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PRICE CHANGES IN FINLAND

SOME EVIDENCE FROM MICRO CPI DATA

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In 2007 all ECB publications feature a motif taken from the €20 banknote.

1 This study was written in the context of the Eurosystem Inflation Persistence Network. The author would like to thank the anonymous IPN referees for their valuable comments, participants of the IPN network for useful discussions and suggestions, and the participants of the seminars in the Bank of Finland, especially Patrick Crowley, Juha Kilponen, Jouko Vilmunen, and Matti Virén. The views expressed in this paper are solely the responsibility of the author and should not be interpreted as reflecting the views of the ECB or Bank of Finland. Any remaining errors are the author's responsibility.

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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.

Since June 2005 the IPN is chaired by Frank Smets; Stephen Cecchetti (Brandeis University), Jordi Galí (CREI, Universitat Pompeu Fabra) and Andrew Levin (Board of Governors of the Federal Reserve System) act as external consultants and Gonzalo Camba-Mendez as Secretary.

The refereeing process is co-ordinated by a team composed of Günter Coenen (Chairman), Stephen Cecchetti, Silvia Fabiani, Jordi Galí, Andrew Levin, and Gonzalo Camba-Mendez. 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

In this paper we analyse the Finnish consumer price changes from February 1997 to December 2004 on the basis of a set of microdata which covers over half of the items included in the Finnish CPI. Our findings can be summarised with four stylised facts. Firstly, only a small fraction of prices change monthly. In the period under review, an average 80% of prices remained unchanged in consecutive months. Secondly, price changes can be large in both directions. Thirdly, positive inflation is due to the higher number of price increases compared to decreases, and the magnitude of price changes is more or less in balance. Finally, the decomposition of monthly inflation to the weighted fraction of products with price changes and the weighted average of those price changes seems to give support for the time-dependent modelling of Finnish consumer prices, although signs of state-dependent pricing can also be found in the data.

Keywords: consumer prices, rigidity, time-dependent pricing, state-dependent pricing

JEL: Classification E31, D40, L11

Non-technical summary

In this paper we study the micro features of the consumer price changes in Finland. We use a micro data set, which contains a major part of the actual CPI data collected and used by Statistics Finland from January 1997 to December 2004. With the CPI weights, it comprises approximately 55% of the items in the CPI basket. Vilmunen (2005) has already applied this data set but while he concentrated on the average price duration (the period of time an individual price remains unchanged), we focus on the pricing process: how it differs between various product groups and how it has evolved over time from late 1990s to the mid 2000. Our main interest is to study whether the data supports a state or time dependent pricing theory – the most often used theories in the modelling of price stickiness in the New Keynesian macro theory.

Our analysis reveals several interesting features in Finish consumer prices. The distributional analysis shows that prices do change fairly seldom, as on average nearly 80% of the price quotas in the data set did not change at all between two consecutive moths. The subgroups are fairly heterogeneous, as in energy only 23% and in unprocessed food 54% of monthly price changes are zeros, while in other three subgroups the frequency is over 80%. However, when prices do change, the changes can be surprisingly large. We can easily find price changes as large as ±50 log percentages in all subgroups except energy and services. Furthermore, the effective distributions are rather large, as in the HICP basket as a whole and in the other subgroups – non-energy industrial goods, processed food and unprocessed food – at least 8% of non-zero price changes are outside the interval [-25, +25]. In all cases the distributions are skewed to the right. This skewedness is pronounced in small price changes: there is considerably less small (1-5 pp) negative price changes than positive ones. These observations support Vilmunen's (2005) interpretation that positive inflation is due to the higher number of price increases compared to decreases, and the magnitude of price changes is more or less in balance.

When focusing on how these distributions have evolved over time, we find that especially at the end of our data period the distributions are rather different than the average distributions. In 2002–2004, the drop in inflation has been mainly driven by non-energy industrial goods. However, because our data lacks several important item groups like telephone calls and international flights, one has to be careful when interpreting the results. This is especially true in case of services, where the above mentioned groups have been the driving force behind the recent downward trend in service inflation.

Finally, our analysis suggests that changes in monthly inflation seem to be due more to variance in the magnitude of price changes than to variance in the fraction of products of which prices have changed. This result is relatively close to what Klenow and Kryvstov (2005) have found from the US data and supports the use of a time dependent pricing theory in a macroeconomic model of the Finnish economy. However, our additional estimations suggests that there also exists signs of state dependent pricing in the data, similar to Dias et al's (2006) findings from the Portuguese and US data.

1 Introduction

In New Keynesian macromodels (see eg Walsh 2003) prices are sticky in the short term, but in the longer term money is neutral. In other words, monetary policy has short-term implications but does not affect the economy permanently. However, if the price stickiness differs between items and item groups, monetary policy could alter relative prices and could affect the real economy even in a somewhat longer time frame.

Modelling of price stickiness is usually either state or time dependent. In the time-dependent model, firms can change their prices only when they have exogenous permission to do so. According to Taylor's (1980) framework, this possibility to change prices occurs in every n:th period. In Calvo's (1983) model, permission is stochastic and based on the Poisson process. In the state-dependent model, the price change frequency is based on an endogenous optimisation process, which is usually in turn based on menu costs or some other trigger variable. In both set-ups, firms set their prices to maximise their expected profits. If the expected change in profits after a price change is larger than the menu cost, a firm will change its price, and vice versa. The reason for the use of excessively simplified time-dependent models instead of more realistic state-dependent models is that the latter often lead to quite complicated models which are not easy to solve.

The recent availability of microdata has enabled researchers to more carefully study pricing process features. While cross-sectional data has been used at least since the 1970s (see eg Parks 1978 and Fisher et al. 1981) to study the relationship between inflation and relative price variability, it has only been on the item level and thus allowed the study of inter-market prices. The recent microdata-based branch of research was initiated by Bills and Klenow (2002), who used microdata on US consumer prices. In Europe, the ECB and the national central banks of the euro area established a study network in 2003 with the objective of forming a deeper understanding of consumer price mechanisms in the euro area with the help of eg microdata on consumer prices. Data on Finnish consumer prices has already been applied by Vilmunen and Laakkonen (2004) and Vilmunen (2005).

While Vilmunen focused on average price duration (the period of time an individual price remains unchanged), the focus of this study is on time series analysis, ie on monthly price changes in various product groups, and on possible differences in the pricing process of the 1990s and of today. The aim is to examine product-group-specific differences in pricing in Finland, based on Statistic Finland's data on the harmonised index of consumer prices (HICP), and try to discover whether the data on Finnish prices supports a state or time dependent pricing theory. The data set consists of shop-specific prices of individual products and covers the period from January 1997 to December 2004.

The present study is organised as follows. In the next chapter we discuss recent empirical literature based on micro CPI data. In chapter three we present the data used in this study. In chapter four we study the characteristics of monthly log changes of the data, both with distributional information for the whole period and changes in those monthly distributions over time. In chapter five we decompose monthly inflation to the fraction of the weighted price changes and to the weighted price changes. Based on this decomposition and on correlation and variance analysis, we study whether the Finnish data is supportive of the time and/or state dependent theories. Chapter six present our conclusions based on the results.

2 Previous empirical studies

The starting point for the recent microdata-based analysis of consumer prices was the study by Bills and Klenow (2002), in which they exploited US data from 1995 to 1997. The item coverage of their data set was about 70% of US consumer spending. As the data allowed them to calculate repricing frequencies and price durations, their main finding was that prices were not as sticky as the earlier literature had argued. According to their results, the median duration for a price change was only 4.3 months, while in the earlier literature it was typically around one year. On average, 26% of prices changed from month to month. In the US data, service prices were stickier (the frequency of monthly price changes was around 21%) than prices of goods (frequency 30%). In addition, price changes in raw goods were more common (frequency 54%) than in processed goods (frequency 21%). According to the authors, both the Taylor and the Calvo pricing models predict much more persistent and less volatile inflation than was found in the data.

Klenow and Kryvtsov (2005) extended Bills and Klenow's (2002) analysis in two directions. Firstly, their data set was larger and covered the time period from February 1988 to December 2003. Secondly, they took a more analytical view of the data as they decomposed the inflation into the weighted fraction of products with price changes and the weighted average of those price changes. On the basis of this they derived the variance decomposition for inflation terms. Their interpretation was that, if the total variance is due to the fraction term, the data supports state-dependent modelling, and, if it is driven by the price change term, the data supports a time-dependent pricing model. According to their estimations, the data clearly supported the latter alternative, as the variance decomposition between the two terms was 3 to 97%. In addition, they calculated the means and correlations between the two terms in the inflation decomposition. In this data set, 29% of prices on average changed between two consecutive months, while the average size of the weighted price changes was 0.61% (the average of absolute values was 13.3%). The correlation between inflation and price change frequency was 0.31, between inflation and price changes 0.99, and between frequency and price change terms 0.24.

In 2003, the ECB and the national central banks of the euro area formed a network to study the inflation process more carefully. One of the issues was microdata analysis. According to Dhyne et al. (2005)[1] the network documented four main findings from the data. Firstly, the average monthly frequency of price adjustment is 15%, suggesting that prices are clearly more rigid in the euro area than in the USA. Secondly, the frequency of price changes is heterogeneous across product groups but more homogeneous across different countries. Thirdly, price increases and decreases – which do occur regularly – are sizeable compared to average inflation. Fourthly, price changes are not highly synchronised across retailers. In addition, the frequency of price changes is affected by seasonality, outlet type, indirect taxation, pricing practices and aggregate and product-specific inflation.

The Finnish contributions are by Vilmunen (2005) and Vilmunen and Laakkonen (2004). They estimate price durations for the whole CPI data, by outlet type, by product group and by major regions, and the average frequencies and sizes of the price changes in the period 1997–2003. Due to the problems related to the data set, they were only able to estimate these figures separately for the time periods 1997–1999 and 2000–2003. As referred to in Dhyne et al. (2005), they found that the average frequency of price changes in Finland is 20.3%, while the size of the average price increase and decrease are 12.6% and 7.7% respectively. The data showed that the changes in pricing processes by major regions were small, but between item groups the pricing processes were heterogeneous. As a conclusion, Vilmunen (2005) states that positive inflation is due to a higher number of price increases than decreases, while the magnitude of price changes is roughly in balance.

3 The data

3.1 The Finnish microdata

The data used in this study contains a major part of the actual consumer price index (CPI)[2] data collected and used by Statistics Finland from January 1997 to

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[1] The individual country papers of which Dhyne et al. (2005) is compiled are Baumgartner et al. (2005, Austria), Auchremanne and Dhyne (2004, Belgium), Vilmunen and Laakkonen (2005, Finland), Baudry et al. (2004, France), Hoffmann and Kurz-Kim (2005, Germany), Veronese et al. (2005, Italy), Lünnemann and Mätha (2005, Luxembourg, Jonker et al. (2004, Netherlands), Dias et al. (2005a, Portugal) and Álvarez and Hernando (2004, Spain).

[2] In Finland the CPI and the harmonised consumer price index (HICP) are calculated from the same data. The major differences between the CPI and the HICP are that the latter excludes eg items related to owner-occupied housing, and that they are calculated with different index formulas. At the moment, the HICP includes around 90 % of the items in the CPI. In this study we approximate the HICP as the CPI minus the excluded items; the included CPI item weights are recalculated to sum up to 1.

December 2004. With the CPI weights, it comprises approximately 55% of the items in the CPI basket; the most important items that are available only at the index level are alcohol prices (with the exception of beer prices), prices related to housing (rents, house prices, heating, interest rates, etc.), telephone calls, and some healthcare-related fees. However, as wine and spirits are sold by a government monopoly, and as health and childcare prices are governed and priced at least partially by central and local government, the available microdata should give us a relatively fair picture of market-based CPI price changes in Finland[3]. In addition, instead of the national CPI index we focus on the harmonised index consumer prices (HICP), which excludes some of the non-microdata, eg owner-occupied housing; Finnish HICP data is a subset of CPI data.

Statistics Finland improved the coverage of the price basket when it reconstructed the CPI index from 1995=100 to 2000=100[4]. The main differences between these indices are in the number of price quotas collected in a month – both the number of different items in the data set and the number of prices collected for a single item – and in the metadata.

Table 1 describes the data sets used in this study. The number of collected items (at the 7 digit classification) increased from 434 to 475 when the basket was updated. As the number of monthly price quotas increased at the same time considerably more, the average number of price quotas per item also increased. We can get an idea of the item substitution by comparing the number of price quotas and the total number of rows in the data set[5]. The size of the data set varies quite significantly even within each of the two data sets. In 1997, the coverage is only about 20,000 observations per month, but in the rest of the years in the 1990s it hovers around 40,000 observations per month. In the second data set, the number of monthly observations is close to 50,000. However, in the euro changeover period – from December 2001 to May 2002 – the number of collected price quotes was larger than normal, averaging around 60,000 items per month.[6]

Unfortunately there is a break in the metadata in January 2000, as the item-specific ID codes are different before and after that time. We are therefore unable

[3] The most problematic sub-series are energy, which in this study lacks heating oil, gas, and electricity, and services, where the declining price trend of cell phone calls has been the driver behind the moderation of service inflation. Also the lack of micro data on rents is a drawback in services.

[4] Somewhat confusingly, the CPI 2000=100 index has been published only from January 2002 onwards. In 2000 and 2001, the published index was the 1995=100.

[5] In our two data sets every single item has its own ID code regardless of whether it has observations (price quotas) for only a single month or for the whole time period. The price spell ends either because there are no more observations available or because the quality changes, which de facto means that the item has changed. Thus, the number of rows equals the total number of different items in the data set during the whole time period.

[6] There are two reasons for the increased number of price quotes during the euro changeover period. Firstly, Statistics Finland was developing the 2000=100 index at the same time as it was producing the 1995=100 index. Secondly, and more importantly, it collected more price information to be able to measure the CPI as well as possible during the euro changeover.

to map the identical items between these two data sets and there is a break at the item level in price changes in January 2000.

3.2 Definitions used in this study

As our aim is to analyse pricing behaviour and possible changes therein, we focus on monthly price changes. We are interested in both their size and their occurrence in the data. The definitions for those features are:

The size of the monthly price changes is defined as a log difference between two monthly price quotas of an identical item.

The frequency of price changes is measured at the item group level as the amount of changing monthly price quotas of identical items divided by the total amount of price quotas of identical items.

The use of log percentage changes is based on symmetry and the fact that the arithmetical average of the item level log changes can be interpreted as a geometric average. The use of log changes leads to a similar inflation at the item level as the calculation method used by Statistics Finland.

The identicality of the items is ensured with the ID and quality information in the metadata. For each item, there is an ID code which reveals that it is collected from a single place and that its definition is close enough to being the same as in the previous months. To be as sure as possible that the item remains exactly the same, we include only those cases where the quality code in the metadata is not different from zero, ie the quality is unchanged.[7]

As regards quality control, our method differs from that used by Statistics Finland, as we include only those items in which the quality is unchanged. The reason for this is that quality correction issues can be very problematic, especially in this data period (eg the measurement of quality change of a cell phone), and because the methods[8] used officially are probably not as good as they should be (Kinnunen-Lehtinen 1998). The decision to exclude price changes occurring with product replacements can be criticised because it leaves out an important portion of price changes. However, because our approximation of monthly inflation tracks fairly well the official CPI inflation (Figure 1a), this problem is probably not so

[7] In addition, we take into account only those price quotas which are not classified as otherwise problematic. For example, quotas classified as missing, or new missing observations in the meta data are dropped from the sample.
[8] Statistics Finland does not use any formal method – such as an hedonic method – for quality control. The quality change is assessed by the price collectors with the help of the sales staff. The consistency of these estimates is double-checked centrally at the compilation stage. This method probably leads to somewhat biased estimates, but neither the size nor the direction of the bias is known.

severe in our data set. Our approximation and the official figure do not diverge at the HICP level (Figure 1b). However, for non-energy industrial goods and unprocessed food the difference in levels is larger.

Due to the large differences in the number of monthly price change quotas, the analysis is based on weighted information. By employing the HICP weights at the item level we avoid the possibility that the variation in the number of monthly price observations could distort the analysis. In the weighting, the objective is not to build a 100% blueprint of the official HICP[9] but to approximate it closely enough that the results can be interpreted as if they were derived from the official index.

The analysis is carried out in chapters 4 and 5. In the subchapters 4.1 and 4.2 we analyse the distributions of the Finnish HICP price changes. In the former, we analyse the monthly log price change distribution for the whole time period 1997–2004. In the latter, we describe how the monthly price change distributions have evolved over time. The analysis is based on the time series of the four first moments of the monthly price changes. In chapter 5 we carry out a Klenow-Kryvtsov decomposition for monthly inflation and search the data to see if we can find support for the use of time and/or state dependent pricing. We also take into account the criticism that the decomposition and its interpretation have received and calculate alternative measures used in other studies for the uniform nonsynchronisation hypothesis analysis.

4 The weighted price changes

4.1 Distributional information

To get an overview of the variation in harmonised consumer price changes between 1997 and 2004, we start by examining the distribution information derived from the whole data set. We calculate the distributions for the whole HICP basket and for its main subseries: energy, non-energy industrial goods, processed food, unprocessed food, and services. The distributions are the HICP weighted sums of item-level frequency distributions from -100 to + 100 log percentages changes.

The distribution based on the whole HICP basket is shown in Figure 2a. As can be seen, most of the monthly price changes are zeros. In fact, as many as 78% of the price changes are zero. The rest of the visible price changes are in the ±40% range. The situation is fairly similar in the subgroups with the exception of energy, where the amount of zero price changes is 23%, and unprocessed food,

[9] In addition to the difference with the quality changes, the official HICP calculation differs from our approximation by using a different index formula.

54%. In non-energy industrial goods, processed food and services the share of zero price changes is over 80%.

In Figure 2b we focus on the non-zero changes. When the prices do change, the mode price change is +1%, of which the share of all non-zero price changes is 5.6% in the HICP basket. The frequency distribution in Figure 2b is rather symmetric but clearly skewed to the right, indicating that positive price changes are more common than negative ones. Cumulatively, 44% of non-zero price changes are located in the interval [+1, +15], while only 27% of them are in the interval [-1, -15]. This large difference arises mainly from very small price changes, as 24% of non-zero price changes are located in the interval [+1, +5] and only 12% in the interval [-1, -5]. Similar phenomena – a small amount of very small price decreases – can also be found in the German data (Hoffmann and Kurtz-Kim, 2006) and in the French data (Baudry et al, 2006).

To get a rough idea whether the euro changeover affected the size of the price changes, in Figure 2c we have erased the price changes between June 2001 and June 2002. Comparing figures 2b and 2c it looks like the euro changeover did not much change the size of the price changes, as the shapes of the two distributions are almost identical. The distribution excluding the euro changeover period is marginally wider (roughly 1 percentage points more mass is located outside the ±50 range) than it is for the whole data set. With regard to skewness the situation is almost unchanged: both within and outside the euro changeover period roughly 4/5 of those price changes whose absolute value is a maximum 5% are positive.

Figures 3a–3e show frequency distributions of weighted price changes (excluding zero changes) for the five subgroups of the HICP: energy, non-energy industrial goods, processed food, unprocessed food and services. The flattest weighted log price change distribution belongs to unprocessed food, where the mode change (+ 6%) has only 2.5% of the whole non-zero price change mass. The distribution is extremely wide, as over 50% of the frequency is located outside the interval [-15, +15] and almost 10% outside the interval [-50, +50]. However, this frequency distribution is also skewed to the right, as the intervals [+1, +5], [+1, +10], etc. all have around 2 percentage points more frequency mass than the comparative negative intervals.

The two narrowest distributions are those for services and energy, although the reasons for the shapes are quite different. Energy price, which in this study refers only to petrol, is characterised by very frequent but rather small price changes. For services, the prices are much stickier, as according to Vilmunen (2005) they change on average only once in 9 months. Despite this, the average price changes are concentrated in a rather small interval, as 45% of price changes are located in the interval [-5, +5]. The service price distribution is also heavily skewed to the right, with 33% of non-zero price changes located in the interval [+1, +5] and only 11% in the similar-sized negative area. In the case of energy price changes, the situation is more even, and actually 44% of non-zero price changes are located in the interval [-1,-5] and 38% in the interval [+1,+5]. The reason for this is that energy prices are mainly driven by the world market oil price, which has fluctuated heavily both upward and downward in our time period.

The last two subgroups, non-energy industrial goods and processed food, show somewhat similar frequency distributions. For non-energy industrial goods the mode of price change is +1 and for processed food +3. In both cases around 30% of non-zero price changes are located in the interval [-5,+5]. These distributions also have more mass on the positive side, as close to 2/3 of [-5, +5] price changes are positive in non-energy industrial goods, and 3/4 in processed food.

4.2 The time series of the moments

After outlining a general view of the price changes, we shall examine how these distributions have evolved over time. We describe the changes in distributions by the time series of their first four moments: the mean, the variance, the skewness and the kurtosis. As in subchapter 4.1, these time series are calculated for the whole HICP basket and for the five subgroups. The advantage of this approach is that we can conveniently describe 94 monthly distributions in four figures.

There are at least two different ways to calculate the standard deviation, skewness and variance from this data. As the sum of the frequencies from -100 to +100 equals monthly inflation, it would have been possible to calculate the second, third and fourth moments around this value. However, because our aim in this chapter is to describe the changes in monthly price change distributions – not to imitate the monthly inflation – we calculate those moments directly from each month's distribution data.[10][11] The moments for the whole basket are shown in figures 4a – 4d. Due the changes in our data set between 1999 and 2000, we have calculated averages of each moment for years 1997-1999 and 2000-2004 separately.

The average of the means of the monthly HICP distributions is positive for the whole period. Despite our weighting, it features more pronounced seasonal features in the 1990s than thereafter (Figure 4a); a feature which is also clearly visible in the official inflation series and is thus unrelated to the methods used in this study. The troughs in the 1990s are probably related to seasonal sales, which in most cases occur in January and July in Finland. The same months are clearly visible in the standard deviation (Figure 4b). Unlike in the mean series, the

[10] In addition, because most of the bins outside the interval [-50,+50] are zeros, if we had calculated the moments around inflation (sum of the frequencies), they would have been smoother than is appropriate in this case.
[11] The monthly mean in each of figures 4–9 equals monthly inflation divided by 201 (the number of bins in our distribution).

averages of the 2nd, 3rd and 4th moments are somewhat different in both subsamples. The volatility is quite moderate in the middle of our data set but starts to increase again from 2003. The skewness (Figure 4c) swings into the negative area at the same time as the volatility starts to increase. This is well in line with the drop in aggregate inflation. The fourth of our moments, kurtosis, displays an opposite time trend as standard deviation: it displays several peaks between 2000 and 2003 but is an average on lower level after 2002 than 2000 and 2001.

As a conclusion for the HICP basket as a whole, the distributions for the entire time period analysed in subchapter 4.1 seem to describe the data from 1997 up to the years 2000–2001. Thereafter, the inflation process has clearly changed, as both the average and skewness differ from the earlier period. In the last two or three years, the monthly price change frequency distributions are leftward skewed and the number of zero price changes seem also to decrease. However, during the whole period the distributions are highly non-normal, mainly because of kurtosis which averages around 6 (1997-1999) and 9 (2000-2004).

The mean for the frequencies in energy price changes is positive in 1997–2004 (Figure 5a). In the first two years the volatility in price changes was clearly smaller than thereafter. As is the case for the monthly mean in energy, the skewness also changes from positive to negative between one or two months. The kurtosis is also very volatile and on average it is clearly higher than for the HICP basket as a whole.

The time series mean for non-energy industrial goods is slightly negative (Figure 6). The same is also true for its skewness in the latter time period. In the last three years of our period, the mean is lower than in earlier years. The series also shows a clear seasonal pattern. However, this pattern is different than the seasonality for the HICP basket as a whole. While in the HICP case it was more pronounced at the beginning of our period, the seasonal volatility for non-energy industrial goods increased in the latter part of our data set. The increase in volatility can also be seen from the standard deviation series. On average the kurtosis also increased in the years 2002–2004.

The mean for processed food (Figure 7, left column) fluctuates around its mean in two-year cycles: in 1998–1999 it was below the mean, in 2000–2001 above it, and in 2002-2004 once again below it. The drop in the mean in March 2004 was related to the drop in alcohol taxation. The time series for standard deviation features a clear seasonal pattern in 1997–1999; the highest peak arises in March 2004 and is related to the alcohol taxation. The skewness follows a similar trend to the mean. Interestingly, the peaks in kurtosis have increased from year 2003 on.

Similar cycles as for processed food can also be detected for unprocessed food (Figure 7, right column). This holds for both the mean and the skewness. The seasonality pattern in the years 1998–1999 for the HICP basket as a whole seems to be driven by unprocessed food, as the troughs in the mean in January and July in those years and especially the peaks in the standard deviation match between these series. The kurtosis is lower after 2000 than before.

The averages for service distributions are positive (Figure 8a) in our both time period. However it has been on a downward trend since 2001. Both the mean and the skewness reached their highest values in 2000 and 2001. Both the standard deviation and kurtosis have decreased in our time period. The average kurtosis is roughly only half as high at the end of our data period than in 1998.

As a conclusion from the subseries, we can note that especially in the case of the non-energy industrial goods - which accounts for roughly 30% of the whole HICP index – the trend in inflation is clearly different at the end of the period than it was in the 1990s and in the early years of the present decade. In addition, the frequency distributions at the end of our time series are different to the distributions for the whole period that were shown in subchapter 4.1. The monthly distributions are also extremely volatile: in all four moments the changes between two consecutive months can be extremely large. When the inflation turns from positive to negative (or vice versa), the changes occur – at least in weighted terms – across a broad category of goods.

5 Consumer price changes in Finland

5.1 Theory and estimators

In this chapter we study whether we can find support for the time or state dependent pricing models from the Finnish inflation data. In both frameworks, firms set their prices to optimise their expected income and profit. In the time-dependent model, firms can change their prices only when they have exogenous permission to do so. According to Taylor's (1980) framework this possibility to change prices occurs in every n:th period. In Calvo's (1983) model the permission is stochastic and based on a Poisson process. According to Goodfriend and King (1998), an important difference between Taylor and Calvo prices is in the additional flexibility in distributed lead and lag mechanisms that the latter has due to its stochastic nature. In the state-dependent model the price change frequency is based on an endogenous optimisation process, which is usually based on menu costs or some other trigger variable. Probably the most cited example of a state-dependent price model is Dotsey, King and Wolman (1999), which can be interpreted as a generalisation of Calvo's approach.

In the present study we follow Cecchetti's (1985) terminology, also used in Dias et al. (2006), where the Taylor models' outcome – that the share of prices changing in each period is constant – is termed as the uniform nonsynchronisation hypothesis (UNS). Calvo's (1983) model can be seen as a special case of pure time-dependent pricing where the share of prices changing in each period fluctuates around its Taylor-based mean. However, our main interest in this study is not to test whether the Finnish data supports a Taylor or Calvo type hypothesis but to find some more general support for the use of a time-dependent pricing mechanism in modelling the Finnish economy. Therefore, we are more interested in the frequency of price changes. If frequency is relatively stable over time, the time-dependent pricing model should fit the data, while large changes in frequency would support state-dependent pricing behaviour.

5.2 The Klenow-Kryvtsov decomposition

The main tool for the examination of possible changes in the pricing process is to decompose the monthly price changes into two components as in Klenow and Kryvtsov (2005)[12]: the fraction of products with price changes in the weighted index and the weighted average of price changes:

[12] The same approach has been applied to French data by Baudry et al. (2006) and to German data by Hoffmann and Kurz-Kim (2006).

(1) $\pi_t = fr_t \bullet dp_t.$

Inflation thus equals the product of the weighted averages of the fraction of items with price changes (fr_t) and the weighted average of price changes (dp_t). The first term can also be referred to as the extent of price changes (extensive margin) and the latter as the size of price changes (intensive margin). In a more formal way we can express (1) as

$$(2)\quad \pi_t = \sum_i \omega_{it} I_{it} \bullet \frac{\sum_i \omega_{it}(p_{it} - p_{it-1})}{\sum_i \omega_{it} I_{it}}.$$

In formula (2), ω_{it} represents the weight of each product i in the index at moment t and I_{it} is a binomial variable of the price change occurrence: I_{it} = 1, if $p_{it} \neq p_{it-1}$ and 0, if $p_{it} = p_{it-1}$. p_{it} is the log price of item i at time t. The 1st term (fr_t) is the fraction of the weighted items changing price in month t, and the 2nd term (dp_t) is the weighted average of log price changes at time t.

For variance analysis, the following variance decomposition can be derived from formula (2), using the Taylor approximation.

$$(3)\quad \text{var}(\pi_t) = \text{var}(fr_t)\,\overline{\text{dp}}^2 + \text{var}(dp_t)\,\overline{\text{fr}}^2.$$ [13]

If the total variance is driven mainly by the first term, ie the variance of the extent of price changes, the data can be interpreted as supporting the state-dependent pricing (SDP) theory. If, on the other hand, inflation variance is derived from the variance of price changes, the product would support the time-dependent pricing (TDP) theory.

Both the decomposition and its interpretation have attracted criticism. As Hoffmann and Kurtz-Kim (2006) state, definition (1) holds without ambiguity in a situation where the basket composition remains unchanged. According to them this is not true in a dynamic universe – where products and outlets in the basket do change over time. However, as the use of a static basket would most probably lead to even more seriously biased inflation and decomposition estimates, we just have to remember this criticism when interpreting the results.

Dias et al. (2006) criticise Klenow and Kryvstov's (2005) interpretation that the share of total variance accounted for by the second term in (3) should represent the presence of a uniform nonsynchronisation (UNS) hypothesis in the data:

[13] In formula (3), it is assumed that the covariance term between the terms is zero. With this data it is so small that its inclusion in either of the terms does not significantly change the results presented below.

$$(4)\quad \alpha_{KK} = \frac{\text{var}(dp_t)\,fr^2}{\text{var}(\pi_t)}.$$

Their criticism is based mainly on the fact that (4) includes elements related to a state-dependent pricing hypothesis. In addition, they note that with the covariance term included in (3) the proportion of the UNS term is not bounded in the range [0, 1]. Based on their criticism, they present two alternative estimators for measuring the importance of the UNS hypothesis. Their estimators are based on the following relationship:

$$(5)\quad fr_t = \alpha\, fr_1 + (1-\alpha)s_t,$$

where the fraction of prices changing in period t equals the firms of type 1 that follow the UNS hypothesis (α) times the fraction of them adjusting their prices in a given period fr_1 plus the share of the other firms following other rules. In an extreme case, if α equals 1, the economy is characterised by the UNS, and if it equals 0, not a single price is set based on it. When Dias et al. make an assumption that firms of type 2 have perfect pricing synchronisation and that s_t is a Bernoulli random variable, they can derive the estimator of the upper bound for the UNS process based on Fisher and Konieczny's (2000) index:

$$(6)\quad \alpha_{FK} = 1 - \sqrt{\frac{\text{var}(fr_t)}{\overline{fr}\,(1-\overline{fr})}}.$$

However, α_{FK} is upward biased if s_t is not perfectly synchronised. Consequently, they derive a third estimator for UNS:

$$(7)\quad \alpha_U = 1 - \max\{fr_t\} - \min\{fr_t\}.$$

As already mentioned, our main interest is not to test the UNS hypothesis. However, for comparability we also calculate these estimates from the data. In Dias et al. (2006) they are calculated both for the Portuguese data and for the Klenow-Kryvtsov (2005) US data.

As in the previous chapter, in addition to the headline HICP inflation we carry out the same calculations for the five main subseries and study whether there is heterogeneity between the pricing processes of different items.

5.3 The decomposed inflation data

The visual examination of the harmonised consumer price inflation and its components (Figure 9) show that the average size of price changes correlate closely with inflation changes, whereas the fraction of products with monthly price changes remains fairly stable, except during sales periods. The correlation between the average size of price changes and inflation is very clear, particularly in the non-energy industrial products, processed food, and services components. The drop in unprocessed food prices in March 2004 (Figure 10, middle left) is again related to a cut in alcohol taxation.

The approximated monthly HICP inflation varies between +1.0 and -1.1%. It is most volatile in the middle of the period and becomes slightly less volatile in the latter part of the time period. On average, 20% of HICP weighted prices change monthly (Table 2a). In other words, an average of 80%, ie 4/5 of prices in the HICP basket remain unchanged in two consecutive months.

The fraction of products with price changes differs considerably across the inflation components. The price of energy changes from the previous month in 78% of observations, while the price of non-energy industrial goods in only 11%. In the energy and unprocessed food components, monthly price changes are much more common than in the other three components. A decreasing repricing frequency can be found in non-energy industrial goods and service prices, while in unprocessed food it starts to increase in 2002.

In the data under review, the average size of weighted price changes is only 0% (Table 2a). However, as the average disguises the fact that both upward and downward changes are common, a more informative measure is the upside and downside weighted price changes. For the HICP basket as a whole, they are both 11%. As is the case with the frequency, upward and downward weighted price changes also differ substantially between subgroups. The changes are smallest in energy and largest in unprocessed food. The changes in service prices are also rather small.[14]

As with the fraction of repricing frequency in the HICP, the positive and negative repricing frequencies in the HICP are also fairly stable between 1997 and 2004 (Figure 10). Somewhat surprisingly the euro changeover does not notably change the repricing frequency with the exception of unprocessed food and services; in the other sub groups the repricing frequencies in January 2002 are not notably different from January in other years. However, service prices seem to have become more rigid after the euro changeover.

[14] The upward and downward price changes in services are significantly smaller ($dp\uparrow$ 5% and $dp\downarrow$ -4%) than those presented in Dias et al. (2005): tables A4 ($dp\uparrow$ 8%) and A5 ($dp\downarrow$ -14%). The main reason for this is that while in Dias et al. the data set was a sample covering 19 item groups in services, our data set is much larger. If we take into account only those 19 items, the size of price changes is much larger. In Finland, many important service prices are somewhat regulated and thus rather sticky. Examples of these are children's daycare, TV licences and general hospital fees, which cover 14% of the services in our data set. In that sense, the sample used in Dhyne et al. (2004) was biased for Finnish service prices.

In all the subgroups, upward price changes are more common than downward ones. However, the changes seem to become more in balance during the time period investigated. A similar development can be detected in all subgroups with the exception of energy prices, where price changes are closely related to oil prices. For unprocessed food, upward and downward price changes have become more common since the euro changeover.

Both upward and downward weighted price changes have remained rather stable at the HICP level. The range of price changes has increased in 2002–2004 only in non-energy industrial goods[15], and in 2004 in processed food. As was the case with the fractions, in price changes there are no detectable dramatic changes with respect to the euro changeover.

Overall, the five subgroups can be divided into three different bands: the smallest price changes occur in services and energy, and the largest in unprocessed food. On average, both upward and downward price changes in energy are only 3%, while in unprocessed food they are around 20%. In the other groups – non energy industrial goods and processed food – as in the HICP basket as a whole, the size of both upward and downward price changes is closer to 10%. In contrast to the repricing frequencies, the price changes are fairly symmetrical. Hence, the positive inflation is the result of a higher number of price increases compared to decreases.

5.4 The correlation analysis and variance decomposition

Both the correlation analysis and the variance decomposition shown in formula (3) support the view that changes in the monthly HICP inflation are mainly due to the time pattern in the price changes, not in the repricing frequency (Tables 2b, 2c and 3). The correlation between price changes and the change in inflation is 0.97 on the level of the HICP as a whole, while the correlation of price change frequency and inflation is much smaller and negative (–0.34).[16] Interestingly, the correlation between frequency and price changes is also negative: the more often the prices change, the smaller they are. However, even this correlation is rather weak.

In the entire data, approximately 99% of inflation variance is due to the variance of price changes. This result is strongly in favour of the time-dependent pricing model being suitable for the description of Finnish inflation data. It is also rather similar to the results that Klenow and Kryvtsov (2005) derived from US data.

[15] The difference between 1997 and the rest of the years in non-energy industrial goods and, more subduedly, in the HICP as a whole is related to the changes in the baskets: officially in 1997 the inflation basket was still based on CPI 1990=100, while in this study we use the CPI 1995=100 weights.

[16] The negative correlation is due to the fact that the proportion of price changes is highest during sales periods when price changes are negative.

According to them, the variance decomposition in the United States is 97-3 in favour of the TDP term.

If, however, we look at the correlations between inflation and upward and downward price changes and their frequencies separately (Table 2c), we see that in most cases the frequency has a larger correlation coefficient than the price change. In fact, this is the case in all but unprocessed food. Based on these results, the data also seems to support the state-dependent pricing theory. It is interesting to compare these results with those of Hoffmann and Kurz-Kim (2006). In Germany, the highest correlation with inflation is found with the upward price change frequency, while in the Finnish data the opposite is the case. This is, however, in accordance with the downward inflation trend of recent years in Finland.

At the HICP level, the size of price changes is negatively correlated (price changes are large in both directions at the same time), while for the upward and downward frequencies the correlation is close to zero (Table 2b). At the subgroup level, the situation is rather different. Somewhat confusingly, the correlation between upward and downward repricing frequencies is negative in non-energy industrial goods, processed food, unprocessed food and services. The price changes of energy and unprocessed food are probably more directly driven by the changes in supply, ie world market prices. This seems to be the case especially in energy, where the correlation between upward and downward price changes is close to zero and the correlation between repricing frequencies is positive: when the amount of positive price changes increases the amount of negative price changes decreases.

The results hold surprisingly well through all subcomponents. The correlation between average price changes and inflation is close to 0.9 even in the weakest case (services). The partial correlation between upward and downward price changes and inflation is fairly large in the case of energy and unprocessed food, which are the most volatile subseries. The correlation between the repricing frequency and inflation remains rather low; it is highest (in absolute value) in non-energy industrial goods. The negative value in that correlation probably represents the high importance of sales in the subgroup. However, both the correlations between inflation and repricing frequency and the repricing frequency and price changes are rather weak in all cases. The results from the variance decomposition are remarkably stable at the sub group level, as they vary from 99 to 100%.

On the basis of Klenow-Kryvtsov decomposition, the data seems to support the use of a time-dependent pricing hypothesis. However, as was discussed in subchapter 5.2, there exist several drawbacks if we try to interpret α_{KK} as an estimator for the UNS hypothesis. Therefore, we also calculate the suggested alternative estimators α_{FK} and α_U. The results are presented in Table 3.

The first thing that stands out in Table 3 is that the results from the alternative estimators differ considerably from the Klenow-Kryvtsov estimator: in all cases the alternative estimators give smaller estimates for the UNS term than α_{KK}. In addition, in all cases α_U yields smaller estimates than α_{FK}.

When we compare these results with those reported by Dias et al. (2006) for Portuguese and US CPI data, they are qualitatively in line with both. The only major difference is that with the Portuguese data α_{KK} yields the smallest estimate. In the Finnish case the estimated results for $\alpha_{KK} - \alpha_{FK} - \alpha_U$ (including the covariance term) are 0.99 – 0.87 – 0.70, for Portugal (1998–2000 data) 0.69 – 0.88 – 0.78 and for the United States 0.96 – 0.94 – 0.80.

6 Conclusion

In this paper we have waded through the monthly Finnish HICP microdata between 1997 and 2004. Although our main interest has been whether we can find signs of the suitability of either time or state dependent pricing theory, we have also analysed the monthly price changes in a more open-eyed way. This analysis has revealed several interesting features in Finish consumer prices.

The distributional analysis resulted in two important findings. On the one hand, prices do change fairly seldom, as on average nearly 80% of the price quotas in the data set did not change at all between two consecutive moths. The subgroups were fairly heterogeneous, as in energy only 23% and in unprocessed food 54% of monthly price changes were zeros, while in other three subgroups the frequency was over 80%. On the other hand, when prices do change, the changes can be surprisingly large. We can easily find price changes as large as ±50 log percentages in all subgroups except energy and services. Moreover, the effective distributions were rather large, as in the HICP basket as a whole and in the other subgroups – non-energy industrial goods, processed food and unprocessed food – at least 8% of non-zero price changes were outside the interval [-25, +25]. However, in all cases the distributions are skewed to the right; this skewedness is pronounced in small price changes.

When focusing on how these distributions have evolved over time, we studied the time series of the first four moments of the weighted log price changes. The most important finding was that the price change distributions have indeed changed over time and especially at the end of our data period the distributions are rather different than the average distributions. In 2002–2004, the drop in inflation has been mainly drive by non-energy industrial goods, as both the mean and skewness of its distribution are negative in that period. However, because our data lacks several interesting item groups like telephone calls and international flights, one has to be careful when interpreting the results. This is especially true in case of services, where the mentioned groups have been the driving force behind the recent downward trend in service inflation.

In Chapter 5 we approximated HICP inflation and decomposed it into two components, the intensive margin and the extensive margin. Analysis suggests that changes in monthly inflation seem to be due more to variance in the size of price changes than to variance in the fraction of products with price changes. On the level of overall harmonised consumer price inflation, as much as 99% of inflation variance is due to variance in the size of price changes. In the examined HICP components, variance in the size of price changes explains over 90% of total variance even in the weakest cases. The results support the use of a time-dependent pricing model in the modelling of the price development in a macroeconomic model of the Finnish economy. The results are also relatively close to those of Klenow and Kryvstov (2005) based on the data on US price changes. Finally, the results from estimators based on the UNS hypothesis yield similar outcomes to the Portuguese and US data. According to those estimates, the contribution the UNS hypothesis can make to explaining our data is much smaller than a broader interpretation of the time-dependent pricing theory would suggest.

These findings can be summarised with four stylised facts. Firstly, only a fraction of prices change monthly in Finland. In the period under review, an average of 80% of prices remained unchanged in consecutive months. Secondly, price changes can be large in both directions. Thirdly, the observations support Vilmunen's (2005) interpretation that positive inflation is due to the higher number of price increases compared to decreases, and the magnitude of price changes is more or less in balance. Finally, a time-dependent pricing model seems to suit the modelling of Finnish consumer prices, although there are hints at state-dependent pricing, as the correlation between inflation and upward and/or downward price change frequency is stronger than the correlation between upward and downward price changes.

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Appendix

Table 1: Summary information on the used data sets + metadata

	Sample	
	1997–1999	2000–2004
Number of months	36	60
Number of items[1]	434	475
Number of prices (approx.)	34 000	49 000
Number of rows in the data set	62 000	130 000
Number of observations (approx.)	1.2×10^6	2.9×10^6
Number of outlets (approx.)	2000	3000

Sources: Kinnunen-Lehtinen (1998), Statistics Finland (2005), Vilmunen-Laakkonen (2005) and author's calculations.

Table 2a: Inflation component means 1997–2004.

	dp	dp↑	dp↓	fr	fr↑	fr↓
HICP	0.00	0.11	-0.11	0.20	0.11	0.09
Energy	0.00	0.03	-0.03	0.78	0.38	0.40
Non-energy industrial goods	0.00	0.14	-0.13	0.11	0.06	0.06
Processed food	0.00	0.12	-0.13	0.12	0.07	0.05
Unprocessed food	0.00	0.20	-0.21	0.48	0.26	0.22
Services	0.00	0.05	-0.04	0.16	0.10	0.06

The time period is 1997M2–2004M12.
'dp' refers to the average size of price changes, and 'fr' to the average fraction of price changes. 'dp↑' and 'dp↓' refer to upward and downward price changes, and 'fr↑' and 'fr↓' to upward and downward price fractions.

Table 2b: Inflation component correlations 1997–2004

	Correlation (dp, π)	Correlation (fr, π)	Correlation (fr, dp)	Correlation (dp↑, dp↓)	Correlation (fr↑, fr↓))
HICP	0.97	-0.34	-0.18	-0.63	-0.06
Energy	0.89	0.02	-0.23	0.09	0.84
Non-energy industrial goods	0.97	-0.32	-0.18	-0.65	-0.69
Processed food	0.89	0.19	0.09	-0.39	-0.36
Unprocessed food	0.95	-0.12	-0.23	0.09	-0.35
Services	0.87	0.07	-0.13	-0.55	-0.34

The time period is 1997M2–2004M12.
'π' refers to monthly inflation, 'dp' to the average size of price changes, and 'fr' to the average fraction of price changes. 'dp↑' and 'dp↓' refer to upward and downward price changes, and 'fr↑' and 'fr↓' to upward and downward price fractions.

[1] The numbers exclude those CPI items which are not included in the HICP. In the first period (CPI 1995=100), the number of dropped items is 8, and in the latter period (CPI 2000=100) 17.

Table 2c: Inflation component correlations 1997–2004

	Correlation (dp↑, π)	Correlation (dp↓, π)	Correlation (fr↑, π)	Correlation (fr↓, π)
HICP	0.08	0.32	0.15	0.67
Energy	0.72	0.55	0.90	0.91
Non-energy industrial goods	0.34	0.33	-0.11	0.46
Processed food	-0.24	0.13	0.55	0.49
Unprocessed food	0.52	0.60	0.33	0.48
Services	0.10	0.28	0.41	0.40

The time period is 1997M2–2004M12.

'π' refers to monthly inflation, 'dp' to the average size of price changes, and 'fr' to the average fraction of price changes. 'dp↑' and 'dp↓' refer to upward and downward price changes, and 'fr↑' and 'fr↓' to upward and downward price fractions.

Table 3: The estimators for the UNS hypothesis 1997–2004

	TDP	SDP	α_{KK}	α_{FK}	α_U
HICP	0.99	0.01	0.99	0.87	0.70
Energy	1.00	0.00	1	0.61	0.06
Non-energy industrial goods	0.99	0.01	0.99	0.81	0.63
Processed food	1.00	0.00	1	0.78	0.69
Unprocessed food	0.99	0.01	0.99	0.81	0.69
Services	1.00	0.14	1	0.81	0.51

The time period is 1997M2–2004M12.

TDP is the proportion of the variance of price changes in the total variance of inflation in the Klenow-Kryvtsov variance decomposition, and SDP is the proportion of the variance in the fraction of items with price changes in the total variance of inflation. α_{KK}, α_{FK} and α_U are estimators for the UNS hypothesis.

Figure 1a: The inflations and their approximations, monthly % changes

The time period is 1997M2–2004M12.

Sources: Statistics Finland and author's calculations.

All inflation is calculated as monthly log changes.

HICP = Harmonised index of consumer prices, NEIG=Non-energy industrial goods, PF = Processed food, UNPF = Unprocessed food.

Figure 1b: The inflations and their approximations, cumulative

The time period is 1997M2–2004M12.

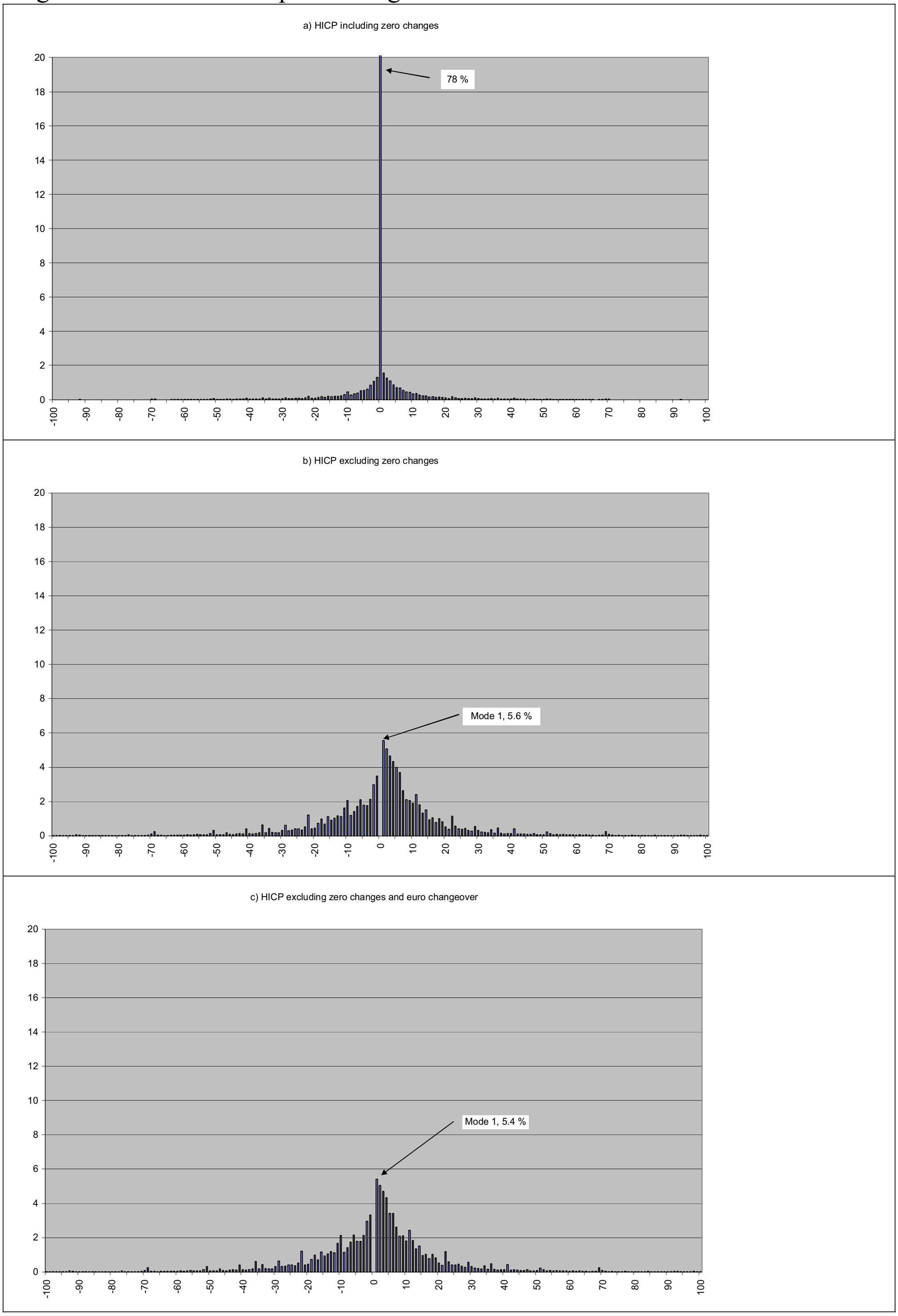
Sources: Statistics Finland and author's calculations.

All inflation is calculated as monthly log changes.

HICP = Harmonised index of consumer prices, NEIG=Non-energy industrial goods, PF = Processed food, UNPF = Unprocessed food.

Due to the break in the data, cumulative inflation starts from 100 in January 1997 and January 2000.

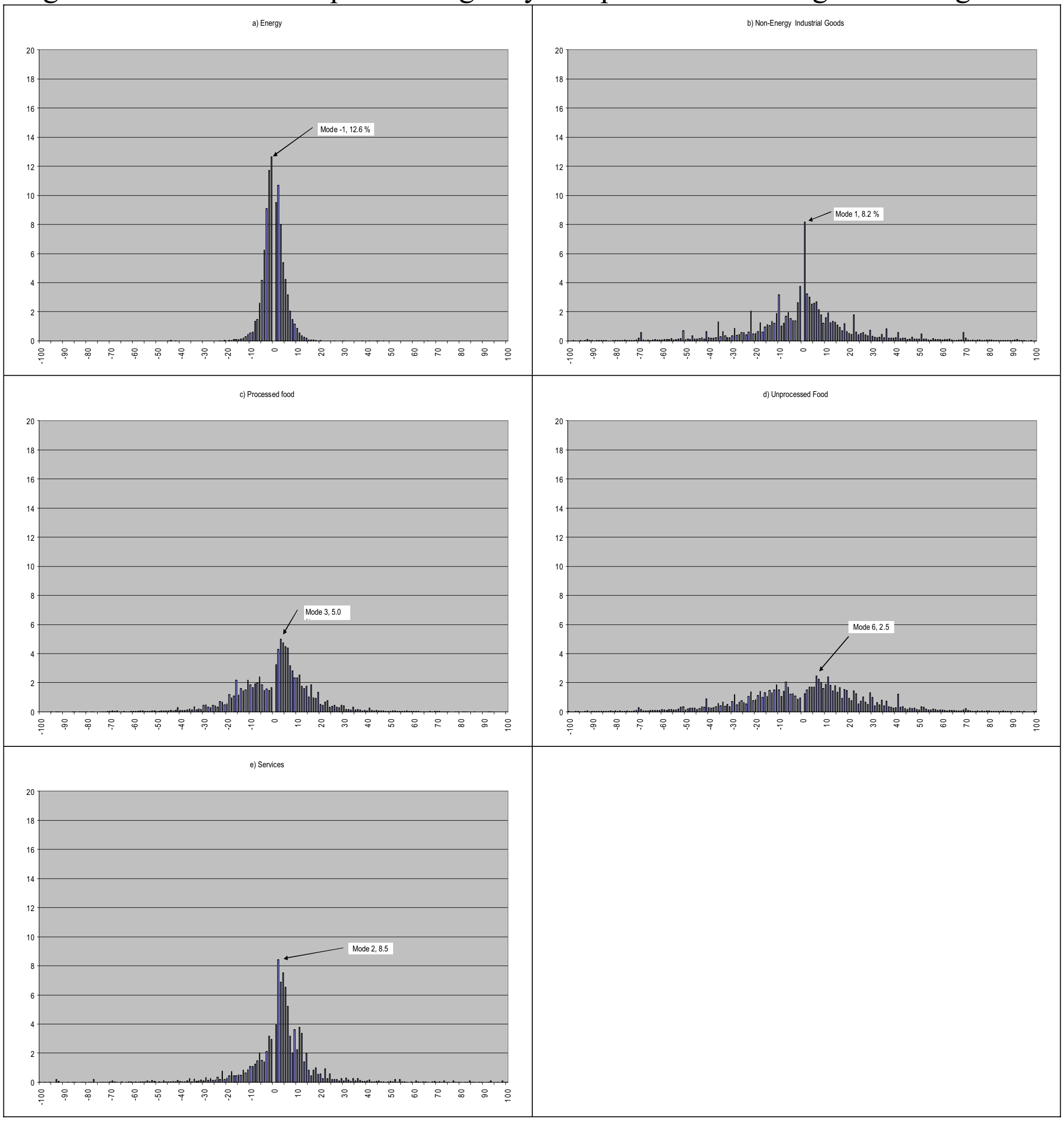
Figure 2: Distribution of price changes



The time period is 1997M2–2004M12.

HICP basket (2a, upper left), HICP basket excluding zero changes (2b), HICP basket excluding zero price changes and euro changeover (2c).

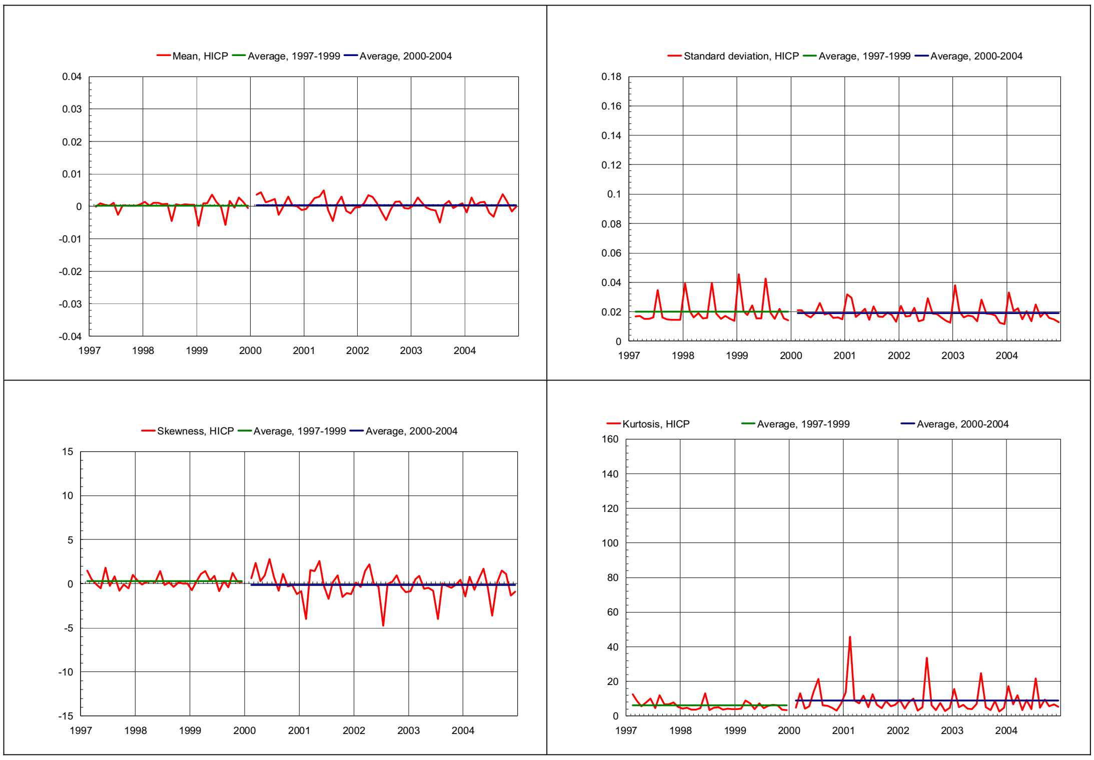
Figure 3: Distribution of price changes by components excluding zero changes



The time period is 1997M2–2004M12.

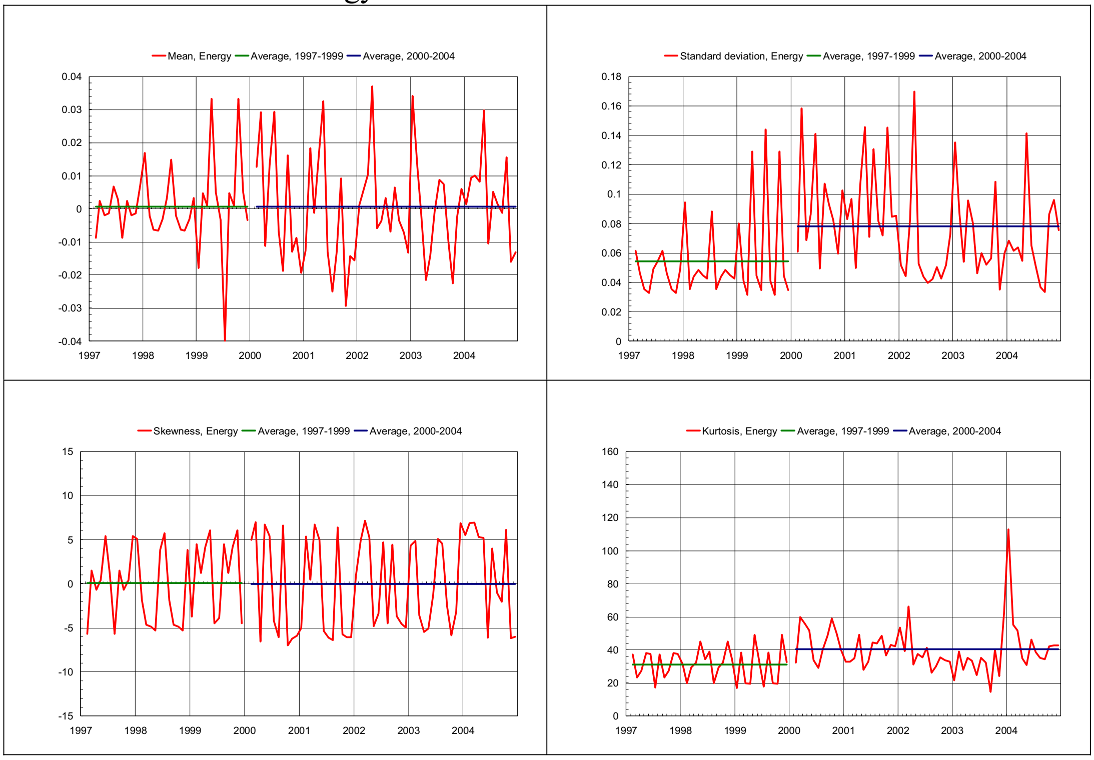
Energy (3a, upper left), non-energy industrial goods (3b, upper right), processed food (3c, middle left), unprocessed food (3d, middle right), services (3e, lower left).

Figure 4: Time series' moments of cross-section distribution of price changes: the HICP basket



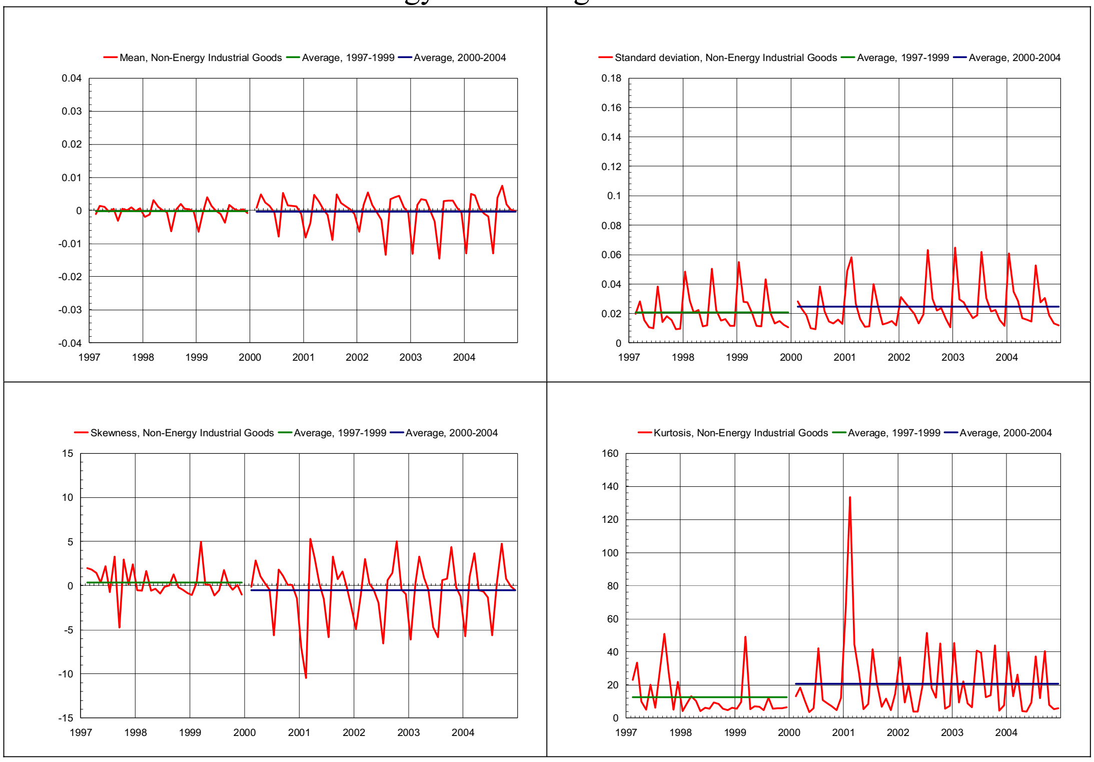
The time period is 1997M2–2004M12.

Figure 5: Time series' moments of cross-section distribution of price changes 1997M2–2004M12: Energy



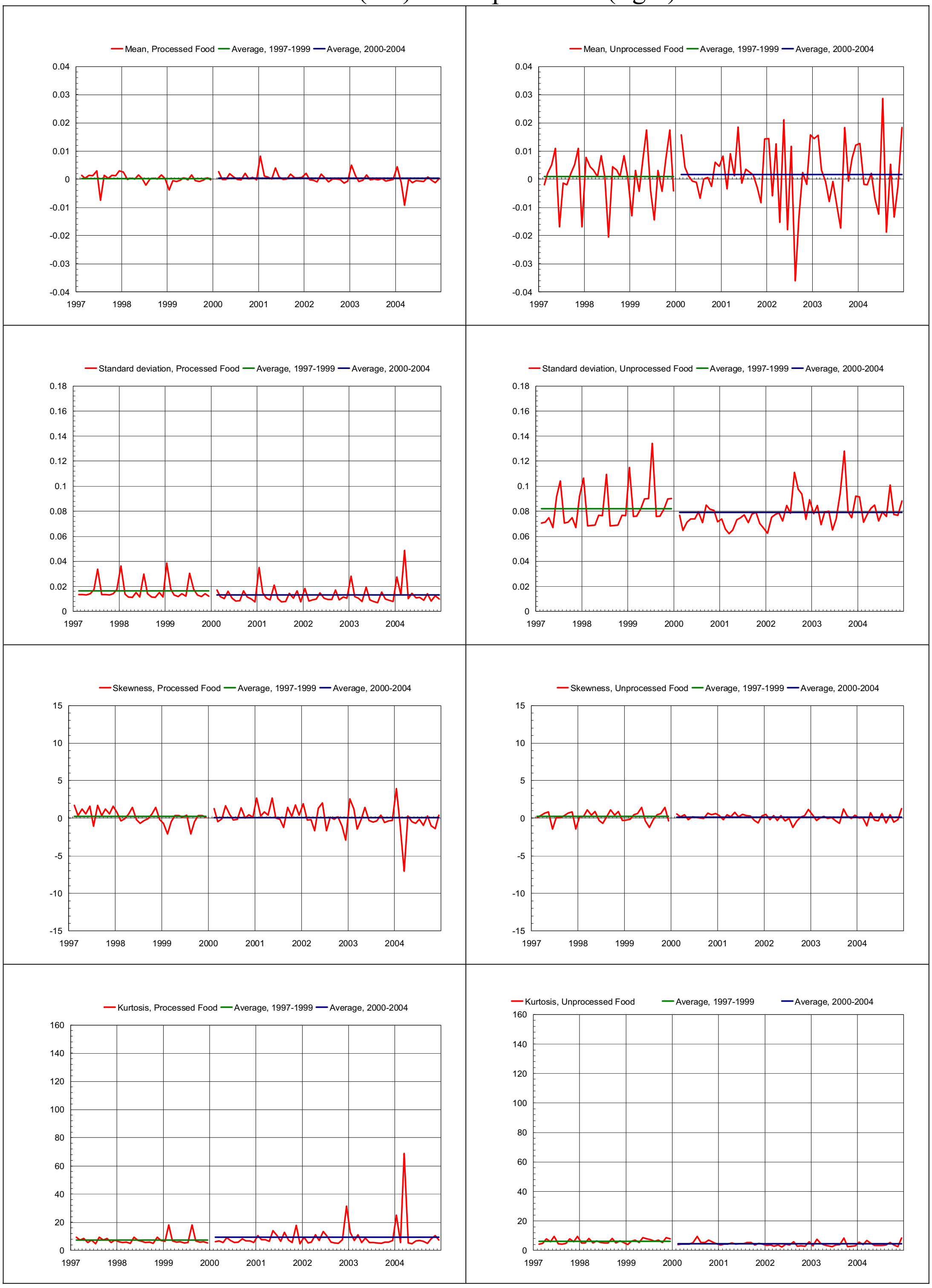
The time period is 1997M2–2004M12.

Figure 6: Time series' moments of cross-section distribution of price changes 1997M2–2004M12: Non-energy industrial goods



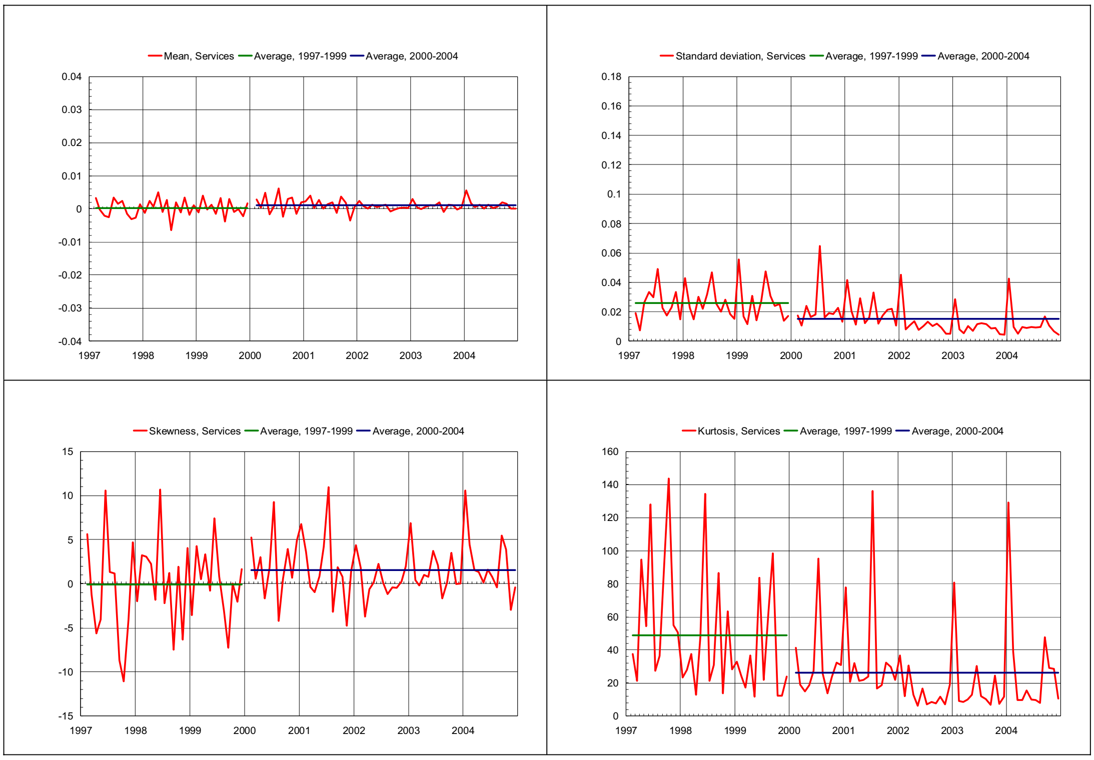
The time period is 1997M2–2004M12.

Figure 7: Time series' moments of cross-section distribution of price changes 1997M2–2004M12: Processed (left) and unprocessed (right) food



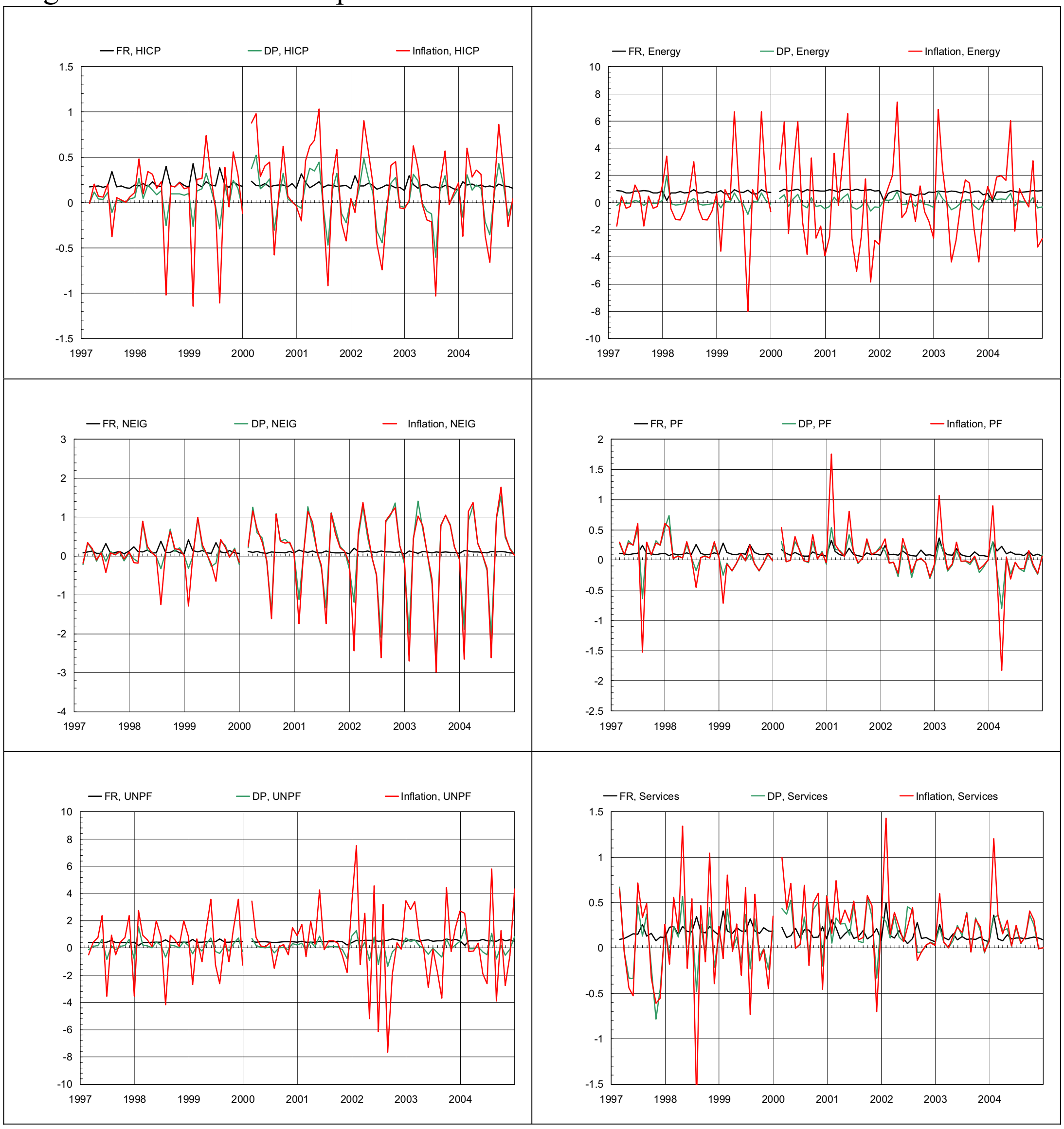
The time period is 1997M2–2004M12.

Figure 8: Time series' moments of cross-section distribution of price changes 1997M2–2004M12: Services



The time period is 1997M2–2004M12.

Figure 9: Inflation decompositions

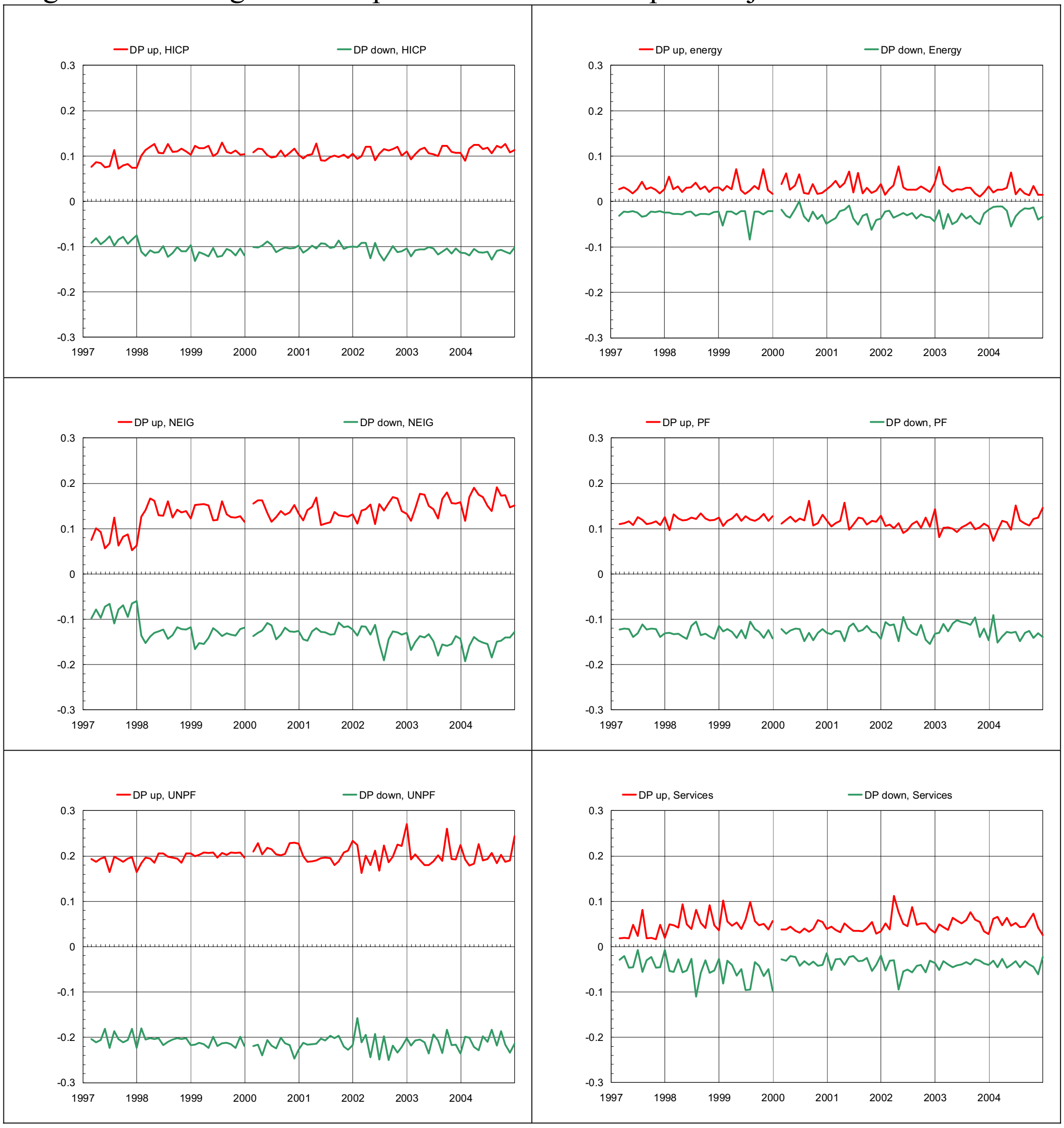


The time period is 1997M2–2004M12.
Sources: Statistics Finland and author's calculations.
In figure 10, price changes (dp) and the fraction of price changes have for clarity's sake been scaled so that 'dp' has been divided by ten and 'fr' by one hundred, respectively.
HICP = Harmonised index of consumer prices, NEIG=Non-energy industrial goods, PF=Processed Food, UNPF=Unprocessed food.

Figure 10: Frequency of pricing adjustment

The time period is 1997M2–2004M12.
Sources: Statistics Finland and author's calculations.
HICP = Harmonised index of consumer prices, NEIG=Non-energy industrial goods, PF=Processed Food, UNPF=Unprocessed food.

Figure 11: Average size of upward and downward price adjustments



The time period is 1997M2–2004M12.
Sources: Statistics Finland and author's calculations.
HICP = Harmonised index of consumer prices, NEIG=Non-energy industrial goods, PF=Processed Food, UNPF=Unprocessed food.

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