Costs, demand and producer price changes*

Claire Loupias
EPEE, Université d'Evry†

Patrick Sevestre‡
Paris School of Economics, Université de Paris I - Panthéon Sorbonne
and Banque de France, Research Department

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†Claire Loupias was belonging to the Research Department of the Banque de France when the first draft of this paper was written.

‡Corresponding author; e-mail address: sevestre@univ-paris1.fr

Abstract We estimate an ordered probit model in order to explain the occurrence and magnitude of producer price changes in the French manufacturing sector. The data we use is a firm panel dataset consisting essentially of the Banque de France Monthly Business Surveys, pooled over the years 1998-2005. Our results show that changes in the price of intermediate inputs are the main driver of producer price changes. Firms also appear to react significantly to changes in the producer price index of their industry: relative prices matter. Variations in labour costs as well as in the demand addressed to the firm also appear to increase the likelihood of a price change but their influence seem to be of lesser importance for explaining producer price variations. We also show that estimating an unconstrained dynamic model allows to improve the estimation results as compared to those associated with a standard state-dependent model. Finally, our results point to an asymmetry in price adjustments. When they face a change in their environment, firms adjust their prices upward more often and more rapidly than they do it downward.

Keywords: Price stickiness, frequency of price changes, price setting-behavior, survey data, ordered probit model.

JEL Codes: E31, C23, C25

1 Introduction

Recent years have witnessed a tremendous amount of research aimed at characterizing and explaining price stickiness at the micro level. Indeed, a number of papers have provided a thorough description of the frequency of price changes and/or of the duration of price spells, both for consumer and producer prices, using quite large and extensive datasets (see among many others Bils and Klenow, 2005, Klenow and Kryvtsov, 2008, and Nakamura and Steinsson, 2008, for the United-States, Dhyne *et al.*, 2006, and Vermeulen et al., 2007, for the euro area, as well as Baudry *et al.*, 2007, and Gautier, 2008, for France).

However, while we now have a thorough knowledge of price stickiness, the empirical evidence about price rigidity is, *at the micro level*, still quite scarce. In other words, while we now have a large amount of empirical evidence about how often and by how much prices change, we have much less elements to assess, *at the micro level*, the discrepancy between these price variations and those we would expect if prices were fully flexible, given the frequency and magnitude of changes in the firms economic environment. Do firm prices react as fast and as fully as they should when costs, demand conditions and/or the firm competitors' prices change? Answering this question is not that easy because while the available microeconomic databases about consumer or producer prices contain lots of information about these prices, they are most often lacking the information about the main determining microeconomic factors of price changes, namely costs and demand changes. Some studies have concentrated on the reaction of individual prices to inflation, considered either at the macroeconomic level or at the industry level (e.g. see Cecchetti, 1986, Lach and Tsiddon, 1992, and more recently, Fougère *et al.*, 2007, Gagnon, 2007, among many others). Unfortunately, although these studies help in understanding how firms react to changes in their relative price, they do not tell much about how they respond to demand and cost shocks they may experience. Another line of research, initiated by Blinder (1991, 1998), provides some answers to these questions, based on survey data. Indeed, Blinder (1991, 1998) ran a survey to investigate the pricing behavior of US manufacturing firms, focusing in particular on their reaction to changes in costs and/or in the demand for their product. Following Blinder (1991), several central banks of the Eurosystem have recently conducted surveys to shed light on the pricing behavior of manufacturing firms in the Euro area (see Fabiani *et al.*, 2006, for the Euro area and Loupias and Ricart, 2006, for France; see also Hall, Walsh and Yates, 2000 for UK). One of the main conclusions of these surveys is that firms indeed change their prices less often than what changes in their environment would dictate in the absence of adjustment costs.

The route we pursue here follows that initiated by Buckle and Carlson (2000) who used data from the quarterly business surveys conducted by the New-Zealand Institute of Economic Research to assess, at the firm level, the influence of input costs and demand variations on price changes. Our approach can also be considered to be parent to the papers by Peltzman (2000), Levy *et al.* (2002), Davis and Hamilton (2004) and, more recently, Stahl (2005) and Eichenbaum, Jaimovich and Rebelo (2008) who, among others, consider the link between price changes and either costs, wages or wholesale price variations at the micro level. In the Banque de France Business Surveys, firms are interviewed every month about the evolution of their prices, about that of their intermediate inputs prices as well as about variations in the orders they receive and in their production.[1] Besides their monthly periodicity, a distinctive feature of the data we use is the merging we have been able to make with another firm-level survey about labour costs run by the French Ministry of Labour. We are then in position to assess in a quite detailed manner the impact on prices of the variations of intermediate input prices, of wages, of the firm production level as well as that of the producer price inflation at the NACE-2digit level.

More precisely, we specify and estimate an ordered probit model close to that considered in Cecchetti (1986) aimed at explaining, at the micro level, the occurrence and magnitude of producer price changes in the French manufacturing sector over the years 1998 to 2005. Our results show that changes in the price of intermediate inputs are the main driver of producer price changes. Firms also react significantly to changes in the producer price index of their industry: relative prices matter. Variations in labour costs as well as in the demand addressed to the firm also appear to increase the likelihood of a price change but their influence seem to be of lesser importance for explaining producer price variations. We also show that estimating an unconstrained dynamic model allows to improve the estimation results as compared to those associated with a standard state-dependent model "à la Cecchetti".

The remainder of the paper is organized as follows. Section 2 provides some basic empirical facts about price changes and those in the firms environment. Section 3 describes the model. Section 4 provides a descriptive presentation of our dataset. The econometric models and estimation results are then presented and discussed in Section 5. Section 6 concludes.

2 Changes in prices versus changes in the firms environment: some basic facts.

According to a survey conducted by the Banque de France in 2004 (Loupias and Ricart, 2006), about 25% of French manufacturing firms having faced demand or cost shocks in 2003 did not change their prices during that same year. The same conclusion can be drawn from other surveys conducted in the USA (Blinder *et al.*,

[1] This kind of business surveys is also conducted by other statistical offices and central banks such as the INSEE in France or the National Bank of Belgium.

1998) or in other countries of the Euro area (Fabiani *et al.*, 2006): firms may explicitly choose not to modify their prices even when their environment changes.

The same message is conveyed by our data, consisting of the series of the Banque de France monthly business surveys, merged with the ACEMO surveys, conducted by the French Ministry of Labour.[2] In the former set of surveys, firms are asked every month to tell whether they modified their prices during the previous month and to give a qualitative assessment of the magnitude of the change, which may range from a large, medium or small decrease to a small, medium or large increase. Firms are also asked about the evolution of the price of their intermediate inputs and about those of the orders they receive and of their production level. The second series of surveys we use contains information about wages at the firm level, which we were able to match with the Banque de France business surveys. The next table provides the frequency of price changes as well as those of costs and/or demand. We consider that a firm experienced a change in its environment as soon as either the price of its intermediate inputs, the wage of its workers or its production level changed during the month under review. We have then made a cross-comparison with the occurrence of price changes.

Table 1: Changes in the environment and price changes

	Change in the environment	No change in the environment	Total
Price change	16,60%	2,40%	19%
No price change	60,90%	20,10%	81%
Total	77,40%	22,60%	100%

Source: Banque de France business surveys merged with the ACEMO survey.
The dataset contains 51067 observations about 2401 firms and the sample period is October 1998 to December 2005.

These figures clearly point to an asymmetry. Out of 100 observed price changes, 87 coincide with a change in the firm environment; a proportion which reaches 96.1% if we consider changes in the environment that occurred either during the month under review or during the previous month (figures not reported here). However, most changes in the firm environment *do not* induce a price change since the probability of observing a price change given that the firm environment has changed is only 21%. This shows the existence of some price rigidity as fully flexible prices should adjust to the variations in costs and/or demand that firms experience.

The next two tables provide more details about the link between price changes and variations in costs. From Table 2, one can conclude that changes in the price of intermediate inputs are a much stronger driver of price changes than wage changes. Although wage changes occur almost as often as variations in the price of intermediate input prices, the latter induce many more price changes than the former. There are several possible explanations of this observation: a first possible explanation may

[2] See Section 4 below for a detailed description of these data.

lie in the magnitude of the cost change corresponding to these two components of the production cost: the intermediate input price changes are quite likely to be of a larger magnitude than those of wages, thus leading to an higher likelihood to induce a price adjustment. Unfortunately, the nature of our data does not allow us to assess the relevance of this hypothesis as the data about intermediate input prices and wages come from two different sources and are of a different nature: the information about wage changes obtained from the ACEMO surveys is quantitative but that about intermediate input prices contained in the Banque de France business surveys is qualitative. Another possible explanation of the stronger impact of intermediate input price changes as compared to that stemming from wage changes might be found in the nature of the shocks associated with these variations. The former might be more easily incorporated by firms in their prices as they are more "visible" to the firms' customers and because they might be more synchronized and common to all firms in the same sector than wage changes. Then, the level of uncertainty about the price decisions of other firms and/or the acceptability of price increases by customers might be stronger when intermediate input prices are seen to increase than when (unobserved) wage increases are granted to the firms' employees. Finally, a last possible explanation of this rather low impact of wage variations on prices may be found in the evolution of labour productivity, stemming from the technological change and/or from possible quantity adjustments in the labour force. An increase in labour productivity clearly lowers the need for firms to incorporate wage increases in prices, at least when this increase is not fully transmitted to wages.

Table 2: Probability of a price change, conditional on cost variations

	Probability of occurrence	Price change conditional on cost variations
Change in input prices and wages	6.1%	39.7%
Change in input prices only	20.1%	36.7%
Change in wages only	16.0%	13.9%
No change in input prices nor wages	57.8%	12.1%
Total	100%	19.0%

Source: Banque de France business surveys merged with the ACEMO survey.
The dataset contains 51067 observations about 2401 firms and the sample period is October 1998 to December 2005.

The next table provides further information by making the distinction between increases and decreases. Here again, prices react more, both positively and negatively, to changes in the price of intermediate inputs than to changes in wages. The main message of this set of figures is that there does not seem to exist a very strong asymmetry in the reaction of prices to cost changes. Although the probability to observe price increases when costs increase is slightly higher than that to observe price decreases following cost decreases, the response of prices to such variations is not much different whether these variations are positive or negative. The fact that some price increases (resp. decreases) may follow cost decreases (resp. increases) can be partly explained by variations in demand which are ignored here but also by other unobserved factors, such as a change in the firm competitive environment for example.

Table 3: Probability of price increases/decreases, conditional on cost variations

	Probability of occurrence	Price decrease conditional on changes in t	Price increase conditional on changes in t
Decrease in both input price and wage	0.2%	27.0%	10.0%
Increase in both input price and wage	3.6%	9.50%	31.1%
Decrease in input price (wage stable or increased)	7.7%	28.4%	7.8%
Increase in input price (wage stable or decreased)	14.6%	8.0%	29.2%
No change in input price (wage stable or decreased)	59.9%	6.3%	5.7%
No change in input price and wage increased	14.0%	6.5%	7.8%

Source: Banque de France business surveys merged with the ACEMO survey.
The dataset contains 51067 observations about 2401 firms and the sample period is October 1999 to December 2005.

Finally, the next table shows that the likelihood of a price change is significantly higher after a cost variation than what it is after a change in demand/production. Despite the fact that the occurrence of demand changes is much more frequent than that of cost changes, prices change much more often after the occurrence of the latter than what they do after changes in demand. Here again, the nature of the shocks involved may explain this difference. Changes in demand/production may be more idiosyncratic than input price variations, thus leading to less price changes because of the uncertainty regarding the firms' competitors pricing decisions.

Table 4: Probability of a price change, conditional on production and cost changes

	Probability of occurrence	Price change conditional on changes in t
Change in both costs and production	27.4%	30.1%
Change in costs only	14.8%	25.4%
Change in production only	35.3%	12.9%
No change in costs nor production	22.5%	10.8%
Total	100%	19.0%

Source: Banque de France business surveys merged with the ACEMO survey.
The dataset contains 51067 observations about 2401 firms and the sample period is October 1998 to December 2005.

On the whole, it appears that price changes are clearly most often associated with changes in the firms environment, be they changes in their costs or in the demand they get. From the modelling point of view, this calls for a state-dependent pricing behavior.

3 The model: a simple state-dependent pricing model

The model we consider is a quite simple state-dependent pricing model, close in spirit to that proposed by Cecchetti (1986) and considered, inter-alia by Buckle and Carlson (2000) and, more recently, by Aucremanne and Dhyne (2004) and Dhyne *et al.* (2007). In this model, firms are assumed to possibly adjust their price in reaction to changes in their environment (such as variations in input costs or in demand). However, they do not necessarily proceed to such changes as they may find it too costly to frequently adjust their prices, due to the existence of price adjustment costs, either physical or associated with the reactions of their customers.

3.1 The optimal price

The main incentive for a firm to change its effective price is the magnitude of the discrepancy between the optimal price P^*_{it} accounting for changes in its environment and the price that will be effective if no change is decided, that is, the price at time $t-1$, P_{it-1}.We may expect that the likelihood to observe a price change is higher the larger this discrepancy. Now, empirically, the problem we are facing is that the optimal price, P^*_{it}, is not observable. In order to circumvent this problem, it is then first necessary to model this optimal price in a way that allows to express it as a function of observable variables.[3]

We consider a firm selling its product on a market where monopolistic competition prevails. Assuming a constant price elasticity of demand, given by a ($a < -1$), profit maximization leads to the usual equality :

$$\begin{aligned} P^*_{i,t} &= \frac{a}{1+a} Mc_{it} \text{ or, in logarithm} \\ p^*_{i,t} &= \ln(P^*_{i,t}) = \ln(\frac{a}{1+a}) + \ln(Mc_{it}) \end{aligned}$$

where Mc_{it} is the marginal cost. We derive this marginal cost from a simple static Cobb-Douglas cost function :

$$C_{it} = A_{i(j)t}\ Q^{\alpha}_{it}\ \ w^{\beta}_{it}\ \ iip^{\gamma}_{it}$$

where Q_{it} represents the firm production level, w_{it} represents the wage cost, iip_{it} the price of intermediate inputs, and $A_{i(j)t}$ represents unobserved variables affecting costs. Then we get

$$P^*_{i,t} = \alpha \frac{a}{(a+1)} A_{i(j)t} Q^{\alpha-1}_{it} w^{\beta}_{it} iip^{\gamma}_{it}$$

[3] Another option is chosen in Dhyne et al. (2007). Because the information they have is limited to prices, they assume a particular decomposition of the optimal price associated with the underlying unobserved costs and demand and estimate a state-dependent model explaining price changes.

or, in logarithm,

$$\begin{aligned} p^*_{i,t} &= \ln(P^*_{i,t}) = \ln(\alpha \frac{a}{(a+1)}) \\ &\quad + \ln(A_{i(j)t}) + (\alpha - 1)\ln(Q_{it}) \\ &\quad + \beta \ln(w_{it}) + \gamma \ln(iip_{it}). \end{aligned}$$

We assume that $A_{i(j)t}$ can be decomposed into three components: a firm specific effect A_i, a sector-specific effect, B_j, and a third term representing a sectoral (common) time-varying component of prices C_{jt}. Because the number of time periods and that of sectors are large in our data (T is greater than 100 and the number of sectors is also quite large), estimating this last component would induce a large loss of degrees of freedom. However, Dhyne *et al.* (2007) show the strong correlation that exists between the sector specific production price indices and such an estimated common (sectoral) component in prices. This is why we have deliberately decided to approximate this (unobserved) component by the sectoral production price indices at the NACE2 level (PPI_{jt}). We set $C_{jt} = PPI^{\delta}_{jt}$.

3.2 The desired price change

As stated above, the main driver of price changes is the discrepancy between the optimal price P^*_{it} and the effective price at time $t-1$, P_{it-1}, that is, in logarithm, the difference $p^*_{it} - p_{it-1}$ (=ln(P^*_{it}/P_{it-1}). Unfortunately, in our data, neither P^*_{it} nor the level of P_{it-1} are observed. However, along a price spell that started at time t_0, one has:

$$p_{it-1} = p_{it-2} = ... = p_{it_0-1} = p_{it_0}.$$

Then, we have:

$$p^*_{it} - p_{it-1} = p^*_{it} - p_{it_0}.$$

Moreover, assuming as usual in state-dependent pricing models that when firms decide to adjust their prices, they fully adjust to the optimal price level, i.e. $p_{it_0} = p^*_{it_0}$, the desired price change can be written as

$$p^*_{it} - p_{it-1} = p^*_{it} - p^*_{it_0}.$$

In other words,

$$\begin{aligned} \Delta p^d_{it} &= p^*_{i,t} - p^*_{i,t_0} \\ &= \Delta_s \ln(A_{i(j)t}) \\ &\quad + (\alpha - 1)\Delta_s \ln Q_{it} \\ &\quad + \beta \Delta_s \log w_{i,t} \\ &\quad + \gamma \Delta_s \log iip_{i,t} + u_{i,t} \end{aligned}$$

where $\Delta_s x$ represents the variation of x over the course of the spell and where:

$$\Delta_s \ln(A_{i(j)t}) = \delta \Delta_s \ln(PPI_{jt})$$

with PPI the industry level production price index. Then,

$$\begin{aligned}
\Delta p^d_{it} &= p^*_{it} - p_{i,t-1} \\
&= p^*_{i,t} - p^*_{i,t_0} \\
&= \ln(A_{i(j)t}) - \ln(A_{i(j)t_0}) + (\alpha - 1)\Delta_s \log Q_{it} + \beta \Delta_s \log w_{i,t} + \gamma \Delta_s \log iip_{i,t} + u_{it} \\
&= \delta \Delta_s \log(PPI_{jt}) + (\alpha - 1)\Delta_s \log Q_{it} + \beta \Delta_s \log w_{i,t} + \gamma \Delta_s \log iip_{i,t} + u_{it}
\end{aligned}$$

The desired price change, which corresponds to the variation of the optimal price since the start of the spell, is thus a function of two groups of variables. First, those which are firm specific: the cumulative change in wages; the cumulative change in the price of intermediate inputs, the cumulative change in the demand being addressed to the firm and, second, the sector-specific and macro variables such as the variation in the sectoral inflation, which corresponds to the common shocks in the industry, as well as macro variables that might have had an impact on firms pricing decisions : dummies for the VAT change that occurred in France in April 2000 (the VAT went down from 20.6% to 19.6%) and dummies for the euro cash change-over in 2002.[4]

3.3 The price change rule

The last step of the modelling relates to the rule that governs the firm price changes. This rule states that when the foregone profit due to the difference $P_{it} - P^*_{it}$ is large enough to offset the cost incurred when changing the price, the price is changed. Sheshinski and Weiss (1977, 1983) derive a general set of conditions under which it is optimal for a firm to adopt such a target-threshold pricing policy, often referred to as an (s, S) rule. We use here a specification close in spirit to that of Cecchetti (1986).

The firm's price change rule can thus be characterized by the maximum distance by which P^*_{it} is allowed to deviate from P_{it} before the price is changed. The firm is assumed to increase its price when $p^*_{it} - p_{i,t-1}$ is positive and larger than a given threshold q_{it} which is positively related to the price adjustment costs. The firm will lower its price if, at the opposite, $p^*_{it} - p_{i,t-1}$ is negative and larger, in absolute value, than a given threshold q'_{it} .

Our data allow to distinguish between small (SI), medium (MI) and large (LI) price increases (resp. decreases, SD, MD, LD). However, given the very limited number of medium and large increases and decreases, these have been merged together and we consider only 5 outcomes: small increases, large increases, small decreases,

[4] These last two variables have been included in our estimated models even though they do not explicitly appear in the above specification.

large decreases and no change. Then, the price change rule can be summarized as follows

$$\begin{array}{rcll} \Delta p_{it} & = & LD \ < SD < 0 & \text{if} \quad \Delta p_{it}^{d} \leq q_{1i(j)t} \\ \Delta p_{it} & = & SD \ < 0 & \text{if} \quad q_{1i(j)t} < \Delta p_{it}^{d} \leq q_{2i(j)t} \\ \Delta p_{it} & = & 0 & \text{if} \quad q_{2i(j)t} < \Delta p_{it}^{d} \leq q_{3i(j)t} \\ \Delta p_{it} & = & SI > 0 & \text{if} \quad q_{3i(j)t} < \Delta p_{it}^{d} \leq q_{4i(j)t} \\ \Delta p_{it} & = & LI > SI > 0 & \text{if} \quad \Delta p_{it}^{d} > q_{4i(j)t} \end{array}$$

with $p_{i,t} = \log P_{i,t}$. We allow for heterogeneity in the thresholds $q_{\tau i(j)t}$ across years, industries and firms/products; we assume that

$$q_{\tau i(j)t} = q_{\tau} + \theta_j + \eta_t + \mu_i \qquad \tau = 1, 2, 3, 4.$$

where the industry and time effects (resp. θ_j and η_t) are fixed parameters to be estimated while μ_i is a firm specific random effect, possibly correlated with the regressors.

4 The dataset

Our dataset results from the merging of two firm-level datasets, the series of the Banque de France monthly business surveys and a dataset obtained from the French Ministry of Labour containing information about firms wages and employment, with the set of monthly producer price indices computed by INSEE (Institut National de la Statistique et des Etudes Economiques), the French national statistical institute, at the 2-digit NACE level.

The aim of this section is to provide a general overview of each of these datasets and to describe the way we have used them to build our econometric sample. The main characteristics of our econometric dataset are then presented.

4.1 Data sources

4.1.1 The Banque de France business surveys

The pooling of the monthly Banque de France manufacturing industry business surveys over the period January 1996 to December 2005 constitutes our core database. This sample covers a significant fraction of the French manufacturing industry. Over the period, it represents about 1,4 million workers, that is about 1/3 of total employment of the French manufacturing industry. The statistical unit is a specific product, defined at the 4-digit NACE level, produced in a given plant/establishment. About 300 different product groups are considered.

There may be multiple observations for some large firms as several establishments of the same firm may be surveyed and because some (large) establishments may report for more than one product. Then, we define an observation unit as a triplet “firm-establishment-product". For the sake of simplicity, this will be referred to as a “firm product” thereafter. But the very large majority of surveyed entities consists of firms with only one establishment and only one product. On the whole, the set of business surveys from January 1996 to December 2005 contains about 480,000 observations, corresponding to about 8,800 different firm products. Indeed, due to the continuous updating of the sample because of entries and exits of firms in the sampled population as well as changes in the sampling process (*e.g.* some products may be discarded while others are included at some point in the period), the sample is not balanced. The average number of units interviewed is about 4000 per month.

The data are essentially obtained through phone interviews conducted during the first week of each month. Firms are asked about the evolution of some key variables (product prices, intermediate input prices, production, orders received, employment) both during the month under review, i.e. most often the month before the one when the survey is conducted[5] and during the 12 months elapsed since the same month one year before. They are also asked about the level of their finished product stocks and that of their capacity utilization, as compared to a normal situation. Finally, three questions are also asked about the expected evolution of the product price and those of the firm production and employment levels over the next few months.

The main variables that we are using in the present study are:
- the variation in the price of the specific product under consideration,
- the variation in the price of intermediate inputs used in the firm production process,
- the variation in the firm production level.

For each of these three variables, the information available is qualitative. Seven possible values of the evolution are considered: "a large decrease", "a moderate decrease", "a small decrease", "no price change", "a small increase", "a moderate increase" and "a large increase". However, as already mentioned, given the small number of medium and large variations (either positive or negative) observed, we have grouped them together so that we only distinguish 5 possible outcomes.

The main features of this database as well as those of the dataset used for estimating the model are presented in section 4.2 below.

4.1.2 The data set on wages (ACEMO survey)[6]

One important drawback of the Banque de France business surveys is the absence of information about the evolution of the firm labour cost. In order to circumvent this

[5] An exception is for surveys conducted in September in which firms are asked about variations that occured during the previous two months (July and August) since 1998.

[6] For a thorough presentation of the ACEMO survey, see Heckel et al. (2008).

problem, we have obtained access to another survey (named ACEMO) carried out by the French Ministry of Labour. The population covered by this survey consists of establishments with at least ten employees in the market non-farm sector, including both the private sector and state-owned companies. Data are collected by a postal survey at the end of every quarter for about 38,000 establishments. The files have been made available to us for the period starting at the last quarter of 1998 and ending at the fourth quarter of 2005.

The ACEMO survey collects information about the level of the monthly base wage, inclusive of employees social security contributions. The data exclude bonuses, allowances, and other forms of compensation. The information refers to a specific job position, not a specific worker. Then, one can observe a wage change because the wage of the worker occupying the position has changed or because the position is given to another worker with a different wage. In this last case, a specific flag indicates such a change. The survey asks firms about the monthly base wage of up to 12 workers belonging to one of four occupational categories (manual workers, clerical workers, intermediate occupations, managers). For establishments with several job positions inquired, we have computed an average evolution of the wage cost, using the available information about the structure of total employment of the establishment. This provides a satisfactory evaluation of the evolution of the labour cost incurred by firms. Indeed, as emphasized in Heckel *et al.* (2008), the base wage is a relevant indicator of the firms wage cost since in France, the base wage represents 77.9% of gross earnings. Furthermore, most bonuses (like '13th month' payments or holidays bonuses) constitute a fixed part of earnings (5.2%) and are linked to the base wage. Performance-related bonuses, which are disconnected from the base wage, represent only a small fraction (3.2%) of workers' earnings. Moreover, excluding or including bonuses and other payments does not alter the distribution of earnings of full-time employees.

The quarterly periodicity of this survey raises an important issue as the data obtained from the Banque de France business surveys are monthly. Two options were available for matching the two datasets: a first possibility was to keep the monthly frequency and make some assumptions about the unobserved timing of wage changes within quarters; alternatively, one could have aggregated the business surveys over time to get them on a quarterly periodicity. The first option has been preferred because it allows us to study more thoroughly the dynamics of price adjustments. Then, we have assumed that wage changes are more likely to occur during the first month of each quarter. Two justifications can be given to sustain this assumption. First, in France, the minimum wage is usually adjusted according to the CPI inflation every year in July (i.e. the first month of the third quarter). Consequently, not only workers paid at the minimum wage see their wage increased in July but also those who are in the lowest part of the wage distribution. Also, many wage increases get effective on the first of January each year (e.g. see the recent survey conducted about wage-setting practices in France, Montornes *et al.*, 2008). It then seems not a too strong assumption to consider that, in the absence of any other information, wage changes that occur during a given quarter do so in the first month of this quarter.[7]

More information about the observed wage changes in the initial database as well as in the econometric sample are also provided in section 4.2 below.

4.1.3 The Producer Price Indices

The last important information we need for estimating our model is the evolution of producer price indices at the industry level. In order to maximize the matching, these production price indices have been collected from the INSEE website using the 2-digit NACE decomposition of the manufacturing industry. However, some indices were not available for the initial years of the period and/or are terminating before the end of 2005, the last year for which the other data are available.

4.2 The econometric database

Our econometric database results from the merging of the three databases described above. Clearly, the matching between the list of establishments surveyed in the Banque de France Business Surveys and that of establishments of the ACEMO survey is not perfect. Moreover, as mentioned just above, the absence of production price indices for some industries at some periods also induces a loss of observations when the matching is done. This matching thus resulted in a file containing about 128000 observations.

Finally, a further trimming of this dataset had to be done, due to the presence of some missing observations but also because of the need to discard observations corresponding to left-censored spells. Indeed, our model assumes that price changes are triggered on the basis of the evolution of the cost and demand variables since the previous price change. Then, all left-censored spells, i.e. all observations corresponding to spells for which the first observation did not immediately followed a price change had to be deleted. A last loss of observations was also induced by the restriction that we imposed that a given firm-product had to be observed over at least 12 consecutive periods.

Finally, we ended with a sample containing 51067 observations, corresponding to 2401 firms products observed over at least 12 consecutive months during the period October 1998 to December 2005. The decomposition by industry (at the 2-digit NACE level) of our econometric sample and that of the initial business survey database in January 2005 are given in table 5 below.

[7] In order to check the sensitivity of our results to this assumption, we have estimated models where wage changes were imputed either at the second or third month of the quarter. The results were clearly less satisfactory. Results associated with the second option, i.e. consisting of an aggregation over time to get a fully quarterly database are presented and discussed in Horny and Sevestre (2008). They are qualitatively similar to those presented below with, however, a slightly lower precision.

Table 5: Sectoral breakdown of the initial database and of the econometric sample as of January 2005.

Industry	Business surveys full database	Econometric sample
DA. - Food products, beverages and tobacco	16.7%	16.6%
DB. - Textiles and textile products	6.8%	4.0%
DC. - Leather and leather products	1.7%	1.7%
DD - Wood and wood products	3.7%	2.9%
DE - Pulp, paper and paper products	8.2%	8.8%
DF - Coke, refined petroleum and nuclear fuel	0.0%	-
DG - Chemicals, chemical products	7.4%	7.4%
DH - Rubber and plastic products	5.7%	6.5%
DI - Other non-metallic mineral products	4.8%	5.4%
DJ - Basic metals and fabricated metal products	16.2%	16.6%
DK- Machinery and equipment n.e.c.	9.4%	9.0%
DL - Electrical and optical equipment	9.0%	7.8%
DM - Transport equipment	5.8%	8.2%
DN. - Manufacturing n.e.c	4.6%	5.1%
Number of firms	4032	1006

Source: Banque de France business surveys merged with the ACEMO survey conducted by the French Ministry of Labour and Social Affairs. The dataset contains 51057 firms observed monthly between October 1998 and December 2005.

This table deserves two comments. First, the main characteristics of the initial database used to build our econometric sample have been preserved. Given that the Banque de France business surveys are based on a representative sample of the French manufacturing industry, one can reasonably expect our econometric sample to be also representative. Second, these figures indicate that the list of most represented industries/products in the sample is quite diverse. The sample contains food products, textile products as well as metal products and machinery and other equipment goods.

There are four crucial variables in our study (final product price changes, intermediate inputs price changes, wage changes and production changes). The next table then provides some basic statistics about the frequency of changes for these variables.

Table 6: Frequency of price, costs and demand changes /increases/decreases in the initial database and in the econometric sample.

	Business surveys full database	Econometric sample
Price changes	18.6%	19.0%
of which increases	10.9%	10.5%
of which decreases	7.7%	8.5%
intermediate input price changes	24.1%	26.2%
of which increases	17.0%	18.2%
of which decreases	7.1%	8.0%
Wage changes[8]	18.1%	22.1%
of which increases	14.7%	19.3%
of which decreases	3.4%	2.8%
Production changes	62.1%	62.7%
of which increases	36.1%	34.8%
of which decreases	26.0%	27.9%
Number of observations	479744	51067

Again, this table shows that the main characteristics of the initial databases used to build our econometric sample have been preserved. Also, it shows that while the occurrence of price changes is about as frequent as that of cost changes (be they due to intermediate input price variations or to wage variations), they are much less frequent than changes in the firm production level. As mentioned in section 2, we may expect prices to respond more strongly to the former than what they do to the latter.

5 Estimation results

5.1 The econometric model

As stated above, the model we wish to estimate is a probit model where the dependent variable may take five different ordered values, set arbitrarily to -2 for a "large or medium price decrease", -1 for a "small decrease", 0 for "no change", 1 for a "small increase" and 2 for a "large or medium increase". This model can then be written as:

$$\begin{array}{lll} \Delta p_{it} = -2 & \text{if} & \Delta p_{it}^d < q_{1i(j)t} \\ \Delta p_{it} = -1 & \text{if} & q_{2i(j)t} \geq \Delta p_{it}^d > q_{1i(j)t} \\ \Delta p_{it} = 0 & \text{if} & q_{3i(j)t} \geq< \Delta p_{it}^d > q_{2i(j)t} \\ \Delta p_{it} = 1 & \text{if} & q_{4i(j)t} \geq \Delta p_{it}^d > q_{3i(j)t} \\ \Delta p_{it} = 2 & \text{if} & \Delta p_{it}^d > q_{4i(j)t}. \end{array}$$

[8] The initial database considered here for wage changes is extracted from the ACEMO survey database; it includes about 600000 observations about wage changes at the establishment level.

with

$$\begin{aligned}\Delta p_{it}^{d} &= \delta\Delta_s \log(PPI_{jt}) + (\alpha-1)\Delta_s \log Q_{it} + \beta\Delta_s \log w_{i,t} + \gamma\Delta_s \log iip_{i,t} \\ &\quad +\theta_1 Dum_{euro,J02} + \theta_2 Dum_{euro,02} + \theta_3 Dum_{VAT,A00} + \theta_4 Dum_{VAT,00} + u_{it}\end{aligned}$$

where $Dum_{euro,J02}$ is a dummy variable taking value 1 for observations dated January 2002 (Euro cash-change over) and 0 otherwise; $Dum_{euro,02}$ is a dummy variable taking value 1 for observations dated between July 2001 and June 2002, that is 6 months before and 6 months after the Euro cash change-over. Along the same lines, we define $Dum_{VAT,A00}$ as a dummy variable for the decrease in the VAT rate that occurred in April 2000 and $Dum_{VAT,00}$ as a dummy variable for the months of March, April and May of the same year. For both the Euro cash change-over and the VAT rate change, we suspect that their effect might have spread over several months.

Because our data have a panel structure, we can check for the possible existence of unobserved heterogeneity. We have then estimated our model both with and without unobserved heterogeneity. More importantly, besides the question of the possible existence of unobserved heterogeneity, one must consider the possibility that some regressors are endogenous. There are indeed several reasons why one may suspect this is the case. First of all, because of the nature of our data, it is most likely that the available statistical information is subject to measurement errors. In particular, our assumption about the timing of wage changes is quite likely not to correspond perfectly to the imperfectly observed wage changes. Another reason why some regressors are quite likely to be endogenous has been pointed out by Willis (2002), following an argument by Card and Sullivan (1988). This argument is that in state-dependent models, the value of a regressor which cumulates past values of a variable (e.g. past variations in wages) over the duration of a spell is clearly dependent on the firm past decisions regarding the endogenous variable. Indeed, the less frequently a firm changes its price, the higher is the value of the cumulative sum of its past wage variations over a price spell, at least when these variations are of the same sign. Thus, the state-dependent regressors in the model may be endogenous and possibly require a specific treatment. Finally, the last possible cause of endogeneity is the likely simultaneity of the firm decision regarding its price, its production level and the wage paid to its workers. This simultaneity is quite likely to induce some contemporeanous correlation between wage changes, production changes and price changes that constitute a part of the cumulative variation observed since the beginning of the price spell.

In order to tackle these various endogeneity problems, we adopt a combination of the approaches suggested by Rivers and Vuong (1988) and Wooldridge (2006). That is, we include in the model the estimated residuals of the first stage regressions of the state-dependent regressors on a set of instrumental variables, as suggested by Rivers and Vuong (1988). More precisely, we first regress our state-dependent regressors ($\Delta_s \log(PPI_{jt})$, $\Delta_s \log Q_{it}$, $\Delta_s \log w_{i,t}$, and $\Delta_s \log iip_{i,t}$) on the lagged values (with lags 1 to 6) of the observed variations of the corresponding variables, i.e. the lagged values of the month to month changes of wages ($\Delta \log w_{i,t-k}$), of intermediate input prices ($\Delta \log iip_{i,t-k}$), of output ($\Delta \log Q_{i,t-k}$), and of the sectoral price index, i.e. the sectoral inflation ($\Delta \log(PPI_{jt-k})$). Our instruments set also contains a set of industry and year dummies as well as dummies for the VAT change that occurred in April 2000 and the Euro cash change-over in January 2002. The former instruments are nothing but the lagged first differences of the cumulative sum defining the state-dependent regressors. Intuitively, what we do here is quite similar to the now usual approach consisting of instrumenting endogenous regressors by their own lagged first differences (e.g. see Arellano and Bover, 1995). Moreover, 6 months is the average duration of the producer price spells in our sample (and in other datasets as well; e.g. see Gautier and Sevestre, 2006). Then imposing a fixed number of lags in the first stage regression whatever the duration of the spell is expected to break the dependence between the past price decisions and the value of these cumulated changes. Indeed, this means that we regress cumulated changes computed over spells lasting from 1 month to more than 24 months on the same set of the first 6 lagged values of the first differences of our regressors. Finally, in order to tackle furthermore the endogeneity associated with the implicit dynamic nature of the model, we follow the suggestion by Wooldridge (2006) and include the first individual observation of the dependent variable as a supplementary regressor in our model.[9] This should also help for weakening the correlation between the unobserved heterogeneity (if any) and the state-dependent regressors.[10]

5.2 The baseline model estimates

The next table contains several estimates of the state-dependent model presented above. We have indeed estimated two versions of this model, in order to assess the robustness of our results. The first version of the model corresponds to the one presented in the previous section, where 5 outcomes are considered for price variations; again these 5 outcomes are: "a medium or large decrease", "a small decrease", "no change", "a small increase" and "a medium or large increase". The corresponding estimates are given in the first three pairs of columns of the table. The first pair of columns corresponds to a simple ordered probit model where no account is taken of the possible endogeneity of the regressors; the second one contains the estimates associated with the endogeneity treatment "à la Rivers and Vuong (1988)"; the third

[9] This approach has also been recently adopted by Aucremanne and Dhyne (2005) in a very similar context. However, we stick here to the initial suggestion of Wooldridge and use the first available observation of the dependent variable as a supplementary regressor. This is possible because our convention for defining the start and the end of price spells is different from that used in Aucremanne and Dhyne (2005). In our case, a price change terminates a price spell.

[10] A last point has to be mentioned: due to the generated regressors problem associated with our two-step estimation procedure, the standard errors have to be corrected. We plan to do so by using a pairs bootstrap procedure to compute valid standard errors.

column contains a further treatment of the possible endogeneity that would be implied by the presence of unobserved heterogeneity, following Wooldridge (2006).

Unfortunately, a possible drawback of our data is that, due to their qualitative nature and the way they are collected, the "measurement" we have of the magnitude of the changes might be imperfect. We would then have a problem of measurement errors, both on the dependent variable and on the explanatory variables. While the problem of measurement errors on the regressors may be expected to be solved by our instrumental variables estimation procedure, this is clearly not true regarding the possible measurement problem of the dependent variable. Indeed, we know that in non-linear models, measurement errors on the dependent variable are much more harmful than what they are in linear models where they just increase the variance of the disturbance term. In order to check whether this might be a serious problem in our setup, we have re-restimated our model by considering only three outcomes: "a price increase", "a price decrease" or "no change". We have applied a similar treatment to the firm level price determinants, i.e. when considering a change in either input prices, wages and production, we just distinguish between increases, decreases and stability and ignore the information about the magnitude of the changes. There is clearly much less ambiguity in the definition of these three outcomes even if one can wonder whether some firms may consider that very small price changes can be considered as an absence of change in price. This last point is probably not really an issue. Indeed, the comparison provided in Gautier and Sevestre (2006) of the characteristics of price changes observed in the Banque de France business surveys considered here and those observed in quantitative data used by the INSEE to compute the Producer Price indices show that the characteristics of price changes are quite similar in both databases. In particular, the frequencies of price changes are close in both databases, while we would expect the frequency observed in the business surveys to be lower than that obtained from quantitative data if firms had a systematic tendency to consider small price changes as an absence of change. This is clearly not what we observe. Then, our conclusions will be reinforced if the results obtained with both models tend to converge, which is the case, as shown in the table below.

Table 7: State-dependent model estimates

	Ordered probit with 5 outcomes						Ordered probit with 3 outcomes			
	Simple Probit		Rivers-Vuong method for endogenous var,		Rivers-Vuong and Wooldridge for unobs. heterog,		Rivers-Vuong method for endogenous var,		Rivers-Vuong and Wooldridge for unobs. heterog,	
	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat
cum_ii_price	0,041	17,82	0,127	29,36	0,144	28,48	0,181	29,06	0,195	27,06
cum_wage	-0,003	-1,10	0,001	0,07	-0,001	-0,07	-0,015	-1,45	-0,010	-0,83
cum_prod	0,008	4,90	0,032	9,63	0,025	6,62	0,046	9,12	0,038	6,69
cum_sect_price	0,013	4,59	0,105	18,99	0,110	17,36	0,109	19,18	0,117	17,95
vat_2000	0,122	1,79	0,080	1,17	0,095	1,36	0,084	1,19	0,098	1,35
vat_2000_2	-0,051	-1,27	0,009	0,22	-0,001	-0,03	0,008	0,20	0,000	0,00
Euro_2002	0,042	0,85	0,043	0,85	0,047	0,91	0,037	0,71	0,038	0,71
Euro_2002_2	-0,101	-4,73	-0,018	-0,81	-0,020	-0,88	-0,005	-0,21	-0,009	-0,39
q1	-2,274	-95,92	-2,188	-83,52	-2,368	-65,48	-1,380	-57,72	-1,481	-42,48
q2	-1,451	-71,03	-1,362	-58,64	-1,467	-43,77				
q3	1,232	61,35	1,356	58,53	1,429	42,79	1,341	56,30	1,425	41,09
q4	2,031	90,29	2,174	85,22	2,291	64,9				
rho=su/(su+sw)					0,128	22,56			0,135	22,17
LogL	35481,5		-35012,699		-34073,848		-30350,516		-29412,381	
Number of obs,	51067		51067		51067		51067		51067	

Note: All the estimated models include sectustry specific and year dummies; The last two models also include estimated first-step residuals to tackle the endogeneity of the state-dependent regressors "à la Rivers-Vuong"; see the appendix for complete results,

The first conclusion that clearly emerges from a quick look across the first three columns of the table is that accounting for endogeneity is clearly important. Ignoring the endogeneity of the state-dependent regressors clearly leads to a strong under-estimation of their impact on the probability of a price change (columns pair 1). However, the comparison of the estimates associated with the methods either ignoring or accounting for the possible existence of some unobserved heterogeneity (columns pairs 2 and 3 and columns pairs 4 and 5) seem to indicate that the magnitude of this unobserved heterogeneity is quite limited. Indeed, the estimated ρ (representing the ratio of the individual effects variance to the total variance of the disturbances) is for both models rather small (about 0.13) and the estimated coefficients and standard-errors do not change much from one set-up to the other. This does not necessarily come as a surprise as we are modelling price *changes* here. While unobserved heterogeneity is certainly an important component of the variability of the products price level, it is likely to be of a lesser importance when considering price changes. Indeed, the variables that constitute this unobserved heterogeneity in levels (e.g. the products differentiation, the level of competition) are very likely not to vary much from month to month. Their contribution to price variations may then be less important. However, one must keep in mind that the other justification we provided for the existence of firm/product individual effects was a possible heterogeneity in the thresholds defining the different magnitudes of price changes. Our results indicate that, once industry differences are taken into account, the remaining heterogeneity across firms within a given industry is not very important.

Coming to the main economic messages conveyed by these estimates, one can first observe that cumulated changes in the price of intermediate inputs are the main driver of price changes. This result is common to the two versions of the model we consider and their various estimates presented in table 7 (see also table 8 for marginal effects[11]). As an example, according to the estimates of the 3-outcomes model (where we only differentiate between increases, stability and decreases), the occurrence of an increase in intermediate input prices leads to an increase of 1.4% of the probability of a price increase (which is 10.5%) and a decrease of 1.2% of that of a price decrease (which equals 8.4%). One interesting consequence of this almost symmetry is that the overall frequency of price changes is not much sensitive to variations in costs and/or in the demand addressed to the firm. When they face an increase in their costs, more firms are incited to increase their prices but an almost equivalent number of firms which would have otherwise lowered their price switch in this case to a price stability decision (see Baudry *et al.*, 2007, who show this also seems to be the case for consumer prices).

Table 8: Marginal effects / State-dependent model

	Ordered probit with 5 outcomes				Ordered probit with 3 outcomes			
	Probability of a small decrease		Probability of a small increase		Probability of a decrease		Probability of an increase	
	observ. prob. = 7.00%		observ. prob. = 8.42%		observ. prob. = 8.44%		observ. prob. = 10.54%	
	margin. effect	Z-stat	margin. effect	Z-stat	margin. effect	Z-stat	margin. effect	Z-stat
cum_rm_price	-0,79%	-27.78	0,90%	27.86	-1,20%	-28.41	1,41%	28.78
cum_wage	-0,01%	-0.07	0,01%	0.07	0,25%	1.45	-0,30%	-1.45
cum_prod	-0,33%	-9.57	0,37%	9.58	-0,41%	-9.11	0,49%	9.11
cum_ind_price	-0,69%	-18.53	0,79%	18.57	-0,92%	-18.98	1,09%	19.08

Note: The marginal effects are giving the probability change associated with a 1% change in the X variables.
They have been computed using the Rivers-Voung estimates.

Cumulated variations in the sectoral price index appear to be the second most powerful driver of price changes. The marginal effect of an increase of 1 percentage point in these cumulated variations raises the probability to observe a price increase by 1.1% and diminishes that to see a price decrease by 0.9%. Here again, we can observe a rather strong symmetry between these two effects, leaving the overall frequency of price changes almost unchanged. Because these variations can be seen as those of the common component in the product prices within a given industry, they can be interpreted as the variations that, if applied to its own price, would leave the firm' relative price unchanged. This result is quite similar to those obtained in the numerous studies that have considered the impact of the macro or sectoral inflation on price changes. Firms pay attention to the evolution of their prices as compared to those of their competitors.

The impact of cumulated changes in the second cost component that we consider here, namely wages, appears to be quite low and hardly significant. This result comes

[11]Because all the state-dependent variables are of the same order of magnitude, the estimated coefficients convey the same message as the marginal effects do. These marginal effects are given in Table 8 below.

as a surprise as it is difficult to believe that wage increases have no effect on the likelihood of a price change. However, as already mentioned above, several arguments may help to rationalize this finding. First, our econometric procedure might not solve the measurement problem we have with this variable. As the results presented in the next section will show, this cannot be considered to be a valid explanation of the current result. A second possible explanation would be that the magnitude of wage changes is probably much smaller (at least in the period we consider here) than that of intermediate inputs price changes. If, as shown in Levy *et al.* (2002), the sensitivity of prices to a cost shock is larger the larger the magnitude of the shock, this may explain the lower sensitivity of prices to wage changes. Moreover, if indeed wage changes are smaller than those of intermediate inputs prices, the cost for the firm of non-adjusting the price is lower after a wage change than what it is when intermediate inputs prices change. Then, the firm can decide to wait for making the necessary adjustment (See Konieczny and Rumler, 2006, for a theoretical model exploiting this argument). A third possible explanation of the low impact of wage changes on prices might be found in the nature of the shocks associated with these variations. Variations in wages might be less easily incorporated by firms in their prices as they are less "visible" to the firms' customers than those of intermediate input prices. Firms would then postpone the price adjustments induced by wage changes until they proceed to price changes induced by intermediate inputs price variations. This would explain why we observe so few price changes occurring when wages change but other costs remain stable (see table 3 in section 2). A fourth argument that may explain this quasi-absence of impact of wage variations on prices is the possibility for firms to take benefit of productivity improvements associated with technological evolutions and/or with quantities adjustments in the labour input. Indeed, several studies have pointed to a limited sensibility of wages to productivity changes (e.g. see Biscourp *et al.*, 2005, Cardoso and Portela, 2005, Guiso *et al.*, 2005, and, more recently, Katay, 2007 and Fuss and Wintr, 2008). In other words, it could be that firms partially offset the consequences of wage increases through the "capture" of a fraction of productivity gains they may experience. Finally, a last possible explanation of this low impact of wage changes on prices might be that the impact of wage variations on wage changes cannot be represented by the standard state-dependent model that we consider here (see below).

Variations in the production level of the firm have a significant but rather low impact on the likelihood of a price change. This result is in line with both the descriptive statistics presented in Section 2 above and with the results of the surveys conducted in the Eurosystem (see Fabiani *et al.* 2006): firms prices are more reactive to costs changes than they are to demand/production changes. A first possible explanation is that production appears to be more volatile than costs: in our sample, the frequency of changes in the production is about 62%, which is almost three times that of costs changes (see table 4 in section 2 above). Then, adjusting prices at the same pace would be probably very costly to firms, both in terms of internal management and in terms of management of the customer relationship. Second, variations in demand are probably more idiosyncratic (across time and/or across firms) than costs changes. Then, the level of uncertainty about both the durability of observed changes in demand and the price decisions of other firms is probably quite important regarding these variations in demand. This may explain why firms may decide to wait before changing their price when they face demand changes.

Finally, our estimates show no significant impact of the VAT change that occurred in April 2000, either immediately or during a longer period. The same is true regarding the euro cash change-over. However, time dummies for 1999 and 2000 are significantly positive (see table A1 in the appendix) which might correspond to a higher probability of price increases in the period that followed the introduction of the euro in firms' financial transactions from January 1999 onwards.

5.3 Are current and recent variations in the environment more likely to induce price changes?

In the above model, it is implicitly assumed that the impact on price changes of each past variation of costs or of demand is the same. Indeed, price changes occur depending on the value of the desired price change Δp_{it}^d which we can write:

$$\begin{aligned}
\Delta p_{it}^d &= p_{it}^* - p_{i,t-1} \\
&= p_{it}^* - p_{it_0}^* \\
&= (p_{it}^* - p_{it-1}^*) + (p_{it-1}^* - p_{it-2}^*) + (p_{it-2}^* - p_{it-3}^*) + ... + (p_{it_0+1}^* - p_{it_0}^*).
\end{aligned}$$

However, one can wonder whether more recent variations in costs or demand have a stronger impact on the firm likelihood to change its prices. Indeed, one may consider that if a past shock did not lead the firm to proceed to a price adjustment, the contribution of this shock for explaining a future price change is going to be of less importance. In other words, firms would discount past losses due to unadjusted prices. A possible rationalization of this behavior would be that despite the absence of adjustment of their prices to a shock, firms might well have proceeded to other kinds of adjustments, namely quantity adjustment regarding their inputs for example, thus being able to partly offset the shock: shocks on input prices may lead to some input substitution while shocks on demand may lead firms to adjust their inventories accordingly (e.g. see Aguirregabiria, 1999).

In order to check whether assuming a constant impact of past costs and demand changes is a valid assumption, we have estimated models where we do not impose this restriction. Thus, we have decomposed the desired price change Δp_{it}^d as:

$$\begin{aligned}
\Delta p_{it}^d &= p_{it}^* - p_{i,t-1} \\
&= p_{it}^* - p_{it_0}^* \\
&= (p_{it}^* - p_{it-1}^*) + \Psi_1(p_{it-1}^* - p_{it-2}^*) + \Psi_2(p_{it-2}^* - p_{it-3}^*) \\
&\quad + \Psi_3(p_{it-3}^* - p_{it-4}^*) + \Psi_4(p_{it-4}^* - p_{it_0}^*).
\end{aligned}$$

Obviously, the last p terms ($p \leq 4$) are set to zero whenever the duration of the price spell is less than p months, in which case, the last and possibly previous terms are not relevant. The results that have been obtained are presented in table 9 below.

Table9: Estimates of a flexible dynamic model

	Ordered probit with 5 outcomes						Ordered probit with 3 outcomes			
	Simple Probit		Rivers-Vuong method for endog. var.		Rivers-Vuong and Wooldridge for unobs. heterog.		Rivers-Vuong method for endog. var.		Rivers-Vuong and Wooldridge for unobs. heterog.	
	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat
ii_price	0,434	49,52	1,100	5,07	1,188	5,32	1,623	5,72	1,737	5,92
ii_price(-1)	-0,069	-5,75	-0,266	-2,51	-0,265	-2,43	-0,361	-2,86	-0,361	-2,77
ii_price(-2)	-0,011	-0,80	-0,056	-1,51	-0,042	-1,10	-0,105	-2,07	-0,092	-1,77
ii_price(-3)	0,020	1,34	0,051	1,80	0,071	2,44	0,060	1,64	0,078	2,06
remain_cum_iip	-0,010	-2,79	0,022	1,15	0,043	2,18	0,049	2,05	0,067	2,65
wage	0,024	3,28	0,170	7,05	0,181	7,31	0,213	5,38	0,231	5,63
wage(-1)	0,000	-0,04	0,012	1,08	0,011	1,00	0,001	0,05	0,005	0,25
wage(-2)	0,009	1,01	0,018	1,47	0,018	1,41	-0,007	-0,34	-0,002	-0,10
wage(-3)	-0,004	-0,41	0,005	0,36	0,004	0,33	-0,054	-2,24	-0,051	-2,01
remain_cum_wage	0,009	2,71	0,046	3,59	0,048	3,53	0,004	0,22	0,015	0,79
prod	0,043	9,32	0,039	0,91	0,035	0,80	0,037	0,55	0,039	0,57
prod(-1)	0,006	1,05	0,019	2,41	0,014	1,78	0,025	2,31	0,021	1,83
prod(-2)	0,002	0,30	0,021	2,88	0,016	2,11	0,042	3,60	0,037	3,06
prod(-3)	-0,009	-1,51	-0,002	-0,26	-0,009	-1,06	-0,010	-0,73	-0,019	-1,32
remain_cum_prod	0,007	3,06	0,039	6,46	0,033	5,00	0,058	6,14	0,052	5,02
sect_price	0,238	18,11	0,148	10,58	0,163	11,20	0,160	11,18	0,179	11,92
sect_price(-1)	0,022	1,36	0,107	4,66	0,118	4,98	0,103	4,39	0,115	4,76
sect_price(-2)	0,003	0,14	0,102	4,29	0,110	4,46	0,112	4,59	0,124	4,88
sect_price(-3)	-0,011	-0,55	0,103	3,73	0,114	3,98	0,112	3,96	0,126	4,29
remain_cum_price	-0,006	-1,52	0,055	4,46	0,055	4,17	0,059	4,63	0,063	4,59
vat_2000	0,087	1,26	0,069	0,96	0,078	1,07	0,082	1,11	0,092	1,21
vat_2000_2	-0,141	-3,45	-0,134	-3,01	-0,152	-3,30	-0,131	-2,91	-0,145	-3,09
Euro_2002	0,064	1,24	0,041	0,64	0,047	0,71	0,062	0,97	0,066	1,01
Euro_2002_2	-0,073	-3,35	-0,020	-0,89	-0,017	-0,72	-0,008	-0,33	-0,005	-0,22
q1	-2,315	-95,64	-2,194	-76,48	-2,373	-62,19	-1,389	-53,03	-1,480	-40,47
q2	-1,473	-70,60	-1,348	-52,22	-1,447	-40,79	1,427	54,49	1,535	41,99
q3	1,308	63,61	1,460	56,40	1,551	43,70				
q4	2,174	92,91	2,349	82,35	2,487	65,87				
rho=su/(su+sw)					0,128	22,76			0,134	22,29
LogL	-34068,394		-33631,712		-32676,041		-29022,000		-28086,465	

Note: All the estimated models include sectustry specific and year dummies; The last two models also include estimated first-step residuals to tackle the endogeneity of the state-dependent regressors "à la Rivers-Vuong"; see the appendix for complete results.

The first two conclusions that emerge from this set of estimates are:[12]

1) the results here are quite different from those presented in the previous section. This is a clear indication that assuming, as we implicitly do in standard state-dependent models, that all past costs and demand changes have the same impact on price changes is an heroic assumption.

2) However, from a very large perspective, the conclusions that we have drawn from the previous results about the relative importance of the impact on price changes of intermediate input price changes, wage changes, production and sectoral price variations remain valid: according to this new set of results, the first listed of these determinants is still, by far, the main driver of price changes while changes in production still appear to have a modest impact on price changes.

However, it is worth having a closer look at these estimates because there are some new insights to get from them. First, while the estimates of the standard state-dependent model presented in the previous section led to the surprising conclusion that wage variations seemed to have no significant impact on price changes, the results obtained with this more flexible model show that wages do impact significantly the probability to observe price changes. Indeed, according to the estimates of the model distinguishing 5 outcomes, an increase of 1% in the wage growth rate raises the probability of a price increase by 0.5% while according to the estimates of the 3-outcomes model, the occurrence of a wage increase raises the probability of a price increase by 0.6% (see table 10 below). This clearly shows that wage changes do impact price changes. Nevertheless, their influence remains much lower than that of intermediate inputs price changes. Indeed, according to the estimates of the 3-outcome model, an increase in the price of intermediate inputs raises the probability of a price increase by 2.7%, that is 5 times the impact of the occurrence of a wage change. The explanations proposed in the previous section to explain this important difference between the impact of the two variables remain relevant here. The magnitude of wage changes is probably much smaller (at least in the period we consider here) than that of intermediate inputs prices variations and variations in wages might be less easy to incorporate in prices as they are less "visible" to the firms' customers. These characteristics of wage changes would then limit the possibility for firms to adjust immediately their output price when they face such wage increases. Moreover, as we also previously mentioned, the possibility for firms to "capture" the productivity gains they may experience and/or to proceed to other adjustments regarding their labour input (e.g. see Fuss, 2008) might reduce their need to proceed to price adjustments. Another interesting result to be noticed is that according to the 5-outcome model estimates, past wage changes that occurred soon after the start of the current price spell (i.e. those accounted for in our "remaining cumulative wage" variable) appear

[12] Because we have a larger number of parameters to estimate here, the set of instruments has been increased by adding a set of quarterly dummies plus two monthly dummies for January and July (which correspond to months with more frequent wage changes) to the previous instruments set.

to impact significantly price changes. It seems that firms that granted wage increases to their workers without having the possibility to adjust their prices immediately proceed to a "catch-up" after a while, maybe at the same time as they make a price adjustment associated with another cost or demand variation. However, this effect disappears when one does not use the quantitative measure of price variations but only a distinction between wage increases, decreases or stability.

Table 10: Marginal effects / Flexible state-dependent model

	Ordered probit with 5 outcomes				Ordered probit with 3 outcomes			
	Probability of a small decrease		Probability of a small increase		Probability of a decrease		Probability of an increase	
	observ. prob. = 7.00%		observ. prob. = 8.42%		observ. prob. = 8.44%		observ. prob. = 10.54%	
	marg. effect	Z-stat	marg. effect	Z-stat	marg. effect	Z-stat	marg. effect	Z-stat
ii_price	-1,62%	-5.06	1,90%	5.06	-2,27%	-5,71	2,67%	5,72
ii_price(-1)	0,22%	2.51	-0,26%	-2.51	0,30%	2,86	-0,36%	-2,86
ii_price(-2)	0,04%	1.51	-0,04%	-1.51	0,07%	2,07	-0,08%	-2,07
ii_price(-3)	-0,03%	-1.80	0,03%	1.80	-0,03%	-1,64	0,04%	1,64
remain_cum_iip	-0,05%	-1.15	0,06%	1.15	-0,14%	-2,04	0,16%	2,04
total effect	-1,44%		1,69%		-2,07%		2,43%	
wage	-0,41%	-7.03	0,48%	7.03	-0,48%	-5,37	0,57%	5,38
wage(-1)	-0,02%	-1.08	0,02%	1.08	0,00%	-0,05	0,00%	0,05
wage(-2)	-0,03%	-1.47	0,03%	1.47	0,01%	0,34	-0,01%	-0,34
wage(-3)	-0,01%	-0.36	0,01%	0.36	0,07%	2,24	-0,08%	-2,24
remain_cum_wage	-0,45%	-3.59	0,53%	3.59	-0,04%	-0,22	0,04%	0,22
total effect	-0,91%		1,08%		-0,44%		0,52%	
prod	-0,04%	-0.91	0,05%	0.91	-0,03%	-0,55	0,04%	0,55
prod(-1)	-0,02%	-2.41	0,02%	2.41	-0,02%	-2,31	0,02%	2,31
prod(-2)	-0,02%	-2.88	0,02%	2.88	-0,03%	-3,6	0,03%	3,59
prod(-3)	0,00%	0.26	0,00%	-0.26	0,01%	0,73	-0,01%	-0,73
remain_cum_prod	-0,25%	-6.44	0,29%	6.44	-0,31%	-6,14	0,37%	6,14
total effect	-0,32%		0,38%		-0,39%		0,46%	
sect_price	-0,17%	-10.49	0,20%	10.50	-0,23%	-11,13	0,27%	11,15
sect_price(-1)	-0,08%	-4.65	0,10%	4.65	-0,10%	-4,39	0,12%	4,39
sect_price(-2)	-0,06%	-4.28	0,07%	4.28	-0,08%	-4,58	0,10%	4,58
sect_price(-3)	-0,05%	-3.73	0,06%	3.73	-0,07%	-3,96	0,08%	3,96
remain_cum_price	-0,18%	-4.45	0,22%	4.45	-0,25%	-4,63	0,29%	4,63
total effect	-0,55%		0,64%		-0,72%		0,85%	

Note: The marginal effects are giving the probability change associated with a 1% change in the X variables.
They have been computed using the Rivers-Voung estimates.

Another interesting conclusion that one can draw from these new estimates relates to the impact of production changes. Whatever the model we consider, our results indicate that production changes impact prices with a lag. The current production variation is never significant while the first two lags as well as the remaining cumulated changes are always significant. Firms would react with some delay to production changes while they react more promptly to cost changes. Two explanations can be given to this result. First, firms might prefer not to react immediately to observed demand changes before they have assessed their durability. As the descriptive statistics provided in Section 2 indicate, the variability of production is quite important. Moreover, changes in demand/production may be more idiosyncratic than cost shocks. Then, because of the uncertainty regarding their competitors pricing decisions, firms may be reluctant to change their price too often and/or too early.

Finally, a last noticeable point that can be outlined in this set of results relates to the impact of the sectoral producer price index variations. Indeed, although slightly decreasing over time, the time profile of the price reaction to these sectoral price changes (considered by firms as an indicator of the average reaction of their competitors) is essentially constant. In other words, while estimating a more flexible model than the usual state-dependent model entails different conclusions about the impact of costs and demand changes, the two models lead to broadly similar conclusion regarding the impact of the sectoral inflation on price changes. Thus, these results tend to confirm the approach generally taken to study the impact of inflation on price changes (e.g. see Cecchetti, 1986, Lach and Tsiddon, 1992 and Fougère *et al.*, 2007, among others).

5.4 What about asymmetries?

Whether price adjustments in reaction to positive and negative shocks are symmetric is still an open issue (e.g. see Peltzman, 2000, Ray *et al.*, 2006, Levy *et al.*, 2006, Müller and Ray, 2007). Indeed, the existing literature does not come to a consensus on this question. The descriptive statistics provided at the beginning of this paper (see Table 3) seemed to point to a rather limited degree of asymmetry in the conditional probability of price changes following costs or demand shocks. In order to check the robustness of this statement, we have run a set of regressions in which we allow prices to react differently whether the observed variation in cost or demand is positive or negative. The results are provided in table 11 below.[13]

[13] We just present the results associated with the treatment of endogeneity as suggested by Rivers and Vuong (1988).Indeed, the estimates presented in the two previous sections show that accounting for a possible unobserved heterogeneity does not affect the results.

Table 11: Estimates of a model with asymmetries

	Ordered probit with 5 outcomes				Ordered probit with 3 outcomes			
	Effect of a decrease in x		Effect of an increase in x		Effect of a decrease in x		Effect of an increase in x	
	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat
ii_price	-0,355	-0,74	1,370	5,87	0,282	0,38	1,530	4,33
ii_price(-1)	0,232	1,17	-0,271	-2,29	0,091	0,34	-0,225	-1,46
ii_price(-2)	0,041	0,55	-0,046	-0,66	-0,001	-0,01	-0,025	-0,26
ii_price(-3)	0,068	0,85	0,085	1,19	0,014	0,12	0,135	1,45
remain_cum_iip	0,132	1,95	0,022	0,35	0,182	1,39	0,030	0,33
wage	0,988	1,54	0,210	6,21	2,432	2,66	0,400	4,30
wage(-1)	-0,067	-2,30	0,034	2,90	-0,054	-1,07	0,006	0,23
wage(-2)	-0,027	-0,83	0,040	2,46	-0,071	-1,20	0,052	1,46
wage(-3)	-0,027	-0,62	0,035	1,17	-0,066	-1,00	0,039	0,76
remain_cum_wage	-0,016	-0,39	0,054	2,75	-0,240	-1,87	0,017	0,71
prod	0,298	2,42	-0,223	-2,00	0,193	1,02	-0,116	-0,49
prod(-1)	-0,050	-1,50	0,065	3,24	-0,015	-0,28	0,070	2,00
prod(-2)	-0,005	-0,25	0,047	2,91	0,018	0,54	0,071	2,56
prod(-3)	-0,031	-1,25	0,027	1,33	-0,009	-0,27	0,022	0,66
remain_cum_prod	-0,100	-1,40	0,119	3,14	-0,061	-0,58	0,119	2,12
sect_price	0,039	1,37	0,204	10,08	0,047	1,61	0,223	10,54
sect_price(-1)	0,100	2,42	0,077	1,66	0,070	1,63	0,161	3,20
sect_price(-2)	-0,037	-0,77	0,221	5,15	-0,003	-0,07	0,226	5,07
sect_price(-3)	0,025	0,35	0,167	2,59	0,058	0,90	0,158	2,47
remain_cum_price	0,019	1,01	0,058	1,88	0,004	0,21	0,096	2,85
q1	-1,971	-21,72			-1,142	-11,89		
q2	-1,117	-12,46						
q3	1,697	18,89			1,679	17,45		
q4	2,585	28,46						
LogL	-33542,947				-28954,329			

Note: The estimates presented i this table are those obtained using Rivers-Vuong approach.

These estimation results and the marginal effects provided in table 12 below lead to a different conclusion. Indeed, cost increases appear to be more rapidly and fully incorporated in prices than cost decreases. In particular, the transmission of intermediate input price increases to the product price is immediate and quite strong while this transmission is delayed and of a much lower magnitude when the shock corresponds to a decrease in this input cost. It is striking to observe that, at the opposite, there is some more symmetry in the reaction of prices to wage changes. Wage costs decreases are incorporated rather rapidly in price decreases, although this is to a lesser degree as compared to the reaction of prices to wage increases. It might be that wage decreases are associated with a labour management policy whereby firms try to gain in competitiveness, which would explain why, when wage costs are lowered, these gains are, at least partly, incorporated in prices. This is another illustration of the argument exposed at the beginning of this paper stating that intermediate inputs price changes are "exogenous" to the firms decisions but that wage costs are probably not. Our results also point to a strong asymmetry in the way prices are adjusted to the sectoral price inflation. Firms adjust their prices upward but do not seem to do it downward so often. This is not a surprise in an environment where, except for a few specific industries, inflation is positive. The need to lower prices is less stringent than to increase them when costs rise. Finally, it is also worth mentioning that the asymmetry we get regarding the reaction of prices to demand changes is not that important. This result is not in accordance with the survey results provided in Fabiani *et al.* (2006) and deserves to be considered again in future research to check for its robustness.

Table 12: Marginal effects in a model with asymmetries

	Ordered probit with 5 outcomes				Ordered probit with 3 outcomes			
	Effect of a decrease in x on the prob. of a small price decrease		Effect of an increase in x on the prob. of a small price increase		Effect of a decrease in x on the prob. of a price decrease		Effect of an increase in x on the prob. of a price increase	
	obs. prob. = 8.42%		obs. prob. = 8.42%		obs. prob. = 10.54%		obs. prob. = 10.54%	
	marg. eff.	Z-stat	marg. eff.	Z-stat	marg. eff.	Z-stat	marg. eff.	Z-stat
ii_price	-0,38%	-0,74	4,09%	5,86	0,30%	0,38	4,46%	4,33
ii_price(-1)	0,16%	1,17	-0,48%	-2,29	0,06%	0,34	-0,40%	-1,46
ii_price(-2)	0,02%	0,55	-0,07%	-0,66	0,00%	-0,01	-0,04%	-0,26
ii_price(-3)	0,03%	0,85	0,10%	1,19	0,01%	0,12	0,16%	1,45
remain_cum_iip	0,27%	1,95	0,12%	0,35	0,36%	1,39	0,17%	0,33
total effect	0,11%		3,76%		0,73%		4,36%	
wage	0,20%	1,54	0,64%	6,20	0,90%	2,66	1,24%	4,30
wage(-1)	-0,01%	-2,30	0,08%	2,90	-0,02%	-1,07	0,01%	0,23
wage(-2)	0,00%	-0,83	0,08%	2,46	-0,02%	-1,20	0,10%	1,46
wage(-3)	0,00%	-0,62	0,06%	1,17	-0,02%	-1,00	0,07%	0,76
remain_cum_wage	-0,01%	-0,39	0,64%	2,75	-0,09%	-1,87	0,20%	0,71
total effect	0,17%		1,50%		0,77%		1,63%	
prod	1,36%	2,42	-1,50%	-2,00	0,73%	1,02	-0,65%	-0,49
prod(-1)	-0,18%	-1,50	0,34%	3,24	-0,05%	-0,28	0,31%	2,00
prod(-2)	-0,02%	-0,25	0,21%	2,91	0,04%	0,54	0,27%	2,56
prod(-3)	-0,08%	-1,25	0,11%	1,33	-0,02%	-0,27	0,07%	0,66
remain_cum_prod	-0,41%	-1,40	1,46%	3,14	-0,20%	-0,58	1,21%	2,12
total effect	0,67%		0,62%		0,50%		1,21%	
sect_price	0,04%	1,37	0,54%	10,01	0,06%	1,61	0,74%	10,52
sect_price(-1)	0,09%	2,41	0,15%	1,66	0,08%	1,63	0,39%	3,20
sect_price(-2)	-0,03%	-0,77	0,35%	5,14	0,00%	-0,07	0,44%	5,06
sect_price(-3)	0,02%	0,35	0,23%	2,59	0,05%	0,90	0,27%	2,47
remain_cum_price	0,03%	1,01	0,33%	1,88	0,01%	0,21	0,69%	2,85
total effect	0,15%		1,60%		0,19%		2,53%	

6 Conclusion

In this paper, we propose an empirical analysis of the impact, at the micro level, of changes in the firms environment (in terms of intermediate inputs prices, wages, demand and sectoral prices) on their price variations. We estimate an ordered probit model using a sample of 2400 firms from the French manufacturing sector that we observe monthly over at least 12 consecutive months between October 1998 and December 2005. Our results show that changes in the price of intermediate inputs are the main driver of producer price changes. Firms also appear to react significantly to changes in the producer price index of their industry: relative prices matter. Variations in labour costs as well as in the demand addressed to the firm also appear to increase the likelihood of a price change but their influence seem to be of lesser importance for explaining producer price variations. We also show that estimating an unconstrained dynamic model allows to improve the estimation results as compared to those associated with a standard state-dependent model. Finally, our results point to an asymmetry in price adjustments. When they face a change in their environment, firms appear to adjust their prices upward more often and more rapidly than they do it downward.

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APPENDIX - Full estimation results

Table A1: State-dependent model estimates

	Ordered probit with 5 outcomes						Ordered probit with 3 outcomes			
	Simple Probit		Rivers-Vuong method for endogenous var,		Rivers-Vuong and Wooldridge for unobs. heterog,		Rivers-Vuong method for endogenous var,		Rivers-Vuong and Wooldridge for unobs. heterog,	
	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat
cum_ii_price	0,041	17,82	0,127	29,36	0,144	28,48	0,181	29,06	0,195	27,06
cum_wage	-0,003	-1,10	0,001	0,07	-0,001	-0,07	-0,015	-1,45	-0,010	-0,83
cum_prod	0,008	4,90	0,032	9,63	0,025	6,62	0,046	9,12	0,038	6,69
cum_sect_price	0,013	4,59	0,105	18,99	0,110	17,36	0,109	19,18	0,117	17,95
vat_2000	0,122	1,79	0,080	1,17	0,095	1,36	0,084	1,19	0,098	1,35
vat_2000_2	-0,051	-1,27	0,009	0,22	-0,001	-0,03	0,008	0,20	0,000	0,00
Euro_2002	0,042	0,85	0,043	0,85	0,047	0,91	0,037	0,71	0,038	0,71
Euro_2002_2	-0,101	-4,73	-0,018	-0,81	-0,020	-0,88	-0,005	-0,21	-0,009	-0,39
q1	-2,274	-95,92	-2,188	-83,52	-2,368	-65,48	-1,380	-57,72	-1,481	-42,48
q2	-1,451	-71,03	-1,362	-58,64	-1,467	-43,77				
q3	1,232	61,35	1,356	58,53	1,429	42,79	1,341	56,30	1,425	41,09
q4	2,031	90,29	2,174	85,22	2,291	64,90				
sect_c1	-0,032	-0,85	-0,086	-2,24	-0,103	-1,52	-0,086	-2,23	-0,110	-1,60
sect_c2	-0,243	-6,49	-0,199	-5,27	-0,213	-3,08	-0,227	-5,90	-0,246	-3,52
sect_c3	-0,057	-1,50	-0,279	-7,03	-0,271	-3,87	-0,279	-6,94	-0,291	-3,98
sect_c4	0,011	0,40	-0,078	-2,79	-0,078	-1,56	-0,107	-3,73	-0,105	-2,01
sect_d0	-0,148	-5,00	-0,243	-7,87	-0,294	-5,27	-0,250	-7,81	-0,318	-5,39
sect_e1	-0,189	-5,11	-0,262	-6,79	-0,335	-4,71	-0,272	-6,95	-0,360	-4,91
sect_e2	-0,019	-0,84	-0,125	-5,38	-0,132	-3,17	-0,141	-5,93	-0,148	-3,39
sect_e3	-0,135	-3,10	0,036	0,80	0,023	0,30	0,038	0,83	0,032	0,41
sect_f1	0,012	0,44	-0,101	-3,75	-0,082	-1,63	-0,154	-5,60	-0,148	-2,86
sect_f2	-0,171	-5,50	-0,206	-6,57	-0,209	-3,49	-0,254	-7,95	-0,244	-3,98
sect_f3	-0,123	-5,43	-0,104	-4,54	-0,084	-1,96	-0,122	-5,23	-0,095	-2,10
sect_f4	0,033	1,51	-0,056	-2,49	-0,066	-1,63	-0,073	-3,18	-0,074	-1,75
sect_f5	0,078	3,61	-0,047	-2,14	-0,056	-1,37	-0,061	-2,67	-0,066	-1,58
sect_f6	-0,292	-6,09	-0,344	-7,10	-0,357	-4,68	-0,378	-7,66	-0,381	-4,86
year_1999	0,027	0,74	0,078	2,06	0,075	1,81	0,093	2,40	0,098	2,30
year_2000	0,221	8,14	0,143	5,08	0,156	4,96	0,131	4,59	0,150	4,65
year_2001	-0,008	-0,34	0,011	0,45	0,018	0,67	-0,002	-0,08	0,003	0,11
year_2002	-0,105	-4,66	-0,027	-1,18	-0,013	-0,52	-0,022	-0,93	-0,011	-0,43
year_2003	-0,203	-10,67	-0,106	-5,43	-0,095	-4,45	-0,097	-4,89	-0,090	-4,11
year_2004	0,042	2,29	0,037	1,97	0,043	2,19	0,043	2,26	0,052	2,58
y_0					0,032	1,95			0,048	2,16
1st stage residuals										
cum_ii_price			-0,114	-22,60	-0,106	-18,87	-0,161	-22,20	-0,142	-17,50
cum_wage			0,012	1,51	0,009	1,07	0,028	2,55	0,011	0,92
cum_prod			-0,028	-7,38	-0,018	-4,37	-0,042	-7,13	-0,029	-4,49
cum_sect_price			-0,119	-18,44	-0,117	-16,40	-0,126	-18,85	-0,126	-16,99
rho=su/(su+sw)					0,128	22,56			0,135	22,17
LogL	35481,5		-35012,699		-34073,848		-30350,516		-29412,381	
Number of obs,	51067		51067		51067		51067		51067	

Table A2: Estimates of a flexible dynamic model

	Ordered probit with 5 outcomes						Ordered probit with 3 outcomes			
	Simple Probit		Rivers-Vuong method for endog. var.		Rivers-Vuong and Wooldridge for unobs. heterog.		Rivers-Vuong method for endog. var.		Rivers-Vuong and Wooldridge for unobs. heterog.	
	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat
ii_price	0,434	49,52	1,100	5,07	1,188	5,32	1,623	5,72	1,737	5,92
ii_price(-1)	-0,069	-5,75	-0,266	-2,51	-0,265	-2,43	-0,361	-2,86	-0,361	-2,77
ii_price(-2)	-0,011	-0,80	-0,056	-1,51	-0,042	-1,10	-0,105	-2,07	-0,092	-1,77
ii_price(-3)	0,020	1,34	0,051	1,80	0,071	2,44	0,060	1,64	0,078	2,06
remain_cum_iip	-0,010	-2,79	0,022	1,15	0,043	2,18	0,049	2,05	0,067	2,65
wage	0,024	3,28	0,170	7,05	0,181	7,31	0,213	5,38	0,231	5,63
wage(-1)	0,000	-0,04	0,012	1,08	0,011	1,00	0,001	0,05	0,005	0,25
wage(-2)	0,009	1,01	0,018	1,47	0,018	1,41	-0,007	-0,34	-0,002	-0,10
wage(-3)	-0,004	-0,41	0,005	0,36	0,004	0,33	-0,054	-2,24	-0,051	-2,01
remain_cum_wage	0,009	2,71	0,046	3,59	0,048	3,53	0,004	0,22	0,015	0,79
prod	0,043	9,32	0,039	0,91	0,035	0,80	0,037	0,55	0,039	0,57
prod(-1)	0,006	1,05	0,019	2,41	0,014	1,78	0,025	2,31	0,021	1,83
prod(-2)	0,002	0,30	0,021	2,88	0,016	2,11	0,042	3,60	0,037	3,06
prod(-3)	-0,009	-1,51	-0,002	-0,26	-0,009	-1,06	-0,010	-0,73	-0,019	-1,32
remain_cum_prod	0,007	3,06	0,039	6,46	0,033	5,00	0,058	6,14	0,052	5,02
sect_price	0,238	18,11	0,148	10,58	0,163	11,20	0,160	11,18	0,179	11,92
sect_price(-1)	0,022	1,36	0,107	4,66	0,118	4,98	0,103	4,39	0,115	4,76
sect_price(-2)	0,003	0,14	0,102	4,29	0,110	4,46	0,112	4,59	0,124	4,88
sect_price(-3)	-0,011	-0,55	0,103	3,73	0,114	3,98	0,112	3,96	0,126	4,29
remain_cum_price	-0,006	-1,52	0,055	4,46	0,055	4,17	0,059	4,63	0,063	4,59
vat_2000	0,087	1,26	0,069	0,96	0,078	1,07	0,082	1,11	0,092	1,21
vat_2000_2	-0,141	-3,45	-0,134	-3,01	-0,152	-3,30	-0,131	-2,91	-0,145	-3,09
Euro_2002	0,064	1,24	0,041	0,64	0,047	0,71	0,062	0,97	0,066	1,01
Euro_2002_2	-0,073	-3,35	-0,020	-0,89	-0,017	-0,72	-0,008	-0,33	-0,005	-0,22
q1	-2,315	-95,64	-2,194	-76,48	-2,373	-62,19	-1,389	-53,03	-1,480	-40,47
q2	-1,473	-70,60	-1,348	-52,22	-1,447	-40,79	1,427	54,49	1,535	41,99
q3	1,308	63,61	1,460	56,40	1,551	43,70				
q4	2,174	92,91	2,349	82,35	2,487	65,87				
sect_c1	-0,031	-0,81	-0,103	-2,52	-0,125	-1,80	-0,072	-1,76	-0,097	-1,37
sect_c2	-0,264	-6,94	-0,239	-6,19	-0,253	-3,53	-0,249	-6,31	-0,267	-3,64
sect_c3	-0,054	-1,40	-0,233	-5,34	-0,230	-3,18	-0,216	-4,80	-0,232	-3,10
sect_c4	0,010	0,34	-0,080	-2,71	-0,087	-1,68	-0,111	-3,63	-0,107	-1,94
sect_d0	-0,169	-5,60	-0,303	-9,16	-0,370	-6,49	-0,293	-8,45	-0,367	-6,02
sect_e1	-0,184	-4,88	-0,289	-7,02	-0,364	-5,03	-0,248	-5,82	-0,337	-4,46
sect_e2	-0,058	-2,54	-0,201	-7,24	-0,214	-4,76	-0,202	-7,34	-0,220	-4,79
sect_e3	-0,073	-1,66	0,012	0,24	-0,002	-0,03	0,056	1,15	0,057	0,72
sect_f1	-0,015	-0,56	-0,102	-3,57	-0,096	-1,83	-0,157	-5,32	-0,161	-2,99
sect_f2	-0,156	-4,95	-0,186	-5,73	-0,183	-2,93	-0,215	-6,46	-0,200	-3,17
sect_f3	-0,137	-6,01	-0,141	-5,80	-0,131	-2,90	-0,149	-6,16	-0,122	-2,66
sect_f4	-0,006	-0,25	-0,124	-4,49	-0,149	-3,33	-0,133	-4,90	-0,148	-3,29
sect_f5	-0,008	-0,37	-0,143	-4,69	-0,165	-3,63	-0,156	-5,30	-0,173	-3,81
sect_f6	-0,298	-6,11	-0,346	-7,03	-0,367	-4,78	-0,388	-7,71	-0,397	-5,02
year_1999	-0,057	-1,52	-0,045	-0,86	-0,049	-0,88	-0,086	-1,53	-0,082	-1,38
year_2000	0,134	4,80	0,046	1,16	0,057	1,33	-0,012	-0,27	0,000	0,01
year_2001	0,061	2,52	0,134	4,48	0,159	4,87	0,126	4,10	0,150	4,47
year_2002	-0,108	-4,70	-0,033	-1,35	-0,008	-0,31	-0,026	-1,05	-0,005	-0,17
year_2003	-0,184	-9,47	-0,112	-5,50	-0,090	-4,04	-0,096	-4,61	-0,077	-3,36
year_2004	-0,051	-2,67	-0,141	-3,51	-0,146	-3,50	-0,137	-3,58	-0,140	-3,52

Table A2 (cont.): Estimates of a flexible dynamic model

	Ordered probit with 5 outcomes						Ordered probit with 3 outcomes			
	Simple Probit		Rivers-Vuong method for endog. var.		Rivers-Vuong and Wooldridge for unobs. heterog.		Rivers-Vuong method for endog. var.		Rivers-Vuong and Wooldridge for unobs. heterog.	
	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat
y_0					0,043	2,64			0,060	2,72
1st stage residuals										
ii_price			-0,708	-3,26	-0,753	-3,37	-1,101	-3,88	-1,162	-3,96
ii_price(-1)			0,061	0,57	0,071	0,65	0,066	0,51	0,083	0,62
ii_price(-2)			0,019	0,47	0,019	0,45	0,014	0,24	0,019	0,33
ii_price(-3)			-0,063	-1,94	-0,068	-2,03	-0,099	-2,28	-0,099	-2,20
remain_cum_iip			-0,037	-1,92	-0,045	-2,27	-0,061	-2,48	-0,063	-2,45
wage			-0,157	-6,21	-0,170	-6,52	-0,227	-5,37	-0,244	-5,57
wage(-1)			0,008	0,44	0,006	0,32	0,044	1,26	0,016	0,45
wage(-2)			0,032	1,70	0,024	1,22	0,150	4,45	0,112	3,19
wage(-3)			0,027	1,43	0,017	0,84	0,149	4,32	0,117	3,25
remain_cum_wage			-0,029	-2,21	-0,034	-2,45	0,015	0,84	-0,003	-0,15
prod			0,003	0,07	0,005	0,11	0,022	0,32	0,018	0,25
prod(-1)			-0,068	-5,33	-0,052	-3,93	-0,094	-4,67	-0,076	-3,60
prod(-2)			-0,065	-5,55	-0,050	-4,10	-0,113	-5,98	-0,096	-4,88
prod(-3)			-0,021	-1,77	-0,006	-0,52	-0,030	-1,53	-0,011	-0,54
remain_cum_prod			-0,036	-5,58	-0,028	-4,00	-0,054	-5,29	-0,042	-3,85
sect_price(-1)			-0,240	-6,90	-0,240	-6,71	-0,257	-7,05	-0,258	-6,84
sect_price(-2)			-0,175	-4,99	-0,173	-4,81	-0,198	-5,40	-0,198	-5,24
sect_price(-3)			-0,185	-4,97	-0,203	-5,27	-0,218	-5,66	-0,239	-5,96
remain_cum_price			-0,061	-4,70	-0,055	-3,98	-0,067	-5,00	-0,063	-4,42
rho=su/(su+sw)					0,128	22,76			0,134	22,29
LogL	-34068,394		-33631,712		-32676,041		-29022,000		-28086,465	

Table A3: Estimates of a model with asymmetries

	Ordered probit with 5 outcomes				Ordered probit with 3 outcomes			
	Effect of a decrease in x		Effect of an increase in x		Effect of a decrease in x		Effect of an increase in x	
	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat
ii_price	-0,355	-0,74	1,370	5,87	0,282	0,38	1,530	4,33
ii_price(-1)	0,232	1,17	-0,271	-2,29	0,091	0,34	-0,225	-1,46
ii_price(-2)	0,041	0,55	-0,046	-0,66	-0,001	-0,01	-0,025	-0,26
ii_price(-3)	0,068	0,85	0,085	1,19	0,014	0,12	0,135	1,45
remain_cum_iip	0,132	1,95	0,022	0,35	0,182	1,39	0,030	0,33
wage	0,988	1,54	0,210	6,21	2,432	2,66	0,400	4,30
wage(-1)	-0,067	-2,30	0,034	2,90	-0,054	-1,07	0,006	0,23
wage(-2)	-0,027	-0,83	0,040	2,46	-0,071	-1,20	0,052	1,46
wage(-3)	-0,027	-0,62	0,035	1,17	-0,066	-1,00	0,039	0,76
remain_cum_wage	-0,016	-0,39	0,054	2,75	-0,240	-1,87	0,017	0,71
prod	0,298	2,42	-0,223	-2,00	0,193	1,02	-0,116	-0,49
prod(-1)	-0,050	-1,50	0,065	3,24	-0,015	-0,28	0,070	2,00
prod(-2)	-0,005	-0,25	0,047	2,91	0,018	0,54	0,071	2,56
prod(-3)	-0,031	-1,25	0,027	1,33	-0,009	-0,27	0,022	0,66
remain_cum_prod	-0,100	-1,40	0,119	3,14	-0,061	-0,58	0,119	2,12
sect_price	0,039	1,37	0,204	10,08	0,047	1,61	0,223	10,54
sect_price(-1)	0,100	2,42	0,077	1,66	0,070	1,63	0,161	3,20
sect_price(-2)	-0,037	-0,77	0,221	5,15	-0,003	-0,07	0,226	5,07
sect_price(-3)	0,025	0,35	0,167	2,59	0,058	0,90	0,158	2,47
remain_cum_price	0,019	1,01	0,058	1,88	0,004	0,21	0,096	2,85
vat_2000	0,028	0,36			0,196	1,94		
vat_2000_2	-0,122	-2,43			-0,090	-1,81		
Euro_2002	0,081	1,16			0,068	1,05		
Euro_2002_2	-0,058	-2,09			-0,007	-0,23		
q1	-1,971	-21,72			-1,142	-11,89		
q2	-1,117	-12,46						
q3	1,697	18,89			1,679	17,45		
q4	2,585	28,46						
sect_c1	-0,140	-1,43			-0,132	-1,55		
sect_c2	-0,077	-1,23			-0,151	-2,19		
sect_c3	-0,226	-2,13			-0,250	-2,53		
sect_c4	0,015	0,26			-0,041	-0,75		
sect_d0	-0,248	-3,83			-0,237	-3,97		
sect_e1	-0,221	-2,67			-0,173	-2,50		
sect_e2	-0,095	-1,82			-0,085	-1,70		
sect_e3	-0,085	-1,02			-0,049	-0,66		
sect_f1	0,020	0,33			-0,081	-1,28		
sect_f2	-0,188	-2,96			-0,185	-3,38		
sect_f3	-0,070	-2,02			-0,109	-3,24		
sect_f4	-0,075	-2,10			-0,070	-2,03		
sect_f5	-0,098	-2,37			-0,122	-3,13		
sect_f6	-0,241	-4,06			-0,275	-4,19		
year_1999	0,029	0,29			0,049	0,49		
year_2000	0,077	1,34			0,056	1,02		
year_2001	0,121	2,76			0,122	2,79		
year_2002	-0,007	-0,18			-0,001	-0,04		
year_2003	-0,115	-3,27			-0,075	-1,96		
year_2004	-0,184	-4,41			-0,114	-2,53		

Table A3 (cont.): Estimates of a model with asymmetries

	Ordered probit with 5 outcomes				Ordered probit with 3 outcomes			
	Effect of a decrease in x		Effect of an increase in x		Effect of a decrease in x		Effect of an increase in x	
	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat	Coeff	Z-stat
1st stage residuals								
ii_price	-0,993	-4,25	0,778	1,61	-1,037	-2,93	0,291	0,39
ii_price(-1)	0,101	0,84	-0,537	-2,67	-0,007	-0,05	-0,527	-1,92
ii_price(-2)	-0,004	-0,06	-0,071	-0,87	-0,105	-1,05	-0,045	-0,35
ii_price(-3)	-0,127	-1,71	-0,043	-0,50	-0,219	-2,23	0,000	0,00
remain_cum_iip	-0,031	-0,49	-0,153	-2,26	-0,034	-0,37	-0,207	-1,58
wage	-0,190	-5,47	-1,020	-1,59	-0,403	-4,25	-2,473	-2,70
wage(-1)	-0,044	-2,12	0,123	1,81	-0,043	-0,97	0,194	1,93
wage(-2)	-0,018	-0,82	0,096	1,65	0,043	0,90	0,134	1,39
wage(-3)	-0,021	-0,63	0,016	0,25	0,013	0,22	0,150	1,57
remain_cum_wage	-0,046	-2,30	0,018	0,40	-0,010	-0,39	0,223	1,67
prod	0,283	2,52	-0,275	-2,23	0,195	0,83	-0,154	-0,82
prod(-1)	-0,085	-3,28	-0,044	-1,15	-0,077	-1,70	-0,138	-2,25
prod(-2)	-0,064	-2,90	-0,074	-2,84	-0,104	-2,74	-0,140	-3,28
prod(-3)	-0,004	-0,17	-0,046	-1,56	0,010	0,25	-0,113	-2,56
remain_cum_prod	-0,112	-2,95	0,087	1,22	-0,109	-1,94	0,047	0,45
sect_price(-1)	-0,256	-4,47	-0,162	-2,20	-0,377	-6,06	-0,086	-1,12
sect_price(-2)	-0,293	-5,36	-0,044	-0,60	-0,316	-5,47	-0,067	-0,88
sect_price(-3)	-0,279	-3,83	-0,046	-0,52	-0,290	-3,94	-0,101	-1,19
remain_cum_price	-0,065	-2,08	-0,023	-1,15	-0,106	-3,07	-0,008	-0,39
LogL	-33542,947				-28954,329			

Note: The estimates presented i this table are those obtained using Rivers-Vuong approach.