PRODUCER PRICE BEHAVIOUR IN ITALY: EVIDENCE FROM MICRO PPI DATA

by

Roberto Sabbatini - Silvia Fabiani - Angela Gattulli - Giovanni Veronese*

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Abstract

This paper investigates the behaviour of producer prices (excluding energy products) in Italy using the micro data underlying the PPI calculated by the Italian National Statistical Institute. The main purpose is to assess the frequency and the size of price changes, in order to obtain a quantitative measure of the unconditional degree of price rigidity in the Italian economy; the analysis is still in a preliminary stage and results are provisional.

Producer prices tend, on average, to remain unchanged for around 6 months. The frequency of price changes fluctuates over time, displaying a seasonal pattern, but it does not seem to be highly affected by the size of price changes. Price duration is lower for consumer food and non-energy intermediate goods (on average 3 and 5 months, respectively); on the contrary, non-food consumer goods tend to change once a year, and capital goods prices slightly less than every two years. As regards asymmetries, price changes tend to be quite symmetric. The degree to which firms coordinate among each other in timing their price changes is relatively low.

There seems to be some evidence that producer prices are more flexible than consumer prices. This raises the issue of whether the retail sector acts in the direction of enhancing price stickiness or whether there are other specific economic factors at stake, such as the presence of menu costs or of attractive prices, widely used in the case of consumer prices, though they are much less important in the case of producer prices.

Key words: producer prices, nominal rigidity, frequency of price change.
JEL codes: D21, D40, E31.

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1. Introduction

This paper investigates the behaviour of producer prices in Italy on the basis of micro data, expanding the empirical evidence on price setting in Italy already obtained from previous studies based on consumer price indices (Fabiani *et al*. , 2003), on survey data (Fabiani *et al*. , 2004) and on CPI micro data (Veronese *et al.*, 2004). The analysis presented here is still in a very preliminary stage, its main purpose being an assessment of the characteristics of producer price changes, in particular their frequency, in order to obtain a quantitative measure of the unconditional degree of nominal producer price rigidity in Italy. Future work will be devoted to the comparison of these results with those obtained in the mentioned studies on CPI and survey data and also to the relationship between the evolution of producer prices and explanatory factors, such as wages and input costs.

Our work is based on data at the maximum level of disaggregation, namely the price of an item of a specific brand. In particular, we rely on around 71.000 elementary price quotes referred to 60 items included in the Italian PPI basket and collected each month from January 1997 to December 2002. The list of products was selected in agreement with the other Central Banks of the euro area conducting similar research in the context of a project carried out within the Eurosystem, the *Inflation Persistence Network* (IPN), in order to ensure a sufficient degree of cross-country comparability of the micro evidence, trying to guarantee, at the same time, that the selected subset is representative of the whole PPI basket. The analysis does not cover energy products, whose prices could not be used for confidentiality reasons.

The paper is structured as follows. In section 2 we discuss the main characteristics of the database. In Section 3 we define the main statistics at the basis of the analysis of the characteristics of price behaviour. Section 4 contains the empirical results and provides a preliminary comparison with the result obtained using the CPI micro data. Section 5 summarises the main findings and discusses the agenda for future work.

2. Description of the database

Our database includes more than 70,000 monthly observations (around 1,000 per month) collected by the Italian National Statistical Institute (Istat) from January 1997 to December 2002 in the context of the computation of the producer price index (PPI). Producer prices are, by definition, only those set by firms on the domestic market (prices set on the foreign market are not included in the computation of the PPI). The information available for each observation – the *metadata* – is listed in Table 1. Metadata are quite detailed. They enable us to precisely identify the price of a particular product, sold by a specific firm in one particular month and to follow that price over time.[1]

The products included in the PPI are classified according to the standard NACE classification, which allocates them with reference to the productive sector. An alternative breakdown, which is also followed in this work, splits the PPI in relation to the economic purpose of each product (essentially, its destination). In particular, the following categories are identified: food products; non-durable consumption goods; durable consumption goods; non-energy

[1] Note that at the firm level the information concerning the main firm characteristics, such as the size of the producer (as measured by number of employees or by the turnover), its location, the percentage of sales on the domestic market, is not available.

intermediate goods; capital goods.[2] This classification is in our view more useful for the analysis of price setting behaviour and of its underlying determinants as the latter are, presumably, more common for items with a similar economic purpose; moreover, only these results allow a meaningful comparison with those for the CPI.

The list of the products considered in this work is reported in Table 2. As for the classification for economic purpose, each product is assigned to a sub-index according to the scheme reported in Table 3. Table 4 summarises the items included in our sample, classified according to the NACE classification and to the economic purpose one, with their weights at 2 and 3 digits (namely, for branches and groups according to the NACE classification).

The weighting scheme needs to be clarified. Istat releases producer price indices and their respective weights up to the 3-digit level for the NACE classification (the so-called "groups"); as regards the classification by economic purpose, this information is released only for the main aggregates.[3] The items in our database, as already said, are individual price quotes and at this maximum level of disaggregation they do not have any weight. Hence, in defining a weighting scheme for such items we use the 3-digit NACE official weights as a starting point. Each of the n products included in a given group (3-digit level) in our sub-sample is then assigned a fraction ($1/n$) of the overall weight of the group to which it belongs. For example, each of the specific products denoted by the code 151121113 and 15131259 ("chicken" and "sausages", respectively), both falling in the group 151 ("meat and meat-based products") for which we have the official Istat weight (2.4 per cent) in the base-year 2000, receive a weight equal to 1.2 (2.4/2) per cent.

The proportion of food and durable consumption goods in our sub-sample is similar to that in the official index; on the contrary, non-food non-durable goods and, in particular, intermediate and capital products are under-represented (Table 4).[4] By restricting the analysis to a subset of the PPI basket, on the one hand we may loose in terms of exhaustiveness of the coverage; on the other hand, we can devote more attention to the accuracy of our analysis and to the preliminary treatment of the data.

We can assess the representativeness of our sub-sample in several ways. First, we compare the general PPI net of energy and the price index computed by aggregating only the official price indices (3-digit level) referred to the products included in our dataset. As shown in Figure 1, inflationary trends during the period under exam are captured closely by our sub-sample of products, independently on the set of weights used. Second, we compute the monthly inflation rate on the basis of the elementary price quotes in our dataset. Our "reconstructed PPI" (by definition net of energy products) indeed mirrors quite closely the official index (Figure 2). All in all, the above comparisons suggest that our sub-sample of elementary prices captures quite closely the developments of the overall PPI net of energy products.

A final remark concerns the presentation of the empirical results. All our statistics refer to the classification by economic purpose and to the NACE at the 2-digit level.

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2 As previously mentioned, energy products, though included in the PPI basket, are not considered here. The reason is that such prices cannot be used for confidentiality reasons, since the producers of energy product are very few (e.g. in the case of gas) and, then, prices collected by Istat could easily be referred to a specific firm.

3 Note that in case a product has more than a final destination, then Istat, as well as the other Statistical agencies of the European Union, in the classification by economic purpose allocates the product in full to the "main" use.

4 Together with energy products, also a few non-energy branches are not represented in our sub-sample, namely 11, 14, 16, 18, 23 of the NACE classification.

3. Basic definitions

The methodological approach followed in this paper is the one adopted in the analysis of the micro CPI data (for details, see Veronese *et al*., 2004), with the advantage of allowing a meaningful comparison of the results. This section summarises the main statistics we use, following the same notation as in Veronese *et al*. (2004).

- Elementary price quote: $P_{jl,t}$, for product j (j =1,.., n_j, where n_j is the total number of products; in our analysis n_j=54), sold by a specific firm l (l = 1,…, n_l) and collected at time t (t= 1,…T). An elementary product is therefore defined by the pair (j,l).

- Price spell: an uninterrupted sequence of unchanged price quotes associated to the elementary product (j,l), that is the sequence $P_{jl,t}$, $P_{jl,t+1}$,…, $P_{jl,t+k-1}$, with $P_{jl,t+s} = P_{jl,t}$ for $s=1,...,t+k-1$. A price spell is therefore an episode of fixed price, which can be fully described by three elements: the date of the first quote (t), the price level of the first quote ($P_{jl,t}$) and the duration of the spell (k), that is $\{P_{jl,t}, t, k\}$.

- Price trajectory: a sequence of s successive price spells for the product (j,l), that is $(\{P_{jl,t}, t_1, k_1\},\{P_{jl,t+k1}, t_2, k_2\}$, $\{P_{jl,t+k1+k2}, t_3, k_3\},\ldots,\{P_{jl,t+k1+\ldots+ks-1}, t_s, k_s\}\}$. By computing $L_{jl}= (k_1 +\ldots +k_s)$ we can define the trajectory length for the elementary product (j,l), which is just the sum of the individual price spell durations.

To characterise price behaviour across products we can follow both a *duration* approach – which measures directly the number of months in which a price remains unchanged – and a *frequency* approach – based on the computation of the frequency of price changes as the proportion of price quotes that change in a given month among the set of existing price quotes. From the frequency an implied duration of the price spells can be calculated; a discussion of how this can be done and further details can be found in Veronese *et al*. (2004)[5].

In order to compute synthetic estimates of average duration and of average frequency of price changes we need to aggregate statistics on elementary products. We follow a "bottom-up" approach, assuming that products display higher homogeneity within certain subgroups (for instance in a given price trajectory or in a given product category).

Starting from the duration approach, several formulas can be used to compute average duration (see Veronese *et al*., 2004, for details on how the next formulas are obtained):

- if we pool all price spells, we obtain the unweighted average duration of price spells (all price spells have equal weight), that is:

$$\bar{d} = \frac{1}{N_{spells}} \sum_{j=1}^{n_j} \sum_{s=1}^{N_{sj}} d_{js} = \frac{N_{elementary\ price\ quotes}}{N_{spells}} \qquad (1)$$

  where j refers to the product (n_j =54), s identifies a specific spell, d_{js} is the duration of spell s of product j, N_{sj} refers to the number of price spells for product j;

- obviously products that exhibit more frequent price changes and, accordingly, more price spells (typically energy goods and unprocessed food), receive a higher weight in equation (1). This problem is overcome by computing the unweighted average duration of price spells, averaged

[5] Note that the two approaches lead to the same results only if the sample does not contain censored price spells.

by product, obtained by first computing the average duration for each product *j*, $\bar{d}_j = \frac{N_{elementary\ price\ quotes\ for\ product\ j}}{N_{spells\ for\ product\ j}}$, (averaging over all its spells, across firms and time), and then averaging it over products:

$$\bar{\bar{d}} = \sum_{j=1}^{n_j} \frac{1}{n_j} \bar{d}_j \tag{2}$$

- the use of PPI product weights (ω_j, $j=1,\ldots,n_j$) in the calculation of the previous statistics leads to the weighted average duration of price spells, averaged by product:

$$\bar{\bar{d}}^{\omega} = \sum_{j=1}^{n_j} \omega_j \sum_{j=1}^{N_s} \bar{d}_j \tag{3}$$

- a further possibility is to first average across price spells in a given trajectory and then average across products, obtaining the unweighted average duration of price spells, averaged by individual trajectory:

$$\bar{\bar{d}}^{traj} = \sum_{j=1}^{n_j} \frac{1}{n_j} \sum_{r=N_{traj;1}}^{N_{traj;j}} \frac{{}_j\bar{d}_r^{traj}}{N_{traj;j}} \tag{4}$$

where $N_{traj;j}$ is the number of price trajectories for product j, and ${}_j\bar{d}_r^{traj}$ represents the average duration of the spells in the r^{th} trajectory of product *j*;

- similarly, the weighted average duration of price spells, averaged by individual trajectory is given by:

$$\bar{\bar{d}}^{traj,w} = \sum_{j=1}^{n_j} \omega_j \sum_{r=N_{traj,1}}^{N_{traj,j}} \frac{\bar{d}_r^{traj}}{N_{traj;j}} \tag{5}$$

In our analysis we aggregate the individual durations mainly according to expression (3) above; to check the robustness of the results, we also present those based on (5).

The main advantage of using the duration approach consists in the ability to report in each period the full distribution of price durations in the dataset. Moreover, only by adopting this approach we can compute the *hazard* and the *survival functions*. In the next section we present a simple non-parametric estimate of the survival function based on the Kaplan-Meier product limit estimator; the estimator is based on the number of spells ending at period *t* and the number of spells still in the risk set (R_t, which at each time *t* consists of the number of spells lasting *at least* until *t*):

$$S(t) = \prod_{\{s:t_s \le t\}} \left(1 - \frac{1}{R_s}\right)^{d_s} \tag{6}$$

Turning to the frequency approach, it entails the computation of the frequency of price changes which, for each product *j*, is equal to the number of price changes in each month (denoted

by NUM_{jt}, for the j^{th} product at time t, where t=2,…T) over the total number of price quotes for that product available in the sample in the same period (DEN_{jt})[6]:

$$F_j = \frac{\sum_{t=2}^{T} NUM_{jt}}{\sum_{t=2}^{T} DEN_{jt}} \tag{7}$$

Under certain conditions of stationarity of the process determining price spells both across the cross-sectional and the time dimension (see Lancaster, 1990)[7], the information about the average spell duration for product j can be recovered as the inverse of the frequency of price changes (implied average spell duration):

$$\overline{T}_j = \frac{1}{F_j} \tag{8}$$

Equation 7, and consequently equation 8, are appropriate when firms change their price only at discrete intervals. One can also assume, as in Bils and Klenow (2002), that prices are changed in continuous time: in such environment, and under a constant hazard model, the implied average duration is:

$$\overline{T}_j = \frac{-1}{\ln(F_j)} \tag{9}$$

and, furthermore, the median time elapsing between two price changes is equal to:

$$T_j^{50} = \frac{-\ln(0.5)}{F_j} \tag{10}$$

The frequency approach presents some advantages compared to the duration approach. First, it does not require a long span of data; in principle, the observation window may be shorter than the average duration of a price spell. Second, if some months are deemed to be exceptional due to some specific events, they can be ignored from the computation of the average frequency of price changes. Finally, the approach also allows to use the maximum amount of information from the dataset, not discarding all the observations from censored price spells but only those observations which involve transitions from/to unobserved prices.

Nonetheless, as pointed out in Baudry *et al*. (2004), also in the frequency approach the analysis needs to be carried out over sufficiently homogenous products (and sub-periods). Here this means that, when aggregating frequencies across products, we first compute statistics at the product level and then average across different items using the 3-digit weights.

The frequency approach can also be followed to calculate the frequency of price increases (decreases) for each product, where the expression in the numerator of equation 7, NUM_{jt} is

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[6] See the Appendix for details.

[7] The stationarity assumption regards the process determining the sample of price spells: this ensures that the probability for a price spell to start in each period is stable over time. Lancaster (1990), in the context of the theory of renewal processes, provides a formal argument for the convergence of the inverse of the frequency of price changes to the mean spell duration.

replaced by $NUMUP_{jt}$ ($NUMDW_{jt}$), indicating the number of positive (negative) price changes in each period t (see the Appendix for details).

A final empirical problem concerns how to deal with censoring. In brief (see Veronese *et al*., 2004, for a detailed discussion of this issue), censoring arises because the true time of beginning (ending) of the first (last) price spell does not correspond to the one observed in the dataset, since it occurs before (after) the first (last) price collection.[8] As a consequence, any measurement of the average duration of the price spells in such a trajectory carried out by ignoring the existence of censoring in the first and in the last spell would be biased. In analysing PPI micro data we have adopted the following two strategies:

Strategy 1: "No censoring": the statistics are computed completely disregarding the issue of censoring, therefore using all price spells.

Strategy 2: "Full censoring": the first and last price spells within each price trajectory are considered as censored (obtaining, thereby, a full symmetry between the number of right and left censored price spells) and the statistics on price duration and on the frequency of price changes are computed only on the basis of the remaining uncensored observations. Under this approach there exists the risk of excluding far too many price spells, especially when considering products subject to very few price changes in their lifecycle.

In the case of the PPI we limit the analysis to this two strategies since the censoring problem is not as pervasive as in the CPI micro analysis, in which we also follow two intermediate strategies (Veronese *et al*., 2004).

4. The results

In this section we report the results obtained adopting both the frequency and the duration approach to investigate the behaviour of price changes. We focus on weighted statistics, computed over the time period that excludes 2002 (around 1,700 price trajectories) and without censoring, in order to facilitate the comparison with the CPI micro results. However, we also report unweighted statistics, results for the whole time interval (1997-2002, around 1,850 price trajectories) and those computed under the full censoring hypothesis.

4.1 Price trajectories and price spells

For the period 1997-2001, the unweighted mean length of the 1,662 price trajectories is 35 months; the differences across the main industrial groupings are very limited, ranging from a minimum of 28 months on average for capital goods to a maximum of 37 for consumer food and intermediate goods (Table 5).

The total number of price spells is approximately 12,400 (Table 6.a); their weighted average duration (equation 1), under the assumption of no censoring (strategy 1), is 5 months. The distribution of spell durations exhibits a pronounced skewness, as shown by the much lower value for the median (1 month)[9].

[8] It is worth remarking that, if the beginning of the collection period coincided with the first time in which a price is set in the considered firm, then the price trajectory would not be censored.

[9] Note that first averaging spell durations within each individual trajectory and then calculating the median of the results across trajectories gives a median duration of 5 months (see last row in Table 6a and in Table 6b).

Substantial differences exist across the main industrial groupings: the mean duration is the highest for consumer durables (12 months) while prices change more often for food products (every 3 months) and for intermediate goods (every 5 months). The lower mean duration of intermediate goods prices is in line with our *a priori*, since they tend to mirror quite closely and with short lags the volatility of raw materials quotations (metals in particular). For non-food non-durable consumer goods, the average price duration is 7 months. The mean duration of the whole aggregate of non-food consumer goods (durables plus non-durables) is 9 months, in line with our results for the CPI micro data (non-energy industrial goods component; see section 4.3).

Excluding censored price spells has an impact on the results, though it is smaller than that found in the CPI micro analysis. Under strategy 2 (full censoring) the average price duration falls from 5 to 3 months (Table 6.b). In general, all components tend to exhibit a lower price duration; in particular, consumer goods excluding food have a mean duration equal to 4 months (compared to 9 under the assumption of no censoring). Instead, results do not vary much if unweighted statistics are computed and if 2002 is included in the time period. As found for the CPI, the distribution of producer prices duration around the mean exhibits a pronounced skewness, as suggested by the comparison with the median, which is significantly lower (1 month for the whole database).

Fact 1: for the whole sub-sample, the weighted average duration of price spells, which captures how long prices tend to remain unchanged, is equal to at least 5 months. Duration is lower for food products (3 months) and higher for consumption goods (durables in particular) and capital goods prices (9 and 12 months, respectively). Intermediate goods on average remain unchanged for 5 months.

Finally, we compute the survival function of the price spells using the Kaplan-Meier approach, distinguishing items according to the classification by economic purpose (Figure 4), which gives the probability of observing a price change (vertical axis) for each given number of months (horizontal axis). Its shape is similar to that we found for the CPI micro data. The probability of a price spell lasting more than 2 months is very low for food (below 0.20) and for intermediate goods (below 0.30). On the contrary, the probability is still above 0.40 after 10 months for consumer durables and capital goods.

4.2 The frequency approach

This section investigates the frequency of price changes, their direction and size and the degree of synchronisation of price changes. The analysis relies on the statistics described in section 3; as already remarked, the focus is on weighted statistics, computed over the period up to 2001 and under the assumption of no censoring (strategy 1).

The weighted average frequency of monthly price changes for the years 1997-2001 is 15% under no censoring (Table 7.a); the weighted average implied duration, which is approximately given by the inverse of the average frequency, is equal to 6 months. The frequency of price changes increases to 25% under full censoring (Table 7.a). Neither the computation of unweighted statistics nor that over the time span including 2002 impact significantly on the results (Tables 7.a-7.b).

The frequency of price changes fluctuates over time, displaying a seasonal pattern (January being the month with the highest frequency; Figures 5 and 6). Average inflation instead does not seem to exert a great influence on the frequency of price changes.

Fact 2: *On average, in Italy 15% of producer prices are changed each month; the average implied duration of price spells is around 6 months.*

The analysis across different products shows a pronounced heterogeneity of results. Consumer food and intermediate goods change on average 3 and 5 months, respectively (Table 7.a). On the contrary, the implied average duration of non-food consumer goods amounts to 10 months, and that of capital goods to 22 months. As regards individual products, few food items (e.g., sausages, flour, sugar and coffee) and intermediate goods, whose production is more closely related to specific raw materials, tend to change quite often (every 2-3 months; Table 8).

Fact 3: *Results on the frequency of price changes are rather heterogeneous across products. In particular, prices of food products tends to change every 3 months, whereas those of capital goods slightly less that every two years. Non-food consumer goods prices (durable and non-durable) tend to change almost once a year.*

As for the direction of price changes, interesting patterns emerge. The prices that exhibit a lower average duration, i.e. those of food and non-energy intermediate goods, also tend to show a more symmetric behaviour (Table 7.a). In the case of food products, the frequency of price increases is almost the same as that of price decreases, 14 and 13%, respectively; for non-energy intermediate goods, the frequencies are 10 and 8%. This might be due to the fact that these prices tend to be more directly affected by the evolution of the international quotations of raw materials, which are typically quite volatile, both upwards and downwards. On the contrary, the asymmetry is more pronounced for the prices of the non-food consumer goods (the frequency of price increases is equal to 6%, as against 3% of price decreases) and of capital goods (3 and 1%, respectively).

As for the whole database, the average frequency of price increases is only marginally higher than that of price decreases (9 and 7%, respectively).

Fact 4: *Producer price changes are on average quite symmetric, with some important differences across categories: the most volatile prices are also those for which price changes are more symmetric, whereas asymmetries are quite pronounced for the prices of non-food consumer goods and of capital goods.*

The size of the average price increase and decrease is approximately the same (4.5% and –4.1%, respectively, under the no censoring strategy; Table 9, part b). This symmetry holds approximately for all components except for capital goods, for which the size of price increases is much higher than that of price decreases (3.4% and –2.0%, respectively). This symmetric behaviour is robust with respect to weighting (part a of Table 9), but less with respect to censoring (part c). In fact, under full censoring for the whole sample the symmetry still holds, for the components results differ from those presented above; in particular (i) as regards durables consumer goods the average price decrease is much higher than the average price increase (-4.1% and 2.0%, respectively); (ii) on the contrary, the behaviour of capital goods prices is now quite symmetric.

Fact 5: *the average percentage change is approximately the same when prices are adjusted upwards and downwards.*

The degree of synchronisation of price changes is, in general, rather low. The synchronisation ratio of price changes is above 50 per cent only for frozen peas, a few pharmaceutical products and a few capital goods (Table 10). There is also some evidence that price increases tend to be more synchronised than price decreases.

Fact 6: Producer price movements of individual products are not highly synchronised.

4.3 Producer prices and consumer prices: a preliminary comparison of results

In this section we provide a very preliminary and tentative comparison between the analysis conducted on the micro PPI data and on the micro CPI data (Veronese *et al*., 2004), largely based on descriptive statistics; a more formal analysis is part of our agenda for future work.

Note that a comparison between CPI and PPI referred to the whole set of items is not meaningful due to the large differences in the composition of the two baskets. This characteristics does not depend on the particular list of items considered in the sample; more generally, it would hold even if the whole CPI and PPI baskets were considered. In particular:

a) services are not included in the PPI. Since in general this was the component exhibiting the highest price duration, this should lead, *ceteris paribus*, to a higher degree of consumer price stickiness than for producer prices.
b) PPI includes non-energy intermediate goods and capital goods, whose dynamics is presumably affected by different determinants than consumer goods. In particular, non-energy intermediate goods tend to be affected with a short lag by the movements of the exchange rate and by the evolution of raw material prices on international markets, which are typically quite volatile.
c) PPI refer only to prices set on the domestic market, whereas CPI also includes the prices of imported goods. In principle we can expect that prices set by foreign producers on the Italian market follow domestic prices; hence, the comparison over the medium term should not be too affected by this difference.
d) Producer prices are net of indirect taxes, whereas consumer prices include VAT and excise duties. As seen in the analysis on the CPI micro data, over the years considered a major indirect tax change took place only in one occasion; hence the comparison between two indices should not be too much affected by this methodological difference.
e) Energy prices were found to be the most volatile components in the CPI micro analysis, but they are not considered in the PPI micro analysis. Hence, all the remaining components being the same, the CPI results should exhibit a lower average price duration than the PPI ones.

All in all, a meaningful comparison between results is only possible for processed food products (unprocessed food are not included in the PPI basket) and for non-food consumer goods. In this section we focus on these two components. We refer to weighted statistics, computed for the period ending in 2001. For the PPI we refer to results obtained under the assumption of "no censoring" (strategy 1); for the CPI, instead, we look at our "best guess" (intermediate strategy).

Average duration of price spells. The mean duration of PPI non-food consumer goods (durables and non-durables) is 9 months, compared to 14 months we found for the CPI (non-energy industrial goods component). As regards processed food products, for the PPI their mean duration is 3 months against 9 in the case of the CPI (Table 11). Such a large difference is partly due to the fact that "meat" is classified in the unprocessed food component in the CPI basket whereas in the PPI it is included in what we have named "processed food".

In general, there seems to be some evidence that producer prices are more flexible than consumer prices for both components. This also raises the issue, which deserves further

investigation, of whether the retail sector acts in the direction of enhancing price stickiness or whether consumer price rigidity is due to other specific economic factors (see below).

The frequency of price changes. The above differences are confirmed by the analysis based on the frequency approach.

As regards processed food products, the duration implied by average frequency is equal to 10 months for consumer prices ("best guess") and much lower for the corresponding producer prices (3 months; Table 11); the same holds in the case of non-energy industrial goods (17 and 11 months, respectively). As already mentioned, differences of such a size can be partly explained in terms of the different composition of the specific items considered (meat in particular), though there is a potential role of the retail sector in magnifying rigidities.

As for the asymmetric behaviour of prices, the comparison between consumer and producer prices shows that, for processed food, the frequency of increases is marginally higher than that of decreases for both producer and consumer prices. The average size of price changes tends to be the same for upwards and downwards price changes. All in all, there do not seem to exist important differences in price behaviour at the two stages.

Finally, an interesting comparison is with the information collected from survey data in Fabiani *et al*. (2004). In that study we mainly investigated producer and/or wholesale prices, since most of the interviewed firms reported that their main customer was another firm. We found that in manufacturing (excluding food) more than half of responding firms change their prices only once a year, while firms producing food products do it with a higher frequency.[10]

We also uncovered interesting evidence on the possible reasons underlying the apparent higher rigidity of prices at the retailer stage than at the production one. A factor which might play a role is the presence of menu costs. The results of the survey indicate that, among the factors which might lead to postpone a price change, pricing thresholds and menu costs are relevant only in the retail sector. Hence, in the short-term consumer prices might be affected by these two further sources of rigidities which, instead, do not play any major role in the case of producer prices. The empirical fact that attractive prices are widely used in the case of consumer prices, though they are much less important in the case of producer prices (see Figure 7), is consistent with this interpretation.

5. Conclusions and future research

Before summarising our main findings, it is worth remarking that our analysis is in progress and lot still needs to be done; hence in the final part of this section we enclose the agenda for our future research.

As regards the main characteristics of producer price changes, the weighted average frequency of monthly price changes for the years 1997-2001 is 15%; this percentage rises only marginally (16%) if we include 2002. Hence, the weighted average implied duration is 6 months. The frequency of price changes fluctuates over time, displaying a seasonal pattern, but it does not seem to be highly affected by the size of price changes.

Producer price changes tend on average to be quite symmetric. The most volatile prices are also those for which price changes are symmetric, whereas asymmetries are more pronounced in

[10] Similar results hold for 2001.

the case of non-food consumer goods and capital goods. The average percentage change is approximately the same when prices are adjusted upwards and downwards.

In general the degree of synchronisation of price changes is rather low; price increases tend to be more synchronised than price decreases.

The analysis across different sectors and products shows a pronounced heterogeneity of results. In particular, consumer food and non-energy intermediate goods change on average 3 and 5 months, respectively. On the contrary, non-food consumer goods tend to change once a year, and capital goods prices slightly more often than every two years.

Results for the micro CPI and the micro PPI analysis can be compared bearing in mind the differences in the methodologies and in the composition of the baskets between the two indices. We restrict the comparison to consumption goods. As regards processed food products, the implied average duration is 10 months for consumer prices ("best guess") and much lower for producer prices (3 months). However, part of this difference is due to the fact that meat is classified in the unprocessed food component in the CPI basket whereas in the PPI it is included, by definition, in the processed food component. A difference also emerges in the case of non-energy industrial goods (17 and 11 months for consumer and producer prices, respectively). All in all, there seems to be some evidence that producer prices are more flexible than consumer prices. Conversely, there don't seem to exist important differences in price behaviour at the production and the consumption stage in terms of asymmetries. For processed food the frequency of increases is marginally higher than that of decreases, while the average size of price changes is the same in both cases for upwards and downwards price changes.

Producer prices seem to be less sticky than consumer prices. This raises the issue of whether the retail sector acts in the direction of enhancing price stickiness or whether there are other specific economic factors at stake, such as, for example, the presence of menu costs. The information emerging from a previous study based on a survey on price setting behaviour provides useful insights. Survey data indicate that among the factors which might lead to postpone a price change, pricing thresholds and menu costs are relevant only in the retail sector. Hence, in the short-term consumer prices might be affected by these two further sources of rigidities which, instead, do not play any role in the case of producer prices. The empirical fact that attractive prices are widely used in the case of consumer prices, though they are much less important in the case of producer prices, documented in the above analysis, is consistent with this interpretation.

As already mentioned, the results presented in this paper are preliminary. The agenda is very rich; some of the issues we intend to consider are: (i) the relationship between producer price changes and sectoral wage changes (How important are automatic indexation schemes?); (ii) the analysis of the sequence of consecutive price changes (same sign or different signs?); (iii) a more formal comparison between results obtained with survey data and with micro CPI. Moreover, we intend to perform an econometric exercise aimed at identifying the main explanatory factors of the frequency of price changes, adopting a similar approach as that followed in the CPI study. In this respect, producer prices present the advantage that other pieces of information can be exploited, in particular regarding demand condition and cost developments.

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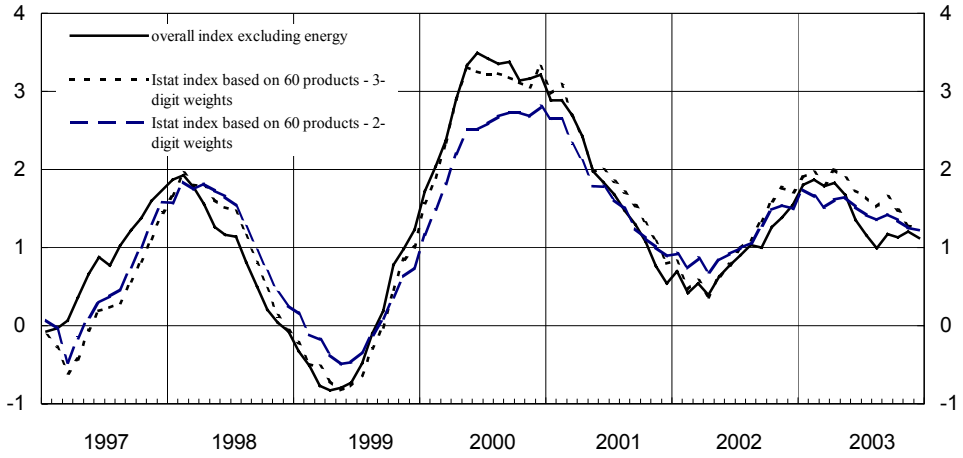
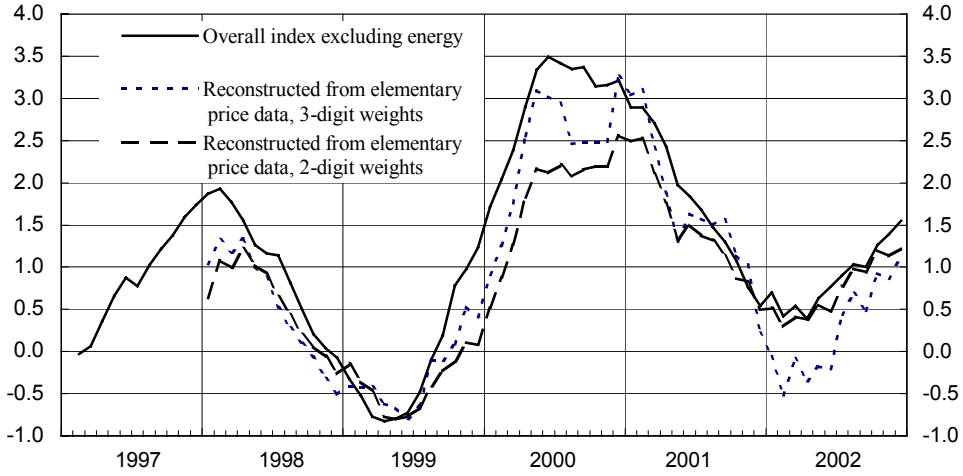
Figures and Tables

Figure 1 – PPI overall inflation excluding energy and 60 items inflation (Istat indices) (1)
(year-on-year percentage changes)



(1) Istat official series for the item considered in our subset (3-digit classification, that is the maximum level which is available), aggregated using either 2 or 3-digit weights.

Figure 2 – PPI overall inflation excluding energy (Istat official index) and inflation computed on the basis of elementary price quotes in our subset (1)



(1) "Reconstructed" series are obtained only from the set of micro data actually used in the empirical analysis.

Figure 3 – Distribution of spells duration

(1997-2001; unweighted statistics)

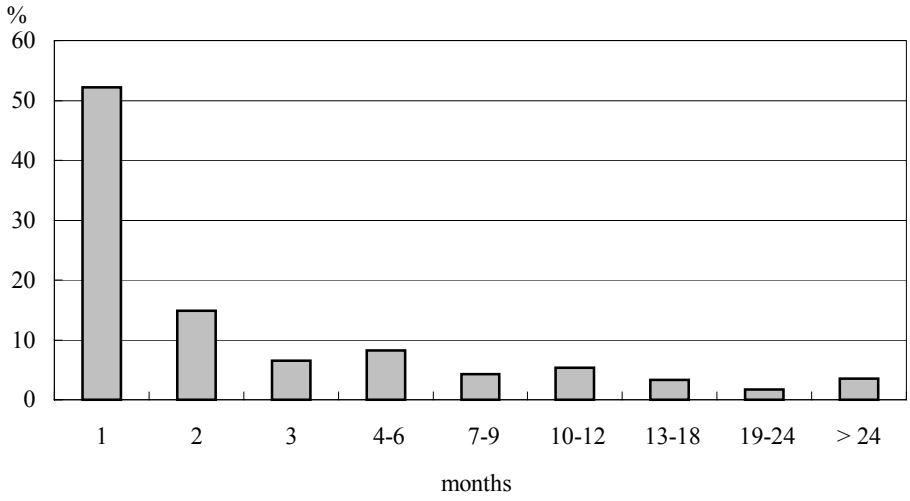


Figure 4- Kaplan-Meier survival function by type of product

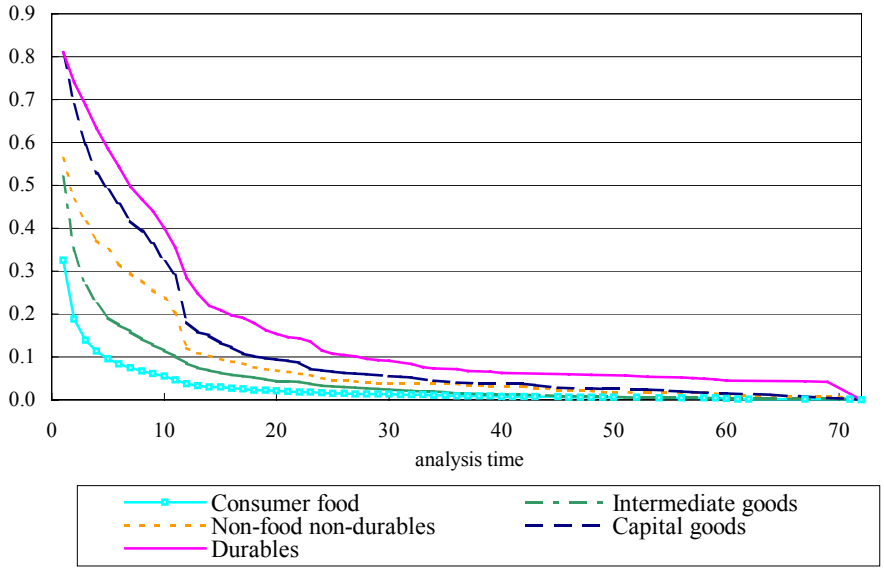


Figure 5 - Frequency and size of price changes

(weighted statistics, 3 digit weights)

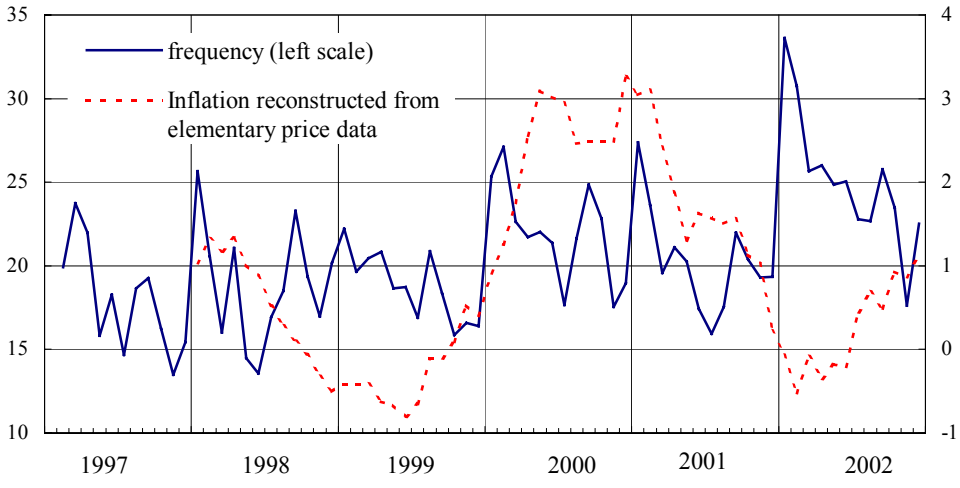


Figure 6 - Frequency of price changes by month
(1997-2001; unweighted statistics)

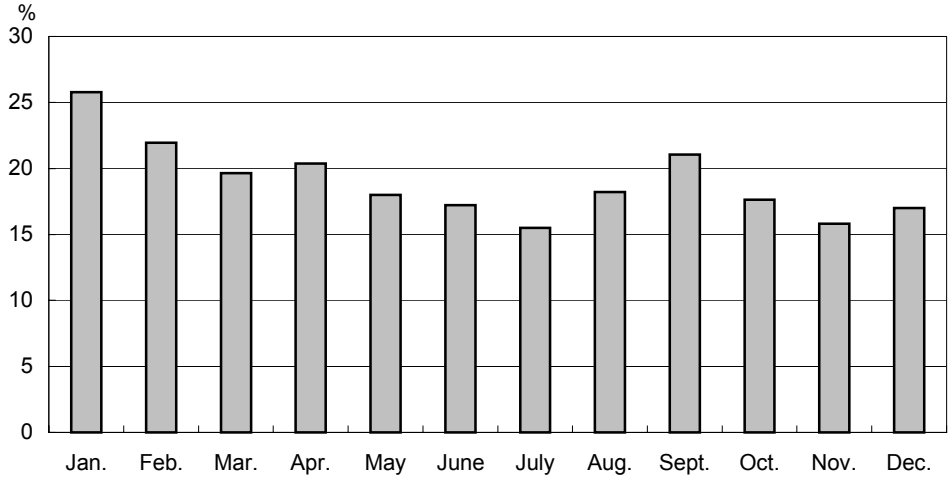


Figure 7 – Share of attractive prices in the whole database

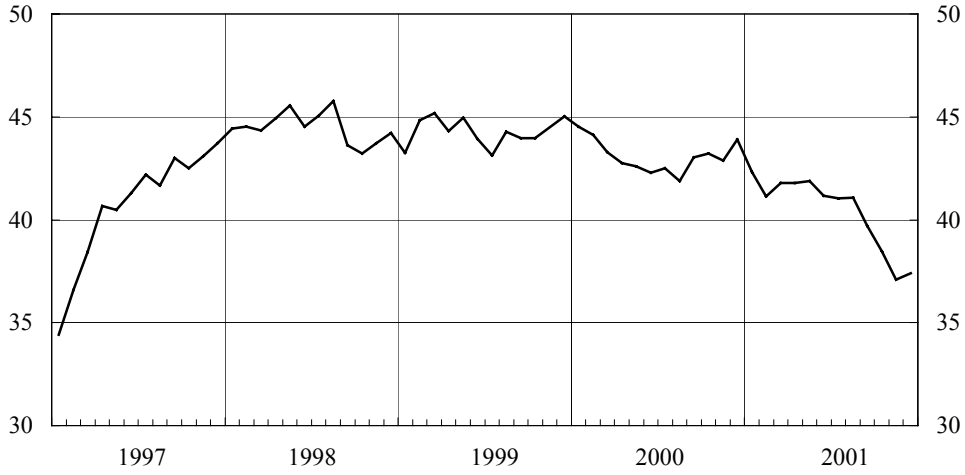


Table 1: Information available for each elementary price quote (metadata)

Reference year and month	Reference year and month
Firm code	Code which identifies the firm which sets the price quote
Product code	Code which identifies the product
Product description	Description of the product
Variety code	Code which identifies the variety of the product
Variety description	Description of the variety of the product
Unit of measurement	Unit of measurement
Reference quantity	Quantity to which the price is referred
Base period price	Price in the base period (e.g. in October 2003 the base price refers to 1995)
Scale factor for the current price	In case a price is, for instance, 1,500 lire up to month t and from month $(t+1)$ is expressed in a different scale, becoming 15,000, this flag indicates that the price must be divided by 10
Scale factor for the base price	When there is a change in the price scale in one month, then this flag indicates how the base price must be adjusted accordingly
Collected price	Price collected each month
Currency code	Flag which indicates whether the price is in lire or in euro
Switch	Flag variable $\neq 0$ if the price collected is not available for different reasons (for example: flag = 3 if the outlet has been closed; flag = 7 if the product is not available; flag = 2 in case of a change of the base period)

Table 2: List of products

NACE 2 digit		Product	purpose
NACE 15 - Manufacture of food products and beverages			
	1	Chicken	food
	2	Sausages	food
	3	Frozen (peas and green beans)	food
	4	Oil	food
	5	Milk	food
	6	Flour	food
	7	Bread	food
	8	Sugar	food
	9	Coffee	food
	10	Beer	food
	11	Mineral water	food
NACE 17 - Manufacture of textiles			
	12	Towels	intermediate
	13	T-shirts	non-durables
NACE 19 - Manufacture of leather and leather products			
	14	Leather for footwear	non-durables
	15	Manufacture of luggage	non-durables
	16	Manufacture of sport footwear	non-durables
NACE 20 - Manufacture of wood and wood products			
	17	Doors	intermediate
NACE 21 - Manufacture of pulp, paper and paper products; publ. and printing			
	18	Paper table cloths and napkins	intermediate
	19	Paper, paperboard	intermediate
	20	Envelopes	intermediate
NACE 22 - Publishing and printing, and reproduction of recording media			
	21	Tapes	non-durables
NACE 24 - Manufacture of chemicals, chemical products			
	22	Paints	intermediate
	23	Pharmaceutical products (7 items)	non-durables
	24	Soap	non-durables
	25	Shampoo	non-durables
	26	Glue	intermediate
NACE 25 - Manufacture of rubber and plastic products			
	27	Tyres	intermediate
	28	Tupperware	intermediate
NACE 26 - Manufacture of other non-metallic mineral products			
	29	Bottles and glass containers	intermediate
	30	Bricks	intermediate
NACE 27 - Manufacture of basic metals			
	31	Iron bars for concrete	intermediate
	32	Metal wires	intermediate
NACE 28 - Manufacture of fabricated metal products			
	33	Windows	capital
	34	Cutlery	intermediate
	35	Tools	intermediate
	36	Locks	intermediate
	37	Central heating	capital
NACE 29 - Manufacture of machinery and equipment n.e.c			
	38	Engines	capital
	39	Tractors	capital
	40	Irons	durables
	41	Freezer	durables
NACE 30 - Office equipment, calculating machines, computers			
	42	Calculating machines	capital
	43	Printers	capital
NACE 31 - Manufacture of electrical equipment			
	44	Bulbs	intermediate
NACE 32 - Manufacture of communication equipment (TV, radio, etc.)			
	45	Television	durables
NACE 33 - Manufacture of optical equipment			
	46	Sun glasses	durables
NACE 34 - Manufacture of transport equipment			
	47	Public-transport (3 items)	capital
	48	Trailers	capital
NACE 35 - Manufacture of other transport equipment			
	49	Mountain bike	durables
NACE 36 - Manufactue n.e.c			
	51	Metal desks for offices	durables
	52	Wood furniture for bedrooms	durables
	53	Wood furniture for dining rooms	durables
	54	Foot Balls	non-durables

Table 3 – Allocation of products in our database to the categories for economic purpose

Groups of products	Nace codes (mix of 2 and 3 digits codes)
Food	151, 153,154,155,,158,159
Non food non-durables	177, 19, 22, 244, 245, 364
Consumer durables	297, 323, 334, 354, 361
Non-energy intermediate goods	172, 20, 21, 156, 243, 246, 25, 26, 27, 286, 315
Capital goods	281, 291, 293, 30, 311, 34

Table 4: Classification by productive sector and economic purpose

Main Industrial Groupings	PPI weights			No. of observations (1)	
	Istat official weights	Sub-sample		*period 1997-2001*	*period 1997-2002*
		2 digit	*3 digit*		
Consumer food	13.1	12.6	11.6	17532	21072
Consumer goods, excluding food	17.2	24.9	11.8	16140	19368
Non-food non- durables	*12.2*	*14.0*	*7.4*	*8760*	*10512*
Durables	*4.9*	*10.9*	*4.4*	*7380*	*8856*
Intermediate goods	34.3	28.5	12.7	18420	22104
Energy	17.5	-	-	-	-
Capital goods	17.9	11.9	7.8	6086	7348
All items	**100.0**	**78.0**	**44.0**	**58178**	**69892**
NACE 2-digit					
NACE-11	0.6	-	-	-	-
NACE-14	0.5	-	-	-	-
NACE-15	12.6	12.6	11.6	17532	21072
NACE-16	0.5	-	-	-	-
NACE-17	3.6	3.6	1.5	1320	1584
NACE-18	3.3	-	-	-	-
NACE-19	2.3	2.3	2.3	2520	3024
NACE-20	2.2	2.2	0.9	1620	1944
NACE-21	2.7	2.7	1.8	2640	3168
NACE-22	2.9	2.9	1.4	480	576
NACE-23	7.8	-	-	-	-
NACE-24	7.4	7.4	4.5	4500	5400
NACE-25	3.5	3.5	3.5	1560	1872
NACE-26	4.5	4.5	1.1	3240	3888
NACE-27	4.7	4.7	2.4	3480	4176
NACE-28	7.7	7.7	3.0	5940	7128
NACE-29	7.8	7.8	2.6	2407	2915
NACE-30	0.6	0.6	0.6	540	648
NACE-31	3.2	3.2	0.2	1200	1440
NACE-32	2.4	2.4	0.2	540	648
NACE-33	1.3	1.3	0.2	1620	1944
NACE-34	4.4	4.4	2.9	1519	1841
NACE-35	0.6	0.6	0.6	900	1080
NACE-36	3.6	3.6	2.7	4620	5544
NACE-37	0.3	-	-	-	-
NACE-40	8.7	-	-	-	-
NACE-41	0.3	-	-	-	-
All items	**100.0**	**78.0**	**44.0**	**58178**	**69892**

(1) An observation is the price of a specific product, sold by a given firm and collected at time t.

Table 5 – Price trajectories

(1997-2001, unweighted; months)

	Number of obs.	Mean	Median	Standard deviation
Duration of trajectories	**1662**	**35**	**37**	**23**
Main Industrial Groupings:				
Consumer food	477	37	48	24
Consumer goods, excluding food	472	34	36	23
Non-food non- durables	*257*	*34*	*36*	*23*
Durables	*215*	*34*	*35*	*22*
Intermediate goods	496	37	43	23
Energy				
Capital goods	217	28	23	21
By NACE 2-digit				
NACE-15	477	37	48	24
NACE-17	42	31	23	22
NACE-19	79	32	25	24
NACE-20	37	44	60	22
NACE-21	65	41	48	21
NACE-22	8	60	60	0
NACE-24	112	40	50	23
NACE-25	47	33	36	23
NACE-26	130	25	19	22
NACE-27	73	48	60	20
NACE-28	158	38	37	21
NACE-29	100	24	20	20
NACE-30	15	36	34	21
NACE-31	37	32	36	24
NACE-32	9	60	60	0
NACE-33	37	44	60	19
NACE-34	62	25	19	21
NACE-35	33	27	12	24
NACE-36	141	33	36	21

Table 6.a – Price spells

(1997-2001; weighted, 3 digit, no censoring, strategy 1; months)

	Number of obs.	Mean	Median	Standard deviation
All items	**12313**	**5**	**1**	**9**
Main Industrial Groupings:				
Consumer food	5932	3	1	7
Consumer goods, excluding food	1883	9	3	13
Non-food non- durables	*1277*	7	2	12
Durables	*606*	12	9	14
Intermediate goods	3830	5	2	9
Energy				
Capital goods	668	12	7	15
By NACE 2-digit				
NACE-15	5932	3	1	7
NACE-17	141	9	6	8
NACE-19	589	4	1	10
NACE-20	178	9	5	12
NACE-21	710	4	2	5
NACE-22	12	40	43	21
NACE-24	771	6	2	9
NACE-25	149	10	3	14
NACE-26	903	4	2	7
NACE-27	965	4	2	7
NACE-28	572	14	7	18
NACE-29	362	9	6	10
NACE-30	38	14	10	14
NACE-31	314	4	1	7
NACE-32	41	13	2	23
NACE-33	61	27	18	21
NACE-34	151	12	7	14
NACE-35	107	8	8	7
NACE-36	317	15	12	14
Averaged by individual trajectory	1662	13	5	17

Table 6.b – Price spells

(1997-2001; weighted, 3 digit, full censoring, strategy 2; months)

	Number of obs.	Mean	Median	Standard deviation
All items	**9588**	**3**	**1**	**4**
Main Industrial Groupings:				
Consumer food	5119	2	1	3
Consumer goods, excluding food	1146	4	1	6
Non-food non- durables	*864*	3	1	5
Durables	*282*	8	5	8
Intermediate goods	2986	3	2	4
Energy				
Capital goods	337	7	4	8
By NACE 2-digit				
NACE-15	5119	2	1	3
NACE-17	73	7	5	7
NACE-19	462	2	1	3
NACE-20	112	5	2	7
NACE-21	593	3	2	4
NACE-22				
NACE-24	579	3	1	5
NACE-25	80	4	2	6
NACE-26	688	3	1	4
NACE-27	828	2	2	2
NACE-28	311	8	4	8
NACE-29	205	5	2	7
NACE-30	16	8	10	5
NACE-31	261	2	1	2
NACE-32	31	2	1	1
NACE-33	11	13	10	7
NACE-34	68	5	3	5
NACE-35	50	9	9	5
NACE-36	101	11	7	10

Table 7.a – Frequency of price changes

(1997-2001)

Main component	Frequency of price changes	Implied median duration (months)	Implied average duration (months)	Frequency of price increases	Frequency of price decreases	% of price increases
Unweighted results (no censoring, strategy 1)						
Consumer food	26.5	2	3	13.2	13.3	49.9%
Consumer goods, excluding food	10.2	6	9	6.6	3.6	*64.2%*
Non-food non- durables	*11.7*	*6*	*8*	*7.5*	*4.1*	*64.6%*
Durables	*7.5*	*9*	*13*	*4.7*	*2.8*	*63.2%*
Intermediate goods	18.4	3	5	9.9	8.5	53.9%
Energy	-	-	-	-	-	-
Capital goods	6.1	11	16	4.3	1.7	71.3%
All items	**14.8**	**4**	**6**	**8.3**	**6.4**	**56.5%**
Weighted results (3 digit - no censoring, strategy 1)						
Consumer food	26.5	2	3	13.5	12.9	51.1%
Consumer goods, excluding food	8.6	8	11	5.6	3.0	*65.4%*
Non-food non- durables	*9.9*	*7*	*10*	*6.3*	*3.6*	*64.0%*
Durables	*6.5*	*10*	*15*	*4.5*	*2.0*	*68.9%*
Intermediate goods	17.9	4	5	9.6	8.3	53.7%
Energy	-	-	-	0	0	-
Capital goods	4.5	15	22	3.4	1.0	76.7%
All items	**15.3**	**4**	**6**	**8.5**	**6.8**	**55.5%**
Weighted results (3 digit - full censoring, strategy 2)						
Consumer food	35.6	2	2	18.8	16.8	52.8%
Consumer goods, excluding food	16.7	4	5	9.3	7.4	*55.8%*
Non-food non- durables	*17.9*	*4*	*5*	*11.3*	*6.6*	*63.0%*
Durables	*15.2*	*4*	*6*	*6.8*	*8.4*	*44.9%*
Intermediate goods	29.8	2	3	15.7	14.2	52.6%
Energy	-	-	-	0.00	0.00	-
Capital goods	10.8	6	9	7.5	3.3	69.4%
All items	**25.0**	**2**	**3**	**13.5**	**11.5**	**54.0%**

Table 7.b – Frequency of price changes

(1997-2002)

Main component	Frequency of price changes	Implied median duration (months)	Implied average duration (months)	Frequency of price increases	Frequency of price decreases	% of price increases
Unweighted results (no censoring, strategy 1)						
Consumer food	27.9	2	3	14.1	13.8	50.4%
Consumer goods, excluding food	10.3	6	9	6.6	3.7	*63.7%*
Non-food non- durables	*11.8*	*6*	*8*	*7.6*	*4.2*	*64.0%*
Durables	*7.5*	*9*	*13*	*4.7*	*2.8*	*62.8%*
Intermediate goods	19.0	3	5	10.2	8.8	53.5%
Energy	-	-	-	0	0	-
Capital goods	6.4	11	15	4.6	1.8	72.4%
All items	**15.3**	**4**	**6**	**8.6**	**6.7**	**56.4%**
Weighted results (3 digit - no censoring, strategy 1)						
Consumer food	28.0	2	3	14.3	13.7	51.2%
Consumer goods, excluding food	8.8	8	11	5.6	3.1	*64.2%*
Non-food non- durables	*10.0*	*7*	*9*	*6.3*	*3.8*	*62.6%*
Durables	*6.6*	*10*	*15*	*4.5*	*2.1*	*68.1%*
Intermediate goods	18.6	3	5	10.0	8.6	53.6%
Energy	0	-	-	-	-	-
Capital goods	4.8	14	20	3.7	1.1	77.6%
All items	**16.0**	**4**	**6**	**8.8**	**7.1**	**55.3%**
Weighted results (3 digit - full censoring, strategy 2)						
Consumer food	35.3	2	2	18.4	16.9	52.1%
Consumer goods, excluding food	13.8	5	7	8.4	5.4	*60.8%*
Non-food non- durables	*15.0*	*4*	*6*	*9.5*	*5.5*	*63.6%*
Durables	*11.9*	*5*	*8*	*6.6*	*5.4*	*55.0%*
Intermediate goods	31.0	2	3	16.1	14.9	52.0%
Energy	-	-	-	-	-	-
Capital goods	11.5	6	8	8.2	3.3	71.7%
All items	**25.0**	**2**	**3**	**13.6**	**11.4**	**54.5%**

Table 7.c – Frequency of price changes

(1997-2001; weighted, 3 digit; no censoring, strategy 1)

Main component	Frequency of price changes	Implied median duration (months)	Implied average duration (months)	Frequency of price increases	Frequency of price decreases	% of price increases
Main Industrial Groupings:						
Consumer food	26.5	2	3	13.5	12.9	51.1%
Consumer goods, excluding food	8.6	8	11	5.6	3.0	*65.4%*
Non-food non- durables	*9.9*	*7*	*10*	*6.3*	*3.6*	*64.0%*
Durables	*6.5*	*10*	*15*	*4.5*	*2.0*	*68.9%*
Intermediate goods	17.9	4	5	9.6	8.3	53.7%
Energy	-	-	-	0	0	-
Capital goods	4.5	15	22	3.4	1.0	76.7%
By NACE 2-digit						
NACE-15	30.4	2	3	15.1	15.4	49.5%
NACE-17	8.5	8	11	6.1	2.4	72.2%
NACE-19	20.2	3	4	11.4	8.8	56.3%
NACE-20	8.9	7	11	7.4	1.5	82.9%
NACE-21	25.0	2	3	13.8	11.2	55.2%
NACE-22	0.8	81	117	0.8	0.0	100.0%
NACE-24	15.6	4	6	9.2	6.4	59.1%
NACE-25	7.4	9	13	4.0	3.4	53.7%
NACE-26	19.9	3	5	11.0	8.9	55.3%
NACE-27	26.9	2	3	13.3	13.6	49.4%
NACE-28	4.9	14	20	3.8	1.1	77.6%
NACE-29	8.9	7	11	6.2	2.7	69.6%
NACE-30	4.3	16	23	2.4	1.9	56.5%
NACE-31	24.1	3	4	7.1	17.0	29.5%
NACE-32	6.0	11	16	1.7	4.3	28.1%
NACE-33	1.5	45	65	0.9	0.6	58.8%
NACE-34	4.6	15	21	4.2	0.3	92.9%
NACE-35	8.5	8	11	5.4	3.1	63.8%
NACE-36	4.0	17	25	3.7	0.2	94.0%
All items	**15.3**	**4**	**6**	**8.5**	**6.8**	**55.5%**

Table 8 – Frequency of price changes and duration – period 1997-2001

(no censoring, strategy 1)

Product	Frequency of price changes	Implied median duration (months)	Implied average duration (months)
Consumer food	**26.5**	**2.3**	**3.3**
Chicken	77.4	0.5	0.7
Sausages	18.3	3.4	5.0
Frozen peas	7.6	8.7	12.6
Oil	24.3	2.5	3.6
Milk	14.5	4.4	6.4
Flour	45.8	1.1	1.6
Bread	6.3	10.6	15.3
Sugar	36.8	1.5	2.2
Coffee	35.1	1.6	2.3
Beer	17.7	3.5	5.1
Mineral water	8.1	8.2	11.9
Consumer goods, excluding food	**8.6**	**7.7**	**11.1**
Non-food non- durables	***9.9***	***6.6***	***9.6***
T-shirts	6.1	11.1	16.0
Leathers for shoes	38.0	1.4	2.1
Manufacture of luggage	6.1	10.9	15.8
Sport footwear	3.0	23.0	33.2
Tapes	0.8	81.4	117.5
Pharmaceutical products	7.3	9.1	13.1
Pharmaceutical products	5.1	13.3	19.2
Pharmaceutical products	17.2	3.7	5.3
Pharmaceutical products	36.6	1.5	2.2
Pharmaceutical products	10.6	6.2	8.9
Pharmaceutical products	24.6	2.5	3.5
Soap	4.4	15.4	22.2
Shampoo	10.4	6.3	9.1
Foot Balls	4.5	15.2	21.9
Durables	***6.5***	***10.3***	***14.9***
Freezer	19.7	3.2	4.6
Irons	14.2	4.5	6.5
Television	6.0	11.2	16.1
Sun glasses	1.5	45.1	65.1
Mountain bike	8.5	7.8	11.2
Metal desks for offices	2.0	33.7	48.7
Furniture for bedrooms	3.2	21.5	31.0
Furniture for dining rooms	4.7	14.4	20.8
Intermediate goods	**17.9**	**3.5**	**5.1**
Towels	18.6	3.4	4.8
Doors	8.9	7.4	10.7
Paper, Paperboard	30.6	1.9	2.7
Paper table cloths and napkins	21.8	2.8	4.1
Envelopes	19.2	3.3	4.7
Paints	28.0	2.1	3.0
Glue	25.7	2.3	3.4
Tyres	3.4	19.8	28.5
Tupperware	7.8	8.6	12.4
Bottles and glass containers	16.9	3.7	5.4
Bricks	39.3	1.4	2.0
tondo per cemento armato	27.6	2.1	3.1
Metal wires	25.5	2.4	3.4
Cutlerly	5.9	11.3	16.4
Tools	2.4	28.2	40.6
Locks	6.8	9.8	14.1
Bulbs	24.1	2.5	3.6
Capital goods	**4.5**	**15.2**	**21.9**
Windows	2.2	30.9	44.6
Central heating	11.8	5.5	8.0
Engines	5.3	12.8	18.5
Tractors	16.3	3.9	5.6
Calculating machines	2.0	34.7	50.1
Printers	9.0	7.3	10.6
Public-transport	1.9	36.0	52.0
Public-transport	4.5	14.9	21.5
Trailers	7.8	8.6	12.4
All items	**15.3**	**4.2**	**6.0**

Table 9 – Size of price changes

(percentages; 1997-2001)

Main component	Average price change	Average price increase	Average price decrease
(a) Unweighted results (no censoring - strategy 1)			
Consumer food	4.90	4.93	-5.21
Consumer goods, excluding food	4.17	3.98	-3.96
Non-food non- durables	4.82	4.69	-4.70
Durables	3.03	2.75	-2.75
Intermediate goods	4.28	4.42	4.17
Energy			
Capital goods	3.15	3.23	-2.75
All items	**4.18**	**4.17**	**-4.12**
(b) Weighted results (3 digit - no censoring, strategy 1)			
Consumer food	4.8	4.9	-4.9
Consumer goods, excluding food	4.3	4.2	-3.8
Non-food non- durables	5.3	5.2	-5.1
Durables	2.7	2.6	-2.1
Intermediate goods	4.4	4.9	-4.4
Energy			
Capital goods	3.2	3.4	-2.0
All items	**4.3**	**4.5**	**-4.1**
(c) Weighted results (3 digit - full censoring, strategy 2)			
Consumer food	4.3	4.2	-4.7
Consumer goods, excluding food	3.5	3.2	-4.0
Non-food non- durables	4.0	4.0	-3.9
Durables	3.0	2.0	-4.1
Intermediate goods	4.0	4.2	-3.7
Energy			
Capital goods	3.4	3.0	-2.7
All items	**3.9**	**3.8**	**-3.9**

Table 10 – Synchronisation of price changes

(1997-2001; no censoring, strategy 1)

Product	Synchronisation ratio of price changes	Synchronisation ratio of price increases	Synchronisation ratio of price decreases
Consumer food			
Chicken	34.3	54.6	49.4
Sausages	21.2	29.3	18.3
Frozen peas	54.5	55.9	41.6
Oil	35.4	34.7	35.8
Milk	22.9	26.2	20.6
Flour	19.1	14.8	18.3
Bread	20.3	23.2	23.8
Sugar	62.9	58.7	53.1
Coffee	20.9	25.4	25.1
Beer	35.2	38.5	25.8
Mineral water	17.0	17.7	17.7
Consumer goods, excluding food			
Non-food non- durables			
T-shirts	37.0	36.2	25.5
Leathers for shoes	23.9	28.2	20.3
Manufacture of luggage	41.6	37.0	35.7
Sport footwear	45.7	47.0	34.6
Tapes	55.4	55.4	-
Pharmaceutical products	51.1	51.2	48.5
Pharmaceutical products	61.5	62.6	57.6
Pharmaceutical products	48.6	44.3	56.4
Pharmaceutical products	39.2	48.5	43.0
Pharmaceutical products	62.2	56.9	54.0
Pharmaceutical products	40.8	48.8	46.7
Soap	34.5	35.7	24.5
Shampoo	21.7	28.4	24.2
Foot Balls	47.3	43.5	38.0
Durables			
Freezer	47.9	55.2	32.5
Irons	45.7	42.0	43.6
Television	23.3	31.0	26.6
Sun glasses	25.2	21.5	23.1
Mountain bike	45.3	44.1	34.5
Metal desks for offices	42.9	43.9	43.9
Furniture for bedrooms	30.4	30.4	22.0
Furniture for dining rooms	27.9	28.1	22.2
Intermediate goods			
Towels	55.4	55.5	60.1
Doors	26.0	25.0	21.1
Paper, Paperboard	25.7	43.4	36.5
Paper table cloths and napkins	33.2	40.5	42.1
Envelopes	38.4	43.8	35.4
Paints	39.1	39.3	38.3
Glue	31.4	28.7	29.9
Tyres	41.1	37.9	40.6
Tupperware	29.9	33.9	28.5
Bottles and glass containers	24.9	26.3	19.0
Bricks	37.8	27.6	32.4
tondo per cemento armato	34.5	45.6	49.1
Metal wires	24.9	30.4	28.1
Cutlerly	50.1	49.7	43.0
Tools	39.4	39.8	40.6
Locks	27.1	27.5	16.7
Bulbs	35.7	27.3	32.5
Capital goods			
Windows	30.5	30.0	27.3
Central heating	29.6	30.7	27.1
Engines	54.4	55.8	38.3
Tractors	44.4	36.9	36.0
Calculating machines	66.5	70.2	40.6
Printers	98.0	71.2	83.2
Public-transport	100.0	100.0	-
Public-transport	100.0	100.0	-
Trailers	39.8	39.1	30.3

Table 11 – Comparison between CPI and PPI results (1)
(weighted statistics)

	Average duration of price spells (months)	Frequency of price changes	Duration implied by average frequency (months)	Frequency of price increases	Frequency of price decreases	Average price increase (%)	Average price decrease (%)
Processed food							
CPI "best guess" (2)	…	9	10	7	4	6	-8
CPI no censoring	3	8	12	5	3	7	-6
PPI no censoring	3	27	3	14	13	5	-5
Non-energy industrial goods							
CPI "best guess" (2)	…	6	17	5	3	6	-7
CPI no censoring	14	4	25	3	1	7	-7
PPI no censoring	9	9	11	6	3	4	-4

(1) Results refer to the years 1996-2001 for the CPI (Veronese *et al*., 2004) and to the years 1997-2001 for the PPI. – (2) Assumption denoted in Veronese *et al*. (2004) as "pseudo-price changes".

Appendix: Definitions and formulas

- Variables. We define the following binary variables for each product *j*:

(1) $$DEN_{jt} = \begin{cases} 1 & \text{if } P_{jt} \text{ and } P_{j,t-1} \text{ are observed} \\ 0 & \text{if } P_{jt} \text{ exists but not } P_{j,t-1} \end{cases}$$

(2) $$NUM_{jt} = \begin{cases} 1 & \text{if } P_{jt} \neq P_{j,t-1} \\ 0 & \text{otherwise} \end{cases}$$

(3) $$NUMUP_{jt} = \begin{cases} 1 & \text{if } P_{jt} > P_{j,t-1} \\ 0 & \text{otherwise} \end{cases}$$

(4) $$NUMDW_{jt} = \begin{cases} 1 & \text{if } P_{jt} < P_{j,t-1} \\ 0 & \text{otherwise} \end{cases}$$

On the basis of the above variables we analyse the frequency of price changes.

- Basic statistics for each product *j*:

- frequency of price changes :

(5) $$F_j = \frac{\sum_{t=2}^{\tau} NUM_{jt}}{\sum_{t=2}^{\tau} DEN_{jt}}$$

- implied median price duration (continuous time):

(6) $$T_j^{50} = \frac{\ln(0.5)}{\ln(1-F_j)}$$

- implied mean price duration (continuos time):

(7) $$\overline{T}_j = \frac{1}{F_j}$$

- frequency of price increases:

(8) $$F_j^{+} = \frac{\sum_{t=2}^{\tau} NUMUP_{jt}}{\sum_{t=2}^{\tau} DEN_{jt}}$$

- average price increase in p.c.

(9) $$\overline{\Delta P}_j^{+} = \frac{\sum_{t=2}^{\tau} NUMUP_{jt}\left(\ln P_{jt} - \ln P_{j,t-1}\right)}{\sum_{t=2}^{\tau} DEN_{jt}}$$

- frequency of price decreases:

$$(10) \qquad F_j^- = \frac{\sum_{t=2}^{\tau} NUMDW_{jt}}{\sum_{t=2}^{\tau} DEN_{jt}}$$

- average price decrease in p.c.:

$$(11) \qquad \overline{\Delta P}_j^- = \frac{\sum_{t=2}^{\tau} NUMDW_{jt}\left(\ln P_{j,t-1} - \ln P_{jt}\right)}{\sum_{t=2}^{\tau} DEN_{jt}}$$

- Price synchronisation. We rely on the synchronisation ratio proposed by Konieczny and Skrzypacz (2002), which is based on the standard deviation of the proportion of price changes (increases and/or decreases) evaluated each month t. In case of perfect synchronisation, the proportion of price changes at time t is either equal to 1 or to 0. As the average frequency of price changes over the sample period is equal to Fj, it means, in the case of perfect synchronisation, that all firms change their price simultaneously in Fj per cent of the cases and do not change their price in (1- Fj) per cent of the cases. Using the probability of price changes, it is then possible to compute the theoretical value of the standard deviation of the proportion of price changes over time in case of perfect synchronisation. This standard deviation associated to perfect synchronisation is:

$$(12) \qquad SDMAX_j = \sqrt{F_j\left(1-F_j\right)^2 + \left(1-F_j\right)\left(0-F_j\right)^2} = \sqrt{F_j\left(1-F_j\right)}$$

This theoretical value is an upper limit for the standard deviation of the proportion of price changes. Similarly, in the case of perfect staggering, a constant proportion F_j of firms changes its price each month and the standard deviation of the proportion of price changes over time is equal to 0. The true standard deviation of price changes for product classification j is:

$$(13) \qquad SD_j = \sqrt{\frac{1}{\tau - 1}\sum_{t=2}^{\tau}\left(F_{jt} - F_j\right)^2}$$

The synchronisation ratio of product classification j is then given by:

$$(14) \qquad SYNC_j = \frac{SD_j}{SDMAX_j}$$

The closer the ratio is to one, the higher is the degree of synchronisation. Similar expressions can be derived for $SYNC^+_j$ and $SYNC^-_j$, the synchronisation ratio of price increases and price decreases.