Sampling schemes using scanner data for the consumer price index

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1. Introduction

The Italian National Institute of Statistics (ISTAT) is carrying out a redesign of the Consumer Price Survey (CPS). The main aim of the project is to modernise the survey, improving and unburdening the data collection phase, together with the progressive introduction of more rigorous sampling procedures, probabilistic where possible, for the selection of outlets and products (items) for the sectors where this is feasible.

The availability of Scanner Data (SD) from the retail modern distribution (food and grocery) is the starting point for the implementation of the innovation in the survey (CPS)[1]. At the moment, for the retail traditional distribution data will continue to be collected by the current survey on field[2]. This choice is determined by the peculiarities of the Italian retail distribution with respect to other countries: the traditional distribution, in fact, is still relevant in many geographical areas of the country.

After an experimental phase, since 2018 ISTAT has started using the SD to compute the consumer price index (CPI). SD are regularly provided since 2014 to ISTAT through the market research company ACNielsen, for the main chains present in Italy and for a sample of about 2,000 outlets deployed all over the country. For 2018 the compilation of the CPI using scanner data is based on a fixed basket perspective, but a gradual transition to a flexible basket is the ISTAT goal. In fact, SD provide the opportunity to move to a dynamic approach and offer a real possibility of computing more accurate indices, since they can, potentially, include the expenditure share of each product. On the other hand, the use of SD in Consumer Price Index (CPI) must deal with some important issues, as attrition of products, temporary missing products, entry of new products and volatility of the prices and quantities due mainly to sales. These are aspects that need to be addressed from both a theoretical and a practical point of view (de Haan et al., 2016).

To make better use of SD it is necessary going beyond traditional methods of price index compilation which do not exploit all the information provided and do not take into account the population dynamics (Chessa et al., 2017). Weighted and chained indices should be considered to incorporate the overall price trend over a given time, including the prices of new products. Furthermore, using chain indices automatically the problem of shrinkage over time due to the attrition of a fixed basket of products is solved. However, in a dynamic approach, constructing series of chained indices is necessary, but high-

[1] Other aspect involved in the review of the survey is the use of web-scraping for collecting prices referred to online market (tourism, mobile phone, etc).

[2] The current strategy of the traditional distribution carried out at territorial level is based on three purposive sampling stages. The sampling units are respectively the municipalities, the outlets and the elementary items for which the prices are collected. The selection criterion at each stage is based on the concept of most representative units: the outlets sample is chosen to be representative of the consumer behavior in the municipality; for each product of the basket the most sold item is selected and the prices of these items are collected throughout the year. The elementary price indices are currently obtained at municipality level by unweighted geometric mean.

frequency chaining of weighted indices, also superlative Fisher and Törnqvist indices, are affected by chain drift, due to non-symmetric effects on quantities sold and expenditure share of goods before and after sale (de Haan and van der Grient, 2011; Ivancic et al., 2011).

The aim of this work is to focus on sampling aspect of the CPIs. The experiments are developed in two main phases that reflect the choice made by ISTAT to make a gradual transition to flexible basket. In fact, in the first experiments, following a fixed basket approach, probability and nonprobability selection schemes of series (references individuated by EAN and outlet codes) are compared. In the second experimental phase, the differences between a fixed and a flexible basket approach are evaluated, trying to measure the magnitude of sampling error and bias for different index formulas in both approaches.

The paper is organized as follows: section 2 provides a brief overview of the use of scanner data for the CPI compilation in some countries; section 3 describes ISTAT SD; section 4 presents context, methodological approach and some results of experiments, first to compare different sampling designs from SD under fixed basket approach and second to compare static and dynamic population approaches; in section 5 some conclusions and further challenges are exposed.

2. Use of scanner data for CPI in the international context

As noted in 2004 by ILO "Scanner data constitute a rapidly expanding source of data with considerable potential for CPI purposes" (p. 54); "Scanner data obtained from electronic points of sale include quantities sold and the corresponding value aggregates on a very detailed level" (p. 92); "Scanner data are up to date and comprehensive" (p. 478).

The Italian National Institute of Statistics (ISTAT), through a contract with Nielsen and an agreement with the six main retail chains operating in Italy, started, at the end of year 2014, receiving SD referred to food and grocery markets and processing them with the objective of experimenting the calculus of CPI. This acquisition places Italy among countries using or testing the use of this source of data for compiling CPI.

In several countries SD are used in the compilation of the CPI: i.e., Switzerland, Norway, Netherlands and Sweden for some years, while Belgium and Denmark only from 2016. Scanner data can be exploited in different ways (Feldmann, 2015). The simplest way is using SD as an alternative source for price collection, replacing collection in the stores, without changing the traditional principles of computing the price indices. This method is currently applied by the Swiss Federal Statistical Office (Vermeulen and Herren, 2006). Alternatively, as in Norway and Sweden, SD can be used as universe from which samples of references can be selected following different methods (Nygaard, 2010; Norberg, 2014). Finally, all (or almost all) SD can be used to compile price indices, without a strict sample selection, but with consequences on the theoretical definition of the index. In the Netherlands, the computation methods is different and data are used in a more extensive way to calculate price indices (van der Grient and de Haan, 2010). The method used assumes a dynamic population approach: elementary price indices of homogeneous items are calculated by monthly chained unweighted geometric index (Jevons); no explicit weighting is applied and expenditure information is used just to select a cut-off sample of matched items during two months in a row.

In a study perspective, SD from retail stores allows researchers to evaluate how different price index formulas at the elementary level perform. In fact, official Consumer Price indices are usually constructed in two broad steps. First, price indices are calculated for narrowly defined, relatively homogeneous products, also known as elementary aggregates. In a second step, these elementary indices are aggregated into a general consumer price index using expenditure weights. Elementary indices are therefore the building blocks of price index numbers. Their development over time measures the inflation of narrow product categories.

While the aggregation at higher level is carried out using generally Laspeyres type formulas with weights deriving from national account or expenditure survey data, official practices in elementary price index construction are still not uniform across countries, deserving further investigation in the consequences of different choices (Gábor and Vermeulen, 2014).

3. ISTAT Scanner data

SD are provided to ISTAT by Nielsen for the 16 main chains in Italy that gave the authorization to transmit the data to ISTAT and for a sample of about 2,000 outlets distributed throughout the country. The modern distribution (with more than 8,000 outlets) is characterized by the presence of about 25 chains that are spread in heterogeneous way throughout the national territory; the heterogeneity reflects a diversity both among geographical areas, products sold and kind of outlets (supermarket and hypermarket).

SD files contain elementary information (turnover and quantities) referred to items weekly sold in a specific outlet: each item is uniquely identified by its barcode (GTIN, Global Trade Item Number or EAN, European Article Number). Information available on turnover and quantities sold in a week do not provide the “shelf price” of the reference (or series, individuated by EAN and outlet codes) but allows to define a unit value or average weekly price. For reasons deriving from operational constraints of the productive process, a restriction is introduced regarding the observable weeks: only the relevant weeks are considered, defined as the first three full weeks (composed of seven days) in each month.

Moreover, Nielsen provided to ISTAT the dictionary which associates to every single EAN code sold in Italy attributes that allows to identify the product (manufacturer, brand, possible sub-brand, size, packaging, variety) and classifies each EAN within the ECR classification (variation of GPC Global Product Classification applies worldwide). ISTAT ensures internally the translation from ECR to COICOP, the classification of products used for the CPI. Consumption segments, not foreseen by the EU-COICOP, are the most detailed domain of estimate for Italian CPI and constitute groupings of homogeneous products; the consumption segments defined for the food and grocery are 126 out of a total of 324.

An important issue, out of the scope of this paper but crucial for the ISTAT CPI, is the need to combine estimates deriving from different data source (modern and traditional distribution) and from probability and purposive samples. The indices deriving from scanner data are combined with indices deriving from the traditional survey using weights of modern distribution and traditional distribution estimated by the consumer expenditure survey.

4. Experimental framework

4.1 Outline

The experiments carried out by our research group were developed in two phases, assuming in the first one only a static population approach (fixed basket) while, in the second, a dynamic population approach as well (flexible basket). The general aim was evaluating the use of SD for the compilation of the elementary price indices (first level of price index calculus on which the subsequent aggregations are based, in the Italian case the consumption segments) from a sampling perspective.

In a dynamic context, the universe of products includes all products that disappear or appear (new products) in the course of a year. The bilateral indices are generally calculated on matched-items: only price relatives of items that are sold in two consecutive months enter in the index formulas (flexible basket) (Ivancic et al., 2011). In a dynamic situation the comparison of two periods, 0 and t, is based on the chain approach. Chain indices take into account the movements of prices within the considered time interval, thus renewing the basket at each sub-interval and, consequently, solve the base change through the change of weights. So, using chain indices the shrinkage effect over time due to the attrition of a fixed basket of products is solved. On the other hand, in the static population, the loss of representativeness of the basket is addressed through the yearly base change of the index and the renewal of the basket. In this context the comparison of two periods, 0 and *t*, or binary temporal index, is based on the direct (traditional) approach.

In the dynamic universe, however, , period-on-period chaining of weighted indices introduces chain drift, also for superlative Fisher and Törnqvist indices, (de Haan et al., 2016). This source of bias, that increases as the time series grows, is due to the non-transitivity of the weighted price indices. Transitivity of indices is not important in the static universe, as chaining is not required for direct (bilateral) indices, but is more important in the dynamic approach.

In this general framework, the goal of the first experiment was to evaluate the performance of different sample selection schemes of series and the use of estimators of weighted and unweighted indices for CPI in a static situation. Following a fixed basket method, different samples of series are selected at the beginning of the reference period and followed during all the year. In this phase a simplification was used: the implications of life-cycle of series, seasonality issues and missing data were not taken into account and only panel series were considered as universe for sampling and price index evaluation. The definition of panel data is based on the permanent series concept, which refers to those series with positive turnover for at least one relevant week (the first three full weeks) in each month of the considered year, starting from the December of previous year.

The population parameters taken in account are three classic aggregation formulas of monthly bilateral price index: Jevons (unweighted), Fisher (ideal) and Lowe (weights from quantities of previous year). In the static population approach, the use of Fisher (superlative) price index formula is undoubtedly the best way to measure price change. Fisher ideal index is thus preferred by economic theory, it uses quantities in different times and allows for substitution effects. The lack of weighting in the Jevons index is a potential source of bias and the opportunity of weighting items "according to economic importance" is supported by the theory of index numbers (de Haan et al., 2016).. In a probabilistic sampling context, it has to be specified that the properties of the estimators must also be considered in relation to the properties of the corresponding indices.

In the second phase of the study, some experiments were carried out to highlight the differences between a static and a dynamic population approach in the construction of the elementary price indices. The goal of the experiments was to analyse as some sources of bias can affect the estimates of different index aggregation formulas in both approaches. In the fixed basket approach, bias can be introduced by the reduction in size of the sample because of disappeared products (shrinkage), by ignoring new products and temporary missing products. In the dynamic population approach, some sources of bias can be related to the matched model and to the type of index aggregation formulas utilised. The matched-model based on exact matching of items sold in two consecutive months does not explicitly account for unmatched new and disappearing items and does not include temporary missing items. Constructing a time series by chaining period-on-period matched-model Jevons indices can avoid chain drift that affects weighted indices. The lack of weighting, the absence of adjustment for quality change and the lack of imputation of temporary missing items are a potential sources of index bias (de Haan et al., 2016). The population parameters here considered are monthly chained bilateral unweighted (Jevons) and weighted superlative indices (Fisher and Törnqvist).

As in the first phase, the experiments were conducted starting from a panel series, but in this case artificial populations were generated with products appearing and disappearing (momentarily and permanently).

Parameters and unbiased estimators

According to a static population approach, for sake of simplicity, a formalization of the population parameters described above and the corresponding unbiased estimators is shown in the following scheme (de Haan et al. 1999).

	Population parameter	Sampling estimator
Jevons	$I_J^{0,t}=\prod_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)^{1/n}$	$\hat{I}_J^{0,t}=\prod_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)^{w_i/\sum_{i=1}^{n}w_i}$
Laspeyres	$I_{LA}^{0,t}=\sum_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)\left(\frac{p_i^0 q_i^0}{\sum_{i=1}^{n}p_i^0 q_i^0}\right)$	$\hat{I}_{LA}^{0,t}=\sum_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)\left(\frac{p_i^0 q_i^0 w_i}{\sum_{i=1}^{n}p_i^0 q_i^0 w_i}\right)$
Paashe	$I_P^{0,t}=\sum_{i=1}^{n}\left(\frac{p_i^0}{p_i^t}\right)\left(\frac{p_i^t q_i^t}{\sum_{i=1}^{n}p_i^t q_i^t}\right)$	$\hat{I}_P^{0,t}=\sum_{i=1}^{n}\left(\frac{p_i^0}{p_i^t}\right)\left(\frac{p_i^t q_i^t w_i}{\sum_{i=1}^{n}p_i^t q_i^t w_i}\right)$
Fisher	$I_F^{0,t}=\sqrt{I_{LA}^{0,t}\, I_P^{0,t}}$	$\hat{I}_F^{0,t}=\sqrt{\hat{I}_{LA}^{0,t}\, \hat{I}_P^{0,t}}$
Lowe	$I_{LO}^{0,t}=\sum_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)\left(\frac{p_i^0 q_i^z}{\sum_{i=1}^{n}p_i^0 q_i^z}\right)$	$\hat{I}_{LO}^{0,t}=\sum_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)\left(\frac{p_i^0 q_i^z w_i}{\sum_{i=1}^{n}p_i^0 q_i^z w_i}\right)$
	q_i^z refers to the quantity series in the previous year	
Törnqvist	$I_T^{0,t}=\prod_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)^{\frac{1}{2}\left(\frac{p_i^0 q_i^0}{\sum_{i=1}^{n}p_i^0 q_i^0}+\frac{p_i^t q_i^t}{\sum_{i=1}^{n}p_i^t q_i^t}\right)}$	$\hat{I}_T^{0,t}=\prod_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)^{\frac{1}{2}\left(\frac{p_i^0 q_i^0 w_i}{\sum_{i=1}^{n}p_i^0 q_i^0 w_i}+\frac{p_i^t q_i^t w_i}{\sum_{i=1}^{n}p_i^t q_i^t w_i}\right)}$

w_i is the direct weight, the inverse of the inclusion probability of the sampling unit deriving from the sampling design

Under a dynamic approach analogous formulas can be expressed for the chain indices, by substituting (*0*,*t*) with (*t-1*,*t*).

A generic chain index obtained as product of index $I^{0,1}$, $I^{1,2}$,…, $I^{t-1,t}$ referred to sub-intervals *s* (0,1), (1,2), ...(t-1, t) can be expressed as

$$I_{chain}^{0,t}=\prod_{s=1}^{t} I^{s-1,s}\ .$$

4.2 First experiments and results: fixed basket approach

The experimental study was developed adopting probability and nonprobability selection schemes of series. The Turin province and some consumption segments (COICOP 6 digits) were chosen for the experiments. SD relative to six retail chains (Conad, Coop, Esselunga, Auchan, Carrefour, Selex) available for year 2014 were used. The sample selection and weighting of price indices was based on the total annual turnover of 2013.

Both for probability and nonprobability sample schemes, series are selected from a sample of outlets: 30 out of 121 of outlets of retail trade modern distribution in Turin province. Outlets are stratified by chain and outlet type (hypermarket and supermarket). In each stratum, the sample has been allocated proportionally to the turnover. The selection of outlets is carried out in each stratum by simple random sampling (SRS).

Nonprobability sampling of series was carried out by selecting series on the basis of cut-off thresholds of covered turnover in previous year, 2013: two samples are formed with all the series covering respectively the 60 and 80 percent of the total turnover in each of the considered consumption segment (coffee, pasta, mineral water) in the selected outlets. Moreover, considering the currently used fixed basket approach, a reference selection scheme was defined selecting the most sold EANs for each representative product in the selected outlets.

For probability sample, the sample size for SSU is fixed by a sampling rate of 5 percent of the number of EANs in each consumption segment in the sampled outlets. Sample series are selected with probability proportional to size (PPS), in terms of total turnover of previous year, by adopting Sampford sampling (Sampford, 1967; Rosén, 1997).

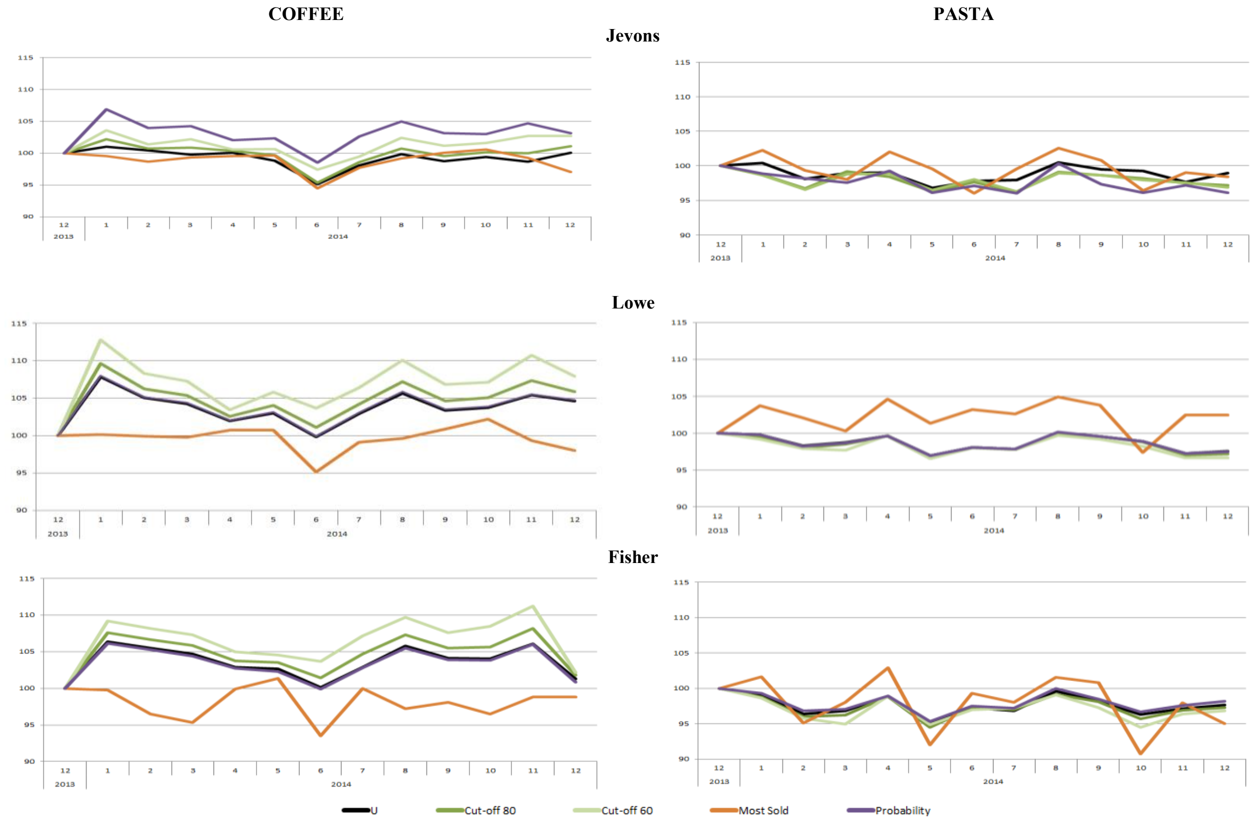
Besides comparing probability and non-probability schemes, a deepening was carried out on some probabilistic designs characterized by the use of different criteria of sample allocation, both for outlets and elementary items (EANs), and different selection methods of the sampling units: 1) one stage stratified sample of EANs; 2) cluster sample of outlets; 3) two-stage sampling with stratification of PSU (outlet) and SSU (EAN). For each sampling design the size of the final sample of EANs was fixed in average at 7,400 to compare the different sampling strategies on equal sizes. The first sampling design was carried out stratifying the EANs by market (ECR group) in each consumption segment. Sample size is allocated among the strata through a Neyman formula, taking into account the variability of prices relatives in the markets observed in the reference year 2013. Two selection schemes were considered, SRS and PPS. In the second design, cluster sampling, a sample of outlets (14 out of 121 outlets) is selected. Outlets were stratified by chain and type. In each stratum, two different allocation of outlets were tested: proportional to the strata turnover and optimal allocation (Neyman). Outlets are selected with both SRS and PPS methods. All the EANs in the selected outlets were included in the sample. Finally, two-stage sampling design was characterized by a stratification of both PSU and SSU. The stratifications adopted for the PSU and the SSU are the same of the two schemes described above. The size of the outlets sample was fixed at a number of 30 out of 121 outlets. For both outlets and EANs, sample allocation in the strata is proportional to the strata turnover. PSU were selected with a PPS method, while SSU were selected both with SRS and PPS methods.

The comparison among the alternative selection schemes was made, for each price index, taking the corresponding true value of the index computed on the whole universe (panel series) as a benchmark. Indices performance were evaluated in terms of bias for all selection schemes. For probability selection schemes, accuracy (bias and sampling variance) of the price indices was studied with a Monte Carlo simulation: 500 samples were selected, according to different sampling designs. Variability and bias for each index were computed on the estimated indices in the replicated samples.

Results

The most meaningful results of the first experimental phase are shown in the following figures. Figure 1, shows the level estimates of the monthly Jevons, Lowe and Fisher indices computed on probability (two stage sampling) and nonprobability samples and the true value (universe panel series SD) of the corresponding index for two consumption segments (coffee and pasta in Turin province).

Figure 1 – Jevons, Lowe and Fisher indices computed with different selection schemes of series for coffee and pasta segments.

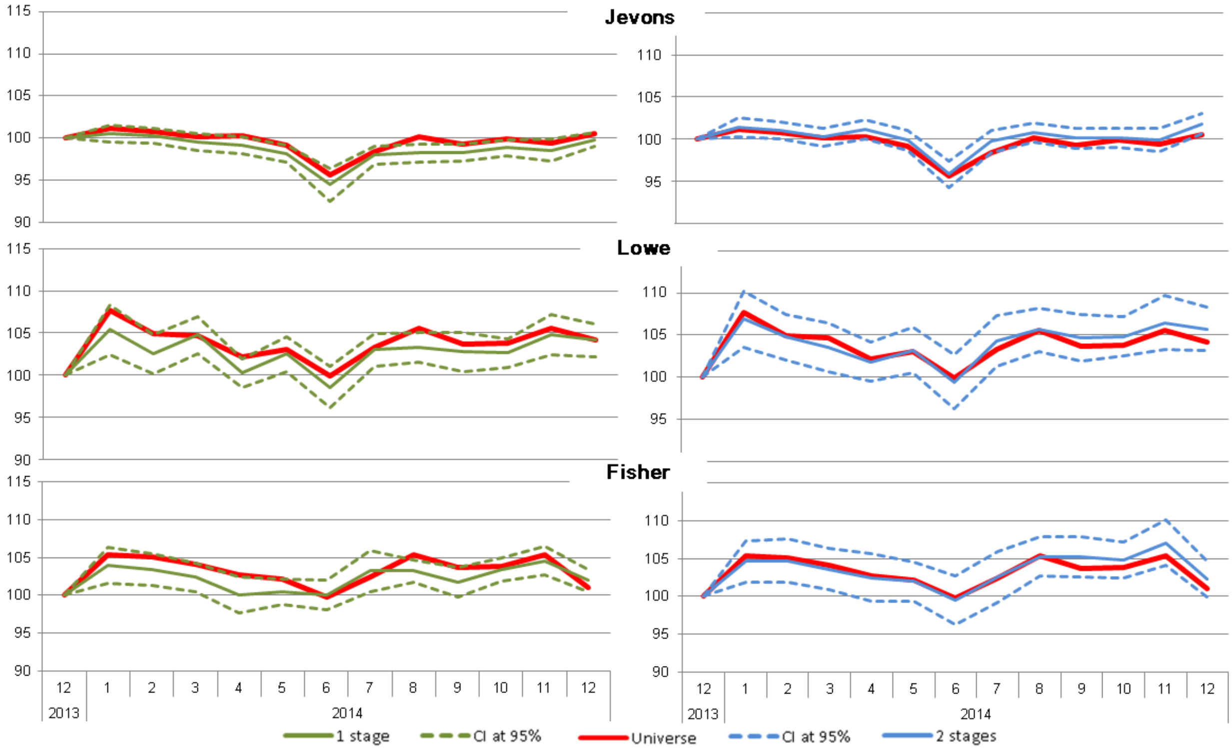


Also from other evidences not shown for sake of brevity, the comparison between probability and nonprobability sample shows that: (i) probability sampling always produce more accurate estimates than nonprobability selection scheme; (ii) sampling scheme is not neutral with respect to the choice of aggregation formulas; (iii) sampling error varies among consumption segments.

Figure 2 illustrates an example of the difference among the three indices estimated under two different sampling designs: cluster sample of outlets (with proportional allocation and PPS selection) versus two stage sample (proportional allocation and PPS selection of outlets and Neyman allocation and PPS selection of EANs).

The comparison between two probability selection schemes highlights that all the estimates seems to catch properly the level and the trend of the related true index. The estimator of Lowe and Fisher indices have in both cases wider confidence intervals (CI) with respect to the Jevons index, due to the variability of quantities involved in the weights. In general the width of CIs are greater under the two stage sampling than under cluster sampling design (one stage), even if the difference does not seem so large.

Figure 2 – Jevons, Lowe and Fisher indices for coffee segment estimated on one sample, confidence interval (CI) of estimates at 95% and true value (computed on the universe of SD).



4.3 Second experiments and some results: static and dynamic population approach

The aim of the second experimental study was to highlight the differences between static and dynamic population approach, using weighted and unweighted indices, and to measure the magnitude of sampling error and bias.

The two approaches refer to different sampling schemes. Under the static approach the series are drawn through a two stage sampling design, in which the Primary Stage-Units (PSU) are the outlets, the Secondary Stage Units (USS) are the EANs. The outlets, stratified by province, chain and type, are selected with probability proportional to their annual turnover. In each selected outlets, in each market, a sampling fraction of 20% of EANs is selected with probability proportional to annual turnover. Under the dynamic approach, only the selection of outlets is considered.

The experimental study is carried out on Rome province in 2015 and some consumption markets (ECR group). To represent the diversity of the population, three consumption markets different by their features are considered:

- Short Semolina Pasta, low dynamism with respect to products and low variability in prices;
- IGP-IGT Italian White Wine, medium dynamism with respect to products and high variability in prices;
- Laundry Bivalent Washing Machine Liquid + Gel, high dynamism with respect to products and medium variability in prices.

To take into account the variability due to the identification of disappearing, new and temporary-missing products and the probability sampling, a kind of super-population approach has been implemented. The panel of products is the reference population. Starting from these data alternative population have been generated where disappearing and new products, temporary missing, from time to time, are flagged applying survival functions; birth rate and “temporary-missing” rate are estimated on the observed complete data set (from which the panel is extracted as the 'always present series'). On these populations the two sampling design are applied and elementary price indices are calculated[3]. The elementary indices considered are Jevons, Törnqvist and Fisher.

Under the dynamic approach, the monthly chained bilateral versions of these indices are used. In this case the Jevons index is computed on all matched items during two months in a row and on a sub-sample identified by a threshold (matched-model with threshold, "Jevons wT"). The threshold is based on average expenditure shares across two adjacent months; items below the threshold are excluded from the computation. Therefore, an implicit weight is applied (Dutch method) (Van der Grient and De Haan, 2010, 2011).

In order to decompose the overall survey error deriving from different sources, in the static approach three sub-population are considered:

A - Panel series: all the products enter in the computation of indices;

B - Static population without disappearing products: the products sold in December of the base year are followed during all the year. The new products are not considered by definition. However, disappearing products are assumed to be present (as if replaced).

C - "Pure" Static population: the disappearing products are not replaced and the new products are not considered by definition.

The difference between C and B gives a measure of the error due to the shrinkage, while the difference between B and A quantifies the error due to ignoring the new products. The impact of temporary missing is derived comparing the values of C with and without temporary missing.

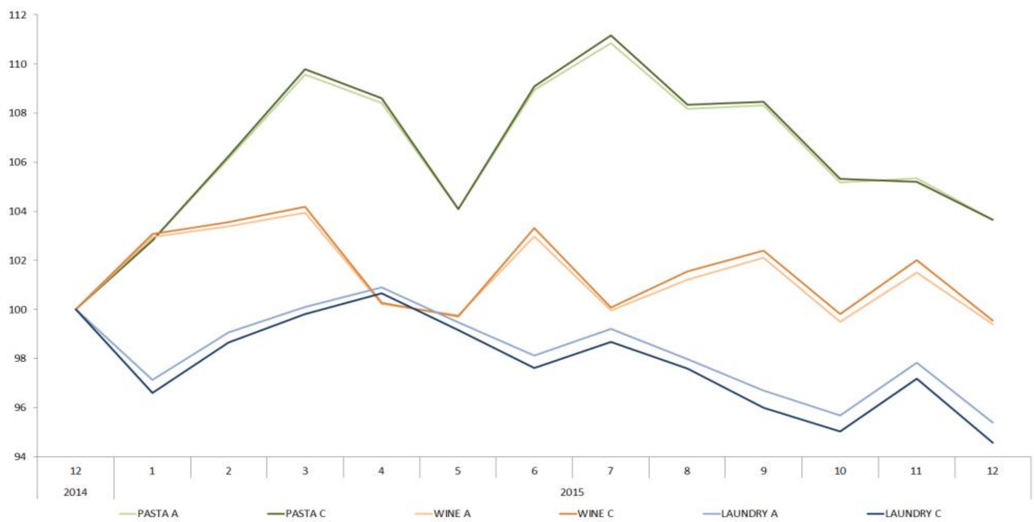
Under the dynamic approach, two sub-population are considered:

A - Panel series. All the products enter in the computation of indices.

D- "Pure" Dynamic population: Only the matched products in two months in a row enter in the computation of price indices.

The difference between D and A can be seen as a difference between a static population and a dynamic one. In this case the impact of temporary missing is derived comparing the values of D with and without temporary missing.

Figure 3. Monthly Jevons indices in scenarios A and C for the consumption markets (static approach).



[3] 500 populations have been drawn and from each population 500 samples have been selected.

Results

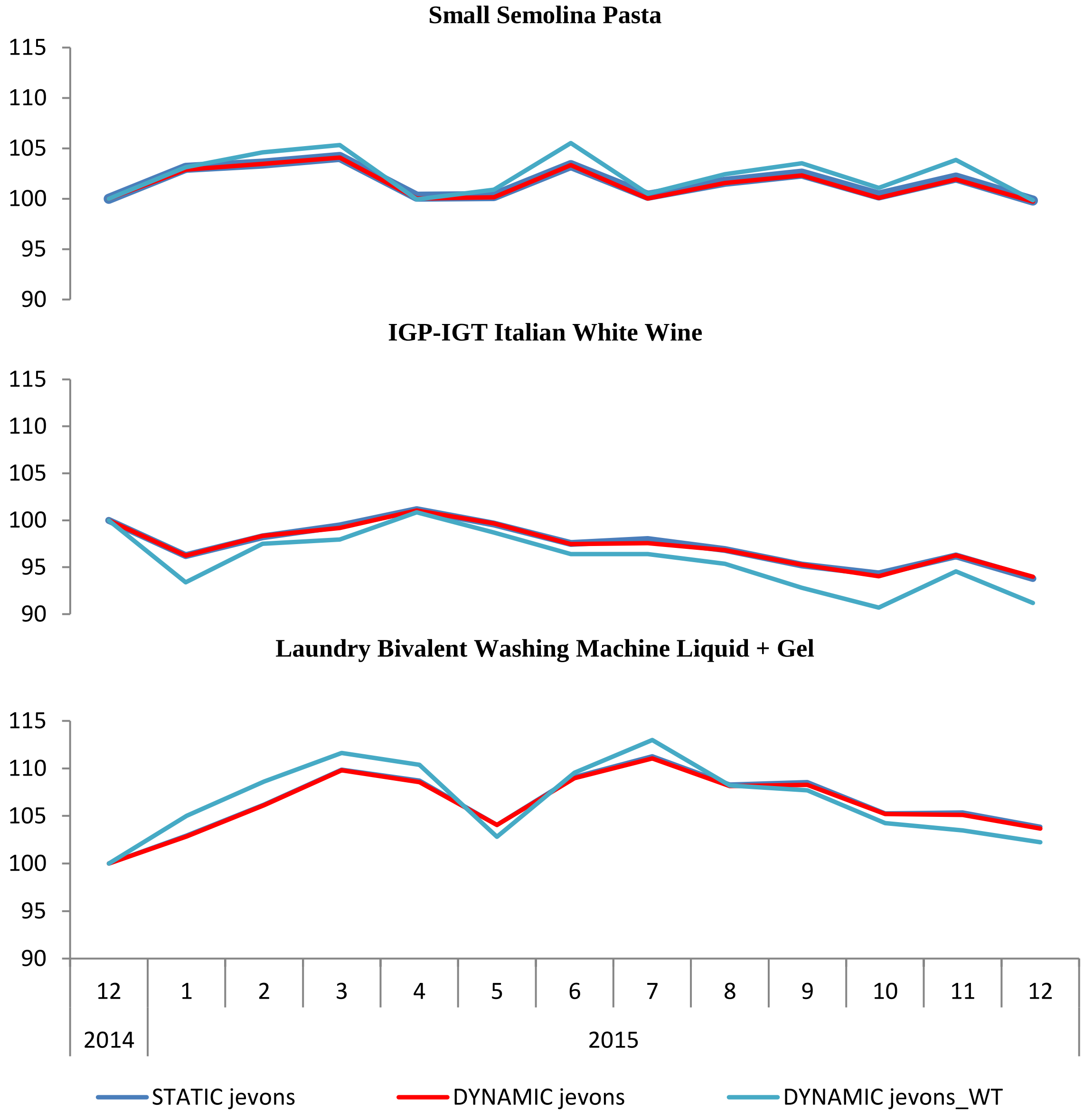
The most meaningful results of this experimental phase are shown to highlight the difference between static and dynamic approach for the Jevons index.

Figure 3 shows that in the static approach the bias due to the shrinkage and to ignoring the entering products increases during the year, especially for more dynamic consumption markets.

The effects are small in “Small semolina Pasta” market and does not affect the variability of estimates, instead it seems affect most “IGP-IGT Italian white wine” market that has medium dynamism but high variability in prices.

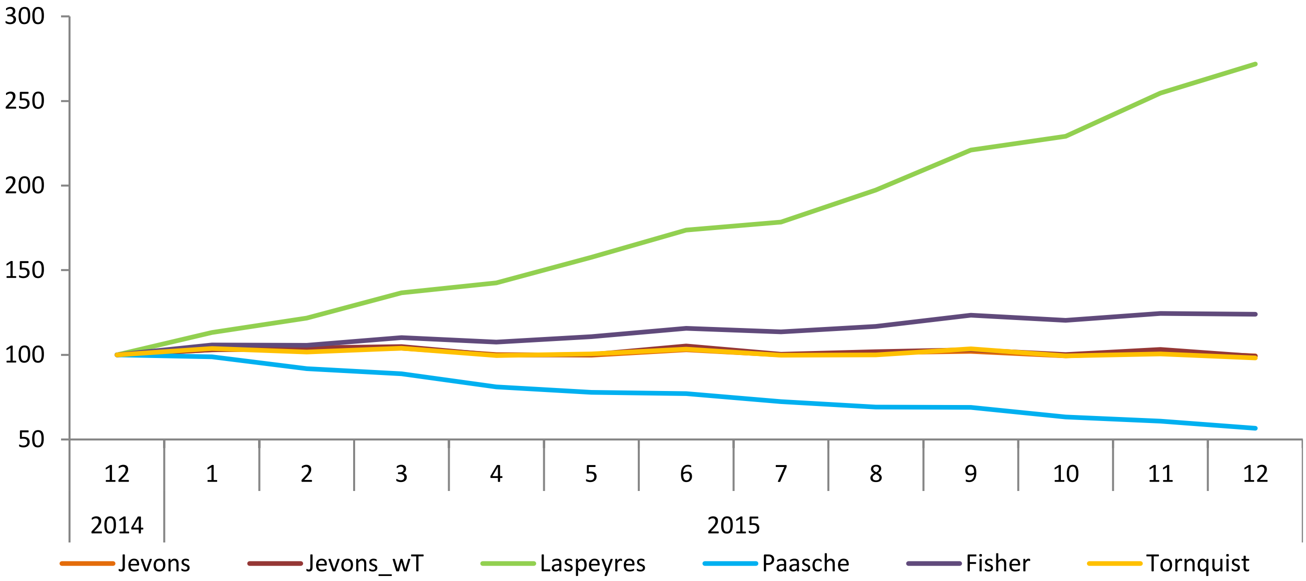
Figure 4 shows a tentative comparison among static and dynamic approach in a close population (scenario A) using the Jevons index with and without threshold. The threshold seems to have a not negligible impact on the levels of the index, mostly for the market with higher variability of prices (IGP-IGT Italian white wine).

Figure 4 – Monthly chained Jevons indices - with and without threshold - in scenarios A under the static and the dynamic approach.



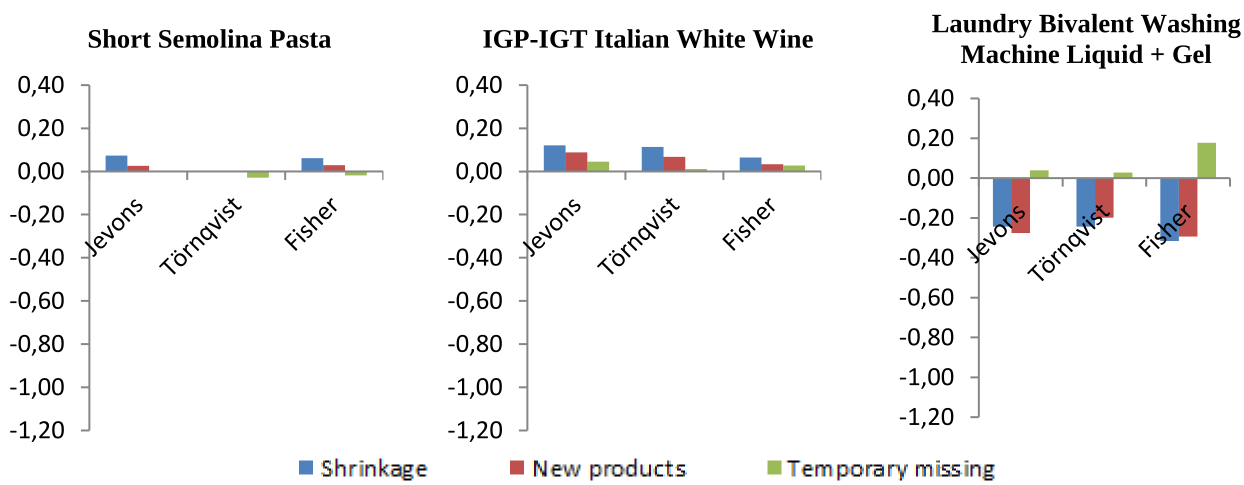
From figure 5, where weighted and unweighted indices are compared for "Short semolina pasta" market, it looks clear that the Jevons index does not suffer of chain-drift, while Laspeyres and Paasche index yes. While Jevons index – both with and without threshold – is stable during the year, Laspeyres and Paasche develop along divergent trends. Superlative Fisher and Törnqvist seem to be bounded between Laspeyres and Paasche values, even if Fisher index is not able to tone down the strong increasing of the Laspeyres index and it affected by an upward chain-drift. Instead, the Törnqvist index seems to be nearer to Jevons.

Figure 5. – Chained weighted and unweighted price indices under the dynamic approach (Short semolina pasta market).



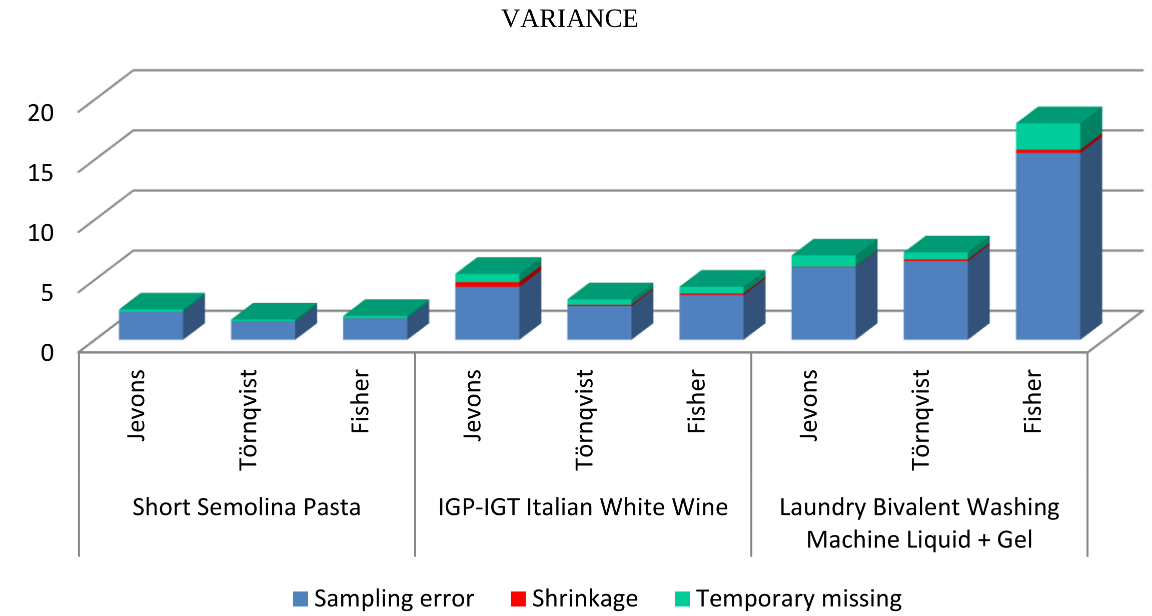
In the following figures the different sources of bias and sampling variance are analyzed in the considered scenarios and approaches.

Figure 6 – Relative percentage differences with respect to the «reference» value of price indices under the fixed approach.



In the fixed approach, splitting the bias by sources, we can note in figure 6 a different behavior among indices and consumption markets. In general, the bias due to the shrinkage is higher than the bias due to excluding the new products and the presence of temporary missing. Furthermore, it increases with the dynamism of the consumption market.

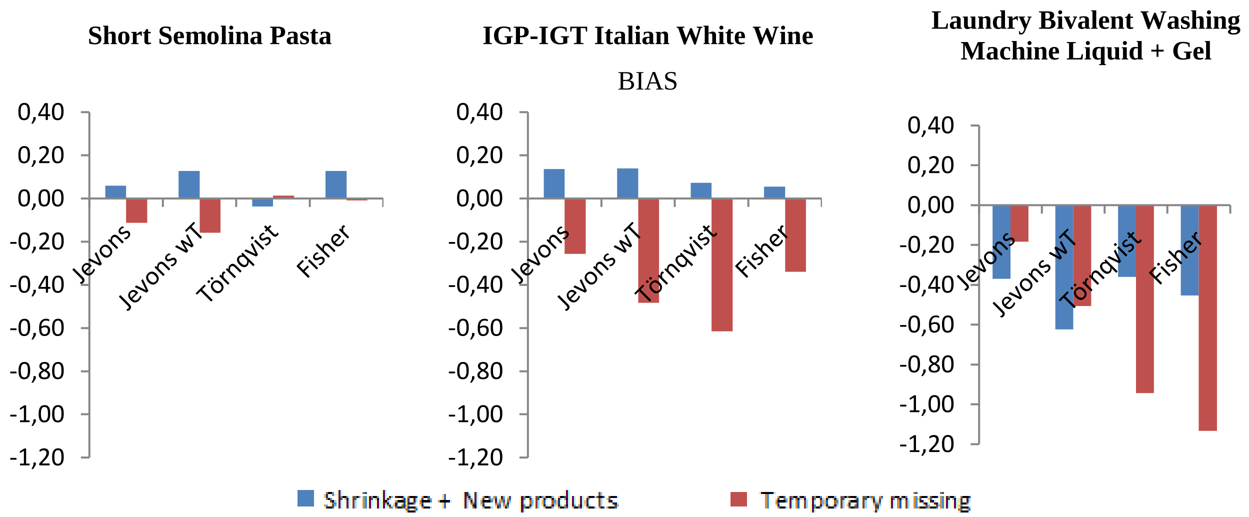
Figure 7 – The increase of percentage relative error due to the shrinkage of products during the year and to the temporary missing under the fixed approach.



With respect to the overall variance, as shown in figure 7, most part is due to the sampling. The shrinkage effect is small in “Small semolina Pasta” market and does not affect the variability of estimates, instead it seems affect most “IGP-IGT Italian white wine” market that has medium dynamism but high variability in prices. The bias due to the temporary missing affect more the market with higher dynamism (“Laundry Bivalent Washing Machine Liquid + Gel”). In general, also variance increases with the dynamism of the consumption market.

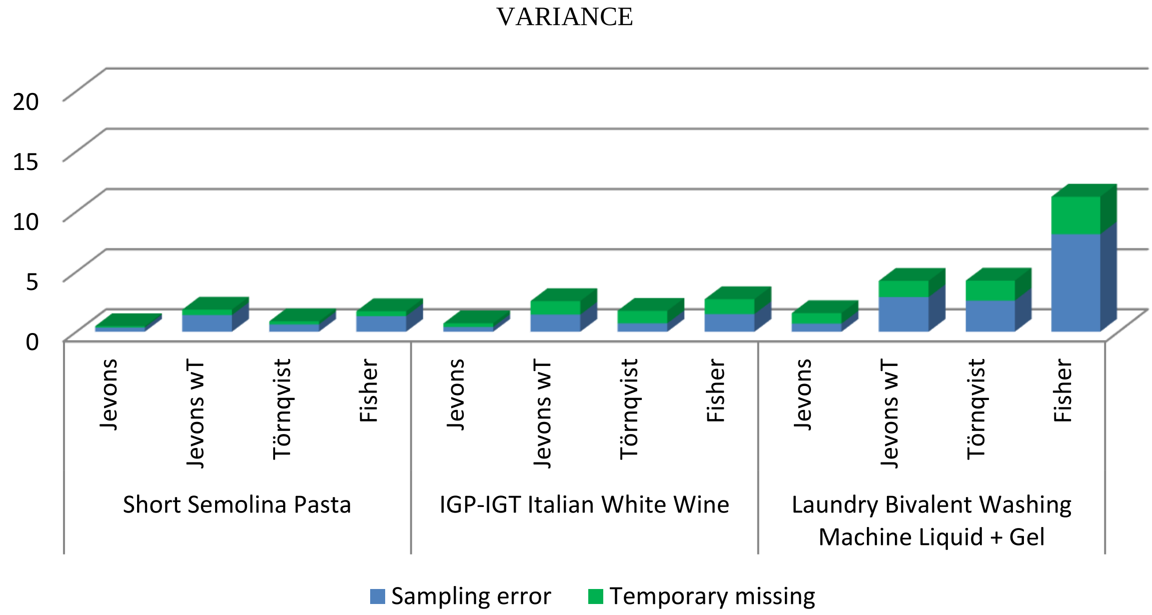
In the dynamic approach, the impact of shrinkage and new product on the bias (Figure 8) is similar to that one under the static approach, while that of temporary missing is higher. This is probably due to the fact that the size of temporary missing included in the computation of the index under dynamic approach is much larger than under the static approach.

Figure 8. Relative percentage differences with respect to the «reference» value of price indices under the dynamic approach.



The variance of the indices under the dynamic approach (Figure 9) is very low, due to the sampling design used (cluster instead of two-stage) and the large size of its sample. Also in this case, the variance increase when increasing the dynamism of the market, together with the variance due to temporary missing.

Figure 9. The increase of percentage relative error due to the shrinkage of products during the year and to the temporary missing under the dynamic approach.



In conclusion, also this study highlights the high heterogeneity of market using scanner data. Sampling and non-sampling error depends on the aggregation formula used and the consumption market features. It seems that the estimators under the dynamic approach are affected by higher bias but much lower variability, especially sampling variability, with those computed under a static approach. This is due to the difference in sample size.

For the same reason, the impact in terms of bias of temporary missing is higher under dynamic approach than under static approach. Further studies can be addressed to derive the sampling and non-sampling error also of multilateral indices which could allow to overcome the chain drift and other issues of weighted indices in the dynamic approach.

5. Concluding remarks

The results of the different experimental phases allowed to individuate the most efficient sampling scheme for the selection of outlets and references in the static approach and to obtain a measure of sampling error and bias in the dynamic approach. The first experiments produced interesting results regarding the performance of sampling schemes and index formulas in a fixed approach. They lead to the conclusion that probability sampling is the better choice in this context.

The possibility of switching to a dynamic approach requires, from an economic perspective, to deal with some complex issues. In fact, weighted indices would enable to exploit better the potential of scanner data for the estimate of elementary index, but they are affected by different drawbacks, first of all the chain drift.

The international debate on the use of scanner data and therefore of a dynamic population approach is currently centered on the issue of how to resolve the chain drift problem related to the chaining of weighted price indices (also Fisher and Törnqvist), while at the same time maximizing the number of matches in the data. A solution to the chain-drift issue might be the construction of weighted transitive multilateral price indices, which are free from chain drift by definition, but other issues must be solved to ensure that previously published index numbers will not be revised. Chaining matched-model superlative indices are recommended in the ILO Manual (ILO, 2004) for the satisfactory properties that characterize them.

Methodological issues submitted to the attention of the Committee

Question 1. In the context of SD, the evaluation of sampling variance seems not a main issue, but from our point of view we should implement some method to obtain an evaluation of sampling errors. Is it better resort to direct estimation or to resampling methods?

Question 2. As dynamic and static approach refer to different population definitions, which can be the key idea to obtain a comparison in terms of accuracy?

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