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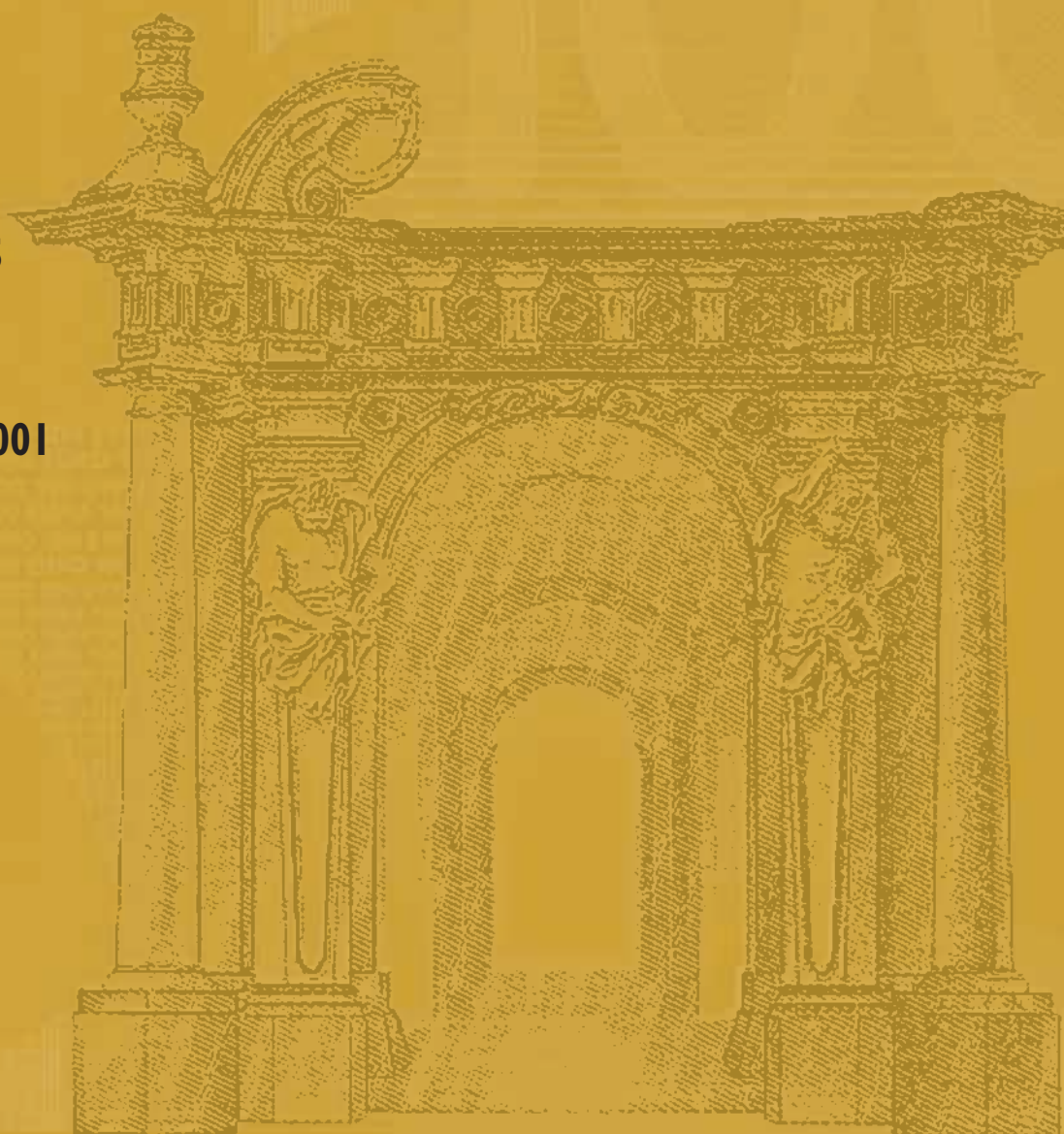
**WORKING PAPER SERIES**

**NO. 332 / APRIL 2004**

**EUROSYSTEM INFLATION  
PERSISTENCE NETWORK**

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

by Mónica Dias, Daniel Dias  
and Pedro D. Neves





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### STYLISTED FEATURES OF PRICE SETTING BEHAVIOUR IN PORTUGAL: 1992-2001<sup>1</sup>

by Mónica Dias<sup>2</sup>, Daniel Dias<sup>2</sup>  
and Pedro D. Neves<sup>3</sup>

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## **The Eurosystem Inflation Persistence Network**

This paper reflects research conducted within the Inflation Persistence Network (IPN), a team of Eurosystem economists undertaking joint research on inflation persistence in the euro area and in its member countries. The research of the IPN combines theoretical and empirical analyses using three data sources: individual consumer and producer prices; surveys on firms' price-setting practices; aggregated sectoral, national and area-wide price indices. Patterns, causes and policy implications of inflation persistence are addressed.

The IPN is chaired by Ignazio Angeloni; Jordi Galí (CREI, Universitat Pompeu Fabra) and Andrew Levin (Board of Governors of the Federal Reserve System) act as external consultants and Michael Ehrmann as Secretary.

The refereeing process is co-ordinated by a team composed of Vítor Gaspar (Chairman), Silvia Fabiani, Carsten Folkertsma, Jordi Galí, Andrew Levin, and Philip Vermeulen. The paper is released in order to make the results of IPN research generally available, in preliminary form, to encourage comments and suggestions prior to final publication. The views expressed in the paper are the author's own and do not necessarily reflect those of the Eurosystem.

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### **Abstract**

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

**Keywords:** price setting; consumer prices; producer prices; frequency of price changes

**JEL classifications:** E31, E32, L11

## Non-technical summary

This paper identifies the stylized features of price setting behaviour in Portugal in the period 1992-2001, through the empirical analysis of the micro-datasets underlying the consumer and producer price indexes. These datasets are an almost unique set of information on price setting practices, as they contain around 5.5 millions prices on some 800 consumption items and slightly less than one million prices on some 500 items produced by the manufacturing industry. The main conclusions of this empirical investigation are the following:

- a) Price changes – both at the consumer and at the producer level – occur very often. In both cases, the monthly frequency of price changes is slightly below 0.25 meaning that, in average, almost 1 in every 4 prices is changed in a given month. This result is remarkably similar to the one presented by Bils and Klenow (2002) for the United States, and higher than the results obtained by Baudry, Le Bihan, Sevestre and Tarrieu (2003) and Aucremanne and Dhyne (2003) for France and Belgium, respectively.
- b) The remarkably high frequency of price changes is, however, upwardly affected by the behaviour in two specific components: unprocessed food, in the case of the CPI, and energy, in the case of the IPPI (with weights of 14 and 17 per cent in the respective indexes, respectively). The frequency of price changes decreases to 0.18 and 0.14, respectively, when one considers the CPI excluding unprocessed food and the IPPI excluding energy prices.
- c) There is a considerable degree of heterogeneity in product price setting behaviour, at both the consumer and producer levels. In both cases, the pdf (probability density function) of the observed frequency of price changes is positively asymmetric, even after excluding unprocessed food and energy. This heterogeneity reflects, on one hand, different frequencies of price changes across different components of the consumer and producer price indexes and, on the other hand, different frequencies of price changes across different retailers or producers for comparable items of the indexes.
- d) The median duration of price spells (defined at the most elementary levels of item and outlet/firm) varies between 8.5 months in consumer prices and one year in the case of producer prices. The fact that those durations are considerably larger than the ones implied by the above mentioned frequency of price changes just reflects the strongly positive asymmetry of the pdf for the frequency of price changes (heavily concentrated near zero but also with long tails towards 1).

- e) In the case of consumer prices, the frequency of price changes of goods (even after the exclusion of food components) is clearly higher than the frequency of price changes of services; in the case of producer prices, the frequency of price changes of consumption goods is clearly higher than the one of intermediate commodities. In this way, when developing theoretical models it is advisable to distinguish, at least, between these different classes of the indexes.
- f) For comparable goods, consumer prices change more often than producer prices. This result – which is in our knowledge the very first comparison with such a broad coverage of consumer and producer prices – confirms empirical evidence previously presented or suggested in Hall, Walsh and Yates (1997), Dutta, Bergen and Levy (2002) and Rotemberg (2002).
- g) There is strong seasonality in price setting. In the case of consumer prices, a marked peak in the frequency of price changes occurs in the first quarter of the year, in the case of services; non-food goods also show a strong seasonal pattern. In the case of producer prices, the frequency of price changes peaks in the beginning of the year, more noticeably in January.
- h) Price increases are more likely than price decreases, as one could expect in a context of positive inflation. However – and curiously for both consumer and producer prices - price increases only account for around 60 per cent of total changes.
- i) In general, price changes are sizeable - both at the consumer and at the producer level – at least having in mind the levels of inflation observed in the Portuguese economy over the sample period. Price changes at the consumer level are larger than at the producer level. It exists also evidence that the magnitude of price increases is broadly similar to the magnitude of price decreases, at both producer and consumer levels. In this way, the positive inflation observed reflects the larger frequency of price changes vis-à-vis the one of price decreases, and not larger price increases than price decreases.
- j) Heterogeneous price setting behaviour at the retailer level is observed by type of outlet: the frequency of price changes increases with the size of the outlet (considering classical stores, supermarkets and hypermarkets).
- k) Periods of higher inflation are characterised by more frequent changes in prices. This result was obtained at the consumption level, as the longer time-series available for consumption prices allowed us to distinguish between a high inflation period (the beginning of the nineties) and a low inflation period (from mid nineties onwards).

## 1) Introduction

The renewed interest on the importance of price rigidities and how it shapes the impact of monetary policies has motivated the recent steady expansion of the literature on 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 (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 stores and its persistence over time; and Hall, Walsh and Yates (1997) on the extent of price rigidities and the importance of market and firm factors). There has also been an effort towards the validation of different models by empirically confirming their predictions. This work, however, is still inconclusive (see MacDonald and Aaronson (2000), Lach and Tsiddon (1992 and 1996), Kashyap (1995), Eichenbaum and Fisher (2003) and Konieczny and Skrzypacz (2003)).<sup>1</sup>

This paper is a first attempt to characterise the consumer price setting behaviour in Portugal, drawing on the micro-datasets underlying the Consumer Price Index and the Industrial Production Price Index. These datasets – by their exhaustiveness, broad coverage and possibilities of comparison between prices at the consumer and producer levels - 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, and to slightly less than one million prices on some 500 items produced by the manufacturing industry.

The aim of this paper is two-fold. Firstly, the general features of price setting are identified, at the consumer and at the producer levels. In particular, the analysis of the datasets focus on the key features of price setting in a market economy as identified by Taylor (1999): (i) price changes have the average frequency of about one per year; (ii) there is a great deal of heterogeneity in price setting, in the sense that a noticeable differences exist between the average lengths of different types of price setting arrangements; (iii) the

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<sup>1</sup> As they stand, many of the theories make few predictions apart from price rigidity, and the few predictions they make are often on unmeasurable or unmeasured variables. This strongly compromises the chances of empirically confirming them (see Blinder (1994)).



frequency of price changes depends on the average rate of inflation. In that respect, this analysis follows very closely the recent work by Bils and Klenow (2002), who draw on the micro-dataset on consumer prices collected by the U.S. Bureau of Labor Statistics to obtain similar, though not necessarily equal, results: (i) differences in price flexibility are large and persistent across consumption categories; (ii) the median duration of prices across all non-housing items is 4.3 months; (iii) prices are more flexible for goods than services.

The second main goal of this paper consists in the comparison of price setting practices at the consumer and at the producer level for the same commodities. This comparison – with such an exhaustive degree of coverage – has not, in our knowledge, been attempted before. Hall, Walsh and Yates (1997), using a survey of 654 UK companies, conclude that price changes are more frequent in the retailing sector (three to four times a year) than in the manufacturing sector (twice a year) or the services sector (once a year). Dutta, Bergen and Levy (2002) use store-level time series data with information on retail prices, wholesale transaction prices and measures of manufacturing costs collected in a single retail chain for 12 goods related to orange juice. They conclude that (i) retail prices change frequently and react quickly and fully to cost changes, (ii) manufacturing prices change often but exhibit rigidity in reaction to cost changes, and, finally, (iii) differences in stickiness are related with the degree of competition, existence of contracts and long-term relationship structures. Finally, Rotemberg (2002) introduces the concept of ‘consumer anger’, reflecting a situation in which consumers believe prices are unfair. Consumer anger tends to lead to stable prices, probably more often in intermediate goods, where more information between parties exists, than in final goods.

This paper is organized as follows. Section 2 describes the micro-datasets and the evolution of aggregate consumer and producer prices. It is worth mentioning that inflation followed a continuous downward trend over the period 1992-1997 and, therefore, this is an extremely convenient period to unveil potential differences in price setting practices at different levels of inflation. Section 3 describes the statistical concepts used in the empirical section of the paper. The key indicator analysed is the frequency of price changes, defined as the proportion of prices that change in the transition between periods  $t$  and  $t+1$  among those observed in both periods. Section 4 presents the main findings on price setting over that period. A comparison between producer and consumer price setting practices, for a set of homogeneous commodities, constitutes the most innovative empirical exercise carried out in section 4. Finally, section 5 concludes.

## 2) Data

This paper uses three micro datasets on consumer and producer prices, all collected by the Portuguese *Instituto Nacional de Estatística* (INE). Two of these 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. These datasets contain information on consumer prices at the outlet and product levels. The third dataset contains information on producer prices at the firm and product level, containing the raw data underlying the Portuguese Industrial Production Price Index. Hereafter it will be designated by the IPPI dataset. It covers the period from January 1995 to August 2002. All three are longitudinal datasets: firms or outlets are followed over time at a monthly or quarterly basis and the same item(s) is(are) sampled within each of them. In what follows, the term “item” designates a product at its most elementary level. That is, it stands for a homogeneous product although different brands and packages of the same item may be classified under the same code.. 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. Given the extremely strict statistical secrecy requirements, the specific products collected in both surveys are unknown.

We chose to restrict the analysis to the period ending in January 2001. This is mainly for two reasons. First, by excluding 2002 we also avoid possible contamination of the results by some atypical behaviour caused by the escudo-euro cash changeover. Second, to ensure that a balanced data with respect to potential seasonal components is being used, the coverage period starts and ends in the month of January, which typically exhibits a comparatively high frequency of price changes. Nevertheless, over the covered period there were policy interventions that might have affected price setting behaviour. The Valued Added Tax (VAT), for instance, changed a number of times, namely in April 1992, January 1995, July 1996 and October 1996. The changes in VAT are expected to affect consumer but not industrial prices due to the different definitions of price in the two surveys. We acknowledge their potential effects and take special care in the analysis of the results for these periods.

We now describe each dataset in more detail and characterize the aggregate behaviour of prices in the period covered.

### a) The CPI datasets

The two CPI datasets cover an 11-year period from 1992 to 2002, overlapping for the full year of 1997. Both datasets comprise information on prices at the outlet and product level, covering outlets nationwide. The basic observation is that of a price of an item in a particular outlet at a given point in time. This item is followed over time within the same store. It is worth mentioning, however, that forced substitutions may occur in the case of the Consumer Price Index. When dealing with such situation, INE agents have to decide if a comparable substitute exists in the outlet or not. In spite of the fact that no direct code identifies that substitution, a simple statistical procedure was designed to estimate the occurrence of a non-comparable substitution. This issue is analysed in the data appendix of the paper, which also describes the key features concerning the data collection process underlying the CPI.

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, product code and outlet code, the CPI datasets also includes information on date, geographical location of the outlet in seven possible regions (NUT II classification), dimension of the outlet allowing for a distinction between hypermarkets, supermarkets and classical stores, a dummy for perishable food products and (incomplete information on) the weights of the items in the typical consumer bundle. As the CPI records are under statistical secrecy, it is impossible to know the specific goods and services that are collected in the survey.<sup>2</sup>

The two datasets share a similar longitudinal structure but are collected using different criteria that may impact on the results. We therefore discuss these differences and similarities here, along with their potential consequences and the proposed solutions. First, the composition of the datasets at the product level is determined using information on family expenditure patterns from the Portuguese Family Income and Expenditure Surveys. Two different surveys underlie the two datasets, thus introducing differences in composition by product between CPI1 and CPI2, though within each CPI the product

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<sup>2</sup> The most detailed product code is composed of eight digits. The first five identify the class, group, subgroup and sub-subgroup; the last three identify the specific good or service chosen for the sample. To guarantee statistical secrecy, the key provided by INE only enables the identification at the first five-digits level.

composition is kept unchanged for the whole duration of the survey. Apart from the relatively infrequent cases where an item is included in one but not in both CPIs, this is just a problem of a different weighing scheme that could, in principle, be resolved by extending the use of one of the CPIs 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. As mentioned above, the most disaggregated classification we use to label products is at the 5-digits level, called the sub-subgroups. This is common to the two datasets. There are 116 5-digits groups of items in CPI1, while the corresponding number is of 183 in CPI2. Thus, we are unable to produce a correspondence between the CPI1 and CPI2 products at the item level that would allow us to use a common weighting scheme. The comparisons at an aggregate level are not problem-free also, both due to the change in weights and to the different composition of the classes that can be either difficult to detect and/or difficult to correct for. Thus, we have centred most of our attention in the most recent period covered by CPI2, 1997-2002. Two main reasons explain such choice: the much longer overlap with the IPPI data and the fact that CPI2 is a richer dataset 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. 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. It disaggregates the whole consumer's bundle in food and non-food items, which are then split in more homogeneous categories: transformed and non-transformed food for the former and durable, semi-durable and non-durable goods, energy and services for the latter. A major advantage of this classification is that it can be easily applied to both CPI and to the IPPI datasets. Moreover, we will show below that they comprise structurally different goods in terms of their price behaviour.

Second, the periodicity of data collection is product-dependent, varying between monthly and quarterly information.<sup>3</sup> This means that some outlets are visited every month while others are only visited once every quarter. In both CPI1 and CPI2, food items are surveyed monthly while most of the non-food items are surveyed quarterly.<sup>4</sup> There are some exceptions, however. Fresh food items (non-transformed) are observed three times every month in the same outlets and the average price is reported in CPI1 while all three

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<sup>3</sup> INE (1992) describes the main features concerning sample definition, selection and size.

<sup>4</sup> However, the rotating scheme used to collect prices observed less frequently means that all products are observed every month.



prices are known 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, and discarded the remaining two to ensure comparability with the other items. At the other extreme, education, books and 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 monthly basis and its importance rises from CPI1 to CPI2. 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 the price setting behaviour. These represent about 1 and 4 per cent of the consumers bundle used in CPI1 and CPI2, respectively. More importantly, quarterly observations are used to estimate monthly figures. This requires some assumptions, depending on the variable being used. We further discuss this subject in the methodological section below.

Third, the definition of price differs between CPIs due to the way sales and promotions are dealt with. Both datasets report retail prices at the moment the purchase occurs, but CPI1 excludes any sales or special prices being applied at the time of data collection while CPI2 reports the effective price, including sales and promotions. Although CPI2 contains information about the occurrence of promotions/sales, we have opted to study the actual prices faced by the consumer as these reflect the actual characteristics of the market. We can, however, use data on the existence of a promotion/sale to assess how important they are to explain the observed patterns and potential differences between datasets in the identified price setting behaviour.

Finally, missing observations are also treated differently in CPI1 and CPI2. Missings can occur either because the product is out-of-stock or the outlet is temporarily (or permanently) closed. In such case, a price is generally reported in both datasets, though the procedure used to estimate it differs. CPI1 uses the last observed price as an estimate of the non-observed price. On its turn, CPI2 uses an estimate of what the non-observed price would be had it changed at the average rate of change observed in the remaining outlets. This procedure is applied for up to 3 consecutive periods. At the end of this time, the store is replaced if it remains closed or the item is replaced by the most popular alternative within category and store, if it remains out-of-stock. Although an unbiased procedure for the purpose of estimating the aggregate rate of inflation, this latter method is likely to introduce an upward bias when the data is used to estimate the probability of a price change. However, CPI2 also contains the information about when the missings occur. This

information was used to exclude missing observations from the analysis. Thus, though the occurrence of missings in the middle of the records is rare in CPI1, it amounts to about 10 per cent of the observations in CPI2. Thus, of course, the exclusion of the missings introduces methodological problems that should be addressed to avoid biased results. As expected, different statistics are differently affected and deserve, therefore, different treatments<sup>5</sup>. This will be further discussed below in the methodological section.

#### **b) The IPPI dataset**

The IPPI dataset reports prices in industry for the following sectors: Mining and Quarrying, Manufacturing, Electricity, Gas, and Water Supply. This study, however, focus only on the Manufacturing industry, thus eliminating the information available for the other sectors. Data runs from January 1995 to August 2002 on a monthly basis. As for the CPI datasets, each observation corresponds to the price of an item in a firm at a given moment in time. Items are classified using the Prodcom Nomenclature at the 12-digits level and are further characterised at a more disaggregated level, including brand. However, due to statistical secrecy we are only able to label the products at the 12-digits classification. Again, this is a longitudinal dataset, with the same firms and items being followed over time. The sample was designed having 1995 as the year of reference and covering firms that produce in part or totally for the domestic market. Up to January 2001, this survey covers 2,406 firms and 538 items.<sup>6</sup>

The price collected by INE is defined as the list price of industrial production traded within the domestic market. More specifically, it corresponds to the gross figures presented in the table of prices for items produced by the firm. Any discounts or subsidies are not deducted and taxes are not added. The relevant price is that in force at the 15<sup>th</sup> of each month.<sup>7</sup>

Missings may occur either because the item is discontinued, the firm closes temporarily or permanently, or it just does not reply in a given month. These missing

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<sup>5</sup> We have tried two alternative approaches to deal with the missing observations within CPI2: used them as they are reported and estimate the probability of a price change when a missing occurs using, among others, the information about whether the observed price changed from before to after the missing. Computations based on these alternatives produce very similar results to the ones we report below and we, therefore, decided to not present them.

<sup>6</sup> INE (1997) describes the main features concerning sample definition, selection and size.

<sup>7</sup> Prices are collected by mail and, if necessary, a fax/telephone/postal insistence takes place at the 26<sup>th</sup> of the reference month.

observations are dealt with in a similar way to that applied to CPI1: they are estimated using the closest past value in time and assuming no price change occurred in the meantime. This criterion is applied for up to 4 consecutive months, after which the item is dropped and replaced by a similar one. The occurrence of a missing is not signalled in the dataset, in contrast to what happens with CPI2. Thus, observable missings in the middle of a record are virtually inexistent. However, they are responsible for incomplete records, these being the ones not observed up to the end of the sampled period. In fact, only about 82 percent of the records ever started during the 1995-2000 period are still in the dataset in January 2001. Other key aspects concerning the data collection process underlying the IPPI are referred to in the annex.

### **c) Comparability between the CPI and the IPPI**

For comparison purposes, we have constructed subsets of the CPI2 and IPPI datasets with similar composition. These are the common samples. Matching was performed at the most detailed labelling information available for both CPI2 and IPPI. This procedure eliminates from the analysis entire classes of items not simultaneously represented in the CPI and IPPI datasets. The two most important examples are services, which were excluded from the CPI as they are not an industrial product, and intermediate goods, which are not included in the CPI dataset and were, therefore, excluded from the IPPI. Overall, the common samples represent about 40 per cent of the consumer's bundle used in CPI2 and about 50 per cent of the manufacturing product.

The comparison between consumer and producer price practices, through the use of the micro-datasets underlying the CPI and the IPPI, raises some comparability issues given the different methodological characteristics of these two indexes. In particular, it is worth mentioning the following aspects: retailer prices include VAT, whereas producer prices do not; different treatment of missing values; sales and promotions are treated in different ways; forced item substitutions are dealt with in different ways in the two indexes. In order to perform meaningful comparisons, both datasets have been appropriately transformed. The detailed description of these transformations is presented in the data annex of the paper.



#### d) The evolution of consumer and producer price indexes over 1992-2002

It is interesting to document the evolution of the Portuguese consumer and producer price indexes throughout the sample period for reference purposes. Figure 1a illustrates the evolution of the year-on-year rates of change of the CPI and the IPPI. Figure 1b illustrates the evolution of the same indexes if energy is excluded.

Inflation followed a continuous downward trend in the period 1992-1997.<sup>8</sup> The annual rate of change of the CPI, excluding housing rents, declined from 8.9 per cent in 1992 to 2.2 per cent in 1997. In the case of goods, the annual rate of change declined from 7.4 to 1.2 per cent; in the case of services, the decline was even more marked, from 13.2 to 4.4 per cent. Such inflation pattern is extremely convenient to unveil potential differences in the price setting behaviour at different levels of inflation. This will be attempted below. The period 1998-2002 was characterized by a CPI inflation rate fluctuating in the range between 2 and 4 per cent (1999 in the first case and 2001 in the second case).

Figure 1a also shows the main features of the evolution of producer prices in the manufacturing industry over the period 1995-2002. The IPPI registered much more marked fluctuations than the CPI. This volatile pattern was decisively affected by the evolution of industrial prices in petroleum refinement industries. Excluding that sector, as shown in figure 1b, the range of fluctuation is narrower. It is clear, however, that production prices fluctuate much more than consumer prices at the aggregate level.

### 3) Methodological notes

The analysis in this paper is purely descriptive, using only very simple statistics. Thus, we do not enrol here in a lengthy explanation of such measures but instead try to justify their choice and to clarify the assumptions on which their computation is based.

Most of the analysis focus on the *frequency of price changes*, defined as the proportion of prices that change in the transition between periods  $t$  and  $t+1$  among those observed in both periods. 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. 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

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<sup>8</sup> The successful disinflation process in Portugal is well documented. See Abreu (2001). The strategy adopted by the Portuguese authorities corresponded to a monetary policy based on exchange rate stability as an intermediate target to reach the final goal of price stability



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 the information about the *average spell duration* can be fully recovered from the *frequency of price changes* while, simultaneously, the inefficiency and biasness inherent to the direct use of the former can be avoided. Inefficiency occurs because the whole censored spells must be discarded when the *average spell duration* is the random variable being used. Biasness 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.

We establish the relationship between the two measures using duration analysis. In fact, the hazard function is a second statistic that we use to provide a more detailed characterisation of the price spells, making its discussion needed on its own.<sup>9</sup>

Take, as before,  $t$  to represent the time period. Moreover, designate by  $s$  the duration of a price spell. The hazard function is the instantaneous rate at which the spells end at duration  $s$ ,

$$\theta(s) = \lim_{ds \rightarrow 0} \frac{P[S < s + ds | S \geq s]}{ds} = \frac{f(s)}{1 - F(s)}$$

where  $\theta$  represents the hazard function,  $S$  is the complete duration of the spell,  $F$  is the cumulative density function of the complete spell duration and  $f$  is the respective probability density function.<sup>10</sup>

The hazard function provides a more detailed description of the duration data than any of the two statistics presented above, given its ability to capture duration dependence, or changes in the probability of a price change as the elapsed duration of the spell grows. Two main reasons can possibly explain the existence of duration dependence. The first is selection bias, whereby spells ending are not randomly selected conditional on the observed characteristics. That is, there is heterogeneity uncontrolled for that partly explains the observed differences in complete durations. Thus, changes in the composition of a sample of spells sharing the same starting date are expected as time evolves, impacting on the hazard rates. The second reason is pure duration dependence, whereby some uncontrolled

<sup>9</sup> In fact, the empirical analysis discusses the survival function, not the hazard rate. The two statistics, however, are univocally related as is clear from the discussion below.

<sup>10</sup> As usual,  $F(s) = P[S < s]$ .

for characteristics of a spell change with duration, affecting the hazard rate. Although the first explanation seems more adequate to the specific application being considered here, suggesting that agents make informed decisions to change prices, the second case is the one implied by the staggered price models, whereby time is the only determinant of price changes. In any case, we can express the *average spell duration* in terms of the survival function,<sup>11</sup>

$$E(S) = \int_0^{+\infty} [1 - F(s)] ds$$

where the survival function is,

$$1 - F(s) = \exp\left\{-\int_0^s \theta(v) dv\right\}$$

To establish this we do not need to impose any assumption apart from  $E(S)$  being finite. Moreover, we are able to use more information than what we would if attempting to estimate the *average spell duration* directly, only discarding spells that are right-censored.<sup>12</sup>

To express the *frequency of price changes* in terms of the distribution of  $S$ , one must first characterise the distribution of elapsed durations observed at any moment in time. This is because this statistic uses the stock of spells at each moment to compute the proportion that end in the transition to the next period. The stock sample is expected to be biased towards long durations, thus exhibiting a different distribution of spell durations than what would be obtained using a flow sample. Let  $u$  denote the elapsed duration of a spell at a moment in time when a stock sample is drawn. The distribution of  $u$  is given by,

$$(1) \quad g(u) = \frac{1 - F(u)}{\int_0^{+\infty} (1 - F(v)) dv} = \frac{1 - F(u)}{E(S)}$$

The interpretation of expression (1) is as follows. The numerator is a measure of the spells started precisely  $u$  periods before the time of the analysis and lasting till that moment. It is just the probability that a spell lasts for more than  $u$ . Similarly, the denominator is a measure of the spells having started at any moment before the time of the analysis and lasting till that moment. This representation requires time homogeneity, meaning that the

<sup>11</sup> See Lancaster (90) for a detailed discussion of duration analysis.

<sup>12</sup> Notice that if the hazard rate is constant ( $\theta(s) = \theta$ ) then the spell duration follows an exponential distribution and  $E(S) = 1/\theta$ . In what follows, however, we do not make any parametric assumptions.

population of spells is constant over time.<sup>13</sup> This happens when the hazard function is constant over time as that implies an also constant inflow of new spells.<sup>14</sup> It is not required, however, that the hazard rate is constant in the duration,  $s$ , only that the hazard function does not depend on  $t$ .

Under this assumption we can write the *frequency of price changes*, call it  $\pi$ , as follows,

$$(2) \quad \pi = \int_0^{+\infty} g(u)\theta(u)du = \int_0^{+\infty} \frac{1-F(u)}{E(S)}\theta(u)du = \frac{1}{E(S)} \int_0^{+\infty} f(u)du = \frac{1}{E(S)}$$

thus recovering the *average spell duration* using the statistic  $\pi$ . Thus, and given the potential bias associated with the use of *spell duration* under the presence of censored spells and missing observations, we adopt the *frequency of price changes* as the main statistic to describe the features of the price setting behaviour.

However, the relationship above is a theoretical one. Its practical implementation should be performed at a sufficiently disaggregated level to ensure homogeneity of the good being analysed, thus guaranteeing that all observations are drawn from the same distribution (and characterised by a specific hazard function). We, therefore, apply it at the most disaggregated level only, by item and outlet (or firm). A second potential source of problems is the occurrence of missing observations. As long as the missings are randomly drawn this does not affect the result in equation (2). By *randomly* we mean that they are not more or less likely at specific stages of the spell, their odds not depending on the elapsed duration. If this is so, the empirical distribution of elapsed durations at any moment in time is an unbiased estimator of the theoretical distribution derived above (equation (1)).

The coexistence of quarterly and monthly observations in the CPI datasets complicates the analysis and limits our ability to compare the price setting patterns of different classes of products or of different sorts of prices (producer and consumer prices). We therefore chose to transform quarterly in 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 (2002), we postulate that the monthly frequency of price changes is constant over time within each

<sup>13</sup> By multiplying  $1 - F(v)$  by the probability that a spell starts at period  $t - v$  one obtains the *probability* measure that a spell observed at time  $t$  has started  $v$  periods before. Under time homogeneity, however, the number of new spells is constant over time, implying that the probability that a spell starts in a particular period is constant over time. But then, this probability cancels out in the ratio.

<sup>14</sup> Whenever a price spell ends a new one is started. Thus, the hazard rate determines both the outflows and the inflows in this specific application.

outlet and for each item. This means that, within each quarter, duration dependence is being ruled out. In such case, we can estimate the unobserved monthly frequency of price changes ( $f_1$ ) using the observed quarterly frequency of price changes ( $f_3$ ) and the relationship  $f_3 = f_1^3 + 3f_1^2(1-f_1) + 3f_1(1-f_1)^2$ .<sup>1516</sup> It is straightforward to show that this equation has a unique zero in the interval  $[0,1]$ .

In addition to the *frequency of price change* and the *hazard function* we also use the *magnitude of price changes* to characterise the behaviour of prices. Again, quarterly observations are transformed to their monthly equivalents under the following hypothesis: first, the computed  $f_1$  is the monthly frequency of price change; 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  $\Delta_3$  and  $\Delta_1$  designate the quarterly and corresponding monthly rates of price change, both either positive or negative.  $\Delta_1$  will equal  $\Delta_3$ ,  $\sqrt{1+\Delta_3}-1$  or  $\sqrt[3]{1+\Delta_3}-1$  with 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  $\Delta_1$  is for all quarterly observations at the item and outlet level.

Finally, it should be noticed that statistics based on the *magnitude of price change*, are sensitive to extreme values or outliers. This can be particularly severe as the magnitude of potential outliers is disproportionately large for positive values. Notice that the distribution of the *magnitude of a price change (increase)* is asymmetric, being bounded below by  $-1$  (or  $0$  if only positive changes are being considered) and unbounded above. Thus, we have replaced means by medians and, in general, used the centiles of the distribution to characterise the behaviour of this random variable.

#### 4) Summary of findings about price setting

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

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<sup>15</sup> 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  $f_1 = f_3$ .

<sup>16</sup> Bills and Klenow (2002) use a similar approach to identify monthly frequencies of price change from an observed mixture of monthly and bi-monthly frequencies.

### a) Findings on consumer price setting

*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. Thus, 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 what has been found by Taylor (1999) and remarkably close to the results of Bils and Klenow (2002), 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. For instance, Baudry, Le Bihan, Sevestre and Tarrieu (2003) and Aucremanne and Dhyne (2003) report estimates of 0.19 and 0.17, respectively for France and Belgium. The higher frequency of price changes in Portugal may reflect, in part, the larger weight of food in the Portuguese CPI. The statistical relationship between frequency of price changes and the level of inflation is discussed below (fact 8).

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

The third column of table 1 presents median average spell durations by item and outlet measured in months.<sup>17</sup> For all items taken together at a moment in time, 50 per cent of the price spells last for less than 8.5 months. These values are considerably larger than the averages implied by the frequency of price changes, reflecting the asymmetric shape of the pdf for the frequency of price changes: it is heavily concentrated near zero but has long tails toward 1, as it can be seen in figures 2 and 3.<sup>18</sup>

*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

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<sup>17</sup> These values are obtained using the average frequency of price changes over time by item and outlet. The median value of such averages is then obtained and inverted to compute the median average duration of a price spell.

<sup>18</sup> An alternative measure of the median spell length, which in our view is less adequate, is that obtained from the average duration by item, taking all outlets together. This alternative measure leads to an intermediate value for the median average spell duration of about 6 months.

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.

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 relatively 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, 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 second 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. In this way, the observed positive inflation reflects the fact that price increases are more frequent than price decreases.*

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. The exception occurs for services, which clearly exhibit stronger positive changes, in particular when the prices are not administered.

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, as would be suggested by a menu-costs model.

*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 toward 1.



There are items that, by its 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 with respect 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 25<sup>th</sup>, 50<sup>th</sup> and 75<sup>th</sup> percentiles. Though the distribution of the medians is quite concentrated around a small positive value, the distributions of the two percentiles 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, its main components, the latter may possibly reflect within group heterogeneity.

What, then, explains such pattern? Under the competitive markets assumption, the differences in the frequency of price changes may originate from the characteristics of the products and their consequences on the elasticity of demand and/or on the costs associated with changing prices (menu costs). The considerable homogeneity in the rates of price change by type of product suggests that size matters for the decision of changing a price, consistently with the menu costs hypothesis. However, figure 3 shows that controlling for the same 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.

While discussing the following facts we will disclose some additional dimensions of heterogeneity that contribute to the explanation of these differences. In particular, fact 7 shows that the price setting behaviour differs notoriously by type of outlet and items are traded in varying proportions in different types of outlets. Another potential source of



heterogeneity discussed in fact 8 respects to the macroeconomic conditions. These could affect the distributions just discussed under differential impacts of aggregate conditions on the price setting behaviour of different items. Finally, seasonal patterns are discussed in fact 9.

*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<sup>19</sup>. Figure 6 clearly illustrates this point by plotting the empirical survival functions for price spells by outlet size.<sup>20</sup> Moreover, this fact is systematically observed for all of the more homogeneous groups of items detailed in figure 7. The importance of the differences seems to depend on the item's type, being particularly notorious for food items. 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 among big outlets, imposing more frequent changes in prices. On its own, however, such explanation is not consistent with the varying importance of the differences in price setting behaviour by type of product. For instance, it is not able to explain why price changes occur so much more frequently in big than in small outlets for processed food and non-food items, while such difference is modest for unprocessed food items even after excluding perishable goods. To make this explanation consistent with such observation one needs to admit that differences in the level of competitiveness between big and small outlets are product-dependent.

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.<sup>22</sup> Most important, fixed costs represent a potentially large share of the

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<sup>19</sup> Large, medium and small outlets were considered separately, corresponding to hypermarkets, supermarkets and classical stores, respectively.

<sup>20</sup> To estimate the survival functions presented in figures 6 and 7 we used the same basket of products, independently of the outlet type. To do so, some items not traded in both types of outlets were excluded from the analysis. This especially affects services, which are usually not traded in medium or large outlets. We then re-weighted the remaining items to reproduce the composition of the basket used to compute the CPI. Thus, any detected differences in the estimates are solely due to differences in the price setting arrangements by type of outlet.

<sup>21</sup> We have reproduced the flow sampling of single spells by weighting each spell according to its duration along with the appropriate CPI weight. This way, the curves in figure 6 and other survival functions discussed below represent the length of the price spells of items from a bundle as if all spells had started at the same moment in time. That is, the survival curves depict the average duration of a spell by item. Thus, the common problem of over-sampling of short spells common in multiple spells samples is overcome.

<sup>22</sup> See Caplin and Spulber (1987) or Tsiddon (1991).

total costs associated with a price change.<sup>23</sup> 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 increase.

*Fact 8: The macroeconomic conditions also influence the price setting behaviour: periods of high inflation are characterised by more frequent changes in prices. Moreover, this behaviour is outlet-dependent.*

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).<sup>24</sup> 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 size of the change in the decision to alter prices.

The evolution of the overall, positive and negative frequencies of price change over time may disclose some dependency of the price setting behaviour on the aggregate economic conditions. We do it for the whole period covered by either CPI1 or CPI2, that is from 1992 to 2001.<sup>25</sup> Results are presented in figures 8 and 9 for all 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 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.

The fall in the frequency of price changes with the level of inflation is consistent with the results from the survival functions displayed in figures 10 and 11. Figure 10 plots the survival of price spells at the different levels of inflation for all items taken together and

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<sup>23</sup> Moreover, economies of scale in the price setting activity are also expected.

<sup>24</sup> 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.

<sup>25</sup> 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 is expected under CPI2 given that promotions are included in the price.

figure 11 splits items by major types. The available evidence seems to suggest that prices adjust more frequently when inflation is higher, though the evidence is only clear for non-food items, particularly services.<sup>26 27</sup>

The observed dependence of the responses to inflation on the type of product seems to imply that changing prices is more expensive for some classes of items, thus becoming less desirable for such items when inflation is low. In particular, it seems to depend on the longevity of the item as would be predicted by a menu-costs model: items with a relatively short life require more frequent re-stocking, possibly making the information about market prices more readily available and diminishing the role of fixed costs in the price setting decisions. If this is so, the price setting mechanism of short-life products is expected to depend less on the level of inflation. Such observation is consistent with the price setting behaviour registered by level of inflation for food as compared to non-food items.

The discussion so far about the heterogeneous nature of the price setting behaviour seems to suggest that outlets change prices when a given threshold is achieved. Such threshold would be defined on the difference between what the seller perceives as the market price and the price she/he has adopted before. A rationale for the threshold rule is provided by the assumption that price setting decisions carry costs, some of them fixed as, for instance, those associated with the collection of information. The different sources of heterogeneous behaviour we have identified, related with the type of outlet, the type of item and the level of inflation, can be interpreted in light of such behaviour rule. However, the price setting behaviour is not only characterised by the decision to change prices but also by the magnitude of the changes. We have seen before (fact 6) that the latter is not strongly affected by heterogeneity, as would also be predicted by a menu-costs model.

Table 3 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 have dropped from the high to the low inflation

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<sup>26</sup> This result is statistically significant. As a matter of fact, given the large number of observations used in this analysis the standard errors of the survivals are extremely low and, therefore, the confidence bands are almost undistinguishable from the respective survivals.

<sup>27</sup> This is also true when spells starting in the first quarter of 1992 are excluded to control for the potential impact of changes in VAT.

periods. Such changes, at the most on the order of 2 percentage points, seem small to explain 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 as would be predicted by a state-dependent, threshold-based decision rule.

*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 9, 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 below also display a seasonal pattern of the same type, particularly for consumption goods. Such behaviour per se, independently of its reason, alters the costs at the retailer's level, thus justifying more frequent adjustments in consumer prices.

Figure 12 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.<sup>28</sup> 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

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<sup>28</sup> 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.

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.

#### **b) Findings on producer price setting**

*Fact 1: In the manufacturing industry, almost 1 in every 4 prices is changed, on average, in a given month.*

The first column of table 4 shows the frequencies of price changes for the total of the sample as well as for the specific sectors analysed. The average frequency of price changes in the manufacturing industry, over the sample period, is 0.23. This figure is remarkably close to the corresponding result for consumer prices. However, as it will become clear in subsection 4c, this is more a statistical coincidence than an evidence of similar price setting practices at the producer and consumer levels. At this stage, it is already important to stress that the price frequency of price changes in one specific industry – i.e. energy, with a weight of around one sixth of the total Industrial Producer Price Index – is clearly above the usual frequencies observed in other industries, significantly rising the aggregate result.

*Fact 2: In the manufacturing industry, 50 per cent of the items exhibit typical spells that last for less than one year.*

Table 4 also displays, in its third column, the median average duration of a price spell by item and firm.<sup>29</sup> Overall, 50 per cent of the items have typical price spells shorter than one year. This value is much larger than what is implied by average frequencies of price changes. As mentioned in section 3, this statistic uses the average spell duration at the most disaggregated level (i.e. a specific item in a given firm) obtained from the inverse of the frequency of price changes over the entire sample period. The striking difference between the median spell duration and the inverse of the average frequency of price

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<sup>29</sup> See footnote number 22.

changes illustrates the very strong asymmetry in the pdf of the frequency of price changes by item and firm, much more marked than in the case of consumer prices.<sup>30</sup>

*Fact 3: There is a considerable degree of heterogeneity in producer price setting behaviour by product. On one extreme case – the oil refinement industry – a price change is expected in each and every month; on the other extreme, some industries only change prices once every other year.*

As in the case of prices at the consumer level, a notable heterogeneity of producer price behaviour practices emerges from the data. The petroleum refinement industry constitutes a very extreme situation, as price changes occur in almost 70 per cent of the occasions. This is likely to reflect the extremely high volatility in the international prices for crude oil, suggesting a very flexible price setting pattern responding to changes in the marginal costs of production. However, the administered nature of the prices for energy during the sample period, at the consumer level, prevented this volatility in producer prices to be transmitted to consumer prices. The high frequency of price changes observed in the petroleum refinement industry affects significantly the frequency of price changes in the manufacturing industry as a whole, as it accounts for around one sixth of the total. Indeed, the average frequency of price changes registered in the manufacturing industry excluding energy is reduced to just over 14 per cent, while the median average price spell duration increases to 14 months.

These latter figures still correspond to very heterogeneous price setting patterns. On the one hand, the food and beverages industry displays relatively frequent price changes, as indicated by an average frequency of just over 20 per cent and median price spells of about 9.5 months. The manufacture of basic metals exhibits a similar pattern to this. On the other extreme, price changes are extremely rare in industries like wearing apparel, rubber and plastics, other non-metallic mineral products and metal products.<sup>31</sup> For these industries, price changes are only observed once every 2 to 3 years.

*Fact 4: The frequency of price changes varies by type of industry. It is larger in consumption than intermediate industries, and it is particularly high in energy industries.*

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<sup>30</sup> Again, and similarly to what was done with respect to consumer prices, the alternative measure of the median spell length using the average duration by item was also computed. This alternative measure leads to an intermediate value for the median average spell duration of about 9.6 months.

<sup>31</sup> This is not a result of the potential relatively short lives of the products in these industries, which could prevent the observation of price changes. On the contrary, most of the products in these industries are followed over the entire duration of the sample.

Table 4 also presents the frequency of price changes and the median spell length by type of industry. The energy sector corresponds exactly to the oil refinement industry, for which a very flexible price setting pattern exists, as described above. The other two classes are consumption and intermediate goods. Prices for consumption goods change more frequently than those for intermediate goods, as indicated by the frequency of price changes (0.17 and 0.12, respectively) and median average spell lengths (of about just over 1 and 1.5 years, respectively). Two different explanations may account for these differences. On the one hand, consumption goods are in a more advanced production stage and, in this way, more likely to accumulate shocks that affect the production cost. In addition, the argument of ‘customer anger’ put forward by Rotemberg (2002) justifies less frequency of price changes in intermediate goods – where more information between parties exists – than in final goods.

Figure 13 displays the survival functions by type of industry and confirms the results presented above. Energy items exhibit very short price spells, while prices for other items frequently remain unchanged for 12 months or even more. It is interesting to notice the significant fall in the survival functions – for both consumption and intermediate goods - when the spells reach one year in length. This decisively indicates the widespread practice of yearly adjustments of prices.

*Fact 5: Strong seasonal patterns are observed for industrial prices, as price changes are concentrated in January.*

Figure 14 displays the frequency of price changes for industrial goods by type of industry. Almost every January registers a peak in the frequency of price changes. This seasonal feature is more apparent in price increases than in price decreases, and in consumer goods than in intermediate goods. Facts 5 and 6, taken together, indicate the widespread practice – for a large number of firms and for various types of industries - of yearly adjustments of prices in January (i.e. price spells that start in January of year  $t$  and last till January of year  $t+1$ ).

The existing information does not allow us to discriminate between time-dependent and state-dependent types of behaviour. The high frequency of price changes in January is, just on itself, a (apparently) strong indication of elements of time-dependency on price setting. However, the very strong concentration of changes in production costs in the beginning of the year – like the update of wage scales and administered prices – is also likely to justify on its own a reassessment of the optimal producer prices.



*Fact 6: Price increases are more likely than price decreases, as one could expect in a context of positive inflation. However, on average, price increases only account for around 60 per cent of total price changes.*

Table 5 also shows the frequency of price increases and price decreases. In a context of a moderate, but positive, rate of inflation, price increases are more frequent than price decreases. However, only 60 per cent of the price changes correspond to price increases. These proportions hold for consumption, intermediate and, this time, for energy as well. In this way, producer price setting practices over the sample period were characterized by relatively frequent price decreases.

*Fact 7: The mean magnitude of price increases is very similar to the magnitude of price decreases; in this way, the observed positive inflation reflects the fact that price increases are more frequent than price decreases, as described in the previous fact.*

Table 5 also shows some descriptive statistics of the empirical distribution of the magnitude of price increases and price decreases. The first interesting result is that price changes are usually sizeable. For instance, in the manufacturing industry (excluding energy) both the median price increase and the median price decrease amounted, in absolute terms, to 3.8 per cent; the third quartile of the distribution of price increases was 6.8 per cent (7.5 per cent in the case of consumption goods and 6.3 per cent in the case of intermediate goods); the first quartile of negative price changes was -8.5 per cent (-8.7 per cent in the case of consumption goods and -8.2 per cent in the case of intermediate goods).

A second interesting feature of the results is that the magnitude of price increases is broadly similar to the magnitude of price decreases. In this way, the positive inflation observed in producer prices is more a result of the larger frequency of price increases, vis-à-vis the one of price decreases, than a result of larger price increases than price decreases.

### **c) The common sample: comparing consumer and producer price setting practices**

Before comparing price setting practices at the producer and consumer levels, it should be noticed that, contrary to what has been done up to now, this analysis does not use weights. Instead, we chose to attribute the same importance to each item in the common sample, thus assuming that each matched group of products is homogeneous with respect to



its constituent items. This way, we guarantee that the identified differences/similarities are not a consequence of the different weighting used in CPI and IPPI, the former aiming at reproducing the typical consumer bundle and the latter representing the relative importance in overall production. However, differences may occur due to the level of disaggregation used to match the goods: the 5-digits classification of the CPI items and the 12-digits classification of the IPPI items. This is the most detailed information we have access concerning the nature of the items and therefore this comparison is made in the most efficient (possible) way. However, it is worth mentioning that each of the considered categories is formed by a group of different (or not necessarily equal), although (necessarily) similar, items. Finally, and as it is described in the data annex, it is worth to recall that the original CPI and IPPI datasets have been transformed such as to allow for comparability of the results. We now present the main results of this exercise.

*Fact 1: Consumer prices change more frequently than producer prices.*

Figure 15 plots the frequency of consumer and producer price changes for each of the comparable categories of items. The diagonal line is the geometric space where equal frequencies would be positioned. Most of the observations are concentrated below the diagonal line, indicating that prices at the retailer level do change more frequently than prices at the producer level. It is also important to point out that points above the diagonal tend to correspond to food industries<sup>32</sup> (like *meat products*) or to goods for which consumer prices were regulated over the sample period (energy).

*Fact 2: Consumer price increases (decreases) are more frequent than producer price increases (decreases).*

Figure 16 presents the frequency of price increases (decreases) at the retailer and producer level. Panel A displays positive price changes and panel B presents negative price changes. The same pattern is observed for both: price changes are always more frequent at the retailing level, independently of the sign.

*Fact 3: For the items in the common sample, the proportion of positive price changes (conditional on the occurrence of a price change) tends to be higher for producer prices than for consumer prices.*

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<sup>32</sup> As a matter of fact, nine out of the 10 points above the diagonal correspond to food industries.

The odds of a positive price change conditional on a change having occurred are larger for producer prices. This is suggested by figure 17, which plots the relative frequency of positive price changes on the overall frequency of price changes. Thus the lower frequency of price changes at the industry level reported above affects more strongly the negative changes in prices.<sup>33</sup>

The more frequent price changes at the retail level may result from the longer path the item has followed up to that stage as compared to when it is finished at the industry level. Thus, it is possible that an item in an outlet has been exposed to a larger number of shocks than the same item at the end of its production process, leading to a rise in the volatility of its price. Such argument, however, does not explain why positive price changes are relatively more important at the producer than at the consumer level.

*Fact 4: More sizeable price changes are found for the CPI than for the IPPI, regardless of the sign of the change.*

Figure 18 plots the median rates of price change for positive and negative changes in panel A and B, respectively. Changes at the retail level are generally larger, independently of the direction of the change. Again, different definitions of price are not responsible for this result. Thus, we are left with either the “end of the road” argument or some differences in the elasticity of demand at the production and consumers levels.<sup>34</sup>

## 5) Concluding remarks

This paper identifies the main stylized features of price setting behaviour in Portugal over the period 1992-2001, through the empirical analysis of the micro-data sets underlying the consumer and producer price indexes. The main conclusions of this empirical research are the following:

- a) The monthly frequency of price changes – both at the consumer and at the producer level – is slightly below 0.25 meaning that, on average, almost 1 in every 4 prices is changed in a month.

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<sup>33</sup> It should be noticed that the common sample does not include the whole CPI bundle or IPPI production items, but only the comparable commodities. Instead, only a proportion of these sets is included in this analysis. This explains the apparent discrepancy between this result and those in facts 4 and 6 for consumer and producer prices, respectively.

<sup>34</sup> Again, the same estimates were computed excluding promotions from the consumer prices. No significant changes were found and the main result remains true.

- b) This remarkably high frequency of price changes is, however, upwardly affected by the behaviour of unprocessed food in the case of the CPI, and energy in the case of the IPPI.
- c) There is a considerable degree of heterogeneity in product price setting behaviour both at the consumer and the producer levels.
- d) The median duration of price spells varies between 8.5 months for consumer prices and 1 year for producer prices.
- e) Goods experience more frequent price changes than services at the consumer's level; consumption goods experience more frequent price changes than intermediate goods at the producer's level.
- f) For comparable goods, consumer prices change more often than producer prices.
- g) There is 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. This is true both at the consumer's and at the producer's level.
- j) Heterogeneous price setting behaviour at the consumer's level is 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).
- k) Periods of higher inflation are characterised by more frequent changes in prices.

The focus of the analysis has been purely descriptive. In particular, the paper does not provide formal testing of alternative pricing models. Alternative price setting behaviours are characterized by, at least, two important dimensions: the frequency of price changes and the magnitude of the price changes. A state-dependent price setting behaviour is typically associated with fluctuations in the frequency of price changes over time as the economic environment changes. On the contrary, time dependency implies that the adjustments occur on the magnitude of the changes more than on their frequency. This distinction is explored in recent work by Klenow and Kryvtsov (2003). The empirical analysis carried out in this study found elements of those two alternative theories: on the one hand, the frequency of price changes seems to be affected by the state of the economy, at least in what respects to consumer prices for which the significant fall in the inflation rate and the strong changes in the VAT rates can be used as sources of variation; on the other hand, seasonality and the strong concentration of price changes in the first quarter of the

year, and January in particular, is compatible with the presence of time-dependence in price-setting.

The fact that the sample period for the consumer prices covers two different inflation regimes in Portugal allows us to have some extra insight on the distinction between the two theories. When comparing the high inflation period with the low inflation period, it is worth noting that the frequency of price changes seems to decline, whereas the distribution of the magnitude of price changes does not seem to have changed significantly from one period to the other. Therefore, this evidence would provide some support for the prevalence of state-dependent pricing. The development of methods to test alternative price-setting theories is, clearly, the key priority for further research with those datasets.

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## Data Annex

This annex is divided in two parts. The first part describes the key aspects concerning the data collection processes underlying the CPI and the IPPI. The second part describes the transformations of the two datasets that were deemed necessary to perform comparisons between price setting practices at the consumer and producer levels.

### A. Data issues

The following table summarizes the main features of the CPI2 and IPPI databases concerning situations that might affect the interpretation of the statistics reported in the text on frequency and magnitude of price changes.

	CPI2	IPPI
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.	The product is discontinued. Products are collected at the firm level and the brand is the same if the producer/firm is the same.
Quantity change	Prices are “standardized” in terms of quantity.	Prices are “standardized” in terms of quantity
Store/firm close	A new store is included in the sample	A new firm is included in the sample
Temporary price discounts	Discounts are registered and a specific code indicates if a discount took (took not) place.	Discounts are not registered in the IPPI.
Forced item substitutions	It occurs. An indirect approach of identification of these cases is described below.	It does not occur. The product is discontinued.
Out of season items	These products were only considered during their season. Price changes are only considered in consecutive months.	Not applicable
Stock-outs	Whenever a stock-out occurs there is a code that identifies this situation. Therefore it was possible to make all the analysis using exclusively observed prices instead of estimated prices (as mentioned in the main text, INE estimates the prices that are missing in the cases of stock-out).	During 4 months the price is kept unchanged. If after 4 months the stock-out continues, the product is excluded from the sample

## Forced item substitutions in the CPI2

Forced item substitutions may occur in the CPI2. When dealing with such a situation, INE experts have to decide if a comparable substitute exists in the shop (and therefore not requiring any type of adjustment) or otherwise (in this last case, and for the purpose of the computation of the price index, an adjustment has to take place, reflecting quality change, product upgrade or model changeover). Unfortunately, there is no code in the CPI2 dataset that indicates such an occurrence.

However, at a fairly disaggregated level – product/region level, which corresponds to some 4400 monthly observations – the INE provided us with a variable indicating if (at least) in one of the outlets a non-comparable replacement existed. To overcome this situation we designed a simple procedure to detect such cases. In particular we searched for outliers<sup>35</sup> and, in the cases that no outlier was found, the highest (absolute) price change was eliminated, as it is known that at least one such non-comparable replacement occurred. This procedure allowed us to identify around 1 per cent of non-comparable replacements amongst the total price sequences (i.e. including both price changes and no price changes)<sup>36</sup>. 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 – in what concerns frequency and magnitude of price changes, in particular – 4 alternative situations were considered:

- a) No treatment of non-comparable substitutions: this corresponds to an upper bound for both the frequency and the magnitude of price changes;
- b) Estimation of non-comparable substitutions: this procedure (described above) was adopted in paper;
- c) Elimination of all the observations concerning price changes at the product/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 product/region level for which we know that (at least) one non-comparable replacement took place were eliminated.

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<sup>35</sup> 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).

<sup>36</sup> Klenow and Kryvtsov (2003) report a frequency of around 1.5 per cent for non-comparable replacements in the micro data collected by the US Bureau of Labor Statistics.

This exercise indicated that the main conclusions on the frequency and the magnitude of price changes are not affected by the situation of forced-item substitution, as the empirical results reported in the text are relatively robust to alternative specifications<sup>37</sup>.

## B. Comparability between the CPI2 and the IPPI

The comparability between the CPI2 and the IPPI is affected by 5 different reasons:

- **Sample constitution:** in the CPI2 sample there are items that do not exist in the IPPI sample and vice-versa. For example, Services exist in the CPI but do not exist in IPPI; Intermediate Goods exist in the IPPI but not in the CPI. In order to overcome these non-similarities, both samples were restricted to common items as explained in the text.
- **VAT:** VAT is also a potential problem for the comparison between CPI and IPPI prices, as CPI prices include VAT but IPPI prices do not. However, in the period used to compare consumer and producer price changes (January 1997 to January 2001) there was no VAT rate change, and therefore the comparability was not affected by this methodological difference in the indexes.
- **Missing values:** In the case of the IPPI, every time a price is not reported the price from the previous month is dragged (i.e. the previous price is maintained). This situation can occur up to 4 consecutive months, but after that the product is necessarily discontinued. In the CPI2 case, whenever the price of a product is not observed, there is a specific code indicating that (and therefore no price is collected/reported). These methodological differences are, of course, likely sources of biases in the comparison, as the IPPI frequency of price changes will tend to be smaller than the CPI one. In order to overcome this situation, a new (transformed) CPI dataset was created replicating the IPPI procedure (i.e., we also dragged the CPI prices every time a missing price was indicated).
- **Sales and Promotions:** CPI prices include promotion and sales while IPPI do not. This situation, once again, is a source of biases in the comparison. In order to overcome this problem – and as in the case of the CPI a specific code indicates the occurrence (or not) of a promotion or sale – the (already) transformed dataset mentioned in the previous bullet was (further) transformed in such a way that for each sale/promotion identified in the CPI dataset the price was dragged (i.e. kept constant at the pre-sale price) during the promotional period.
- **Forced item substitution (non-comparable substitution):** the forced item substitution is dealt with in different ways in the two price indexes. In the case of the IPPI, if a specific product is discontinued then the record is interrupted and, in principle,

<sup>37</sup> Results of this exercise are available upon request.



a new one replaces the previous one; therefore, there is a clear indication that a product replacement took place. In the case of the CPI, however, INE experts have to decide if a comparable substitute exists in the shop (and therefore not requiring any type of adjustment) or otherwise (in this last case a quality adjustment takes place). Unfortunately, there is no code in the CPI dataset that indicates such an occurrence. However, at a fairly disaggregated level – product/region level, which corresponds to some 4400 monthly observations – the INE provided us with a variable indicating if (at least) in one of the outlets a non-comparable replacement existed. As explained in section A of this annex, a specific procedure was designed to detect (with some margin for error) such cases. Therefore a new spell starts each and every time such an occurrence of a non-comparable replacement is estimated.

- **Forced item substitution (comparable substitution):** as mentioned in the previous bullet, the INE experts may decide, when collecting the CPI micro-prices, that a comparable substitute exists in the shop; there is no direct (or indirect) way to identify such a situation<sup>38</sup>; this situation is dealt with in a different way in the IPPI, as the sequence of prices is discontinued and a new one starts to be registered; the direct comparability of CPI and IPPI frequencies of price changes would not be appropriate, in such circumstances. In order to overcome this difficulty, the IPPI was transformed in order to (approximately) replicate the characteristics underlying the CPI data-set. The procedure is relatively easy: whenever a sequence of prices is interrupted, at the firm level, and a new one is initiated we define (for this purpose) a full sequence of prices, as if no discontinuity had taken place<sup>39</sup>.

All the results reported in section 4c) refer to comparisons performed between the (as mentioned above) transformed CPI and IPPI datasets, for the restricted sample of comparable items.

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<sup>38</sup> Klenow and Kryvtsov (2003) report a frequency of around 1.5 per cent for comparable-replacements in the micro-data underlying the US CPI.

<sup>39</sup> It is worth mentioning that this procedure, if anything, upwardly biases the frequency of price changes in the IPPI, as it covers simultaneously the occurrence of comparable and non-comparable replacements. For this reason it was not adopted in section 4b. However, for the purpose of comparing IPPI and CPI price changes it provides a convenient safety margin.

**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 positive price changes	Monthly frequency of negative price changes	Magnitude of positive price changes			Magnitude of negative price changes		
			1st quantile	Median	3rd quantile	1st quantile	Median	3rd quantile
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
Administred price services	0.060	0.029	0.035	0.054	0.095	-0.190	-0.073	-0.022
Non administred 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 – 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 3:**

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.

**Table 4: IPPI - frequency of producer price changes  
Monthly figures**

	Monthly frequency of price change	Median frequency of price change	Median duration (in months)	Number of observations	Weights
Total	0.231	0.083	12.0	718269	1.000
Total excluding energy	0.143	0.069	14.4	717693	0.833
By type of good					
Intermediate goods	0.116	0.056	18.0	337495	0.422
Consumer goods	0.171	0.069	14.4	380198	0.411
Energy	0.665	0.681	1.5	576	0.167
By type of industry					
Manufacture of food products and beverages	0.207	0.104	9.6	85653	0.357
Manufacture of tobacco products	0.093	0.083	12.0	216	0.007
Manufacture of textiles	0.090	0.042	24.0	111862	0.076
Manufacture of wearing apparel; dressing and dyeing of fur	0.050	0.042	24.0	126744	0.030
Manufacture of wood and of products of wood and cork, except furniture	0.122	0.071	14.0	79519	0.044
Manufacture of coke, refined petroleum products and nuclear fuel	0.665	0.681	1.5	576	0.167
Manufacture of chemicals and chemical products	0.111	0.056	18.0	61568	0.094
Manufacture of rubber and plastic products	0.071	0.028	36.0	38197	0.032
Manufacture of other non-metallic mineral products	0.040	0.028	36.0	63950	0.100
Manufacture of basic metals	0.243	0.139	7.2	7834	0.017
Manufacture of fabricated metal products, except machinery and equipment	0.032	0.028	36.0	31222	0.019
Manufacture of electrical machinery and apparatus n.e.c.	0.166	0.069	14.4	10600	0.020
Manufacture of furniture; manufacturing n.e.c	0.179	0.056	18.0	100328	0.036

**Notes to table 4:**

Estimates correspond to the 1995:1-2001:1 period. They were obtained from the IPPI dataset using information on all items in the manufacturing sector. Estimates for the median duration were obtained from the inverse of the median frequency of price changes at the item\*firm level (see section 3 for further details). All estimates use IPPI weights at the most detailed level available. The weights presented in the last column were rescaled to add one.

**Table 5: IPPI - Frequencies and magnitudes of producer price changes.  
Positive and negative price changes.  
Monthly figures.**

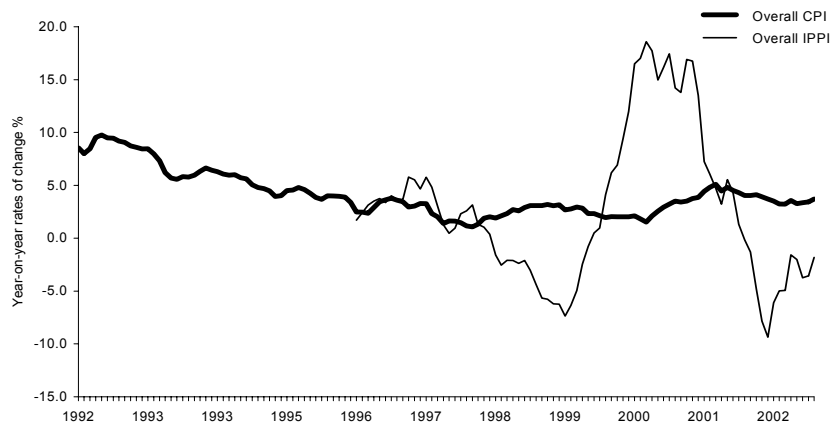
	Monthly frequency of positive price changes	Monthly frequency of negative price changes	Magnitude of positive price changes			Magnitude of negative price changes		
			1st quantile	Median	3rd quantile	1st quantile	Median	3rd quantile
Total	0.136	0.095	0.022	0.046	0.091	-0.098	-0.048	-0.018
Total excluding energy	0.086	0.057	0.019	0.038	0.068	-0.085	-0.038	-0.015
By type of good								
Intermediate goods	0.069	0.047	0.019	0.036	0.063	-0.082	-0.038	-0.015
Consumer goods	0.103	0.068	0.020	0.039	0.075	-0.087	-0.038	-0.014
Energy	0.382	0.283	0.071	0.107	0.167	-0.132	-0.091	-0.062

**Notes to table 5:**

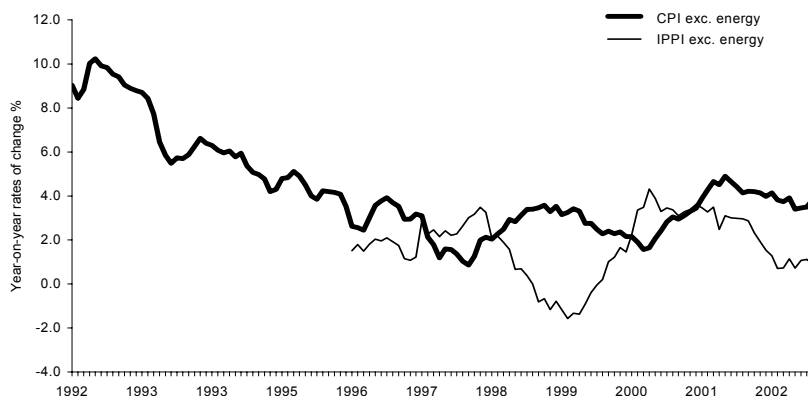
Estimates correspond to the 1995:1-2001:1 period. They were obtained from the IPPI dataset using information on all items in the manufacturing sector. All estimates for the magnitudes of price changes are conditional on a price change having occurred, either positive or negative depending on the case. All estimates use IPPI weights at the most detailed level available.

**Figure 1: Consumer Price Index (CPI) and Industrial Production Price Index (IPPI) over time**

Panel A: Overall CPI and IPPI indexes



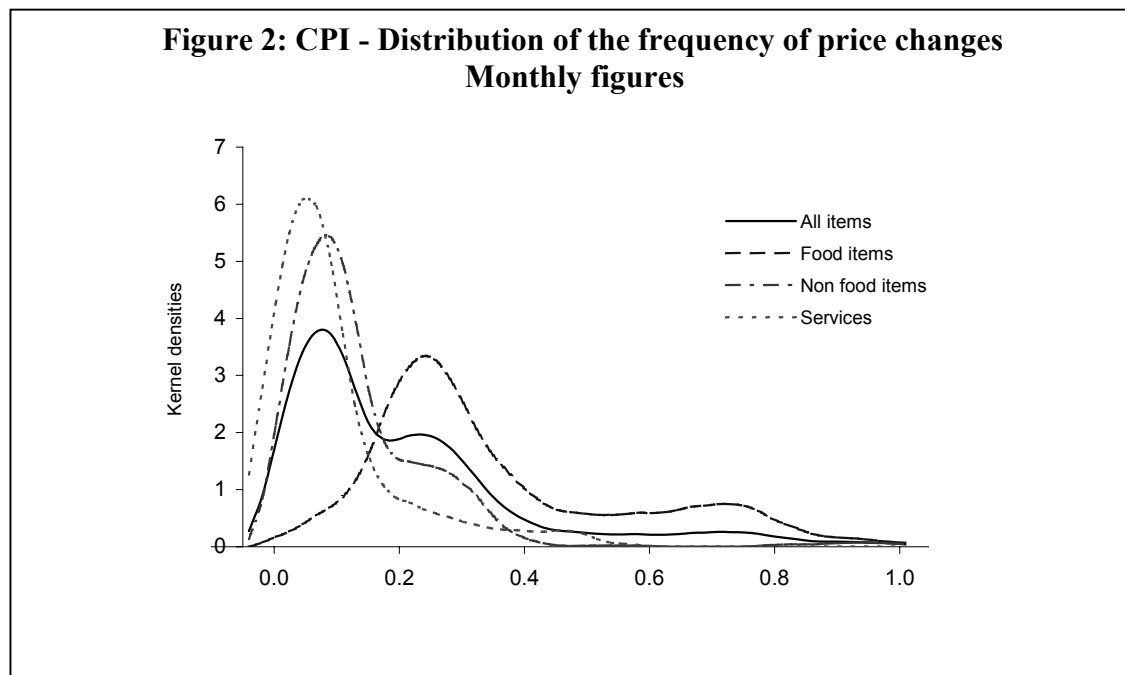
Panel B: Overall CPI and IPPI indexes excluding energy



Source: Instituto Nacional de Estadística



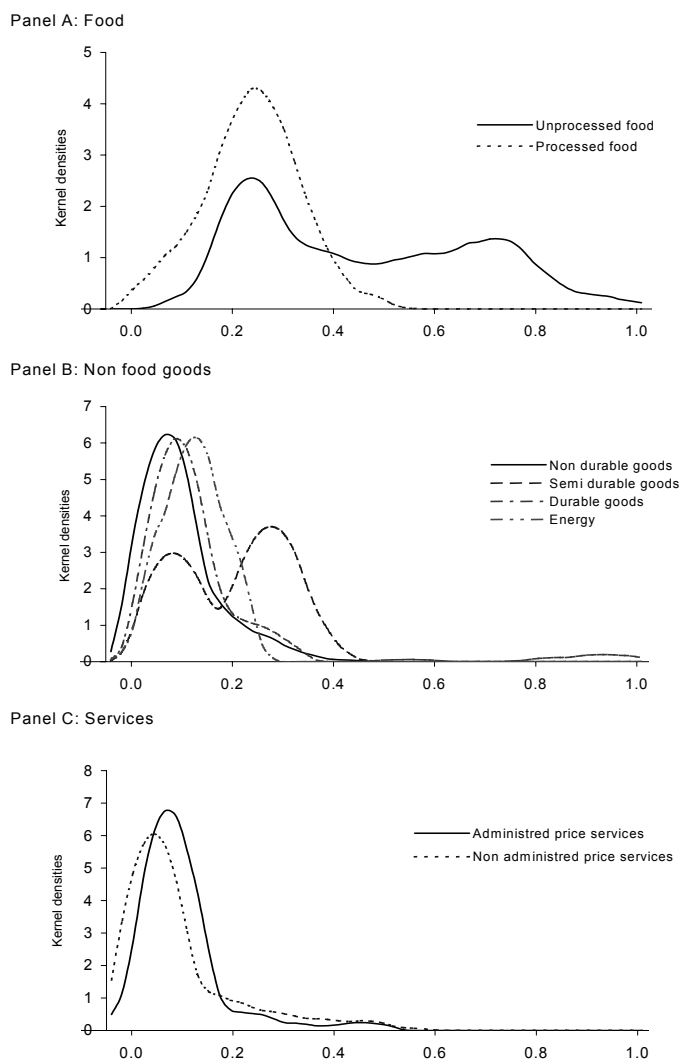
**Figure 2: CPI - Distribution of the frequency of price changes  
Monthly figures**



**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.

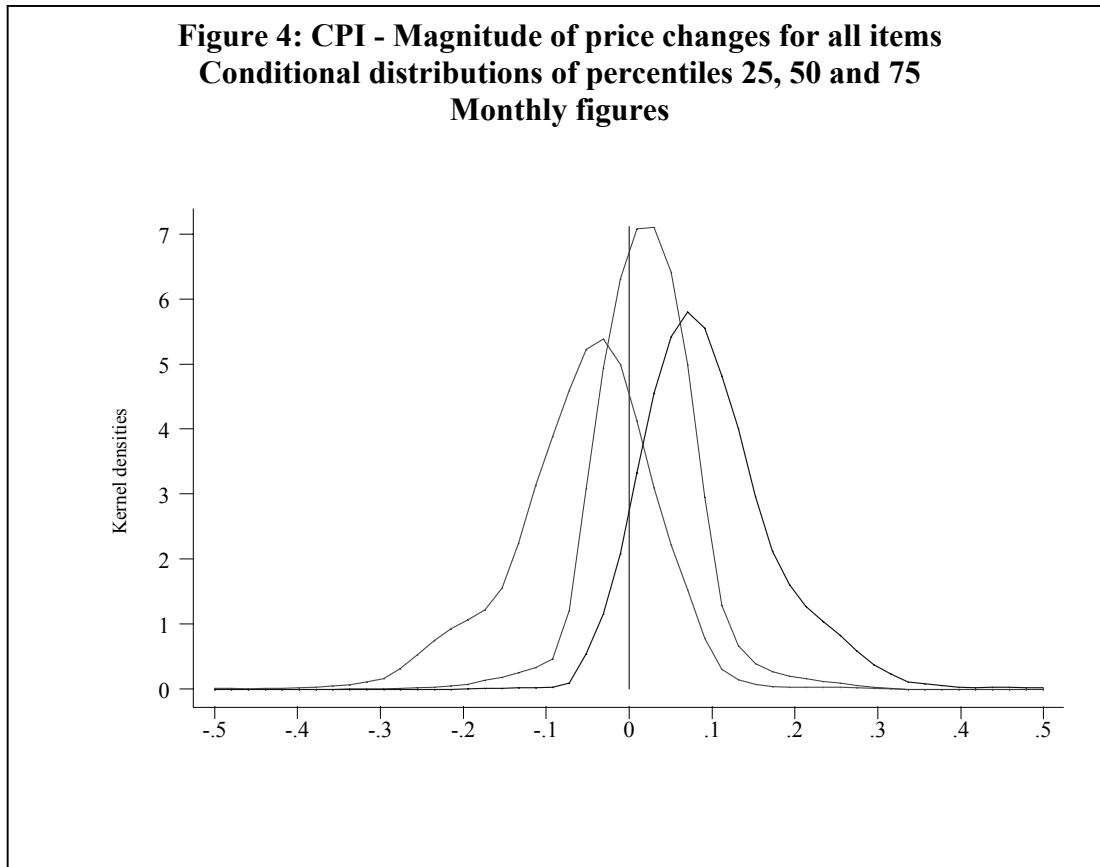
**Figure 3: CPI - Distribution of the frequency of price changes by type of item.  
Monthly figures**



**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.

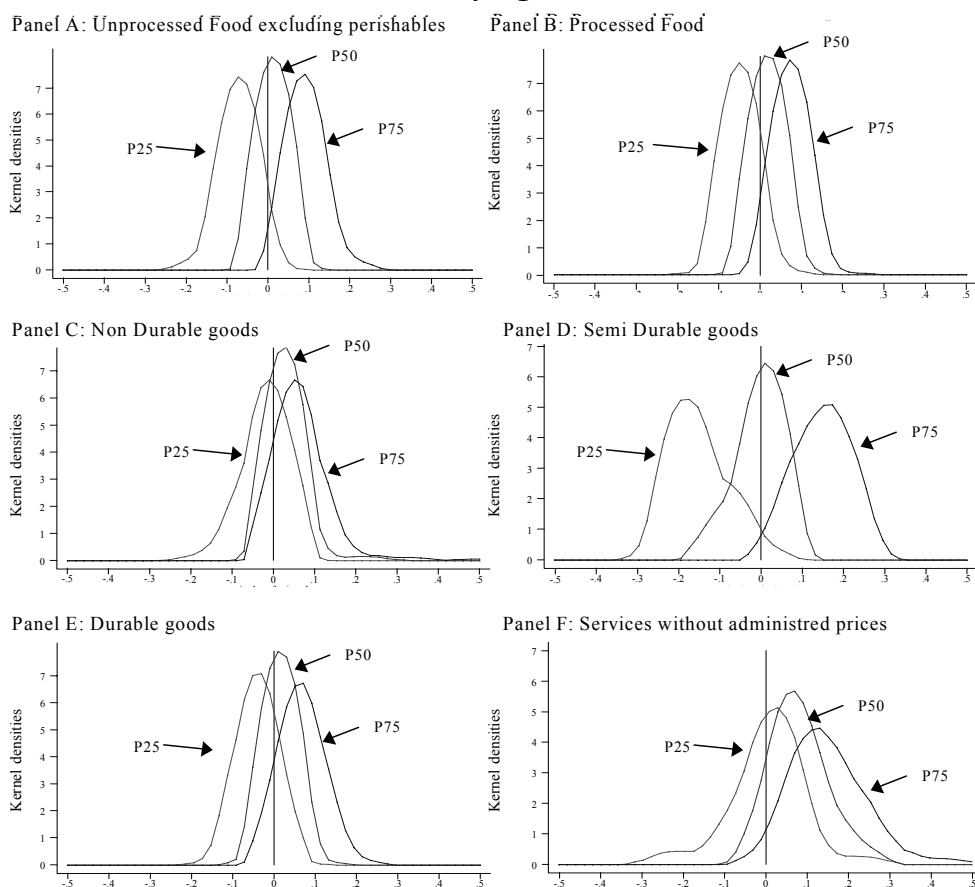
**Figure 4: CPI - Magnitude of price changes for all items**  
**Conditional distributions of percentiles 25, 50 and 75**  
**Monthly figures**



**Notes to figure 4:**

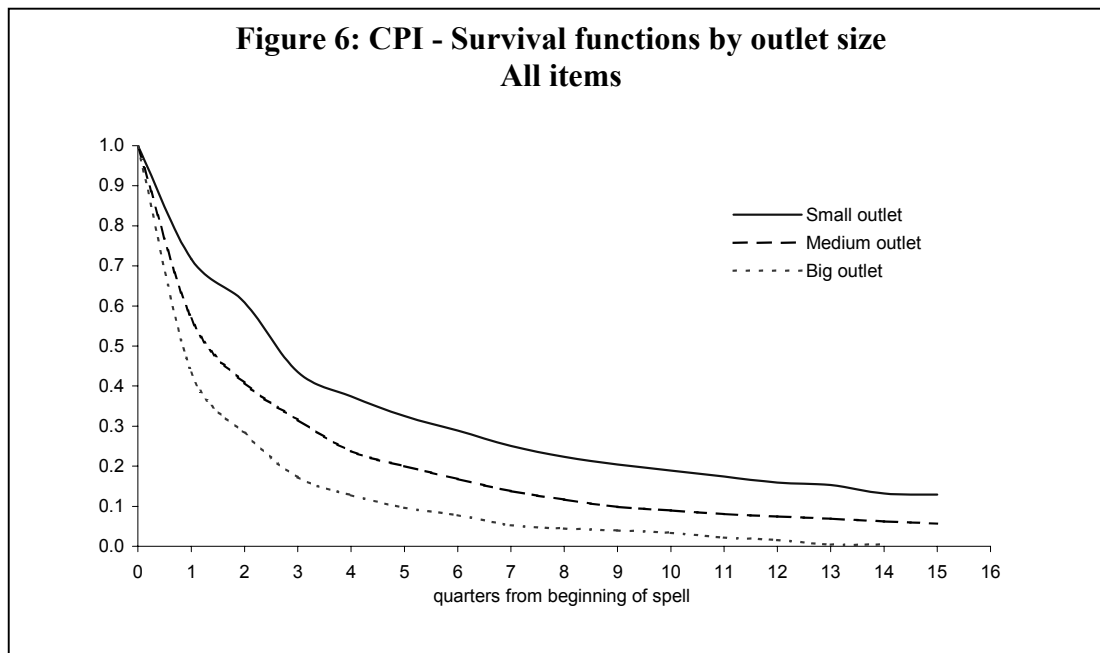
This graph illustrates the distributions of the 25<sup>th</sup>, 50<sup>th</sup> and 75<sup>th</sup> percentiles of the magnitudes of price changes conditional on a change having occurred. Estimates correspond to the 1997:1-2001:1 period. They were obtained from the CPI2 dataset using information on 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:**

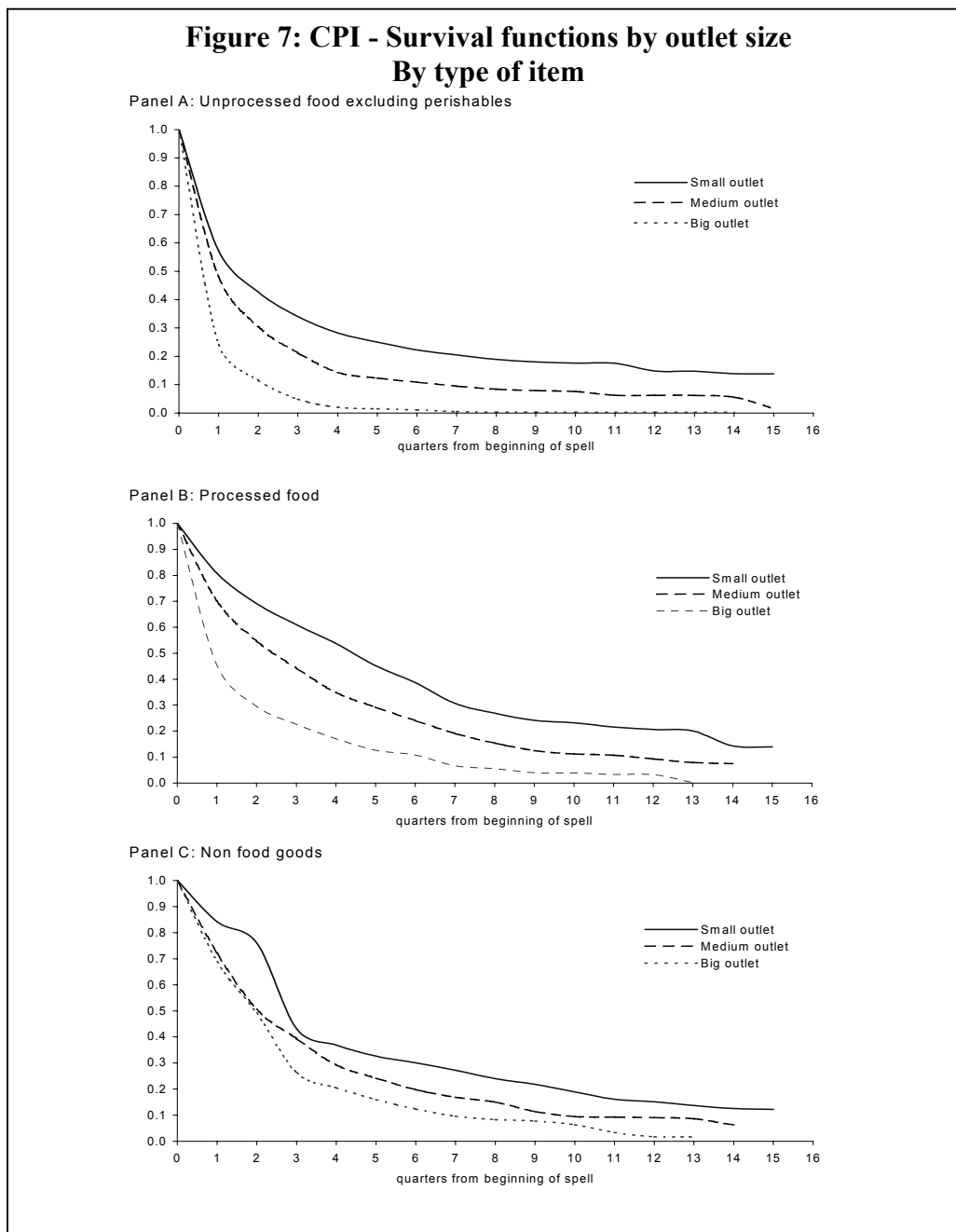
This graph illustrates the distributions of the 25<sup>th</sup>, 50<sup>th</sup> and 75<sup>th</sup> percentiles of the magnitudes of price changes conditional on a change having occurred. Estimates correspond to the 1997:1-2001:1 period. They were obtained from the CPI2 dataset using information on 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.



**Notes to figure 6:**

This graph illustrates the survival functions by type of outlet. A point in a curve corresponding to a value of  $x$  in the x-axis represents the probability that a price spell last for longer than  $x$  periods. 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 observed yearly were excluded from this analysis. The CPI2 is a sample of multiple spells, thus with an over-representation of short spells. We therefore re-weighted the spells to account for their length in order to reproduce the results that would be obtained from a flow sample of a single spell. Thus, the interpretation of the curves is that of the survival of the prices of a bundle of commodities as if they would all be changed at a given point in time and followed after that until a new change occurred. We used non-parametric Kaplan-Meier estimates of the survival functions. The composition of the bundle is the same across outlet. CPI weights were used at the most detailed level possible.

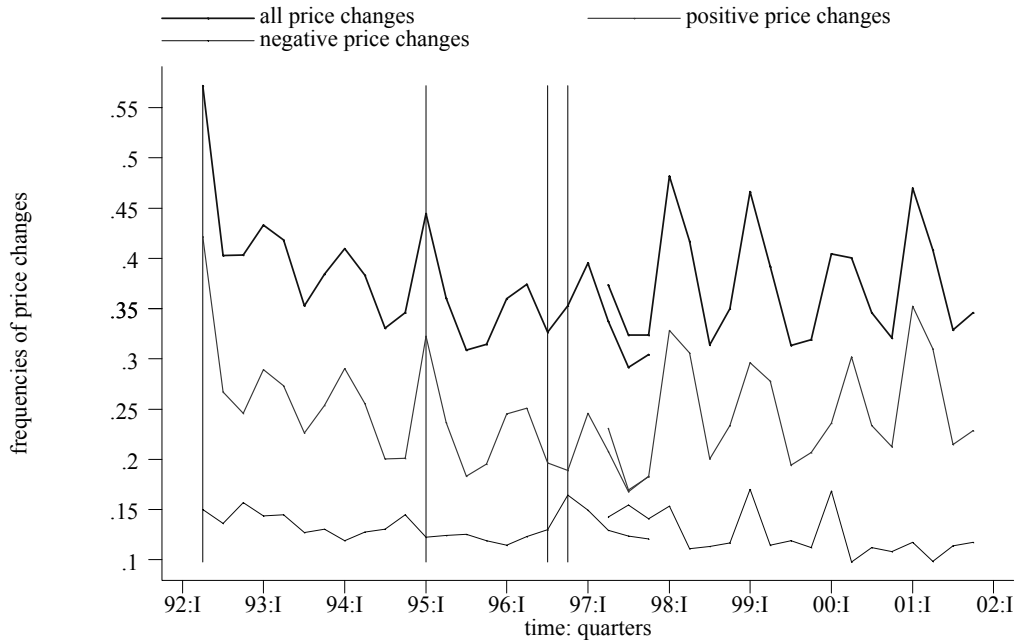
**Figure 7: CPI - Survival functions by outlet size  
By type of item**



**Notes to figure 7:**

This graph illustrates the survival functions by type of outlet. A point in a curve corresponding to a value of  $x$  in the x-axis represents the probability that a price spell last for longer than  $x$  periods. 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 observed yearly were excluded from this analysis. The CPI2 is a sample of multiple spells, thus with an over-representation of short spells. We therefore re-weighted the spells to account for their length in order to reproduce the results that would be obtained from a flow sample of a single spell. Thus, the interpretation of the curves is that of the survival of the prices of a bundle of commodities as if they would all be changed at a given point in time and followed after that until a new change occurred. We used non-parametric Kaplan-Meier estimates of the survival functions. CPI weights were used at the most detailed level possible. The composition of the bundle is the same across outlet.

**Figure 8: CPI - Frequency of price changes over time**  
**All items**  
**Quarterly figures**



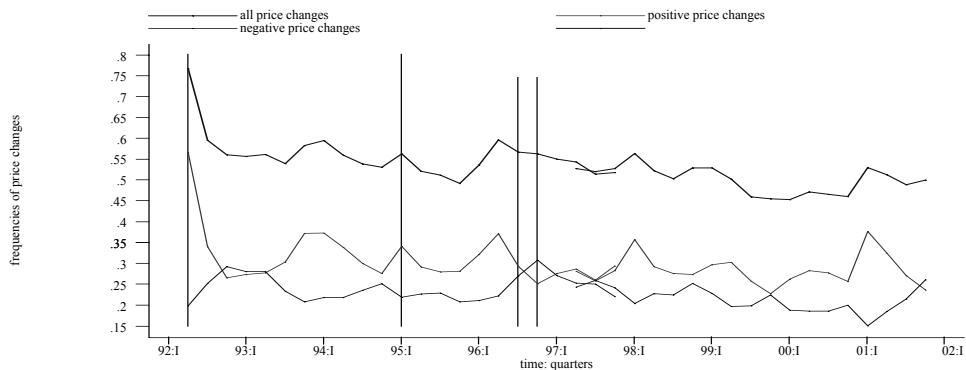
**Notes to figure 8:**

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.

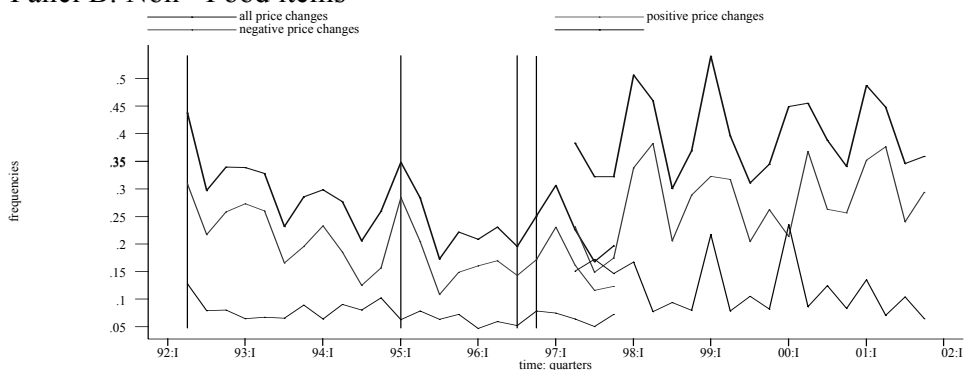


**Figure 9: CPI - Frequency of price changes over time  
By type of item  
Quarterly figures**

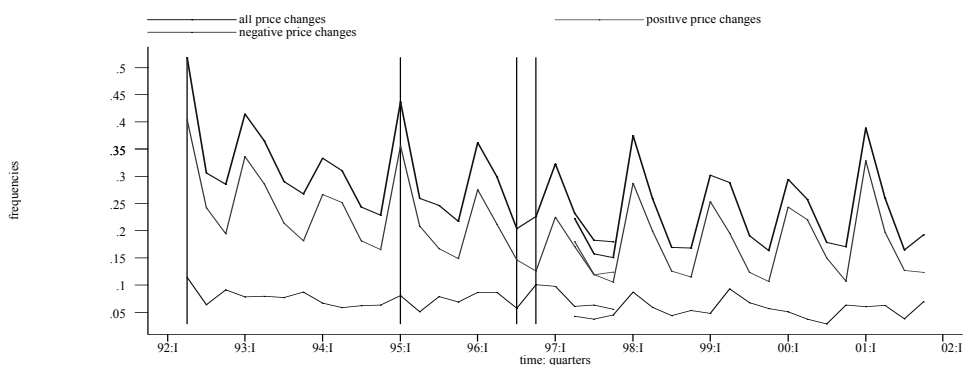
**Panel A: Food items**



**Panel B: Non - Food items**



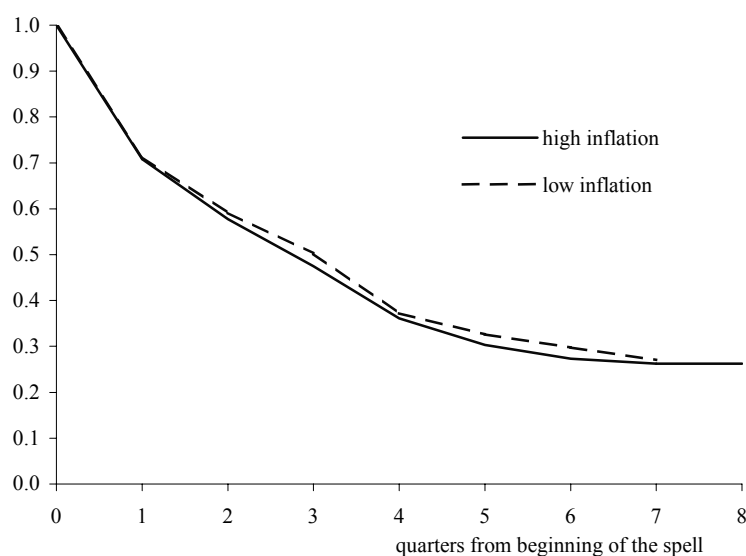
**Panel C: Services**



**Notes to figure 9:**

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.

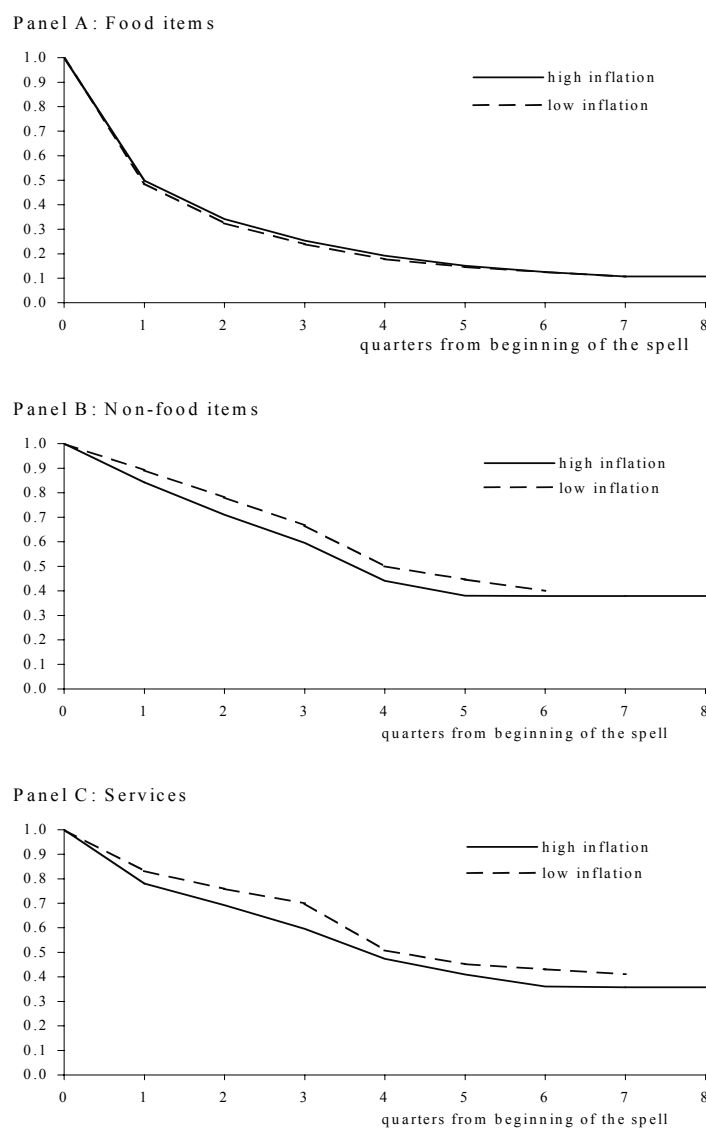
**Figure 10: CPI - Survival functions by level of inflation**  
**All items**



**Notes to figure 10:**

This graph illustrates the survival functions by type of outlet. A point in a curve corresponding to a value of  $x$  in the  $x$ -axis represents the probability that a price spell last for longer than  $x$  periods. Estimates are based in spells starting during 1992:1-1993:12 and 1996:1-1997:12 for the high and low inflation curves, respectively. They were obtained from the CPI1 dataset using information on all items followed monthly and quarterly except housing rents. Items observed yearly were excluded from this analysis. The CPI1 is a sample of multiple spells, thus with an over-representation of short spells. We therefore re-weighted the spells to account for their length in order to reproduce the results that would be obtained from a flow sample of a single spell. Thus, the interpretation of the curves is that of the survival of the prices of a bundle of commodities as if they would all be changed at a given point in time and followed after that until a new change occurred. We used non-parametric Kaplan-Meier estimates of the survival functions. CPI weights were used at the most detailed level possible. The composition of the bundle is the same for the two periods.

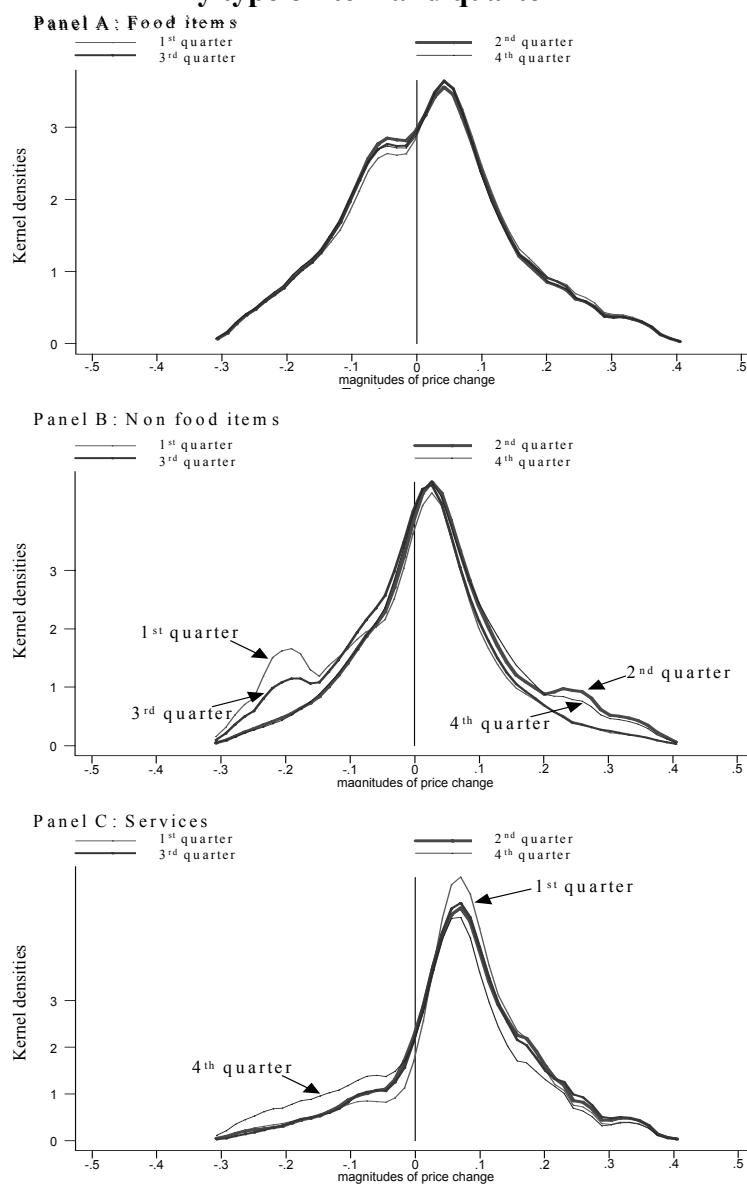
**Figure 11: CPI - Survival functions by level of inflation  
By type of item**



**Notes to figure 11:**

This graph illustrates the survival functions by level of inflation. A point in a curve corresponding to a value of  $x$  in the x-axis represents the probability that a price spell last for longer than  $x$  periods. Estimates are based in spells starting during 1992:1-1993:12 and 1996:1-1997:12 for the high and low inflation curves, respectively. They were obtained from the CPI1 dataset using information on all items followed monthly and quarterly except housing rents. Items observed yearly were excluded from this analysis. The CPI1 is a sample of multiple spells, thus with an over-representation of short spells. We therefore re-weighted the spells to account for their length in order to reproduce the results that would be obtained from a flow sample of a single spell. Thus, the interpretation of the curves is that of the survival of the prices of a bundle of commodities as if they would all be changed at a given point in time and followed after that until a new change occurred. We used non-parametric Kaplan-Meier estimates of the survival functions. CPI weights were used at the most detailed level possible. The composition of the bundle is the same for the two periods.

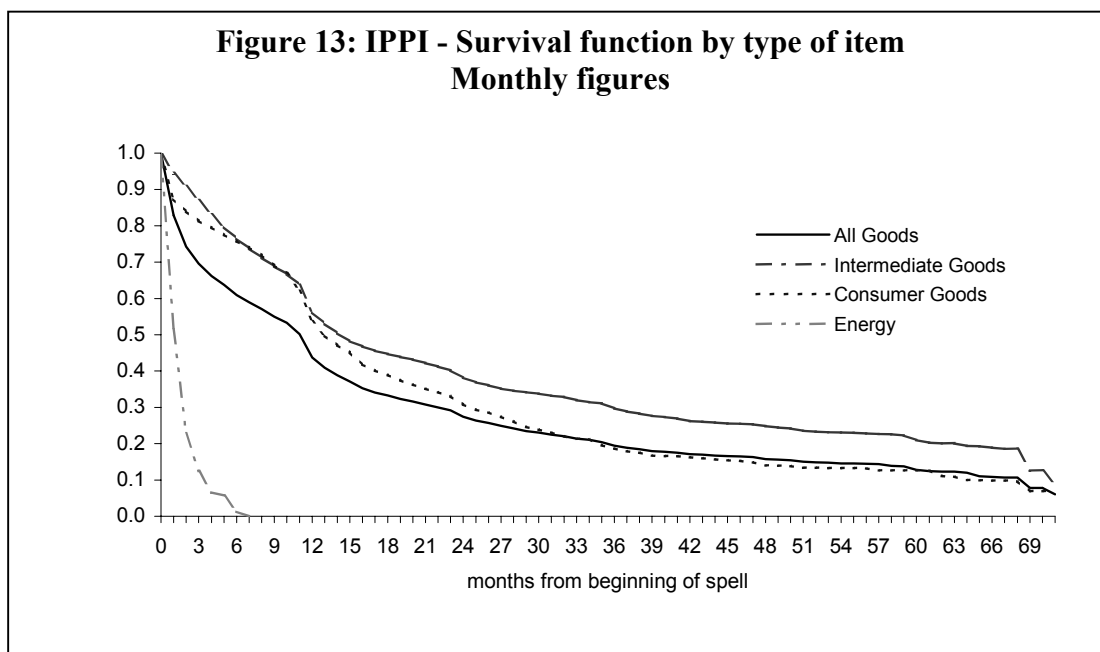
**Figure 12: CPI - Distribution of the quarterly rates of price changes  
By type of item and quarter**



**Notes to figure 12:**

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.

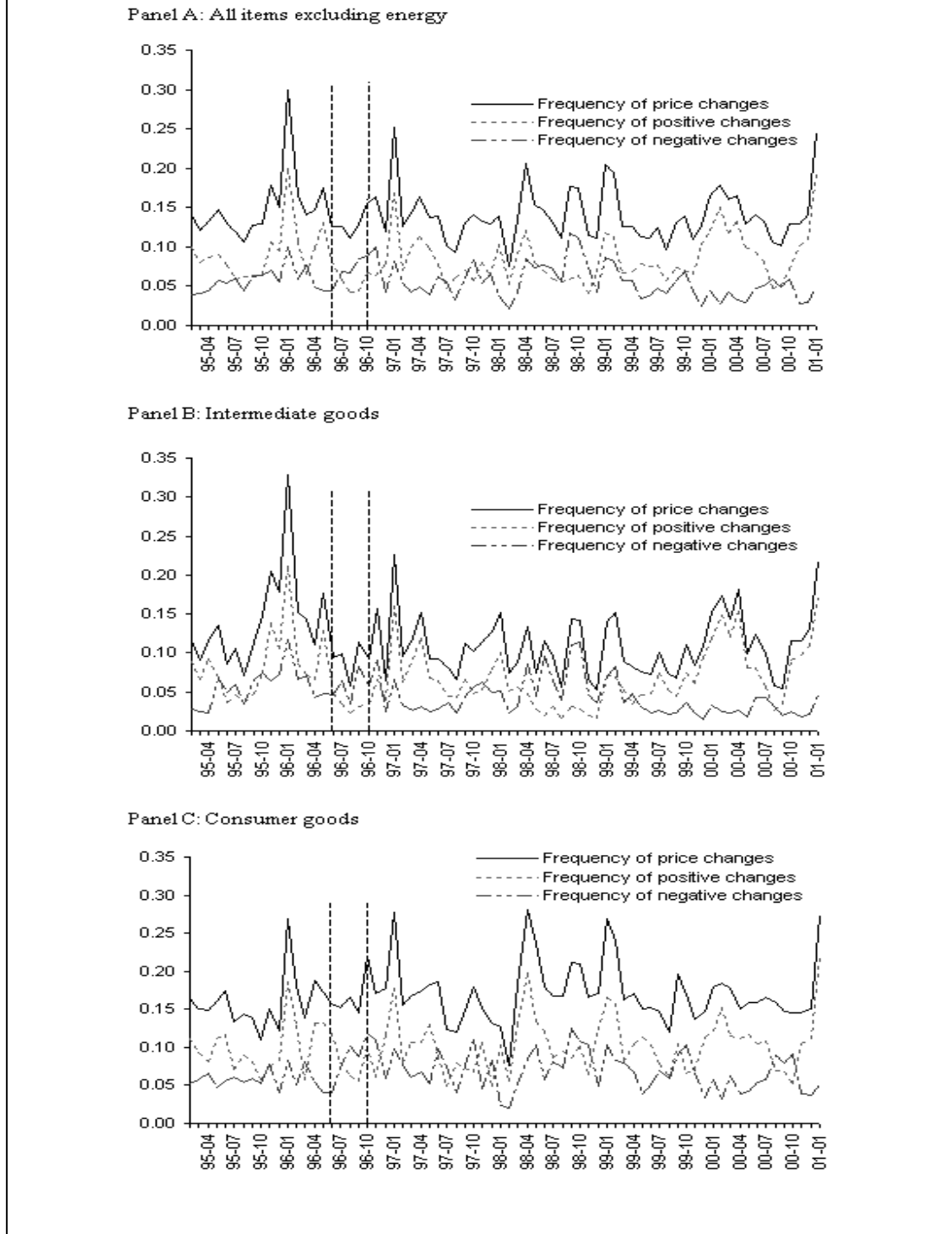
**Figure 13: IPPI - Survival function by type of item**  
**Monthly figures**



**Notes to figure 13:**

This graph illustrates the survival functions by class of item. A point in a curve corresponding to a value of  $x$  in the x-axis represents the probability that a price spell last for longer than  $x$  periods. Estimates correspond to the 1995:1-2001:1 period. They were obtained from the IPPI dataset using information on all items in the manufacturing industry excluding. The IPPI is a sample of multiple spells, thus with an over-representation of short spells. We therefore re-weighted the spells to account for their length in order to reproduce the results that would be obtained from a flow sample of a single spell. Thus, the interpretation of the curves is that of the survival of the prices of a bundle of commodities as if they would all be changed at a given point in time and followed after that until a new change occurred. We used non-parametric Kaplan-Meier estimates of the survival functions. IPPI weights were used at the most detailed level possible.

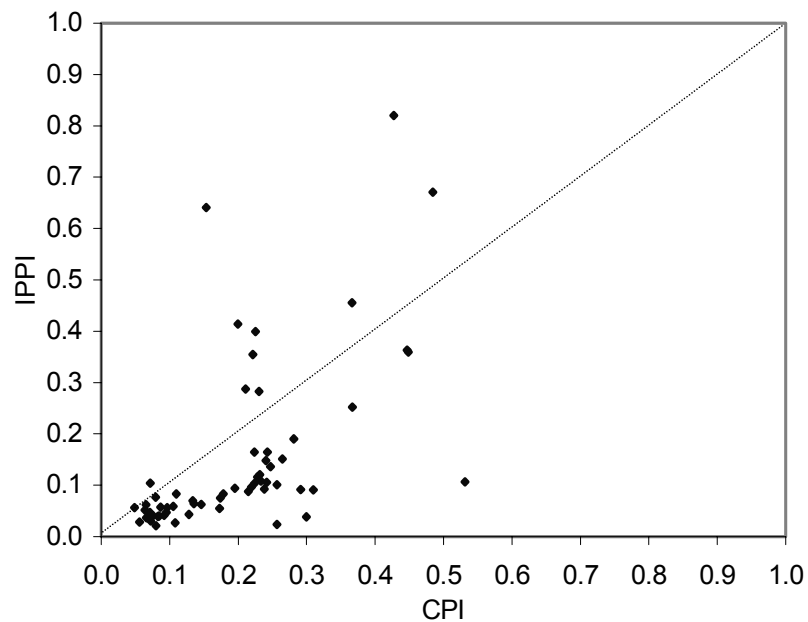
**Figure 14: IPPI - Frequencies of price changes over time  
By type of item  
Monthly figures**



**Notes to figure 14:**

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 1995:1-2001:1 period. The vertical lines indicate VAT rate changes. They were obtained from the IPPI dataset using information on manufacturing items. All estimates use IPPI weights at the most detailed level possible. The composition of the bundle is kept constant over time.

**Figure 15: CPI vs IPPI - frequency of price changes at the consumer and industry level  
All common items**



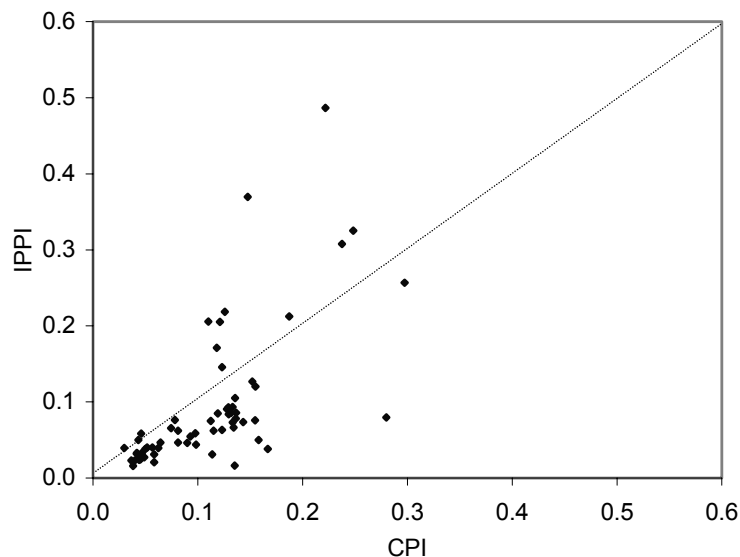
**Notes to figure 15:**

This graph illustrates the frequency of price changes for consumer and producer prices. Items were matched at the most detailed level possible in order to construct a common sample. The common sample was used over the overlapping period of 1997:1 to 2001:1. No weights were used in these estimates.

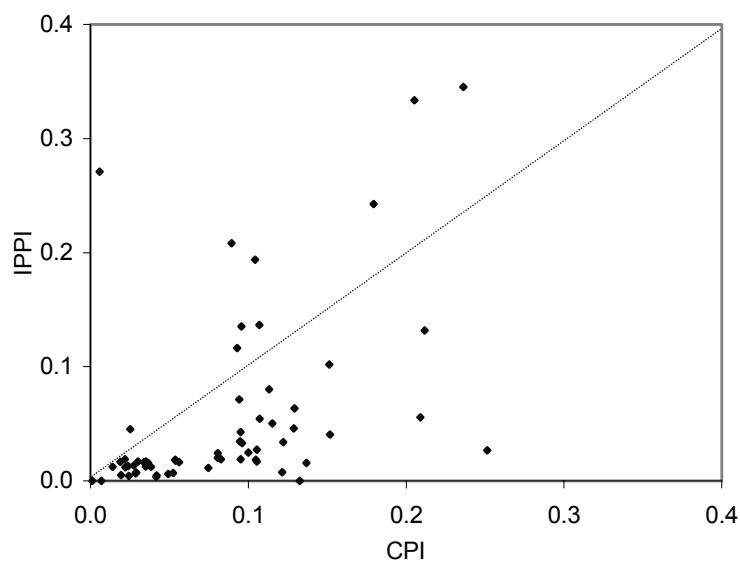


**Figure 16: CPI vs IPPI - Frequency of price changes at the consumer and industry level**  
**Positive and negative price changes**  
**All common items**

Panel A: Positive price changes



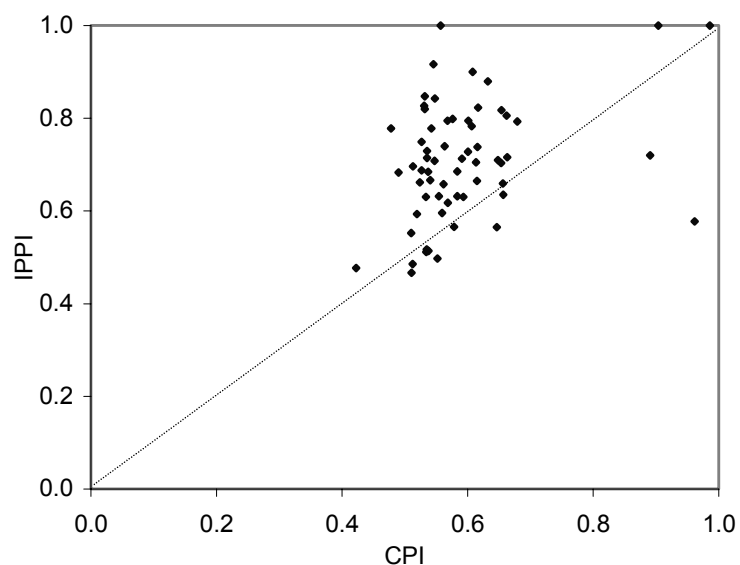
Panel B: Negative price changes



**Notes to figures 16:**

This graph illustrates the frequency of price changes for consumer and producer prices. Items were matched at the most detailed level possible in order to construct a common sample. The common sample was used over the overlapping period of 1997:1 to 2001:1. No weights were used in these estimates.

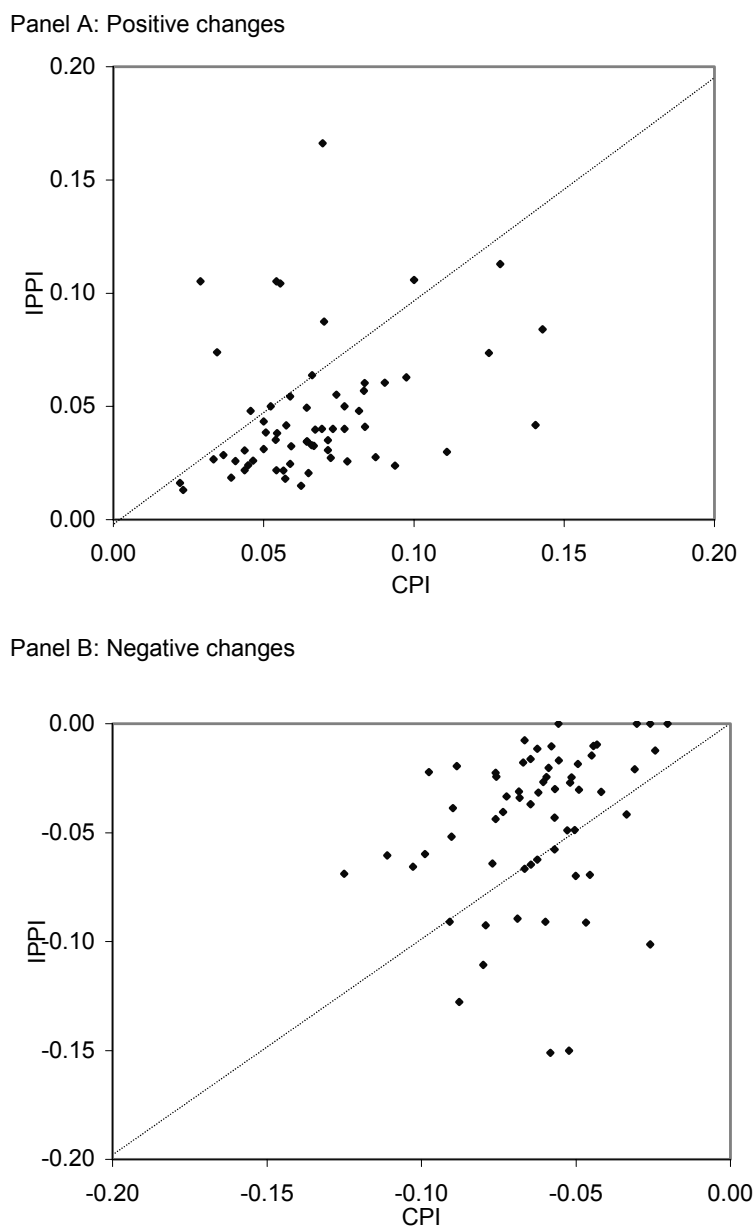
**Figure 17: CPI vs IPPI - Proportion of positive price changes  
All common items**



**Notes to figure 17:**

This graph illustrates the frequency of price changes for consumer and producer prices. Items were matched at the most detailed level possible in order to construct a common sample. The common sample was used over the overlapping period of 1997:1 to 2001:1. No weights were used in these estimates.

**Figure 18: CPI vs IPPI - Median magnitudes of price changes in CPI and IPPI**  
**Positive and negative price changes**  
**All common items**



**Notes to figure 18:**

This graph illustrates the median magnitudes of price changes for consumer and producer prices. Items were matched at the most detailed level possible in order to construct a common sample. The common sample was used over the overlapping period of 1997:1 to 2001:1. No weights were used in these estimates.

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