Methodological aspects and empirical evidence in the use of administrative sources to estimate price dynamics in external trade [1]

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Abstract

This paper explores the possibility to widen the current offer of unit value and price indicators in external trade throughout a more intensive and efficient use of the available administrative sources. In particular, it firstly overviews the opportunities offered by a fuller exploitation of custom records linkage to other sources, such as business registers. Secondly, it presents a suitable conceptual and methodological framework for the estimates of price indicators based on custom records regarding, on the one hand, the definition of the reference population and the target parameter and, on the other hand, a statistically founded method to supersede the lack of details on the characteristics of the products. A generalised method of univariate density estimation and clustering is proposed to estimate homogeneous market segments on the basis of the elementary unit value distribution. A basic version of such method is applied to a subset of Italian custom records referred to years 2005-2007 and it is used to simulate estimates of export and import price dynamics.

Keywords: Unit values, Import and export price indices, Non parametric density estimates, Univariate clustering, Market segments, Administrative sources.

1. Introduction

In the last decade the main international organizations have supported a more intensive use of administrative records for statistical purposes in order to reduce the burden on enterprises and the costs of sample surveys.[4] Administrative data, in fact, are usually very detailed and often easily accessed: if properly treated, they allow the national statistical institutes to meet the increasing demand for additional information. Care must be taken in reconciling them to the statistical needs, but they can be a valid tool to supplement more traditional statistics.

This work discusses the possibility of producing alternative indicators on the behaviour of the prices of goods traded on international markets by means of a more intensive use of

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[4] See for instance UN (2003), Eurostat (2005), OECD (2008) and EC (2009): the latter in particular confirms and supports the strategic role of administrative sources in driving innovations and quality improvements in official statistics. This approach is clearly fostered also by the MEETS program (see the Decision n. 1297/2008/ec of the European Parliament and of the Council of 16 December 2008 on a Programme for the Modernisation of European Enterprise and Trade Statistics).

the available administrative data. Interesting opportunities are in fact at hand for more detailed analysis of unit value dynamics throughout the linkage of custom records to other statistical sources, such as business registers and other structural business statistics, in order to improve the offer of suitable indicators for competition analyses. More thoroughly, the paper focuses on the possibility of using custom data to estimate price indices for imported and exported goods, and on the appropriate conceptual and methodological framework which is needed for this task: on the one hand a proper statistical definition of both the reference population and the target parameter and, on the other hand, a statistically founded method to supersede the lack of details on the characteristics of the products.

Two main methodological challenges are tackled here. The first one regards the specification of a suitable conceptual framework for price indicators based on unit values: the issue is dealt with in par.2 where a solution has been tailored according to the most recent methodological achievements of the Harmonised Index of Consumer Prices (hereafter HICP) in terms of target population, target parameter and statistical design. The second challenge is about the tools to be used for a full exploitation of the information conveyed by custom data in order to supersede some of the main shortcomings of unit values: in par.3 we propose a method based on the estimation of the univariate density function of unit values and on the use of a clustering algorithm to partition the population in market segments, exploiting the qualitative information available in custom records. Par.4 discusses the empirical results of this approach applied to a large subset of Italian import and export data referred to three important groups of products – namely, textiles, footwear and machinery for general purposes – in the period 2005-2007. An evaluation of this approach and some suggestions for further research are finally drawn in the concluding remarks.

2. UVIs and XMPIs: standard theory and new perspectives

2.1 Preliminary remarks

In the economic field, foreign trade statistics are probably one of the best examples of a cost-effective way of producing information through administrative records. Custom data are quite exhaustive and updated and, once they are reconciled to the statistical needs, they provide most of the official information on the international position of a country. Nevertheless, with respect to certain areas of research, custom records have not been used to their full extent yet: new perspectives, for instance, are opened by linking business and trade statistics; others can be imagined in the field of competitiveness analysis.

With respect to the latter, one of the oldest debate in literature is about the use of custom data to produce measures of international price changes. Traditionally the problem of price competitiveness has been framed - and solutions have been proposed - within the macro-economic perspective of national accounts.[5] Nevertheless, the discussion has recently taken

[5] See for example EUROSTAT (2001b) and IMF (2009). EUROSTAT has undertaken for many years a series of actions to enable Member States to produce reliable and comparable price and volume measures of National Accounts aggregates. Commission Decision 98/715 clarified the principles to be applied in measuring prices and volumes for most products of the ESA95 and set up a research programme for the remaining issues. EUROSTAT (2001b) provided a Manual on price and volume measures in National Accounts to give more detailed guidelines in this field. The

a different turn due to the existence of a strong demand for more detailed information able, for example, to explain the latest economic turmoil: whenever drastic economic events occur, the attention is often focused primarily on the behaviour of price relatives and on their influence on the inflation mechanism across countries.[6]

By the same token, in some countries the debate is fixed on the opportunity to asses the "quality upgrading" of exported products in order to understand to what extent pure price competition is still the main strategy pursued by firms on foreign markets (Giovannetti, 2007). Beyond single experiences, though, what is emerging is that detailed demands imply detailed answers that do not have to be necessarily satisfied through the usual approach based on macro-founded indicators (such as traditional price and unit value indexes). More articulated contexts need to be built following, for instance, micro-economic approaches where custom data can be used to their maximum extent (firm-level single transactions) in order to reduce costs and take advantage of both their high level of detail and large availability.

Sample surveys, in fact, are usually quite expensive and consequently sample size is often relatively small: results, then, are expected to be reliable and sound only for the parameters for which the sample scheme has been designed. In the domain of price statistics, for instance, a limited sample size may assign too relevant a role to the management of non responses, replacements and quality adjustments that, on their part, may generate a bias in the estimates if not adequately controlled for within a well structured and coherent statistical design. On the contrary, the use of very large data bases (almost of a census nature such as those from custom records) to produce some measurement of "price" dynamics in a micro-economic frame must be compelled to a definition of the statistical domains consistent with the peculiarity of the data source (therefore, not necessarily identical to what is commonly adopted for a sample survey).

Recent innovations in price collection techniques - and the ensuing access to a larger amount of price quotes – are inducing a more extensive use of unit values (hereafter UV) for the estimation of elementary price indices[7] stimulating the need of providing further methodological approaches.[8] The international literature on the use of UVs as price measures in micro-economic contexts, though, is comparatively meagre especially from the external

Commission Decision 98/715 clarified the principles for the measurement of prices and volumes based on the results of the research programme. The Commission has thus identified the most appropriate estimation methods to be applied (A methods), the alternatives which may be used if the most appropriate methods cannot be implemented (B methods) and the methods which shall no longer be used by 2006 (C methods).In a National Accounts context the preferred measure of price changes is a proper price index estimated from a sample survey. Unit value indices are considered as a secondary choice (B) if price indices cannot be made available. In this respect Member States are also expected to produce innovations and methodological advancements on B methods in order to improve reliability of the estimates (EFC 2010). See also Von der Lippe (2007).

6 In this frame, for instance, the European Commission has recently promoted the monitoring of import and consumption price developments in the EU in order to measure the extent to which consumers eventually benefited from import price decreases (as in textiles and clothing), to quantify linkages between tariffs and consumer price inflation, to analyse possible explanations for the magnitude of these linkages, or to identify factors linking consumer prices to future changes in EU import protection policy. This strategy was outlined in EC (2006) where it is argued that trade liberalisation and more open trade regimes would benefit European citizens in several ways, including through lower prices. See on this issue also Francois et al. (2007) and Institute for International and Development Economics (2007).

7 We refer to improvements in consumer price collection through scanner data (De Haan et al. 1997; Fenwick 2001; Jain et al. 2001; Silver et al. 2002; Triplett 2001; Koskimäki et al. 2003) and other sources like e-commerce and administrative or private databases.

8 Francoise et al. (2007).

trade perspective. The reason is twofold. On the one hand, the use of foreign trade data at firm level is quite a recent achievement boosted by a wider availability of statistical business registers and the improvement of record linkage techniques between business and trade statistics. On the other hand, the use of such measures limited to macro-economic contexts has prevailed for a long time, leaving a more structured micro-economic debate to lag behind.

In Italy, the idea of a more efficient use of custom data stems from the debate about the quality of measurements in official statistics with regard to the economic performance of the country.[9] Economists and users have remarked their dissatisfaction for the lack of import prices indicators (MPIs) and criticized the fact that production price indexes on non-domestic markets (XPIs) are not taken into account in compiling national accounts estimates for deflation purposes, the current practice relating to foreign trade components being, in fact, centred on the use of unit value indices (hereafter UVIs).[10] The recurring objection, by far the dominant point of view, is that UVIs are not proper price indexes and will never be, but unfortunately no alternative solution has been proposed yet to compensate for the lack of MPIs.[11] The debate, clearly shaped within the traditional accounting context, is characterized by a direct opposition of pro and cons of the two categories of indicators.

It is not the purpose of this paper to go into the methodological and theoretical underpinnings of the discussion on deflation practices, for which international manuals already give their valid contribution, nor to insist on methodological elements characterising UVIs as opposed to export/import price indexes (XMPIs). On the contrary, what we intend to explore is the possibility to propose measurements of external trade price dynamics in a micro-oriented context based on a more intensive use of custom data at their finest level of detail (firm level), in order to build up a system of conceptually sound and coherent indicators to be made available for analytical purposes.

2.2 UVI components and segmentation

Given the data set of the micro data corresponding to the transactions taking place in year *y*, with regard to a specific flow (import or export), each generic element can be represented through the following vector:[12]

$$t = [V_t \ , Q_t \ ; c_t \ , CN8_t \ , f_t \ , m_t \ ] \tag{1}$$

where V is the value and Q the corresponding traded quantities, c is the foreign country, CN8 is the eight-digit code of the official commodity classification[13], f is the firm identifier,

[9] The methodology to derive UVIs has been recently reviewed by ISTAT on the basis of sounder techniques for outlier detection and correction (Anitori et al. 2008, 2010).

[10] Banca d'Italia (2008), ISAE (2009). In Italy XPI were released in 2008 (base year 2005=100) but the series are too short to allow a reliable use for NA purposes. Moreover the lack of MPI would imply an asymmetry in the deflation of the import component of GDP when compared to export. This is the reason why NA decided to use UVIs for deflating the corresponding aggregates raising a never ending discussion on the real amount of the industrial value added.

[11] For an earlier analysis of this issue see Siegel (1991).

[12] Vector *t* reproduces the typical structure of a custom record.

[13] The EU official commodity classification adopted in foreign trade statistics is the Combined Nomenclature, directly derived from the UN Harmonised System, where goods are classified up to 8-digit level of detail (around 9.500 codes).

and *m* is the month in which the transaction takes place. From each vector *t* the unit value of a single transaction is derived as follows:[14]

$$P_t = \frac{V_t}{Q_t} \tag{2}$$

Omitting for simplicity the suffixes concerning the country and the firm's code, for the reference month *m* the unit value UV_m^{CN8} of the generic product is equal to the total value of all the transactions of the domain in the observed month divided by the corresponding total quantities[15]:

$$UV_m^{CN8} = \frac{\sum_{\forall t|m_t=m} V_t^{CN8}}{\sum_{\forall t|m_t=m} Q_t^{CN8}} = \frac{\sum_{\forall t|m_t=m} \left(\frac{V_t^{CN8}}{Q_t^i} \right) Q_t^{CN8}}{\sum_{\forall t|m_t=m} Q_t^{CN8}} = \sum_{\forall t|m_t=m} P_t^{CN8} q_t^{CN8} \tag{3}$$

where $q_t^{CN8} = \frac{Q_t^{CN8}}{\sum_{\forall t|m_t=m} Q_t^{CN8}}$ are normalised quantity weights. The unit value index in the reference period *0* is equal to the ratio of the respective UVs derived from (3):

$$UVI_m^{CN8} = \frac{UV_m^{CN8}}{UV_0^{CN8}} = \frac{\sum_{\forall t|m_t=m} P_t^{CN8} q_t^{CN8}}{\sum_{\forall t|m_t=0} P_t^{CN8} q_t^{CN8}} \tag{4}$$

Following the Laspeyres formula, further aggregations of the CN8 headings are derived as value-weighted averages:

$$UVI_m = \frac{\sum_{CN8} UVI_m^{CN8} V_0^{CN8}}{\sum_{CN8} V_0^{CN8}} = \sum_{CN8} UVI_m^{CN8} v_0^{CN8} \tag{5}$$

where $v_0^{CN8} = \frac{V_0^{CN8}}{\sum_{CN8} V_0^{CN8}}$ are the normalised value weights.

Due to its custom-made nature, though, no further distinction of the items of a product is possible within each 8-digit heading. Hereafter we shall refer to the classification with CN followed by the number of digits.

[14] With reference to the single transaction we adopted the symbol *P*, which usually suggests a reference to a price, to denote the elementary unit value. Actually, the unit value defined in (2) can be interpreted as a price only if it is assumed that every transaction is referred to homogeneous items. In principle homogeneity cannot be ensured nor somehow assumed to be the rule. Hereafter we shall conventionally adopt the symbol *P* to represent the unit values computed within a presumably homogeneous context.

[15] Expression (3) holds if $Q_t^i > 0$, which can be easily assumed by default.

Assume now that, on the basis of some specific criterion, the set of the transactions referred to each single domain can be partitioned in K^{CN8} distinct and exhaustive segments defined according to some specified criteria.[16] Then expression (3) can be rewritten as follows:

$$UV_m^{CN8} = \sum_{k=1}^{K^{CN8}} \sum_{\forall t \in k | m_t = m} P_t^{CN8} q_t^{CN8} = \sum_k \overline{P}_m^{CN8,k} q_m^{CN8,k} \tag{6}$$

where $\overline{P}_m^{CN8,k}$ and $q_m^{CN8,k}$ are respectively the average UV and the normalised volume-weight of the *k*-th segment (*k=1,2,……K*) in month *m*. By adapting this result to expression (4) we obtain:

$$UVI_m^{CN8} = \frac{\sum_k \overline{P}_m^{CN8,k} q_m^{CN8,k}}{\sum_k \overline{P}_0^{CN8,k} q_0^{CN8,k}} = \frac{\sum_k \left(\frac{\overline{P}_m^{CN8,k}}{\overline{P}_0^{CN8,k}} \right) \overline{P}_0^{CN8,k} q_m^{CN8,k}}{\sum_k \overline{P}_0^{CN8,k} q_0^{CN8,k}} =$$

$$= \sum_k I_m^{CN8,k} v_0^{CN8,k} + \sum_k I_m^{CN8,k} v_0^{CN8,k} \left(\frac{q_m^{CN8,k} - q_0^{CN8,k}}{q_0^{CN8,k}} \right) = I_m^{CN8} + R_m^{CN8} \tag{7}$$

where $I_m^{CN8,k}$ and $v_0^{CN8,k}$ are respectively the UVI and the normalised value weight of the *k*-th subset in the base year.[17] The first term on the right side of (7) is the Laspeyres weighted average of the within-segment UVIs. The second term measures the weighted co-variation between the UVIs and the change in the market shares (in terms of volumes) of their respective segment: this component is by definition null if market shares do not change. It also represents that part of unit values' dynamics in a specified domain which depends on the composition effects among the segments.[18]

Further aggregations of the elementary domains might easily be obtained from (7):

$$UVI_m = \sum_{CN8} I_m^{CN8} v^{CN8} + \sum_{CN8} R_m^{CN8} v^{CN8} = I_m + R_m \tag{8}$$

The criteria actually adopted for partitioning are very important for the meaning of the results obtained from (7). If the segmentation criteria are held constant across all domains it is possible to compare aggregated UVIs dynamics by segment and to measure the

[16] Such criteria may have to do with any information contained in vector *t* or with any auxiliary variable obtained by linking custom data with other sources such as for instance a business register.

[17] Expression (7) only applies to the segments existing in the base period. Entirely new segments which eventually appear in the current month must be either mapped into one of the already existing segments or imputed.

[18] In the literature on price statistics this last term is known as "unit value bias" and it is referred to any comparison between a UVI and the embedded price index (Parniczky 1980; Balk 1998 2008; Jain at al. 2001; Silver et al. 2002; Bradley 2005; Silver 2007). We prefer to treat this term simply as a residual, in order to stress the fact that it marks a drawback in the use of unit values as price indices but not an intrinsic negative property of unit values *per sé*.

aggregated composition effect among segments; in other words, $I_m^{CN8,k}$ can be aggregated also by segment:

$$I_m^k = \sum_{CN8} I_m^{CN8,k} v^{CN8,k} \tag{9}$$

and similarly for R_m^k. This happens for instance when segments are selected according to some auxiliary variables contained in the available data set (i.e. size classes of transaction values) or defined by the linkage with other statistical sources, such as firm level data from business registers or business statistics (i.e.: number of employees, class of turnover, region, legal type, main economic activity etc.). In such cases, in fact, neither conceptual nor methodological issues emerge in computing (9) - and, consequently, R_m^k - and these indicators can be seen as an enrichment of the information regularly disseminated.

On the contrary, what is more demanding from a methodological point of view is to build indicators of import and export price dynamics. For this purpose, the partition of the transactions into segments must follow the characteristics of homogeneity of the products: in this case, the within component (*I*) could be envisaged as very close to a price index. If such partition in segments is also economically and conceptually founded, expression (7) can be used to derive both the price component in the UVIs dynamics and an the estimate of the residual (*R*), the result depending on the theoretical and conceptual approach adopted to define the index and on the accuracy with which the segments are defined. In the remainder of the paper we develop some steps in this direction providing both a generalised methodological framework and a relatively basic method of partitioning transactions into market segments, testing the results of an empirical application. In particular, the provision of a suitable statistical frame for price indices estimation from custom data will be discussed in par. 2.4.

2.3 UVIs and XMPIs in the standard theory

It has been clearly stated both in literature and in international manuals that UVIs cannot be considered as proper estimates of foreign trade price indexes due to conceptual and methodological differences that prevent the definition of a common statistical ground for the estimation of the population parameter.[19] The recognised "superiority" of a proper XMPIs relies essentially on the evidence that most of the information needed to build up

[19] See for example EUROSTAT (2001a), IMF(2009), UN(1981), and the contributions of Parniczky (1980), Bradley (2005), Silver (2007), Balk (2008). International manuals admit the adoption of UVI only if it is proved that the products which they refer to are sufficiently homogeneous and stable over time; in general, though, the practice is rather discouraged. "*UVIs (...) do not generally control for changes in the product mix within one item, leading to quality changes mistakenly included in the price component. Their coverage of products is generally complete, but even at the most detailed level of trade classification can often include a range of different products. Where the products within an item of the trade classification may appear to be homogeneous this may in reality not be the case as products of similar description may be of very different quality. It may be possible to construct more homogeneous UVIs if the country of origin (or destination) is also taken into account. UVIs are clearly unsuitable for products that are unique or change quickly in specification. (....) The use of UVIs for some products is clearly inappropriate. (....)For product groups that are sufficiently homogeneous over time, UVIs can (...) be considered B methods. The volatility of the UVIs should be examined as a test for suitability (...)*." (EUROSTAT 2001a, p. 51-2).

the estimates comes from a direct and purposive survey where some sources of potential bias can be controlled for *ex ante*. A UVI instead, being some sort of a by-product, does not guarantee the same quality standard despite some well known and appreciated advantages. Nevertheless, it has been repeatedly suggested the idea that a more sophisticated treatment of unit values - by means of a complete exploitation of the content of custom records - might offer a good alternative for the estimation of price indices.[20] The study of unit values behaviour within a highly detailed group of products is, in particular, focussed on as an important element in determining the feasibility of their use as price indicators. On the one hand, most of the attraction in the use of custom records relies on the potential exhaustiveness of the source. Custom data provide an almost full coverage of the transactions on which the target population of a foreign trade index should be based on, whilst survey data collections provide estimates usually based on relatively small samples whose size is conditioned by budget and burden constraints. Custom data also immediately account for the entry of new products (and the exit of old ones), making it possible a continuous and updated monitoring of the markets; direct surveys, instead, rely on intense quality adjustment and replacement techniques to deal with entries and exits. Furthermore, custom records provide a full coverage of the products traded (direct surveys generally regard only manufactured goods) and, finally, they include all the firms dealing with external markets, whilst XMPI surveys tend to exclude trading companies (especially at export).

On the other hand, the main drawbacks in the use of custom records derive from the fact that a direct enquiry to firms for some important details is precluded: the impossibility of checking the specific conditions related to the single transactions, known in literature as price determining characteristics (i.e: the terms of sales, the time of contract, the transaction quantity etc…), the evidence of misclassifications and compilation errors can undermine the accuracy of the estimates. In particular, the lack of details about the product for which a "price" must be obtained is the most serious shortcoming. Although commodity classifications are very detailed, the impossibility of identifying the characteristics of the items classified within a same elementary code does not allow to check if its internal structure remains stable over time. This implies that an increase/decrease in the UV may be due to unidentifiable non-price effects that impair the measurement of pure price changes (Balk 1998; Von der Lippe 2001; IMF 2009): in other words, the UV of a specific product code is potentially biased with respect to the correspondent price if no homogeneity of the items transacted within that code is assured - that is, if composition effects are at work.[21]

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[20] IMF (2009, p. 85-7) suggests to put more efforts on stratification (geographical or by firm) and data validation (treatment of outliers). EUROSTAT (2001a, p. 51-2) traces a solution based on a combined use of UVIs and price indices (estimated through a survey) for goods with stable UVIs and on the estimate of adjustment factors to be applied to the rest of the products. EFC (2010, pag.38-39) suggests stronger efforts on the improvement of B-methods: "*In order to accelerate the availability of more reliable and comparable data, it was proposed to consider the B output methods as reference methods, and to include the results of A methods in satellite accounts, while pursuing the development of more robust and harmonised explicit quality adjustment methods. All efforts should now be focused on further specifying and implementing B output methods that are solid theoretically and that can be applied consistently by all Member States, in particular in the context of the revision of the European System of Accounts*.".

[21] More precisely, one or more of the following conditions must be respected in order to avoid any bias in the use of a UVI to estimate a price index: quantities must increase proportionally between the price reference and the price reporting periods; the prices in the reference period must be all equal; absence of correlation between quantity relatives and price relatives (Balk 2008, p. 74).

This is the central issue in the conceptual frame supporting the statistical design of a price survey: under specific and sometimes elaborated assumptions, all is based on the strict control of items' characteristics so that any change is somehow managed and eventually reflected on the estimates (matched-model approach).[22] The driving practical principle of the matched-model approach is that, with regard to the products traded by a single firm, no quality change must intervene to modify the item's characteristics in order for a price difference between two points in time to be a "pure" price change. This assumption guarantees a coherence of the measurement not only at firm level but also for aggregations across firms selling or buying the items belonging to the same product heading: even if the items are not identical across firms, the aggregation of the elementary price indices within each heading is not affected by non-price effects. However, since in practice the frequency of the shifts in the commodity characteristics is quite high - especially at import - several methods for quality adjustment are recommended by international manuals in order to maintain measurement coherence over time.[23].

Despite the fact that at some stage of the survey strategy, firms and broad product categories are selected with probabilistic criteria, the final selection of the items for which price quotes are collected is usually purposive (i.e., it is made together with some representative of the firms and chosen among the most traded over a long period): in this way the usual problems related to the classifications adopted in foreign trade statistics are overcome and the aim of a pure price index better defined. The fact that the final sample of items is not randomly chosen can generate biased estimates, unless it is assumed that firms' pricing policies regarding the selected items do not differ systematically from the rest of the items traded and that the firm does not change its available offer.

Through the matched-model approach the universe from which the survey is designed has its own structure defined, depending on the particular set of commodities, price determining characteristics, industries etc. the statistician is interested in. Several possible universes can be identified according to the aim of the index, but once the population is chosen the structure is clear. Changes in this structure may occur (i.e: new products coming in/old products going out) but adjustments are in principle always possible to preserve the original assumptions.

In this context, the very nature of custom data makes them not compatible with the matched model approach and, more generally, with any approach based on a strict control over items' characteristics: if no items' specification is possible, composition effects are almost impossible to be controlled for. Custom data do not allow like with like comparisons.

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[22] No changes in the data collection, in items specifications, in the reporting firm, in the country of origin/destination of the goods etc. are allowed. In other words, all the *price determining characteristics* of the good must be kept constant over time (see IMF 2009). "*Pricing matched commodities constrains the selection of commodities to a static Universe of commodities given by the intersection of the two sets of commodities existing in the two periods compared. This static universe by definition excludes both new commodities and disappearing commodities, and in both cases their price behavior is likely to diverge from that of the matched commodities. Price indices have to try to take account of the price behaviour of new and disappearing commodities so far as possible.*" IMF (2009, p. 27).

[23] Inappropriate or over adjustments in XMPIs can be a problem often resulting in smoother time series; unfortunately, the impact of quality adjustments on price estimates is very seldom assessed even if this information could be very important to evaluate the accuracy of the estimation.

2.4 Conceptual issues in a HICP perspective

It follows that in order to give a sound statistical meaning to tentative price measures based on custom records, some alternative statistical structure of the universe is needed. To define such a structure it might be fruitful to refer to the most recent developments in the methodological and legal framework of the European Harmonised Index of Consumer Prices (HICP)[24] where design based approaches have been largely discussed and formalised. The aim is pursued without renouncing to the exploitation of the richness of administrative sources to its maximum extent.

The central issue in the HICP methodological and legal framework is the identification of a structure of the target population based on the concept of consumption segment. Namely a "consumption segment by purpose" or "consumption segment" is *"(...) a set of transactions relating to product-offers which, on the grounds of common properties, are deemed to serve a common purpose, in the sense that they are marketed for predominant use in similar situations, can largely be described by a common specification and may be considered by consumers as equivalent."*.[25] Every universe can be partitioned into exhaustive consumption segments where each segment is characterised by clusters of transactions which are deemed to be homogeneous with regard to marketing targets, consumption purposes and product characteristics.

Consumption segments are entities relatively stable over time and represent the fixed objects to be followed in a Laspeyres perspective. The target parameter - a monthly Laspeyres index - is obtained as the ratio of two simulated consumption expenditure (Ribe 2000) consistently defined by mapping the transactions within each consumption segment in the weight reference-period onto the product-offers available in the same segment, respectively, in the price reference and price reporting periods. From an economic perspective, consumption segments define a structure in the target population which depends solely on the functioning of the market and on the purposes of consumers.

Although the HICP Regulation recognises that some ambiguities still concern the definition of consumption segments,[26] and although the definition of the mapping function remains an open issue, the above theoretical structure establishes a logical correspondence between pairs of objects in two periods making it possible to compare like with like; as a consequence, sampling, grossing up, percentage changes etc. from this frame make full sense from a statistical point of view, once the underlying logic is agreed upon. Another key point of this structure is the fact that the adoption of consumption segments fosters the strategic role of a case-by-case analysis of consumer markets (as it happens, for example, with the structure of supply and demand, the marketing approaches and the segmentations adopted by producers and dealers etc.).

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[24] See EUROSTAT (2001b), EC Regulation n.1334/2007.

[25] EC Regulation 1334/2007. A product-offer identifies the object of each transaction between two parties, namely *"(...) a specified good or service that is offered for purchase at a stated price, in a specific outlet or by a specific provider, under specific terms of supply, and thus defines a unique entity at any one time"* (EC Regulation 1334/2007, art.1.1): the set of all the transactions, and consequently the product-offers they refer to, contribute to characterise the statistical target population.

[26] EC Regulation 1334/2007 explicitly recognises that *"(...) an ambiguity in this concept concerns the level of aggregation at which it is defined and applied"*. This structured framework for the definition of HICP statistical universe remains in fact a theoretical tool open to a range of different solutions, while methodological and empirical research is still needed in order to provide complete statistical designs. The consumption segments represent also the population used for replacements and substitutions as each of them can be seen as a self-standing sub-universe.

On these premises, it is interesting to explore the possibility to structure a reference universe for custom data in a similar fashion, defining economic objects as clusters of transactions, homogeneous according to some rules, and labelling them as market segments.[27] The partition in subgroups will obviously need to be exhaustive within the domains they refer to. According to a HICP-type of approach these market segments represent the fixed entities whose price level has to be followed over time. Once the structure is defined in a weight reference year it will be replicated on to the set of available transactions in any current period in order to give sense to the target index number. This will help to overcome the main uncertainty pending on any "price" measure obtained from custom records (mostly related to the fact that any reference to some clear target population never seem to be straightforward) giving a new relevance to the measurement of the target parameter.

Assuming the viewpoint of a firm dealing with external markets, a criterion is needed to split the sets of transactions relating to each single reference domain into market segments. For each separate flow we decided to identify as a single domain the set of all transactions relating to a specific CN8 heading traded with a certain geographical area (hereafter GEO)[28] in a specific time period. This level of detail was judged, in fact, most appropriate to give evidence of the existence of different markets (and implicitly to deal with different items in the same CN8 heading), the only caution being to ensure the presence of a sufficient number of observations within each domain.[29]

3. The partition of UVIs target population into market segments: a generalisation of the clustering approach

Consider a generic domain *d* of transactions, defined by a given pair of CN8 and GEO in a given period. Consider also a transformation of the associated unit values (2):[30]

$$x_t = G(P_t) \tag{10}$$

Assume now that the domain is partitioned in K market segments[31] and that the values of x_t^k ($k=1,2,...,K$) within each segment are the realisations of a random variable with

[27] Reference to market segments as opposed to the consumption segments defined for the HICP is due to the fact that in external trade frame the point of view is traditionally that of firms and not of consumers.

[28] We chose to adopt the same geographical breakdown used for ISTAT UVIs series (Istat, 2003) in order to enable comparisons with the official figures. The breakdown includes both single countries and *ad hoc* areas. The general rule allows to single out all the 27 countries of the EU area and for each continent (or subcontinent) countries for which foreign trade with Italy is particularly important or shows a growing trend. We acknowledge that in some cases it would have been more appropriate to tailor this breakdown on our specific investigation needs in order to improve the coverage in specific areas, this aspect being of paramount importance and a relevant issue for further investigations.

[29] It is possible to identify finer strata (i.e: firm level domains by CN8 and GEO) if the number of transactions included in each of them allowed it. Here information at firm level is maintained but it will be used once markets segments are identified. Note that the possibility to link custom data to business registers enables to consider groups of firms on the basis of characteristics like activity sector, size, region, etc.. which could be stratification variables themselves. The only constraint remains, obviously, the number of observations within each strata.

[30] G is usually a log-transformation given that the distributions of unit values are frequently asymmetric and positively skewed.

[31] A single domain could be represented, for instance, by exports of cotton T-shirts (CN8) to Germany in each month of 2007. Distinct market segments could be represented by the (unknown) quality score (very low, low, medium, high ecc.) of T-shirts presumably reflected in the level of the UVs.

unknown density function $f^k(x)$. Assume also that, due to the transformation (10), the functions f^k are all well-behaved, i.e. nearly symmetric around their mode $\bar{x}^k$ (with $\bar{x}^k \geq \bar{x}^{k-1}$) and with a relatively small standard deviation σ^k. The overall density function computed for any value *x* in the whole domain is derived from the weighted average of the *K* densities:

$$f(x) = \sum_k f^k(x) q^k \tag{11}$$

where q^k are the normalised volume weights of each market segment in the *k-th* domain. The objective is to provide an estimate $\hat{f}(x)$ of $f(x)$ and to derive from it a possible partition in market segments. Since both the true partition of the domain and the functions $f^k(x)$ are all unknown, $\hat{f}(x)$ can be estimated on the basis of the empirical distribution of the data collected in the target period: such an estimate can be obtained by means of non parametric methods - for instance, some type of univariate kernel method (fixed or variable) or by means of a nearest neighbour estimate or with other dedicated approaches.[32]

While the density functions $f^k(x)$ can be assumed to be roughly symmetric around their mode, $f(x)$ and its estimate $\hat{f}(x)$ are generally asymmetric with a plurality of local maxima.[33] The problem is to check for the local maxima of $\hat{f}(x)$, to examine the saddles around them and to assess the possibility to treat it as the mode of a function $\hat{f}^{\hat{k}}(x)$ referred to the estimated market segment $\hat{k}$ defined on the basis of the some measures of homogeneity and concentration of the unit values in the domain. The set $\{\bar{x}^{\hat{k}}\}$ of the $\hat{K}$ estimated local maxima selected from the analysis of $\hat{f}(x)$ is used as a set of market segment identifiers:[34] let $\pi^{\hat{k}}(x)$ be the probability that each observed *x* in the domain belongs to the generic segment $\hat{k}$.[35] The estimate of the average unit value for $\hat{k}$ in a given year is then obtained as:

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[32] Bean et al. (1980), Silvermann (1981, 1986), Izenman et al. (1991), Terrell et al. (1992), Jones et al. (1996).

[33] It is well known that for density estimation a global window width kernel estimator may not perform well when the underlying empirical density features require different amounts of smoothing at different locations points (Wand et al. 1991). This is certainly likely to happen with UV or price distributions, usually characterised by log-normal densities and, a strongly positive skewness. One of the anonymous referees has rightly pointed out that "*the number of modes (and minimums) on a kernel-estimated function does depend on the scale (original or logarithmic) of the data*" with possible alterations of the original multi-modal structure of the data. We certainly agree on the need for further research in this direction and especially in the automated detection of false maxima, eventually determined by the overlapping tails of two contiguous $\hat{f}(x)$ and more likely to happen with log-transformed data.

[34] The choice of the notation relating to *K* wants to stress the fact that the estimation of the market segments is the core methodological issue.

[35] The selection of these segments might for example be obtained with a clustering algorithm (Pisani, 1993) and/or by a discriminant analysis. These approaches will be tested as further developments of the results exposed in this paper.

$$\overline{P}^{\hat{k}} = \frac{\sum_{t \in \hat{k}} x_t Q_t \pi_t^{\hat{k}}}{\sum_{t \in \hat{k}} Q_t \pi_t^{\hat{k}}} = \sum_{t \in \hat{k}} x_t q_t^{\hat{k}} \tag{12}$$

The monthly series of the average prices $\overline{P}_m^{\hat{k}}$ is accordingly derived and, as a consequence, the monthly price indices by segment can be compiled as follows:

$$I_m^{\hat{k}} = \frac{\overline{P}_m^{\hat{k}}}{\overline{P}^{\hat{k}}} \tag{13}$$

and the index for the whole domain is given by:

$$I_m = \sum_{\hat{k}} I_m^{\hat{k}} w^{\hat{k}} \tag{14}$$

where $w^{\hat{k}}$ are the normalised value weights of the $\hat{k}$-th segments. It is important to notice that the segmentation is domain-specific and that there is no possibility to compare segments of different domains.[36]

As an example, we report the outcome of a case study related to three distinct CN8 headings, each belonging to one of the groups of products we decided to focus on, namely Other textiles, Footwear and Machinery for general purposes. These groups represent part of the *core* of Italian trade although they have quite different characteristics: in particular, the first two typically address consumer markets whilst the latter concerns mainly investment goods tailored on industry needs.[37]

For each heading, two domains have been selected among those with a larger number of records according to the country of destination. Figure 1 plots the estimated density distributions $\hat{f}(x)$ of the log-transformed unit values (10) for each domain. Such estimates have been obtained by means of a uniform kernel of fixed radius.[38] It is possible to notice that within each CN8 the shape of $\hat{f}(x)$ changes as we consider different destinations. In the case of Other textiles, for instance, this is particularly evident: export UVs relating to country A have in fact a bi-modal distribution - corresponding to quite different UV levels (respectively 13.5 and 30 euro) - well separated by low density saddles; in this specific case, the delimitation of at least two segments appears feasible.

UVs referred to country B show, on the contrary, an unimodal density distribution (the mode being almost coincident with the lowest of country A) with some noise in the right tail:

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[36] This implies that expression (9) cannot be applied and that it is not possible to derive aggregate indices by segment.

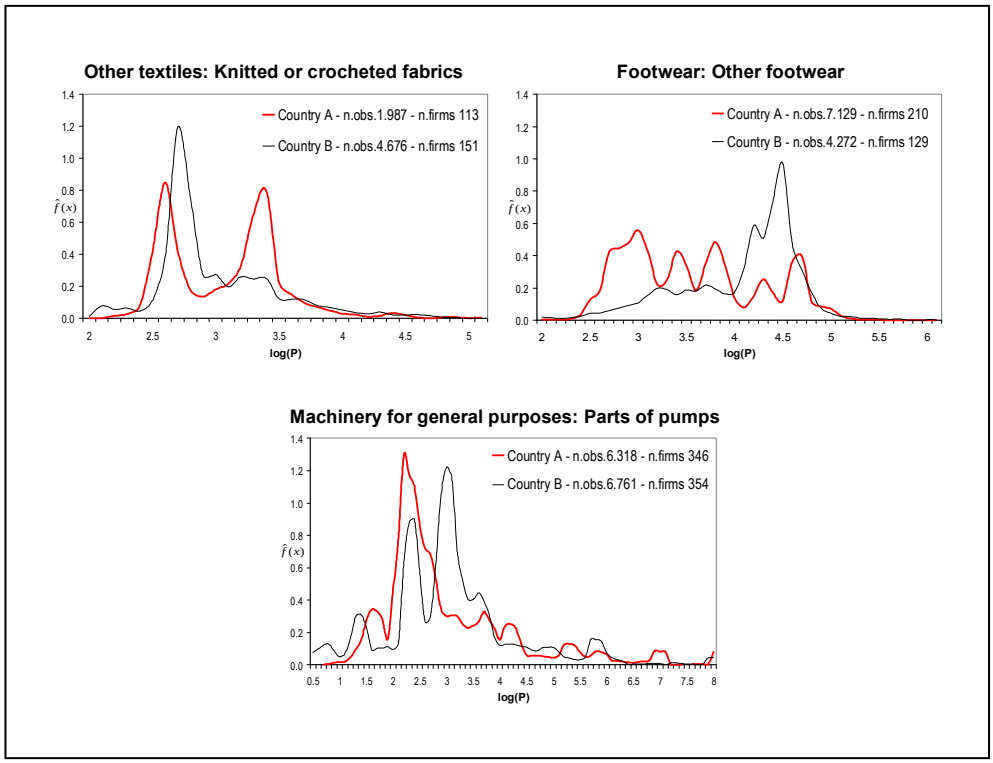
[37] In 2005, at export, Other textile represented about one third of total Textiles (10% at import) , Footwear more than half of Leather goods (53% at import) and Machinery for general purposes is more than 30% of Total machinery and apparel (29% at import). The CN8 headings considered in the case study are: "Knitted or crocheted fabrics" (code 60041000) for Other textiles, "Other footwear" (code 64039996) for Footwear and "Parts of pumps" (code 84139100) for Machinery for general purposes. The groups correspond to the 3-digits of the EU Classification of Products by Activity (CPA) which is linked to the CN through a corresponding table. See, http://ec.europa.eu/eurostat/ramon/index.cfm?TargetUrl=DSP_PUB_WELC.

[38] See Silverman (1986). The observations have been weighted by the corresponding volumes and standardised, while the radius has been set to 1% of the standard deviation.

the isolation of at least one single segment appears here very reasonable. For Footwear, the example reports quite different shapes of $\hat{f}(x)$: in particular, the density referred to country A has at least four well separated local maxima, ranging from 20 to 110 euro. The one relating to country B is by far more concentrated on a high-priced segment (distribution around the mode reveals a lower kurtosis with a high-density saddle point on the left): in this specific case, a single segment would imply too large a range in UV levels (from 60 to 120 euro) and further efforts are needed to improve the discriminatory power of the method. As for Machinery, $\hat{f}(x)$ appears to be unimodal with respect to country A with a large positive tail, whilst two local maxima appear for the density function relating to country B (corresponding to a range from 11 to 20 euro), sharply separated by low density saddles. In both cases the segments appear well defined, although slightly asymmetric for country A.

The example suggests that further investigation are needed whenever the partition algorithm is not sufficiently discriminating; in such cases a more intensive use of firm level information and further investigations on the distribution of the variable may be necessary in order to improve the classification method and to avoid excessively time-consuming elaborations usually associated to the application of density estimation and cluster analysis to such large and complex data sets.

Figure 1 - Density function $\hat{f}(x)$ of the log-transformed export unit values by CN8 heading and country of destination. Year 2007



4. An application to a subset of custom data

4.1 Main features of the data base

Based on the general approach outlined in par. 3, in this paragraph we test a straightforward, time saving and effective method of partitioning each domain into market segments in order to compile an estimate of both the price dynamics and the residual composition effect seen in expression (7) above. For this purpose, we use custom data referred to all import and export transactions observed between 2005 and 2007 relating to the CN8 headings belonging to the groups of products singled out in the example above (see Figure 1).

Table 1 outlines the main structural characteristics of the available information in 2005 (base year of the forthcoming index).[39] Several hundred thousands of records are available in the CPA groups under scrutiny and, as expected, the number of transactions at export nearly doubles the corresponding elementary data at import. The amount of domains - defined by crossing the CN8 headings and more than fifty GEO modalities - ranges from 3,000 to more than 9,000 at export and from 2,000 to more than 5,000 at import, showing in both cases larger absolute values in textiles and machinery. In footwear, though, the amount of transactions is the most relevant despite the lower number of products and firms. Within each CPA group, trade is highly concentrated on few CN8 and firms, giving evidence of a certain number of low-value transactions, occasional operators and low volumes.[40]

Table 1 - Main characteristics of custom data set, by type of flow and CPA group. Year 2005

MAIN GROUPS OF PRODUCTS (CPA)	No of products traded (CN8)	No of trans-actions	Firms		Domains			
					CN8-GEO		Firm-CN8-GEO	
			N.	Trans-actions *(avg)*	N.	Trans-actions *(avg)*	N.	Trans-actions *(avg)*
			EXPORT					
Other textiles	301	481.874	10.800	*44,6*	9.583	*50,3*	75.636	*6,4*
Footwear	73	892.016	6.869	*129,9*	3.245	*274,9*	100.607	*8,9*
Machinery for g.p.	224	823.958	13.353	*61,7*	7.223	*114,1*	118.868	*6,9*
			IMPORT					
Other textiles	302	247.560	10.099	*24,5*	5.381	*46,0*	56.997	*4,3*
Footwear	73	227.988	6.149	*37,1*	1.913	*119,2*	25.666	*8,9*
Machinery for g.p.	223	413.892	12.637	*32,8*	4.186	*98,9*	5.183	*7,8*

Source: elaboration based on custom data

Although the variability of UVs within a single CN8 is generally extremely high,[41] the auxiliary information included in custom data may help to reduce it drastically. The results

[39] These characteristics remain stable also in the following two years.

[40] As example we refer to the case of Other textiles at export where about one third of the products sold with more than 1.000 outward transactions account for 87,8% of total transactions and 85,9% of values. Figures by GEO show that one fourth of the areas accounts for 95% of the total value of transactions. Finally, only 10 to 15% of firms have more than 100 transactions: those firms account, though, for 70-90% of the total value traded depending on the CPA group.

[41] In three headings out of four the UV have a coefficient of variation higher than 100%; in a quarter of the headings it is higher than 500%.

of the analysis of variance reported below in table 2 show that, within each CN8 most of the UV variability is accounted for by firm and GEO (the F-test is highly significant for most products in both cases). At a 5% significance level, firm effect is considerable for more than 90% of the headings both at import and at export, whilst GEO effects appear in general more significant at export or, specifically, for imported footwear. Interaction effects on the contrary are significant in less then 20% of the headings (below 10% for textiles).

Due to the high coverage and to the explanatory power of the firm level information, these results seem to encourage the search for solutions based on selective designs where original domains characterised by a low number of observations may be aggregated, for instance, by properly defined geographical areas, without biasing the estimates.

Table 2 - Analysis of variance on the distribution of unit values, by type of flow and CPA group. Years 2005-2007 *(number of CN8; % share of CN8 headings with 5% significant F-test)*

YEARS	Other textiles				Footwear				Machinery for g.p.			
	No of CN8	Firm effect	GEO effect	Inter-action	No of CN8	Firm effect	GEO effect	Inter-action	No of CN8	Firm effect	GEO effect	Inter-action
					EXPORT							
2005	106	96,2	65,1	36,8	67	100,0	67,2	49,3	106	92,5	66,0	41,5
2006	112	98,2	60,7	32,1	69	100,0	68,1	60,8	106	94,3	67,9	45,3
2007	108	94,4	69,4	33,3	68	98,5	70,6	58,8	108	87,0	63,9	41,6
					IMPORT							
2005	69	100,0	33,3	2,9	36	100,0	63,8	19,4	80	91,3	41,3	18,8
2006	72	95,8	27,7	6,9	40	100,0	67,5	20,0	86	93,0	44,2	17,4
2007	75	98,7	42,7	9,3	41	100,0	68,3	9,8	89	92,1	44,9	13,5

Note: The test has been limited to the CN8 headings with at least 1.000 observations and to the domains (firm-CN8-GEO) with at least 20 observations

4.2 A simplified approach for identifying market segments

The general method outlined in par. 3 provides a partition of each domain in several market segments on the basis of the underlying distribution of unit values (eventually transformed according to expression (10). It relies, in particular, on the estimation of the domain's density function. The use of unit value densities implies the assumption that consistent differences among unit values within a single domain are an indirect evidence of the existence of several market segments. Although this is not necessarily true for all domains, we deemed it conceivable in general, due to the fact that pricing policies on foreign markets are usually constrained by international competition; in particular, with regard to a specific product sold in (or bought from) a specific country by several firms, we reckon not unlikely to assume that differences in price levels may reflect differences in the product offers, the latter being supposed on their part to intercept different market targets. The more homogeneous the product heading, the truer; more generally, we believe that if the amount of observations at firm level in each domain is very large this assumption can be still reasonable and hold.

Nevertheless, from a practical point of view, care must be taken to ensure an accurate screening of the characteristics of the domains' density distributions and, consequently, of the validation of the statistical procedures adopted to classify observations into segments.

The method of partitioning proposed here is based on a deterministic linear algorithm applied on annual data with the aim to obtain estimates, at CPA 3-digit level, of the UVI components *I* and *R* as defined in (7), that is the price index referred to the specific partition in market segments (i.e. the average within-segments component) and the additive residual measuring the composition effects between market segments in a same domain. For each domain the method singles out one subset of homogeneous transactions as follows.

Consider the distribution of the transformed UVs (10) associated to the transactions of each domain *d* as defined in par. 3.[42] Call x^q the *q*-th percentile of their distribution.[43] Given an integer $j \geq 1$ relatively small, we consider the estimate of the density distribution of transformed UVs as a function of the *j* inter-percentile relative range (suffix relating to the domain *d* is here suppressed):

$$\hat{f}\left(x^q\right) = \lambda - \frac{x^q - x^{q-j}}{(x^q + x^{q-j})/2} \tag{15}$$

where *q=j,...,100* and λ is a positive scale parameter.[44] Select the percentile $x^{q'}$ that maximises the function (4.1) over a predefined threshold $(\lambda - \mu)$:[45]

$$x^{q'} \mid \hat{f}\left(x^{q'}\right) = \max_{x^q}\left[\hat{f}\left(x^q\right)\right] \quad and \quad \hat{f}\left(x^{q'}\right) > \lambda - \mu \tag{16}$$

When $x^{q'}$ exists, the centre of the interval ($x^{q'-j}$, $x^{q'}$) is consequently considered as a major accumulation point of the domain:[46]

$$x' = \frac{\left(x^{q'} - x^{q'-j}\right)}{2} \tag{17}$$

We use (4.3) as the centre of a price interval $\left(x'_L, x'_U\right)$ which marks the borders of the main market segment in *d*, labelled with $\hat{k}^d$.[47] Several alternatives have been tested concerning the criteria to derive the above interval. Two classes of solutions have been considered in our empirical work: symmetric intervals and asymmetric intervals with constrained UV's variability.[48]

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[42] Only the domains with at least 200 transactions have been considered in the analysis. Nevertheless, the weights of the excluded domains are used for upper level aggregations of the indexes.

[43] In this case we considered bounded quantity weighted percentiles. In any case, $x^0 = \min(x)$ and $x^{100} = \max(x)$.

[44] The *j* inter-percentile relative range is the ratio between the difference between the *q*-th and the *(q-j)*-th percentiles and their average: it varies between 0 and 1. In our applications we set *j=4* on the basis of empirical evaluations. The smaller *j* the higher the probability of identifying false accumulation points; a higher *j* increases the smoothness of the density function. As a matter of fact *j* plays the role of the bandwidth in kernel density estimation (Silverman 1986).

[45] In the elaborations, μ was set to 0.1.

[46] In principle the occurrence of more minimums is possible, especially for $\hat{f}(x) = 0$: in this cases the main accumulation point is chosen taking into account the values of function $\hat{f}(x)$ in an extended interval.

[47] The notation stresses the fact that the main segment *k* is domain-specific.

[48] The bounds of symmetric intervals are expressed in function of x' : $x'_L = x'(1-\vartheta)$ and $x'_H = x'(1+\vartheta)$, with $1 > \vartheta > 0$. The bound of asymmetric intervals are determined adding to segment *S* all the transactions with a lower distance from x' until a variability threshold is reached.

Given this interval, all transactions belonging to the segment $\hat{k}^d$ are determined as follows:

$$if \quad x_t \Big| \; x'_L \le x_t \le x'_U \quad \Rightarrow \quad t \in \hat{k}^d$$

4.3 Price index estimates and chaining

The price index of domain *d* is estimated using the set of all the transactions belonging to the market segment $\hat{k}^d$ as determined in par. 4.2. With reference to a base year *y* and to a reporting month *m*, the average price in segment $\hat{k}^d$ for firm *f* in month *m* is estimated as follows:[49]

$$\hat{\bar{P}}^{d,f}_{m;y} = E_{\forall t \in \hat{k}^d | m_t = m}\left(P_t\right) \tag{18}$$

The corresponding elementary price index at time *m* is the ratio of the average prices compiled in (18) in the current period *m* and in the base year *y*:

$$\hat{I}^{d,f}_{m;y} = \frac{\hat{\bar{P}}^{d,f}_{m;y}}{\hat{\bar{P}}^{d,f}_{y;y}} \tag{19}$$

Further aggregations of these indices are obtained as weighted averages of (19), where weights are proportional to the corresponding values in the base year; in particular, weights include also the transactions not directly used for the computation of the indices – i.e. those not belonging to segment $\hat{k}^d$. For instance, indexes by CN8 are computed as follows:

$$\hat{I}^{CN8}_{m;y} = \sum_{GEO} v^{CN8,GEO}_y \sum_f \hat{I}^{d,f}_{m;y} v^{d,f}_y \,, \tag{20}$$

and similar formulas are applied to calculate indices at CPA level and/or larger geographical areas.

By chaining, the series referred to month *m* in year *y+n* on a common reference base *y* is obtained as:[50]

$$\hat{I}_{y+n,m;y} = \hat{I}_{y+n,m;y} \prod_{q=1}^{n} \hat{\bar{I}}_{y+q;y+q-1} \tag{21}$$

[49] The mean used to aggregate price quotes may assume various possible forms, for instance a geometric or arithmetic mean, weighted or unweighted. We opted for a weighted arithmetic mean.

[50] For simplicity we have put the bases of the indices equal to 1 instead of the usual 100. We opted here for a chain link expressed by the index of year *y+q* based on the previous year: for the estimation of the link the transactions in year *y+q* are mapped into the segments estimated for year *y+q-1*.

4.4 Coverage and empirical outcomes

In 2005[51] more than 600 thousands observations and 2.300 domains for export and 260 thousands observations and 1.000 domains for import were used for the estimation of the indices with the "percentile method" discussed above (Table 3). Coverage is higher for EU flows, where about 30% of total custom records were used due to the fact that intra-community trade is traditionally more intense (in fact, the number of transactions per domain is higher). A more appropriate geographical breakdown referred to Extra-EU trade would probably improve coverage in the relating flows also in terms of number of domains.[52] It can also be observed that for EU coverage is lower in terms of values: this is probably due to the fact that the method tends to select "low UV" segments. Import and export indexes have been estimated by domain and then aggregated by CPA group and main area (EU27, EMU and Rest of the World) according to the formulas described in par.4.3 in order to compare them with official UVIs. In particular, indices produced by means of the "percentile method" (labelled as "NEW" in the tables and figures below) were compared both with official UVIs and XPIs at export, but only with official UVIs at import due to the lack of the corresponding official MPIs.

Table 3 - Domains and observations used for index estimation by flow, product and area. Year 2005 *(no. of domains and transactions; % share on total transactions and values)*

CPA GROUPS	EU27				Rest of the World			
	Domains	Observations			Domains	Observations		
		No.	% on total trans.	% on total value		No.	% on total trans.	% on total value
			EXPORT					
Other textiles	769	123.854	33,1	26,9	222	17.506	16,3	20,0
Footwear	626	231.953	35,4	21,1	272	51.594	21,8	19,9
Machinery for g.p.	899	144.708	24,1	19,5	313	24.168	10,8	10,5
Total	2.294	500.515	30,7	21,1	807	93.268	16,4	14,0
			IMPORT					
Other textiles	320	54.897	34,1	17,0	166	16.052	18,5	22,8
Footwear	186	54.986	36,1	27,8	109	20.238	26,8	32,3
Machinery for g.p.	437	100.337	30,8	17,0	157	13.853	15,7	24,9
Total	943	210.220	32,9	19,4	432	50.143	20,0	26,9

As expected, the NEW series appear in general smoother than official UVIs (Table 4), the latter showing in fact a stronger upward trend as well as a wider infra-annual variability.

In all the CPA groups under scrutiny the annual inflation measured by UVIs is several points greater than that measured by NEWs. The spread between the two indicators (which can be considered as a proxy of the entity of the residual component R in par. 2.1) is always positive despite some distinctions across industries and areas.

Other textile NEW indices registered a very sluggish growth both at import and export whilst UVIs revealed a faster growth especially toward non-EU countries. A similar outcome is found for machinery.

[51] Almost an identical picture was found with reference to the rest of the period (years 2006 and 2007).

[52] In fact only 3.316 domains, out of the 20 thousands found in the universe of export transactions in year 2005, respected the condition of having at least 200 observations; moreover, a group of 200 domains were also excluded due to the impossibility to clearly identify a high density cluster.

The case of Footwear appears emblematic: EU and non-EU price dynamics as measured by NEW series appear similar and regular, whilst UVIs record a faster growth for extra-community trade, especially at export. In general, there is evidence of a residual component *R* being more impressive for trade outside EU, where competition is usually based on wider product offers and firms' pricing policies are exposed to currency fluctuations. Table 4 also reports two variability indicators confirming (if necessary) the higher volatility of UVIs.

Figures 1 and 2 in the Appendix show the peculiarity of Footwear: UVIs in both flows have a cyclical behaviour associated to a strong upward trend whilst, on the contrary, NEW indices seem to reflect cyclic movements only partially; the average yearly rate of change registered by UVIs, nearly 10% in the whole period, is probably the result of a change in the relative weight of market segments, seasonal effects not controlled for and the evidence of the role of the component *R*.

Table 4 - Official UVIs and NEW indices, by flow, product and area. Years 2005-2007 *(% average annual change of monthly indexes)*

	Other textiles				Footwear				Machinery for g.p.			
	EU27		Rest of the World		EU27		Rest of the World		EU27		Rest of the World	
	NEW	UVI	NEW	UVI	NEW	UVI	NEW	UVI	NEW	UVI	NEW	UVI
						EXPORT						
% change (a)												
2006/2005	0,7	1,1	0,1	4,1	1,2	6,2	1,2	9,2	0,6	4,7	2,2	5,8
2007/2006	0,3	1,7	-0,5	1,3	1,2	5,7	1,3	10,0	1,6	3,1	2,6	4,9
2007/2005	0,9	2,8	-0,4	5,5	2,4	12,3	2,4	20,0	2,2	7,9	4,8	10,9
Variabilit indicators (b)												
CV (%)	0,6	1,6	0,7	2,7	1,6	6,3	1,7	9,9	1,2	3,6	2,6	6,2
Quartile range	0,8	2,3	0,8	4,8	2,4	9,8	2,6	14,9	2,3	6,0	4,7	8,9
						IMPORT						
% change (a)												
2006/2005	0,7	2,1	0,1	3,5	1,6	6,4	1,2	6,1	1,0	4,7	-1,2	8,1
2007/2006	0,0	2,2	-0,6	2,2	-1,0	2,7	-0,6	4,1	1,1	1,5	0,0	0,1
2007/2005	0,7	4,4	-0,6	5,8	0,6	9,3	0,6	10,4	2,1	6,2	-1,2	8,2
Variabilit indicators (b)												
CV (%)	0,7	2,1	1,0	2,9	1,3	5,9	1,6	5,1	1,1	3,2	1,0	4,4
Quartile range	0,7	3,5	1,4	4,5	1,8	11,5	2,2	7,6	1,5	4,7	0,9	7,0

Source: ISTAT for UVIX series

(a) Compiled on the yearly averages of the indices.

(b) Compiled on the series of the monthly indexes in the whole period.

A similar behaviour can be found for Machinery with reference to extra-EU trade in both flows; in this case, more attention is probably needed to define market segments since the sector is characterised by a strong heterogeneity. The comparison between the official XPIs based on a sample survey and the NEW index at export (see Table 5 below and Figure 3 in the Appendix) shows, as expected, smaller and non-systematic differences in the dynamics of the two indicators in almost all the CPA groups of products, as compared to the previous comparison between NEW indices and the official UVIs. Note that the best approximation between the two series is shown by Other textiles, especially at the Euro-zone level where the indices dynamics looks quite similar. As opposed, XPIs referred to Machinery but regarding the same area show a much stronger and growing trend, whilst greater similarity is found with regard to the Rest of world.

Table 5 - XPI and NEW indices by product and area of destination. Years 2005-2007 *(% average annual change of monthly indexes; values)*

INDICATOR	Other textiles				Footwear				Machinery for g.p.			
	EMU12		Rest of the World		EMU 12		Rest of the World		EMU12		Rest of the World	
	NEW	XPI	NEW	XPI	NEW	XPI	NEW	XPI	NEW	XPI	NEW	XPI
Indexes												
2005-2006	0,8	0,6	0,2	0,7	1,2	2,5	1,0	3,1	0,3	4,0	2,1	2,7
2006-2007	0,3	-0,3	-0,2	1,3	1,5	2,0	1,5	0,7	1,8	5,0	2,2	1,8
2005-2007	1,1	0,3	0,0	2,0	2,8	4,5	2,4	3,7	2,1	9,2	4,2	4,5
CV (a) (b)	0,6	0,6	0,5	0,9	1,8	2,0	1,5	1,8	1,1	3,8	2,1	1,9
Quartile range	0,9	0,7	0,6	1,3	2,6	4,3	2,0	3,6	2,2	8,6	4,1	3,7

Source: ISTAT for XPIs series

Note: (a) Indicator compiled on the series of the index levels (36 observations)

(b) Percentage

5. Concluding remarks

This work discusses the possibility of producing, on a regular basis, a set of price indicators of the goods traded on international markets by means of a more intensive and efficient use of the available administrative data. Two perspectives, in particular, have been discussed. The first one relates to an integrated use of custom data and other statistical sources - such as business registers - as a cost effective way to widen the current offer of indicators of unit values dynamics. The possibility of partitioning transactions into segments according to some criterion defined on the basis of auxiliary variables relating to firms characteristics and behaviour, can help to split UVI dynamics in a "within-segment" component and in a residual "between-segment" component. Useful information for competition analysis and strategic positioning on international markets can be thus derived in a relatively easy and low cost way.

The second perspective extends this logic to the case of partitions based on the degree of homogeneity of the goods. Here, though, more relevant methodological issues are raised: firstly, there is the need to tackle the impossibility to appreciate homogeneity in the available data due to the lack of detailed information on items' characteristics even at the finest levels of the classification; secondly, the huge amount of information provided by custom records compels to tailor a suitable conceptual and methodological framework for the estimation of any price measure of an economic significance. In this respect, the challenge would concern the definition of the reference population, the statistical design and the target parameter.

With respect to this latter point, the most recent achievements in HICP methodology appear particularly suitable for this task, in particular with regard to the role played by the concept of "consumption segments" in the statistical design: in an external trade context, market segments are thus identified as the statistical objects to be followed over time in order to provide the reference population of transactions with a structure. The proposed approach to define market segments is based on univariate density functions' estimation and clustering so to single out, within each domain, groups of transactions homogeneous with regard to elementary UVs behaviour.

The empirical results shown in par. 4 and in the Appendix appear quite encouraging, although obtained by means of a basic version of the method outlined in par. 3. The estimated dynamics appears reasonably similar to the official XPI and the long term differences among the two indicators are relatively small, even if the estimated series show a higher short term variability due to the entropy deriving from the larger amount of data used for their estimation. On the contrary, the new series often diverge from UVIs as a consequence of the composition effects taking place among market segments.

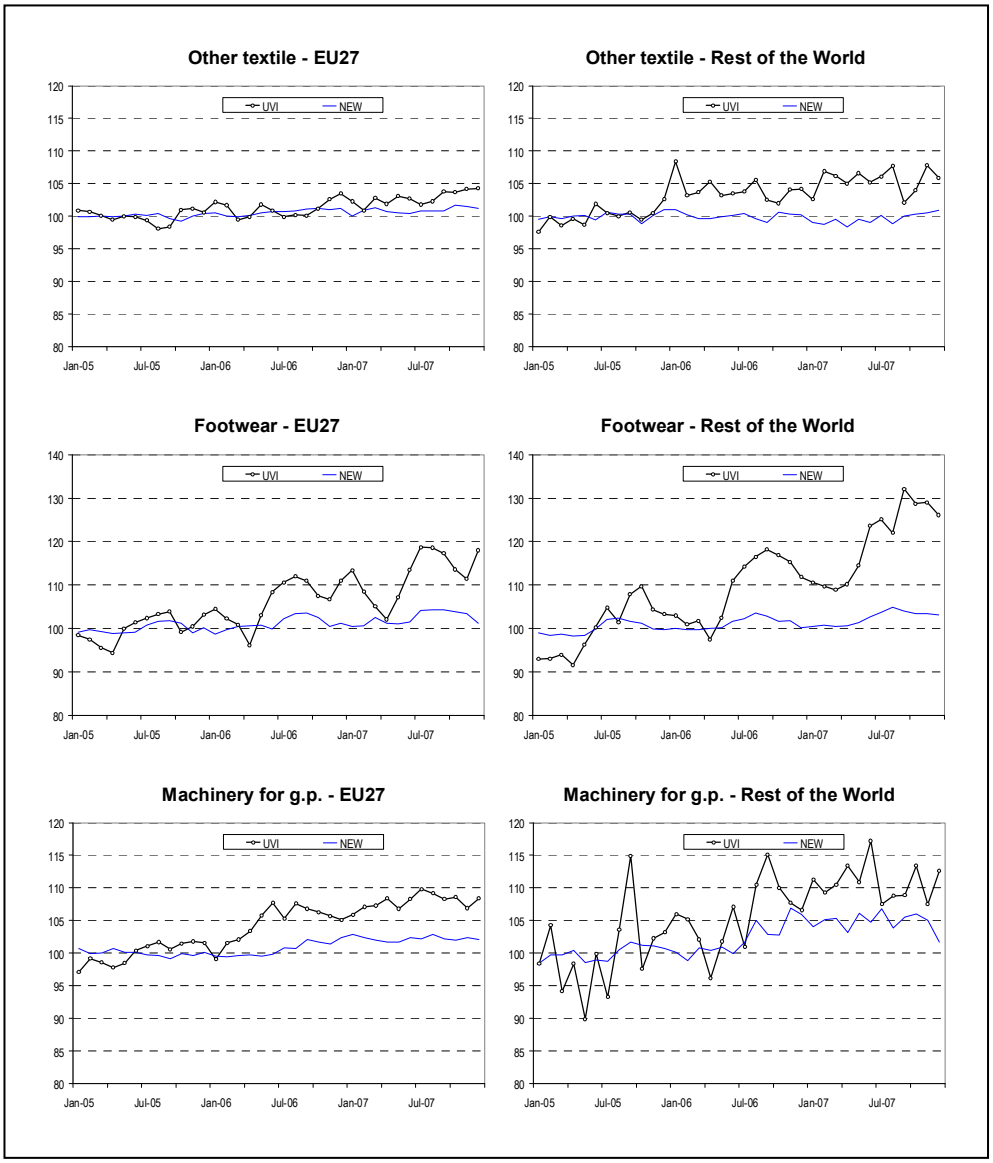
Further research is obviously needed to improve the general statistical frame and, in particular, the method adopted for market segments partitioning. The choice of the target time period used to estimate market segments is one of the key issues: the annual segmentation adopted in par. 4 might result vulnerable should inflationary pressures or high short term UV variability emerge, since it could induce smoothing and consequently a zero-change bias into the estimates. Alternative solutions are actually under scrutiny and could be found in the adoption of a shorter-term rolling target periods (such as for instance a moving quarterly period).

The estimation of density functions and the clustering algorithm also deserve further studies; the generalised method in par.3 is promising but more sophisticated methods can be found to optimize and stabilise the resulting partition of the reference population; the main challenge seems to lay in non-parametric density estimation techniques, since the choice of the degree of smoothing is a key element also for the successive application of the clustering method. Given the extremely large number of domains and observations, one more issue has to do with the research of automatic solutions able to select for each domain the best smoothing parameter. The adoption of automatic clustering algorithm also needs further investigations in two respects: the choice of a time saving method and the control of the borders of the clusters. As for this latter point, the adoption of probabilistic clustering appears quite promising.

Finally, sensitivity analysis can be applied to test the robustness of the estimates by means of simulation techniques. Robustness in fact is a key element to assess the feasibility of the methodology especially for dissemination purposes.

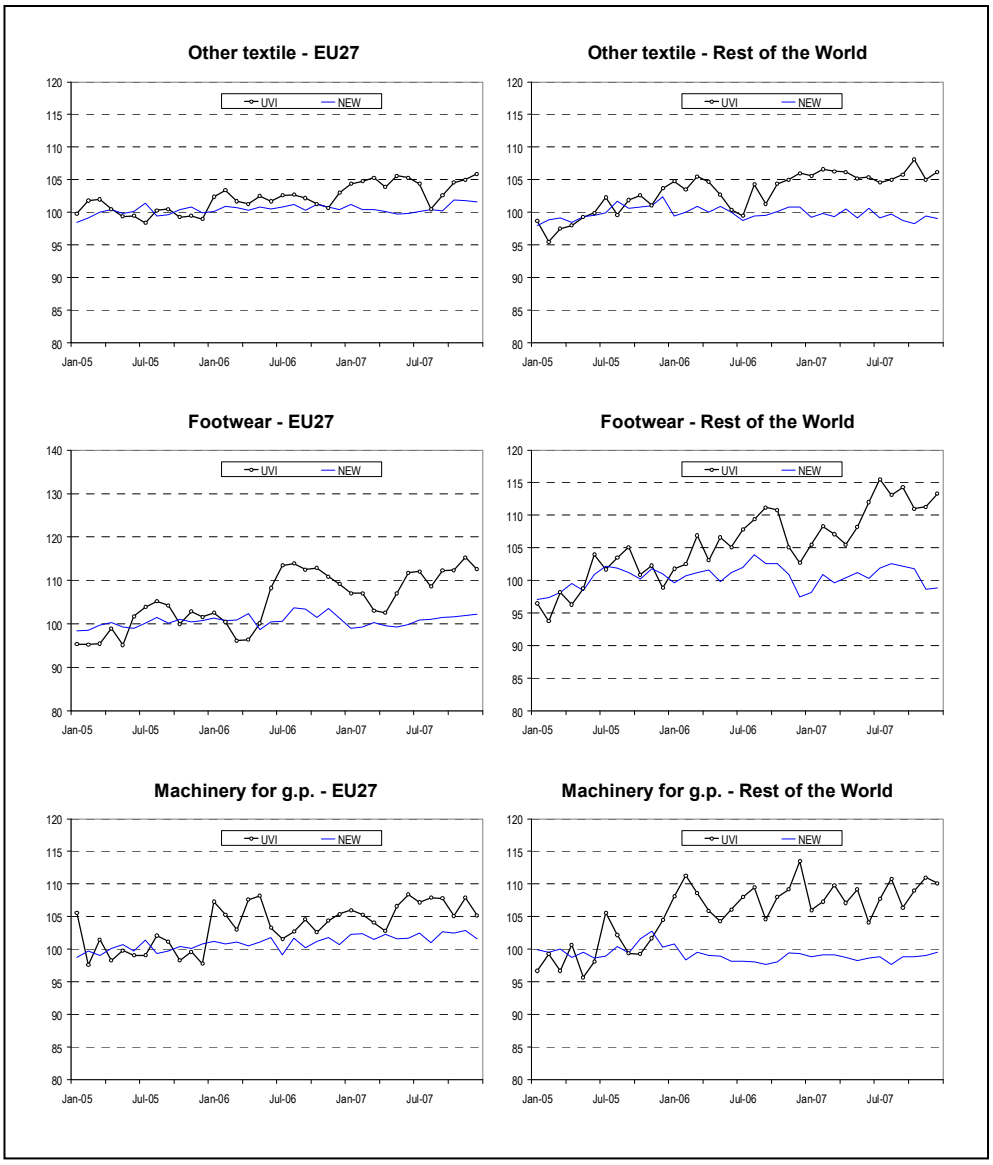
Appendix

Figure 1 - UVI and NEW monthly indices by product and area of destination. Exports. Years 2005-2007 *(base year: 2005=100)*



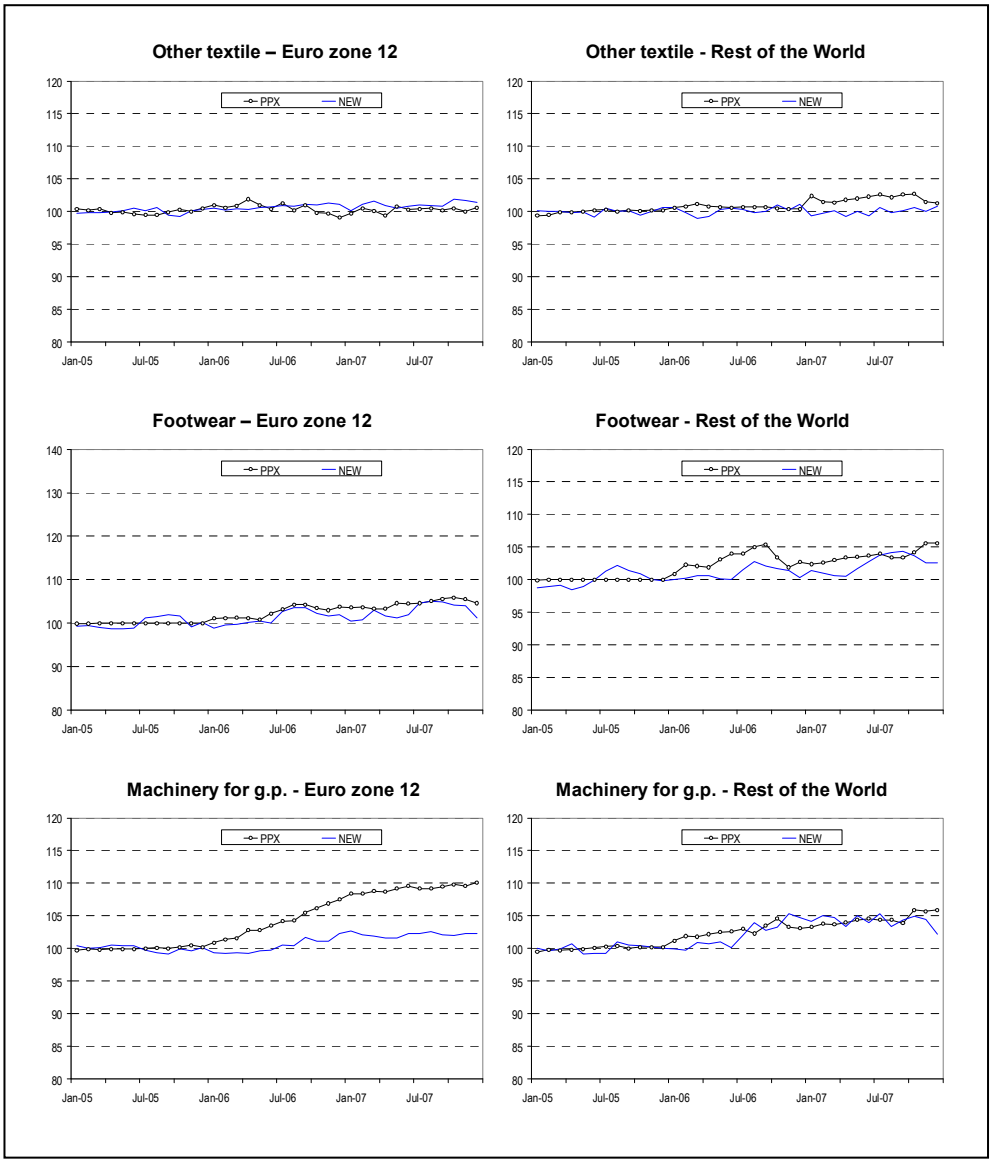
Source: ISTAT for UVIs series

Figure 2 - UVI and NEW monthly indices by product and area of origin. Imports. Years 2005-2007
(base year 2005=100)



Source: ISTAT for UVIs series

Figure 3 - XPI and NEW monthly indices by activity and area of destination. Years 2005-2007. *(base year 2005=100)*



Source: ISTAT for PPIX series

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