

# **The use of business census-like data in 2005 National Accounts major revision**

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*Key words: national accounts, census-like data sources, editing*

## **1. Introduction**

A major National Accounts general revision was ended in 2006 with a complete application of SEC95 and implementation of NACE rev.1.1 classification of economic activities for the years 1970-2004. General revisions are based on the estimation of economic aggregates and accounts for a benchmark year (in our experience the year 2000), for which all estimation methods are reconsidered using all available informative resources. The new estimates also implement the following important community regulations: the new processing of the financial intermediation services indirectly measured (FISIM), which provides for the attribution of financial intermediation service consumption to various economic operators, the adoption of chain indexes for volume evaluations and the adoption of the economic activity classification Ateco 2002<sup>1</sup>, besides that the Italian version of the NACE rev.1.1.

Gross National Income Committee Recommendations on edit and imputation methods were also considered (GNI Assessment – Italy, Eurostat, 2004). In fact Italian National Accountants have access to Structural Business Surveys (SBS) microdata and undertake their own imputation using different methods than business statisticians. New national

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<sup>1</sup> We must bear in mind that since 2002, ISTAT has introduced a new classification, the ATECO 2002 (Istat, 2003), which is a version of the NACE Rev.1.1, adapted to the structure of the Italian economy. The previous classification adopted by Istat, ATECO 91, was a national version too of the NACE Rev.1 (ISTAT, 1991). ATECO coincides with NACE for the first four digits.

accounts edit and imputation methods guarantee estimates that converge with those obtained by SBS.

This paper pays attention to the estimate of the economic aggregates related to large enterprises (100 workers and over). Even though they represent only 0.23% of the total of enterprises, they amount to 43% of the total in terms of turnover. The *Enterprises' System of Accounts survey* (ESA), a census-type survey carried out on all enterprises with more than 100 workers, represents the main source for this size class, together with the the "Balance-sheets " archive, which contains the balance-sheets of stock enterprises (used for integrating the total non-response).

The availability of SBS census-like data sources has been very important for the revised economic macro-aggregates estimations. The most important matter has regarded the enterprises' economic values per worker, which, together with the full-time equivalent employment (FTEE), represents the key variable of the model used for estimating economic aggregates (Istat, 2004). The aim of innovations consists in improving the accuracy of the estimates for the analysis domains of the national accounts through the minimization of the differences between the levels surveyed and published by the enterprises' surveys and the economic aggregates estimations, referred to this universe (the so-called universe of "regular" economy), on comparable domains. The objectives that surveys meet consist in reconstructing the economic values of the reference universe, object of publication as yearly data, to describe its structural characteristics and the changes registered in its structure from one year to another. But the survey is not fully adequate for a "micro" analysis in historical series of the phenomenon, especially when the data are used on a very precise level, such as in the case of the NA, given the lesser number of enterprises in the estimation domains and the higher impact on the estimates due to a non complete measurement of the company events.

The next Chapter (Chapter 2) describes the main characteristics of the sources used. After a description of the editing methods previously adopted, Chapter 3 illustrates a simple statistical editing procedure for the "basic" National Accounts variables expressed as economic values per capita. It is based on a minimal set of hypotheses about data generating process, and aims to evaluate, also for unbalanced panel data, the

degree of homogeneity of each observation respect to the others, from a temporal and cross-sectional point of view. Chapter 4 presents an estimation of a proxy of the error, obtained by means of resampling methods, relatively to the large enterprises domain. The availability of these estimates could be very useful for balancing the aggregates on the offer (of goods and services) side with those related to the demand (Stone 1990). Finally, Chapter 5 concludes with some future research perspectives.

## **2. Description and quality of the sources used**

The main source for estimating the economic aggregates of enterprises with at least 100 workers is the Enterprises System of Account survey (ESA), a structural-type survey carried out every year by Istat on a census basis. In order to reduce the entity of error on the analysis domains for the estimates of the NA, the survey data were used on a micro level. The NA has been using the enterprises survey data on a micro-level since the general 1988 revision. The need of having micro data derives, in particular, from the fact that the estimation domains are different compared to those established by the surveys: this involves carrying out further editing processes and using different estimators. The use of a specific data control and correction method is due to the difference that exists between the concept of quality of the survey and the concept of quality of the NA estimates: the process used for improving the quality of the NA estimates from the survey data can thus differ from that of the survey. Of course, the two aspects tend, though partially, to overlap each other (Puggioni, 2000). The controls on the micro-data are both preliminary and integrated in the construction and analysis process of the accuracy of the estimates of the NA aggregates. We would point out the fact that these controls are specific to the construction process of the national accounts and do not substitute but only complete and integrate the analysis processes of each statistic survey. Timeliness-related reasons could induce the NA to use an informative set made up of provisional data, both from a formal point of view (e.g. provisional accounts data issued by the enterprise and which could be modified within a certain date), and by the number of available units compared to the final ones (e.g. the survey at

time t-2 is used even though it is not complete). The integration of the non-responses represents, in any case, a way of minimising the bias of the provisional estimates, in relation to the definitive ones, which we obtain with the availability of the survey's complete informative set. The integration of the sources by the NA allows identifying any possible errors in the micro-data, in addition to evaluating the components of non-sample error (*coverage errors, measurement errors, non-response errors*).

### **2.1 Survey on the Enterprises' System of Accounts**

This census-like survey is addressed to all enterprises with at least 100 workers, which amount to about 9000 units (Istat, 2005). The data collected refer to the enterprises, classified according to their main economic activity, and to their functional units, derived from each enterprise by separating the main economic aggregates based on the different lines of activity, in order to supply homogeneous data by sector of economic activity. The classification of the economic activities of the enterprises is the 5-digit ATECO (equivalent, as previously said, to the NACE - Rev.1.1 since 2002). All multi-territorial enterprises are requested to provide data on a territorial level too (Administrative region /NUTS2) regarding the number of workers, expenditure for personnel and gross capital formation. The regional value added is estimated proportionally to the regional distribution of the personnel expenditure indicated by the enterprise. All the economic activities are surveyed, except for the agriculture-zootechnics-hunting and fishing, the financial activities (except for the auxiliary activities of financial intermediation and insurances), the public administration and the associative organization activities and activities carried out by families and cohabitations. In the case of partial non-responses, missing data are filled by means of the remaining valid answers and by means of the relations of balance existing between the questionnaire items. Such analytical imputation is done both automatically and manually by the unit that has in charge the survey. As regards the total non-response, two integration methods are applied:

- in the case of stock enterprises, by integration with the balance-sheets;

- as regards the remaining enterprises, integration of the variables is done using the so called “donor imputation”.

The performance of the integration from balance sheets is enhanced by the legal nature of the enterprises included in the field of observation, of which over 90% are made up of stock enterprises. The total amount of a variable for a certain stratum is equal to the sum of all amounts of the respondent enterprises and of the integrated enterprises. The coverage degree, in terms of number of enterprises, equals on average 50-55%, value that by the integration from the balance sheets, even reaches about 90%. In terms of workers, the coverages reach 60% and 95% respectively.

## ***2.2 Balance-sheets of stock enterprises***

The use of stock enterprises’ balance-sheets data is a part of the Istat project about the use of administrative archives for statistical purposes. This archive is submitted to a careful analysis, which highlights its correct use for statistical purposes. This analysis involves identifying the conceptual reference framework relative to the information object of analysis, identifying the statistical target population, the survey and analysis units, the characters, the classifications, the updating periods and modalities, as well as identifying the rules for converting the administrative data into statistical information (Vaccari, 2002). These balance sheets have indeed been proven to be adequate at representing many of the variables held in ISTAT questionnaires and in particular:

- The high level of alignment between the information drawn from the balance sheets and the information drawn from the surveys;
- The degree of accuracy and control of the variables registered;
- The degree of sources timeliness;
- The consistent reduction of the response burdens;
- The adequacy (as regards a delimited set of variables) to the Eurostat definitions held in Regulation EU 58/97 (Dabbicco, 2001).

The companies that must present their balance sheets to the Chambers of Commerce, which will then make them available and consultable within the chamber network

(Infocamere), are the following: limited liability companies, stock companies, partnerships limited by shares, limited liability cooperative companies, unlimited liability cooperative companies, small cooperative companies, consortiums with an external activity, foreign company with a secondary office in Italy, economic pressure group, limited or limited liability consortium companies. . This coverage excludes the balance sheets presented by companies whose activities are centred on monetary and financial intermediation activities (sector J that includes the ATECO two-digit codes from 65 to 67) and which have presented these balance sheets according to the scheme provided for the financial companies. As previously mentioned, these balance sheets are used for integrating the total non-response of the ESA survey by the structural statistics service (see Dabbicco, De Gregorio, 2002, as regards the methodological details on the alignment of the definitions between the sources and the calculation model).

### **3. Editing and estimate of the parameters for large enterprises**

The estimate of the parameters concerns both the questionnaire items and derived variables (production, costs, from the difference of which value added is obtained). The domain of interest is represented by the combination of:

- economic activity (4-digit ATECO),
- size class (100-249, 250-499, 500 and over workers).

The analysis carried out on the data surveyed, conducted by the National Accounts in order to ensure accurate estimates for very small analysis domains, has pointed out the need of applying an editing process for identifying the outliers. Moreover, the data on the enterprises are used not only for the target population of the survey but also for estimating the hidden economy. Thus, more attention needs to be paid on the use of these data for a correct expansion of the economic data to the target population of the National Accounts, which must measure the so-called “non-regular” component of the economy too. Another critical point is the analysis of the functional units of the enterprises with more than one economic activity: the measurement of the “real” homogeneous production units of the enterprises is more difficult when the break-up

and merging events are more numerous and frequent: presence of outliers is sometimes due to the lack of observation of an enterprise event in the reference year of the survey.

### ***3.1 The previous editing and estimation process***

In the previous revision (for more details, see the Inventory, Istat, 2004), the use of the ESA survey had two goals, in relation to the enterprises with at least 100 workers:

1. the estimation of the economic values (production, value added) per worker and in level for the year 1992;
2. the estimation of the variation between year  $t$  and year  $t-1$  of the economic values per worker, since 1992.

The estimation of the 1992 levels was based on comparison and analysis of the ESA survey data with all the available information and the censuses data. About the years following 1992, a panel of enterprises and functional units is selected based on a record-linkage, according to the identification code and the economic activity. In order to reduce the negative impact in terms of panel coverage, determined by the company events, a record linkage with the “events” file was first carried out. This file keeps all the identification codes of the companies involved in company events. The edit directly depended on the panel technique adopted. The panel included also enterprises that were not present in both years but were linked to those included in the panel by means of a break-up and/or merging event. The data were controlled according to a longitudinal-type approach; in particular, two types of control were done.

- *Deterministic control.* We identify as outliers all the units that present at least one annual absolute variation of some per capita (value added, production, wages and salaries) greater than 200%. The units characterised by break-up or merging were generally accepted since such events could justify an abnormal trend.
- *Probabilistic control.* Subsequently, a statistical procedure was activated in order to identify the outliers in relation to the economic activity class and size class. Each unit was compared with the interval constructed on the average and on the mean square deviation of the annual variation of the per capita value added, calculated in

relation to the first 3 digits of the ATECO and to two size classes (100-249, 250 and over workers). The acceptance interval was fixed at a 95% confidence level. The units that fell outside the interval were carefully analysed and accepted if they were indeed not wrong. The low frequency classes (that is, classes that do not ensure enough reliability to the use of the acceptance interval proposed) were controlled separately.

The grossing up to the target population is realized by means of a direct method, that is, multiplying the per capita by the number of workers or employees (in case of labour cost items) of the reference year.

In symbols:

$$(1) \quad \hat{Y}_{ij}^{dir} = \frac{\sum_{k \in D_{ij}} Y_k}{\sum_{k \in D_{ij}} W_k} \sum_{h \in T_{ij}} W_h$$

where:

i = index of economic activity class (i=1, ..., 461),

j = index of size class (j=1, ..., 5),

k = index of enterprises held in domain  $D_{ij}$  of the survey,

h = index of enterprises held in domain  $T_{ij}$ .

In order to guarantee more stability to the estimates, we carried out an aggregation of the strata when the number of the panel units or the relative sum of workers was in percentage terms lower than 10% of the total of strata. Such operation was done attributing to the strata the per capita value calculated in relation to the first 3 digits of the ATECO. The technique used, based on a panel integrated with the information relative to the enterprises events, proved to be over the past years not fully suitable for facing the growing trend of the enterprise events. In the last general revision, that has induced to review such setting.



### 3.2 The new editing and estimation methodology

The use of an unbalanced panel let to consider all the survey information and overcomes the difficulties deriving from the enterprises events; it also makes possible to assure the coherency with the levels measured by the survey. The procedure includes the following steps.

- *The accounting admissibility filter*

Negative values are admitted only for changes in stocks: if the items different from changes in stocks are negative, they are considered as missing data.

The statistical units with a negative production are removed from the analysis and they are implicitly taken into consideration during grossing up to the target population step.

- *Smoothing time series-cross section*

The values per worker of each single variable of interest for constructing the NA economic aggregates are analyzed under the hypotheses that the fourth moment exists, in order to limit the probability of observing particularly extreme values. In the case under examination, such hypothesis has always occurred thanks to the size of the reference domain, having a finite number of units. In particular, the first two local sample moments are evaluated by means of a gaussian kernel estimator for each observation, where the observation is excluded in order to obtain estimations less sensitive to the additive outliers:

$$(2) \quad m(x_i^h) = \sum_{\substack{j_s \in D \\ j_s \neq i_t}} x_{j_s}^h k(i_t, j_s), \quad h=1,2$$

$$(3) \quad k(i_t, j_s) = \exp\left[-0.5(x_{i_t} - x_{j_s})^2 / \mathbf{I}_x^2\right] / \sum_{j_s \neq i_t} \exp\left[-0.5(x_{i_t} - x_{j_s})^2 / \mathbf{I}_x^2\right]$$

where  $I_x$  is the parameter that drives the location degree of the statistics for the  $x^{\text{th}}$  variable,  $i_t$  and  $j_s$  are the indexes regarding the  $i^{\text{th}}$  statistical unit observed at time  $t$  and, respectively, the  $j^{\text{th}}$  statistical unit at time  $s$ , that is, the observations that fall under domain  $D_{ij}$ . The literature relative to the quantification of the local parameter is rather wide [a review, though not exhaustive, is offered by Turlach (1993)]. Due to computational burdens (implied by the extensive application of the smoothing on all the elementary variables useful for calculating the main national accounts aggregates), the choice adopted reflects the rule of thumb that uses the standardised gaussian as reference distribution when minimising the approximate integrated mean square error:  $I_x = \hat{S}_x \cdot (4/3n)^{1/5}$ . Gijbels, Pope, Wand (1999) show relations between kernel estimators and exponential moving averages. In our case, the domain  $D_{ij}$  is multi-dimensional (being linked to the reference year, to the economic activity classes and to the enterprise size expressed in terms of workers) and the smoothing is a simple instrument useful for avoiding the modulation of explicit distributions referred to tens of variables. Thus, the editing procedure aims at evaluating the intensity of the deviation of each observation from an interpolant constructed as weighted moving average of the remaining statistical units within a multi-dimensional domain. The stratification by 101 economic activity branches and three size classes expressed in terms of workers makes several domains “lighter” and it is not very useful the calculation of confidence intervals based on asymptotic properties. Such difficulties and the validation to which the variables are submitted by the Structural Statistics Service induce to reason in prudential terms, using the Cebicev inequality to decide the substitution of the observed data with those locally fitted.

### ***3.3 Editing rules aimed at guaranteeing positive trade margins.***

After completing all checks on each item, accounting coherence among the variables that determine the trade margins is done. The trade margins are calculated from the survey data as difference between the sales of goods acquired not submitted to processing and the corresponding sum of purchases and changes in stock. The

framework of the Italian economic accounts uses the estimations from the surveys on enterprises for all economic activity branches, unlike the surveys that calculate the margins only as regards the trade economic activities. This objective is reached by means of the following steps, that assure the production is not modified:

- calculation of stratum mean profile based on observations with non negative margin, that is weights calculated as ratio between each item in the production formula and the aggregate total amount,
- imputation of the profile obtained at the previous step to the enterprises with a negative margin, under the constraints of invariance for production level.

### **3.4 Estimation of the levels of the variables**

The estimation of the economic variables' levels is done by means of the same method used before the 2005 general revision: at a domain level, the value per worker of each variable is calculated and grossed up to the population by means of a direct method, that is, multiplying each per capita by the number of workers or employees (in the case of labour cost items).

In symbols:

$$(4) \quad dir\hat{Y}_{ij} = \frac{\sum_{k \in S_{ij}} Y_k}{\sum_{k \in S_{ij}} W_k} \sum_{h \in T_{ij}} W_h$$

where:

i = index of economic activity class (i=1, ..., 461),

j = index of size class (j=1, ..., 5),

k = index of enterprises held in domain  $S_{ij}$  of the survey,

h = index of enterprises held in domain  $T_{ij}$  of target population.

#### **4. Proxy of the total error in estimations for enterprises with more than 100 workers**

The previously indicated domains (4-digit NACE Rev.1.1 – Size class) represent the initial domains on which the estimates are carried out, subsequently submitted to aggregation, up until arriving to the domain of interest, represented by the 101 economic activity branches<sup>2</sup>. A proxy of the error for production and value added, carried out for 101 branches, has been calculated. Under the hypothesis that the non-responses of the statistic units are random, the empirical distribution of the estimators for per capita of production (prpm) and value added (vapm) was estimated and from these, the confidence intervals at the significance level of 5% and the RRMSE have been calculated. The empirical distributions were drawn from 10,000 replications of a sub-sampling without replacement [Politis and Romano (1994)]. The table in appendix indicates, for the year 2000, the RRMSE and the confidence intervals – expressed as index number where “100” equals the validated data – excluding the strata with survey coverage equal to 100% and strata with a numerosness of the data surveyed inferior to 40 units. It is possible to notice that the figures are almost always less than 3% (for value added only 10 branches out of 38 have figures greater than 3%, but always less than 10%, while for production only 8 branches out of 38 have figures greater than 3% but always less than 8%).

#### **5. Conclusions**

The main innovation introduced in the last general revision of the national accounts, completed in 2006, for the year 1970-2004, in relation to the estimate of the economic values of enterprises with at least 100 workers, regarded the editing of the variables surveyed in the *Survey on the Enterprises' System of Accounts*. The Italian National Accounts, since the 1987 general revision, directly considers the business micro-data. The use of the micro-data is indeed one of the important characteristics of the construction method

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<sup>2</sup> Intermediate level between second and third digit of NACE Rev.1.1 Classification.

of the national accounts by Istat. This approach allows using more efficiently the statistical sources, allowing for a more complete integration too. The need of carrying out a new analysis of the data surveyed and of using estimators different than those provided for the survey data derives from the need of carrying out estimates for different domains, generally smaller, than those provided for by the surveys. It also derives from the fact of having to use a very wide set of items and economic aggregates (production, intermediate costs, value added, total turnover, gross capital formation, labour cost). As regards the impact of the new editing on the economic data, it is evaluated on the value added by +1% (Faramondi, Foschi, Puggioni, 2006). It is to notice the improvement represented by the greater closeness of new national accounting estimates of economic aggregates in comparison to the corresponding levels evaluated through the survey. This paper also presents an evaluation of a proxy of the error levels, in relation to the publication domains of the NA data. Although these estimates are based on very restrictive hypothesis, they constitute a potential corner stone for future improvement related to the national accounts aggregates estimates balancing and possibly a new strand of research to investigate. In the future, the goal consists in making further progress as regards the method of model-based sources integration and estimators calibration, following the objective of fully using the available informative content.

## Appendix

**Table of percentiles and RRMSE (proxies) for the per capita production and value added**

101 Branches	NACE Rev.1.1	Coverage %	5°p. prpm	95°p. prpm	RRMSE prpm	5°p. vapm	95°p. vapm	RRMSE vapm
10	151	93.94	93.9	108.2	4.3	95.7	106.9	3.3
11	152,154,158	88.41	95.8	102.5	2	95.6	103.1	2
13	155	86.27	95.4	103	2.2	96.7	105.4	2.7
17	159	95.56	96.3	106.2	2.8	86.7	111	6.2
18	171,172,173	98.50	97.7	101.9	1.3	98.3	101.3	0.9
19	174,175,176,177	99.07	97.6	102.4	1.5	95.6	102.4	1.9
20	181,182,183	98.47	95.8	103.7	2.4	96.5	103	2
24	211,212	97.44	97.2	102.3	1.6	95.7	102.5	2.2
25	221,222,223	97.73	93.1	103.2	3.3	89.2	103.6	4.3
27	241	94.12	95.6	103.6	2.4	97.6	102.6	1.5
28	242,243,246	98.81	95.7	103.6	2.5	96.7	103	1.9
29	244,245	98.73	97.8	101.8	1.2	97.1	102.3	1.6
31	251	96.36	96.1	104.1	2.4	97.7	102.7	1.5
35	265,266	97.26	96	103.1	2.2	94.7	103.4	2.8
37	271,272,273,274,275	94.17	97.6	102	1.3	98.1	101.5	1.1
38	281,282,283	97.35	96.7	102.8	1.8	97.2	102.4	1.6
39	284,285,286,287	99.44	97.3	102.1	1.5	98.6	101.3	0.8
40	291,292,294,295,296	98.62	98.6	101.4	0.9	99.1	100.9	0.6
42	297	95.59	96.9	102.6	1.8	96.6	101.9	1.7
45	312,313,314,315,316	99.38	96.5	104.6	2.2	95.9	104.5	2.5
49	331,332,333	96.39	97.7	102.3	1.4	96.4	106.4	2.7
51	341,342,343	98.58	97.4	101.9	1.5	96.3	101.9	1.8
56	361,363	98.68	94.6	103.3	2.4	97.7	104.2	1.8
58	364,365,366	93.02	94.9	104.6	2.9	97.2	102.7	1.6
60	401,403	54.32	98.8	100.8	0.6	99.1	100.8	0.5
63	451,452,453,454,455	99.17	92.6	103.5	3.1	97.2	102.8	1.7
64	501,503,504,505	96.72	86.2	104.7	5.2	90.9	107	4.3
67	512,513,514,515,518,519	96.46	88.1	108	6.2	80.6	111.5	9.7
68	521	97.82	95.8	103.3	2.3	95.2	103.8	2.3

70	523,524,525,526,527	97.71	94.3	106.2	3.5	94.2	104.9	3
75	602	97.18	92.3	107.1	4.4	76.9	110.6	9.3
79	631,632,634	98.98	94.2	104.2	3.1	91.5	103.9	3.8
81	642	94.74	90.5	102.9	3.9	88.4	105.8	4.7
88	721,722,723,724,725,726	99.14	95.9	103	2.2	96.5	102.2	1.7
90	741,742,743,744,745,746,748	98.37	91	106.5	4.6	94.7	107.3	3.8
91	747	99.57	96.9	101.6	1.3	98.1	101.3	0.9
97	900	82.46	94.9	106.7	3.2	97.1	104.3	2
99	921,922,923,924,925,926,927	98.00	80.7	106.2	8	85.2	108.8	7.4

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