EXPERIMENTAL STATISTICS: A NEW COMMON LANGUAGE FOR UNCOMMON DATA

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Abstract. In recent years, the data deluge from unofficial sources has forced national statistical institutes in developed countries to think differently. Direct surveys are no longer able to satisfy the growing demand for data for very small territorial areas with rapid publication frequency. The use of administrative sources and social networks is producing new studies and analyses towards a new paradigm of official statistics. International research groups are already working hard to provide high quality data which, however, are not yet "mature" to become official statistics. The Italian case and other international cases represent a complete state of the art of experimental statistics.

1. Introduction

Official statistics is experimenting a deep change, a real revolution, which will entail modifications with regard to many aspects. The national statistical institutes (NSIs) of developed countries are no longer able to face a more and more increasing demand for timeliness data and information on very specific domains of analysis, for instance small territorial areas. Since traditional direct survey is often not sufficient to meet such demand for detailed information, in the last decades, many NSIs have been integrating data from direct surveys with information from administrative sources. This is often done by implementing “statistical registers”, that are microdata files whose records can be thought of as, at least approximately, representative of the population units. Although use of administrative sources may result in sensible improvement of the estimates because of the high target population coverage, it is often not able to meet the new information needs.

On the other hand, the advent and the massive use of social networks allow citizens to have huge amount of information usually not covered by administrative sources. Retrieving information from the new data sources is appealing but implies important issues to deal with: 1) people not used to comprehend statistical data may incur wrong interpretations; 2) data are not guaranteed to be representative of the phenomenon of interest and the ensuing analysis may be strongly biased.

These issues are often not sufficiently investigated by literature on big data and innovative data sources that mainly focuses on IT aspects (Daas et al., 2015). On the other hand, it is well known that, from the official statistics perspective, these aspects must be adequately considered and dealt with (Cheung, 2012; Daas et al., 2012a; Glasson et al., 2013; Groves, 2011).

In the recent years, NSIs are taking up these challenges, putting efforts to find up-to-date solutions. In this context, *experimental statistics* (ES) have been receiving increasing attention. They are based on using "non-conventional" data to meet new information needs in a timely way. Using non-traditional information sources and innovative tools implies the need to find a new "common language" and shared validation procedures to guarantee comparability among different institutions, in particular NSIs.

The word "experimental" refers not only to new analyses but also to new methodologies, data sources and tools that still need to be verified in terms of compliance with standard quality requirements and harmonisation rules. Despite of the experimental nature, their potential is very high. In fact, they fill in the information gaps in a timely way, serve as a driving force for developing new analyses and indicators, and ensure a valuable information support to policy makers (Carciotto, Signore, 2021).

Users play an essential role for ES evolution. In fact, their feedback allows to properly assess the product relevance and functionality. In fact, because of their experimental nature, not all the ES will shift towards official statistics. It is necessary to consider that an experimental statistic could not meet the requirement needed to become official in a structural way or in the long period. In this case, it should remain experimental, to go on with its "maturation" process through testing. Indeed, thanks to possible new data and further technological development in the future, this statistic may become an essential resource to define and model the multidimensional phenomena.

Essentially, the theme under investigation in this paper can be set as follows. ES are statistics that are in the testing phase and not yet fully developed. The experimental label is typically used where: i) the statistics remain subject to testing of quality, volatility and ability to meet user's needs; ii) new methods are being tested and are still subject to modification or further evaluation; iii) there is partial coverage (for example, of subgroups, regions or industries) at that stage of development; iv) there may be potential modification following user's feedback about their usefulness and credibility. ES are published to involve potential users and stakeholders at an early stage in assessing their quality and suitability. Users should be aware that such statistics potentially have a high degree of uncertainty. For this reason, when released, the limitations of experimental products have to be clearly explained in the methodological note. Moreover, when ES are alternative versions of existing official

statistics, users can become familiar with them and understand the potential benefits of new methods and approaches.

This paper is structured as follows: Section 2 illustrates the ES state of the art in the international context, Section 3 focuses on some experiences at Istat, the Italian NSI; Section 4 provides some general conclusions.

2. International context

In recent years, Eurostat is increasingly interested in developing ES as well as in fostering their production within the NSIs. In fact, on Eurostat website two specific sections are devoted to ES: one for those regularly produced by Eurostat itself, the other one for the ESS (European Statistical System) – Experimental Statistics Hub where links to the NSIs that produce ES can be found.

On its website, Eurostat defines ES as those that "*use new data sources and methods to better respond to our users' needs in a timely manner*". To confirm its interest in this area, in 2018 Eurostat organised an EMOS – European Master in Official Statistics named "Experimental statistics: new methods for new data" aimed, among others, at understanding benefits and risks related to the production of ES. More recently, Eurostat has launched some *grants* to finance ES development within the "Single Market Programme". The focus has been put on some specific sectors, such as the foreign trade and the use of AI (artificial intelligence) and ML (machine learning) tools for official statistics. The scope is to develop new statistics and indicators, or new methods and tools, to improve the analysis of the phenomenon under investigation.

From the ESS NSIs' point of view, there is no univocal definition for ES and no shared rules for producing and managing them. Moreover, not all the NSIs produce ES, as this is not mandatory. In some cases, ES are defined in terms of differences with official statistics. Specifically, while the latter is mainly based on "direct" measures (data from surveys, in some cases administrative data), ES are produced through "indirect" measures and carried out with innovative methods (multi-source statistical models, data integration tools, big data analysis, etc). An important aspect of official statistics is related to the "closeness" between what has to be measured and what is actually (directly) measured. This is particularly true when the information is extracted from accurately designed (possibly sample) surveys. On the other hand, data based on traditional statistical surveys as well as on administrative sources often do not ensure adequate timeliness and, in addiction, survey data can be affected by sampling and measurement errors.

Differently from official statistics, ES typically do not fit *a priori* statistical concepts and definitions "by design". Instead, they require more complex

elaboration and interpretation processes in order to be shifted to the current official statistics. Moreover, quality requirements have to be carefully checked before using outputs from ES. On the other hand, new concepts and information needs can emerge from ES production process, so the ES may drive official statistics toward a wider informative horizon.

Below approaches and experiences on ES production in some international institutions are reported.

2.1. Austria

Statistics Austria regularly manages experimental projects that offer new possibilities to produce statistics on many topics, using innovative methods and alternative data sources. Given the ongoing digitalisation, ES allow to enlarge the field of analysis. Users' feedback and interactions with Academia are deemed very useful.

Since ES results may be different from official ones in terms of "maturity" and quality, they are identified with an ad hoc logo to specify their provisional nature and possible interpretation difficulties. Innovation, that is the development of new statistical methods and the use of new data sources, is considered essential for an efficient and high quality data production process.

After testing and ensuring quality in a proper way, the main objective is to use ES within official statistics in order to improve data quality, reduce data collection costs and burden on respondents. On the website, ES are available only when they have reached the official statistics status.

2.2. Germany

According to DESTATIS (the German NSI) definition, ES are those based on innovative methods and new data sources. The degree of "maturity" and results quality are different from official statistics, mainly with regard to harmonisation, coverage and methodology.

In any case, great attention is paid to ES potential in providing new and interesting methods of analysis. One of the NISs' main objectives is to promote development and innovation: not only in terms of techniques and methodologies, but also in terms of analysis integration, using new data sources and methods. For transparency purposes, the results of innovative projects, which are still in an experimental stage, are published in the experimental section of the website.

Users are invited to leave feedback on methods and procedures since not all the experimental studies may be useful. Some ES will remain experiments while others will be included in official statistics production.

On the website, a useful section is dedicated to "workshop reports". These are reports on projects that have tested new methods for data collection or analysis aimed at improving official statistics in terms of quality or timeliness. In the same section, the evaluation and feasibility studies, carried out for some specific ES, are published.

2.3. Lithuania

Unlike official statistics, ES do not have a release calendar but are produced taking into account needs and real possibilities. Moreover, ES are not included in the official statistical program, they are not comparable among countries and methodologies are not consolidated but still under test. While official statistics is based on surveys and administrative sources, ES use also mathematical forecasting methods and alternative data sources.

On the website, Statistics Lithuania specifies the reasons for developing ES. The main intention is to meet the increasing users' needs. In fact, in some cases, the specific experimental statistic can be more accurate than the corresponding official one. In other cases, ES can meet information need that is not available in official sources (as a remarkable example, the estimation of the non-observed economy is mentioned). In any case, the main strength is the timeliness of release.

2.4. Poland

The stakeholders' increasing information needs have pushed to strengthen the information production process, including the development of ES. They have the scope of innovating methodological studies and filling in specific information gaps. The statistics published include results from innovative research that makes use of experimental methods and new methodological approach, still under development. The experimental results are not considered official statistics yet. The research work on ES is carried out within Statistics Poland objectives and statute as well as within projects financed by external funds.

2.5. Spain

ES are mainly aimed at meeting users' needs through innovation within statistical production. On the INE (the Spanish NSI) website, the projects under development are published: they are innovative in relation to data sources, methods, analysis' scope or modalities of data dissemination.

These are considered experimental since they have not reached the requested "maturity" yet, in terms of reliability, stability and data quality, to be included in official statistics. *"However, the available results are offered to users for their use and evaluation due to the relevance that these may have and as a means to improve the products themselves by seeking the views of the information's final recipients."*

Besides some ES, some official statistics defined as former experimental are available on the website.

2.6. The Netherlands

ES are included in the website section devoted to innovation. They are defined as *beta* products under development. Statistics Netherlands works regularly to update its statistical products and processes and carries out research on new data sources and methods, like those related to artificial intelligence. The main scope is to create new statistics or improve the existing ones as well as to develop new techniques aimed at integrating NSI's and other institutions' (Academia, private companies and public institutions) data.

On the website, some indications are given about the method to develop ES. Innovations are released together with a *proof of concept* to explain the potential of the new method or data source. The successful proofs of concept can be further developed to build up new ES that will be named beta products.

During the development of *beta* products, the data source stability is evaluated, methods are validated and the operational requirements are analysed. An innovation is considered as completed *"once the experimental statistic has been successfully converted into a full-fledged, one-time publication or an official statistic*". Of course, not all the experiments become final products.

2.7. Switzerland

ES are produced using new methods and/or new data sources. They are consistent with the Federal Statistical Office innovation strategy. Through their publication, it is possible to involve users at a very early stage in order to develop and strengthen the output.

Experimental projects are aimed at meeting users' needs in terms of efficiency, quality and timeliness.

ES have a high potential for further development, mainly with respect to methodology that remains under evaluation. For this reason, they are clearly identified with a logo to be easily identified.

The experimental projects can be: i) under development; ii) shifted to standard production; iii) stopped for specific reasons and possibly reactivated; iv) concluded without being shifted to standard production.

2.8. United Kingdom

ES are official statistics that are still in a testing phase and are not fully developed yet. Users have to be aware that ES potentially have a high degree of uncertainty. Their limits are clearly explained when released.

The experimental label is used when: i) the statistic remains subject to test of quality, stability and ability to meet users' need; ii) new methods still subject to change or further evaluations are being tested; iii) there is partial coverage; iv) there could be potential changes after users' feedback about their usefulness and credibility.

The main reasons why the Office for National Statistics releases ES are: 1) involving the potential users and stakeholders in a preliminary step to evaluate their quality and suitability; 2) when they are alternative versions with respect to existing official statistics, they can help users become familiar and understand the impact of new methods; 3) they can provide useful information to users only if they are well explained and understood.

When the evaluation process is completed, the experimental label is removed and the statistic is published as official statistics. This occurs when statistical methods are deemed robust, there is a good coverage, users' feedback shows that these products are useful and reliable as well as when the development stage has ended.

2.9. United States

ES are innovative statistical products based on new data sources or new methodologies that users can utilise when other relevant products are not available. For this reason, the US Census Bureau asks for feedback from users and stakeholders on quality and relevance of these new products.

The development of experimental data is an important step towards the creation of new and regularly released statistical products. When resources are available, the experimental data that have the required quality standards and meet users' demand can be regularly produced and included as permanent products in the same web section dedicated to ES.

Experimental data cannot ensure quality standards defined for official statistics. For this reason, they are clearly identified (ad hoc logo and dedicated web section) and released supported by methodology and research documents.

2.10. European Central Bank

The majority of ECB and ESCB (European System of Central Banks) statistical information has high quality levels in terms of harmonisation, coverage and methodological soundness.

At the same time, there are some cases where it is necessary to find a compromise with regard to one or more quality dimensions. For this reason and to increase the transparency of data releases, the ECB has developed ES.

According to the ECB website, experimental data are data collected and produced by ECB whose quality is somehow lower with regard to the other statistics produced.

However, they are considered sufficiently reliable to be useful for ESCB objectives and can therefore be interesting for external users too. ES include, for example, those statistics that are not fully developed in terms of coverage or harmonisation in the Euro zone. While they are of immediate value for analysts, they are still in a test phase and are subject to improvement. There may be cases where some data keep their experimental status since the data source needed to improve their quality is not available or requires very high costs.

2.11. OECD

On the OECD website there is not a specific area for ES. They are published together with official statistics, even if they have a clear experimental feature. Just to cite some examples of ES published: "Household distributional results in line with national accounts, experimental statistics", "Experimental Statistics: Distributional information on household income, consumption and saving", "Experimental Statistics: Supplementary socio-demographic information.

Comparing ES management across the different institutions analysed shows that there is no rigorous common definition of ES. However, most Institutions agree on some key elements to qualify statistics as *experimental*: innovation, new data sources, new methods, new tools, new analyses, processes/outputs not full "mature". Some institutions (e.g., Eurostat, NSI Italy, NSI Spain, US Bureau of Census) have adopted specific dissemination strategies (such as, ad hoc logo and graphical standards) to clearly distinguish ES from Official Statistics. Finally, almost all statistical institutions consider users' feedback as essential to promote ad further improve ES.

3. The Italian case

Istat has been producing ES since 2018. As for many other NSIs, ES are strongly related to product and process innovation, with particular regard to the use of new data sources, methods and tools to better and rapidly meet the increasing users' need. These statistics are defined experimental because they still need to be tested in terms of compliance with quality requirements and harmonisation rules, as well as they still require to be fully transformed into technological and organisational solutions.

Some ES are based on the use of new data sources held by private subjects. Istat can have access to privately held data only through specific bilateral agreements with private companies, within collaboration and research protocols. These partnerships can be useful not only to produce ES but also to enable the mutual exchange of knowledge at expert level. Collaboration with private companies may result in the incorporation of new sources into the regular production process, when feasible. A

sensible example is the use of scanner data for the production of statistics on consumer prices.

It is important that privately held data can be accessed for statistical purposes in a sustainable way. The Italian statistical law does not include specific provisions on access to privately held data, since it was enacted in 1989, at a time which predates the demand for access to this kind of data (Markelevičius et al., 2023). On the other hand, the increasing attention paid in the last years to privacy issues and the recent legislation on data protection pose big challenges to the use of private data for statistical purposes.

In many cases, outcomes from ES available to users are also included in official documents and institutional reports, underlying that their nature is experimental. Among others, important examples are the "Use of the Open Street Map to calculate indicators for road accidents on the Italian roads" in the 2023 SDGs Report (Istat, 2023) and the analysis of the impact of the Ukrainian invasion on the "Social Mood on Economy Index" in the 2022 Annual Report (Istat, 2022). The latter index is regularly updated and has had many applications in different scientific contexts (Carnazza, 2023; Catanese et al., 2022; Righi et al., 2022).

A special mention deserves the experimental statistic "Municipality indicators", published for the first time in 2018. It has become increasingly important to measure wellbeing at a municipality level not only in academic research but also for economic programming by central Government and local authorities. Municipality indicators framework is a multi-source system where experimental data sources are enhanced by other more consolidated informative sources. The municipality indicators capture the territorial structural features from demographic, social, environmental and economic points of view. Moreover, they provide measures that reflect the level of wellbeing reached by local communities. This experimental statistic has been a precious data source to measure many multidimensional phenomena at the Municipality level. This possibility is more important considering the deep change the official statistics is living, in particular in the area of population census. Measuring wellbeing at a Municipality level has produced many scientific papers. These ones have influenced policy makers with regard to the description of the territorial socio-economic context for a more aware socio-economic planning (see also: Fioroni e Quondamstefano, 2021; Arlotti e Bernardi, 2022; Perchiunno et al., 2023; Montorsi e Gigliarano, 2021; Ciacci et al., 2021; Bonardo e Quondamstefano, 2020; Scaccabarozzi et al., 2022; Pratesi et al., 2021; Mazziotta, 2019).

The municipality indicators system has been promoted within the partnership among Istat, the National Association of Italian Municipalities (ANCI) and the Union of the Italian Provinces (UPI).

A valuable contribution to the development of ES is the use of open data made available by other institutions of the Italian National Statistical System (Sistan). For

instance, the municipality indicators incorporate information provided by the Ministry of the Interior, the Ministry of Economy and Finance, the Ministry of Enterprises and Made in Italy, and the Higher Institute for the environmental protection and research (ISPRA).

Another remarkable example is the experimental project "Use of the Open Street Map to calculate indicators for road accidents on the Italian roads". The project is aimed at building a set of innovative indicators measuring different aspects of the vehicle traffic on the Italian road network, with special focus on the road safety. Integration of different data sources such as Istat surveys, Geographic Information System (GIS), Open Street Map (OSM), provides a multidimensional framework to perform analyses of accidents with regard to roads, vehicle and persons involved. The outcome of the project can help decision makers to introduce policies to improve road safety and reduce social costs.

Finally, it is worth mentioning the experimental project "Municipal demographic projections - January 1st, 2022-2042". Demographic projections aim at studying the probable future of a population in terms of total size and structural components. This product can be used by policy makers to analyse population aging trends and to develop forecasting models. Data are available at different levels of aggregation and can be downloaded directly from the information system available on the Istat website. This project can provide useful input for policies on health services, social security, environment, education and transport.

4. Conclusions

Experimental statistics is statistics which is not, or not yet, official. This means that the ES production process has not (yet) been "certified" by the institution(s) responsible for the validation process (typically NSIs). The experimental nature of the statistics may refer to any step of the statistical production process. In fact, innovative approach and methods can be introduced in different phases such as sampling design, data collection, treatment of non-sampling errors, data modelling, data dissemination, etc. In order for an experimental statistical product be validated and promoted to the "official status", some quality requirements have to be verified. The validation process involves different quality dimensions such as *relevance*, *timeliness*, *comparability*, *accuracy*. If the quality level is judged as too low with respect to some of these elements, the ES can still be made available to the users but with suitable warnings that make them aware of the experimental nature of the statistical product.

It is quite hard to define in general and in quantitative manner the requirements that allow experimental statistics to be shifted into official statistics. Setting

requirements depends on the specific information need and has to take into account the different options which are available. This often involves evaluating the trade-off between different quality dimensions. For instance, gathering data from the web, may imply sensible advantage with respect to an ad hoc well designed survey in terms of costs and timeliness. On the other hand, data from the Internet may not be guaranteed to be representative of the population under investigation, so that outcome from analyses based on these data may be affected by strong bias.

In any case, the huge availability of data from "non traditional" sources makes it possible to investigate new phenomena or to sensibly improve statistical analyses of already studied fields.

At an international level, ES have become a not replaceable scientific tool to face, as rigorously as possible, the data deluge (including junk data) citizens have to undergo daily. Therefore, testing and experimenting a number of data sources that, if properly processed, may be integrated within official statistics seems to be essential. This process is the same in many NSIs and international organisations that, thanks to inter-institutional research groups, are able to exchange experiences and good practices. This process is aimed at sharing methodologies and unconventional data processing analysis. In this context, it is also necessary not only to find common criteria to standardise the shifting process from experimental to official statistics but also to promote comparability among NSIs that produce ES on similar topics. On the other hand, NSIs are called to face the challenges related to the trade-off between i) the reduction of data collection costs and burden on respondents and ii) the huge investments in terms of human resources and IT tools that the increasing production of experimental data will inevitably imply.

In the near future, valuable updating and progress at a national and international level will be increasingly frequent in this field. Istat has already developed many different experimental projects that have been deemed remarkable by Academia, institutions and, mainly, local authorities. As a result of the availability of open data and methodologies that are more and more manageable by everyone (thanks to generalised software), ES will be hopefully able to be integrated within official statistics, providing a tool to analyse complex realities.

To this aim, NSIs will have to develop shared rules and procedures to transform ES into official statistics, putting efforts to reach comparability and suitable quality standards. In some cases, ES will be able to replace the traditional production process based on direct surveys or administrative sources. An example can be the use of data from satellites to improve agricultural statistics. Another important application could be the use of fiscal data from electronic invoices to timely produce statistics on economic transactions.

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