STYLISED FEATURES OF CONSUMER PRICE SETTING BEHAVIOUR IN PORTUGAL: 1992-2001*

Mónica Costa Dias

Institute of Fiscal Studies and University College of London

Daniel A. Dias

Banco de Portugal, Anderson School of Management – UCLA and CEMAPRE

Pedro Duarte Neves

Banco de Portugal and Universidade Católica Portuguesa

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* Correspondence to: Daniel A. Dias, 110 Westwood Plaza, Entrepeneurs Hall, Suite C525, Box 951481, Los Angeles, CA, 90095-1481, USA, email: daniel.dias.2010@anderson.ucla.edu.

Abstract

This paper identifies the empirical stylized features of consumer price setting behavior in Portugal using two micro-datasets underlying the consumer price index. The main conclusions are: 1 in every 4 prices change each month; there is a considerable degree of heterogeneity in price setting practices; prices of goods change more often than prices of services; price reductions are common, as they account to around 40 per cent of total price changes; price changes are, in general, sizeable; finally, the price setting patterns seem to depend on the level of inflation as well as on the type of outlet.

Key Words: price setting; consumer prices; frequency of price changes.

JEL classifications: E31, E32, L11

1) Introduction

It is well recognised that the mechanism of price formation strongly determines how nominal shocks affect the economic conditions. The renewed interest on the importance of price rigidities and, in particular, on how it shapes the impact of monetary policies has motivated the recent steady expansion of the literature in this field (see, for instance, Blinder (1994), Taylor (1999), and Wolman (2001)). However, the considerable amount of theoretical work now available contrasts sharply with the lack of empirical evidence that supports any of the many existing theories against the others. To overcome this, some recent studies have tried to empirically characterise the price setting behaviour and the factors that may explain such behaviour.[1] Apart from very few exceptions, however, such work has had a narrow scope, focusing on specific products. There has also been an effort towards the validation of different models by empirically confirming their predictions. This research, however, is still largely inconclusive.[2]

This paper is a first attempt to characterise the consumer price setting behaviour in Portugal, drawing on two micro-datasets underlying the Consumer Price Index. These datasets – by their exhaustiveness and broad coverage - are almost unique pieces of information on price setting practices, corresponding to around 5.5 millions prices on some 800 consumption items, over the period 1992-2002.

The aim of this paper is to identify the general features of price setting. In particular, we focus on some key characteristics of price setting in a market economy, namely the heterogeneous nature of prices' persistence and responses to the aggregate economic conditions. In this respect, the present analysis follows very closely the recent work by Bils and Klenow (2004) and Klenow and Kryvtsov (2005), who draw on the micro-dataset on consumer prices collected by the U.S. Bureau of Labour Statistics. At each stage, as appropriate, we also discuss the consistency of different theories with the observed patterns being documented.

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[1] Some examples are Caucutt, Ghosh and Kelton (1999) on the rigidity of prices over the business cycle and the importance of durability and seller concentration, Lach (2002) on the dispersion of prices across store and their persistence over time, or Hall, Walsh and Yates (1997) on the extent of price rigidities and the importance of firms and market factors.

[2] See MacDonald and Aaronson (2000), Lach and Tsiddon (1992 and 1996), Kashyap (1995), Eichenbaum and Fisher (2003) or Konieczny and Skrzypacz (2003). As they stand, many of the theories make few predictions apart from price rigidity, and the few predictions they make are often on immeasurable or unmeasured variables. This strongly compromises the chances of empirically confirming them (see the discussion in Blinder (1994)).

The remaining of this paper is organized as follows. Section 2 describes the micro-datasets and the evolution of aggregate consumer prices. Section 3 describes the statistical concepts used in the empirical section of the paper. Section 4 presents the main findings on the consumer price setting practices. Finally, section 5 concludes.

2) Data

We use two micro datasets on consumer prices, both collected by the Portuguese *Instituto Nacional de Estatística* (INE). The two datasets were designed to produce the aggregate Consumer Price Index for Portugal and cover two different periods, January 1992 to December 1997 and January 1997 to December 2002. Hereafter, they will be denoted by CPI1 and CPI2, respectively. Information on consumer prices is reported at the outlet and product levels. Both datasets are longitudinal: outlets are followed over time at a monthly, quarterly or, in very few cases, yearly basis and the same item(s) is (are) sampled within each of them. There are over 3,000,000 observations in CPI1 and around 2,000,000 in CPI2 up to January 2001, on over 10,000 and 13,000 outlets and 460 and 780 items, respectively. Information on prices is collected on a number of outlets for each item, though brands and packages are not necessarily the same across stores. Thus, prices for the same items across stores are not comparable. Apart from prices, item code and outlet code, these datasets also include information on date, geographical location of the outlet (seven possible regions by NUT II classification), type of outlet (big and small stores in CPI1; hypermarkets, supermarkets, classical stores, discount stores, market and other in CPI2), a dummy for perishable food items and the weighting in the typical consumer bundle used to construct the aggregate CPI. Given the strict statistical secrecy requirements, the specific items collected in both surveys are unknown.[3]

The basic observation is that of an item's price in a particular outlet at a given point in time. Such item is followed over time within the same store. It is worth mentioning, however, that forced substitutions may occur. When dealing with such cases, INE agents have to decide whether a comparable substitute exists in the outlet. Despite being directly unobservable, CPI2 contains information on substitutions at an aggregate level. We use this information to assess the sensitivity of our results to the occurrence of

[3] The most detailed product code is composed of eight digits. The first five digits identify the class, group, subgroup and sub-subgroup; the last three digits identify the specific good or service chosen for the sample. To guarantee statistical secrecy, the key provided by INE only identifies the first five-digits.

substitutions. A more detailed discussion of the correction method is described in Appendix A, along with other key features concerning data collection. We further define *record* as the whole observed path of an item within a firm or outlet, and *spell* as the observed period during which the price of an item in a firm or outlet is kept unchanged.

We chose to restrict the analysis to the period ending in January 2001. This was for two reasons. First, the coverage period starts and ends in the month of January, ensuring that a balanced data with respect to potential seasonal components is being used. Second, by excluding 2002 we avoid possible contamination of the results by some atypical behaviour caused by the euro cash changeover.[4] Nevertheless, the covered period has seen policy interventions that could affect price setting patterns. The Valued Added Tax (VAT), for instance, changed a number of times, namely in April 1992, January 1995, July 1996 and October 1996. We acknowledge these changes and take special care in analysing the results for these periods.

The two datasets share a similar longitudinal structure. However, existing differences in the data collection rules that may affect the results. We now discuss such differences along with their potential consequences and how they have been dealt with.

First, the composition of the datasets at the item level is based on family expenditure patterns obtained from the Portuguese Family Income and Expenditure Survey. Two different instances of the same survey underlie the two datasets. As a consequence, the composition of the dataset by item changes from CPI1 to CPI2. Within each dataset, however, the product composition is kept unchanged over time. Apart from the infrequent cases of items included in one but not in both datasets, this is mostly a problem of different weighing schemes that could, in principle, be solved by extending the use of one of the datasets weights to the other. However, the classification itself changed from CPI1 to CPI2. Moreover, and although items are classified at a very detailed level, we are unable to label them at the observed detail for statistical secrecy reasons There are 116 5-digits groups of items in CPI1, while the corresponding number is of 183 in CPI2. For these reasons, we are unable to produce the correspondence between the CPI1 and CPI2 products at the item level and cannot implement a common weighting scheme at the finest classification level. Comparisons at a more aggregate level are not problem-free due to the change in weights and composition of the classes that can be both difficult to detect and to correct for. Thus, we have centred most of our attention in the most recent period

[4] The goal of this paper is to characterize the price setting behaviour in Portugal during "normal" periods. For that reason we opted to exclude the euro cash changeover from the analysis.

covered by CPI2, 1997-2002. The main reason is that CPI2 is a much richer dataset than the CPI1 in a way we will discuss below. CPI1 is mostly used to evaluate the impact of different levels of inflation on price setting practices, as it covers the 1992-1997 period characterized by a marked disinflation process in Portugal. This can be seen in Figure 1. For the sake of comparability and for the interest of the information per se, we use a breakdown of the CPI by the nature of the items, distinguishing between Food, Non-Food and Services. We will show below that these classes of products comprise structurally different items in terms of price setting behaviour.

Second, the periodicity of data collection is product-dependent, varying between monthly, quarterly and yearly information.[5] This means that some outlets are visited every month while others are only visited once a year. The yearly, quarterly and monthly observations represent, respectively, 1%, 51% and 48% of the consumer bundle in CPI1. The same proportions are, respectively, 4%, 58% and 38% in CPI2. In both CPI1 and CPI2, food items are surveyed monthly while most of the non-food and services items are surveyed quarterly.[6] There are some exceptions, however. Fresh (non-transformed) food items are observed three times every month in the same outlets and the average price is reported in CPI1 while all three prices are reported in CPI2. In the latter case, we chose to keep the monthly central observation, obtained during the calendar week in which the 15th day of the month lies. The remaining two observations were discarded to ensure comparability with the other items. At the other extreme, education, books and some services are reported annually only, as well as the prices for domestic services in CPI2. Moreover, some of the non-food items, mostly non-durables, are also reported on a monthly basis and their relative importance increases from CPI1 to CPI2. All the remaining items are observed quarterly. In dealing with such diversity, we need to standardise the time unit for comparison purposes. We start by excluding items observed on a yearly basis, as this information is too poor for the purpose of studying price setting behaviour. These represent a relatively negligible share of the consumers' bundle in both datasets. More importantly, quarterly observations are used to estimate monthly figures. This requires some assumptions, which we discuss in the methodological section below.

Third, the definition of price differs between the two datasets due to the way sales and promotions are dealt with. Both datasets report retail prices at the time of data collection. However, CPI1 excludes any sales or special prices while CPI2 reports the

[5] INE (1992) describes the main features concerning sample definition, selection and size.
[6] The rotating data collection scheme means that prices are reported every month for all products.

effective price, including sales and promotions. Although CPI2 reports the occurrence of promotions/sales, we have decided to study the actual prices faced by the consumer, including promotions and sales, as these reflect the actual characteristics of the market. We can, however, use data on ongoing promotions/sales to assess how important they are in explaining the observed patterns and potential differences between datasets in the identified price setting behaviour.[7]

Finally, missing price observations are also treated differently in CPI1 and CPI2. Missing observations can occur either because the product is out-of-stock or the outlet is temporarily (or permanently) closed. Whenever a product price is not observable, a price is generally reported in both datasets but the procedure used to predict it differs. CPI1 uses the last observed price as an estimate of the non-observed price while CPI2 uses an estimate of what the non-observed price would be had it changed at the average rate for the same item in that period as observed in the other outlets. This procedure is applied for up to 3 consecutive periods. At the end of this time, the outlet is replaced if it remains closed or the item is replaced by the most popular alternative within category and outlet, if it remains out-of-stock. Although an unbiased procedure for the purpose of estimating the aggregate rate of inflation, the treatment of missing prices in CPI2 introduces an upward bias in estimates of the probability of a price change. However, CPI2 also reports the occurrence of missing observations. We used this information to exclude missing observations from the analysis. As a consequence, while (identifiable) missing observations are rare in the middle of price records in CPI1, they amount to about 10 per cent of the observations in CPI2.

3) Methodological notes

The analysis in this paper is purely descriptive, focusing primarily on two dimensions of the price change decision: i) the frequency of price changes and ii) the magnitude of price changes. The analysis relies on these simple statistics and we, therefore, skip their discussion here. However, some assumptions are required to deal with the special characteristics of the datasets discussed above. For clarity, we shall discuss these now.

[7] About 2.2% of the observed prices are flagged as sales or promotions in CPI2.

The frequency of price changes is defined as the proportion of times a price for an item in an outlet is changed over T observation periods. We have computed the frequency of price changes at the item level, for which we use pairs of consecutive price observations within a store. There are two main advantages of this statistic as compared, for example, with the most commonly used alternative, the average (or median) spell duration. First, it uses the maximum possible amount of information, not discarding incomplete spells due to censoring.[8] Whenever a spell is censored, either due to a missing value or to the start or end of the sampling period, the computation of the frequency of price changes discards only the transitions involving the period for which the price is not observed. Such procedure does not produce bias for as long as missing observations are randomly selected, where randomness means that missing observations cannot be persistently drawn from periods where price changes do (do not) occur. Second, under certain conditions, specifically homogeneity of the population, the information about the *average spell duration* can be recovered from the *frequency of price changes* while, simultaneously, the inefficiency and bias inherent to the direct use of the former can be avoided.[9] Inefficiency occurs because the whole censored spells must be discarded when the *average spell duration* is the random variable being used. Bias occurs because long spells are more likely to be censored, either due to the occurrence of missing values or to the end of the sample period. If missing values are frequent, as is the case with CPI2, the induced bias can be quite important.

The coexistence of quarterly and monthly observations in the datasets limits our ability to compare the price setting patterns of different classes of products. We therefore chose to transform quarterly into monthly figures for comparative purposes only. There are many possible ways of performing such transformation, depending on the underlying assumption one wishes to accept. Following Bils and Klenow (2004), we postulate that the monthly frequency of price changes is constant over time within each outlet and for each item.[10] In such case, we can estimate the unobserved monthly frequency of price changes

[8] The data being used here is not afflicted by the non-randomness characteristic of stock samples since what is sampled is items in stores, not price spells. For the items in stores, we observe their prices for a certain period of time, in a succession of contiguous spells.
[9] See, for instance, Lancaster (1990) for a discussion on renewal process theory.
[10] Alternative parametric assumptions, allowing or not for duration dependency, could be considered. An extreme alternative is, for example, that any given item in an outlet experiences, at the most, one price change within a quarter, meaning that $f_1 = f_3/3$. At the other extreme is the assumption that an outlet changing the price of an item decides to do it repeatedly in every month within the quarter, meaning that $f_1 = f_3$.

by outlet (f_1) using the observed quarterly frequency of price changes (f_3) from the relationship $f_1 = 1 - (1 - f_3)^{\frac{1}{3}}$.

We also want to look at the share of positive and negative price changes. To estimate these frequencies, we have assumed that the proportion of positive (negative) price changes is the same for both quarterly and monthly data, $f_1^+ = f_3^+ / f_3 \times f_1$ ($f_1^- = f_3^- / f_3 \times f_1$).

We checked these assumptions by generating quarterly data from the monthly observations and estimating monthly figures using both the original monthly data and the constructed quarterly data. Given the results of this experiment (Appendix B) we think that the assumptions we had to make in order to estimate monthly statistics using quarterly data are very reasonable and adequate.

Bils and Klenow (2004) analyse both the frequency of price changes and the duration of prices' spells using a well known relationship between the two measures: under some conditions (stationarity and homogeneity), the average spell duration is the inverse of the frequency of price changes. This relationship is only valid for homogeneous data. Thus, in the best case scenario it can only be applied at the most disaggregated level. In this paper we used the item*outlet level, as in Baharad and Eden (2004), instead of doing it at the product level, as in Bils and Klenow (2004). As it is shown in Baharad and Eden (2004), estimation at a more aggregate level leads to downward biased estimates of the median duration of price spells due to heterogeneity at the store level.[11]

Data on the relative magnitude of price changes is also plagued by the same "heterogeneous frequency of data collection" problem. We use a similar procedure to the one applied to the frequency of price changes, transforming quarterly observations into their monthly equivalents. This was done under the following assumptions: First, the estimated f_1 *is* the monthly frequency of price changes; Second, any sequential price changes within a quarter are of the same order of magnitude; and Third, within any quarter there are only positive or negative monthly price changes, not both simultaneously. Let Δ_3 and Δ_1 designate the quarterly and corresponding monthly relative magnitude of price change, both either positive or negative. Δ_1 will equal Δ_3, $\sqrt{1+\Delta_3} - 1$ or $\sqrt[3]{1+\Delta_3} - 1$ with

[11] Baharad and Eden (2004), in their study for Israel, obtain a median average duration of 8 and 4 months using the frequency of price changes estimated at the product*outlet and product level, respectively. We have obtained similar results for Portugal (presented below).

probabilities $3f_1(1-f_1)^2$, $3f_1^2(1-f_1)$ and f_1^3, respectively. From here, we can compute what the average Δ_1 is for all quarterly observations at the item and outlet levels.

As in the case of the estimation of the monthly frequency of price change, we also performed a robustness check of our assumptions for the estimation of the monthly magnitude of price change using quarterly data (see Appendix B for results). Once again, we could not find evidence that our assumptions are inadequate.

Finally, because averages are very sensitive to outliers and extreme values we have opted to present the weighted median (as well as other quantiles) of the individual averages instead of the weighted average. The only exception is the frequency of price changes, for which both the average and the median are presented.

4) Summary of the findings

This section explores the micro-datasets previously described to identify the main stylised features of consumer price setting in the Portuguese economy over the sample period.

Fact 1: On average, almost 1 in every 4 prices is changed in a month.

The first column of table 1 reports monthly frequencies of price changes for all items taken together and split by major groups. The weighted frequency of price changes is 0.22. That is, price changes affect, on average, almost a fourth of all prices in every month. Therefore, price changes in Portugal seem to occur more frequently than is reported in Taylor (1999) and remarkably close to the results in Bils and Klenow (2004), who estimated an average frequency of price changes of 0.26. The empirical evidence for Portugal is on the upper range of the estimates available for Europe. A summary paper by Dhyne et al (2006) reports a higher frequency of price changes only for Luxembourg (0.23) while figures above 0.2 have only been found in 4 countries (Portugal, Luxembourg, France and Finland). The other tail of the distribution shows countries like Spain, Germany or Austria with estimated price change frequencies around 13.5%. In part, such differences can be explained by the inclusion of sales or promotions in the analysis. While Portugal and France include sales and promotions in the estimation process, both Spain and Germany do not. Nevertheless, Baudry, Le Bihan, Sevestre and Tarrieu (2004) suggest that sales and promotions should not be seen as the only reason for such large inter-country differences. These authors estimate an increase of 3% in the average frequency of price changes when sales and promotions are considered. This means that the sales and promotions only explain 50% of the gap between, for instance, Portugal and Spain.

Fact 2: 50 per cent of the items in outlets display average price spells shorter than 8.5 months.

The third column of table 1 presents the median average spell durations by item and outlet measured in months.[12] For all items taken together at a moment in time, 50 per cent of the price spells last for less than 8.5 months. This value is considerably larger than the one reported in Bils and Klenow (2004) for the US – 4.5 months –, but smaller than the one for the Euro Area presented in Dhyne et al (2006) – 10.6 months. A possible explanation for such a large difference with respect to the U.S. is within item heterogeneity at the outlet level. Bils and Klenow (2004) do not account for differences across stores selling the same items. By disregarding heterogeneity across stores, we estimate the median average price spell to be 6 months. Similar results were obtained by Baharad and Eden (2004) using data for Israel. They estimate the average spell duration to be 7.9 and 4.1 months when heterogeneity at the outlet level is and is not allowed for, respectively.

Fact 3: The frequency of price changes is considerably larger for food than for other items, mostly due to the behaviour of unprocessed food items, and the prices of goods change more frequently than the prices of services.

Even at a considerable aggregate level as the one displayed in table 1, large differences in the price setting behaviour by type of product are evident. The most extreme result concerns unprocessed food, which exhibits a degree of price variability that clearly exceeds that observed for the remaining components of the CPI: almost 50 per cent of items in this class are expected to register a price change at any given month. Such result does not hold for processed food items, suggesting that the behaviour of unprocessed food prices is likely to be driven by supply-side factors related with the seasonal nature of many unprocessed food items. Thus, prices for unprocessed food seem to respond in a flexible way to changes in market conditions.

[12] These values are the inverse of the median average frequency of price changes (second column of table 1).

The frequency of price changes is much smaller for all other groups. At one extreme is the group of semi-durable items, mainly formed of clothing and footwear. These are items strongly affected by seasonal sales and promotions, thus explaining the comparatively high frequency of price changes (almost once every three months). The most unexpected result in this table is that for durable items. It suggests that more than 1 in every 4 prices for durable items change in each month, clearly above the figure for non-durable items (just over 1 in every 10 prices) and nearly the same figure as that found for semi-durables. This result is strongly influenced by the behaviour of prices for new and used cars, amounting to more than 50 per cent of the consumer's expenses in durable goods. For them, product homogeneity over time can hardly be ensured, as some product characteristics change very frequently. Their exclusion from the analysis reduces the monthly frequency of price changes for durable items to 9.4 per cent only, below the respective value for non-durables. Finally, the prices for services change at a low frequency (about once in every 10 months, on average). It is worth noting that, given the sample size being considered, all these differences are statistically significant.

The same pattern is displayed in the third column of table 1. According to this measure, 50 per cent of the unprocessed food items have spell durations shorter than 2 months, while this goes up to 5.5 months for processed food, 7.3 months for non-food good items and 14 months for services.

Fact 4: With the exception of food, clothing and footwear items, positive are more frequent than negative price changes.

Columns 1 and 2 in table 2 show the monthly frequency of price increases and price decreases for February 1997 to January 2001. The two figures are very close for food items, being split almost evenly. This is probably a consequence of the seasonal nature of many items in this class, for which rises and drops in prices are expected to be equally likely. In turn, non-food goods and services are significantly more likely to experience positive price changes, with more than two thirds of the changes being price increases. This is the expected pattern in an inflationary period and is systematically observed for all the more homogeneous classes distinguished in table 2 apart from that of semi-durable items. The typical seasonal pattern of clothing and footwear, with a sales' period twice a year, may explain the evenly distribution of price changes between positive and negative for this class. Overall, and as one could expect in a context of positive inflation, price increases are more likely than price decreases. However, price increases only account for around 60 per cent of total price changes.

Fact 5: Price increases and price decreases have, in general, the same order of magnitude. Thus, the observed positive inflation reflects the fact that price increases are relatively more frequent.

The remaining columns of table 2 display the 25th, 50th and 75th percentiles of distribution of the magnitudes of price changes conditional on their sign. These statistics do not show systematic differences between positive and negative price changes. That is, though more frequent, positive price changes are not generally larger in absolute value than negative price changes. One exception is services, which clearly exhibit stronger positive changes particularly when the prices are not centrally determined.

It is also worth noting that price changes are, in general, sizeable, as shown in columns 3 to 8 in table 2. Even the first (third) quartile of the conditional distributions of the magnitude of price increases (decreases) exhibits values typically above the average inflation rate for the corresponding period. Thus, size does seem to matter on the decision to change prices.

Fact 6: There is a considerable degree of heterogeneity in price setting behaviour by product. This applies to the decisions to change prices but it is not so obvious with respect to the magnitude of the changes.

The frequency of price changes varies considerably among different consumption goods, even after controlling for the type of item. Figure 2 displays the distributions of the average monthly frequencies of price changes for items at the most detailed level, for all items taken together and split by food and non-food goods and services. The distributions are more concentrated for non-food goods and services, but nevertheless exhibit considerable within-group heterogeneity. Some distributions show multi-modal patterns and all have long tails towards 1.

There are items that, by their nature or exposure to public intervention, may show atypical price setting patterns that influence these results. To assess the importance of such hypothesis we have also computed the distribution of the frequency of price changes for narrower groups, separating items that are arguably traded in different markets under different conditions, like unprocessed food, energetic items and services with administered prices. Figure 3 presents the results for food items (panel A), non-food goods (panel B) and services (panel C). The main conclusions drawn from the analysis of figure 2 still hold for each and every sub-group, particularly in what respects to the large amount of within-group heterogeneity in price setting behaviour.

Figure 4 presents the distribution of the magnitudes of price change. This is done conditional on the occurrence of a price change (i.e., zeros were excluded). The graph presents both the distribution of the median rates of price change by product and the distributions of the 25th, 50th and 75th quantiles. Although the distribution of the medians is quite concentrated around a small positive value, the distributions of the 25th and 75th quantiles are much more disperse. Figure 5 details the analysis by type of item. In general, the distributions become much more concentrated and close together, suggesting that the decision of how much to change is much more homogeneous than that of whether to change prices. The exceptions are semi-durable goods and services. While the former might be strongly affected by the seasonal sales and promotions typical of clothing and footwear, the latter may possibly reflect within group heterogeneity.

The considerable homogeneity in the rates of price change by type of product suggests that size matters for the decision of changing a price. However, figure 3 shows that controlling for some of the items' characteristics seems to explain just a small proportion of this variability. The distributions become less disperse, but not in a way such that the conclusion about within-group heterogeneous price setting behaviour can be withdrawn. In particular, processed food items show very heterogeneous patterns and so do semi-durable goods.

In what follows we will disclose some additional dimensions of heterogeneity that contribute to the explanation of these differences.

Fact 7: Heterogeneous price setting behaviour is observed by type of outlet: the frequency of price changes increases with the size of the outlet.

Big outlets adjust more frequently their prices than small outlets do.[13] Table 3 presents clear evidence on this. While the overall frequency of price changes is 0.522 in big outlets, the same figure is 0.347 and 0.203 in medium and small outlets, respectively. This pattern is systematically observed for all the more homogeneous groups of items we have been considering.[14]

[13] Large, medium and small outlets were considered separately, corresponding to hypermarkets, supermarkets and classical stores, respectively.
[14] Results available under request from the authors.

There are several potential explanations for the heterogeneous behaviour observed by type of outlet. On the demand side, it could be related with a more fierce competition between big outlets, imposing more frequent changes in prices. One possible indicator of the degree of competition between outlets is the proportion of promotional/sales prices. In general, one would expect more promotions/sales within a more competitive environment. The proportion of promotions/sales for big, medium and small outlets is 0.040, 0.028 and 0.012, respectively. Alternatively, supply-side elements may play a key role in the explanation. The menu-costs hypothesis postulates the existence of costs associated with price changes arising, for example, from collecting information about the evolution of market prices and from re-labelling.[15] Most important, fixed costs represent a potentially large share of the total costs associated with a price change.[16] Thus, differences in price setting behaviour are expected to depend on the outlet size with the fixed costs becoming more negligible as the volume of sales increases.

Fact 8: The macroeconomic conditions also influence the price setting behaviour: periods of high inflation are characterised by more frequent changes in prices.

The sample period covered by CPI1 corresponds to most of the recent disinflation period of the Portuguese economy. For practical purposes, we define a high inflation period (1992-1993, with an average inflation rate of 7.7 per cent), a medium inflation period (1994-1995, with an average inflation rate of 4.6 per cent) and a low inflation period (1996-1997, with an average inflation rate of 2.7 per cent).[17] Thus, we are able to compare the price setting patterns at different inflation levels, through the use of CPI1. Such analysis can be informative for two reasons. First, it might reveal an additional heterogeneity dimension. And second, it allows for a discussion about the importance of the magnitude of change in the decision to alter prices.

The evolution of the overall, positive and negative frequencies of price changes over time may disclose some dependency of the price setting behaviour on the aggregate economic conditions. We use the whole period covered by either CPI1 or CPI2 to perform this analysis (that is, from 1992 to 2001).[18] Results are presented in figures 6 and 7 for all

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[15] See Caplin and Spulber (1987) or Tsiddon (1991).

[16] Moreover, economies of scale in the price setting activity are also expected.

[17] Over 1997-2002, the period covered by CPI2, the rate of inflation fluctuated in a much more narrow band. This justifies the focus on the sample CPI1 to highlight this point.

[18] The two datasets are expected to exhibit different patterns as they are based in different methodologies, cover a different bundle of goods and use different weights. In particular, higher frequencies and more variability over time are expected under CPI2 given that promotions are included in the price.

items taken together and by major types of items, respectively. The total frequency of price changes seems to exhibit a downward trend during the first period of analysis, from 1992 to 1997. This remains true after excluding the atypical behaviour of the periods with changes in VAT (1992:II, 1995:I, 1996:III and 1996:IV) and applies to all items except food. The continuous fall in the frequency of price changes with the level of inflation during the CPI1 period is driven by the behaviour of positive price changes. In turn, the frequency of negative price changes seems to remain unaffected by changes in aggregate economic conditions.

Table 4 presents additional evidence on the price setting pattern but this time using the magnitudes of price change by level of inflation. Both the mean and the median values of the distributions of the magnitude of price changes are presented. This is done by level of inflation and separately for positive and negative changes. There are no discernible differences between the two periods for food items, but, if anything, the magnitudes became larger in absolute terms as inflation fell. In turn, the magnitudes of the positive changes in prices for non-food items and services decreased as inflation dropped. Such changes, at the most on the order of 2 percentage points, seem small to totally justify a fall in the inflation rate on the order of 5 percentage points as the one registered between 1992-93 and 1996-97. Given that these classes of items register a quarterly frequency of price changes of about 0.25 over this period and represent about 55 per cent of the consumer's bundle, an upper bound for their contribution to the change in inflation is on the order of 1 per cent if one takes the price changes to be all positive. That is, only a small part of the change in inflation seems to be explained by these changes, apparently leaving most of the adjustment to occur on the frequency of price changes.

Fact 9: There is strong seasonality in the price setting scheme for non-food items, particularly with respect to services. Seasonal factors also affect the magnitude of price changes for non-food items.

A strong seasonal price setting pattern is displayed for services in panel C of figure 7, with pronounced peaks in the frequency of price changes occurring every first quarter of the year. Non-food goods (panel B) display a less marked but still strong pattern while no obvious seasonality is observed for food items (panel A).

Such systematic behaviour may reflect changes in costs or in the demand that occur systematically at the start of the year and to which sellers are quick to adjust. Alternatively, it can reflect some time–dependent pattern. The typical change in regulated prices and wage rates occurring in January suggests that such seasonal pattern may be a response to changing economic conditions. Moreover, the production prices, discussed in a companion paper, also display a seasonal pattern of the same type, particularly for consumption goods. Such behaviour per se, independently of what explains it, alters the costs at the retailer's level, thus justifying more frequent adjustments in consumer prices.

Figure 8 displays the distribution of the rate of price changes conditional on the occurrence of a change. This is done separately for each quarter of the year, considering the several years in the sample together by using the homologous quarters.[19] Moreover, we also distinguish between different types of items. Food items exhibit undistinguishable distributions by quarter, suggesting that seasonality is not a main issue. On the contrary, non-food goods do show strong differences between, on the one hand, the first and the third quarters and, on the other hand, the second and the fourth. More specifically, the distributions for the first and the third quarters have more mass on negative values, probably a consequence of the occurrence of sales and promotions in that period. The second and the fourth quarters exhibit the opposite pattern, as a consequence of the updates of prices after the sales season. Panel C presents the case for services. All quarters display identical patterns except for the last quarter of the year, where a much stronger tendency for significant price cuts is observed.

5) Concluding remarks

This paper identifies the main stylized features of consumer price setting behavior in Portugal over the period 1992-2001 using the micro-data sets underlying the consumer price index. The main conclusions of this empirical research are the following:

a) The monthly frequency of price changes is slightly below 0.25 meaning that, on average, almost 1 in every 4 prices is changed in a month.
b) This remarkably high frequency of price changes is strongly affected by the behaviour of unprocessed food, for which prices are very volatile.
c) The median duration of consumer price spells is about 8.5 months.
d) There is a considerable degree of heterogeneity in product price setting behaviour.

[19] The analysis of each quarter in each year separately was also performed. However, homologous quarters in different years exhibit undistinguishable distributions for the rate of price changes. Therefore, we opted for considering them together.

e) Heterogeneous price setting behaviour is also observed by type of outlet: the frequency of price changes increases with the size of the outlet (where classical stores, supermarkets and hypermarkets are being considered).
f) Periods of higher inflation are characterised by more frequent changes in prices.
g) There is a strong seasonality in price setting.
h) Price increases are more likely than price decreases, as they account for around 60 per cent of total changes.
i) In general, price changes are sizeable, at least having in mind the levels of inflation observed in the Portuguese economy over the sample period.

The focus of the analysis has been purely descriptive. In particular, this paper does not test alternative pricing models. However, even without a formal testing our results provide useful underlying information for micro-founded monetary analysis, drawing attention to the importance of: *(i)* sectorial heterogeneity; *(ii)* prevalence of price changes in both directions; *(iii)* dependence between the rates of price adjustment and the level of inflation; *(iv)* size of price adjustments.

In future research it will be important to test formally the alternative pricing models as they are crucial in the understanding of the monetary policy effects and, consequently, optimal monetary conduction. It will also be interesting to analyze the impact on the transmission of monetary shocks of some of the price setting characteristics here identified.

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Appendix A: data

This appendix describes the key aspects concerning data collection in CPI2.

A.1. Data issues

The following table summarizes the main features of the CPI2 that may affect the values and interpretation of the statistics reported in the text on frequency and magnitude of price changes.

	CPI2
Brand change	The rule is to keep always the same brand along time, but brand may change if the product disappears (see discussion on forced items substitution). From store to store, brands and packages can be different.
Quantity change	Prices are "standardized" in terms of quantity.
Store closedown	A new store is included in the sample to replace the old one.
Temporary price discounts	Discounts are registered and a specific code indicates if a discount took (took not) place.
Forced item substitutions	It occurs. An indirect approach to identify these cases is described below.
Seasonal items	Only considered during their season. Price changes are only considered in consecutive months.
Stock-outs	These are reported in CPI2 and all the analysis used observed prices only.

A.2. Forced item substitutions in the CPI2

Forced item substitutions may occur in the CPI2. In these cases, a comparable or non-comparable substitute is selected depending on whether or not a comparable substitute exists in the store. When a non-comparable substitute must be selected, an adjustment reflecting the quality change, products upgrade or model changeover needs to be considered for the purpose of computing the price index.

Unfortunately, there is no code in the CPI2 dataset to signal non-comparable items' substitution. However, there is information at the regional level about whether at least one non-comparable replacement occurred in a store within the respective region. We use this information to assess the importance of this type of replacements in our results. When non-comparable replacements occurred in a region at a period in time, we assumed any outliers in the magnitude of price change identified such replacements.[20] When no outliers occurred, the highest (absolute) price change was selected instead. This procedure suggests that 1 per cent of the overall month-to-month transitions are affected by non-

[20] Tukey's definition of outliers was applied to the distribution of price changes (conditional on the occurrence of a price change): outliers are defined as observations that lie above (below) 1.5 times the inter-quartile range of the price changes distribution (this covers both suspected outliers and outliers).

comparable replacements.[21] A new spell starts each and every time such an occurrence of a non-comparable replacement is estimated.

In order to assess the robustness of the results reported in the paper, four alternative cases were considered:

a) No treatment of non-comparable substitutions: this corresponds to an upper bound to both the frequency and the magnitude of price changes;
b) Estimation of non-comparable substitutions: this procedure (described above) was used to compute the estimates discussed in the main text;
c) Elimination of all the observations concerning price changes at the item/region level for which we know that at least one non-comparable replacement took place: this corresponds to a lower bound for the frequency of price changes;
d) As an additional sensitivity exercise, we also considered a situation in which all the price sequences (i.e. price changes and no price changes) at the item/region level for which we know that (at least) one non-comparable replacement took place were eliminated.

The empirical results reported are robust to the alternative assumptions considered.[22]

Appendix B: Estimation of monthly figures from quarterly data – adequacy of adopted methodology

As described in section 2, both CPI datasets have monthly, quarterly and annual data, raising some comparability problems. To overcome this, we have discarded items with annual observations only and have estimated the monthly figures from quarterly data. The later procedure is expected to produce biased estimates. We evaluate how serious this bias can be in this appendix. To do this, we restrict the analysis to items observed monthly and estimate the true and estimated monthly frequencies of price change for these items only. Estimated monthly frequencies of price change are obtained for quarterly data constructed from monthly data by discarding information on 2 months out of every quarter. The same procedure was applied to the magnitude of price changes. The obtained bias, the difference between the true and the estimated monthly figures, is described in tables A.1 and A.2. The results show that the estimation of monthly figures from quarterly data does not seem to create significant bias.

[21] Klenow and Kryvtsov (2004) report a frequency of around 1.5 per cent for non-comparable replacements in the micro data collected by the US Bureau of Labour Statistics and Hoffmann and Kurz-Kim (2006) estimated a maximum impact of 1.4% on the overall frequency of price changes due to the existence of non-observed replacements.

[22] Results available from the authors upon request.

Table A.1 – Impact of estimating monthly frequencies of price changes using quarterly data

	Bias frequency of price changes				Bias frequency of positive price changes				Bias frequency of negative price changes			
	Average	1st quartile	Median	3rd quartile	Average	1st quartile	Median	3rd quartile	Average	1st quartile	Median	3rd quartile
Food	0.048	0.133	0.033	-0.011	0.022	0.075	0.018	-0.008	0.026	0.074	0.018	-0.003
Non-food	0.012	0.084	0.021	-0.015	0.007	0.047	0.013	-0.009	0.005	0.035	0.000	-0.004
Services	0.009	0.019	0.000	-0.005	0.004	0.016	0.000	-0.004	0.005	0.000	0.000	0.000
Total	0.043	0.120	0.026	-0.011	0.020	0.068	0.015	-0.007	0.023	0.066	0.013	-0.003

Table A.2 – Impact of estimating monthly magnitudes of price changes using quarterly data

	Bias average magnitude of positive price changes				Bias average magnitude of negative price changes			
	Average	1st quartile	Median	3rd quartile	Average	1st quartile	Median	3rd quartile
Food	0.002	0.026	0.002	-0.018	-0.002	0.017	-0.002	-0.025
Non-food	0.000	0.016	0.001	-0.019	-0.003	0.014	-0.002	-0.021
Services	0.002	0.004	0.002	0.001	-0.008	-0.001	-0.001	-0.005
Total	0.002	0.024	0.002	-0.017	-0.002	0.016	-0.002	-0.024

Table 1: CPI - frequency of consumer price changes
Monthly figures

	Monthly frequency of price changes	Median frequency of price changes	Median duration (in months)	Number of observations	Weights
Total	0.220	0.117	8.5	1996529	1.000
By type of good					
Food	0.366	0.326	3.1	1290061	0.254
Unprocessed food	0.472	0.476	2.1	636834	0.139
Unprocessed food excluding perishables	0.382	0.370	2.7	413676	0.000
Processed food	0.239	0.188	5.3	653227	0.115
Non-Food	0.207	0.126	7.9	521161	0.463
Non-Durables	0.114	0.072	14.0	213204	0.093
Semi-Durables	0.277	0.189	5.3	108303	0.077
Durables	0.259	0.157	6.4	182245	0.200
Energy	0.131	0.143	7.0	17409	0.094
Services	0.110	0.067	15.0	185307	0.283
Administred price services	0.089	0.072	14.0	12327	0.064
Non administred price services	0.116	0.063	16.0	172980	0.219
By type of industry					
Food and non-alcoholic beverages	0.372	0.333	3.0	1201657	0.241
Alcoholic beverages, tobacco and narcotics	0.144	0.091	10.9	98640	0.034
Clothing and footwear	0.275	0.186	5.4	107433	0.077
Housing, water, electricity, gas and other fuels	0.080	0.072	14.0	20533	0.088
Furnishings, household equipment and routine household maintenance	0.109	0.067	15.0	204937	0.075
Health	0.046	0.047	21.5	62487	0.064
Transport	0.257	0.164	6.1	50227	0.224
Communication	0.113	0.077	12.9	3451	0.026
Recreation and culture	0.120	0.054	18.5	69016	0.038
Education	0.077	0.091	10.9	2548	0.006
Restaurants and hotels	0.186	0.083	12.0	93742	0.085
Miscellaneous goods and services	0.111	0.072	14.0	81858	0.042

Notes to table 1:
Estimates correspond to the 1997:1-2001:1 period. They were obtained from the CPI2 dataset using information on all items followed monthly and quarterly except housing rents. Monthly figures were estimated for quarterly data using estimates at the outlet*item level (see section 3 for further details). Items collected yearly were excluded from this analysis. Estimates for the median duration were obtained from the inverse of the median frequency of price changes at the outlet*product level (see section 3 for further details). All estimates use CPI2 weights at the most detailed level available. The weights presented in the last column were rescaled to add one.

Table 2: CPI - frequency and magnitude of consumer price changes
Positive and negative price changes
Monthly figures

	Monthly frequency of positve price changes	Monthly frequency of negative price changes	Magnitude of positive price changes			Magnitude of negative price changes		
			1st quartile	Median	3rd quartile	1st quartile	Median	3rd quartile
Total	0.136	0.084	0.044	0.081	0.154	-0.142	-0.075	-0.036
By type of good								
Food	0.194	0.173	0.048	0.085	0.153	-0.131	-0.077	-0.040
Unprocessed food	0.247	0.225	0.067	0.116	0.203	-0.169	-0.097	-0.057
Unprocessed food excluding perishables	0.210	0.172	0.059	0.093	0.149	-0.125	-0.077	-0.047
Processed food	0.129	0.109	0.041	0.068	0.111	-0.105	-0.062	-0.035
Non-Food	0.141	0.066	0.039	0.058	0.135	-0.170	-0.085	-0.033
Non-Durables	0.080	0.033	0.036	0.051	0.099	-0.118	-0.067	-0.031
Semi-Durables	0.128	0.150	0.082	0.184	0.356	-0.261	-0.166	-0.090
Durables	0.188	0.071	0.027	0.057	0.110	-0.117	-0.058	-0.024
Energy	0.111	0.020	0.041	0.042	0.050	-0.043	-0.024	-0.006
Services	0.076	0.035	0.067	0.101	0.168	-0.108	-0.063	-0.031
Administered price services	0.060	0.029	0.035	0.054	0.095	-0.190	-0.073	-0.022
Non administered price services	0.080	0.036	0.069	0.108	0.168	-0.105	-0.063	-0.031

Notes to table 2:
Estimates correspond to the 1997:1-2001:1 period. They were obtained from the CPI2 dataset using information on all items followed monthly and quarterly except housing rents. Monthly figures were estimated for quarterly data using estimates at the outlet*item level (see section 3 for further details). Items collected yearly were excluded from this analysis. All estimates for the magnitudes of price changes are conditional on a price change having occurred, either positive or negative depending on the case. All estimates use CPI2 weights at the most detailed level available.

Table 3: CPI - frequency consumer price changes by type of store
Monthly figures

	Monthly frequency price changes	Median frequency price changes	Monthly frequency of positve price changes	Monthly frequency of negative price changes	Median duration (in months)
Type of outlet					
Big outlets	0.522	0.500	0.277	0.245	2.0
Medium outlets	0.347	0.292	0.189	0.159	3.4
Small outlets	0.203	0.146	0.126	0.077	6.9

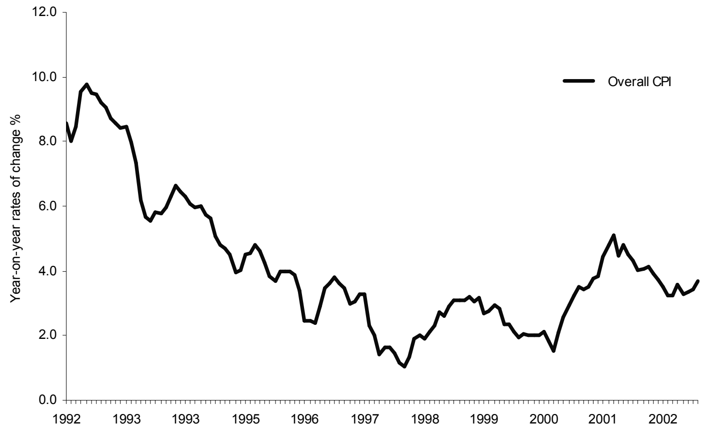
Notes to table 3:
Estimates correspond to the 1997:1-2001:1 period. They were obtained from the CPI2 dataset using information on all items followed monthly and quarterly (except housing rents). Monthly figures were estimated for quarterly data using estimates at the outlet*item level (see section 3 for further details). Items collected yearly were excluded from this analysis. Estimates for the median duration were obtained from the inverse of the median frequency of price changes at the outlet*item level (see section 3 for further details). The composition of the bundle is the same across stores. All estimates use CPI2 weights at the most detailed level available.

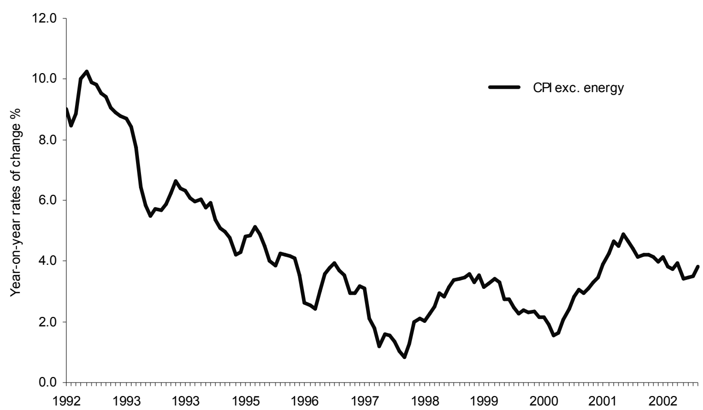
Table 4: CPI – Magnitudes of price changes by level of inflation
Monthly and quarterly figures

	High inflation				Low inflation			
	Positive price changes		Negative price changes		Positive price changes		Negative price changes	
	mean	median	mean	median	mean	median	mean	median
Food items	0.089	0.065	0.093	0.064	0.094	0.065	0.096	0.067
Non-food items	0.115	0.078	0.116	0.072	0.095	0.061	0.128	0.079
Services	0.149	0.116	0.132	0.074	0.127	0.095	0.143	0.089

Notes to table 4:
Estimates correspond to the 1992:1-1993:12 and 1996:1-1997:12 for the high and low inflation periods, respectively. They were obtained from the CPI1 dataset using information on all items followed monthly and quarterly except housing rents. Items collected yearly were excluded from this analysis. All estimates for the magnitudes of price changes are conditional on a price change having occurred, either positive or negative depending on the case. The estimates for food items are monthly rates of price changes. The estimates for non-food items and services are quarterly rates of price changes. All estimates use CPI1 weights at the most detailed level available.

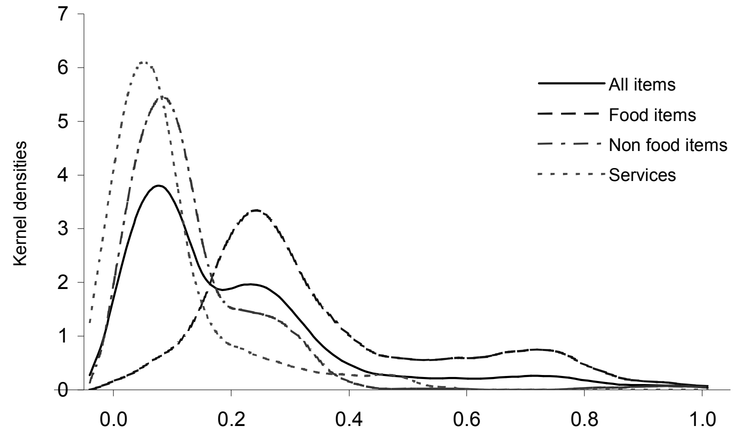
Figure 1: Consumer Price Index (CPI) over time





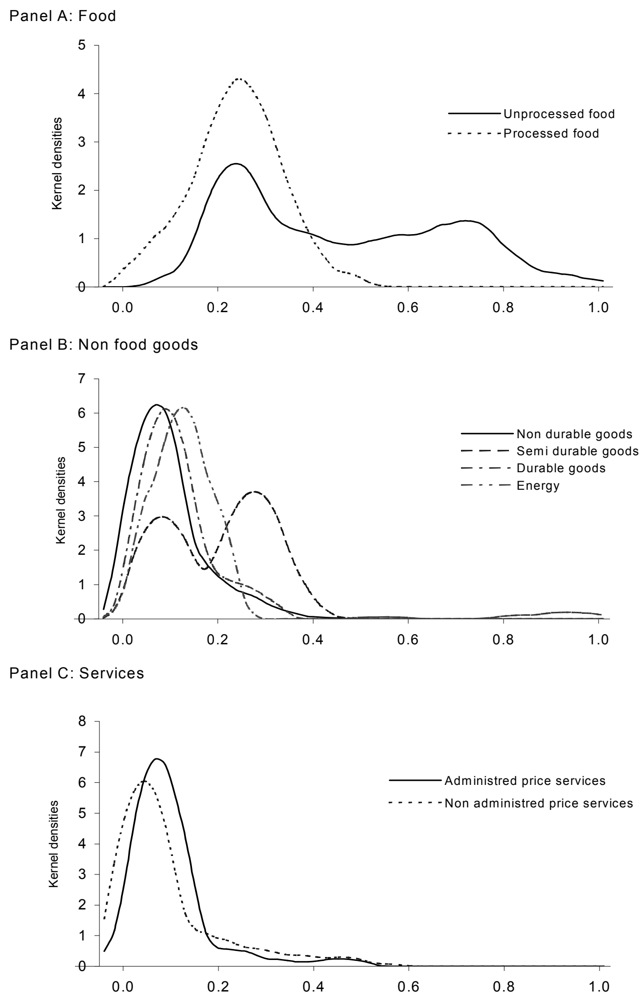
Source: Instituto Nacional de Estatística

Figure 2: CPI - Distribution of the frequency of price changes
Monthly figures



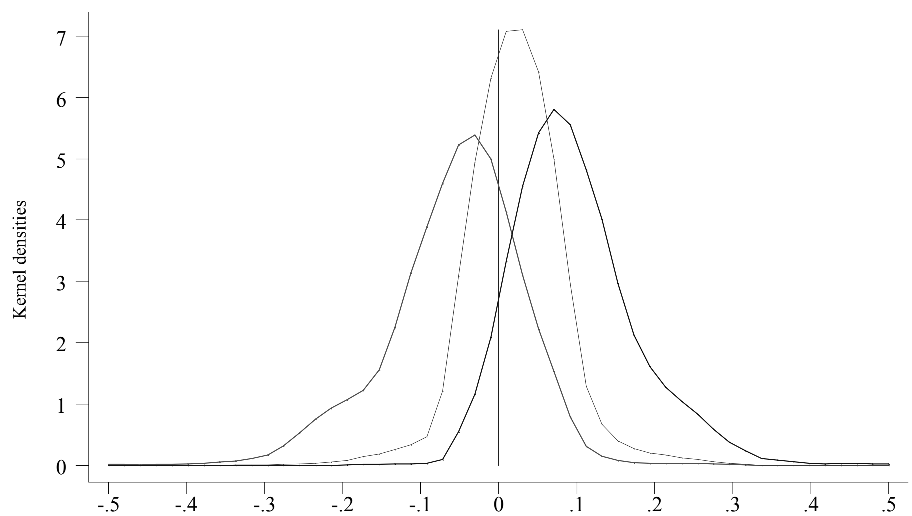
Notes to figure 2:
This graph illustrates the distribution of the average frequency of price changes by item. Estimates correspond to the 1997:1-2001:1 period. They were obtained from the CPI2 dataset using information on all items followed monthly and quarterly except housing rents. Items collected yearly were excluded from this analysis. Monthly figures were estimated for quarterly data using estimates at the outlet*item level (see section 3 for further details). Averages were then computed by item and constitute the basic observation used in these graphs. The distributions were estimated using kernel weights. No CPI weights were used in these estimates.

Figure 3: CPI - Distribution of the frequency of price changes by type of item. Monthly figures



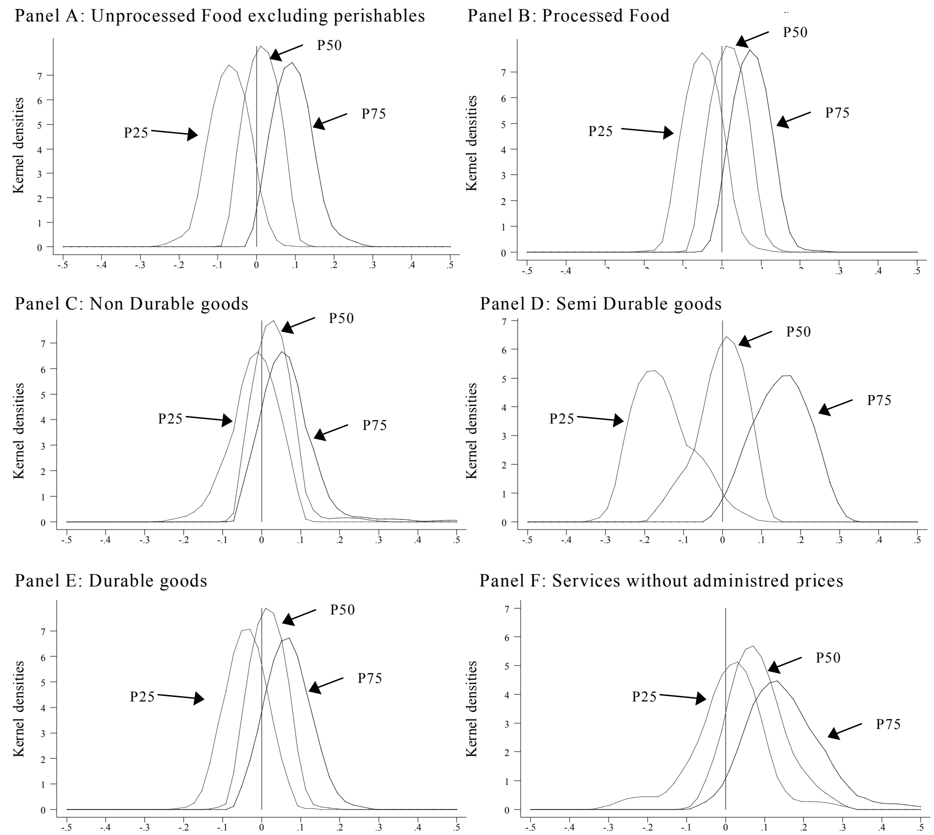
Notes to figure 3:
This graph illustrates the distribution of the average frequency of price changes by item. Estimates correspond to the 1997:1-2001:1 period. They were obtained from the CPI2 dataset using information on all items followed monthly and quarterly except housing rents. Items collected yearly were excluded from this analysis. Monthly figures were estimated for quarterly data using estimates at the outlet*item level (see section 3 for further details). Averages were then computed by item and constitute the basic observation used in these graphs. The distributions were estimated using kernel weights. No CPI weights were used in these estimates.

Figure 4: CPI - Magnitude of price changes for all items
Conditional distributions of percentiles 25, 50 and 75
Monthly figures



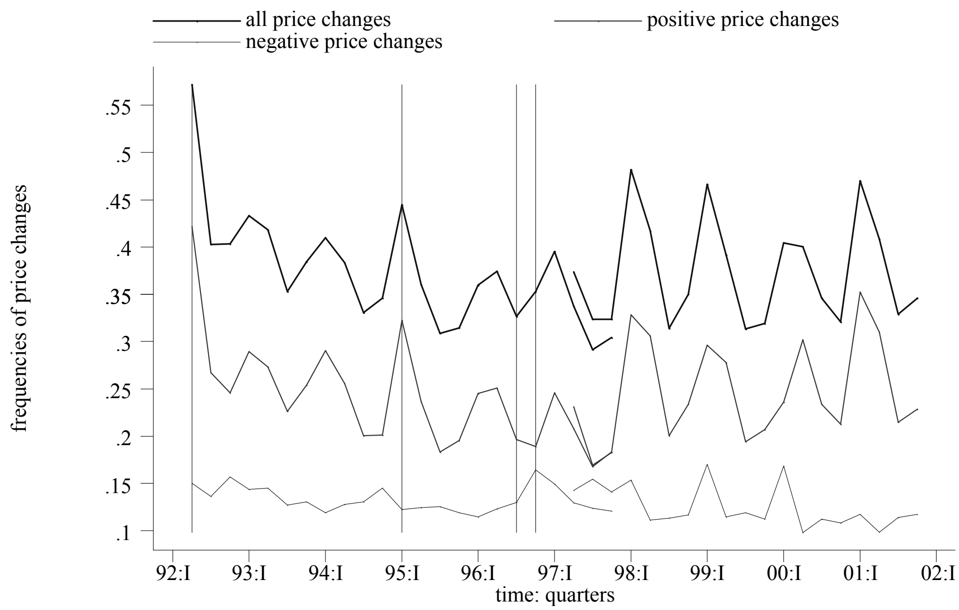
Notes to figure 4:
This graph illustrates the distributions of the 25th, 50th and 75th percentiles of the magnitudes of price changes conditional on a change having occurred. Estimates correspond to the 1997:1-2001:1 period. They were obtained from the CPI2 dataset using information on all items followed monthly and quarterly except housing rents. Items collected yearly were excluded from this analysis. Monthly figures were estimated for quarterly data using estimates at the outlet*item level (see section 3 for further details). The distributions were estimated using kernel weights. No CPI weights were used in these estimates.

Figure 5: CPI - Magnitudes of price changes by type of item
Conditional distributions of percentiles 25, 50 and 75
Monthly figures



Notes to figure 5:
This graph illustrates the distributions of the 25th, 50th and 75th percentiles of the magnitudes of price changes conditional on a change having occurred. Estimates correspond to the 1997:1-2001:1 period. They were obtained from the CPI2 dataset using information on all items followed monthly and quarterly except housing rents. Items collected yearly were excluded from this analysis. Monthly figures were estimated for quarterly data using estimates at the outlet*item level (see section 3 for further details). The distributions were estimated using kernel weights. No CPI weights were used in these estimates.

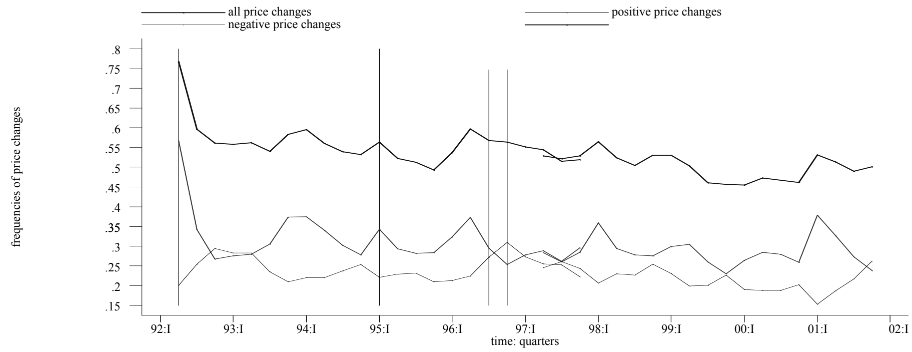
Figure 6: CPI - Frequency of price changes over time
All items
Quarterly figures



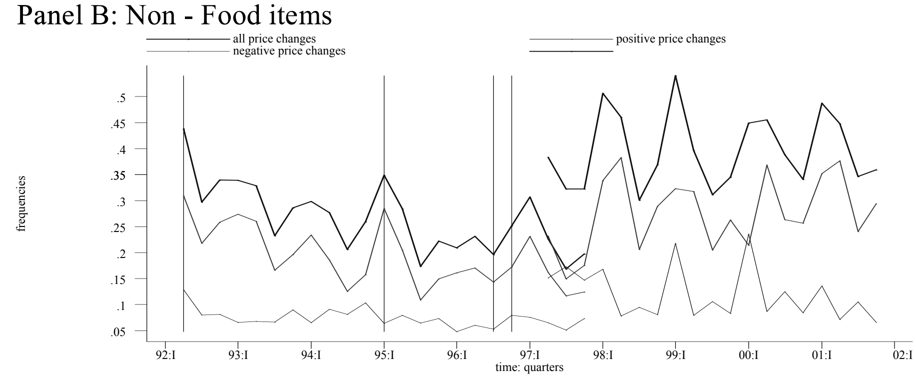
Notes to figure 6:
This graph illustrates the frequency of price changes over time, both for all changes and for positive and negative changes separately. Estimates correspond to the 1992:1-2001:1 period. The vertical lines indicate VAT rate changes. They were obtained from the CPI1 and CPI2 datasets using information on all items followed monthly and quarterly except housing rents. Items collected yearly were excluded from this analysis. Quarterly figures were estimated from monthly data by randomly selecting the relative position within the quarter of the monthly observation to be used in the analysis. This was performed at the item*outlet level. All estimates use CPI weights at the most detailed level possible. The composition of the bundle is kept constant over time. In this graph, the top, middle and bottom lines correspond to all, positive and negative frequency of price changes, respectively.

Figure 7: CPI - Frequency of price changes over time
By type of item
Quarterly figures

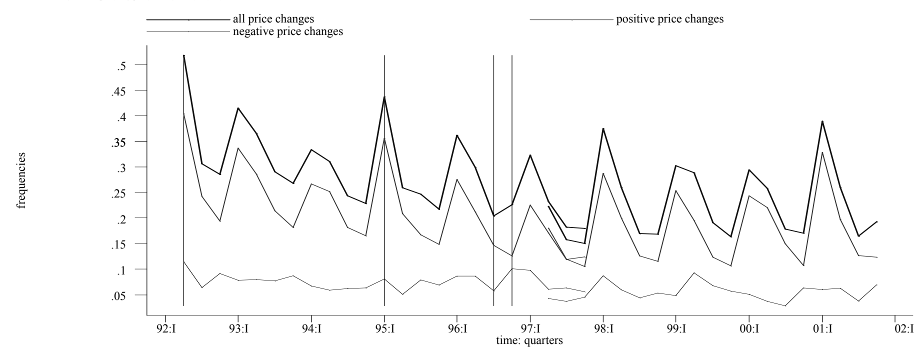
Panel A: Food items



Panel B: Non - Food items

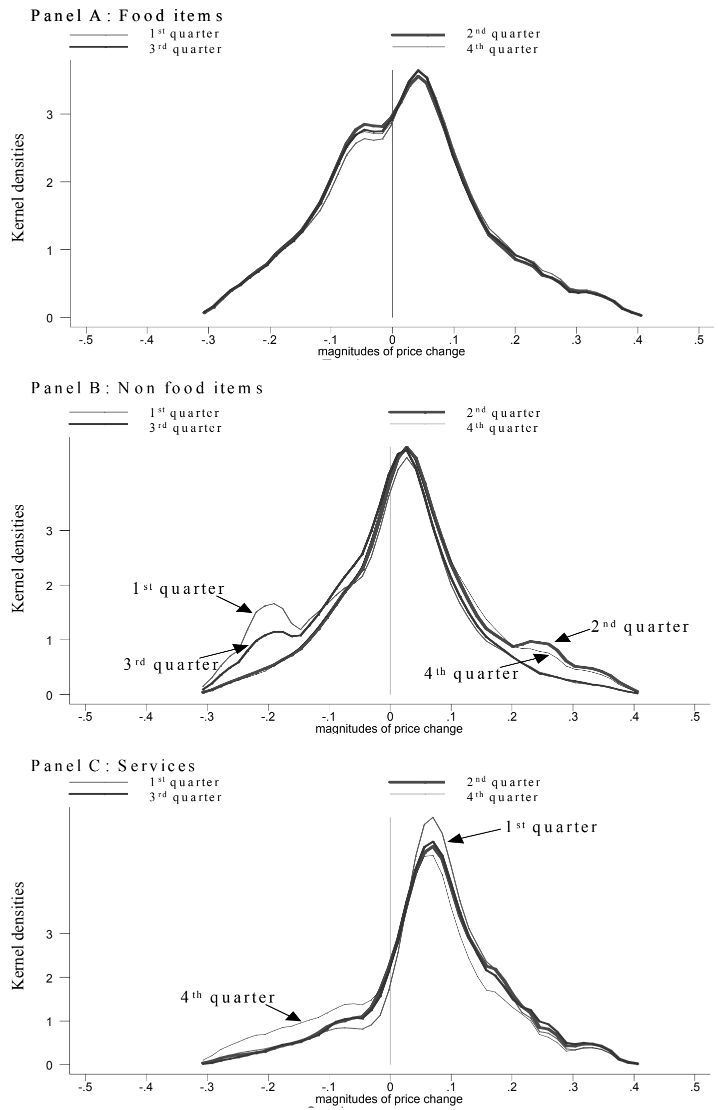


Panel C: Services



Notes to figure 7:
This graph illustrates the frequency of price changes over time, both for all changes and for positive and negative changes separately. Estimates correspond to the 1992:1-2001:1 period. The vertical lines indicate VAT rate changes. They were obtained from the CPI1 and CPI2 datasets using information on all items followed monthly and quarterly except housing rents. Items collected yearly were excluded from this analysis. Quarterly figures were estimated from monthly data by randomly selecting the relative position within the quarter of the monthly observation to be used in the analysis. This was performed at the item*outlet level. All estimates use CPI weights at the most detailed level possible. The composition of the bundle is kept constant over time. In each one of the graphs on the three panels, the top, middle and bottom lines correspond to all, positive and negative frequency of price changes, respectively.

Figure 8: CPI - Distribution of the quarterly rates of price changes
By type of item and quarter



Notes to figure 8:
This graph illustrates the central 90 per cent of the distributions of the magnitude of price changes conditional on a change having occurred. Estimates correspond to the 1997:1-2001:1 period and are performed by quarter, homologous quarters in different years being considered together. They were obtained from the CPI2 dataset using information on all items followed monthly and quarterly except housing rents. Items observed yearly were excluded from this analysis. Quarterly figures were estimated from monthly data by randomly selecting the relative position within the quarter of the monthly observation to be used in the analysis. The distributions were estimated using kernel weights. The composition of the bundle is the same for all quarters. No CPI weights were considered in these computations.