholders.

It is therefore imperative, for the public purse and for the democracy, that the NSIs assume responsibility for the task of statistics brokerage, and gradually replace the value chain with the value shop as their main value configuration model. Thereby the NSIs will be elevated from commodity producers to processing factories. Their statistics will not be merely accurate but also appropriate for the society's purposes. A surrounding network of users will build statistical literacy, for the benefit of the users, who obtain competitive advantage from their more advanced knowledge, and for the benefit of the NSIs, which obtains more and increasingly more demanding orders. The current downward spiral, driven by budget constraints, is turned upwards. The NSIs will not necessarily live happily forever thereafter, but they will have better control of their own future.

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The Boundary of the Public Sector in National Accounts Versus IPSAS[1]

Giovanna Dabbicco[2] | *"Parthenope" University of Naples; National Statistical Institute of Italy, Rome, Italy*

Abstract

The ongoing debate about the necessity of harmonized accruals-based public accounting standards and the possible implementation of an integrated reporting covering public accounts and government finance statistics (GFS) reporting, have widened the potential scope for comparative research on consolidation practices in Whole of Government Accounts (WGA) and National accounts, notably in the European Union. This development would probably add momentum to broaden the scope of reporting to WGA.

The article analyses in depth the conceptual frameworks behind financial reporting and national accounts, to better understand the differences between the definition of public sector and its boundary in national accounts as compared with financial reporting. This would form a useful input to the overall research agenda on WGA.

Keywords

National accounts, GFS, IPSAS, general government sector, public sector, WGA

JEL code

H83, H11, H62, H63, E02, E62

INTRODUCTION

Discussions about the possible implementation of an integrated reporting covering public accounts and government finance statistics (GFS) reporting, notably in the European Union, and even an integrated budgetary framework,[3] have widened the potential scope for comparative research on consolidation practices in Whole of Government Accounts (WGA) and National accounts (Heald & Georgiou, 2000).

The question "*To which extent public entities are to be consolidated*" (Lequiller, 2014) explicitly addresses the boundary of the public sector, both in terms of national accounts and financial /budgeting reporting, as an important issue to be explained and researched. Information on methodologies and practical

[1] An earlier version of this article was presented at the Conference of European Statistics Stakeholders (ESS), Rome Sapienza University, Dpt. of Statistical Sciences, November 24–25, 2014. A previous version was presented at CIGAR PHD Seminar in Kristianstadt, 8–10 September, 2014. This work is part of a broader research undertaken by the author for her doctorate thesis.

[2] PhD scholar of Accounting, Management and Economics, Researcher/Economist in National Accounts and Government Finance Statistics; "Parthenope" University of Naples; National Statistical Institute of Italy (ISTAT), Via A. Depretis 74/B, 00184 Rome, Italy. E-mail: dabbicco@istat.it; giovanna.dabbicco@uniparthenope.it.

[3] To manage economic interdependence, and also including setting EU budget and national budgets, see Van Rompuy et al. (2012).

implementation should be improved, also respecting the integrity of these two distinct reporting systems (Dabbicco, 2013a, 2013b; Eurostat, 2013c; Heald & Georgiou, 2000).

The "core entities" of government include central government, state government, local government (provinces, municipalities, etc.) and social security funds, but the scope of analysis might be greatly increased when consideration is given to the other actors through which government may achieve its fundamental role of delivering goods and services to the community.

Indeed, during the 1980s and 1990s under the influence of New Public Management (NPM) reform of the public sector (Hood, 1995; Lapsley, 1999), characterized by a new focus on economy, efficiency and effectiveness of the resources used and public services delivered, and cost accounting, decentralization and externalization of goods and services provision (Brusca & Condor, 2002; Grossi & Soverchia, 2011; Grossi & Steccolini, 2014), there was a drive to create separated entities, often through government owned and/or totally or partially controlled corporations, notably at local and extra budgetary level (Bisogno, 2014; Christiaens & Rommel, 2008; Lapsley, 1999) or through tendering procedures.

Implementation of public policy through Non Profit Institutions (NPIs), such as schools, universities and public hospitals, as well as special purposes entities, are special cases to be mentioned when drawing a reporting boundary for government. A further development concerns the implications of public-private partnerships (PPP) which in some cases represent creative accounting aimed at transferring debt (and related deficit impacts) off government balance sheets (Dabbicco, 2015; Mintz et al., 2006; Warren, 2014).

Given this broader group of entities, greater emphasis has been placed on the existing concept of government identified as the "*public sector*" and researchers need to tackle the conceptual issues related to "hybrid public- private forms" (Grossi & Newberry, 2009; Perry & Rainey, 1988; Rainey &Bozeman, 2000).

This would also need to consider the issue of determining a separate reporting entity, using a standardized boundary approach (Challen & Jeffery, 2006) to provide a *comprehensive* and *comparable* report on government activities.

The extension of financial reporting to the whole public sector "network", as an aggregation of entities[4] has been considered in the literature (see Grossi, 2009, Grossi et al., 2011) as a tool to report information on all subsidiaries, joint ventures, associates and other quasi-corporations. Notably, WGA are commonly perceived as relevant to improve public accountability and fiscal transparency (Chan, 2003, 2009; Christensen, 2009; Grossi 2009; Grossi et al., 2011), though many accountants would not consider a consolidated entity to cover all the government or the public sector.

This extension appears also driven by the ongoing debate about the needs of harmonized accruals-based public accounting standards (IPSAS/EPSAS) for EU Member States, at micro and macro level, as a prerequisite to enhance the quality of comparable statistical information and improve government decision-making.

Whilst there are several differences between the two set of reporting (statistical and IPSAS) (Dabbicco, 2013a, 2013b; IPSASB, 2012b, 2014b; IMF TFHPSA, 2006; Lequiller, 2014), the differences in consolidation boundary plays a central role and can be thought of as a starting point in reducing such differences.

In this context, WGA may be seen as a final step of a (trans) national reform programme on government accounting (Chow et al., 2008; Grossi et al., 2011) and fiscal reporting to improve comparability of public entities, enhance policy decision-making, and increase accountability (Aggestam, Chow et al., 2014).

Purposes of the paper and research method

Against that background, this paper will analyse the definition of the public sector "reporting entity" and aggregate consolidation, notably related to the way in which entities (institutional units) are grouped

[4] Including, in addition to government departments, sub-national bodies such as state governments, and government owned businesses that primarily engage in market activities.

for statistical reporting rather than consolidated by applying the concept of control, which appear to be the main conceptual issues (Hassan, 2013; Walker, 2009, 2011) for delineation of the public sector boundary and WGA.

Hence, differences in the resulting boundary will be discussed as an input to the overall research agenda on WGA, including the opportunities for convergence of financial reporting with the statistical bases.

The paper is based on participant observations and documental analysis. It also includes knowledge based on previous work experiences and analysis of the relevant literature on the issues arising from the examination of the public sector boundary.[5]

1 DIFFICULT AREAS IN ENTITY'S CLASSIFICATION AND DEFINITION OF PUBLIC-PRIVATE BOUNDARY IN NATIONAL ACCOUNTS /GFS VERSUS FINANCIAL REPORTING/IPSAS

1.1 Entity classification and public-private boundary issues in National Accounts/GFS[6]

According to the National Accounts principles and definitions underpinned by the European System of Accounts (ESA 2010) (EC, 2013a), the elements which influence the classification of entities and the delineation of public-private boundary in ESA, particularly between the general government sector and the corporations sector, hence, the sector where they should be to consolidated, are:

I. Nature (public/private);
II. Status of institutional unit;
III. Control over entities/assets;
IV. Type of output – market/non market.

The analysis of the last element, alongside the concept of control, is fundamental for classification issues since the analysis of public sector entities distinguishes government controlled units that are engaged in *market* production from those who are engaged in *non-market* production (see ESA, 2010, chapter 20).

The concept of economically significant prices is used for the market- non market output analysis to direct the delineation of the public sector, notably to differentiate between the general government sector and the corporations sectors.

To identify a market or non-market producer, the ESA 2010 indeed suggests to develop an analysis based on the institutional unit and local kind-of-activity unit (KAU) that has produced the output, and take into account the type of consumers of the goods or services subject to analysis, assessing for example whether the public sector is the only provider of the goods or services, as well as suggesting several criteria which seek to assess the existence of market circumstances and sufficient market behaviour by the producers. These are collectively known as "qualitative criteria".

As for (empirical) quantitative criteria, according to ESA 2010 paragraph 3.39 the analysis for the distinction between market and non-market producers should be carried out with reference to the ratio of sales

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[5] The method includes empirical material such as agendas and proceeding of meetings, reports on on-going projects, and public consultation papers of the organisations which play a relevant role in public sector standard-setting (i.e. IPSASB, Eurostat, the Chartered Institute of Public Finance and Accountancy (CIPFA), Le Conseil de normalisation des comptes publics (CNoCP), other international institutions (i.e. OECD, IMF) and large audit firms with specific expertise in the field of public sector accounting. The literature review also includes ESA 2010 and IPSAS conceptual frameworks, accounting and statistical manuals (MGDD, EC, 2014; GFSM 2014, IMF 2014), recommended practice guidelines, other non-binding documents and studies. The author's participative observation is notably related to several Eurostat task Forces on IPSAS/EPSAS and participation in a series of seminars and conferences (i.e. OECD accrual symposium, Eurostat conference Toward EPSAS, EGPA, CIGAR) in the field of the research.

[6] For a literature and standards review on statistical information and definitions under ESA 2010 see Appendix. *"A literature and standards review on methodological approaches to the public sector boundary"* section I *"Statistical information and the System of European Accounts (ESA) framework"* which is reflected throughout this paragraph.

to production costs when the producers sells goods to other corporations or households at *economically significant prices*.[7]

Therefore, the ESA 2010 has developed a further important interpretive element to be used by experts for delineation of the general government sector from public corporations which is free competition on the market (see more in ESA 2010 paragraph 20.25–26), drawing on the literature and evidences about the "market" and "hierarchical" context (for a comparative literature review see Perry and Rayney, 1988).[8]

In the sectoral classification of public entities the determination of the degree of risk assumed by them in the exercise of their activity is also important. In many cases, the business risk is reduced due to the fact that the unit operates in the market with financial support in terms of subsidies or guarantees from the State, so that it could be argued that, in fact, it is acting on behalf of the Government, although this element alone may be not conclusive.

One might consider that, in the implementation of the recommendations and definitions of national accounts, one basic principle is to ignore the formal appearance, in terms related to legal, administrative or accounting nature, in favour of economic substance of transactions.[9] In this context, the construction of complex structures, such as may occur through the use of corporate legal forms, makes the interpretation of these operations only possible by analysing the complex transactions that they put in place.

However, the concept of economically significant price, apparently simple, might be a source of considerable interpretative doubts, and therefore difficult to implement in practice.

In a straightforward sense, economically significant prices might refer to the prices that the market is willing to pay for various types of goods and services, and it would be assumed that the price is economically significant when the producer is private.

But in the market, for political and regulatory purposes, there may also be found administered or "political" prices, prices which are lower than market prices. In particular, government often controls units to involve them in production that the market is not willing to offer at the required amount and/or prices. These entities may receive subsidies in the forms of various contributions, current or capital, from the State or other public authorities that control them, which could reduce their exposure to market pressures.[10] Whether or not the unit has the ultimate ability to choose its own business policy may be difficult to judge in these cases.

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[7] This analysis is based on the "50% criterion" checking if the sales cover a majority of the production costs (including depreciation and cost of capital) (ESA 2010 3.33 ss.). It is also necessary to verify, where production is sold to another government entity, that the entity is not an ancillary service (see ESA 2010 par. 3.12): in these cases, the units are named "ancillary units". In the case of units producing *ancillary services* which are controlled by governments, according to ESA 2010 rules they should be considered as integrated into the unit who controls them if analysing its activity it is clear that is intended to provide services only for the benefit of that government unit. This should be done unless it competes with a private producer on the market and its price satisfies the general criteria for being economically significant.

[8] Another aspect to take into consideration is the type of activity that the entity carries out: it appears quite self-evident that if the principal activity of the entity is a typical activity of government and if it is carried out under a monopoly condition imposed by government, this unit might be classified in the sector of "General Government".

[9] Whilst legal criteria are useful means to define a kind of *identikit* of the unit, the leading classification criteria are not linked to the legal form that entities assume, indicating the existence of a *practical trade-off* between the "economic behaviour" and the "legal forms" to identify economic substance and ownership (Grossi, et al., 2011; ISTAT, 2005a). See ESA 2010, 20.308, Eurostat Manual on Government Deficit and Debt (MGDD I.2.2 (7) (EC, 2014)). As an example, an entity may have the legal status of a corporation but may not be a market producer and therefore is classified in the GGS.

[10] A verification tool for "economic significance" might be given, for example, by microeconomic analysis of the curve of marginal and average costs for a single enterprise, by business break- even analysis or financial analysis based on return on equity (ROE) of the enterprise in the market. It would be, however, a difficult analysis from the statistical point of view, due to the lack of appropriate data and complexity of calculations. In addition it may be argued that such analysis would be not totally applicable to the case of a public entity which may receive government financial support. Furthermore, in some cases the classification is made by examining business plans, which target costs, margins and objectives for the future.

The review of the criteria for the identification of the boundary between the public (market) corporations and government sectors would also imply a definition of which is the notion of a profit relevant for the public interest (see Perry & Rainey, 1988; Rainey & Bozeman, 2000).[11]

The government sector classification is reported in a separate presentation of the activities of government with the GFS giving an integrated picture of government accounts and measures of government economic activity (ESA 2010, 20.1, 20.68). Whilst the general government sector simply represents the aggregation of units, some have wondered if it could be assimilated to a separate "reporting entity" with its own logic and strategy.

1.2 The differences and similarities between private and public sector and the problematic notion of government "reporting entity"[12]

Literature available on differences and similarities between private and public sector do not show satisfactory findings on the reasons and conditions on which public entities differ from private. The various studies and empirical researches[13] focussing on *multidimensional* definitions – based mainly on the public interest, public goods and market failures, control/hierarchy and ownership/funding – have argued that differences lie in organisational environments and structure, goals, constraints, incentives, formalisation of personnel procedures, purchasing processes and other administrative (bureaucratic) procedure, motivation and culture, while in some cases have disputed that distinction between public and private entities (for a comparative literature on public versus private organisations see Perry & Rainey, 1988, and also Rainey & Bozeman, 2000; for analysis relating to statistical reporting see ISTAT, 2005a, 2005b).

However, it appears that such studies, described as often limited in scope and representativeness, have not resolved the categorisation issue, especially with regard to the "grey area" between the two extremes of "bureau" and "private" enterprises (Perry & Rainey, 1988, pp. 195–196).

As for the definition of a government reporting entity, a key characteristic according to the literature is that of providing accountability for the use of resources for management decision making (Chan, 2003). The emphasis for a reporting entity is not only on financial needs, such as for profit entities, where they are traditionally related to investors and the distribution of profit. In fact, for government entities there is no market (see Perry & Rainey (1988); Rainey & Bozeman (2000))[14] and the control relationship usually does not take the form of equity.

Even in the case of legislation used to solve such boundary issues (for example the case of the Italian list of general government entities relevant for Excessive Deficit Procedure (EDP) purposes, which has been used to address the perimeter of application of the Law which reforms Italian public finances and accounting (L. 196 of 31 December 2009), see MEF, 2010) there would be a need to specify the underlying concepts to be adopted in delineation.

1.2.1 The specific classification issues in the IPSASs

Although the IPSASB has not consciously addressed the aspect of control in its conceptual framework (CF) work, it has updated its definitions and concepts of control in Financial Reporting at standards level

[11] Which might be interpreted under ESA 2010 as *operating profit*, which excludes holding gains and losses, investment grants and other capital transfers, and equity purchases (but does include net interest, which has been added to the 50% test under ESA 2010).

[12] For a literature and standards review on financial reporting, definitions and the IPSAS framework see Appendix. *"A literature and standards review on methodological approaches to the public sector boundary"* section II *"Financial reporting and the IPSAS framework"* which is reflected throughout this paragraph.

[13] Such studies draw on economics and political sciences and on organization theory.

[14] However, recent trends show the importance of investors in certain capital market for specific public entities or some ministry departments (i.e. defense). See Newberry (2014).

with the new IPSASs on Separate Financial Statements, Consolidated Financial Statements, Investments in Associates and Joint Ventures, and Joint arrangement (IPSASs 34–37).[15]

As in the ESA 2010 context, the IPSAS's concept of control in the public sector poses challenges to determine the boundary at the level of an entity and of a group of entities, and avoiding misclassification.

It appears that the IPSAS's criteria of control have not solved the issue of determining a separate reporting entity, using a standardized and comparable approach at international level.

Given that the assessment of control in IPSAS 35, compared to the IPSAS 6, appears less restricted by conditions with the IPSASB stressing in many points that "an entity shall consider all facts and circumstances when assessing whether it controls another entity", substantial judgements are needed through a case by case analysis.

Notably, control is based on the aspects of "power" and "benefits" (as in IPSAS 6), but the definition has changed to focus on an entity's ability to influence the nature and amount of benefits through exercise of its power.

In other word, IPSAS 35 assumes that an entity controls another entity when it is exposed to variable benefits (or holds rights in such benefits) and at the same time has the ability to affect the nature and amount of those benefits by exercising their power.

The (explicit) link between power and the benefits is the new element introduced (as in International Financial Reporting Standards (IFRS) 10),[16] which in fact, requires the entity to have the "ability to use its power ... to direct that other entity to work with it to further its objectives" (IPSAS 35, paragraph 36, IPSASB, 2015).

In summary, three elements – power, variable benefits and the link between power and benefits - need to be investigated for a better understanding of their definitions and to determine, accordingly, the consolidation scope, taking into account that IPSAS 35, as the ESA 2010, (and SNA 2008, UN et al., 2009), mentions judgmental analysis and analysis of more than one factor to be considered in complex cases. (Bergman, 2009; Bisogno, 2014; Eurostat, 2013 b; IPSASB 2012a, 2013c, 2015; Grossi et al., 2011; Grossi et. al, 2014).

Considering the above elements of control, the term "benefits" used, which is an explicit element of the control under IPSAS,[17] might be subject to interpretation. For example, it might refer to financial and non-financial benefits, which may include returns or other advantages.[18]

Furthermore, the guidance over how to decide who has the ultimate "power to govern", i.e., the current ability to direct the relevant activities of an entity, discusses economic dependence in the public sector[19] as an important element to be considered in assessment of control. It explains that economic dependence, alone, does not give rise to power but need to be assessed with other rights which may occur in conjunction. But the new standard in that assessment retains the concept of whether an entity has discretion to take funding from or do business with another public sector entity. Whilst it clarifies that discretion may be exercised in accepting or not funding from a government, or in the manner in which those funds are to be used, these assumptions appears somewhat hypothetical, difficult to assess in practise.

In other words, application of the control criteria may lead for categories of entities to different and unstable interpretations of the definition of the government reporting entity within jurisdictions and

[15] The effective date for the application of this standard starts on January, 1, 2017 (but early application is encouraged). It may be argued that one possible reason why the concept of control hasn't been included in IPSASB CF (2014c) is because at the time of CF release the ongoing process to update IPSAS 6–8 may have required an immediately subsequent amendment.

[16] Applied by the private sector.

[17] Whilst only implicit in the ESA.

[18] Guidance on all these meanings has been provided with IPSAS 35, along examples of benefits to assist in initial assessment of whether control over other entities exists. See Appendix.

[19] Including an example of economic dependence.

over time (Challen & Jeffery, 2005) which, obviously, reduce the compatibility of public entities' financial statements.

In terms of what entities to allocate within the public sector boundary, some entities such as agencies, securitization entities, trusts, housing agency, insurance schemes, some financial institution directed to government agencies, PPPs schemes, Pension schemes, or other special purposes entities may require a carefully approach when testing control/boundary and can be controversial in consolidation (Challen & Jeffery, 2005; Laking, 2005; Walker, 2009).[20]

As an example, this would be the case of government owned banks whose consolidated assets and liabilities would potentially swap government balance sheets owing to their size, but which would be of interest if government has a substantial power of control over them.

On the other hand, it should be noted that the IPSASB in respect of specific types of controlled entities which should not be consolidated (IPSAS 35 BC10–12) identifies difficulties in separately identifying categories of entities on a consistent basis across jurisdictions and over time. This is, for example, for entities rescued from financial distress or Government Business Enterprises (GBEs), based on the differences in the way the definition is being applied in practice in different jurisdictions and on the fact that similar activities can be conducted by a variety of entity types both within and across jurisdictions.

In other words, it may be argued that the IPSASB reasoning is that differences in application of definitions for some categories of entities among jurisdictions cannot be solved.

Furthermore, the Board's position is that proposals for different accounting treatments for such categories of entities "might lead to consistent treatment for a group of entities within a jurisdiction, which might not result in comparable accounting for similar activities" (IPSAS 35 BC10–12).

To meet user needs for information for consolidation of *all* controlled entities, having regard to the complexity of government involvement with other entities, i.e. particularly at the whole of government level, the IPSASB mentions the costs of the consolidation process on a line by line basis, which are high when the number of controlled entities is high and may be perceived to outweigh the benefits of consolidating those entities.[21]

The IPSASs do not define the notion of *public sector*, whereas a definition is given by the ESA 2010 (chapter 20 paragraph 303) to include the general government and public corporations.

It must also be observed that while IPSAS has adopted the criteria of control as the rationale to determine the scope of reporting, other standard setters have adopted as a primary test the notion of financial accountability, assuming a different perspective based on the relevance of the budget rather than power and benefits[22] (Bisogno, 2014; GASB, 14, 1991; IPSASB, 2015; Walker, 2009).

2 THE DIFFERENCES BETWEEN IPSAS AND ESA/GFS AND THE SCOPE OF REPORTING

The comparison of ESA/GFS concept of control seems broadly *not inconsistent* with the IPSAS concept of control, although there would be still be some room for both GFS and IPSAS to remove the "unnecessary" differences in order to achieve a better reconciliation of these two sets of reporting.

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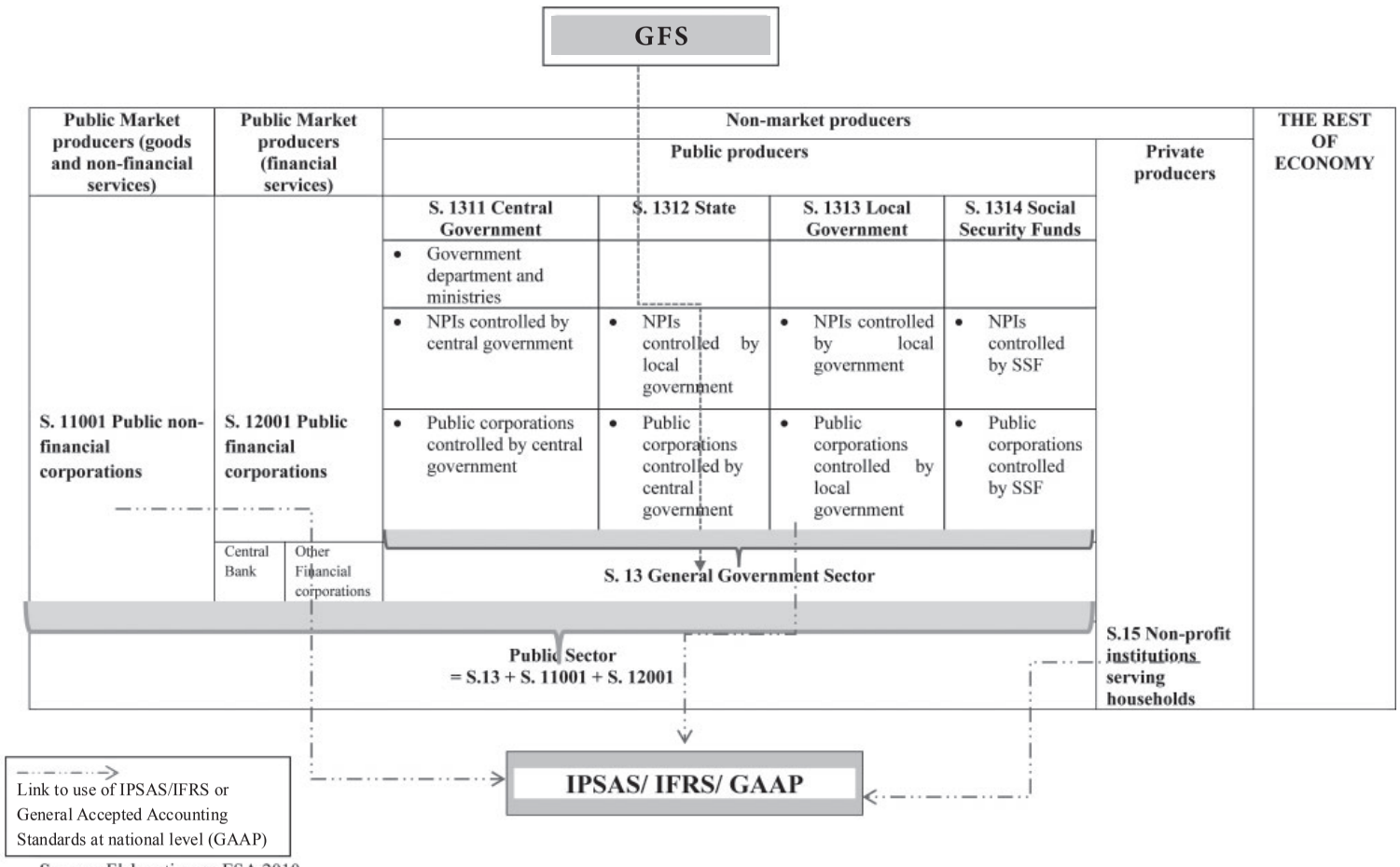
[20] The IPSASB in the process to finalize the IPSAS 35 examined the issue of consolidation of entities rescued from financial distress or controlled by financial intervention and the issue of consolidation exception for "investment entities" which may have only one investment or only one investor (IPSASB, 2013c, 2015).

[21] The IPSASB also indicated for this issue alternatives provided by statistical reports and separate financial statements. IPSAS 34, which has been issued concurrently with IPSAS 35, provide guidance in accounting for investments in controlled entities, joint ventures and associates when an entity elects, or is required by regulations, to present separate financial statements (IPSASB, 2015) on the basis of fair value through profit or loss, These may be presented as the only financial statement, or in addition to consolidated financial statements, or in addition to financial statements in which investments in associates or in joint ventures are accounted for using the method of equity.

[22] For IPSASB considerations on the non-appropriateness of the Budget's entity approach for general purpose financial reporting see IPSAS 35 BC 13.

Figure 1 The boundary of the public sector in GFS versus financial reporting



Source: Elaboration on ESA 2010

Most of the differences derive substantially from the ESA 2010 institutional sector approach, which aggregates the entities into sectors as they were a single institutional unit, whereas the IPSASs follow an approach based on the consolidated reporting entity on the basis of the control line by line.

The statistical and accounting communities have been indeed active over the last decade in promoting such harmonisation and contributing to public accounting standard setting (Eurostat 2013c, 2013d; IPSASB, 2012b, 2013b, 2014b; 2015; IMF TFHPSA, 2006).

Nonetheless, a fundamental difference in approach remains, since the IPSASs would not consolidate the accounts of two government entities where there is no link of control to each other, compared to the GFS which consolidate all "governments entities" based on their economic nature, whether control exists or not (Dabbicco, 2013b; Eurostat, 2013b, 2013c; Lequiller 2014; IPSASB, 2012b, 2014b).

This is particularly relevant for local entities and for other decentralized governments which would under IPSAS not be included within the consolidated accounts of another reporting entity if there is no control link.

In addition, central government is treated under ESA/GFS as being a single unit encompassing most of the ministries, departments, agencies, boards, legislative bodies and other executive entities which do not have the status of institutional units and are therefore grouped within the overarching authority which "controls" them, whereas they may be not considered separate reporting entities in IPSAS.[23]

However, it may be noted that IPSAS 35, in the context of assessing the scope of a decision maker's decision-making authority, has introduced as factors to be considered the purpose and design of the other entity being assessed for control, and assessments of whether an entity is acting as a principal or an agent.

Furthermore, IPSASs encompass a significant exclusion from scope of reporting for GBEs.[24] This because they sells goods and services, normally assuming the risk of the business and are not reliant on continuing government funding, therefore they may find it appropriate to apply IFRS in place of specific public accounting standards. Nevertheless, GBEs should be consolidated in Consolidated Financial Statements of another public sector entity when they are "controlled" by them.

Therefore, the public sector accounting consolidation may have a larger area compared to the GFS consolidation, because GFS consolidates all government controlled entities including all public corporations when these corporations are "non-market" (and resident), but controlled market public corporations are outside the perimeter of general government (Dabbicco, 2013a, 2013b; Eurostat, 2013b, c; IPSASB, 2015; Lequiller, 2014).[25]

The IPSASB's approach to the definition of consolidation in the IPSASs is to prepare the related financial statements and reports on either a compulsory or voluntary basis, with standards for both individual and consolidated accounts. This is another key aspect when compared with the ESA, which *require* in Europe the identification and classification of each (government) institutional unit (resident in a country) to a macroeconomic (*general government*) sector, for which economic flows and stocks can then be demonstrated.

DISCUSSION AND RESEARCH AGENDA

To consider what is inside and what is outside the public sector boundary appears a sensitive interpretation task. It would imply to consider government policy over its relevant activities, notably on resource

[23] Other classification differences may be related to units which are jointly controlled by two (or more) different levels of governments (IPSAS 35; IPSASB, 2013c).

[24] This is currently under review by the IPSAS Board and a consultation paper has been issued.

[25] In the previous IPSASs there was, in addition, an exemption from consolidating controlled entities under temporary control, although the IPSAS 35 has removed this exemption, requiring additional disclosures in respect of those entities. Other conceptual differences may be found in some hybrid forms of financial institutions, in Central Bank and for entities rescued from financial distress.

allocation. Accompanying, but relevant, legislative and fiscal government entity compliance requirements, as well as (public) governance issues as a result of decentralization and externalization of government activities, also at the macroeconomic level of surveillance would also need to be considered.

The Whole-of-Government level would require the consolidation of a number of entities such as departments, agencies, GBEs, financial institutions and special purpose entities, with the core government.

The boundary consolidation or "whole of government" concept is somewhat addressed by IPSAS 22,[26] but this standard is also not compulsory, and is not considered an alternative to consolidation of all controlled entities for presentation of such information. This makes it difficult to address reconciliation needs with NA/GFS as IPSASs remain more focused on annual individual accounts or sub-sectorial consolidation (AASB, 2005, 2007; Dabbicco, 2013a, 2013b; Lequiller, 2014).

In this context, it has been proposed in the international debate that the public accounting concepts should be better aligned with GFS.[27] In the revision process with the exposure draft (ED) 49 (IPSASB 2013a, 2014a) for the new standard issue the IPSASB took into account the approach of GFS, including consideration of the indicators of control of non-profit institutions and corporations, to avoid unnecessary differences.

But the IPSAS concept of control continues to result in a different approach (IPSAS 35 BC 4) compared to the role assigned to the concept of control performed into "type of output, then control" classification approach in GFS of the new ESA 2010 (chapter 2).[28]

Considering the ESA 2010 approach, among other issues, it emerges that the work of allocation of the statistical units to the register of private or public entities might face problems in using the type of output as first criterion in analysis of the units. It is often necessary to analyse first (cross-checking the available sources), the principal characteristics of the structure of the entities, i.e. nature, legal status, and, notably, control. Only subsequently, by matching the corresponding economic data, would it be possible to identify the type of output. On the other hand, the nature of the concepts of control and economically significant prices may deserve reconsideration in the future, notably for the subjectivity observed in application.

From an IPSAS perspective, if more consideration had been given to the decentralization of government functions, and to the resulting central role assigned to the local entities dependent on them (Brusca and Condor, 2002), this would raise the need to consolidate all local entities and their dependent or delegated bodies, moving, for example, to a whole of government level.

But the IPSASB has deemed that there are scarce empirical research available on user needs and usefulness of consolidated financial information in respect of specific types of controlled entities and for WGA, and that a limited number of countries currently present consolidated whole of government financial statements (IPSAS 35 BC12; 16) (Aggestam, Chow et al., 2014).

The ongoing debate about the necessity of harmonized accruals-based public accounting standards for EU Member States, and about the feasibility of an integrated reporting, covering public accounts and GFS, may add momentum to broaden the scope of reporting to whole of Government Accounts, including opportunities for convergence of statistical and accounting reporting.

However, the issues analysed in this paper appear as key preparatory issues to be solved for the research agenda on such developments, notably singling out the need for a more systematic categorisa-

[26] Which focuses on the general government sector.

[27] The IPSASB in 2014 has issued a policy paper on "Process for Considering GFS Reporting Guidelines during Development of IPSASs" and on its agenda there is a further analysis on the issues from the 2005 research report (IFAC, 2005).

[28] In relation to this point an apparent inconsistency may be observed between ESA 2010 chapter 2 which seems notably to first require the analysis of output and subsequently the control criteria, and the dedicated government chapter (chapter 20), which seems to adopt a reversed approach of control-output. This apparent ambiguity of the chapters seems to have been solved by the relevant groups of GFS experts giving a prominence to the classification rules for the GGS in chapter 20.

tion of the public- private distinction in the research's theory to serve the delineation of the boundary of the public sector.

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APPENDIX

A LITERATURE AND STANDARDS REVIEW ON METHODOLOGICAL APPROACHES TO THE PUBLIC SECTOR BOUNDARY

I. Statistical information and the System of European Accounts (ESA) framework

1. The statistical unit

Official economic and business statistics are structured around the identification of statistical units, data on which can be aggregated together. Within the European Union, in order to ensure comparability at national and European levels, statistical units are defined in a uniform manner for all Member States by using three methodological criteria: legal, accounting or organizational criteria, geographical and activity criteria.[29]

Under these conditions, statistical information on economic activity is developed in different directions:

- at the microeconomic level, where the main unit of analysis to compile the statistics is the single entity (through its local unit), or group of entities, or holding entities, and
- at the macroeconomic level, where the ESA 2010 has been developed at European level as the brother of the worldwide System of national account (SNA 2008) with a series of adaptations to the specificities of the countries of the European Union.

To this end, the ESA 2010 defines some *standard* types of statistical units: - the *institutional unit* (ESA 2010 paragraph 2.12), - the *local kind-of-activity unit (KAU)* and - the *unit of homogeneous production (UHP*).[30]

The different types of statistical units correspond to the different purposes for which they may be used. However, they are connected to each other since there is a hierarchical relationship between institutional units and LKAUs (a unit may have one or more LKAUs): for example, structural business statistics data refer to "enterprises" which represent a main source on which to base national accounts estimates.

In practice, the three types of statistical units are obtained by grouping or de-grouping microdata collected with reference to the unit responding to statistical surveys.

Institutional units to serve to the need of macroeconomic (aggregate-level) information are grouped into *sectors* and *subsectors*, *on the basis of the uniformity of their economic behaviour,* related to their core functions and type of production.[31]

The Government Finance Statistics (GFS) framework, referring to the General Government Sector (GGS), requires that data be produced for (i) each level of government (for example, central, state and local government) and (ii) the combined GGS.

It might also happen that some institutional units control others and this makes it necessary to consider a group of entities as a separate entity.[32]

2. The government controlled entities and the GGS in ESA 2010

According the ESA 2010 "The General Government Sector includes all institutional units which are nonmarket producers controlled by government, whose output is intended for individual and collective consumption, and are financed by compulsory payments made by units belonging to other sectors; it

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[29] Council Regulation 696/93 of March 15, 1993. For the resulting list of statistical units of the production system see Annex, section I. (ISTAT, 2005a).

[30] Institutional unit is characterized by ownership, autonomy of decision, accountability and set of accounts. On such definitions see more in ESA 2010 2.03, 2.144–2.154.

[31] For definition of institutional sectors see ESA 2010 2.45 2.134; ISTAT 2005b.

[32] On definition of groups see ESA 2010 ch. 2 par. 2.13; 2.15-16, and Reg. 696/93. This definition is under revision by the Eurostat working group on ESSNET on International Profiling large and complex MNEs.

also includes institutional units principally engaged in the redistribution of national income and wealth, which is an activity mainly carried out by government".[33]

The first step to identifying general government units is to establish if a unit is public or private. For "core entities" the criteria to classify them in the "General Government" sector do not give rise to particular problems.

However, in addition to these entities, there are a number of other entities who have decision-making autonomy and a full set of separate accounts, which are created for carrying out specific functions, such as construction and management of roads, health or educational services, and which are often called extra-budgetary units or special purpose entities. They might be controlled by another public unit and are classified to the General Government sector, unless they are considered as market-producers (financed by their own sales), in which case they are included in the (public) non-financial (or financial) corporations sector.[34]

3. Notion of control in the ESA 2010

As delineation criteria ESA 2010 defines control over a financial or non-financial corporation as the ability to determine the general policy or programme of that entity" (ESA 2010 paragraph 20.18), for example choosing board directors.

In some cases, such as for corporations, the control results from an equity link, but the relationship between government units usually does not take the form of equity so that control might result from other forms of ownership.

Therefore, to identify a production unit according to ESA 2010 as government controlled it is needed to assess that is (a) owned (for example on the basis of the voting shares) or (b) controlled (e.g. on the basis of the control of appointment and removal of Directors) by general government. If neither of these conditions is applicable, the unit is private, so it must be included in the other institutional sectors (represented by financial and non-financial corporations and quasi-corporations or households or Non-profit institutions serving households (NPISH)).

A number of additional criteria should be taken into account as indicators of control according to ESA, although the two criteria above in most cases would be sufficient to determine the nature of a unit.[35]

An entity controlled by government could be profit-seeking (and able to distribute any profit to its owners), or may be a unit that does not aim for distributable profits (non-market producer).

As for boundary of government and the (public) *financial corporations*, i.e. those institutional units principally engaged in financial intermediation activity, the same criteria for control which are to be applied for non-financial corporations are used. However, the market/non market criteria are generally not relevant and, instead, the qualitative criteria are prominent, i.e. whether they behave as a "normal" financial intermediary (See MGDD, I.2.3, EC, 2014).[36]

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[33] For definition of "General Government" sector see ESA 2010 par. 2.111 and par. 20.05 et ss.

[34] In ESA 2010 separate subsectors for public-controlled corporations: S.11001 ("public non-financial corporations") and S.12001 ("public financial corporations") are established, although the compilation of separate accounts for these subsectors has been in the past on a voluntary basis. In this context, public *market* corporations are currently classified in the S.11 ("non-financial corporations") or S.12 ("financial corporations"), depending on their activity. However, in consideration of increasing interest in public corporations, and their potential impact on government finances, there has been a noticeable expansion of data collected for them in the European Union.

[35] The ESA 2010 includes eight indicators of control of corporations and five indicators of control of non-profit institutions. It also explains that in other cases a number of separate indicators may collectively indicate control. For more detail see ESA 2010 20.38–20.39 and MGDD, I.2.3 (EC, 2014).

[36] As examples of public financial corporations which are not a financial intermediaries one may mention financial auxiliaries such as stock markets or independent financial regulators.

Non Profit Institutions (NPI) classified to the general government sector are a special case of entities identified with indicators of the government control, similar to those of (public) corporations (ESA 2010 par. 20.15). Proceeding from this, the degree of financing by government, meaning *predominant public funding* might not be sufficient to consider the NPI as being controlled by government if it remains able to determine its policy or programme. The application of these criteria – beyond the appointment of officers – is therefore not conclusive, because, in many cases, a single indicator is not sufficient to establish, beyond any doubt, if the control is private or public. It is necessary, therefore, to consider the criteria as a whole and the decision will be judgmental (ESA 2010 par. 20.15).

II. Financial reporting and the IPSAS framework

1. The notion of reporting entity and of groups in IPSAS

The International Public Accounting Standards Board, originally created as the Public Sector Committee (PSC) has worked for nearly 20 years in establishing accounting standards for the public sector and promoting their application.

The IPSASB, in its conceptual framework describes a public sector reporting entity as an entity that prepare prepares General Purpose Financial Reporting (GPFRs).[37]

A key characteristic of a reporting entity in IPSAS is that there are users (service recipients or resource providers) who depend on the financial statements for their information needs (for accountability or decision-making purposes according IPSASs), and this has been also highlighted in the previous literature (Challen & Jeffery, 2005; IPSASB CF, 2014c; IFAC, Study 1 and Study 8, 1996; Grossi et al., 2011; Mack & Ryan, 2006; Walker, 2009).

An additional key characteristic is that it is an entity that raise resources from, or on behalf of, its constituents, and/or use resources to undertake activities for the benefit of, or on behalf of, its constituents (IPSAS CF 4.3, 2014c).

The IPSASs concept of reporting entity appears therefore driven by the objectives of financial reporting which aim to provide information useful to users for accountability and decision-making purposes, and it is based on identification of the existence of service recipients or resource providers. As for the implications in identification of such reporting entities the ISPASB mentions professional judgment in determining reporting entities (IPSASB CF, BC4.5–4.7, 2014c).

Whilst the IPSASs do not define the notion of public sector as in the ESA 2010 a reporting entity may also be considered as a "group reporting" entity, " that present GPFRs as if they are a single entity" (IPSASB CF, 4.2, 2014c).

The criteria to be satisfied for inclusion in a group reporting entity are developed at level of standard in the ISPAS 35, where the term "economic entity" is used to define, for financial reporting purposes, a group of entities comprising the controlling entity and any controlled entities.

In a nutshell, the term economic entity has a greater relevance in the interpretation of the IPSAS framework for whole of government reporting, because it regroups a controlling entity and its controlled entities in a newly single reporting entity (Challen & Jeffery, 2005; Eurostat 2013b; IPSASB, 2012a, 2013c, 2015; Lequiller, 2014).

At this level the IPSASB has also introduced the need to take into account in economic entity's determination the constitutional arrangements in a government and "in particular the ways in which government power is limited and allocated, and how the government system is set up and operates" (IPSAS 35.17). This, notably, in the view of the author may open to the case of whole-of-government level.

[37] "The government and some other public sector entities have a separate identity or standing in law (a legal identity)…or be an organization, administrative arrangement or program without a separate legal identity" (IPSASB CF, 2014c).

2. The notion of control in IPSAS

For the purpose of financial reporting, IPSAS 35 defines control as "power over the other entity" so as to "benefit" from its involvement with the other entity and the "ability to use its power over the other entity to affect the nature or amount of the benefits from its involvement" with the other entity".

Therefore, three elements are relevant:

- the existence of power over the controlled entity,
- the exposure to the variability of the benefits achieved by the controlled entity, and
- the ability to use that power to influence the benefits of the controlled entity, which are all defined trough factors and indicators to determine the scope of consolidation under IPSAS.

The power over the other entity is characterized by the existence of (substantive) rights that give the entity the ability to perform actions that affect the determination of the benefits of the controlled entity and it is based on a capacity, independent from its effective exercise.

In considering whether the entity has the power, similarly to ESA 2010, ownership criteria and the power to appoint or remove key management personnel are adopted, and these are the same as in private sector. Binding arrangements (i.e. existing legislation, executive authority, regulation), and the design and purpose of the other entity[38] are also considered.

As for benefits, it might be mentioned distributions (i.e. dividends), or the existence of residual interests on assets and obligations on liquidation of the other entity. Benefits may be financial or non-financial benefits (returns or advantages) which have been defined under IPSASs.[39]

The link between power and the benefits of the controlled entity is a new element in IPSASs, (derived from IFRS 10) which, in fact, require that the entity should perform actions that affect these benefits, alongside the determination of whether the entity is a principal or an agent.

The Board has looked into GFS approaches to assess the extent to which there are opportunities for harmonization on the definition of control with statistical reporting, considering some documents (i.e., Exposure Drafts) comparing concepts of control in financial and statistical reporting (IPSAS 35, IPSASB 2012a, 2013a, 2013b, 2014a) , notably mentioning some of the indicators of control in GFS and explaining some differences, according the IPSASB due process of GFS issues consideration.

Entities which operate as government business entities (GBE) are currently excluded from the scope of IPSASs,[40] particularly when the government's ability to control and influence the financial and operational decision making by these entities is limited (Challen & Jeffery, 2005; IMF, 2006; IPSAS preface, IPSASB 2014a).[41]

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[38] I.e. what the entity does, who directs the relevant activities, who benefit of these activities. But the ISPASs mention all facts and circumstances to be considered in assessing whether an entity has power over another entity.

[39] See IPSAS 35 paragraph 32 which gives examples of benefits, and also mentions "exposure to loss from agreements to provide financial support" and other less quantifiable as "improved outcomes".

[40] The IPSAS Board has started a project to examine this treatment for GBEs. For definition of Government Business Enterprises see IPSAS 1.7 (a–e).

[41] The IPSASs mention that eeconomic dependence, alone, does not give rise to power over an entity, therefore for entities that are economically dependent on a public sector entity, where the "economically dependent entity retains discretion as to whether it will take funding from an entity, or do business with an entity, the economically dependent entity still has the ultimate power to govern its own financial or operating policies."

Risk of Unemployment and Earnings Levels by Socio-Economic Group – Introduction of ESeG Classification

Dalibor Holý[1] | *Czech Statistical Office, Prague, Czech Republic*
Gabriela Strašilová[2] | *Czech Statistical Office, Prague, Czech Republic*

Abstract

The article focuses on the patterns of the individual position in the labour market according to various socio-economic groups using draft classification of European Socio-economic Groups (ESeG). The position is primarily measured by a specially developed indicator on the Risk of Unemployment based on data of the Labour Force Survey. Secondly, the data of Structure of Earnings Survey is used for calculation of earnings levels. The results have proven that discrepancies among various ESeG groups are considerable and justify the use of the classification for analyses in the field of social position and labour market.

Keywords

Socio-economic groups, classification ESeG, social status, risk of unemployment, earnings, Labour Force Survey, Structure of Earnings Statistics

JEL code

J64, J31, J81, J82

INTRODUCTION

The labour market has become a focal point of economic science lately. Judging only by sums and/or arithmetic means is not a reasonable option in times when we monitor growing variability in almost every field of study. One of the exploitable breakdowns – despairingly almost not employed in the Czech Republic – is a socioeconomic stratification. Authors desired to present it and, for this purpose, they used a most recent – one can say brand new – classification of ESeG.

1 METHODOLOGY OF ESEG

The new prototype on the classification of European Socio-economic Groups has been developed by the ESSnet project under Eurostat supervision in 2011–2014. The ESSnet was composed by the National

[1] Na padesátém 81, 100 82 Prague 10, Czech Republic. E-mail: dalibor.holy@czso.cz.
[2] Na padesátém 81, 100 82 Prague 10, Czech Republic. E-mail: gabriela.strasilova@czso.cz.

Statistical Institutes of France, the Czech Republic, Italy and Hungary, and collaborated with a number of French research institutes and the Czech Institute of Sociology. Its work was linked to previous social-economic-class or occupational status schemes (Ganzeboom, Treiman, 1996), especially EGP (Erikson, Goldthorpe, Portocarero) and lately ESeC, which was connected to ISCO-88 (Harrison, Rose, 2010; also Krejčí, Leontiyeva, 2012).

The basic idea behind ESeG is to split the population upon relatively coherent social-economic categories – groups with similar characteristics not only in the labour market, but immanently expressing the social status. The fundamental criteria considered have been the autonomy in employment and the human capital. These criteria are also strongly correlated to the attraction of the job (Goldthorpe, Hope, 1974). However, the final prototype has not been created ideologically but it is purely evidence-based using a whole variety of topics under questioning. Therefore, as an analytical tool to measure social status, the ESeG could be used for various social fields: working conditions, health, living conditions, housing conditions, deprivation and poverty, as well as the social mobility and the intergenerational inheritance of inequalities (Šafr, 2012).

Although the socio-economic hierarchy is changeable by definition (Machonin, 2003), basic pecking order is quite steady, therefore the ESeG "ladder" is spread from managers (group 1) to less skilled workers (group 7), another two groups are added for inactive population. The ESeG has also the second level where groups are split into several subgroups predominantly corresponding to professional area (see Tables). Whereas basic group scale should be used by sociologists, the 2nd level is designed for great statistical surveys such as LFS or SES (EUROSTAT ESSnet, 2015).

ESeG Classification (1st level)

1 Managers
2 Professionals
3 Technicians and associate professional employees
4 Small entrepreneurs
5 Clerks and skilled service employees
6 Industrial and agricultural employees
7 Less skilled workers
8 Retired persons
9 Other non-employed persons

By the decision of Directors of Social Statistics WG of Eurostat, the ESeG has been developed solely on the "core social variables" of the official EU statistics, i.e. status in employment, occupation according to 2digit ISCO-08 and auxiliary variables – age and self-declared labour status – for two groups of inactive population.

Some sociological studies already declared that the Czech society has become again a class society (Katrňák, Fučík, 2010). The aim of this article is to cast light on how much this expression is justifiable from the point of view of labour conditions.

The work of Michel Amar, François Gleizes and Monique Meron of INSEE for Eurostat emphasizes the differences along the European continent, as for representation of various economic sectors and distribution of jobs, e.g. the proportion of farmers fluctuates from 1% on Malta and Slovakia to 27% in Romania. Their work also revealed that stability of employment was falling and the risk of unemployment increased when moving from top to bottom of the ESeG hierarchy (Amar, Gleize, Meron, 2014). The authors of the article intend to validate these results (made for the whole European Union) using national LFS data and put further detail on the labour market situation of socio-economic group in the Czech Republic.

2 DATA SOURCES

The analysis stems from two essential statistical sources on the labour market situation, both produced by the official Czech Statistical System:

- Labour Force Survey
- Structure of Earnings Survey

The Labour Force Survey (LFS) is a continuous household survey conducted by the Czech Statistical Office since 1993 (CZSO website). Data on economic activity of individual persons in the household sampled are collected in the electronic questionnaire. The results are published monthly (basic rates) and *en masse* quarterly, with key indicators of employment rate, unemployment rate and working time. LFS covers whole population living in individual households; it also enables to calculate indicators on household composition and educational structures of population. The LFS is produced in almost all European countries, ensuring comparable results which are presented by Eurostat.

The national Structure of Earnings Statistics (SES) is a perpetual enterprise survey conducted by the TREXIMA Ltd. on behalf of the Ministry of Labour and Social Affairs since 1994 (ISPV website). Data on personal information together with earnings of individual employees plus information on the enterprise as a whole are collected electronically. The survey is sample one for stratum of business enterprises with numbers of employees 10–250 (small and middle-sized) and exhaustive for big enterprises with numbers of employees higher than 250; non-business organizations are surveyed exhaustively by the Ministry of Finance and the resulting data are merged to SES. Data on extra-small businesses are modelled using administrative data and 4-yearly special surveys.

The national SES results are published quarterly on enterprise level and yearly/half-yearly on the level of individual employee (breakdowns by sex, education, age, etc.), with key indicators of average earnings, of earnings medians and quantiles (5%, 10%, 25%), of numbers of employees and of average time paid. In contrast with LFS, the SES covers only paid employees; self-employed persons without wages cannot be covered.

The SES is also conducted Europe-wide; but only with four-yearly periodicity; thus, last available comparable EU results being for reference year 2010 (EUROSTAT, 2015).

For the sole purposes of this article, special calculations have been made on both sources.

3 METHODOLOGY OF THE RISK OF UNEMPLOYMENT AND EARNINGS

The Czech Labour Force Survey enables comparing numbers of employed people with the unemployed within the same ESeG category because of the question on previous job. As we deem the bias caused by a time shift insignificant, we would use simple ratio of people in unemployment to total labour force as a measure of risk of unemployment (RU). It means that we compare – for individual ESeG (sub)group – numbers of people who lost and still have not found new job relatively to the size of the group. The inverse probability (addition to 1) would be a number of people with the job to whole labour force within the ESeG group. For this article, years 2011–2014 have been used for calculations, both as quarters and whole year results.

The Structure of Earnings Statistics provides data on individual employee, therefore distributions of earnings are available, expressed both as frequencies and/or as quantiles. For our purposes, the medians and some percentiles were used, beside average figures. Moreover, the parts of wages are surveyed as well, enabling to compare influence of basic wage, bonuses, overtime pay etc. for various groups of employees.

Along with earnings levels, we should take into account the size of the groups, i.e. number of employees, as well as the average time paid (hours per month). As the share of women differs in various ESeG groups, we should consider this fact during data analysing.

For this article, special calculations have been used on years 2011, 2012 and 2013.

4 SITUATION ON THE CZECH LABOUR MARKET

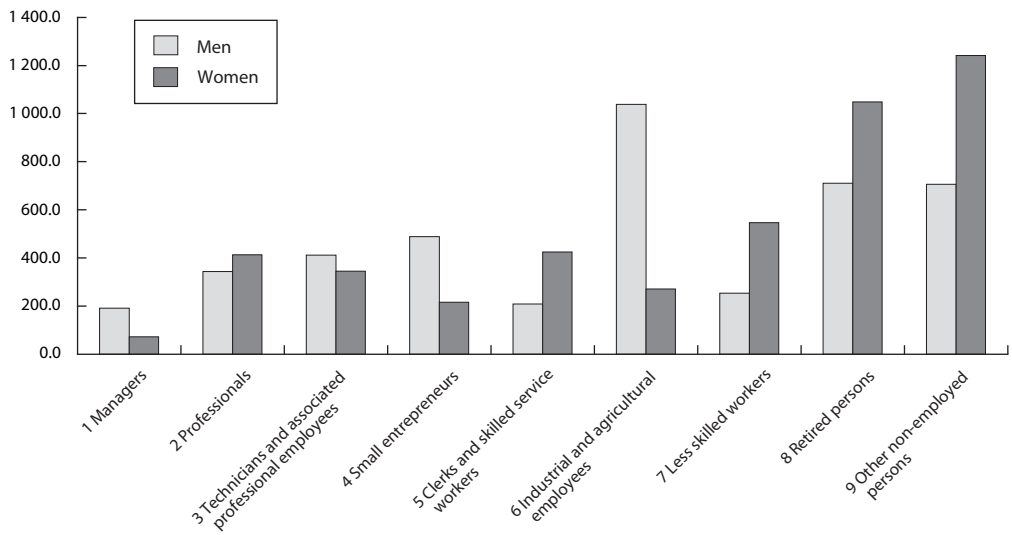
4.1 Risk of Unemployment and other labour conditions

First of all, we have to take into consideration, that population/ labour force/ employment is not evenly distributed along ESeG groups. Using LFS data for whole year 2014, the managers represented 3% of the whole adult population in which the employers (self-employed managers) showed only 0.8% and the employees 2.2%.

Simply, the two largest groups of population are those of inactive people: proportions of 21.8% showed the Other non-employed persons (covering also Unemployed not elsewhere classified) and 19.7% the Retired persons, who are internally classified into ESeG subgroups by their latest employment. The biggest group as for the employed persons were the Industrial and agricultural employees with 14.7%, followed by the Less skilled workers with 9.0%. The "bronze medal" was split between Professionals and Technicians – both showing 8.5% of the whole population aged 15+ years, in 2014.

Also two sexes were not evenly distributed, which is manifested in the Figure 1, and requires no commentary.

Figure 1 Numbers of persons aged 15+ by ESeG



Source: LFS 2014, special calculation

The joblessness is a phenomenon widespread in all economic active ESeG groups but the probability is considerable uneven. The highest risk of unemployment has definitely been among the Less skilled workers especially the Blue collar employees and food assistants in elementary occupations (ESeG 7.2.) and also Cleaners and helpers and services employees in elementary occupations (ESeG 7.3.). In danger are both men and women: using 2014 data, the RU for men in ESeG 7.2. was 17.9%, for women 16.9%. In previous years, the situation was not better, on the contrary; the year 2012 was the worst: ESeG 7.2. men had RU 24.0% and women 17.3%; ESeG 7.3. had for men 20.9% and for women 13.6 %. In 2011, more than one third of male cleaners and helpers and services employees in elementary occupations was jobless.

Typically, in manual professions, men are in greater risk of unemployment than women, but there are exceptions: ESeG 6.2. Food processing, wood working, garment employees, where women showed almost twice higher RU in all years. Also in elite classes, especially high managers, as well as for petite-

bourgeoisies, women are under much higher pressure than men, but for the former we had only small numbers as women hit the "glass ceiling" there.

On the other hand, time dimension is almost negligible for the two elite groups of managers and professionals, where RUs fluctuate about 1.5%. All in all, the smallest ever had been the risk of unemployment among big entrepreneurs, which is obvious, and among health professionals – less than 1 percent, which illustrates that these people can be as fearless as they can easily negotiate for earnings rising.

Also other groups of professionals are so demanded in the labour market, that their unemployment rates can be called natural; it means that they do not linger in the jobless state but only flow from one job to another. The actual unemployment rate is rather a fluctuation rate then.

The real unemployment is an existential thread for some sub-groups of middle class and predominantly for working class. For illustration, getting jobless is twenty-one-times more probable in subgroup 7.2. than among the Health professionals. Note please that for ESeG 3, the Health associate professionals had very small RU in all years as well.

Other criteria of labour market position could be the work in unusual hours. Working on shifts, on Saturdays and Sundays as well as on evenings and nights, destroys social and family life and in consequence leads to shorter life span.

It is no wonder that working in unusual hours is more typical for less qualified occupations, especially in factories where a permanent operation can be predicted (see Table 3). Health professions, where shift work in hospitals refers also to the professionals (belonging to the high class) made an exception.

For men, shift work is often among health associate professionals, personal care employees, also armed forces occupations and protective service employees or stationary plant and machine operators and assemblers. Women work in shift most likely as stationary plant and machine operators and assemblers, as armed forces occupations and protective service employees and as customer service clerks. Self-employed apparently cannot work in shift.

Working on unusual hours cannot be omitted for lower managerial self-employed (hotels, restaurants, trade, culture), even higher managerial self-employed, but most probable has been among armed forces occupations and protective service employees; also one third of stationary plant and machine operators and assemblers worked at evenings and/or nights. Because of dependence on the nature, agricultural employees are likely to work on weekends.

The probability of weekend work for armed forces and protective service workers is twelve times higher than for teaching professionals (which principally do not work on weekends at all).

4.2 Earnings levels of employees

The earnings level of managers in 2013, measured by arithmetic means, was more than twice (2.2times) higher than overall average. Their distribution was extremely spread (the coefficient of variation was 103% and decile ratio 5.5) and curved, the 5^{th} percentile was higher only by 36% than percentile of all employees; on the other side, managerial 95^{th} percentile was 2.8times higher, and this salary of CZK 149 091 was also 6.6times higher than overall median earnings. Generally, the medians show that managerial earnings are 1.8times higher than middle earnings in the Czech Republic.

Higher managerial employees earned much more money that the smaller subgroup of their lower colleagues – 90% of managers in hotels, restaurant, trade and culture had earnings from CZK 11 306 to CZK 81 368; it is about one half of the value of higher managers in every quantile.

The professionals' earnings were more flat than managerial ones. Nine in ten of these highly skilled employees earned between CZK 18 451 and CZK 78 921. Thus, the decile ratio was 2.9 and duodecile ratio was 4.27 – compared to 10.65 of managers; the coefficient of variation was 64%. According to the median values, earnings of professionals were by one third higher than overall value.

Table 1 Earnings levels by ESeG

	Average earnings	Earnings in main quantiles		
		5th percentile	Median	95th percentile
Total	26 444	10 326	22 557	53 528
1 Managers	57 315	14 003	41 368	149 091
2 Professionals	37 628	18 451	30 200	78 921
3 Technicians and associated professional employees	29 130	13 451	26 299	52 025
5 Clerks and skilled service workers	21 578	9 788	20 119	37 910
6 Industrial and agricultural employees	21 782	10 980	20 888	35 555
7 Less skilled workers	15 931	8 960	14 338	27 608

Source: SES 2013, special calculation

In more detailed look, second group of professionals was divided into two: scientific occupations (plus business and administration) on the one richer hand, and teaching and similar occupations on the other poorer hand. The first part consists of science, engineering, ICT, health, business and administration professions where average earnings are more than CZK 40 thousand; the richest was the subgroup of business and administration professionals (CZK 42 790), but comparing the 5th percentiles, the richer were science, engineering and ICT professionals with CZK 19 131.

Peculiarly, the highest 5th percentile of all ESeG subgroups had teaching professionals (20 634 CZK); however, starting from medians up, they were the most poorly paid subgroup of professionals. As for 95th percentile, the teachers were by 44% lower than the value of professionals' total. It demonstrates the extreme evenness of their salaries, decile ratio being 1.6.

As regards the health professionals, there is anomaly concerning overtimes which extends their working hours (it is consistent with the findings on the LFS data): the overall average was 174.4 h/month whereas theirs was 187.5 h/month. Overtime pay is regularly paid by 25% higher than normal hours, so overtime hours increase earnings significantly. The extreme values refer predominantly to men.

Following two elite groups downwards we can find technicians and associated professionals, their average earnings were higher than the overall average by 10%. The inner structure by branches is very similar to professionals; we found the highest salaries at science, engineering and ICT whereas the poorest were at legal, social and cultural activities. Also, the size of differences is quite the same. Apparently, there is general society values order in work here, where teaching and social work is at the very bottom.

The fourth ESeG group consists of clerks and skilled service workers; these are typical middle-class jobs. Also here the personal care employees had by far the poorest pay, with median of CZK 16 671, while clerk occupations showed more than CZK 21 thousand. On the other hand, their wages were remarkably even, with decile ratio 1.7, comparable only with subgroups of teachers as for the flatness of distribution. (Usual decile ratio of subgroup was about 2.5.)

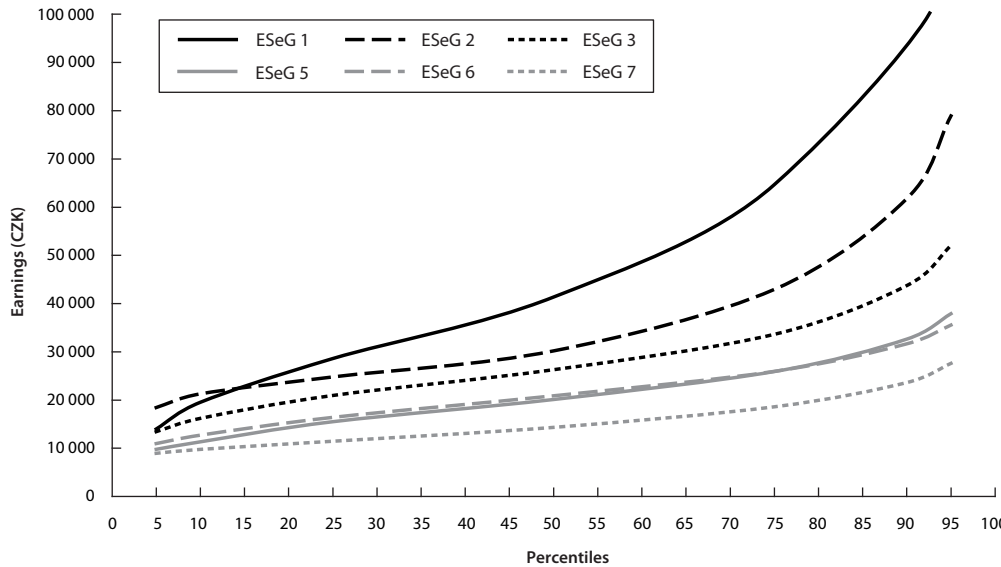
Second outlying subgroup here were the armed forces occupations and protective service employees, where decile ratio was 3.4; median earnings CZK 17 531 and almost one quarter earned less than 11 thousand CZK, but 95th percentile was CZK 36 659.

The working class was split into two ESeG groups and it obviously had strong reasons: while the industrial and agricultural employees had median wages CZK 20 888, the less skilled workers had to be satisfied with CZK 14 338.

It is worth remembering that the last group consists not only of typical blue collar workers, but also of personal services and sales employees. These precarious jobs showed the second poor earnings level (median CZK 14 408); the very worst paid subgroup was cleaners and helpers and services employees

in elementary occupations with CZK 11 893. The wages of this bottom subgroup are one of the flattest with decile ratio 1.8; we can say that these workers are even in poverty, 90% of them earned between CZK 8 553 CZK (the minimum wage in the economy) and CZK 17 975.

Figure 2 Quantiles distribution of earnings by ESeG



Source: SES 2013, special calculation

CONCLUSIONS

The Czech labour market has profiled itself onto discrete strata during recent 25 year, i.e. since the beginning of the transition to capitalist economy. We tried to describe these strata using draft classification of European Socio-economic Groups. Although these groups cannot explain the most of the variance found in the risk of unemployment and earnings level, this tool proved reasonable for description of inconsistencies faced by individual groups of economically active people.

The thread of unemployment is imminent for low qualified workers. One of the six of the cleaners, helpers and services employees in elementary occupations had actually been jobless in 2014. On the other hand, such a situation is quite unimaginable for highly educated people working as professionals or managers.

Sticking to it, low qualified employees had the lowest earnings levels in the economy, which pushes them broadly to the position of low wage earners (also generally called working poor) that has been internationally defined as earnings less than two thirds of national median (EUROSTAT, Statistics Explained). In contrary, the managerial earnings are generally the biggest, but tremendously uneven. A part of managers earn relatively poor salary, comparable to wages of middle workers, illustratively, one of ten earned less than CZK 19 544. On the other side, the richest 10% part of managers earned more than CZK 106 782, i.e. 4.7 times the overall median earnings.

The situation of the Czech Republic shows a little difference from EU averages. There is a small part of people working in agriculture (the fourth smallest share of farmers), somewhat bigger part of small entrepreneurs than should be adequate for the Central Europe; and, on the other hand, it has a lot of blue collar workers (EUROSTAT Database). It originates from the dissimilar structure of the economy domi-

nated by industry. The Czech Republic has also a small part of part-time workers and disproportionally high gender pay gap (Amar, Gleize, Meron, 2014).

The difference in risk of unemployment between professionals and less skilled workers is considerable in the majority of European countries; the average value is about 10 percentage points (Amar, Gleize, Meron, 2014), which is similar to the Czech Republic. Also commonly used measures for earnings inequality show similar figures for the Czech Republic as for other EU states (EUROSTAT, Statistics Explained). Seeing this, the analysis shows that the recent social structure of Czech Republic did not differ from standard Western Europe societies with free market economy.

Table 2 The risk of unemployment by ESeG sub-group, 2014 LFS

	Probability of unemployment		
	men	women	average
11 Higher managerial self-employed	0.3	1.9	0.4
12 Lower managerial self-employed	0.6	-	0.5
13 Higher managerial employees	2.0	1.5	1.9
14 Lower managerial employees	2.2	5.4	3.7
21 Science, engineering and ICT professionals	1.2	2.7	1.5
22 Health professionals	0.2	1.0	0.8
23 Business and administration professionals	3.0	1.4	2.3
24 Legal, social and cultural professionals	0.6	2.7	1.6
25 Teaching professionals	1.7	1.2	1.3
31 Science, engineering and ICT technicians and associated professionals	1.7	3.8	2.1
32 Health associate professionals	0.8	1.0	1.0
33 Busines and administration associate professionals	2.8	4.2	3.6
34 Legal, social and cultural associate professionals	6.6	6.1	6.3
35 Non-commissioned armed forces officers	0.9	10.7	1.6
41 Skilled agricultural self employed workers	1.7	3.2	2.0
42 Technicians, clerical support, services and sales self employed workers	2.2	3.5	2.9
43 Craft and related trades self employed workers	3.8	5.1	3.8
51 General and numerical clerks and other clerical support employees	3.2	4.8	4.4
52 Customer service clerks	5.7	8.3	7.8
53 Personal care employees	5.0	5.7	5.6
54 Armed forces occupations and protective service employees	4.1	6.1	4.5
61 Building and related trade employees	8.2	3.0	8.1
62 Food processing, wood working, garment employees	6.5	10.0	8.3
63 Metal, machinery, handicraft, printing, electrical and electronic trades employees	3.2	3.6	3.3
64 Stationary plant and machine operators and assemblers	5.2	8.8	6.8
65 Drivers	4.2	8.1	4.5
71 Personal services and sales employees	5.7	9.1	8.2
72 Blue collar employees and food assistants in elementary occupations	17.9	16.9	17.5
73 Cleaners and helpers and services employees in elementary occupations	15.9	11.0	11.3
74 Agricultural employees	7.5	10.2	8.7

Source: LFS 2014, special calculation

Table 3 Working in unusual hours by ESeG sub-group, 2012–2014 LFS

	Unusual working hours type		
	Shift work	**Evenings and nights**	**Saturdays and Sundays**
11 Higher managerial self-employed	N/A	17.3	32.2
12 Lower managerial self-employed	N/A	27.4	42.4
13 Higher managerial employees	1.6	7.1	10.3
14 Lower managerial employees	5.6	-	18.5
21 Science, engineering and ICT professionals	1.2	8.2	12.2
22 Health professionals	13.2	29.8	33.5
23 Business and administration professionals	0.7	7.7	13.2
24 Legal, social and cultural professionals	1.7	9.3	15.6
25 Teaching professionals	2.5	3.2	3.9
31 Science, engineering and ICT technicians and associated professionals	6.3	11.1	12.4
32 Health associate professionals	12.0	22.0	25.1
33 Busines and administration associate professionals	2.1	4.4	6.7
34 Legal, social and cultural associate professionals	5.1	10.5	21.0
35 Non-commissioned armed forces officers	12.4	-	36.2
41 Skilled agricultural self employed workers	N/A	12.8	41.9
42 Technicians, clerical support, services and sales self employed workers	N/A	15.3	32.0
43 Craft and related trades self employed workers	N/A	9.0	28.4
51 General and numerical clerks and other clerical support employees	3.8	5.7	6.2
52 Customer service clerks	11.9	16.2	25.8
53 Personal care employees	15.1	28.5	36.1
54 Armed forces occupations and protective service employees	21.4	44.1	45.6
61 Building and related trade employees	3.0	5.1	12.5
62 Food processing, wood working, garment employees	10.2	17.4	15.4
63 Metal, machinery, handicraft, printing, electrical and electronic trades employees	10.7	17.1	15.5
64 Stationary plant and machine operators and assemblers	20.3	32.9	21.5
65 Drivers	9.9	24.7	27.3
71 Personal services and sales employees	15.2	16.1	39.1
72 Blue collar employees and food assistants in elementary occupations	10.5	15.0	15.8
73 Cleaners and helpers and services employees in elementary occupations	4.4	6.9	13.6
74 Agricultural employees	10.0	14.8	38.2

Source: LFS 2014, special calculation

Table 4 The indicators on earnings by ESeG, year 2013

	Average earnings	Earnings (CZK) in main quantiles				
		P5 5th percentile	P10 1st decile	P50 Median	P90 9th decile	P95 95th percentile
Total	26 444	10 326	11 972	22 557	41 600	53 528
1 Managers	57 315	14 003	19 544	41 368	106 782	149 091
Higher managerial employees	61 022	16 772	21 848	44 078	112 607	157 114
Lower managerial employees	32 980	11 306	12 443	24 720	59 837	81 368
2 Professionals	37 628	18 451	21 292	30 200	61 773	78 921
Science, engineering and ICT professionnals	42 790	19 131	22 391	37 023	68 768	85 186
Health professionals	40 779	17 842	20 588	34 273	70 378	85 192
Business and administration professionals	44 459	17 518	20 997	36 379	74 589	98 495
Legal, social and cultural professionals	31 795	15 384	17 533	27 033	49 966	63 309
Teaching professionals	28 390	20 634	21 758	26 052	34 833	44 543
3 Technicians and associated professional employees	29 130	13 451	16 208	26 299	43 744	52 025
Science, engineering and ICT technicians and associated professionals	31 593	14 550	17 451	28 829	47 047	54 503
Health associate professionals	23 612	12 057	14 039	23 585	32 327	35 281
Busines and administration associate professionals	29 384	13 438	16 361	26 338	44 101	53 844
Legal, social and cultural associate professionals	22 143	12 024	14 196	20 750	31 099	35 717
5 Clerks and skilled service workers	21 578	9 788	11 341	20 119	32 641	37 910
General and numerical clerks and other clerical support employees	22 802	10 118	12 557	21 109	34 151	39 232
Customer service clerks	22 118	10 969	13 255	21 282	30 679	36 253
Personal care employees	17 035	11 616	12 676	16 671	21 870	24 372
Armed forced occupations and protective service employees	19 742	9 124	9 672	17 531	32 682	36 659
6 Industrial and agricultural employees	21 782	10 980	12 723	20 888	31 667	35 555
Building and related trade employees	19 531	10 624	11 871	18 838	27 914	30 768
Food processing, wood working, garment employees	17 807	9 752	10 748	16 536	26 154	30 329
Metal, machinery, handicraft, printing, electrical and electronic trades employees	24 051	12 438	14 965	22 913	34 615	38 876
Stationary plant and machine operators and assemblers	21 560	11 813	13 327	20 436	31 279	35 272
Drivers	21 121	10 218	11 887	20 972	30 324	32 968
7 Less skilled workers	15 931	8 960	9 777	14 338	23 631	27 608
Personal services and sales employees	16 262	9 234	10 007	14 408	24 488	29 331
Blue collar employees and food assistants in elementary occupations	16 294	8 650	9 599	15 498	23 738	26 403
Cleaners and helpers and services employees in elementary occupations	12 375	8 553	9 081	11 893	15 960	17 975
Agricultural employees	19 095	12 057	13 360	18 609	25 461	27 340

Source: SES 2013, special calculation

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Comparing Two Non-Compensatory Composite Indices to Measure Changes over Time: a Case Study

Matteo Mazziotta[1] | *Italian National Institute of Statistics, Rome, Italy*
Adriano Pareto[2] | *Italian National Institute of Statistics, Rome, Italy*

Abstract

Composite indices are increasingly recognized as a useful tool to measure socio-economic phenomena such as quality of life, competitiveness, development, and poverty. Considerable attention has been devoted in recent years to the methodological issues associated with composite index construction, particularly non-compensability and comparability of the data over time. In this paper, we compare two non-compensatory composite indices for measuring multidimensional phenomena and monitoring their changes over time: the Adjusted Mazziotta-Pareto Index (AMPI) and the Mean-Min Function (MMF). The AMPI is a non-linear composite index that rewards the units with balanced values of the individual indicators. The MMF is a two-parameter function that allows compensability among dimensions with a cost that increases with unbalance and can be seen as an intermediate case between a compensatory and a full non-compensatory index. An application to a set of individual indicators of development in the Italian regions is also presented.

Keywords

Composite index, compensability, normalization, aggregation, ranking

JEL code

C43, I31

INTRODUCTION

In the last years, a large number of composite indices to assess countries, according to some socio-economic measure, have been proposed in literature (Bandura, 2008). Composite indices are based on several individual indicators or sub-indices (pillars). These indicators or sub-indices are aggregated by analytical methods to give an overall score for each country or geographical area. The results are used to either create a ranking or to simply summarize the data (Freudenberg, 2003; OECD, 2008).

However, there is no part of the composite index construction that cannot be questioned. For example, additive methods assume a full compensability among the different components of the index (e.g., a high

[1] ISTAT, Viale Oceano Pacifico 171, Rome, Italy.
[2] ISTAT, Viale Oceano Pacifico 171, Rome, Italy. Corresponding author: e-mail: pareto@istat.it.

GDP per capita may offset any educational deficit and vice versa), but a complete compensability among the main dimensions of the phenomenon is often not desirable (Munda and Nardo, 2009). For this reason, more and more often a non-compensatory approach has been adopted. For example, in 2010, the aggregation method of the United Nations' *Human Development Index* (HDI) was changed from the arithmetic mean to the geometric mean in order to penalize unbalanced or skewed development across dimensions (UNDP, 2010). Another important issue is the level of comparability of the data over time (Tarantola, 2008). All the methods allow for space comparisons, whereas time comparisons may be difficult to make or to interpret. For example, standardization with respect to the mean and standard deviation allows the performance of countries to be followed over time only in relative terms, whereas it is not possible to appreciate any absolute change.

In this work, we compare two non-compensatory composite indices which allow for time comparisons in absolute terms: the Adjusted Mazziotta-Pareto Index (AMPI) and the Mean-Min Function (MMF).

The AMPI[3] is a non-linear composite index which, starting from a linear aggregation, introduces a penalty for the units with unbalanced values of the indicators. It is composed of two parts (a measure of the mean level and a measure of the amount of unbalance) and, differently from other methods, may be used for constructing both 'positive' and 'negative' composite indices[4] (Mazziotta and Pareto, 2013c).

The MMF is an intermediate case between arithmetic mean, according to which no unbalance is penalized, and min function, according to which the penalization is maximum, because the other values cannot increase the value of the index. It depends on two parameters that are respectively related to the intensity of penalization of unbalance and intensity of complementarity between indicators (Casadio Tarabusi and Guarini, 2013).

In Section 1, the main steps to implement a composite index are reported and some methodological issues, such as non-compensability and comparability of the data over time, are discussed. In Sections 2 and 3, a brief description of AMPI and MMF is presented. In Section 4, an empirical comparison is made by using a set of regional indicators of development in Italy, in 2004 and 2011. Finally, some comments about the results are given.

1 CONSTRUCTING A COMPOSITE INDEX

Constructing a composite index is a complex task. Its phases involve several alternatives and possibilities that affect the quality and reliability of the results. The main problems, in this approach, concern the choice of theoretical framework, the availability of the data, the selection of the more representative indicators and their treatment in order to compare and aggregate them.

It is possible, shortly, to identify the following steps to do (Salzman, 2003; OECD, 2008; Mazziotta and Pareto, 2013c):

1. *Defining the phenomenon to be measured*. The definition of the concept should give a clear sense of what is being measured by the composite index. It should refer to a theoretical framework, linking various sub-groups and underlying indicators. If causality is from the concept to the indicators we have a *reflective* measurement model; if causality is from the indicators to the concept we have a *formative* model (Diamantopoulos, 2008).

[3] The AMPI has been proposed within the BES Project. The goal of this project – born of a joint initiative of the Italian National Institute of Statistics (Istat) and National Council for Economy and Labour (Cnel) – is to measure equitable and sustainable well-being in Italy.

[4] A composite index is 'positive' if increasing values of the index correspond to positive variations (i.e., an improvement) of the phenomenon (e.g., well-being). On the contrary, a composite index is 'negative' if increasing values of the index correspond to negative variations (i.e., a worsening) of the phenomenon (e.g., poverty).

2. *Selecting a group of individual indicators*. Ideally, indicators should be selected according to their relevance, analytical soundness, timeliness, accessibility and so on. The selection step is the result of a trade-off between possible redundancies caused by overlapping information and the risk of losing information. A statistical approach to the choice of indicators involves calculating the correlation between potential indicators, and including the ones that are less correlated in order to minimize redundancy.
3. *Normalizing the individual indicators*. This step aims to make the indicators comparable as they often have different measurement units. Another motivation for the normalization is the fact that some indicators may be positively correlated with the phenomenon to be measured (positive 'polarity'), whereas others may be negatively correlated with it (negative 'polarity'). We want to normalize the indicators so that an increase in the normalized indicators corresponds to increase in the composite index. There are various methods of normalization, such as *ranking*, *re-scaling* (or Min-Max), *standardization* (or *z*-scores) and 'distance' from a reference (or *indicization*).
4. *Aggregating the normalized indicators*. It is the combination of all the components to form one or more composite indices (mathematical functions). Different aggregation methods are possible. The most used are additive methods that range from summing up unit ranking in each indicator to aggregating weighted transformations of the original indicators. Multivariate techniques as *Principal Component Analysis* (PCA) are also often used (Dunteman, 1989).[5]

Aggregation step has always been an interesting but controversial topic in composite index construction (Saltelli, 2007). A fundamental issue concerning the aggregation is the degree of compensability or substitutability of the individual indicators or pillars. Compensability among indicators is defined as the possibility of compensating any deficit in one dimension with a suitable surplus in another. Thus we can define an aggregation approach as compensatory or non-compensatory depending on whether it permits compensability or not (Casadio Tarabusi and Guarini, 2013). Compensability is closely related with the concept of unbalance, i.e., a disequilibrium among the indicators that are used to build the composite index. In a non-compensatory approach, all the dimensions of the phenomenon must be balanced and an aggregation function that takes unbalance into account, in terms of penalization, is often used (unbalance-adjusted function). A compensatory approach involves the use of linear functions, such as the arithmetic mean that ignores unbalances. A non-compensatory approach generally requires unbalance-adjusted functions, such as the AMPI and the MMF. *Multi-Criteria Analysis* (MCA) can also be used (Munda and Nardo, 2009). However, the MCA provides results in terms of ranks, and not of an index, so the researcher can only follow the unit rankings though time (Booysen, 2002).

Another important issue concerning composite index construction is the level of comparability of the data across countries and over time. Comparisons over time may be absolute or relative (Mazziotta and Pareto, 2013a). We say that a time comparison is 'relative' when the composite index values, at time *t*, depend on one or more endogenous parameters (e.g., mean and variance of the individual indicators at time *t*). Similarly, we say that a time comparison is 'absolute' when the composite index values, at time *t*, depend on one or more exogenous parameters (e.g., minimum and maximum of the individual indicators fixed by the researcher). Comparability of the values of a composite index firstly depends on the normalization method. *Ranking* and *standardization* allow only for relative comparisons since they are exclusively based on values of the individual indicators at the time of reference. Other methods, such as *re-scaling* and *indicization*, require that the minimum and maximum (e.g., the 'goalposts' of the HDI) or

[5] Note that normalization and aggregation are interconnected issues. For example, if the individual indicators are transformed in z-scores, they cannot be aggregated by a geometric mean because it is defined only for sets of positive values. Furthermore, some methods perform both tasks simultaneously (e.g., PCA).

the base of index numbers are independent from the time of reference in order to perform comparisons in absolute terms (Tarantola, 2008).

2 THE ADJUSTED MAZZIOTTA-PARETO INDEX

The AMPI is a non-compensatory composite index based on a *re-scaling* of the individual indicators in the range (70; 130) according to two 'goalposts', i.e., a minimum and a maximum value which represent the possible range of each variable for all time periods and for all units.

Let $\mathbf{X} = \{x_{ijt}\}$ be a three-way array (or three-dimensional matrix) of size n (number of units) x m (number of indicators) x p (numbers of time periods). A normalized array $\mathbf{R} = \{r_{ijt}\}$ is calculated as follow:

$$r_{ijt} = \frac{(x_{ijt} - \mathrm{Min}_{x_j})}{(\mathrm{Max}_{x_j} - \mathrm{Min}_{x_j})} 60 + 70\,, \tag{1}$$

where x_{ijt} is the value of indicator j for unit i, at time t, and Min_{x_j} and Max_{x_j} are the 'goalposts' for the indicator j. If the indicator j has negative 'polarity', the complement of (1) with respect to 200 is computed.

Denoting with $\mathrm{M}_{r_{it}}$ and $\mathrm{S}_{r_{it}}$, respectively, the mean and the standard deviation of the normalized values for unit i, at time t, the generalized form[6] of the AMPI is given by:

$$\mathrm{AMPI}_{it}^{+/-} = \mathrm{M}_{r_{it}} \pm \mathrm{S}_{r_{it}} \mathrm{cv}_{it}\,,$$

where $\mathrm{cv}_{it} = \mathrm{S}_{r_{it}}/\mathrm{M}_{r_{it}}$ is the coefficient of variation for unit i, at time t, and the sign ± depends on the kind of phenomenon to be measured. If the composite index is 'positive' then the AMPI^{-} is used, else the AMPI^{+} is used (De Muro et al., 2011).

To facilitate the interpretation of results, it is possible to choose the 'goalposts' so that 100 represents a reference value (e.g., the average in a given year).

A simple procedure for setting the 'goalposts' is the following.

Let Ref_{x_j} be the reference value for indicator j. Denoting with $\mathrm{Inf}_{x_j} = \min_{it}\{x_{ijt}\}$ and $\mathrm{Sup}_{x_j} = \max_{it}\{x_{ijt}\}$, the 'goalposts' are defined as:

$$\begin{cases} \mathrm{Min}_{x_j} = \mathrm{Ref}_{x_j} - \Delta_{x_j} \\ \mathrm{Max}_{x_j} = \mathrm{Ref}_{x_j} + \Delta_{x_j} \end{cases}$$

where $\Delta_{x_j} = (\mathrm{Sup}_{x_j} - \mathrm{Inf}_{x_j})/2$.[7]

The AMPI allows to compare the trends of the various units over time and it may be simultaneously applied to different type of units (e.g., countries, regions, cities) without loss of comparability.

3 THE MEAN-MIN FUNCTION

The MMF is a two-parameter function that incorporates the two extreme cases of penalization of unbalance: the zero penalization represented by the arithmetic mean (complete compensability) and the maximum penalization represented by the minimum function (full non-compensability). All other possible cases are intermediate.

Given a normalized three-way array $\mathbf{Z} = \{z_{ijt}\}$, the MMF is defined as:

$$\mathrm{MMF}_{it} = \mathrm{M}_{z_{it}} - \alpha\left(\sqrt{(\mathrm{M}_{z_{it}} - \min_j\{z_{ijt}\})^2 + \beta^2} - \beta\right) \qquad (0 \le \alpha \le 1;\ \beta \ge 0) \tag{2}$$

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[6] It is a generalized form since it includes 'two indices in one'.

[7] Normalized values will fall approximately in the range (70; 130).

where $M_{z_{it}}$ is the mean of the normalized values for unit i, at time t, and the parameters α and β are respectively related to the intensity of penalization of unbalance and intensity of complementarity between indicators.

The function reduces to the arithmetic mean for $\alpha = 0$ (in this case β is irrelevant) and to the minimum function for $\alpha = 1$ and $\beta = 0$. So, the interval of definition of the values of the MMF is: $\min_j\{z_{ijt}\} \leq MMF_{it} \leq M_{z_{it}}$.

The MMF has some properties that other important unbalance-adjusted functions lack, such as an unrestricted domain that is independent from the choice of the normalization procedure. By choosing the values of parameters appropriately one should obtain the aggregation function that best suits the specific theoretical approach. However, there is not a general rule for tuning these values (Mazziotta and Pareto, 2013b).

4 AN APPLICATION TO REAL DATA

In order to compare AMPI and MMF, an application to a set of indicators of development in the Italian regions, in 2004 and 2011, is presented. Five basic dimensions are considered: Health, Income, Work, Education and Environment.

The variables used are the following:[8]

I1) 'Life expectancy at birth', expressed in years (positive polarity);

I2) 'Income distribution inequality' – Gini coefficient (negative polarity);

I3) 'Employment rate for people aged 20–64', expressed in percentage (positive polarity);

I4) 'People aged 25–64 with low education level', expressed in percentage (negative polarity);

I5) 'Greenhouse gas emissions', expressed in CO_2 equivalent tons per capita (negative polarity).

In Table 1 is reported the data matrix, of size 22 (number of regions plus national average) x 5 (number of indicators of development) x 2 (numbers of years).

Table 1 Individual indicators of development in the Italian regions – years 2004, 2011

Region	2004					2011				
	I_1	I_2	I_3	I_4	I_5	I_1	I_2	I_3	I_4	I_5
Piemonte	80.6	0.309	66.9	52.0	9.76	81.8	0.303	68.4	42.7	7.13
Valle d'Aosta	80.6	0.296	70.7	54.9	6.81	81.8	0.282	71.2	48.3	4.95
Liguria	80.9	0.314	63.5	44.2	12.31	81.6	0.341	67.4	37.1	9.08
Lombardia	81.0	0.320	69.1	49.3	9.59	82.3	0.291	69.0	41.6	8.39
Bolzano/Bozen	81.2	0.298	73.0	58.1	6.10	83.2	0.256	76.0	46.3	5.50
Trento	81.2	0.271	69.6	43.3	6.10	82.8	0.274	71.0	34.2	5.50
Veneto	81.3	0.281	67.7	53.6	10.24	82.4	0.276	69.2	42.8	7.70
Friuli-V.G.	80.6	0.273	65.8	49.0	11.58	81.7	0.301	68.2	42.1	10.59
Emilia-R.	81.3	0.299	71.7	48.0	12.16	82.4	0.289	72.1	39.4	9.86
Toscana	81.6	0.268	66.8	51.7	7.56	82.6	0.283	67.6	45.0	5.87
Umbria	81.5	0.286	65.2	43.3	14.01	82.6	0.278	66.6	34.1	9.94
Marche	81.9	0.280	67.8	48.5	6.97	82.9	0.284	67.2	42.1	6.41
Lazio	80.2	0.328	62.6	41.6	7.72	81.8	0.328	63.2	33.9	6.45
Abruzzo	81.0	0.293	60.7	47.0	5.80	82.1	0.279	61.1	38.4	4.15
Molise	81.0	0.286	56.4	51.2	8.28	82.1	0.303	54.7	47.5	7.77
Campania	79.4	0.347	49.2	57.7	3.57	80.4	0.353	43.1	52.9	3.74
Puglia	81.2	0.303	48.8	60.4	14.07	82.1	0.314	48.6	54.1	11.87
Basilicata	80.5	0.298	53.6	53.0	4.66	82.0	0.344	51.7	46.1	2.93
Calabria	80.8	0.333	50.5	53.5	3.38	82.1	0.317	46.2	48.4	3.25
Sicilia	80.2	0.348	47.0	59.5	8.44	81.1	0.334	46.2	53.2	7.67
Sardegna	80.8	0.323	55.0	61.4	11.64	81.9	0.277	55.6	53.5	9.47
Italy	**80.8**	**0.328**	**61.3**	**51.9**	**8.91**	**82.0**	**0.319**	**61.2**	**44.3**	**7.43**

Source: <http://noi-italia.istat.it>

[8] Note that the purpose of the application is purely illustrative. The choice of the indicators is arbitrary and based on data availability.

Since we are measuring the development, the AMPI$^-$ is used. A MMF with proportional compensability ($\beta = 0$) is considered, for $\alpha = 0$ (MMF_1), $\alpha = 0.5$ (MMF_2) and $\alpha = 1$ (MMF_3). The normalization procedure for calculating the MMF is given by (1), thus we have $z_{ijt} = r_{ijt}$ in (2).[9] Furthermore, the 'goalposts' were set so that 100 represents the Italy's value in 2004.

Tables 2 and 3 show the final scores (value) and rankings (rank) of the Italian regions for 2004 and 2011, respectively. The mean absolute difference of rank and the Spearman rank correlation coefficient between AMPI$^-$ and MMF are also reported.

As we can see, the AMPI$^-$ is more similar to the MMF_2, i.e., the MMF with medium penalization (the mean absolute difference of rank is 0.4 for 2004 and 0.2 for 2011; the Spearman rank correlation is 0.992 for 2004 and 0.996 for 2011). This is due to the fact that both AMPI$^-$ and MMF_2 are based on a penalty function (calculated in a different way) subtracted to the arithmetic mean.

The results are very different if we compare the AMPI$^-$ and the MMF_3, i.e., the MMF with maximum penalization (the mean absolute difference of rank is 2.6 for 2004 and 1.8 for 2011; the Spearman rank correlation is 0.813 for 2004 and 0.913 for 2011). In this case, we have large differences of rank and almost all the regions have a different position in the two rankings. For example, in 2004, Umbria ranks 10th with the AMPI$^-$ and 20th according to the MMF3, since the minimum function does not allow indicators I_1–I_4 to compensate for the 'bad' value of I_5.

Finally, differences between AMPI$^-$ and MMF_1, i.e., the MMF with zero penalization or arithmetic mean, represent a middle result between the previous ones (the mean absolute difference of rank is 0.5 both for 2004 and 2011; the Spearman rank correlation is 0.988 for 2004 and 0.991 for 2011).

Table 2 Composite indices of development in the Italian regions – year 2004

Region	AMPI$^-$		MMF_1		MMF_2		MMF_3		Difference of rank		
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	AMPI$^-$ –MMF_1	AMPI$^-$ –MMF_2	AMPI$^-$ –MMF_3
Piemonte	102.1	14	102.5	15	102.3	15	95.4	6	–1	–1	8
Valle d'Aosta	106.3	6	107.4	6	106.9	6	93.3	7	0	0	–1
Liguria	100.9	16	102.2	16	101.6	16	81.7	15	0	0	1
Lombardia	104.4	9	104.7	12	104.6	11	96.4	5	–3	–2	4
Bolzano/Bozen	108.0	5	109.5	5	108.8	5	86.4	11	0	0	–6
Trento	117.1	1	117.9	1	117.5	1	105.6	2	0	0	–1
Veneto	105.9	7	107.4	7	106.7	7	92.9	8	0	0	–1
Friuli-V.G.	103.5	12	105.9	10	104.7	10	85.6	13	2	2	–1
Emilia-R.	105.3	8	107.0	8	106.2	8	82.5	14	0	0	-6
Toscana	112.1	3	113.4	3	112.7	3	100.4	3	0	0	0
Umbria	103.7	10	106.8	9	105.3	9	72.5	20	1	1	–10
Marche	114.6	2	115.1	2	114.9	2	107.4	1	0	0	1
Lazio	103.0	13	104.1	13	103.6	13	89.7	10	0	0	3
Abruzzo	109.4	4	110.0	4	109.7	4	98.8	4	0	0	0
Molise	103.6	11	104.8	11	104.2	12	91.0	9	0	–1	2
Campania	87.8	19	91.8	18	89.8	19	76.9	18	1	0	1
Puglia	87.3	20	90.5	20	88.9	20	72.2	21	0	0	–1
Basilicata	101.7	15	103.7	14	102.7	14	85.8	12	1	1	3
Calabria	97.8	17	100.4	17	99.1	17	80.2	16	0	0	1
Sicilia	86.5	21	87.5	21	87.0	21	73.7	19	0	0	2
Sardegna	90.3	18	91.2	19	90.8	18	79.2	17	–1	0	1
Italy	**100.0**		**100.0**		**100.0**		**100.0**				
Mean absolute difference									**0.5**	**0.4**	**2.6**
Rank correlation									**0.988**	**0.992**	**0.813**

Source: Elaboration of the authors

[9] We normalized the individual indicators by a re-scaling in order to perform time comparisons in absolute terms.

Table 3 Composite indices of development in the Italian regions – year 2011

Region	$AMPI^-$		MMF_1		MMF_2		MMF_3		Difference of rank		
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	$AMPI^- - MMF_1$	$AMPI^- - MMF_2$	$AMPI^- - MMF_3$
Piemonte	114.5	11	114.6	11	114.6	11	109.6	5	0	0	6
Valle d'Aosta	117.8	8	118.2	8	118.0	8	107.8	6	0	0	2
Liguria	107.6	14	109.3	14	108.4	14	91.8	13	0	0	1
Lombardia	116.5	10	117.1	10	116.8	10	102.8	8	0	0	2
Bolzano/Bozen	126.6	2	127.7	1	127.2	2	112.2	2	1	0	0
Trento	127.1	1	127.6	2	127.3	1	117.6	1	–1	0	0
Veneto	118.9	6	119.5	7	119.2	6	106.5	7	–1	0	–1
Friuli-V.G.	110.1	13	111.0	13	110.6	13	90.9	14	0	0	–1
Emilia-R.	116.7	9	117.9	9	117.3	9	94.9	11	0	0	–2
Toscana	119.2	5	119.5	6	119.3	5	111.5	3	–1	0	2
Umbria	118.0	7	120.1	5	119.0	7	94.5	12	2	0	–5
Marche	120.4	3	120.9	3	120.6	3	110.6	4	0	0	–1
Lazio	112.6	12	114.3	12	113.4	12	99.9	9	0	0	3
Abruzzo	119.7	4	120.8	4	120.3	4	99.6	10	0	0	–6
Molise	106.5	15	107.6	15	107.1	15	87.8	16	0	0	–1
Campania	89.6	21	93.8	21	91.7	21	66.7	21	0	0	0
Puglia	94.3	19	96.8	19	95.5	19	76.7	18	0	0	1
Basilicata	103.9	16	107.1	17	105.5	17	82.4	17	–1	–1	–1
Calabria	103.7	18	107.3	16	105.5	16	72.4	19	2	2	–1
Sicilia	93.6	20	95.1	20	94.3	20	72.3	20	0	0	0
Sardegna	103.9	17	106.1	18	105.0	18	89.6	15	–1	–1	2
Italy	**109.0**		**109.5**		**109.2**		**99.7**				
Mean absolute difference									**0.5**	**0.2**	**1.8**
Rank correlation									**0.991**	**0.996**	**0.913**

Source: Elaboration of the authors

Table 4 Composite indices of development in the Italian regions – variations 2004–2011

Region	$AMPI^-$		MMF_1		MMF_2		MMF_3		Difference of rank		
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	$AMPI^- - MMF_1$	$AMPI^- - MMF_2$	$AMPI^- - MMF_3$
Piemonte	12.5	5	12.1	5	12.3	5	14.2	4	0	0	1
Valle d'Aosta	11.5	7	10.7	9	11.1	8	14.5	3	–2	–1	4
Liguria	6.6	15	7.1	13	6.9	13	10.1	11	2	2	4
Lombardia	12.1	6	12.3	4	12.2	6	6.4	12	2	0	–6
Bolzano/Bozen	18.6	1	18.2	1	18.4	1	25.7	1	0	0	0
Trento	9.9	10	9.7	11	9.8	11	12.0	7	–1	–1	3
Veneto	13.0	4	12.1	6	12.5	4	13.7	5	–2	0	–1
Friuli-V.G.	6.5	16	5.1	18	5.8	17	5.3	13	–2	–1	3
Emilia-R.	11.4	8	11.0	7	11.2	7	12.4	6	1	1	2
Toscana	7.1	13	6.1	16	6.6	15	11.0	8	–3	–2	5
Umbria	14.3	2	13.3	3	13.8	3	21.9	2	–1	–1	0
Marche	5.7	18	5.7	17	5.7	18	3.2	15	1	0	3
Lazio	9.6	11	10.1	10	9.8	10	10.2	10	1	1	1
Abruzzo	10.4	9	10.8	8	10.6	9	0.8	16	1	0	–7
Molise	2.9	19	2.8	20	2.9	19	–3.2	18	–1	0	1
Campania	1.7	21	2.1	21	1.9	21	–10.2	21	0	0	0
Puglia	7.0	14	6.3	15	6.6	14	4.4	14	–1	0	0
Basilicata	2.1	20	3.3	19	2.7	20	–3.4	19	1	0	1
Calabria	5.9	17	6.9	14	6.4	16	–7.8	20	3	1	–3
Sicilia	7.1	12	7.6	12	7.3	12	–1.4	17	0	0	–5
Sardegna	13.5	3	14.9	2	14.2	2	10.4	9	1	1	–6
Italy	**9.0**		**9.5**		**9.2**		**–0.3**				
Mean absolute difference									**1.2**	**0.6**	**2.7**
Rank correlation									**0.969**	**0.990**	**0.839**

Source: Elaboration of the authors

The variations over 2004–2011 can be evaluated in Table 4.

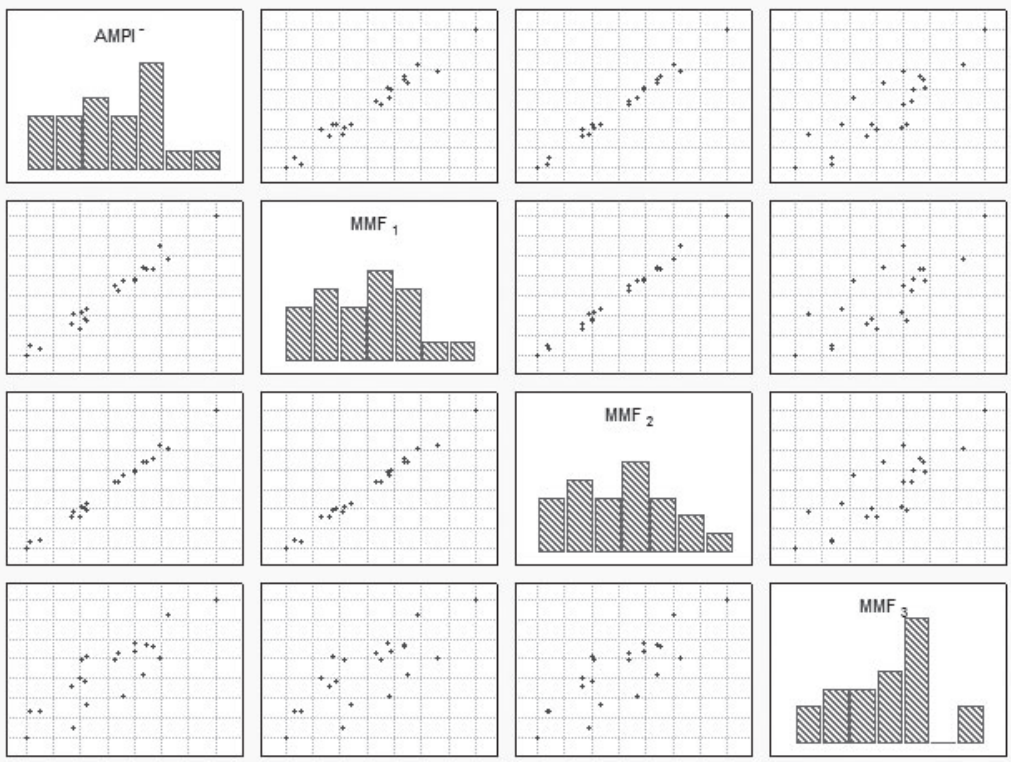
Note that, while the $AMPI^{-}$, MMF_1 and MMF_2 increase of about 9%, at national level, the MMF_3 decreases of 0.3%. In this case, in fact, the minimum value of the normalized indicators is considered as score and the regions of the South Italy are particularly penalized. In particular, Campania drops from 76.9, in 2004, down to 66.7, in 2011, according to the MMF_3 (variation of –10.2), whereas Calabria shows a reduction from 80.2 to 72.4 (variation of –7.8).

The differences between the two investigated computation methods do not change, by comparing the rankings of the variations over time (the mean absolute difference of rank between $AMPI^{-}$ and MMF_1 is 1.2, between $AMPI^{-}$ and MMF_2 is 0.6, between $AMPI^{-}$ and MMF_3 is 2.7; the Spearman rank correlation between $AMPI^{-}$ and MMF_1 is 0.969, between $AMPI^{-}$ and MMF_2 is 0.990, between $AMPI^{-}$ and MMF_3 is 0.839).

In order to assess the consistency of the results across regions and over time, a matrix-plot is shown in Figure 1, where the variations of the four composite indices are 'crossed' and the crossing of each pair is represented by one *x*-*y* scatter-plot.

In general, the variations are concordant (most of the points are located around a straight line at 45 deg.) and the nearest results are obtained with $AMPI^{-}$ and MMF_2, as we have seen already. Note that the use of the minimum function (MMF_3) produces the most irregular distribution of the variations, since no averaging of normalized indicators is made (with or without penalization).

Figure 1 Matrix-plot of the composite indices in the Italian regions – variations 2004–2011



Source: Elaboration of the authors

CONCLUSION

Most of the socio-economic phenomena such as quality of life, competitiveness, development, and poverty have a multidimensional nature and require the definition of a set of individual indicators in order to be properly assessed.

Individual indicators are often summarized and a composite index is created. However, the procedure for constructing a composite index is very far from being aseptic and requires a number of subjective decisions to be taken.

Non-compensability and comparability of the data over time are central issues in the construction of composite indices. Non-compensatory composite indices may be obtained by unbalance-adjusted functions, whereas the question of comparability mainly depends on the normalization method. A *re-scaling* or Min-Max transformation can satisfy this need, when the minimum and maximum values, for each indicator, are found across all the considered time periods or, alternatively, are fixed by the researcher.

In this paper, a comparison between two different non-compensatory approaches for monitoring multidimensional phenomena over time is made. The AMPI is a non-linear composite index that normalizes individual indicators by a *re-scaling* in the range (70; 130), where 100 represents a reference value, and aggregates them with a arithmetic mean adjusted by a penalty function related to the amount of unbalance. The MMF is a two-parameter function that poses no constraint to the choice of the most appropriate normalization procedure, and allows the user to adapt it to different kinds of analysis (with progressive or proportional compensability, with complete or incomplete compensability).

The application to real data shows that the AMPI is very similar to an 'intermediate' MMF. However, it respects both the constraint of time comparisons and the non-compensability by using an easier and more transparent methodology than the MMF.

Aside from the procedure used, composite indices provide an irreplaceable contribution to simplification, but they are based on methods that flatten the information and can lead to a myopic reading of reality, especially if they are not supported by an adequate selection and interpretation of the individual indicators.

Therefore, in order to obtain valid and reliable results, it is absolutely essential to support the choice of the set of individual indicators with an appropriate theoretical framework that defines the social reality in each of its dimensions.

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Benford's Law and Possibilities for Its Use in Governmental Statistics[1]

Richard Hindls[2] | *University of Economics, Prague, Czech Republic*
Stanislava Hronová[3] | *University of Economics, Prague, Czech Republic*

Abstract

Benford's Law (sometimes also called Benford's Distribution or Benford's Test) is one of the possible tools for verification of a data structure in a given file regarding the relative frequencies of occurrence of the first (or second, etc.) digit from the left. If it is used as a goodness-of-fit test on sample data, there are usually no problems with its interpretation. However, certain factual questions arise in connection with validity of Benford's Law in large data sets in governmental statistics; such questions should be resolved before the law is used. In this paper we discuss the application potential of Benford's Law when working with extensive data sets in the areas of economic and social statistics.

Keywords

Benford's Law, goodness-of-fit test, Z-test, national accounts

JEL code

E22, C43

INTRODUCTION

Correctness and indisputability of macroeconomic data is one of the basic principles in governmental statistics. These attributes are achieved by the use of verified methods to collect and process data, attested procedures, and balance computations with the aid of all available sources of information. The national accounts system is one of the "tools" we use for verifying the meaningfulness and cohesion of the governmental statistics. National accounts is a system of inter-related macroeconomic statistical data, arranged in the form of integrated economic accounts. We can compare this system with a crossword puzzle in which indices stand for letters. In other words, each entry is added to the total index value in the row, and one of different indices in the column, similar to letters in a crossword puzzle being parts to "down" and "across" words. This arrangement of data ensures that all items are inter-related and balanced – nothing is lost and nothing is used to excess. Without disputing the national accounts of any country, it is clear that a balanced inter-related system of data can be created from fictitious or even incorrect data items. Other

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[2] Faculty of Informatics and Statistics, Department of Statistics and Probability, nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic. E-mail: hindls@vse.cz.
[3] Faculty of Informatics and Statistics, Department of Economic Statistics, nám. W. Churchilla 4, 130 67 Prague 3, Czech Republic. E-mail: hronova@vse.cz.

tools are suitable for verifying that the items of national accounts are indeed correct. In addition to the usual factual and logical checks on the data sources and procedures, such verification can be supported by certain formal tools. Benford's Distribution is one of them.

1 WHAT IS BENFORD'S LAW?

The substance of Benford's Law can easily be expressed in words: in a given set of data, the probability of occurrence as the first digit from the left is different for each of the digits 1, 2, ... 9. Numbers starting with one occur more often than those starting with two, which are in turn more frequent than those starting with three, etc., and numbers starting with nine are the least frequent ones. This observation is hard to believe at first sight. However, its validity has been empirically confirmed (first in 1881, and then again in 1938). Thanks to a new mathematical approach developed at the end of the 20th century, this law found its way to be included into the theory of probability. Many a time, successful applications, including testing mathematical models and computer designs, as well as error detection in accounting, have indicated its validity.

1.1 Historical Note

By the irony of fate, it was not Frank Benford who assisted at the birth of the distribution that is now called Benford's. Neither was he the first who tried to prove it mathematically. As a matter of fact, Simon Newcomb in the late 19th century first defined a distribution governing the occurrence of numbers with a given digit as the first one from the left. R. A. Raimi and T. P. Hill tried to put forth a mathematical proof of this specific law in the 1990s.

Curiosity and imagination, besides knowledge and experience, undoubtedly play an important role in scientific discoveries. This was also the case of the distribution (law) later called Benford's. American mathematician and astronomer Simon Newcomb noticed in a library that the beginning pages in logarithm table books are much more worn out than the rest. On the basis of this observation he realised that students much more often look up logarithms of numbers beginning with one than those beginning with two, the latter more often than those beginning with three, etc., and from that he deduced: the probability of occurrence for numbers beginning with one is largest, and larger than that for numbers beginning with two, etc. Empirically he derived[4] the following formula for the probability of occurrence for numbers in which digit d stands the first from the left:

$$P(d) = \log_{10}\left(1+\frac{1}{d}\right), \qquad \text{for } d = 1, 2, \ldots, 9. \tag{1}$$

This rule means that the probability of occurrence of a number beginning with one is 0.3010, beginning with two 0.1761, etc., to the probability of a number beginning with nine, which is 0.0458. He also derived probabilities corresponding to the digit second from the left (now, of course, zero has to be included); mutual differences are significantly lower for digits 0, 1, …, 9 at the second position: the probability of zero is 0.1197, and that of nine is 0.0850).[5]

Nowadays Newcomb's paper has hundreds of citations, but in its time it passed practically without notice and more or less fell into oblivion. Many years later American physicist Frank Benford also noticed the irregular wear of logarithmic table books' pages, and derived the same logarithmic formula for the first and second digits from the left. In 1938 he published his conclusions based on studying a large number of data sets for different areas (hydrology, chemistry, but also baseball or daily press – Benford, 1938).

[4] Cf. Newcomb (1881).
[5] Cf. Table 1.

Unlike Newcomb's paper, Frank Benford's met certain attention, perhaps thanks to recognition of his name in physics. Newcomb had been forgotten by then and the logarithmic relationship for occurrence of the first (and second) digit from the left was "christened" Benford's.

The wider use of Benford's Law in the second half of the 20th century brought about a number of questions concerning its validity. There were data sets (from natural sciences, economics, but also everyday life) in which Benford's Law was valid, but it was always possible to find situations for its rejection (phone numbers from a certain area, shoe or cloth sizes, etc.). Naturally, a question arose whether Benford's Law can or cannot be proved mathematically. In particular, T. P. Hill (Hill, 1995a; Hill, 1995b; and Hill, 1998), and R. A. Raimi (Raimi, 1969a; Raimi, 1969b; and Raimi, 1976) tried to find such a proof, but no strict mathematical proof was found.[6] If nothing else, their theoretical efforts led to an approximate formulation of Benford's Law validity: if we take random samples from arbitrary distributions, the collection of these random samples approximately obey the Benford's Law.[7]

1.2 Theoretical basis

Formula (1), first derived by Newcomb and later again by Benford, has a more general validity; or rather, it can be adapted into a form which defines occurrence of any digit at the second, third, etc. positions. In this connection, however, we have to ask whether such occurrence does or does not depend on occurrence of preceding digit(s) from the left, or is conditional with respect to such occurrence. In other words, in the former case we deal with probabilities of independent events, while in the latter conditional probabilities are due to be used.

Occurrence of a digit from 1, 2, …, 9 at the first position from the left is governed by Formula (1), but occurrence of a digit from 0, 1, …, 9 at the second position from the left (on assumption that it is independent of occurrence of a particular digit at the first position from the left) is given as

$$P(d) = \sum_{k=1}^{9} \log_{10}\left(1 + \frac{1}{10k + d}\right), \qquad \text{for } d = 0, 1, \ldots, 9. \tag{2}$$

Regarding independent occurrences of digits from 0, 1, …, 9 at the third and following positions, the last formula can be generalised:

$$P(d_k) = \sum_{d_1=1}^{9} \sum_{d_2=0}^{9} \cdots \sum_{d_{k-1}=0}^{9} \log_{10}\left(1 + \frac{1}{\sum_{i=1}^{k} d_i . 10^{k-i}}\right), \qquad \text{for } d_k = 0, 1, \ldots, 9. \tag{3}$$

and the mutual differences between probabilities of occurrence of a particular digit get smaller already at the second position from the left; and starting at the fifth position (independent of the preceding ones) Benford's Law approaches the uniform multinomial distribution. Table 1 shows the changes in the probability values for independent occurrence of digits 0, 1, …, 9 at the first to fifth positions from the left.

The results presented above imply that, starting from the third position from the left, differences in probability values are very small and only occurrence of digits at the first and second positions from the left are interesting from the viewpoint of practical applications.

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[6] Perhaps the best characterisation is that by R. A. Raimi in the conclusion of his paper (Raimi, 1969b, p. 347). Referring to the validity of Benford's Law for addresses of 5 000 people from a "Who is Who" publication, he says: "Why should the street addresses of a thousand famous men obey the logarithm law? I know no answer to this question".

[7] Cf. Hill (1998) and Raimi (1969b).

Table 1 Probability of occurrence for digit *d* at the *j*th position from the left

d \ *j*	1	2	3	4	5
0	x	0.1197	0.1018	0.1002	0.1000
1	0.3010	0.1139	0.1014	0.1001	0.1000
2	0.1761	0.1088	0.1010	0.1001	0.1000
3	0.1249	0.1043	0.1006	0.1001	0.1000
4	0.0969	0.1003	0.1002	0.1000	0.1000
5	0.0792	0.0967	0.0998	0.1000	0.1000
6	0.0669	0.0934	0.0994	0.0999	0.1000
7	0.0580	0.0904	0.0990	0.0999	0.1000
8	0.0512	0.0876	0.0986	0.0999	0.1000
9	0.0458	0.0850	0.0983	0.0998	0.1000

Source: Authors' own calculations

Another situation arises when probability of occurrence of a digit from 0, 1, …, 9 at the second position from the left is conditional on occurrence of a particular digit from 1, 2, …, 9 at the first position from the left. Conditional probability of occurrence for d_2 at the second position from the left on the condition that the first digit from the left is d_1 equals

$$P(d_2 / d_1) = \frac{\log_{10}\left(1+\frac{1}{10d_1+d_2}\right)}{\log_{10}\left(1+\frac{1}{d_1}\right)}, \qquad \text{for } d_1 = 1, 2, \ldots, 9, \text{ and for } d_2 = 0, 1, \ldots, 9. \tag{4}$$

For example, probability of "2" occurring at the second position on condition of "3" being the first digit from the left is

$$P(D_2 = 2 / D_1 = 3) = \frac{\log_{10}\left(1+\frac{1}{32}\right)}{\log_{10}\left(1+\frac{1}{3}\right)} = \frac{0.0134}{0.1249} = 0.1070.$$

Values of conditional probability for pairs of digits calculated with the aid of Formula (4) are shown in Table 2.

Table 2 Conditional probability values of occurrence for d_2 on condition d_1

d_1 (first digit from the left)	d_2 (second digit from the left)									
	0	1	2	3	4	5	6	7	8	9
1	0.1375	0.1255	0.1155	0.1069	0.0995	0.0931	0.0875	0.0825	0.0780	0.0740
2	0.1203	0.1147	0.1096	0.1050	0.1007	0.0967	0.0931	0.0897	0.0865	0.0836
3	0.1140	0.1104	0.1070	0.1038	0.1008	0.0979	0.0952	0.0927	0.0903	0.0880
4	0.1107	0.1080	0.1055	0.1030	0.1007	0.0985	0.0964	0.0943	0.0924	0.0905
5	0.1086	0.1065	0.1045	0.1025	0.1006	0.0988	0.0971	0.0954	0.0938	0.0922
6	0.1072	0.1055	0.1038	0.1022	0.1006	0.0990	0.0976	0.0961	0.0947	0.0933
7	0.1062	0.1047	0.1033	0.1019	0.1005	0.0992	0.0979	0.0966	0.0954	0.0942
8	0.1055	0.1042	0.1029	0.1017	0.1005	0.0993	0.0982	0.0970	0.0959	0.0949
9	0.1049	0.1037	0.1026	0.1015	0.1004	0.0994	0.0984	0.0973	0.0964	0.0954

Source: Authors' own calculations

The relationships considered above for Benford's Law are valid for arbitrary data sets and are invariant with respect to the change of radix base or units of measurement. Equivalently expressed, data sets governed by Benford's Law will remain governed even if expressed in a base other than decimal, or in other units of measurement (physical, currency, etc.) or if the original data items are all multiplied by an arbitrary constant. This fact implies that any arithmetical operations carried out on data governed by Benford's Law will again be governed by the same law.[8]

The fact that we have at our disposal Benford's Distribution of the first (and second) digit from the left[9] provides us with an option to check any data set for a fit to the data structure governed by Benford's Law. The best choice for such a procedure is the χ^2 goodness-of-fit test, which can be used as a standard hypothesis test if the respective data set comes from a random sample. The tested hypothesis, denoted by H_0, asserts the fit of the empirical distribution with Benford's Law, and the alternative hypothesis H_1 claims the contrary. The test criterion is the statistics

$$G = n\sum_{d=1}^{9}\frac{(p_d - \pi_d)^2}{\pi_d}, \tag{5}$$

which has, under validity of H_0, approximate distribution χ^2 [8], and
where π_d – theoretical relative frequencies under Benford's "Law;
p_d – empirical relative frequencies; and
n – sample size.

The critical values are the respective quantiles of χ^2 [8]; on a 5% significance level, the 95% quantile will be used, that is, $\chi^2_{0.95}$ [8] = 15.5. For a test of the fit at the second position the procedure would be similar, but there are ten groups and nine degrees of freedom. If the underlying sample is small, we also have to respect the condition of a sufficient frequency count in each "cell" ($n\pi_d \geq 5$).

Another option for testing the fit of sample data to Benford's Law is the use of *Z*-statistics; this procedure again verifies the fit between empirical and theoretical frequencies, but separately for each digit, not as a whole. Under hypothesis H_0, the following *Z*-statistics has approximate normal distribution

$$Z_d = \frac{\sqrt{n}\left(|p_d - \pi_d| - \frac{1}{2n}\right)}{\sqrt{\pi_d(1-\pi_d)}}, \tag{6}$$

where π_d – theoretical relative frequencies under Benford's "Law;
p_d – empirical relative frequencies; and
n – sample size.

The critical value (in this case, separate for each digit) is the respective quantile $u_{1-\alpha/2}$ of the normed normal distribution. On a 5% significance level, we get $u_{0.975}$ = 1.96. Kossovsky (2015) recommends that the two-tailed test should always be used, i.e., the critical value given by quantile $u_{1-\alpha/2}$, because absolute value stands in the numerator in Formula (6), and therefore it is not necessary to distinguish between directions of the deviation from Benford's Law (it means that both lower and higher relative frequencies than the theoretical value under Benford's Law admit the same interpretation).

Although both tests lead to conclusions that are intuitively similar, there is a difference between them. Namely, the former (*G*-statistics) comprehensively assesses the validity of Benford's Law for a given set

[8] Cf., e.g., Watrin et al. (2008).
[9] For the above-mentioned reasons we are not going to consider more positions from the left.
[10] Cf. Kossovsky (2015).

of first digits (possibly second ones as well). The particular digit for which the deviation from Benford's Law is the highest must be looked up among values

$$\frac{(p_d - \pi_d)^2}{\pi_d}, \qquad \text{for } d = 1, 2, \ldots, 9, \text{ or } d = 0, 1, \ldots, 9.$$

The second approach (Z_d-statistics) evaluates the deviation for each individual first digit independently, and it is immediately obvious which first digits do or do not comply with Benford's Law. The same considerations of course apply to testing the fit of empirical data to Benford's Law for the second digit from the left.

Mean Absolute Difference (*MAD*) is also often used to test the fit to Benford's Law. This approach, however, goes beyond standard hypothesis testing because the distribution of the *MAD* statistics is unknown. The mean absolute difference value (for the case of the first digit from the left)[11] is

$$MAD = \frac{\sum_{i=1}^{9} |p_d - \pi_d|}{9}, \tag{7}$$

where π_d – theoretical relative frequencies under Benford's "Law;
p_d – empirical relative frequencies.

Since we do not know the distribution of the *MAD* statistics, empirical threshold values[12] are used for evaluation the outcome for *MAD* – cf. Table 3.

Table 3 Degrees of fit for MAD statistics

MAD value	Degree of fit between empirical and theoretical (Benford's) distributions
0.000 – 0.006	Close fit
0.006 – 0.012	Acceptable fit
0.012 – 0.015	Loose fit
0.015 plus	No fit

Source: Nigrini (2011)

Unlike the previous approaches, which are classical statistical inference instances, the *MAD* statistics is more suitable for verifying the fit in a data set not considered a random sample because all data items in the given area are included. This is often the case when checking extensive sets in corporate accounting and macroeconomic data.

2 PRACTICAL APPLICATIONS

The simplicity and, undoubtedly, a certain degree of mystery of Benford's Law[13] have led to a large volume of literature on this subject.[14] Most often, discussions appear about the use of Benford's Law in checking accounting and macroeconomic data.

[11] For testing the second digit from the left, the calculation is similar but there are ten groups.
[12] Cf. Nigrini (2011).
[13] The fact that validity of Benford's Law has not been proved mathematically is also a frequent topic.
[14] From among the most recent ones, we refer to Miller (2015) – it is a very good presentation of applications and experience with them, especially in the areas of economy, accounting, and also natural sciences.

Using Benford's Law for verification of accounting data correctness is one of the approaches that have recently been often used in financial auditing and (tax) inspections. However, we have to realise that this approach never will and never can substitute for professional, comprehensive and extensive effort carried out by auditors and inspectors – it can only help them find the "weak points". If an accounting data set deviates from Benford's Law, this mere fact is not evidence of data falsification or improper manipulations. It is just an indicator of where attention of auditors/inspectors should be focused. If there is such a deviation, the total fit according to (5) is usually not assessed, but deviations of individual digits are evaluated to show where the attention should be focused. In other words, tests of fit to Benford's Law should only be employed in auditing and inspections as an auxiliary tool in addition to standard procedures, or as the first step in searching for possible instances of data falsification. All authors who deal with the use of Benford's Law in auditing, taxes and inspections agree on the statement cited in the preceding sentence.[15]

Benford's Law has a similar application potential in the area of macroeconomic data. Literature in this area is substantially less extensive than in the previous case, but interesting approaches and results can even be found here. Undoubtedly the best-known contribution to the discussion on Benford's Law is that of Rauch et al. (2011). The authors of that paper focus on verification of Benford's Law validity for selected data of national accounts in 27 member states of the European Union in the period from 1999 to 2009 (data in the ESA 1995 methodology). Aware of the problem implied by the large power of a goodness-of-fit test applied to extensive data sets, they decided for a "descriptive" approach based on ordering the member states according to their values of the total deviation from Benford's Law (5). The position of each state on this scale may, in their opinion, be of assistance to Eurostat – to what extent and in what direction Eurostat's verification procedures should be used. Their analysis (based on relative frequencies of occurrence for the first digit from the left) showed that the least trustworthy, from the Benford's Law viewpoint (more exactly, the average value of the *G*-statistics) were the national accounts data of not only Greece, but also of Belgium, Romania, and Latvia. On the other hand, the best fit to Benford's Law was identified for national accounts data of Luxembourg, Portugal, the Netherlands, Hungary, Poland, and the Czech Republic.

Those excellent results of the Czech Republic inspired us to verify the validity of Benford's Law on new data of national accounts processed and published by the Czech Statistical Office according to the ESA 2010. Our ambition is not to prove the validity of Benford's Law in a wider context of national accounts time series, in which even more favourable results would certainly be achieved, but to illustrate the possibilities of this tool in checking data quality. The data set we tested for fit to Benford's Law for the first and second digits from the left was that of national accounts data of the Czech Republic in 2013 (the preliminary report for 2013). Altogether there were 2 817 digits at the first position from the left, and 2 729 digits at the second position. Statistics (5), (6), and (7) are used for testing the fit. The results for the first digit from the left are shown in Table 4.

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[15] Cf., e.g., Carslaw (1988), Nigrini (2005), Nigrini (1996), Guan et al. (2006), Niskanen and Keloharju (2000) or Watrin et al. (2008).

[16] Cf., e.g., Nye and Moul (2007) or Gonzales-Garcia and Pastor (2009).

[17] Generally, data sets connected with the Stability and Growth Pact were considered. Altogether there were 36 691 numerals in 297 sets.

[18] Nonetheless, the problem with Greece's national accounts had been known before. As early as in 2002, Eurostat twice rejected data of the general government in Greece due to untrustworthiness, and again in 2004 (cf. Report by Eurostat on the Revision of the Greek Government Deficit and Debt Figures – <http://ec.europa.eu/eurostat/documents/4187653/5765001/GREECE-EN.PDF>).

[19] Data of the Czech Republic only showed a significant deviation from Benford's Law in 2002, when the value of the test criterion (5) exceeded the critical value of 15.5.

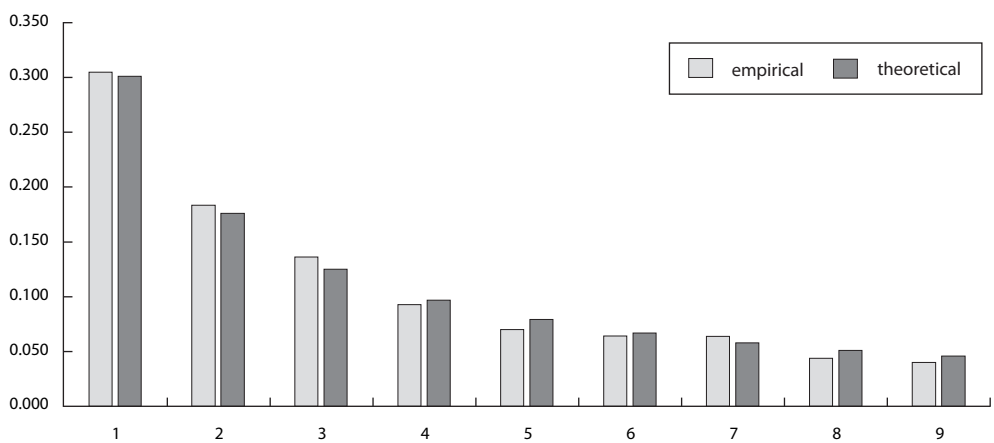
Table 4 Fit to Benford's Law – first digit from the left

First digit from the left	Absolute frequency n_d	Relative frequency p_d	Probability π_d	G	Z_d	MAD
1	858	0.305	0.301	0.000042	0.390146	0.004
2	517	0.184	0.176	0.000314	1.011605	0.007
3	384	0.136	0.125	0.001036	1.797649	0.011
4	262	0.093	0.097	0.000157	0.668436	0.004
5	198	0.070	0.079	0.000999	1.713259	0.009
6	181	0.064	0.067	0.000108	0.534417	0.003
7	180	0.064	0.058	0.000601	1.300798	0.006
8	124	0.044	0.051	0.000995	1.675934	0.007
9	113	0.040	0.046	0.000696	1.388463	0.006
Total	2 817	1.000	1.000	13.004949	x	0.006

Source: <www.czso.cz>, authors' own calculations

The entries in Table 4 clearly show that, regarding the first digit from the left, the data of the national accounts of the Czech Republic in 2013 comply with Benford's Law for all three characteristics. In the goodness-of-fit test we obtain statistics $G = 13.00$, which is smaller than the critical value of $\chi^2_{0.95}$ [8] = 15.5; hence the hypothesis is accepted that the empirical and theoretical (Benford's) distributions are identical. The values of the Z_d-statistics for each of the digits are all smaller than the critical values of the normed normal distribution ($u_{0.975} = 1.96$). We can therefore observe that, for none of the digits, the differences between the empirical and theoretical frequencies are deemed statistically significant. The *MAD* characteristic also indicates a good fit (cf. Table 3) of the data structure of the national accounts of the Czech Republic in 2013 to Benford's Law. Figure 1 illustrates the fir between the empirical frequencies and theoretical probabilities for the first digit from the left.

Figure 1 Fit to Benford's Law – first digit from the left



Source: <www.czso.cz>, authors' own calculations

The results of the comparison between the data structure of the national accounts of the Czech Republic in 2013 and Benford's Law are shown in Table 5.

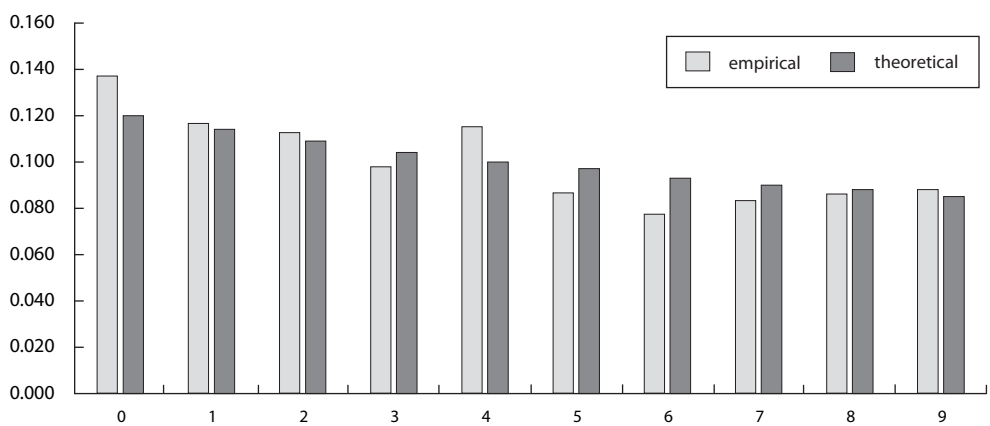
Table 5 Fit to Benford's Law – second digit from the left

Second digit from the left	Absolute frequency n_d	Relative frequency p_d	Probability π_d	G	Z_d	MAD
0	374	0.137	0.120	0.002422	2.710896	0.017
1	318	0.117	0.114	0.000056	0.385125	0.003
2	307	0.112	0.109	0.000112	0.555222	0.003
3	267	0.098	0.104	0.000365	1.023155	0.006
4	314	0.115	0.100	0.002268	2.590616	0.015
5	236	0.086	0.097	0.001141	1.824810	0.011
6	211	0.077	0.093	0.002644	2.787807	0.016
7	227	0.083	0.090	0.000517	1.211364	0.007
8	235	0.086	0.088	0.000041	0.314340	0.002
9	240	0.088	0.085	0.000102	0.517204	0.003
Total	2 729	0.863	1.000	19.774976	x	0.009

Source: <www.czso.cz>, authors' own calculations

Items in Table 5 prove that national accounts data of the Czech Republic in 2013 do not fully comply with Benford's Distribution regarding the second digit from the left. In the goodness-of-fit test we obtain statistics $G = 19.77$, which is higher than the critical value of $\chi^{20.95}$ [9] = 16.9; hence the hypothesis is rejected that the empirical and theoretical (Benford's) distributions are identical. The values of the Z_d-statistics show that the deviations (bold print in Table 5) from the probabilities given by Benford's Law are present for digits 0, 4, and 6; for them, the corresponding values of the Z_d-statistics are larger than the critical value, which is the quantile of the normed normal distribution ($u_{0.975} = 1.96$); hence these deviations are deemed statistically significant. The *MAD* characteristic indicates "only" acceptable fit (cf. Table 3) of the data structure of the national accounts of the Czech Republic in 2013 to Benford's Law.

Figure 2 Fit to Benford's Law – second digit from the left



Source: <www.czso.cz>, authors' own calculations

Let us recapitulate: the evaluation of the fit of the national accounts data of the Czech Republic in 2013 to Benford's Law with respect to the second digit from the left, the fit has not been proved and the differences are significant for digits 0, 4, and 6. However, their more frequent occurrence does not enable us to draw any principal conclusions because this phenomenon is related to a preliminary report. It will be interesting to re-evaluate the situation when the final report of 2013 has been published. We can also see in Figure 2 that the differences for the second digit from the left are not of a principal nature.

CONCLUSIONS

As already stated above, the role of Benford's Law is that of a detection and indicator tool. Deviations of empirical data, i.e., relative frequencies of occurrence for digits 1, 2, …, 9 as the first (or second) digit from the left, from Benford's Law at the beginning of the verification process are not, as such, manifestations of infringement on (say, accounting) rules. At the beginning of the analysis, such deviations are just partial signals that there is certain discrepancy from Benford's Law. Nothing more, and nothing less. Such a signal may be used as recommendation in what direction subsequent analysis should be carried out. Namely, it should focus on the items (accounts, subsets, etc.) for which the highest degree of deviation is shown, e.g., within the Z-test, – Formula (6).

Different situations may arise. Either the revealed deviations are explained in a factual and prescribed way (if the deviation is not random) or no such explanation is identified. In the latter case, it should be seriously investigated why and how the deviation occurred. From experience, a number of instances are known in which unexplained deviations led to identification of principal departures from prescribed procedures and even forensic proceedings were initiated against the parties concerned.

The described approach is open to discussion. Economists, auditors, accountants etc. have varied opinions about the detection potential of Benford's Law. On the one hand there are zealous advocates of a notion that a signal triggered by a deviation from Benford's Law in, say, macroeconomic data (i.e., data on the macroeconomic level) or accounting data (i.e., on the corporate level) is a really serious event to which proper attention should be given because it will lead to the root from which errors – sometimes fully intentional – stem. On the contrary, there are those who feel that the detection role of Benford's Law is a mere formality because the root of the errors will be discovered anyway.

Trust in detection and signalling roles of Benford's Law thus mainly depends on the level of personal experience of those who may use this checking approach. A theoretical dispute aimed at creating a feeling that Benford's Law is useful usually misses this target. This observation is based on practical experience of the authors of the present paper.

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Statistics in Applications – Book Review

Eva Kačerová[1] | *Czech Statistical Office, Prague, Czech Republic*

HENDL, J. et al. *Statistika v aplikacích* (Statistics in Applications). 1st ed. Prague: Portál, 2014. ISBN 978-80-262-0700-9.

The publication follows the *Overview of Statistical Methods* and demonstrates a wide usage of statistics and statistical methods in various fields and spheres of human life. It consists of 21 chapters, each devoted to applications of statistics in a different branch of science. The book is co-written by 14 authors who did not count with deeper knowledge of mathematics among readers than that taught at the secondary school. There are sample applications to make it easier for readers to understand more difficult parts; they have been chosen to clarify material relationships in a concrete problem situation by figures and charts. Moreover, for the reader not to be bogged down in a stream of information there are also pictures that are merely illustrative and do not lack humour. Supplements contain not only statistical tables but also recommendations for teaching of statistics, fundamental principles of official statistics, and principles of work with files of Big Data type.

Opening chapters deal with the basics of statistics. However, it is not a typical textbook-type text; the author strives to underline issues that usually make problems to students in the Czech Republic. It results from the PISA 2012 international research that it is namely data analysis, which is the problematic part. Today, we can no longer operate just with the simplest concepts such as the average, median, and mode; classical analytical methods comprise estimation methods and hypothesis testing; nowadays, with a growing need to make analyses of big multi-dimensional data sets, more and more coming into focus are cluster analysis, factor analysis, canonical analysis, discriminant analysis, and regression analysis; really big sets of data are worked with more and more often. Many times, all the time more frequently available statistical software does our work; however, it is not enough to simply press a button and wait for the result. A user has to possess knowledge of what data a particular method can be applied on and has to be able to deal with the results properly. Therefore, attention is briefly paid also to interpretation problems in statistics.

It is namely contemplation on interpretation of statistical results that makes chapter five. Reading any piece of statistical data one should sceptically ask oneself the following questions: Who says that? How does he know it? Does it make sense? Who is it good for?

[1] Na padesátém 81, 100 82 Prague 10, Czech Republic. E-mail: eva.kacerova@czso.cz.

A chapter about Czech official statistics presents in detail mainly websites of the Czech Statistical Office (the CZSO). Readers are informed about the types of statistics (in the sense of statistical surveys) the CZSO produces. They will find many pieces of information about the volume and types of outputs. It is not only the Statistical Yearbook of the Czech Republic that is published by the CZSO once a year; the CZSO publishes lots of data from various areas of the economy, industry, and life of the society, it carries out various sample surveys, approximately once in a decade also the largest statistical event on the territory of the Czech Republic: Population and Housing Census. Unlike many other statistical offices all over the world it also processes results of all types of elections that are held in the CR.

Those who have problems with English and are not familiar with German or French either can find in a chapter devoted to the European Statistical Office (Eurostat) a detailed guide that will enable them to go through Eurostat databases and to generate their own tables in a required breakdown.

In chapter eight, we can get familiar with a concrete application of statistics for the first time – namely, population statistics. Statistics is used there as a term also in the sense of record keeping. The reason is that demographic statistics is based on keeping of records of births, deaths, immigrants, emigrants, recorded are also marriages, divorces, and abortions. As for practical applications, calculation of life tables and demographic projections are presented.

Another chapter informs the reader what gross domestic product and gross national product are, it explains how to calculate inflation, and what situation has to occur for us to speak about deflation as well as that not all persons without work are counted as the unemployed.

Further, attention is paid to availability of data from social researches. Having a big amount of various surveys many of which work with big volumes of data, new methods and approaches to work with data emerge; actually, a brand new branch is founded called computational science, which combines mathematics, various branches of social sciences, and information sciences.

Despite sociology belongs to social sciences, those devoted to it cannot avoid statistics. Although sociologists usually use simple classification to frequency tables or contingency tables, to be able to interpret the results correctly they often need to know also regression or factor analysis.

Quantitative statistical methods can be applied also when studying media communication. It does not have to apply only to measurement of viewer ratings, page traffic, weekly/daily reach, and visiting rate of the media, but also content analysis and analysis of media communications.

Two chapters deal with statistics in education. The former explains international classifications of types of education. The latter introduces to the reader various databases, in which data on education can be obtained.

Chapter fifteen deals with usage, acquisition, and analysis of statistical data in the health sector. The importance of statistics in that area is confirmed also by many articles in various biomedical databases.

Sport and statistics. Does it seem that it does not marry? Statistics in sport – it is not mere keeping of records on placing or the number of passes or goals; researchers acquire also original data via statistical surveys or use biographical database systems. The latest trend is to analyze big volumes of data that are generated by electronic recording apparatuses right during sport performances.

Do you know what kinanthropology and anthropomotorics are? That is what an introduction to chapter seventeen deals with. Usage of statistics in those fields is demonstrated on case studies, which show possibilities of usage of analysis of variance and explorative or confirmative factor analysis.

Also in medicine we can meet statistics. Applications of statistics in medicine can lie in simple calculations such as the average or median or in complex analyses for which wide theoretical knowledge is expected. Complexity and difficulty of statistical procedures in epidemiological studies are illustrated by a commented study of British physicians. The authors also described statistical principles of clinical studies. Essentials of a clinical study as for its statistical part are already a specific branch of statistics. The ethical part of clinical studies has not been set apart, either.

Today, a statistical analysis is part of almost every biological study. It is proved by research works, which have been chosen to show how from usually complicated data of biological character (that were recorded often under difficult and experimentally unrepeatable conditions) one should obtain maximum gain. Selected examples thus presented the potential of statistics in biological disciplines.

The last chapter, twenty-one, is devoted to statistics and control of processes. Methodology of statistical taking delivery of goods enables to impartially evaluate whether a delivery satisfies (or not) requirements for quality as agreed upon by the supplier and the receiver.

A chance plays an irreplaceable role in our lives and therefore statistics plays such an important role in cognition and our lives. Nowadays, statistical data surround us everywhere. A study of statistics or at least awareness of where we can meet statistics, how we should understand it, but also the fact that we cannot overestimate it, can help us be better oriented in all the time enlarging amount of information.

Development of Agricultural Statistics from Design to Publication of Data

Éva Laczka[1] | *Hungarian Central Statistical Office (HCSO), Budapest, Hungary*

Abstract

Agricultural statistics have the longest and richest past in the history of the independent Hungarian statistical service. During the 150 years history of Hungarian statistics agricultural statistics have always been in the forefront of developments and their implementation. The developments that were realized through the years concerned equally the functioning of the system of agricultural statistics, the methods used, the technical solutions applied, but they also brought numerous novelties in the communication of agricultural data. It is maybe not a lack of modesty to mention that in the majority of cases, developments in the field of agricultural statistics have influenced the whole Hungarian statistical system. It does not happen frequently either that thanks to statistics, new concepts are introduced in agricultural terminology, statistical data influence the development of agricultural policy. It is not easy and would maybe be unworthy to qualify or rank the developments presented in this article. Nevertheless I would like to highlight among them –due to their novelty and specificities- two major developments, the elaboration and use of spot maps, and the setting up and introduction of the unified (electronic) data processing system. I hope however that the solution we used to publish quickly preliminary census data, the database of the plantation survey using geo-coordinates, or the agricultural atlas and interactive graphs used in agricultural statistics will also arouse the interest of the reader.

Keywords

Agricultural censuses, spot-map, unified data processing system, communication tools

JEL code

Q1

INTRODUCTION

Hungarian agriculture in a nutshell

Due to the natural characteristics of the country, Hungarian agriculture has played an important role in Hungarian economy over the past decades, and this is still the case nowadays. In 2014 the share of Hungarian agriculture in GDP was 3.7 percent. The total gross output of agriculture was 2410 billion HUF, out of which crop products represented 58 percent, animals and animal products 35 percent, agricultural services and secondary activities 7 percent.

From the 9.3 million hectares surface area of Hungary 5.3 million hectares are agricultural land area (in the European Union it is only in Denmark that this proportion is higher), forest area is close to 2 million hectares.

[1] E-mail: eva.laczka@ksh.hu.

The greatest share in crop production is the output of cereal crops, in 2014 it represented 68 percent of sown area. In the composition of animal husbandry the proportion of poultry stock (39 million heads) is higher than cattle stock (802 thousand heads) or pig stock (3.1 million heads).

In the period of the Agricultural Census 2010 8.6 thousand enterprises and 567 thousand private holdings performed agricultural activity. 54 percent of the enterprises was exclusively engaged in crop production, 6 percent in animal husbandry only, while the proportion of enterprises with mixed activity amounted to 40 percent. The proportion of the different types of activities performed by private holdings differed to some extent. In 2010 nearly half (49 percent) of private holdings dealt exclusively with crop production, 22 percent with livestock production and 29 percent with both activities (KSH, 2011).

The surveys have been observing for more than ten years the purpose of the production of private holdings as well. According to census data in 2010 60 per cent of private holdings produced exclusively for own consumption (which corresponded to the data of the previous full scope census). There has been a change in the proportion of private holdings producing specifically for the market, it increased from 8 percent to 20 percent between 2000 and 2010. The remaining private holdings sold the surplus remaining after own consumption (KSH, 2011).

In 2014 labour input amounted to full time work (1 800 hours/year) of 445 thousand persons. Three quarter of the total labour input is not salaried labour input (which corresponds basically to mainly part-time agricultural activity performed in private holdings). The proportion of the persons employed in national economy (working for the majority 8 hours a day) in the branches of agriculture, game farming, forestry and fishery represented 4.6 percent of total employment.

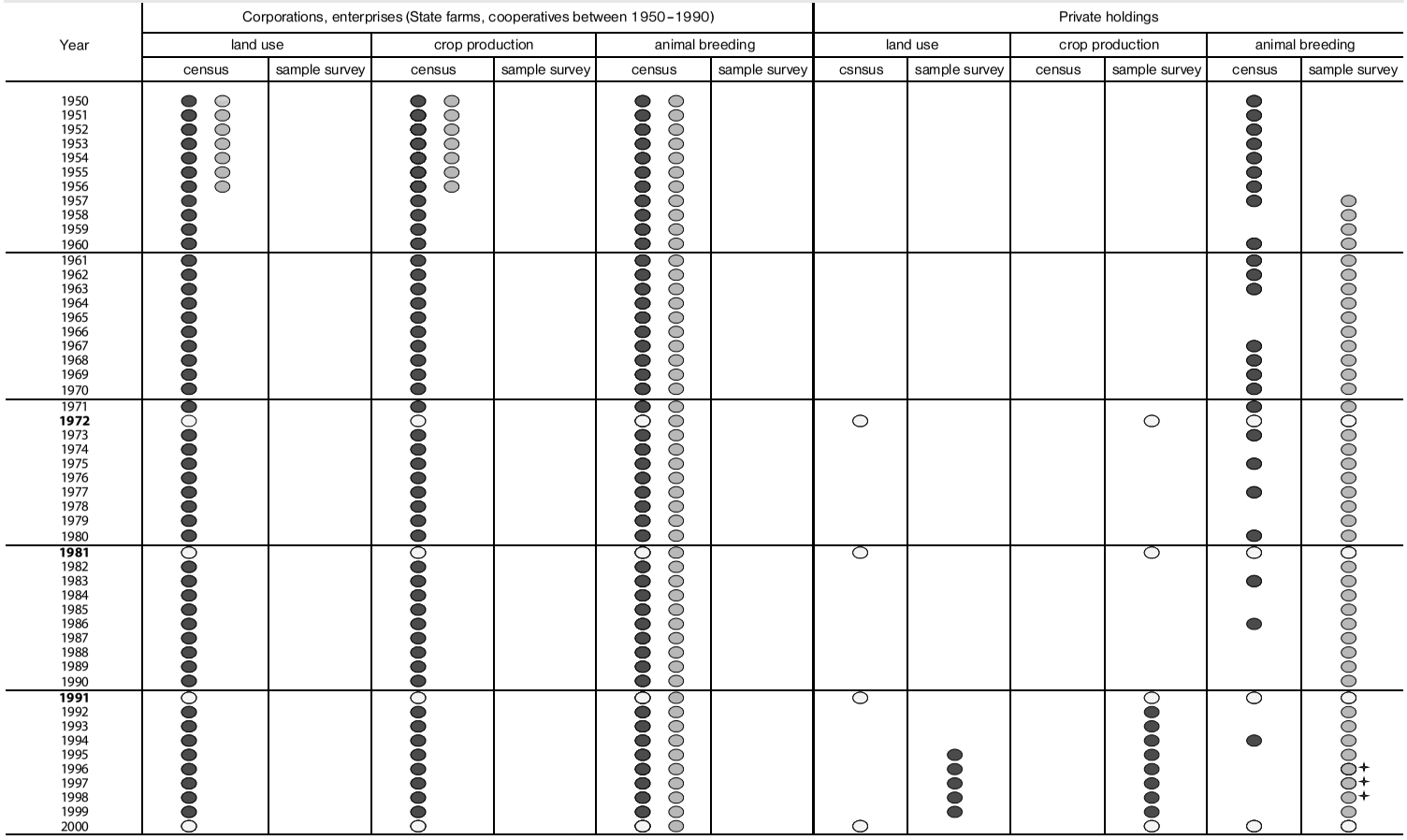
The distribution according to the legal forms of farming of agricultural product output provides also important information on the structure and efficiency of Hungarian agriculture. This is especially the case when the proportion of the output is presented for different legal forms of farming, size categories and private holdings according to the purpose of the farming.

Figure 1 Share of agricultural gross output by type of organizations, 2012

<table>
<tr><th>Corporations, enterprises (49.9%)</th><th>Private holdings (50.1%)</th></tr>
<tr><td>Agriculture, forestry and fishing
under 5 employees
5.4%</td><td rowspan="2">Producing for own consumption
8.0%</td></tr>
<tr><td rowspan="2">Agriculture, forestry and fishing
over 5 employees
39.8%</td></tr>
<tr><td>Marketing surplus over own consumption
9.5%</td></tr>
<tr><td>Other Industries than agriculture, forestry
and fishing producing agricultural products
4.6%</td><td>Market oriented private holdings
32.6%</td></tr>
</table>

Source: Laczka (*Gazdálkodás Journal*, 2014)

Table 1 System of agricultural atatistics (1950–2000)



Source: Laczka, É. *Statistical and economic interpretation of the farm concept* (PhD Dissertation)

Hungarian agricultural statistics in brief

Hungarian agricultural statistics can pride itself on the longest and richest history in the independent Hungarian statistics. The Hungarian statistical service was founded in 1867, year when the predecessor of the current statistical office was set up under the leadership of Károly Keleti, the first president of the national statistical office. The newly founded statistical office considered as priority tasks the development of the Hungarian system of agricultural statistics and demographic statistics. The contribution of the Office to the international statistical work is illustrated by the fact that the European methodology of vineyard and wine statistics was elaborated with the guidance of Károly Keleti serving as the basis for the vineyard and wine census conducted by the Hungarian Statistical Office in 1872. The publication analysing the results of the census is still available to the readers in the Library of the Hungarian Central Statistical Office (HCSO).

The Hungarian statistical office has carried out until now 7 agricultural censuses and nearly as many vineyard and orchard surveys. Since the turn of the Millennium, besides the regular decennial agricultural censuses farm structure surveys compulsory in the European Union are carried out every two or three years on big samples.

It was in the second half of the 19th century that Hungarian agricultural statistics were transformed from descriptive statistics – mainly based on tax and other state registers – into a system of statistical surveys based on methodologies elaborated by the statistical office. The elaboration of macro statistics (national accounts) started as well in the first half of the 20th century. The creation of the territorial network of the statistical office was a milestone in the life of Hungarian statistics – including agricultural statistics. The 19 county directorates of the statistical office were created in 1952 with the task of implementing data collections and primary data processing. Beyond creating the conditions of statistical data collections, our predecessors strived to ensure that data collections reflect properly the changes in the economy, society and policy, and provide proper information on agriculture for users.

The above mentioned activities are illustrated in Table 1 which presents the censuses, the regular annual and periodical surveys and their changes in the period between 1950–2000. The table is a good illustration of how after the fifties, sixties – when in Hungary land use was prohibited for households (private persons) – the conditions resulting from the gradual removal of limitations were mirrored by agricultural statistics. The regular full scope and representative surveys covered at the turn of the Millennium the observation of agricultural activities performed by households.

1 INNOVATIONS MOTIVATED BY AGRICULTURAL STATISTICS

Beyond improving the coverage of agriculture, numerous initiatives of Hungarian agricultural statistics have later influenced the whole Hungarian statistical system. I would like to highlight the following examples:

- the first representative survey was conducted in agricultural statistics,
- the notion of "small scale production" was introduced in Hungarian agricultural economics on the basis of the publication analysing the results of the Agricultural Census of 1972,
- it was in the field of agricultural statistics that the first division of labour was elaborated – between the Statistical Office and the Ministry of Agriculture,
- the methodology of the quick publication of preliminary data was developed for the Agricultural Census 2000,
- the idea of "spot-maps" emerged during the preparation of the vine and orchard survey of 2001,
- the first dataset with geo-coordinates was prepared with the data of the vine and orchard survey of 2001,
- the first electronic data processing system – governed by statisticians . was introduced in the field of agricultural statistics,

- the vine plantation survey of 2009 was the first survey where three quarter of the data came from administrative sources reducing considerably respondents' burden,
- last but not least, I would like to present the new tools used for the communication of agricultural data.

The above mentioned developments influence directly or indirectly Hungarian statistics even nowadays, their results are integrated in the statistical system.

1.1 The first representative surveys

In Hungary experts considered for a long time the relative proportion of the two main branches (livestock and crop production) as the indicator of agricultural development. In the seventies the proportion of animal husbandry reached the level of crop production, and surpassed it in the nineties. Unfortunately as a result of the economic and social processes after the turn of the Millennium this balance was disturbed. The need to have information on livestock appeared already at the beginning of the 19th century but the current practice of animal counting, different for agricultural enterprises and private holdings was created in 1949. While state farms and cooperatives reported the number of livestock quarterly, in the fifties the Office developed for the first time a system of representative surveys to cover the livestock of the population. The statistical office has been continuously developing the methodology of quarterly representative surveys.

- In the fifties and sixties complete villages were integrated into the sample which was determined with the help of grids placed on maps. The sample size was 30 percent.
- In the seventies the areas of the sample were selected on the basis of the intensity of pig farming (the most important animal species), which allowed to reduce the sample size to 10 percent.
- Since 1995 the selection of the sample areas has been done according to the size of the holding, on the basis of the data from the districts the estimation was done at the beginning with ratio estimation, and later with the spreading of computers with regression estimation. This made possible to reduce sample size to 4–5 percent.

Nowadays according to the requirements of the European Union quarterly livestock counting is not implemented any more, data on livestock are collected in the framework of the representative agricultural surveys carried out in June and December, using the previous methodological experiences as well.

1.2 The notion of small scale production

In the sixties detailed and accurate statistical information was available on big farms. State farms and agricultural cooperatives represented only two third of agricultural production. – The badly organized supply and low salaries – gave rise to small scale backyard farming in the villages, a well delimited division of labour was formed between the two sectors. In order to have a clear picture of the situation the need of a comprehensive agricultural census emerged. As domestic needs were coupled with the strengthening need to follow FAO international recommendations Hungary announced in 1970 that the country would join the agricultural world census round. The agricultural census was carried out in 1972 with the aim of satisfying as far as possible information needs. As statistics on state farms and agricultural cooperatives were satisfactory in most fields, the emphasis was put on the surveying of the agricultural activity of households. Statisticians decided to survey private holdings with a full scope survey and eight representative surveys based on it. Data were collected on many aspects of agriculture previously not known. The census revealed that nearly half of the population participated in some form in agricultural production and consumed the agricultural products produced by the households. Social stratification showed also that "small scale" agricultural production was not only the prerogative of peasants, but was performed to a considerable extent by all the social categories. The data of the census contributed to a notable extent to transforming the policy previously applied in relation to small-scale agricultural production. This notion firstly used by statisticians became part of the specialized literature.

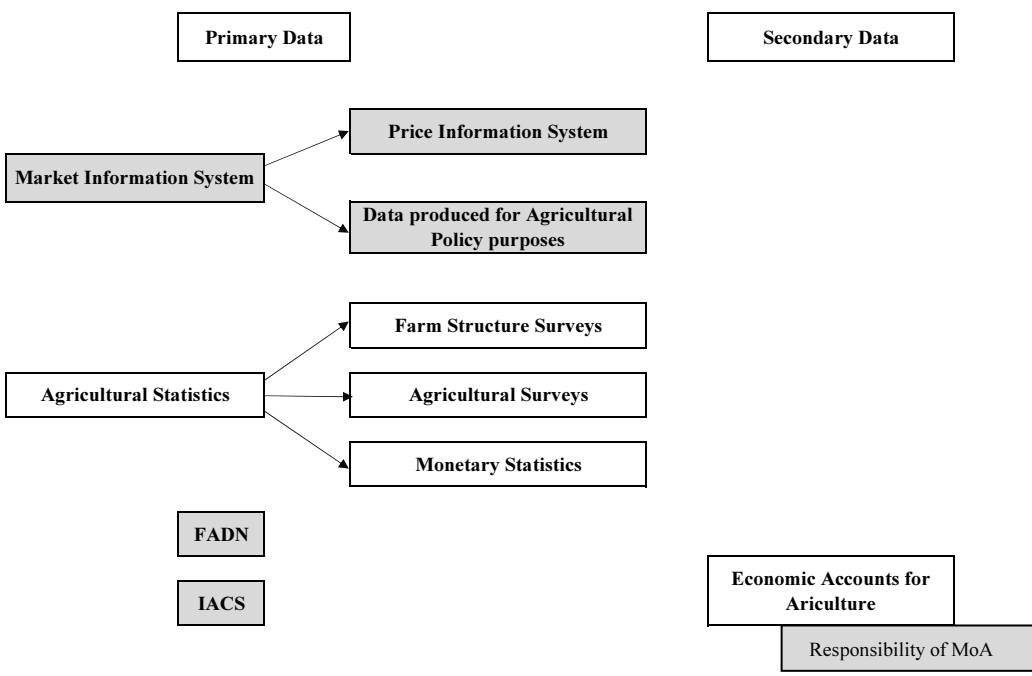
1.3 Division of labour between the Statistical Office and the Ministry of Agriculture

In Hungary the compilation of agricultural statistics has traditionally been the common task of the statistical office and the Ministry of Agriculture, and this applies for today as well. The basic concept of the division of labour was already at the beginning that estimations were the task of the Ministry of Agriculture, while the statistical office was in charge of data collection serving the "statistical measurements of facts".

The reconsideration of the division of labour became even more important before the accession to the European Union (at the end of the nineties and during the first years of the turn of the Millennium). One of the most important task was to assess the degree of harmonisation of agricultural statistics at that time, to see to which extent the practice followed by the country was in line with the legal requirements of the European Union. The first screening, assessment took place in 1999. At the time of the screening one third of Hungarian agricultural statistics was conform with the requirements of the European Union, and one third needed minor or major corrections with a view to harmonisation. The screening revealed completely new tasks to be implemented by Hungarian agricultural statistics, like the introduction of the system of Economic Accounts for Agriculture, the implementation of plantation surveys and several previously not covered statistical fields.

In order to establish a clear division of labour we have redefined the tasks being the exclusive competence of the statistical office (for example census implementation,) and the tasks being entirely the responsibility of the Ministry of Agriculture (for example forestry statistics). We have also identified common tasks (like the compilation of the Economic Accounts for Agriculture) with a clear and detailed distinction and indication of the indicators that had to be compiled by each institution. The division of labour determined at the turn of the Millennium is still valid nowadays, as shown in the Figure 2.

Figure 2 Division of labour between the HCSO and Ministry of Agriculture



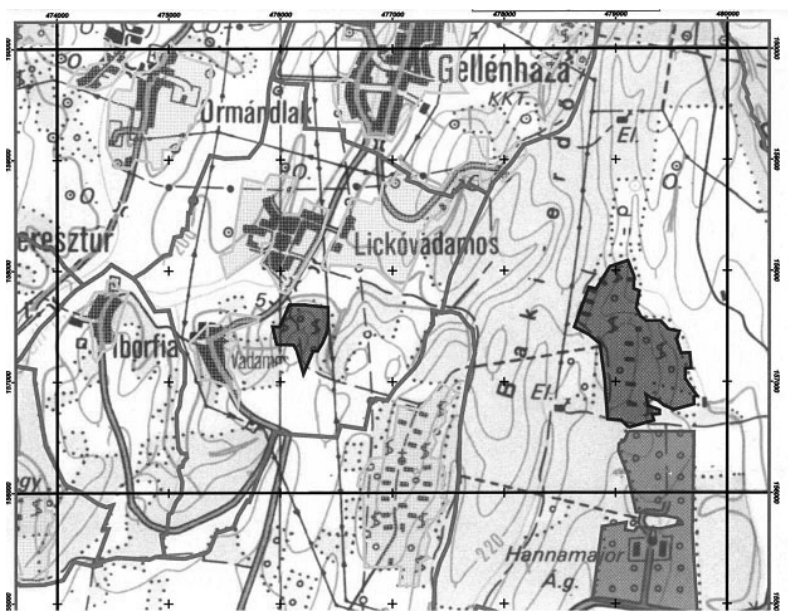
Source: Own construction

1.4 Publication of preliminary census data within six months after the census

The sixth full scope Agricultural Census was implemented at the turn of the Millennium (in 2000). The conduct of the census was necessary because the conditions of agricultural production were most deeply affected by the change of the political system. There had been a radical change of ownership in agriculture, the focus of the production shifted from the big agricultural enterprises to the private holdings. The conduct of the census was also urged by the accession to the European Union, a stocktaking of the situation in agriculture before accession was a necessity. The census was composed of a full scope census of all the units performing agricultural activity and of representative surveys implemented for the units selected from the whole population surveyed. The reference period of the full scope census was the 31st of March 2000.

Due to the changes that had taken place and the accession of Hungary to the European Union, decision makers, analysts, professional organisations were eager to know the results of the census. The door-to-door interviews of the 2 million respondents, the filling in of the questionnaire lasted only two weeks, but data entry, editing and processing was a huge task for statisticians. As the expectations were great, it would not have been a good solution to publish only a few important data among preliminary data, but it would not have been acceptable either to publish the data in a year's time only. These considerations gave rise to the idea to select – randomly – from the questionnaires completed in the first two weeks of April 2000 a 1 percent sample. After quality control these questionnaires were entered and processed by statisticians out of turn. The publication presenting and analysing the preliminary data of the census included all the important indicators of the questionnaire at country level. Preliminary data of the census were published within six months after census taking. The "idea" born in the case of the agricultural census 2000 is still applied, Hungarian statisticians used it for example for the publication of the preliminary data of the Hungarian population census of 2011.

Map 1 Spot-Map (Zala country), 2001



Dark grey spots = vineyard area **Grey spots** = orchard area **Light grey spots** = mixed area

Source: HCSO, Vineyard and Orchard Census 2001 documentation

1.5 Spot maps

Due to its climate conditions, in Hungary vineyards and orchard plantations represent a higher proportion of agricultural area than the average of the EU Member States. In Hungary the first vineyard census was carried out in 1872 and the first orchard census in 1895. After the plantation censuses of the 19th century, vineyard and orchard censuses were conducted in 1935 only and later in the fifties and sixties.

Due to the importance of the sector in the Hungarian agriculture, the greatest challenge before EU accession was the implementation of the full-scope vineyard and orchard census (that was conducted in 2001). The greatest problem originated from the fact that the census population could not be defined neither from administrative nor from reliable statistical sources. The solution was to design the so-called "spot maps". This meant that with the use of remote sensing data the place of vineyard and orchard (and mixed) plantations could be marked on topographical maps. Spot maps were excellent tools both for organising enumeration and validating the data collected.

1.6 The first database with geo-coordinates

The form of the published data is also an important part of communication. Information and data concerning farms are expected nowadays to be published with geo-coordinates. For Hungary the first database with geo-coordinates was created for the data of the vineyard and orchard censuses of 2001. This had been supported by the use of spot maps and the enumeration by parcels. In the case of the member states of the European Union, databases with geo- coordinates can be produced for the Farm Structure Surveys (FSS), which is also a requirement of the current FSS regulations.

Picture 1 Vineyar parcell data (Mór, Fejér county) presented in the geo-coordineted database (2001)

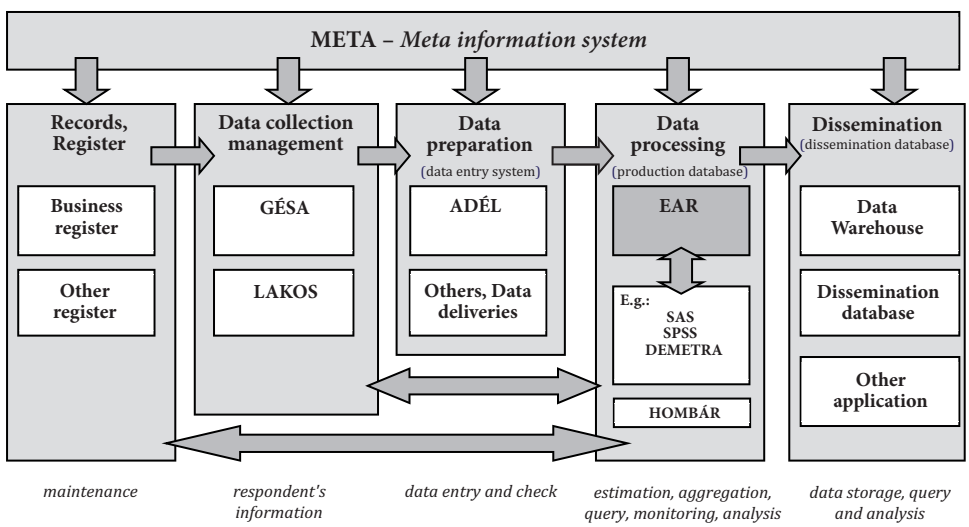
Source: HCSO, Vineyard and Orchard Census 2001 Database

1.7 The Unified Data Processing System (HOMBÁR/EAR)

After the turn of the Millennium Hungarian statisticians dealing with agricultural statistics applied successfully for an EU-tender aimed at developing agricultural statistics. The resources of the project

made possible to review the data processing tasks of agricultural statistics. The renewal of data processing was justified by the fact that the traditional data processing system was relatively slow, it was not adequate for the efficient implementation of quality control, it was not sufficiently well-documented, and last but not least it required important human resources. Agricultural statisticians and IT developers developed a special, new data processing system that was called HOMBÁR (meaning granary). The concept of HOMBÁR is quite similar to the LEGO game; agricultural statisticians and IT experts created LEGO bricks (statistical operations) of different forms that were programmed by the IT experts. Using a comparison, the system functions in such a way that statisticians chose or assemble LEGO bricks according to their purpose of building a horse or a tractor. This means that if the statistical process changes, statisticians reorder the LEGO bricks (as the system can react to the changes in a flexible manner). In this way data processing is led and managed by statisticians, the task of the IT team is "just" to secure the IT operation of the system and produce the new LEGO bricks (statistical operations). The development lasted 3 years and further 2 years were needed before the processing of agricultural survey data with the new system became a routine for statisticians. The use of the HOMBÁR system made possible to reduce by half the time of data processing and by 30–40 per cent the human resource needs. The HOMBÁR provided a proper documentation, relation with the databases, and integrated more efficient quality controls. At that time agricultural statisticians thought that the HOMBÁR was not suitable to process account type of data, like the Economic Accounts for Agriculture. On the basis of the experiences of HOMBÁR, the Hungarian Central Statistical Office decided in 2008 to extend the system to the whole statistical production of the office. As the whole statistical system is broader than agricultural statistics, and is in a certain sense more complex, further development was needed. The new, extended system was called the Standardized Data Processing System (EAR). The development work accelerated at the beginning of 2013, and the routine operation of the system in the whole statistical office is expected by the end 2015. Another tender supported the office in introducing the processing of national accounts data in the EAR system for which the EAR was complemented by a supplementary "control system". Nowadays the processing of the production accounts of national accounts is done with this system. The purpose of the paper is to present the concept, the functioning and the advantages of the new data processing systems.

Figure 3 EAR in the statistical data production process



Source: NTTS 2015 Conference presentation

1.8 Use of administrative data sources, the first administrative data based Vineyard census

In relation to agricultural censuses, the use of administrative data sources for statistical purposes has always been a key issue. At the beginning its most important function was to determine the survey population of the surveys and support the organisation of the data collections. During the past decades, administrative data sources acquired a growing importance in the validation of the collected data, which is valid still nowadays. In the past years the need to reduce respondent burden became a central issue, and as a consequence subject groups of the census questionnaires were increasingly replaced by administrative data. The greatest change was the vineyard census in 2009 when two third of the census data was based on administrative data sources (only one complementary sample was needed). The vineyard census of 2015 will be based in its entirety on administrative data sources.

In broader terms – despite its importance – the use of administrative data is not yet unhampered even nowadays. The legal obstacles of the use of administrative data sources need to be removed. There are still several examples when the legal acts regulating certain registers do not allow the use of administrative data for statistical purposes. The definitions, concepts used by administrative registers differ frequently from those used in statistics which is a source of further problems (the implementation of the 2009 and 2015 vineyard censuses are good examples of how to solve it).

The developments linked to Big Data can open new possibilities in the case of agricultural statistics as well. In this respect developments are only starting even if Hungarian agricultural statistics have been using remote sensing data for already 20 years now for the most important early crop production data.

1.9 Communication tools applied in Agricultural Statistics

As in other statistical areas, the publication and dissemination of agricultural data is also a great challenge. Furthermore data must be published in a different "style" according to the targeted audience: respondents, experts, decision makers and the general public.

One of our most popular communication tool for respondents was the so-called "Calendar" of agricultural statistics. Relying on Hungarian traditions we had prepared a special calendar that beyond serving as a normal calendar presented the monthly agricultural surveys to be carried out with the details of their implementation. It also contained useful information for farming, crosswords, but also recipes.

Without being exhaustive, I would like to mention only some examples. The plantation database with geo-coordinates previously mentioned served to inform experts.

Thanks to the technical development that has taken place since that time we have now at our disposal very useful visualisation tools as well. Examples of these tools can be found on the homepage of the HCSO. I would highlight two examples. One is the "Agricultural radar", the interactive radar chart presenting for the period 2000–2012 the annual volume changes for the main product groups from the production account of the Economic Accounts for Agriculture (*www.ksh.hu*).

The other example is the interactive tool "Macroeconomic processes in agriculture" which presents for the period 2000–2013 the annual changes in the macroeconomic processes of agriculture with the main indicators of the EAA (output of crop products, output of livestock and animal products, total agricultural output, intermediate consumption, gross value added, income of production factors, entrepreneurial income) (*www.ksh.hu*).

In Hungary the use of map applications has also its traditions in agricultural statistics. Despite this fact the "Agricultural Atlas" can be considered as a new result. More than 100 cartograms illustrate with visual tools the results of the last two agricultural censuses and the changes between the two periods.

Last but not least, the broad dissemination of census data enhances statistical culture, improves the knowledge and responsiveness of respondents. Good examples are the two events that we organized after the last Agricultural Census in one of the open-air (village) museums of Hungary. We tried to make attractive to the visitors of the museum the world of numbers by showing them old books on the history

of agriculture, colourful statistical publications and graphs, the statistical quizzes organized allowed also an interactive exchange between statisticians and visitors.

CONCLUSION

We could ask why agricultural statistics can be an ideal basis and starting point of developments. I think that several factors lie behind the reasons. Agricultural statistics are in the different countries – almost without exception – the statistical field with the richest traditions and the longest history. This could happen because already during the years of the birth of statistics people wanted to know how many persons were living in their country and which were the sources of food supply for the population. The more developed countries in Europe had implemented already in the second half of the 19th century the first agricultural censuses and population censuses. Based on the censuses (providing the statistical population) it was possible to elaborate the system of the regular (annual and infra-annual) data collections, and later of the representative surveys. At the beginning of the 20th century, after the setting up of national accounts (macro-statistics) – built on the results of micro-statistics – the compilation of agricultural macro-data was required. In the case of Hungarian statistics, EU accession (2004) gave a new impetus to the development of agricultural statistics. The European Union required among others the compilation of the satellite account of agriculture (Economic Accounts for Agriculture). This means that agricultural statistics are "mapping" the statistical systems, starting from micro statistics to a system of macro statistics, they form a complex system. The complexity of the system, the systems approach require increased efficiency in the field of quality criteria, technical development which is considerably facilitated by the IT explosion of the past years. The huge databases resulting from the complex systems entailed the elaboration of new solutions in communication, which relied also the excellent possibilities provided by technical development.

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