



# Official statistics in the era of big data opportunities and threats

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## Abstract

In recent years, the quantity of digital data created, stored and processed in the world has grown exponentially. The demand for statistical information has never been so apparent. For ‘official statistics’, the public informational infrastructure provided by statistical authorities, this new era offers not only essential opportunities but also manifold threats. In order for official statistics to function as a language for all kinds of societal interactions and decision-making, it is essential that the product ‘information’ is fit for purpose. This is an essential shift in perspective. Quality of official statistics needs to be seen with a much wider scope, going beyond the side of production, including the use side and analysing scientifically how these two sides are interacting in a dynamic relationship.

**Keywords** Co-production of statistics and society · Quality of statistical information · Ethical standards · Data literacy

## 1 Statistics and modernity

Essentially, statistics is the science of learning from data. Certainly, it is a modern technology that is part of the standards of today’s information age and society and is used in a wide array of fields. ‘Official statistics’ is one of these domains of practical applications of the ‘quantification as a social technology’ [1] belonging to those with the longest history. Since the beginning of the nineteenth century [2], official statistics—as a child of the enlightenment—has grown and developed side by side with the different forms of the (modern) state. Desrosières uses the term ‘mutual co-construction’ for three interlinked phenomena, (A) a theory of the state (economy), (B) interventions of the state (policies) and (C) quantification of ‘variables’ specifically targeted by policy measures (statistics) [3]. Basically, official statistics can be defined by using three questions [4]:

- Who? Normally, official statistics are produced and provided by statistical offices, i.e. public administrations
- What? Statistical programme and priorities are prepared according to public sector standards (i.e. participation of civil society) with the final decisions partly taken in legislative procedures

- How? Statistical methodologies are nowadays subject of international cooperation and manifested in statistical standards; high-level quality is assured through management systems and ethical codes.

The relationship between official statistics as a technology and the society has been analysed by a relatively small community of historically interested scholars working in the intersection of statistics, sociology, political and historical sciences. Standard literature such as ‘The Politics of Large Numbers—A History of Statistical Reasoning’ [5], ‘Trust in Numbers: The Pursuit of Objectivity in Science and Public Life’ [1] or ‘The Mutual Construction of Statistics and Society’ [6] provides for a profound understanding of this two-way dynamic interaction between official statistics on the one hand and societies, politics and economies on the other. This literature deals with the complexity of relationships, by highlighting the role of official statistics throughout historical episodes of the last two centuries in a couple of countries (France, England, Germany, USA, etc.); for other countries (e.g. Italy) corresponding literature exists [7,8]. ‘X-Complexities’ is the term that is used by Longbing Cao, when he introduces his definition of data science: ‘data science = { statistics  $\cap$  informatics  $\cap$  computing  $\cap$  communication  $\cap$  sociology  $\cap$  management ? data  $\cap$  domain  $\cap$  thinking }’ [9].

This article will deal mainly with the ‘soft’ (non-technical) components in this multidimensional space, namely with

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‘sociology’, ‘management’ and ‘communication’, focussing on official statistics organised as a respected and reliable institution in the public sector and service of the state, will say the ‘macro’ level of politics and the entire society. It should be seen as complementary to the more technically oriented discussions on ‘Informatics’, ‘Statistics’ and ‘Computing’, which have become one of the main themes for nowadays’ conferences, for example the Conference of the Italian Statistical Society 2017 [10]. In any case, fights between technical and non-technical schools of thought must be avoided. As history has shown, progress is blocked [11], when the triangle of driving forces (science, statistics, society) is not seen as ‘An Eternal Golden Braid’ [12].

In order for official statistics to function as a language, a ‘boundary object’ [13] for all kinds of societal interactions and decision-making, it is essential that the quality of statistical products and services is outstanding, an authority in itself. For Porter ‘the language of quantification may be even more important than English in the European campaign to create a unified business and administrative environment’ [1]. This is the landmark and the competitive advantage of official statistics. Once this authority is undermined, be it through real quality problems or only through perception, trust in official statistics will be replaced by suspicion and statistics will become part of political fights and games.

Against this background, it is important to define quality of statistics with a much wider scope, including not only the production but also the use side of statistical information and how these two sides are interacting in a dynamic relationship.

The era of the data revolution has started, significantly changing the picture on both sides. On the one hand, the availability of enormous amounts of data gives the statistical business a completely new push into a direction that is not yet sufficiently understood, although there is growing awareness for the synergies and potentials of close cooperation between statistics and other disciplines of data science [9,14].

On the other hand, the demand in terms of ‘evidence-based decision-making’, (new public) management and other applications of a neoliberal governance model [15] creates a forceful driving force on the pull side. The ‘Internet of Things (IoT) [16], Artificial Intelligence (A.I.) and the growing importance of algorithms are posing new questions in areas other than technological ones: ‘Society must grapple with the ways in which algorithms are being used in government and industry so that adequate mechanisms for accountability are built into these systems. There is much research still to be done to understand the appropriate dimensions and modalities for algorithmic transparency, how to enable interactive modelling, how journalism should evolve and how to make machine learning and software engineering sensitive to, and effective in, addressing these issues’. [17]

While uncertainties and risks are constantly growing in the eyes of citizens and while the impacts of globalisation

become more and more visible, it appears as if people have had enough of experts [18] and as if ‘post-truth-politics’ would gain credibility and support, opening opportunities for populist and nationalist activists of all kind. In this context, a profound epistemological shift is needed since complexity and irreversibility undermine the idea that science can provide single, objective and exhaustive answers [19]. In the late modernity of risk societies [20], there is the epistemic and methodological necessity to empower people—citizens and policy makers—with the appropriate insight in order to enable them to make the best possible decisions for achieving sustainability and pursuing resilience in a complex world: ‘The tools for thought of the enlightenment no longer suffice for mastering the challenges of the present. The course European societies are taking can be compared to the exploration journeys of bygone days. Maps, which ought to provide orientation and security, seem to have lost their value. We are journeying into the uncertain and have yet to discover new paths and routes in many areas’. [21]

The challenges facing official statistics are typically related to general difficulties with statistical thinking [22] or with the interpretation of statistical aggregates, such as Quetelet’s ‘average man’ [23]. In addition to these cognitive issues, there are other important aspects, which relate to the particular role, mandate and institutional setting of official statistics in (democratic) societies. ‘Variables’ of official statistics have to be developed, designed and standardised in such a way that they can serve manifold purposes [24,25]. ‘Choices as to defining and carrying out concrete ‘measurement’ of such indicators are, however, not only a technical question but concern the whole political context in which they take place’. [26] In this sense, one can find analogies to the legal system of a society [27], as methods and definitions are highly standardised and regularly revised (often at international level), following new inputs from data, science or changes concerning the phenomena that are observed. [28]

It seems to be necessary and urgent to launch a (scientific) debate and reflection in the professional communities and to foster research on the role of official statistics for the society (and vice versa), making use of scientific concepts, such as ‘co-production’ [29] or ‘gouvernementalité’ [30]. Science, research and development contribute essentially to the quality of measurements and their results, be they based on statistical survey methodologies or driven by data science concepts. Apparently, this relates in the first place to the relevant technical disciplines [31]. But this should be supplemented by going beyond pure methodologies, by taking on board aspects from other disciplines, such as sociology, historical or legal sciences. There are many different strands of science contributing research on processes of quantification and the impact of quantification within social contexts [32]. Those scientific inputs should address questions and issues such as:

- History of official statistics, phases and episodes with a potential to explain the interaction between knowledge generation and society; the making of states; statistics under authoritarian, liberal and neoliberal regimes
- Official statistics as part of a knowledge base for life
- Historical, cultural and governance systems of the countries; differences between the statistical authorities and their performance over the globe and in Europe; international/supranational governance in statistics
- Creation of knowledge; measurement in science and practice; limits of measurement; facts and (science) fiction; statistics and theories, such as economic theory; epistemology, falsification (or verification) of theories
- Use, misuse, abuse of evidence; the power of knowledge and how to share it; relationship to conceptual frames in politics
- Public value in the context of public administration; participation of citizens via effective and efficient mechanisms
- (new) Enlightenment, knowledge for the empowerment of citizens, (statistical) literacy, education, participation in decision-making, fostering the democratic process
- Communication of data, metadata and quality for users with unequal pre-knowledge and (statistical) literacy
- Quality of information, institutions, products and processes; how to come to conventions about methodologies and programs of work; quality assurance
- Professional ethics (for individuals) and good governance (for institutions)
- Professional profiles: survey methodologist, data scientist, accountant, data architect, social science engineer, etc.

## 2 Statistics count

‘The need for official statistics has never been so apparent’ [33]. Data requests cover a wide range of aspects of society, including relatively new fields such as well-being and climate change. The last financial and economic crisis led to stronger economic governance of the European Union and highlighted the need for reliable, trustworthy statistics in order to make this new governance successful.

In this context, official statistics should be able to fulfil the requirement of scientific quality and excellence. European statistics, as produced by Eurostat with its partners at national level, are independent and based on common measures, standards, methodologies and technologies established in accordance with a high professional code of ethics. That is mainly what differentiates official statistics from the other data available online today. Far from the “fast-food” logic of providing ever more data with no concern for quality, European statistics are the equivalent of haute cuisine. They are

high in quality, reliable and comparable. Just as haute cuisine must incessantly reinvent itself in order to stay at the forefront of gastronomy, official statistics is also confronted with a rapidly changing context and needs. They are currently facing an impressive number of challenges: the ‘data revolution’ and the emergence of ‘big data’, the race for efficiency which requires us to do ever better with ever fewer resources, the need to measure new and complex phenomena, such as sustainability, not to mention the increasingly pressing calls for more factual, evidence-based policies.

### 2.1 Compass and magnet

Official statistics thus have a fundamental role to play in modern societies, guiding public policies, supporting business decisions and allowing citizens to assess the progress achieved and compare themselves with their neighbours. Official statistics count more and more: by giving insight in the development of economic, societal or environmental issues over time and space, statistics help us to assess the world we live in and to react adequately to changes and challenges. Official statistics have thus become a key element in the liberal form of governing (‘governmentality’) that was dear to Michel Foucault [30,34]. However, the wonderful power of statistical knowledge also has dangers [35] From a cognitive instrument which is emancipating and participative, it can turn into a veritable technocratic tyrant which is, to varying degrees, hidden behind management doctrines (‘evidence-based decision-making’), mainstream thinking or ideologies [36–38]. Official statistics are and must remain a way to impart knowledge about our societies, an instrument of rationality, a tool to enhance decision-making and effectiveness. They must inspire confidence, not suspicion. They must convince, not pressurise. They must aid, not enslave. They must emancipate, not subjugate. They must reveal, not mislead.

Official statistics are a marker, a reference point for what we are and where we come from, a compass allowing us to observe, assess and find our bearings. In this sense, official statistics must be considered only as proof, evidence or an indication, and never as an end in themselves, a decision in essence or an automatic law (decisions to be augmented, not automated). They must clarify and facilitate choice, rather than impose the approach to be taken. They are a policy element, not a policy in themselves [39]. They must rationalise debate rather than instrumentalise it. Yet the temptation is strong and the attraction almost magnetic. Therefore, so as not to lose our bearings, the statistical compass must not be the preserve of technicians [40]. Statisticians must engage with the public and cooperate even more intensively and regularly with the various users and stakeholders, whether they are public or private decision-makers, journalists, researchers or citizens. The aim is to better understand their needs (as

users of statistics) and their constraints (as sources of statistics) in order to offer them appropriate information—what they need to know and what it is good to understand—in a suitable manner. To do this, official statistics must both adopt a new pedagogy and create a real data culture, becoming more flexible and reactive, to ensure that they are well received and understood, which requires the input of other disciplines, thus pointing again to the general role of science and the corresponding ongoing debate [41]

## 2.2 Map and territory

This necessary statistical pedagogy must strike a balance between disseminating intelligible messages as widely as possible and adhering strictly to precision, between excessive simplification and needless complexity, between vulgarisation and overly scientific methods and results. It must also clearly draw the boundaries between objective truths and subjective reality.

Just as the map is not the territory, so (official) statistics will never be as accurate and complete as the reality they represent. There will always be more or less significant differences, omissions, generalisations and distortions between statistics (the map) and the field in question (the territory). Indeed, statistics are only a partial representation at a given moment in time of a reality which is not static, but in constant motion and of a complexity which is impossible to portray precisely and exhaustively [42]. The danger would then be to become a consenting victim of the ‘street light syndrome’, where the lack of wide-angle lighting on ongoing developments might prevent us from paying attention to them, resulting in the risk that we may discover their importance too late.

It is therefore necessary today to start examining phenomena from various, wider angles. Official statistics has been doing this for several years already, particularly as regards the measurement of economic and social progress [43,44]. It cannot limit itself only to the angle of Gross Domestic Product (GDP). It must go beyond the essential GDP data and draw in particular on environmental and social indicators, in terms of quality of life and well-being.

Consequently, the ‘software’ behind statistical work needs to be tailored to a changing world and new needs.

## 2.3 Making a difference in an ocean of information

Whether or not we are aware of it, official statistics therefore play an increasingly important and decisive role. Decisions in modern democratic societies are supposed to be underpinned by a solid base of reliable, objective statistics. Decision-makers at EU level, in the Member States, in local authorities and in businesses need statistics in order to make decisions. More generally, all citizens need statistical results to inform

themselves, enabling them to draw their own conclusions and to participate in the political process. Independent, impartial, reliable and accessible statistics free of charge for everyone has thus become an essential feature of the knowledge base in a true democracy; they underpin the development of sound, fact-based policies; they help decision-makers to develop enlightened policies which affect millions of people; they allow us to make better decisions which ultimately improve everyone’s lives.

## 2.4 Zettabytes and yottabytes

In recent years, the quantity of digital data created, stored and processed in the world has grown exponentially. Every second, governments and public institutions, private businesses, associations and even citizens generate series of digital imprints which, given their size, are referred to as ‘Big Data’. The wealth of information is such that it has been necessary to invent new units of measurement, such as zettabytes or yottabytes, and sophisticated storage devices in order to deal with the constant flow of data. The world can now be considered as an immense source of data. Broad consensus reigns with regard to the wonderful opportunities which the ‘Big Data’ phenomenon can bring in relation to the statistics acquired from traditional sources such as surveys and administrative records. These opportunities which ‘Big Data’ could offer are: much faster and more frequent dissemination of data; responses of greater relevance to the specific requests of users since the gaps left by traditional statistical production are filled; refinement of existing measures, development of new indicators and the opening of new avenues for research; a substantial reduction in the burden on persons or businesses approached and a decrease in the non-response rate. Last but not least, access to ‘Big Data’ could considerably reduce the costs of statistical production, at a time of severe cutbacks in resources and expenditure. However, the ‘Big Data’ phenomenon also poses a certain number of challenges: These data are not the result of a statistical production process designed in accordance with standard practice. They do not fit the methodologies, classifications and definitions, and are therefore difficult to harmonise and convey in the existing statistical structures. Complex aggregates such as the GDP or the Consumer Price Index aim at measuring macroeconomic indicators [45] for the nation as a whole; their substitution by big data sources seems to be out of reach. In addition to this, ‘Big Data’ raise many major legal issues: security and confidentiality of data, respect for private life, data ownership, etc. All of the above means that, at least for now, ‘Big Data’ can be used only to a limited degree to supplement rather than replace sources of traditional data in certain statistical fields.

## 2.5 Facts and alternatives

‘It is so comfortable to be a minor. If I have a book that thinks for me, [...] then I have no need to exert myself.’ [46]. Immanuel Kant wrote this in 1784 in order to rouse his contemporaries into thinking for themselves. But what does the legacy of the enlightenment look like today? What is the contribution of statistics? Statistical history may well be rooted in our cultural, political and social backgrounds, but as these change—and become more international—how do the resulting tensions play out?

The Oxford Dictionaries and the Society for the German Language have both chosen ‘post-truth’ [47] (or in German ‘post-faktisch’ [48]) as Word of the Year 2016.

In recent years, as the European Union has expanded, there has been growing mistrust on the part of citizens towards institutions considered to be aloof, engaged in laying down rules perceived as insensitive to individual peoples, if not downright harmful. ... As a result, the great ideas which once inspired Europe seem to have lost their attraction, only to be replaced by the bureaucratic technicalities of its institutions. [49]

This short selection of quotes could easily be expanded by referring to the ongoing debate in the follow-up of the unexpected political disruptions in 2016. Information and facts are not neutral. Just as other manufactured products they open manifold possibilities, of ‘dual’ use and of risks, which must be anticipated by responsible information producers in their policies and production processes. One of the key questions that has again to be asked is related to the role that sciences have played in the past and in how far this role needs to be critically assessed and revised [19].

## 2.6 Ethics and governance

In the age of Big Data, Artificial Intelligence and Algorithms, a need for ethical guidance and legal frameworks is revitalised under new conditions: ‘In the world being opened up by data science and artificial intelligence, a version of the basic principle of the partnership between humans and technology still holds. Be guided by the technology, not ruled by it’. [50] What might facilitate the (perceived new) search for orientation and balance is the stock of ethical and governance principles that is available, emerging from two hundred years of history in official statistics.

Firstly, the community of statisticians has agreed on a Declaration of Professional Ethics, which ‘consists of a statement of Shared Professional Values and a set of Ethical Principles that derive from these values.’ [51] It is the individual professional statistician that is in the focus of the declaration, aiming at giving orientation and protection by setting professional standards.

Secondly, different Codes of Conduct have been developed for the statistical institutes and authorities. The most influential and politically important ones are the UN Fundamental Principles of Official Statistics [52] and the European Statistics Code of Practice [53]. The latter one is embedded in European legislation, such as the Treaties [54] (Art 338) and the European Statistics Regulation 223 [55]. The Code of Practice contains three groups of (in total) 15 principles, which address the Institutional Environment, the Statistical Process and the Statistical Output. A number of indicators is related to each of these principles, in order to allow for an internal assessment or external reviews (meanwhile conducted twice for all EU Member States). This will say that the European Code of Practice is not just a ‘bible’, rather a cornerstone of a Total Quality Management [56] approach in European Statistics [56]

## 3 Conclusions and guiding principles

The following guiding principles were presented in the Conference of European Statistical Stakeholders CESS 2016 in Budapest [57]

### 3.1 Statistics is a key for people empowerment

High-quality (official) statistics strengthen democracy by allowing citizen access to key information that enhances accountability. Access to solid statistics is a fundamental “right” that permits choices and decisions based on information. Without statistics, there cannot be a well-grounded, modern and participatory democracy.

Statisticians should be aware of the power of data which lies in their transformation capacity of information and as such contributing to a key aspect of knowledge.

### 3.2 Open data are fundamental for open societies

Official statistics are the cornerstone of public open data. They are the basis of open government. In the EU Open Data Portal, Eurostat statistical database accounts for the bulk of data offered. Enhancing access to statistics in open formats enables the free use of data, its interoperability and consumption in integrated modalities. Open statistics as a result allow to make sense of complex phenomena and help in their interpretation without borders and limits. As such open statistics are a key source of free dialogue in our societies.

Statisticians should ensure open and transparent access to data and metadata and measure their actual use for information and knowledge.

### 3.3 ‘Datacy’ is a key enabler for citizens

Statistical literacy is critical to ensure that individuals can benefit from the power of statistics and can make use of open access to statistical information and its associated services. Data literacy is not limited to knowledge of basic statistical information, it entails knowing the limits of statistics and their use/misuse. Capabilities to understand statistics and how they are produced are a fundamental skill for a whole individual and an aware citizen.

Statisticians should proactively invest in ‘datacy’ capabilities in society at large and measure the results of statistical literacy.

### 3.4 The future is smart statistics

The value of data for statistical services is in the statistical methods which ensure quality. In the digital ecosystem where data are abundant and a commodity, the value of information is increasingly based on algorithms that generate tailored insights for users [58].

Statisticians should continue to invest in methods and algorithms that enhance the quality of data for statistical services tailored to users’ needs.

### 3.5 More influence means more responsibilities

As statistical information is increasingly used for policy decisions, statisticians need to investigate how their services are used. They should also examine the ethical implications and the impact of evidence use on the policy cycle.

It is a duty of statisticians to explore the link between statistics, science and society and to lead intellectual reflections on the possible risk of reliance on data-centrism.

### Compliance with ethical standards

**Conflict of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest.

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