EUROPEAN CENTRAL BANK

EUROSYSTEM INFLATION PERSISTENCE NETWORK

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THE BEHAVIOUR OF PRODUCER PRICES

SOME EVIDENCE FROM THE FRENCH PPI MICRO DATA

by Erwan Gautier

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1 This study has been developed in the context of the Eurosystem Inflation Persistence Network. Data have been processed under the responsibility of INSEE in the context of a convention between INSEE and Banque de France (20B-21B-E301/R05019/2005). We are grateful to L. Pollina and E. Le Rey for their advice. We have benefited from comments at various seminars and conferences, including at the ECB, Banque de France, INSEE, Journées de Microéconomie Appliquée (2006), Congrès de l'AFSE (2006). We thank S. Tarrieu and L. Baudry for their wonderful research assistance. We also thank an anonymous referee of the ECB Working Papers Series, D. Fougère, T. Heckel, H. Le Bihan, J. Mairesse, B. Mojon, P. Sevestre and C. Thévenot, for their very heplful comments and discussions. The views expressed in this paper do not necessarily reflect the opinion of the Banque de France or the opinion of INSEE.

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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-Méndez 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-Méndez. 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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CONTENTS

Abstract

This paper provides some new empirical features on price setting behaviour for French producers using micro data underlying the producer and business-services price indices over the period 1994-2005. Some crucial methodological issues on the collection of producer prices are raised. Then, the main features of producers' price setting are presented: producer prices are modified quite frequently and by small amounts. A high heterogeneity across sectors is also observed: business-services prices change less often than industrial producer prices. The data lend some support to predictions of both time- and state-dependence models: Taylor contracts are not unusual but prices also respond to the changes in the firm's economic conditions. Nevertheless, time-dependent models are shown to be the most relevant theories to explain the producer price rigidity.

Keywords: Price stickiness, price duration, producer price index, frequency of price change.
JEL codes: E31, D43, L11, L16.

Non-technical summary

The main objective of central banks around the world is to stabilise inflation. Most recent macroeconomic research assumes that monetary policy has a delayed impact on inflation because of nominal rigidities at the micro level; firms adjust their prices infrequently and only a partial and delayed response to economic shocks is transmitted into prices. Almost all microeconomic empirical studies on price rigidity focus on consumer price-setting behaviour (Cecchetti (1986), Bils and Klenow (2005), Dhyne *et al.* (2006)). One main explanation is that, in policy practice and in academic research, interest is focused on a unique inflation measure, Consumer Price Index (CPI), whereas other measures are available like Producer Price Index (PPI). However, some macroeconomic research recently shows that a monetary policy which does not take into account PPI inflation or PPI sector shocks, tends to generate larger welfare losses than a policy rule which targets a weighted sum of CPI and PPI inflation (Huang and Liu (2005)). At the micro level, evidence on producer price stickiness is rather scarce and most of the available empirical results were collected in the United-States in the thirties. Some new empirical evidence has been recently provided for European countries (Vermeulen *et al.* (2006)) and the aim of this paper is to add some evidence on stickiness in French producer prices.

For this purpose, a unique large database is examined; it contains more than three million price quotes collected in order to compute the French Producer Price Index (PPI) and Business-Services Price Index (BSPI). These price quotes are supposed to measure transaction prices, duty-free, without discount. The economy is widely covered: more than 90% of the PPI and almost 100% of the BSPI, and the time dimension is also considerable, from 1994:01 to 2005:06. Contrary to consumer prices, producer prices can not be directly observed by the pollsters from statistical offices, first, because there is no specific outlet to observe transactions among firms, and, second because it can only be reported if there is some transaction for this product between a seller and a buyer. The paper discusses important methodological issues raised by these data like "Which prices should be collected?" or "How to collect them?".

These data are used in order to evaluate the degree of flexibility of producer prices. Three questions can be of interest for macroeconomists who estimate models based on micro-level producers' optimization behaviour. How do producer prices change? Do they show some stickiness? To which extent do data lend support to the predictions of various theories of price rigidity?

Our main conclusions are the following. First, French producer prices are modified quite frequently, the weigthed average price duration is around 6 months. Price decreases are only

slightly less frequent than price increases in the industry. Prices are changed by rather small amounts, the median price change is around 2% and there is no asymmetry between price increases and price decreases. Second, there is a high degree of heterogeneity across sectors: business-services prices are modified less frequently and by larger amounts than industrial prices, and across industrial sectors, finished products' prices remain constant longer than intermediate goods' prices.

Some evidence of both time- and state-dependence is found in the data. Some firms change their prices every year or every two years, mostly in January, which is consistent with the theory of Taylor price contracts. Consistent with state-dependent models, price changes are also determined by sectoral inflation, business-cycle phases, and prices of raw materials. VAT changes slightly affect the probability of a price change even if producer prices are reported excluding VAT. Finally, the market structure plays a role in the transmission of shocks into prices: the less competitive market is, the less the shocks are transmitted into prices.

Finally, the Klenow-Kryvtsov inflation decomposition leads us to conclude that time-dependent price models are the most relevant to replicate the aggregate producer price development. An augmented decomposition also shows that inflation is highly correlated with the difference between the share of price increases and the share of price decreases: the volatility of inflation is mainly explained by the variability of the difference between the share of price increases and the share of price decreases and not by the variability of the sizes of price increases and price decreases.

"The fact that some prices are rigid or sticky, while others are variable, has attracted a good deal of comments from economists in recent years" Tucker (1938)

1 Introduction

The main objective of central banks around the world is to stabilise inflation. Most recent macroeconomic researches assume that monetary policy has an impact on inflation because of nominal rigidities at the micro level; firms adjust their prices infrequently and only a partial and delayed response to economic shocks is transmitted into prices. Almost all microeconomic empirical studies on price rigidity focused on consumer price-setting behaviour (Cecchetti (1986), Bils and Klenow (2005), Dhyne *et al.* (2006)). One main explanation is that, in policy practice and in academic research, interest is focused on a unique inflation measure, Consumer Price Index (CPI), whereas other measures are available like Producer Price Index (PPI). However, some macroeconomic researches recently raise the issue of which price index should be stabilised by the central banks (Woodford (2003)). Thus, Huang and Liu (2005) analyse the optimal monetary policy when the central banker ignores the exact sources of rigidities. They conclude that a monetary policy which does not care about PPI inflation or PPI sector shocks tends to generate larger welfare losses than a policy rule which targets CPI and PPI inflations. Basu (1995) also finds that a moderate degree of rigidity in the intermediate goods sector can lead to large economy-wide rigidity; rigid producer prices can be considered as a multiplier for price stickiness. Consequently, it is crucial to provide empirical evidence on producer prices and to evaluate their degree of rigidity.

Evidence on producer price stickiness has been rather scarce over the last twenty years, only a few articles used micro-data to investigate the behaviour of producer price setting. However, the rigidity of producer prices was once an important field of research: between 1886 and 1935, three articles on rigid producer prices were published, fourteen between 1935 and 1939, and twenty-five between 1954 and 1965 (Stigler, Kindahl (1970)). F. Mills published in 1927 the first study on the frequency of price change, The Behavior of Prices. Using 200 wholesale price indices of the BLS during the period 1890-1925, he exhibited some first insights and figures on the industrial firms' price setting behaviour. In the thirties, some economists interpreted his results and built a first theory. Means (1935, 1972) introduced a huge debate among economists on the industrial price-setting behaviour in the United States and claimed that most prices did not behave in a "classical" manner. Using the same dataset as Mills on the period 1926-1933, he computed the frequency of price change. Means introduced a distinction between market prices which are determined by market conditions and vary with each transaction, and administered prices which are "set by administrative action and held constant for a period of time". In 1970, Stigler and Kindahl published for the NBER The behavior of industrial prices as an answer to Means' theory. Using a unique dataset of transaction price reports, they denied the importance of administered prices for industrial price setting. Weiss (1977) tried to reconcile these two approaches. More recently, Carlton (1986) used the same dataset as Stigler and Kindahl to carry a detailed analysis on producer prices' rigidity in the United States and showed that it is not uncommon that some individual prices remain unchanged for many years[3]. By contrast, the micro-economic evidence on industrial price stickiness appears quite scarce in the recent period: for instance, to our knowledge no quantitative evidence is available on French producer price rigidity[4] but some new empirical evidence has been recently provided for European countries (Vermeulen *et al.* (2006))[5]. How do French producer prices change? Do they show some stickiness? To which extent do data lend support to the predictions of price rigidity theories?

To answer these questions, a unique large database is examined; it contains more than three million price quotes collected in order to compute the French Producer Price Index (PPI) and Business-Services Price Index (BSPI). These price quotes are supposed to measure transaction prices, duty-free, without discount. The economy is widely covered: more than 90 % of the PPI and almost 100% of the BSPI, and the time dimension is also considerable, from 1994:01 to 2005:06.

Our main conclusions are the following: French producer prices are modified quite frequently and by rather small amounts. There is a high degree of heterogeneity across sectors: business-services prices are modified less frequently and by larger amounts than industrial prices, and across industrial sectors, finished products' prices remain constant longer than intermediate goods' prices. Some evidence of both time- and state-dependence is found in the data, some firms change their prices every year or every two years, mostly in January, which fits the theory of the Taylor price contract. As supposed by state-dependent models, price changes are also

[3]Caucutt *et al.* (1994, 1999) characterize some determinants of producer price rigidity like durability and concentration but they use BLS micro indices and not producer price individual quotes.

[4]Desplatz (2000) is the only study using micro French PPI data but the issue of price rigidity is not analysed. Qualitative data were also examined by Loupias, Ricart (2004) and Loupias, Sevestre (2006) to provide some features on the price setting behaviour of French firms.

[5]This paper brings the main results obtained in Belgium (Cornille, Dossche (2006)), France, Germany (Stahl (2005)), Italy (Sabatini *et al.* (2005)), Portugal (Dias *et al.* (2004)) and Spain (Alvarez *et al.* (2006)).

determined by economic shocks and producer prices are more likely to increase (respectively decrease) when sectoral inflation rises (respectively decreases). Finally, the Klenow-Kryvtsov inflation decomposition leads us to conclude that time-dependent price models are the most relevant to replicate the aggregate producer price development.

The paper is organised as follows: Section 2 raises important methodological issues on how producer prices are collected and measured. In section 3, the main patterns of price behaviour of French firms are described. Section 4 examines to which extent producer prices are rigid and what can be learnt from producer prices on the time- and state-dependent price behaviours. Section 5 concludes by summarizing the main findings.

2 Measuring individual producer prices.

The dataset consists of monthly, quarterly, semi-annual and annual price reports collected by the INSEE (Institut National de la Statistique et des Etudes Economiques) in order to compute the French Producer Price Index (PPI) and the Business-Services Price Index (BSPI). The theoretical field for PPI is relatively large and covers all products manufactured and sold in France by industrial firms, which corresponds to sections C (Mining and quarrying), D (Manufacturing) and E (Electricity, gas and water supply) of NACE Rev. 1.1 classification (General industrial classification of economic activities within the European Community)[6]. Reported prices must be observed at the first commercialization stage, without including transport and commercialization costs or invoiced VAT. The sample contains more than three million price reports, 95% of them were collected between 1994:01 and 2005:06, and the analysis is here restricted to this period. Moreover, for statistical confidentiality reasons, some prices reports are not available[7], especially for electricity and heating manufacturing which represents 5% of the total in terms of PPI weights. Finally, more than 90% of the price quotes used to compute French PPI are available. The collection of business-services prices began in 1995, this sector represents 15% of the national value added. For the moment, only some branches are surveyed: renting of cars and construction and civil engineering machines, computer and related activities, accounting

[6]Some groups are excluded from collection: mining of uranium and thorium ores, publication, processing of nuclear fuel, weapons and ammunition, building and repairing of ships and boats, manufacturing of aircraft and spacecraft, and recycling.

[7]If less than three firms produce a given product or if a firm gathers more than 85% of the revenues of a product, the price subindex is not published.

and consultancy, advertising, security services and industrial cleaning. The coverage rate of this survey is about 25 % of the sales in business-services sector. The business-services dataset contains about 100 000 price quotes collected from 1995 to 2005. To our knowledge, it is the first time that the price setting behaviour in the business-services sector is examined.

2.1 Which producer prices are reported?

Contrary to retail or consumer prices, producer prices can not be directly observed by the pollsters of statistical offices, first, because there is no specific outlet to observe transactions among firms, and then, because it can only be reported if there is some transaction for this product between a seller and a buyer. This raises many important methodological issues about quoting prices such as "which prices should be collected?", "how to collect them?". Stigler and Kindahl (1970) emphasise these methodological difficulties and suggest that the collected prices should be transaction prices rather than list prices. The BLS collected at that time list prices from sellers even if the product was not sold. Stigler and Kindahl criticised this approach and built their own dataset composed of actual transaction prices recorded from the buyer. European and American statistical offices have now reached a consensus on collecting actual transaction prices (BLS (2003), INSEE, (1999)).

For this purpose, the national statistical office carries a quantitative survey to first select some representative firms in each branch and secondly, to select in these firms, several "control transactions" which are supposed to be the most representative of each firm's transactions. However, for practical purposes, firms may find it difficult to provide a given transaction for a customer or a product. This reflects a trade-off between the requirements of the statistical office and the possibilities of the firms' accounting services. As a consequence, the dataset contains heterogeneous types of prices, and some of them differ from the ideal definition of a transaction price. For this reason, along with data, a code is also reported to describe the nature or the type of the price. The "type of price" variable takes 7 values: actual transaction price, average price, billing price, estimated price, contract price, national price and price index.

Half of the prices contained in the French PPI dataset are either coded actual transaction prices or average transaction prices (Table 1). The former are close to an "ideal" measure of producer price and the national statistical office observes a unique product for a repeated identical transaction between a producer and a buyer; this type of record is the most suitable to evaluate the individual price durations or the frequency of price change. The latter is more difficult to use for our purposes. The recorded price may be an average price for a given product during a repeated identical transaction within a month, thus close to the former price measure, but it may also be an average price for all customers and for all products of a firm. Though such an average price could be a good indicator to build the PPI, it can be considered as useless for our micro-study. Indeed, changes in an average price are not informative about the incidence of individual price changes. The five remaining types of prices are less numerous, representing around 15% of price reports contained in the dataset; their definition is often close to the "actual" transaction price, they are considered as informative on individual price changes[8].

2.2 Which prices to analyse price rigidity?

Our aim here is to separate among all prices the presumably "average" prices from the actual transaction prices. One possible strategy is to restrict our sample to the first price category: "actual" transaction prices. However, the qualitative information code on the nature of price quotes is not available for the business-services and the food consumer goods sectors. Consequently, the coverage rate of the sample is lowered to 75% of the PPI index in terms of weights and only two thirds of prices are reported along with this qualitative "type" code. Ultimately, less than 15% of prices are coded as "actual" transaction prices (Table 1). Three reasons prevent us from using directly these codes to select our sample. First, some of the price quotes for which qualitative information is missing may be "actual" transaction price and would be unduly rejected from the sample with this strategy, implying substantial loss of valuable information. Secondly, the natures of price are not precisely defined and some prices coded "average prices" can contain useful information. For example, an "average price" for a specific product sold to several customers at the same price can be considered as an actual transaction price, whereas an "average price" calculated for all firms' customers and for all its products is difficult to analyse. Finally, some measurement errors can be found in the reported codes. Therefore, this qualitative indicator is only used here as an *ex post* criterion to validate our procedure described below. The proportion of "actual" transaction price quotes in the selected dataset will be here an indicator of the efficiency of the selection procedure.

Prices collected along with the qualitative code "average price" change more frequently than

[8] "Billing price" is a price observed on the invoice, "Estimated price" is a fictive price calculated by the firm for a fictive transaction, "Contract price" is determined by a contract between a firm and its client, "National price" is settled at a national level, "Price index" is calculated by the firm itself for a specific product.

other prices (the frequency of price change is 60% against less than 15% for actual transaction price). A straightforward explanation is that an average price is a sum of many prices and in case of staggered prices, the probability that the sum of several prices changes is higher than the probability that an individual price changes. For example, let us consider an average price of six independent individual prices, when the individual price change probability is equal to 0.15, the probability that the average price changes is 0.6[9]. The main criticism formulated by Stigler and Kindahl (1970) against Means (1935) was based on a similar methodological issue. Stigler and Kindahl (1970) claimed that the prices used by Means (1935) were averages of several prices collected by different reporters for a specific product, so that the measure of price rigidity obtained mostly depended on the number of price reporters. Our strategy to identify "true" transaction prices is the following: we assume that a price trajectory is composed of average prices whenever it contains a large number of price durations equal to one period. Let T_i the number of price durations equal to one period for the product i and N_i the total number of price spells. For each product trajectory, we compute c_i, the proportion of durations equal to one $c_i = \frac{T_i}{N_i}$. We define a maximum value $c^{\max}$ for c_i. Whenever $c_i > c^{\max}$, the spell is disregarded from the database, since it is considered as an average price spell. On the contrary, whenever $c_i < c^{\max}$, the product spell is kept in our sample. The sample is defined as:[10]

$$S = \left\{ i \ \ / \ \ \frac{T_i}{N_i} < c^{\max} \right\}$$

Our aim is then to choose an "optimal" $c^{\max}$: the sample should be as representative as possible of the PPI total dataset but it must also contain the smallest number of "average price" trajectories. Five datasets corresponding to four values of $c^{\max}$: 60%, 70%, 80% and 90% are built. When $c^{\max}$ is decreasing, some products are removed from the sample because the condition on $c^{\max}$ may be too restrictive for these specific products. For example, only 12% of price quotes for the product "Lead, zinc and tin production" are contained in the sample "$c^{\max} = 90\%$". Our assumption, for these specific products, is that individual prices are actually modified at each period. It is also probably the case for oil and gas products or for food products like meat. We

[9] Let $P(\Delta p_i = 0)$ the probability that the individual price i does not change. $P(\Delta p_i = 0) = 1 - 0.15 = 0.85$ If the average price is calculated with n i.i.d. prices, the probability that none of these prices is modified is equal to : $P(\Delta p_1 = ... = \Delta p_n = 0) = (0.85)^n$, if $n = 6$, this is equal to 0.4 and the probability that the average price changes is equal to 0.6.

[10] Only monthly and quarterly data are considered in this selection process, semi-annual and annual data are supposed to be properly reported.

then assume that if more than 90% of price quotes for a product disappear from the database, the price of that product is actually modified at each period[11].

To choose the "optimal" $c^{\max}$, different statistics are calculated in each sample: the coverage rate of the dataset in terms of weights, the coverage rate of the total number of products, the share of prices coded by the INSEE as "transaction price" - which is interpreted as the risk of wrongly rejecting actual transaction data - and the share of prices coded by the INSEE as "average price" - which is interpreted as the risk of accepting wrongly "average price" data in the sample. This latter indicator decreases dramatically for the three first values of $c^{\max}$, then this proportion remains stable for the last two samples. Therefore, in the sample "$c^{\max} = 70\%$", most of the "average prices" trajectories have been removed. Restricting the sample to "$c^{\max} = 60\%$" is unnecessary because the quality of the sample in terms of price reports type is not significantly improved. The share of prices coded "transaction price" remains quasi-constant close to 95% for the case "$c^{\max} = 70\%$". Thus, few actual transaction prices are wrongly rejected with this procedure. The coverage rate of products is higher than 50% for most of the industrial sectors. The dataset associated with the criterion "$c^{\max} = 70\%$" is here considered as the baseline dataset.

2.3 Baseline dataset.

More than 1.5 million industrial price quotes and more than 100 000 business-services price quotes are contained in the selected *baseline* dataset. The additional information recorded along with the price can be divided into two parts:

A first piece of information relates to the product. An individual code provides us an identification number for the firms, and each product within a firm is identified by a number. The combination of these two codes provides us an identification number for a specific product manufactured in a specific firm. Each product is associated with a group of products at the level 4 of the Nace Rev 1.1 classification. Each group of products is then contained in one of the following seven economic sectors: business-services, capital goods, intermediate goods, energy and consumer goods (divided in food, durables and non-food non-durables products). Almost

[11] The following products are concerned: manufacture of other non-distilled fermented beverages, production and preserving of meat, manufacture of prepared animal feeds, manufacture of glass fibres, manufacture of plaster products for construction purposes, manufacture of basic iron and steel and of ferro-alloys, manufacture of bricks, tiles and construction products, manufacture of other inorganic basic chemicals, lead, zinc, and tin production, manufacture of industrial gases, cold forming or folding, manufacture of refined petroleum products.

47% of the observations are collected in the intermediate goods sector. Finally, a measure of the amount of sales for each product in each firm is available, which allows an evaluation of the relative weight of a product or a firm in a given sector.

The second piece of information relates to the price. The year and the month of the record are collected. For each year, the dataset contains more than 100 000 industrial producer price quotes. Another available information is the periodicity of price collection: most prices (94%) are collected monthly and almost 6% are collected quarterly. The prices of some specific products are reported bi-annually, especially clothes. In the business-services sector, most price quotes are collected quarterly. A quality effect coefficient is also available; this coefficient is quantitative and a quality adjusted price is calculated by combining the collected price and this qualitative effect.

The weighted statistics presented hereafter are computed using PPI and BSPI weights. These weights are available at the level 4 of the NACE Rev. 1.1 classification and not at the elementary product level. Therefore, for each level of the classification, we compute an unweighted statistic and then aggregate statistics are calculated by averaging over the level 4 of the Nace Rev. 1.1 classification. The weights of PPI are revised by INSEE every five years, and are available for the periods 1995:2000 and 2000:2005. Therefore, an average of these two sets of weights is computed to calculate the weighted statistics.

3 How do producer prices change?

This section aims at providing the main features of price setting among French firms: how long does a producer price last? How frequently and by which magnitude do prices change?

3.1 Main features.

How long does a price last? As noted by Baudry *et al.* (2005), measuring price duration is not straightforward, and all micro based measures of price durations are based on statistical assumptions and definitions that should be emphasised. Price durations can be calculated in two different ways. An indirect approach consists in computing the frequency of price change and calculating the implied price duration from the inverse of frequency. A direct measure of price durations can also be computed by calculating the time elapsed between two price changes.

Censoring and truncating should in this case be taken into account[12]. Each month, around 25% of industrial producer prices are modified (Table 4). An upper bound for this figure is obtained with the frequency calculated from the sample where $c^{\max} = 80\%$: 27.6% and a lower bound is obtained with the statistic associated to the sample where $c^{\max} = 60\%$: 22.9%. The implied average price duration is around 7 months for industrial producer prices, which is lower than the average consumer price duration (8.4 months) for France (Baudry *et al.* (2005)). This can be partly explained by the structure of the index. In the Consumer Price Index (CPI), the weight of Services (whose prices are the most rigid) is around one third whereas in PPI, no services prices are taken into account. Direct measures of price durations provide similar results. In France, the weighted average producer price duration is 6.2 months (Tables 6, 7) against 7.2 months for consumer prices (Baudry *et al.* (2005)). If we consider the censoring issue (Table 8), price duration measures are quite consistent, for non-censored price spells, the weighted average price duration is 5.2 months and for right-censored spells it is equal to 7.8 months.

How large is a price change? The size of price changes is calculated as the amount of price variation between two dates of collection expressed as a percentage of the initial price[13]. The weighted average size of a price change is about 4% for an increase and -4% for a decrease (Table 5), the weighted median is quite lower: 2.3% for a price increase and -1.9% for a decrease. Small price changes are frequent and there is no downward price rigidity as far as the size of positive price changes seems equal to the size of negative ones. The distribution of price changes for all industrial prices is quite symmetric (Figure 3). Its skewness is equal to 0.04 and around 40% of price changes are price decreases (Table 5).

3.2 Sectoral heterogeneity.

Figure 1 shows that the distribution of the frequency of price change is nearly U-shaped across products, a pattern already described by Mills (1927) or Means (1935). This reflects a high sectoral heterogeneity. Three groups of sectors may be distinguished:

The first group gathers energy, food consumer goods and intermediate goods (Tables 4, 5, 7). In this group, prices are frequently changed. Each month, two thirds of energy prices are modified, reflecting the considerable variability of oil prices. Food and intermediate goods sectors also show high frequencies of price change respectively, 35% and 23% implying average durations

[12] See the appendix for methodological details.

[13] See the appendix for methodological details.

of respectively 4.4 and 7.4 months (respectively 4.4 and 6.4 months with a direct measure). However, there is also a huge heterogeneity across products within the sector of intermediate goods. In these three sectors, the sizes of price changes are quite variable: in absolute value, the average size of price change goes from 3 to 6% depending on the variability of sectoral shocks. More remarkably, the distributions of sizes of price changes show no asymmetry. The shares of price increases for these sectors are lower than the average for the whole industry and their skewness are slightly positive, close to 0 (0.44 for food, 0.12 for energy, 0.13 for intermediate goods). These distributions are also relatively spread out, the kurtosis calculated for these sectors are the lowest among all industry sectors, which implies that high price changes are not rare.

A second group of sectors can be distinguished; it contains durables, other consumer goods and capital goods whose prices change less often. Each month, respectively 13.4%, 12.0% and 9.9% of prices are modified, which implies price durations larger than 9 months. The direct measures of price durations are quite smaller, around 8 months (Tables 4, 5, 7). The distributions of sizes of price changes for these sectors are highly concentrated around zero; for instance, for durables, the proportion of price changes ranged between 0 and 2% is close to 35%. Moreover, the distributions of the sizes of price changes are asymmetric: around zero, price increases are more frequent than price decreases; the skewness are negative (-0.08 for capital goods, -0.46 for other consumer goods and -0.71 for durables). It provides for these three sectors some evidence in favour of a mild downward rigidity.

Finally, the frequency of price change for the business-services sector is much smaller. Around 7 % of prices in this sector are changed each month, which implies price duration of more than one year (Figure 2, Tables 4, 5, 7). The average size of price changes is larger than in industrial sectors, 6.3% for increases and -6.6% for decreases. The distribution of the sizes of price changes is asymmetric around zero and small price decreases are uncommon. Nonetheless, the skewness of the distribution of size of price changes calculated on the whole sample is rather close to zero (-0.1) but it is close to -1 when it is computed on the interval [-5;5]. This asymmetry around zero is larger than those observed in the industry. This distribution is also spread out because of quite frequent large price changes (Figure 4) and the kurtosis is lower than in the industry (around 3.8 versus 6.3 for the lowest sectoral value in industry).

This huge heterogeneity across sectors has been examined by Blanchard (1982) and more recently by Clark (1999). Blanchard (1982) mentions that price setting must be influenced by the number of manufacturing stages; the variability of prices in primary goods' sectors (energy, food) is larger than those observed for the intermediate goods sector. The volatility of intermediate inputs' prices is even larger than the variability of the prices of final goods like durables. Clark (1999) also finds that the response of producer prices to monetary shocks depends on the stage of production; at an early stage of production, monetary shocks imply larger and quicker responses than at the final stage of production.

3.3 International comparisons.

To which extent can the observations on price adjustments in France be compared with the international evidence? Producer prices change more frequently in France than in the euro area (21% in the euro area (Vermeulen *et al.* (2006)) versus 25% in France). However, the results are not easily comparable since the coverages of PPI are different among studies; for example, the sample used in the Belgian study does not contain energy prices which are the most volatile, whereas electricity prices which lower the frequency of prices change of energy are excluded from the Spanish study. Moreover, the industrial sector structure may also be distinct from a country to another. The comparison with the American results is even more difficult: Carlton (1986) finds that in the United States the average producer price duration is twice larger than those obtained for France whereas in Caucutt *et al.* (1999), the producer price duration is slightly more than half of the French one. This can be largely explained by methodological and measurement issues; Caucutt *et al.* (1999) employ BLS micro price indices which can be considered as average prices. As mentioned in section 2, the probability that an average price changes is systematically larger. Carlton (1986) uses transaction prices but his dataset does not cover all American PPI and the prices were collected in the sixties.

The French results on the size of price changes are similar to the ones found in the other European countries such as Spain (nearly 5% on average in absolute value), Italy (4% on average in absolute value) or Germany (3.3% on average in absolute value). However, in Belgium or in Portugal the variability of price change seems to be slightly higher. More interestingly, some results found on the French data and on the American data are similar, like frequent small price changes and no downward price rigidity; the simple average size of price changes in absolute value in the U.S. is equal to 4.3% for all types of periodicity contracts and equal to 2.6% for the monthly contracts. Moreover, for most products, Carlton (1986) and Caucutt et al. (1999) find that the median size of price change in absolute value is equal to 2% or less which is close to the French result.

The sectoral heterogeneity in the frequency of price change is also quite similar in France, in the euro area and in the United States. The prices of primary goods are frequently modified. In the Portuguese energy sector, 66% of prices change each month; for the United States, Carlton (1986) finds an average price duration of 2.7 months for monthly contracts of gasoline and Caucutt *et al.* (1999) find a truncated price duration of 2 months for butane gas. In the intermediate goods sector, some common features are also observed; for example, in France, the price of the product "Plywood" lasts on average 9 months whereas the price of "Cement" lasts on average 17 months. Carlton (1986) finds quite similar durations for the same products (5 months for "Plywood" and 13 months for "Cement"). This result is quite striking because the former prices are reported in France in the nineties whereas the latter are collected in the United States in the sixties. Finally, the prices of the final products change less frequently in Europe and in the U.S. For instance, Caucutt *et al.* (1999) find that the prices of "industrial machinery and equipment" last on average 4.2 months, whereas for French PPI, they last around 10 months. However, for both datasets, the average price duration of this specific product is one of the largest.

4 Interpreting producer price stickiness.

A common feature of New Keynesian economics is to start from a micro-level firms' optimization behaviour and then aggregate these decisions to replicate the inflation process. These models suppose that at the micro level, prices are sticky and all economic shocks are not directly transmitted into prices. Two alternative hypotheses are often considered to model this price stickiness: the number of firms modifying their prices at each period can be determined either exogenously (time-dependence) or endogenously (state-dependence). What can be learnt from French producer prices on the form of price stickiness?

4.1 Price contracts: some evidence of time-dependence.

According to the surveys led in different countries among industrial firms[14], implicit or explicit contracts are the main reasons why producers do not change their prices as often as they wish.

[14] Blinder (1991), Fabiani *et al.* (2005), Loupias, Ricart (2004), Apel *et al.* (2005), Hall *et al.* (1997) lead specific surveys on price setting behaviour respectively in the U.S., in the Euro area, in France, in Sweden and in the U.K.

This observation lends some support to the model of Taylor (1980) which assumes that prices remain constant for a fixed and predetermined period of time. Is there any evidence of this form of time-dependence in the data?

First of all, a significant proportion of firms set their prices according to calendar time. The frequency of price change shows high seasonal peaks (Figures 7, 8). Most of the firms wait for January to change their prices; the frequency of industrial price change is equal to 39% in January against 25% in the others months[15](Table 9). For capital goods, durables and other consumer goods, the frequency of price change in January is on average three times higher than in the other months. This seasonal pattern was already observed by Means in the thirties in the U.S.: 16.8% of price changes of "metals and implement" goods occurred in January whereas around 8.3% would be expected in case of a perfect uniform distribution. The calculation with French "core industry" data of this proportion gives striking similar results: 16.1% of price changes occur in January. Not only are prices set according to a calendar time but most of them last exactly one or two years. For the total industry, 15%, 3%, 1.3% of the prices beginning in January last respectively one, two and three year(s) against 5%, 0.8%, 0.3% of the prices beginning in other months (Table 11). For the core industry, nearly 25% of prices beginning in January last exactly one, two or three years. Almost 50% of business-services prices beginning in the first quarter last one or two years. This last hypothesis is reinforced when the proportion of price durations exactly equal to one year is calculated for each firm. For almost 10% of firms in some industrial sectors and for almost 20% of firms in the business-services sector, the majority of the price durations observed last exactly one year (Table 10).

Moreover, after having restricted the sample to the price durations exactly equal to one or two years, the distributions of sizes of price changes show some specificities. We plot on the same graphs (Figures 6a, 6b), the distribution of the sizes of price changes when the price durations are exactly equal to 12 months together with the distribution when the duration is around one year (10, 11, 13 or 14 months) in the core industry and in the business-services sector. This way, we control the impact of elapsed duration on the size of price change. If there was nothing special about 12-month price contracts, we would expect both distributions to be similar. However, some significant differences appear: the distribution of sizes of price changes for 12-month durations shows high peaks between 2 and 3% and is asymmetric, skewed on the

[15] This peak in January is less pronounced for consumer prices: in France, the frequency of price change in January is slightly higher than 20% against 17% for the other months.

right whereas the distribution for durations around 12 months is quite symmetric (Table 12). On the whole, the firms changing their prices each year are more likely to increase mechanically their prices by 2 or 3%[16].

Finally, we investigate the characteristics of the firms which modify their prices each year by 2 or 3% by focusing our analysis on competition indicators; we use the four-firm concentration ratio at the level 4 of the NACE classification and an indicator of market power of each firm calculated as the revenues of each firm divided by the total revenues of a branch at the level 4 of the NACE classification (Table 13). The industrial firms which change their prices by 2 or 3% after 6, 12 or 24 months are in more concentrated markets, and their market power is slightly higher than the market power of other firms. These latter can not set these price contracts and may react more quickly to the economic shocks.

4.2 Explaining price changes: some evidence of state-dependence.

The state-dependent model assumes that the firm is more likely to change its price when it experiences large shocks. Evidence of state-dependence is here provided by estimating three logit models with fixed effects explaining the firms' decision of changing, increasing or decreasing their prices (Tables 14a, 14b). Five groups of variables are selected to potentially explain the price change's decision: seasonality, specific events (e.g. changes in VAT in August 1995 from 18.6% to 20.6%, in April 2000 from 20.6% to 19.6% and euro-cash changeover), input costs (raw materials), sectoral inflation and output gap. Finally, a four-firm concentration ratio is introduced to take into account the impact of the market structure on the transmission of shocks into prices. Controls for each year are included and the observations are weighted[17]. This model can not be considered as a structural model but rather as an analysis of the impact of different economic shocks on the price change decision[18].

Means (1935) and Stigler and Kindahl (1970) focused their analysis on the cyclical behaviour of producer prices. The former claimed that producer prices are not reactive to the changes in the economic cycle. Most of prices do not decrease during recessions and price increases are seldom during expansions. According to Stigler and Kindahl (1970), prices fully respond to

[16] Similar patterns are observed for price durations equal to 6 months versus 5 and 7 months and for durations equal to 24 months versus 22, 23, 25, 26 months.

[17] Similar results are obtained with unweighted observations.

[18] Cecchetti (1986) with magazines' prices or Alvarez, Hernando (2006) with consumer prices in Spain estimated similar conditional logit models.

cyclical changes. A sectoral indicator of the output gap is built by linearly detrending the sectoral production indices. First, the output gap weakly affects the probability of price change, this is explained by its reversed impacts on price increase and price decrease. During expansions (respectively recessions), prices are less (respectively more) likely to decrease and are more (respectively less) likely to increase in the industry and in the business-services sectors. However, the marginal effects of output gap evolutions are rather low, around 1% on average on the probability of price increase or price decrease.

Another potential variable explaining price changes is the sectoral monthly rate of inflation; the first theoretical state-dependent papers on price setting (Sheshinski and Weiss (1977)) but also their empirical counterparts (Cecchetti (1986)) emphasised the role played by inflation on the frequency of price change. An increase in the sectoral inflation would decrease the relative price and then lead the firm to increase its nominal price. The sectoral inflation is sometimes interpreted as a measure of shocks transmitted into prices by other firms; if many firms change their price, a firm is more likely to modify its own price. The empirical estimates are in line with these predictions. If the inflation increases by 1%, the probability of a industrial price increase rises by more than 0.7%. On the contrary, if the inflation decreases by 1%, the likelihood of observing a price decrease rises by almost 0.7%. This mechanism explains why the impact of the sectoral inflation on the price change decision is quite null. Negative (respectively positive) inflation rates have a positive (respectively negative) effect on the probability of price decrease and a negative (respectively positive) effect on the probability of price increase.

Changes in costs should also have an impact on the price change decision. The raw material inputs' prices affect the equilibrium output price, and shocks in the raw material prices should be transmitted into the producer prices. For instance, during the period 1999-2000, the frequency of price increase rises contemporaneously with the tough increase of the raw materials' prices (Figure 7). The estimates confirm this insight. Both industrial and food material raw prices affect positively (respectively negatively) the likelihood of a price increase (respectively decrease). However, their impacts are quite weak.

Producer prices are supposed to be reported excluding VAT. Nevertheless, the VAT increase in 1995 had a positive (respectively negative) impact on price increase (respectively decrease), which leads to a small peak in the frequency of price increase (Figure 7). The VAT decrease in April 2000 had a significant positive effect on the probability of price decreases and the frequency of price decrease rose from 5-6% to 12%. Moreover, the frequency of price change in January

2000 is smaller than in other years, one could suppose that firms did not change their prices in January as usual and waited until the VAT change in April to modify their prices. The impact on the business-services prices of the VAT change in 2000 is not significant. The last event is the euro-cash changeover, in January 2002, more than 60% of prices were modified. Most of these price changes are due to rounding and are equally distributed between increases and decreases.

Finally, we test the impact of the market structure on the transmission of shocks into prices. Theoretical models show that monopolistic firms change their prices less often than oligopolistic firms (Rotemberg, Saloner (1987)) because the latter are more likely to change their prices in response to smaller perturbations. In our estimation, the market structure variable is introduced in the model in interaction with inflation and output gap variables. Our estimates are consistent with the predictions of the model. An increase of the inflation by 1% rises the likelihood of a price increase by 7%, but in the least competitive sectors this probability is weaker. The less competitive market is, the less the shocks are transmitted into prices.

4.3 Assessing the relevance of time- and state-dependent pricing rules.

Previous sections have shown that both the state-dependent model and the time-dependent model do capture some patterns of producer price setting. Using the Klenow-Kryvtsov decomposition of inflation, the relative relevance of the different theories is here measured. This decomposition approximates the inflation π_t^* as the product of the probability of a price change f_t by the average size of price change dp_t :

$$\pi_t^* = f_t \times dp_t$$

Two samples of industrial producer prices are considered: all items and core items (i.e. excluding energy and food products). The 12-month inflation of total industry is on average less than 1% from January 1994 to June 2005, it ranges from -2.7% to more than 5%, which implies a high standard deviation. Though the core inflation is on average quite similar to the total inflation, it is less volatile. The Klenow-Kryvtsov decomposition provides a good approximation of the actual inflation in both cases. The average monthly inflations obtained are close or equal to the actual averages. The standard deviations are well approximated but they are lower than those observed. The correlation between the actual inflations and the approximate inflation rates are large (Table 15).

Computing the decomposition for business-services prices is more difficult because no aggregate business-services price index is available. Consequently, we compute a "pseudo" business-services price index as a weighted average of the different disaggregated available price indices. This index is quarterly and begins in June 1995. The 12-month inflation is on average about 0.5% but it is also quite volatile. The results of the inflation's recomposition are quite similar to those found for industrial prices. The moments of quarterly recomposed inflation are equal to the moments of actual inflation. The correlation analysis is less encouraging, only the frequency of price increase is correlated to the inflation and the recomposed quarterly inflation does not exactly reproduce the "actual" inflation in the services.

To measure the relevance of time- and state-dependence price setting theories, we now turn to the decomposition of the inflation's variance suggested by Klenow, Kryvtsov (2005):

$$V\left(\pi_t^*\right) = \overline{f}^2 V\left(dp_t\right) + \overline{dp}^2 V\left(f_t\right) + 2\overline{dp}\overline{f}cov(dp_t, f_t) + o_t$$

where $\overline{f}$ is the average frequency of price change, $\overline{dp}$ is the average size of price changes, o_t denotes second-order term.

The first term is interpreted as the time-dependent contribution to the inflation variance; in fact, in the model of Calvo (1983) which is now commonly used for modelling time-dependent price-setting in macro models, the frequency of price change is supposed to be exogenous, as a consequence the fluctuations of inflation are only explained by the variations of the size of price changes. The sum of the last terms is the state-dependent contribution to the inflation variance.

The results with the different samples of industrial and services prices are in line with Klenow, Kryvtsov (2005) since the time-dependent contribution to the variance of inflation is high, 92.2% for all items, 81.4% for core items and 82.3% for business-services (Table 16). The state-dependent contributions are quite low, ranging from 7.8% to 18.6%. The variance of producer price inflation is badly explained by the variability in the frequency of price change, which suggests that that price-setting is consistent with a Calvo model. Moreover, the seasonality of the frequency of price change explains a significant part of the state-dependent contribution. After controlling for seasonality, the time-dependent contribution rises to almost 100% in all cases (Table 16). The first Klenow-Kryvtsov decomposition can lead to underestimate the time-dependent contribution. The distribution of the frequency of price change over time is better approximated by an aggregation of (at least) two time-dependent price setters: Calvo agents would explain the constancy of frequency of price change and the peaks in the frequency of price change reflect the behaviour of the Taylor price setters.

What drives the inflation process? The inflation is correlated with the size of price changes but does inflation vary because of a volatility in the size of price increases and decreases or because of variations in the shares of price increase and decrease? The first approximation can be expanded as:

$$\pi_t^* = \overline{f} \times (\omega_t^+ dp_t^+ - \omega_t^- dp_t^-)$$

where ω_t^+ (respectively ω_t^-) is the share of price increases (respectively decreases) and dp_t^+ (respectively dp_t^-) is the average size of price increases (respectively decreases). The sizes of price decreases and price increases are observed to be quasi-constant over time in industry and business-services sectors (Figures 9 and 10), which leads to the approximation:

$$\pi_t^* = \overline{f} \times \overline{dp^0} \times (\omega_t^+ - \omega_t^-)$$

where $\overline{dp^0} = \overline{dp^+} = -\overline{dp^-}$ is the average sizes of price increases and decreases in absolute value which are equal and quasi-constant over time. The inflation process is therefore only determined by the difference between the share of price increases and the share of price decreases. In the industry, $\overline{f}$ is equal to 0.25 on average, and $\overline{dp^0}$ equal to 4% on average (in absolute value). Consequently, the correlation coefficient between the producer price inflation and this difference between the shares of increases and decreases is larger than 0.75 for total industry and core industry (Figure 11)[19]. This link is relatively weaker for the business-services sector. Inflation rises because most of the firms increase their prices and not because the size of price increases is higher.

5 Conclusion

Producer prices change quite frequently, each month, 25% of prices are modified. The size of price changes is rather small, on average around 4%. Nevertheless, there is a high degree of sectoral heterogeneity, in the business-services sector, price durations are higher than in the industry sectors, and prices are modified by larger amounts. The prices of energy, food, and intermediate goods are modified more frequently than those of finished goods. The frequency of price change in France is rather higher than in the euro zone but the sectoral heterogeneity is similar in most European countries. More surprisingly, some similarities are also found with the American results obtained with data collected in the sixties, prices are modified by small amounts, and the ranking of sectoral price durations is the same.

[19]This correlation calculated on consumer price inflation in Germany (Hoffman, Kurz-Kim (2006)) is equal to 0.71.

Are producer prices time- or state-dependent? This paper has provided some evidence of Taylor price contracts. A small but significant fraction of firms only modify their prices each year in January. Using a conditional logit model, the role of state-dependence in the price setting is also underlined. Sectoral variables play a key role in the price change's decision. A price increase (respectively decrease) is more likely to occur when sectoral inflation is high (respectively low), producer prices are slightly cyclical, the probability of price change rises after a sharp increase of inputs prices. Finally, a Klenow-Kryvtsov decomposition of inflation variance is used in order to assess the relevance of the different pricing rules. The variance of producer price inflation is mostly explained by time-dependent price setting behaviours. Moreover, the inflation process is almost entirely driven by the fluctuations in the difference between the shares of price increases and price decreases, which may suggest some new research on the theoretical models of price rigidity.

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6 Appendix.

A price quote is defined as $P_{j,k,t}$ where[20], j is an index for product at the level 4 of product classification, $j = 1, ..., J$, k is an index for the firms which manufactures the product j, $k = 1, ..., K_j$, t is an index for time, $t = 1, ..., T$, an individual product is identified by the pair (j, k). ω_j is the weight for product j at the level 4 of the Nace rev1 classification.

Durations

A price spell is an episode of time during which the price of one product remains fixed. A price spell i can be fully characterised by the price $P_{j,k,i}$ set during this price spell, and the duration of the price spell $D_{j,k,i}$. This duration can be computed as the difference between two calendar dates : the date of the first observation of a price $P_{j,k,i}$ and its last observation. Let $t_{j,k,i}$ the calendar date associated with the first observation of price $P_{j,k,i}$ during the price spell i and $N_{j,k}$ the number of price spells for product j manufactured by firms k. The duration of a price spell can be calculated as : $D_{j,k,i} = t_{j,k,i+1} - t_{j,k,i}$ where $i = 1, ..., N_{j,k-1}$ and $D_{j,k,N_{j,k}} = t_{j,k,N_{j,k}+1} - t_{j,k,N_{j,k}} + 1$ otherwise.

Product trajectory is defined as the sets of price spells for a specific product j produced in a firm k, it is fully characterised by all its pairs $(P_{j,k} \ , \ D_{j,k})_i$ where $i = 1, ..., N_{j,k}$ it can be computed as the sum of spells prices durations : $L_{j,k} = \sum_{i=1}^{N_{j,k}} D_{j,k,i}$

The number of observed product trajectories corresponds to the total number of products : $K = \sum_{j=1}^{J} K_j$

The average trajectory length is the sum of all trajectory length divided by the number of products : $\overline{L} = \frac{\sum_{j=1}^{J} \sum_{k=1}^{K_j} L_{j,k}}{K}$

The total number of price spells : $N = \sum_{j=1}^{J} \sum_{k=1}^{K_j} N_{jk}$

The average number of price spells by product trajectory is the total number of price spells divided by the number of products : $\overline{N} = \frac{N}{K}$

The average price duration for elementary product j is the sum of price durations on all spells of this product divided by the number of price spells : $\overline{D}_j = \frac{\sum_{k=1}^{K_j} \sum_{i=1}^{N_{j,k}} D_{j,k,i}}{\sum_{k=1}^{K_j} N_{jk}}.$

The weighted average price duration by individual product is the weighted average of j

[20] See Baudry et al (2005) for more details on the methodological issues

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average price durations D_j: $\overline{\overline{D}} = \sum_{j=1}^{J} \frac{\omega_j}{N_j} \left(\sum_{k=1}^{K_j} \sum_{i=1}^{N_{j,k}} D_{j,k,i} \right) = \sum_{j=1}^{J} \omega_j \overline{D}_j$

The weighted quantile of price duration is computed as : let $(x_1, x_2, ..., x_M)$ a sequence of price durations sorted in an ascending order, where M is the total number of price durations, $\min(D_{j,k,i}) = x_1, x_2, ..., x_M = \max(D_{j,k,i})$ and $\frac{\omega_m}{N_m}$ weight associated to each x_m (individual ordered price duration). The aggregate quantile of order $y\%$ is then defined as: $d_y = \left\{ x_m / \sum_{m=1}^{M} \frac{\omega_m}{N_m} = y \right\}$

Frequency of price change

Let $I_{j,k,t}$ an indicator function for price change for firm k at date t for elementary product j which means $I_{j,k,t} = 1$ when $P_{j,k,t} \neq P_{j,k,t-1}$ and $= 0$ otherwise, $t = 1, ..., T_k$, the time index for firm k and K_j the number of individual products for elementary product j. Note that the first observation is missing. The average frequency of price change for elementary product j is the number of ones divided by the number of quotes for this elementary product : $f_j = \frac{1}{(K_j-1)(T_j-1)} \sum_{k=1}^{K_j} \sum_{t=2}^{T_j} I_{j,k,t}. = \frac{N_j-1}{T_j-1}$. The weighted average frequency of price change : $\overline{f} = \sum_{j=1}^{J} \omega_j \times f_j$

The weighted average frequency of price change for elementary product j at date t: $f_{j,t} = \frac{1}{(K_j-1)} \sum_{k=1}^{K_j} I_{j,k,t}$. The weighted average frequency of price change at date t: $f_t = \sum_{j=1}^{J} \omega_j f_{j,t}$

Size of price change

Let $I^{+}_{j,k,t}$ (respectively $I^{-}_{j,k,t}$) an indicator function for price change for firm k at date t for elementary product j which means $I_{j,k,t} = 1$ when $P_{j,k,t} > P_{j,k,t-1}$ (respectively $P_{j,k,t} < P_{j,k,t-1}$) and $= 0$ otherwise, $t = 1, ..., T_k$, the time index for firm k and K_j the number of individual products for elementary product j.

The size of price increase[21] : $dp^{+}_{j,k,t} = I^{+}_{j,k,t}. \left(\frac{P_{j,k,t}}{P_{j,k,t-1}} - 1 \right) .100$

The weighted average size of price increases for elementary product j: $\overline{dp}^{+}_j = \frac{\sum_{t=1}^{T_k} \sum_{k=1}^{K_j} dp^{+}_{j,k,t}}{\sum_{t=1}^{T_k} \sum_{k=1}^{K_j} I^{+}_{j,k,t}}$

The weighted average size of price increases : $\overline{dp}^{+} = \sum_{j=1}^{J} \omega_j \overline{dp}^{+}_j$

The weighted average size of price increases for elementary product j at date t: $\overline{dp}^{+}_{j,t} = \frac{\sum_{k=1}^{K_j} dp^{+}_{j,k,t}}{\sum_{k=1}^{K_j} I^{+}_{j,k,t}}$. The weighted average size of price increases at date t : $\overline{dp_t}^{+} = \sum_{j=1}^{J} \omega_j \overline{dp}^{+}_{j,t}$

[21] The same statistics can be computed for decreases.

Table 1: Type of prices (unweighted)

	c=1			c=0.7		
	Nb obs.	%	f (%)	Nb obs.	%	f (%)
Actual transaction price	419 776	13.8	13.0	391 664	24.6	9.0
Average price	1 138 002	37.5	61.5	462 657	29.1	22.4
Billing price	257 276	8.5	21.8	223 561	14.1	12.9
Estimated price	32 879	1.1	27.4	27 259	1.7	15.5
Contract price	13 166	0.4	19.4	11 903	0.7	13.4
National price	2 464	0.1	78.6	509	0.0	5.7
Price index	125 223	4.1	44.6	80 163	5.0	22.8
Missing values	1 042 761	34.4	61.8	391 806	24.6	26.3
Total	**3 031 547**	**100**	**50.3**	**1 589 522**	**100**	**18.6**

f : Frequency of price change (percentage of price changes per month); "c" is the threshold above which some trajectories are disregarded as presumably "average price" trajectories

Table 2: Coverage rate of products (monthly and quarterly data)

(%)	*c=1*	Qual.	c=0.9	c=0.8	**c=0.7**	c=0.6
Consumer Goods						
- Food	*100*	0.0	56.4	45.7	**39.8**	35.9
- Durables	*100*	31.8	76.5	71.6	**69.3**	67.9
- Non-Food Non-durables	*100*	24.4	70.1	63.8	**60.0**	57.4
Capital Goods	*100*	29.8	75.0	70.3	**67.4**	64.7
Intermediate Goods	*100*	16.6	61.3	54.6	**50.5**	47.5
Energy	*100*	1.9	88.5	87.3	**86.9**	86.4
Total	*100*	19.3	66.3	59.9	**56.0**	53.3

"c" is the threshold above which some trajectories are disregarded as presumably "average price" trajectories; Qual.: this dataset contains price quotes reported along with the qualitative codes for "actual" transaction prices, billing prices and contract prices.

Table 3: Observations (monthly and quarterly data)

Coverage rate (%)	*c=1*	Qual.	c=0.9	c=0.8	**c=0.7**	c=0.6
Total	*100*	20.8	65.4	59.1	**55.8**	53.8
Actual transaction price	*100*	100	96.6	95.5	**94.6**	93.8
Average price	*100*	0	54.0	46.0	**42.0**	40.0
Change in coverage rate (%)						
Total	-	-	-34.6	-9.6	**-5.5**	-3.5
Actual transaction price	-	-	-3.4	-1.1	**-0.9**	-0.9
Average price	-	-	-46.0	-14.8	**-8.7**	-4.8

"*c*" is the threshold above which some trajectories are disregarded as presumably "average price" trajectories; Qual.: this dataset contains price quotes reported along with the qualitative codes for "actual" transaction prices, billing prices and contract prices.

Table 4: Frequency of price change (p.c. per month) and implied price duration (in months).

	Frequency of price change				Implied average duration			
(%)	*c=1*	c=0.8	**c=0.7**	c=0.6	*c=1*	c=0.8	**c=0.7**	c=0.6
Consumer Goods								
- Food	*65.5*	37.8	**31.9**	27.1	*1.6*	3.4	**4.4**	5.7
- Durables	*36.2*	15.2	**13.4**	12.4	*3.1*	7.8	**9.0**	9.8
- Non-Food Non-durables	*29.0*	12.7	**9.9**	8.4	*4.6*	9.5	**11.9**	13.8
Capital Goods	*34.5*	14.2	**12.0**	10.7	*3.3*	8.1	**9.4**	10.5
Intermediate Goods	*50.5*	25.5	**22.8**	21.2	*3.1*	6.5	**7.4**	8.2
Energy	*69.6*	65.9	**65.9**	65.7	*1.7*	2.2	**2.2**	2.3
Total - Industry	*48.4*	27.6	**24.8**	22.9	*2.9*	6.3	**7.4**	8.4
Business- services	*14.8*	8.0	**7.0**	6.3	*8.0*	13.0	**14.5**	16.4

"*c*" is the threshold above which some trajectories are disregarded as presumably "average price" trajectories

Table 5: Frequency (p.c. per month) and size of price increases and decreases.

(%)	f^+	ω_f^+	$\overline{\Delta p^+}$	$\widetilde{\Delta p^+}$	f^-	ω_f^-	$\overline{\Delta p^-}$	$\widetilde{\Delta p^-}$
Consumer Goods								
- Food	17.5	57.5	3.7	2.0	14.5	42.5	-3.3	-1.7
- Durables	8.4	63.4	2.7	1.5	5.0	36.6	-2.9	-0.9
- NF-ND	5.9	60.6	4.9	2.5	4.0	39.4	-5.4	-2.4
Capital Goods	6.6	58.2	3.7	2.0	5.4	41.8	-3.8	-1.9
Intermediate Goods	12.5	56.1	4.1	2.5	10.3	43.9	-3.8	-2.1
Energy	36.4	57.4	5.8	3.5	29.5	42.6	-4.8	-2.9
Total - Industry	13.8	58.1	4.1	2.3	11.0	41.9	-3.9	-1.9
Business- services	4.5	64.1	6.3	2.9	2.5	35.9	-6.6	-3.8

f : Average frequency of price change; ω_f : Share of price changes; $\overline{\Delta p}$: Average of price changes; $\widetilde{\Delta p}$: Median of price changes

Table 6: Spells durations (in months), number of price spells by product spell.

		Nb of obs.	Mean	Std	Median	Min.	Max.
c=1	*Spell duration*	*69 194*	*43.7*	*31.6*	*37*	*1*	*138*
	Number of spells	*1 467 861*	*20.7*	*25.7*	*10*	*1*	*138*
c=0.8	Spell duration	41 792	42.9	31.6	35	2	138
	Number of spells	384 873	12.7	18.7	6	1	137
c=0.7	**Spell duration**	**39 185**	**43.0**	**31.7**	**35**	**2**	**138**
	Number of spells	**326 773**	**12.2**	**18.6**	**5**	**1**	**137**
c=0.6	Spell duration	37 314	43.2	31.8	36	2	138
	Number of spells	298 309	12.1	18.7	5	1	137

Table 7: Price durations (in months) by sectors (baseline database, c=0.7).

	Trajectory spells		Duration statistics						
	Nb obs.	%	Mean	Std	Min.	q1	Med.	q3	Max
Consumer Goods									
- Food	39 681	12.1	4.4	5.7	1	1	3	5	96
- Durables	21 106	6.5	7.4	8.6	1	2	5	9	138
- Non-Food Non-durables	26 906	8.2	8.8	9.9	1	2	6	12	112
Capital Goods	44 062	13.5	7.6	9.0	1	2	5	11	136
Intermediate Goods	162 189	49.6	6.4	8.9	1	1	3	3	56
Energy	32829	10.0	2.2	3.3	1	1	1	8	138
Total	326 773	100	6.2	8.3	1	1	3	8	138
Business- services	42 800	100	10.8	8.0	3	6	9	12	84

Table 8: Price durations (in months) by censoring types for the baseline database.

	Trajectory spells		Duration statistics						
	Nb obs.	%	Mean	Std	Min.	q1	Med.	q3	Max
Industry									
00	255 521	78.2	5.2	6.5	1	1	3	7	98
10	32 021	9.8	7.2	9.3	1	1	3	10	134
01	32 021	9.8	7.8	10.1	1	2	4	9	127
11	7 210	2.2	17.0	16.6	2	5	12	21	138
Services									
00	22 363	27.4	8.1	5.2	3	3	6	12	60
10	9 475	33.6	10.7	7.0	3	6	12	12	60
01	9 475	33.6	10.7	8.8	3	3	9	12	72
11	1 487	5.3	24.7	12.6	6	15	21	33	84

Table 9: Frequency of price change (p.c. per month) by month.

(%)	Jan.	Feb.	Mar.	Apr	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Industry - total	39.1	25.0	23.8	25.1	21.9	21.3	25.5	18.7	22.7	23.7	21.3	21.1
Industry - core	31.7	17.2	16.1	16.6	14.4	13.9	17.1	11.0	15.9	15.5	13.7	13.5
Services	11.2	11.2	11.2	6.2	6.2	6.2	5.7	5.7	5.7	5.1	5.1	5.1

Table 10: Distribution of shares of price durations equal to 12 months per firm

(%)	0%	]0;10]%	]10;25]%	]25;50]%	]50;75]%	]75;100]%
Industry - total	61.8	15.2	9.7	7.9	2.9	2.6
Industry - core	59.2	16.2	10.3	8.3	3.3	2.8
Services	44.4	7.4	13.9	14.8	7.6	11.9

This share is computed as the number of price durations equal to 12 months divided by the total number of price durations. Example : for 2.6% of firms in total industry, more than 75% of price durations observed last exactly one year.

Table 11: Price durations (in months) by first month for the baseline database.

(%)		1	3	6	12	18	24	36	48
Industry total	January	33.0	11.1	7.3	14.9	1.3	2.9	1.3	1.1
	Other months	37.9	14.2	6.3	5.0	0.7	0.8	0.3	0.1
Industry core	January	24.4	10.2	8.3	18.1	1.3	3.1	1.3	1.1
	Other months	31.7	11.9	7.0	5.7	0.9	0.8	0.3	0.1
Services	Q1	-	26.6	25.0	43.8	1.4	5.2	1.0	0.2
	Other quarters	-	46.3	32.9	6.7	2.9	1.1	0.2	0.0

This percentage is computed as the total number of prices beginning in January (resp. in other months) which last for instance, 12 months divided by the total number of price beginning in January (resp. in other months). Example : in total industry, 14.9% of prices beginning in January last 12 months

Table 12: Size of price change (excl. energy and food, monthly data, excl. Jan 2002)

	Industry core						Services	
Price duration	6	ar. 6	12	ar. 12	24	ar. 24	12	ar. 12
Nb obs	6132	9359	8795	9043	1071	1442	2405	1452
Med (%)	1.0	0.4	2.1	1.9	2.0	1.5	2.2	1.8
Mean (%)	1.0	0.4	1.8	1.3	1.7	-0.3	2.4	1.6
Skew. (%)	3.7	0.4	1.0	0.5	1.9	-1.9	1.7	1.0

ar. 6 : price durations which are equal to 5 and 7 months; ar. 12 : price durations which are equal to 10, 11, 13 and 14 months; ar. 24 : price durations which are equal to 22, 23, 25 and 26 months

Table 13: Size of price change and market structure (excl. Jan 2002)

		Core Industry						Services	
Price duration (months)		6	ar. 6	12	ar. 12	24	ar. 24	12	ar. 12
Four concentration ratio (%)	Mean	35.3	34.9	34.9	35.5	33.2	30.1	17.2	17.1
	Med.	32.6	31.3	31.5	34.8	30.9	25.6	19.0	13.2
Market power (%)	Mean	4.1	3.5	4.4	3.7	3.5	3.1	2.1	1.7
	Med.	1.4	1.4	1.9	1.8	1.6	1.4	0.3	0.4

All comparisons are made for price changes equal to 2 and 3%. ar. 6 : price durations which are equal to 5 and 7 months; ar. 12 : price durations which are equal to 10, 11, 13 and 14 months; ar. 24 : price durations which are equal to 22, 23, 25 and 26 months.

Table 14a: Conditional logit estimation (Business-Services)

	Change			Increase			Decrease		
	Est.	Marg. effect	P-val.	Est.	Marg. effect	P-val.	Est.	Marg. effect	P-val.
Q1	1.4842	0.2535	0.00	1.5226	0.2621	0.00	0.8158	0.1696	0.00
Q2	0.0793	0.0162	0.07	0.1734	0.0353	0.00	-0.1094	-0.0249	0.09
Q3	0.4018	0.0788	0.00	0.4596	0.0906	0.00	0.2185	0.0483	0.00
Pre-euro	0.3069	0.0590	0.01	0.2230	0.0442	0.11	0.4215	0.0882	0.02
Euro	1.6902	0.2219	0.00	1.1672	0.1810	0.00	0.4201	0.0877	0.03
Post-euro	0.5248	0.0960	0.00	-0.1110	-0.0235	0.51	1.1635	0.2070	0.00
VAT 2000	0.3271	0.0624	0.06	0.3200	0.0620	0.10	0.2823	0.0605	0.33
Sectoral inflation	-0.0349	-0.0072	0.12	0.1791	0.0372	0.00	-0.3178	-0.0715	0.00
Sectoral output gap	0.0053	0.0011	0.33	0.0469	0.0097	0.00	-0.0373	-0.0084	0.00
	L= - 11 814.4			L= - 8 395.4			L= - 5 698.1		
	Nb obs = 39 104			Nb obs =35 569			Nb obs = 21 974		

L: log-likelihood ; Marginal effect: effect of one percentage point increase in explanatory variable at the sample average point. Dummies variables are included for each year. Pre-euro and Post-euro: dummies variables for the period around the euro cash changeover of January 2002, respectively 3 months before and 3 months after.

Table 14b: Conditional logit estimation (Industry)

	Change			Increase			Decrease		
	Est.	Marg. effect	P-val.	Est.	Marg. effect	P-val.	Est.	Marg. effect	P-val.
January	1.3276	0.2844	0.00	1.2275	0.2422	0.00	0.4616	0.1147	0.00
February	0.4543	0.1094	0.00	0.4926	0.1104	0.00	0.0782	0.0192	0.00
March	0.2461	0.0602	0.00	0.2958	0.0681	0.00	-0.0135	-0.0033	0.49
April	0.3112	0.0758	0.00	0.3397	0.0777	0.00	0.0366	0.0090	0.07
May	0.1386	0.0341	0.00	0.2386	0.0553	0.00	-0.0717	-0.0175	0.00
June	0.1570	0.0386	0.00	0.1799	0.0419	0.00	0.0375	0.0092	0.05
July	0.4397	0.1060	0.00	0.4251	0.0961	0.00	0.1399	0.0345	0.00
August	-0.3390	-0.0845	0.00	-0.1109	-0.0266	0.00	-0.3112	-0.0745	0.00
September	0.2317	0.0568	0.00	0.2559	0.0591	0.00	0.0330	0.0081	0.08
October	0.2820	0.0689	0.00	0.2453	0.0568	0.00	0.1085	0.0267	0.00
November	0.0350	0.0087	0.03	0.0528	0.0125	0.00	-0.0035	-0.0009	0.85
Pre-euro	-0.0370	-0.0092	0.15	0.0449	0.0106	0.11	-0.0750	-0.0183	0.01
Euro	1.8861	0.3454	0.00	0.8809	0.1808	0.00	1.5614	0.3535	0.00
Post-euro	0.0372	0.0092	0.11	0.0395	0.0093	0.12	-0.0027	-0.0007	0.92
VAT 1995	-0.2253	-0.0562	0.00	0.1127	0.0264	0.12	-0.4250	-0.0998	0.00
VAT 2000	0.1947	0.0477	0.00	0.0040	0.0010	0.91	0.3383	0.0841	0.00
Sectoral inflation	0.0812	0.0201	0.00	0.3156	0.0750	0.00	-0.2684	-0.0658	0.00
Inflation x conc.	-0.0576	-0.0143	0.00	-0.1602	-0.0381	0.00	0.1141	0.0280	0.00
Sectoral output gap	0.0068	0.0017	0.00	0.0348	0.0083	0.00	-0.0338	-0.0083	0.00
Output gap x conc.	-0.0369	-0.0143	0.00	-0.0733	-0.0174	0.00	0.0466	0.0114	0.00
Raw mat. - Food	0.0012	0.0003	0.05	0.0041	0.0010	0.00	-0.0026	-0.0006	0.00
Raw mat. - Industry	-0.0017	-0.0004	0.00	0.0051	0.0012	0.00	-0.0087	-0.0021	0.00
	L= - 294 370.8			L= - 250 012.3			L= - 207 299.3		
	Nb obs = 1 049 553			Nb obs =962 108			Nb obs = 790 643		

L: log-likelihood ; Marginal effect: effect of one percentage point increase in explanatory variable at the sample average point. Dummies variables are included for each year. Pre-euro and Post-euro: dummies variables for the period around the euro cash changeover of January 2002, respectively 3 months before and 3 months after.

Table 15: Across-time means (and standard deviations) and correlation with monthly inflation.

	seas. adj.	Mean (Std)				Correlation with π		
		f	dp	π^*	π	f	dp	π^*
ALL	N	0.24 (0.06)	0.29 (0.72)	0.08 (0.18)	0.08 (0.27)	0.16	0.65	0.63
	Y	0.24 (0.02)	0.29 (0.64)	0.07 (0.15)	0.08 (0.26)	0.09	0.65	0.65
CORE	N	0.16 (0.06)	0.23 (0.75)	0.05 (0.14)	0.07 (0.17)	0.36	0.34	0.51
	Y	0.16 (0.01)	0.23 (0.70)	0.04 (0.11)	0.07 (0.14)	0.35	0.23	0.70
SERVICES	N	0.23 (0.15)	0.38 (1.52)	0.14 (0.38)	0.14 (0.40)	0.31	0.26	0.43
	Y	0.22 (0.04)	0.34 (1.37)	0.07 (0.31)	0.17 (0.32)	0.09	0.14	0.13

seas. adj.: Seasonality, VAT changes, eurocash changeover controls are included. ; f : Frequency of price change; dp: Average size of price change; π^*: Pseudo monthly inflation; π: Actual monthly inflation.

Table 16: Inflation's variance decomposition.

(%)	seas. adj.	TDP	SDP
ALL	N	92.2	7.8
	Y	97.9	2.1
CORE	N	81.4	18.6
	Y	98.8	1.2
SERVICES	N	82.3	17.7
	Y	101.2	-1.2

seas. adj.: Seasonality, VAT changes, eurocash changeover controls are included; TDP: time-dependent contribution to the variance of inflation (in p. c.); SDP: state-dependent contribution to the variance of inflation (in p. c.)

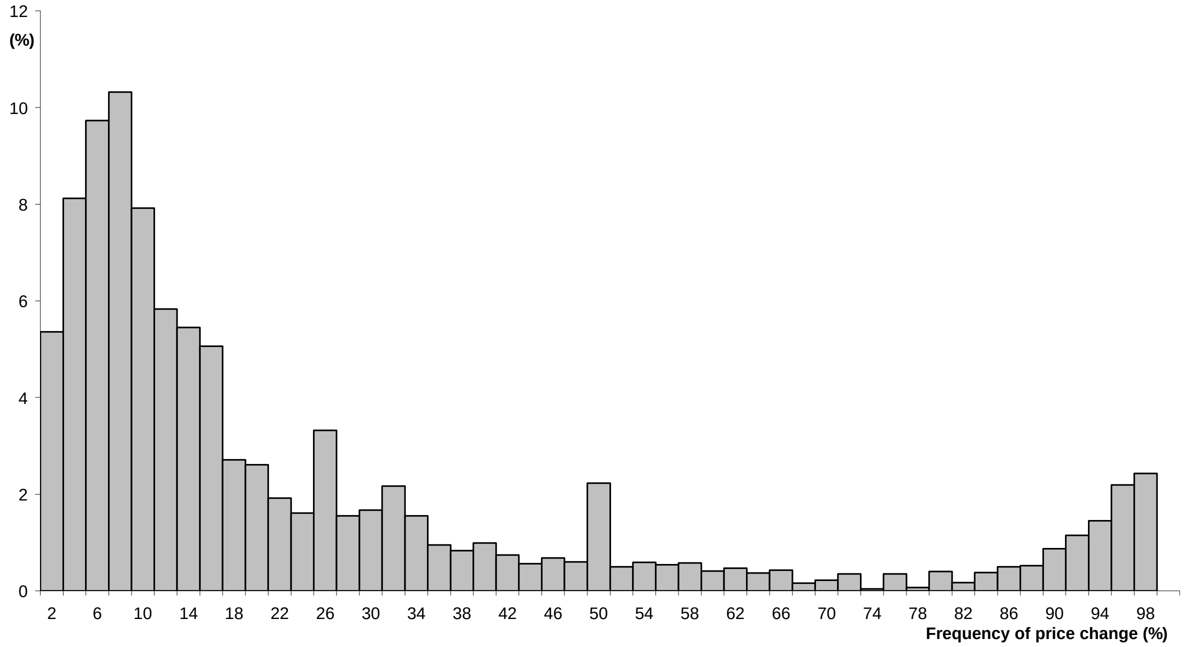

Figure 1 : Frequency of price change (industry - weighted)

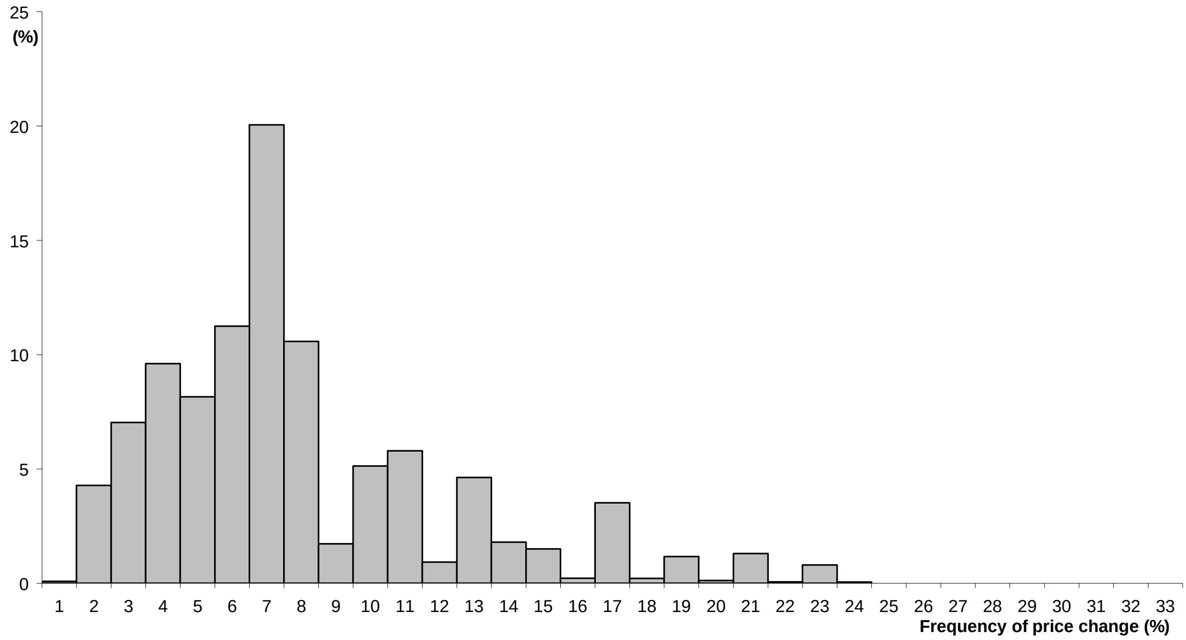

Figure 2 : Frequency of price change (Business-services - weighted)

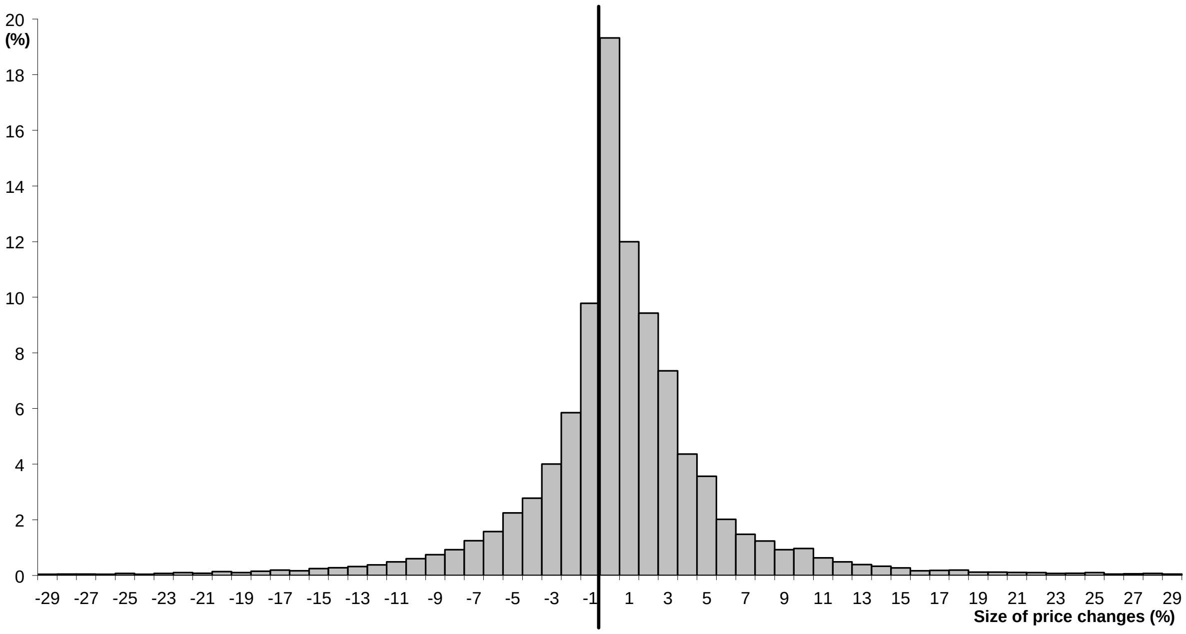

Figure 3: Size of price changes (PPI - weighted)

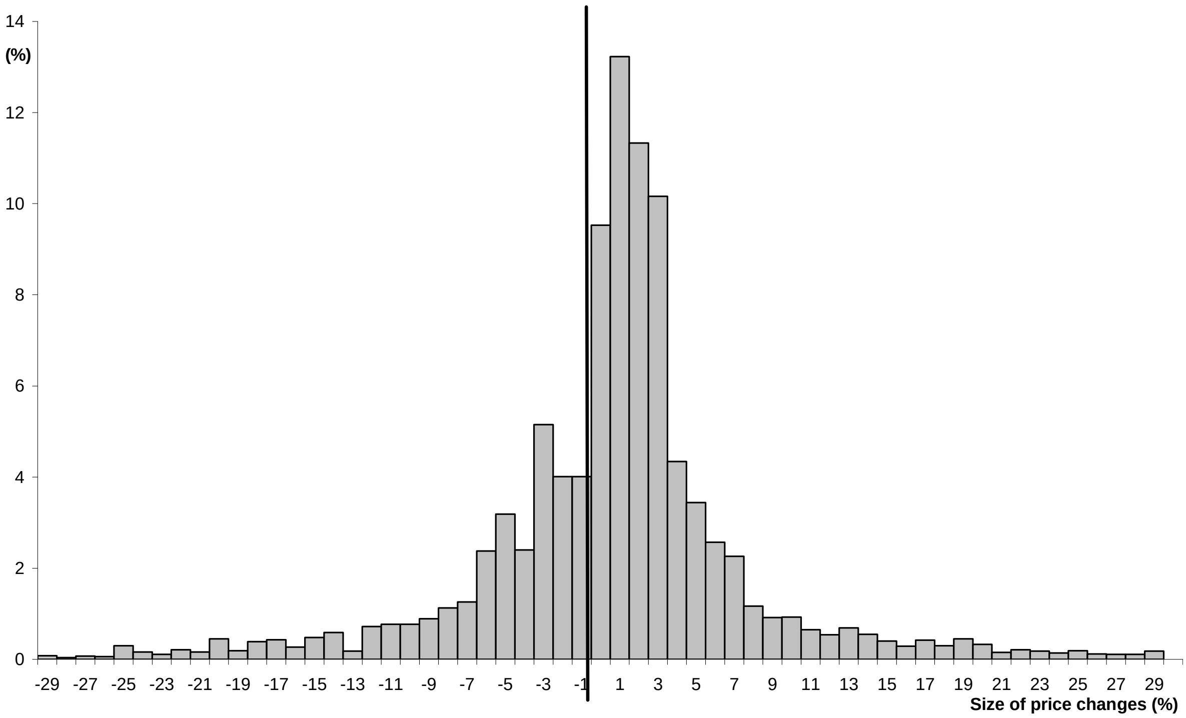

Figure 4: Size of price changes (Business-services - weighted)

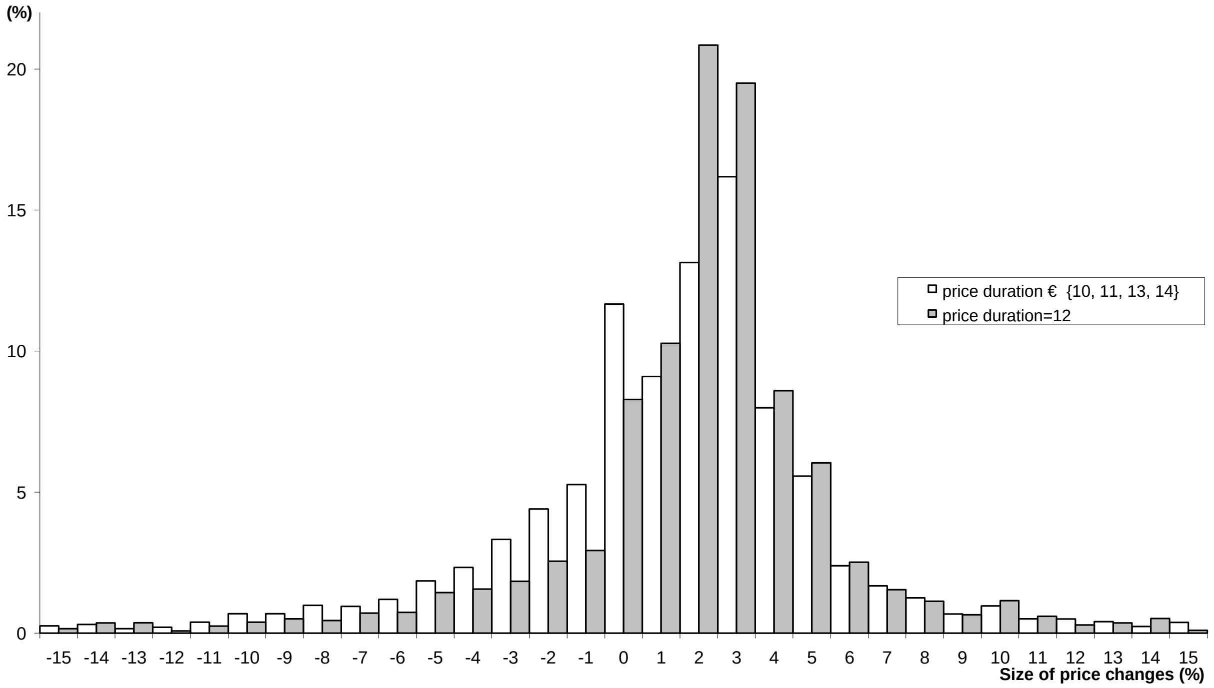

Fig 6a: Core industry - Size of price changes when price durations = 12 months

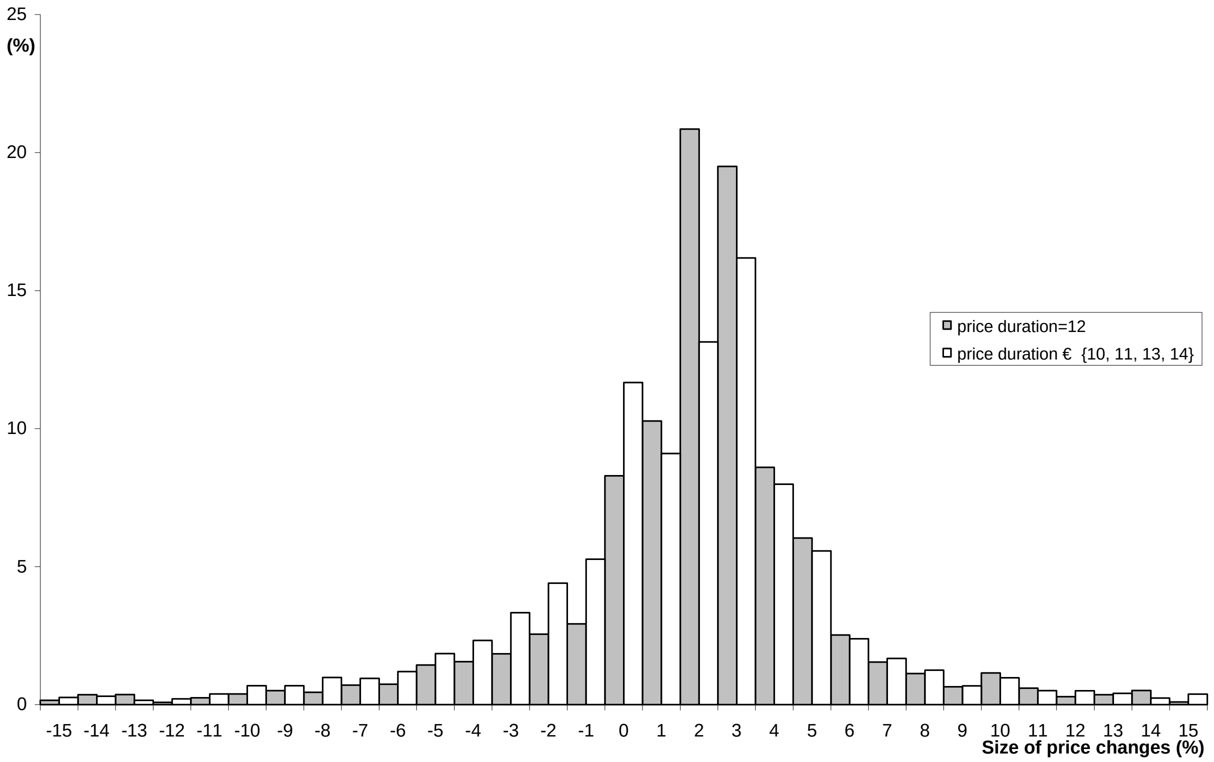

Fig 6b: Business-services - Size of price changes when price durations = 12 months

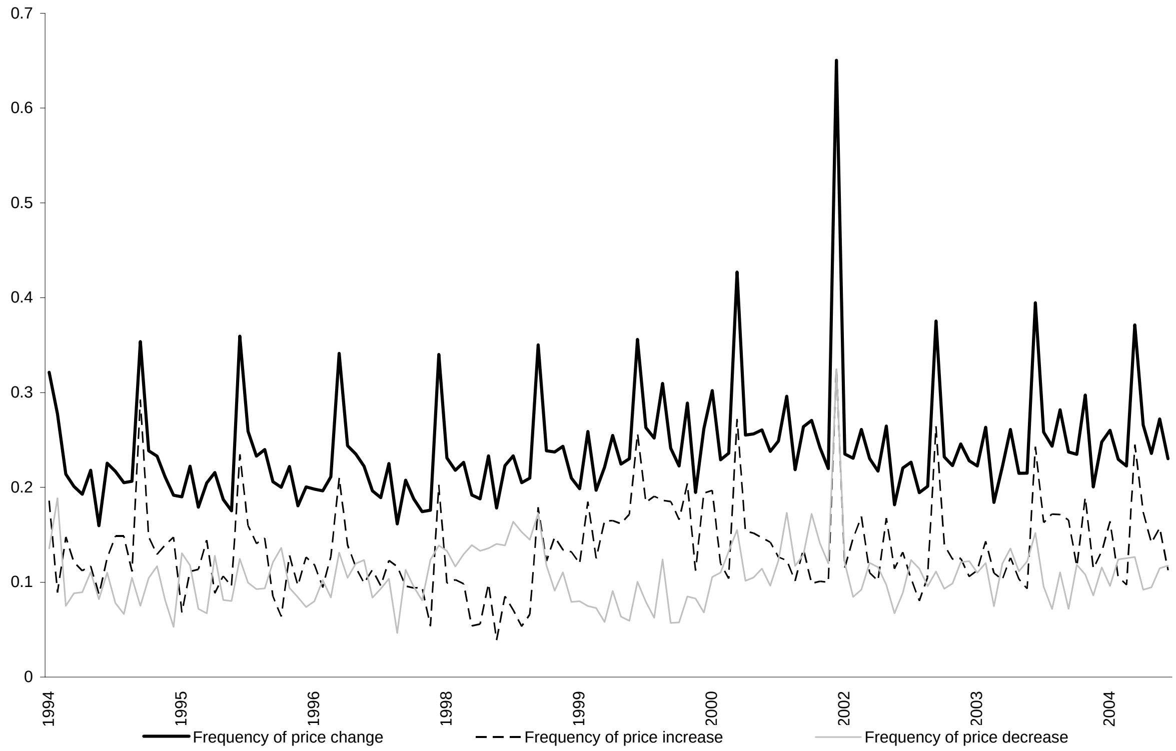

Figure 7: Industry: monthly frequency of price change (average).

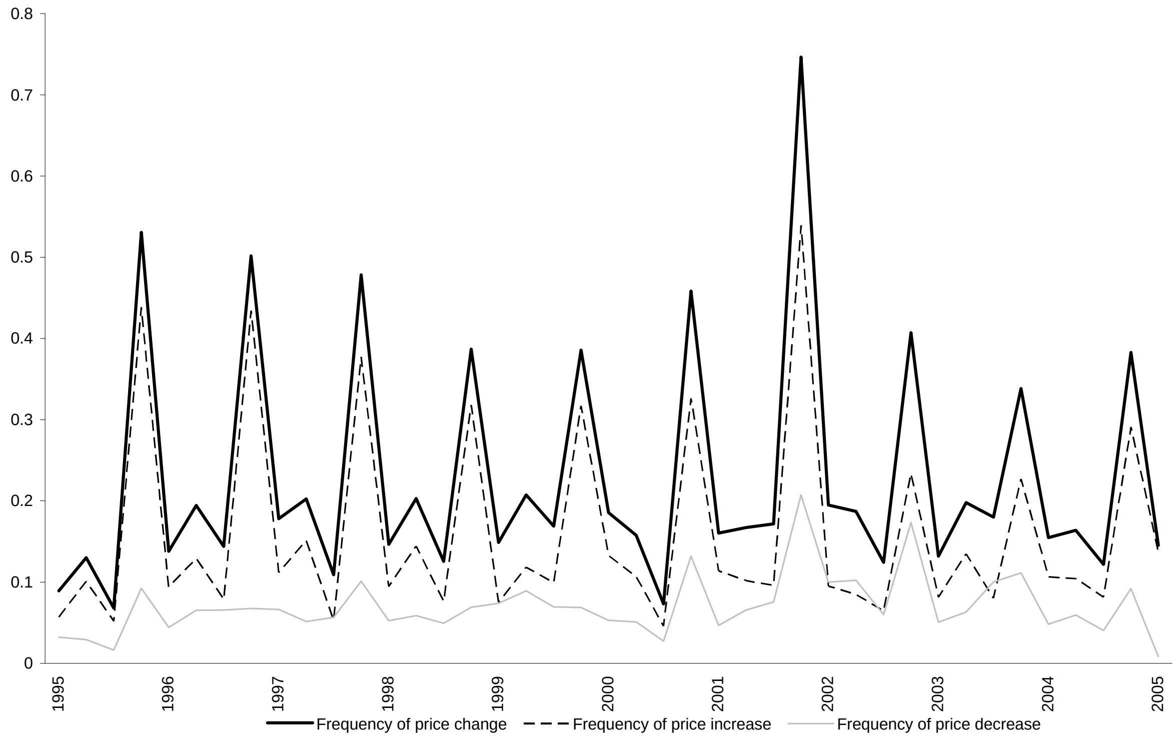

Figure 8: Business-services: quarterly frequency of price change (average).

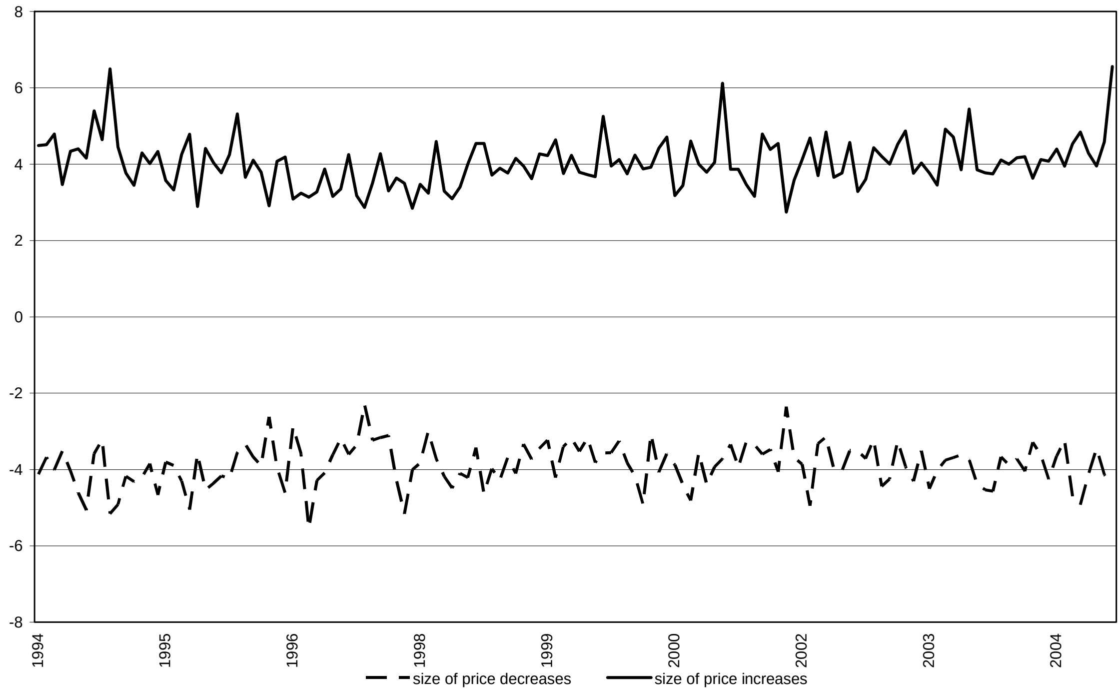

Figure 9: Industry: size of price changes (average)

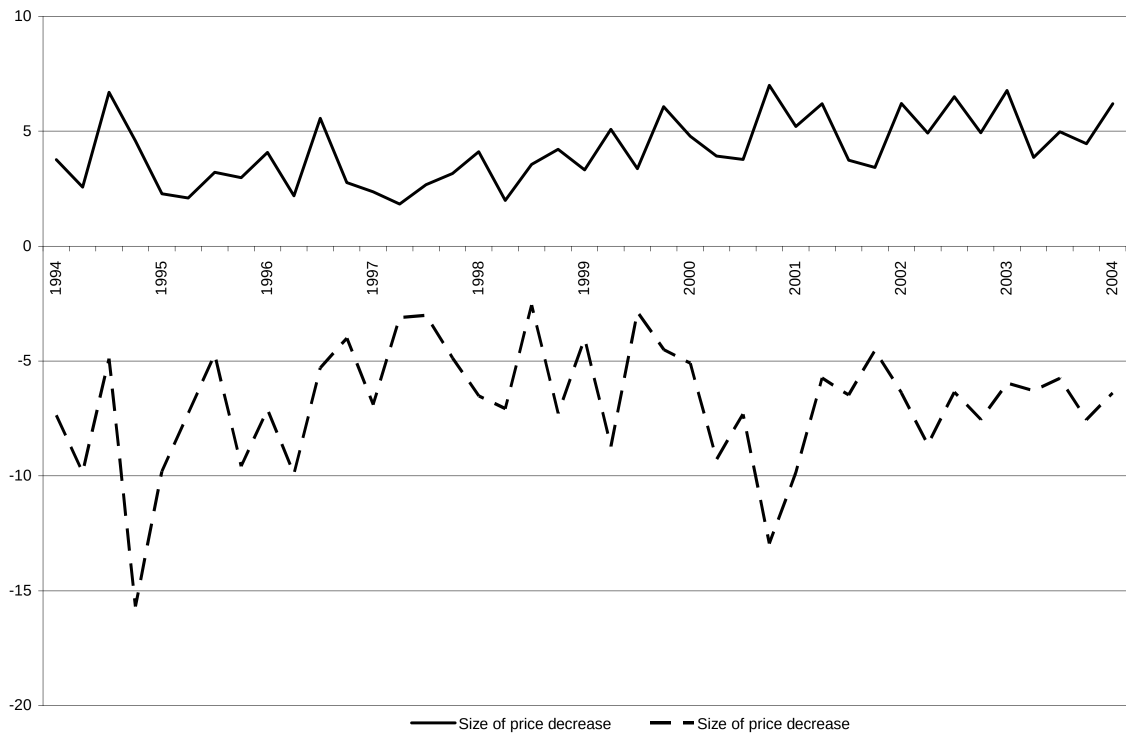

Figure 10: Business-services: size of price changes (average)

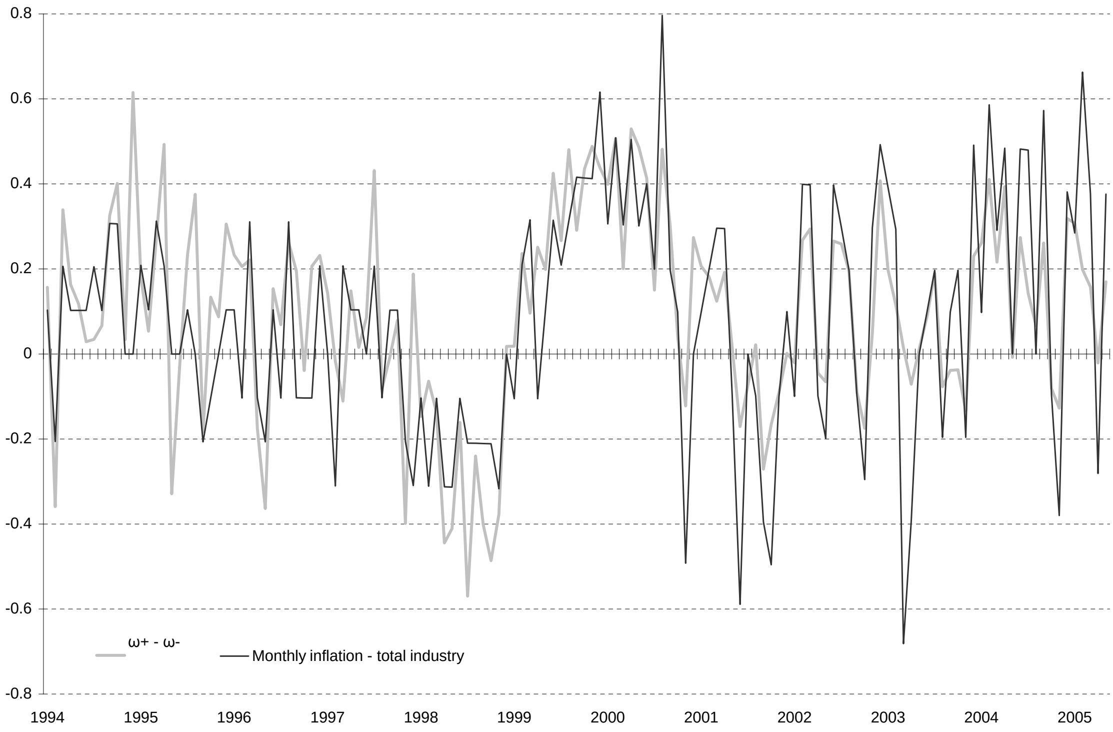

Figure 11 : Monthly inflation and difference between the shares of price increases and price decreases (total industry)

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9 771561 081005