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Why are Prices Sticky?
Evidence from Business Survey Data☆

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Abstract

This paper analyzes the price setting behavior of German retail and wholesale firms using data from a large panel of monthly business surveys from 1990-2006 with the aim to assess different price setting theories. The firm-level data allows matching changes in firms' prices to several other idiosyncratic variables. Using an Ordered Probit specification, a menu cost model in the spirit of Cecchetti (1986) is estimated relating the price adjustment probability to both time- and state- dependent variables. Evaluating the relative importance of the different theories is important due to their divergent implications concerning the real effect of monetary policy. First, results suggest an important role for state-dependence; macroeconomic variables characterizing the state of the economy show large and highly significant effects. Moreover, firm-specific factors such as changes in orders or the expected business development significantly change the repricing probability. Thus, purely time-dependent models are not supported by the results. Second, the data promote pricing models with intermediate inputs in which stickiness "accumulates" through the production chain. The variability of input costs is among the most important determinants for the repricing probability. Moreover, retail prices adjust fast to changes in input costs suggesting a lack of additional stickiness at the retail level.

Keywords: Price setting behavior, time dependent pricing, state dependent pricing, sticky prices
JEL: E31, E32, E50

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1. Introduction

In order for monetary policy to have real effects, macroeconomic models largely rely on nominal frictions such as price or wage stickiness. In the last decades, a large body of theoretical literature emerged analyzing the nature of price rigidity with the main focus on the relative importance of the different mechanisms underlying the price setting behavior of firms. Moreover, the improved availability of detailed price data recently allowed to analyse implications of micro price data for these theoretical models with the aim of disentangling and analyzing the different sources of price stickiness [1]. Among the most prominent theories are those characterizing firms' decision to adjust prices as either time- or state-dependent. One difficulty in modeling price setting, however, has been to appropriately map the features observed in the micro data into aggregate outcomes. In the menu cost model of, for instance, Caplin and Spulber (1987), prices are adjusted infrequently but still nominal shocks have no effects on the real economy. On the other hand, in models of imperfect information (Mackowiak and Wiederholt, 2009), monetary shocks have large and persistent real effects even though there is frequent price adjustment[2]. Similarly, Christiano et al. (1998) shows that there is no simple mapping from the frequency of price changes observed in micro data to impulse responses of prices and quantities to shocks at the macro level.

Due to these difficulties, attempts have been made to model the price setting decision of firms more realistically. One approach has been to differentiate between firms' reaction to firm-specific and aggregate shocks and include both types of disturbances in a menu cost model (Golosov and Lucas, 2007). Additionally, imperfect information models as, for instance, Mackowiak et al. (2009), stress the importance of idiosyncratic shocks for price adjustment.

[1]Recent examples are Bils and Klenow (2004), Klenow and Kryvtsov (2008) or Nakamura and Steinsson (2008a) for the US and publications within the Inflation Persistence Network (IPN) for the euro area such as Dhyne et al. (2005) for consumer prices and Vermeulen et al. (2007) for producer prices.

[2]See Mackowiak and Smets (2008) for a survey.

Indeed, using aggregate data, empirical evidence has been found that firms adjust prices slowly in response to aggregate shocks but immediately react to changes in firm-specific conditions (Boivin et al., 2009). A different strategy to generate more persistent responses of output to a monetary shock has been to allow for nominal rigidity at different production stages in price setting models. In these models, firms at each stage of processing face sticky input costs preventing them from changing their own prices following a shock to the economy. Thus, intermediate inputs act as "multipliers" for price stickiness (Basu, 1995; Huang and Liu, 2001).

In the following analysis, a large panel of monthly survey data compiled by the Ifo Institute for Economic Research covering about 423,000 German retail and wholesale firms is used to shed more light on the above mentioned issues. The dataset contains qualitative information on price changes as well as a number of additional variables reflecting idiosyncratic conditions of the firms. In particular, an ordered probit menu cost model is specified and estimated in the spirit of the seminal target-threshold model by Cecchetti (1986). Within this empirical specification, the probability of price adjustment is related to a set of both time- and state-dependent regressors. Evaluating the relative importance of these different price setting theories clearly is of policy-relevance due to their divergent implications for the effects of monetary policy (Dotsey et al., 1999). Judging the validity of time- versus state-dependent elements using a menu cost specification is not a new approach. However, due to the idiosyncratic nature of the survey data, information on prices can be related to other firm-specific variables allowing to more extensively capture the specific state of the individual firms. This is not possible using other types of price data, as, for instance, individual price records, and is thus new to the analysis of price setting in Germany. Moreover, the survey data allows to link information on prices to input costs on a product group-specific basis allowing to analyse the transmission of price shocks through different production stages.

The empirical analysis covers two main issues. First, it will be assessed whether factors characterizing the state of the firm are significant determinants for the probability of price adjustment next to time-dependent elements. In time-dependent models, firms regularly adjust prices independently of the environment they are faced with (Taylor, 1980; Calvo, 1983). Therefore, the frequency of price setting is constant. Contrarily, state-dependent pricing theories assume a fixed cost of price adjustment preventing firms from changing prices as long as the adjustment cost exceeds the cost arising from having implemented a sub-optimal price (Dotsey et al., 1999). The probability of price adjustment thus depends on the state of the economy. In contrast to time-dependent models, therefore, both the size and the frequency of price adjustment varies with the state of the economy. The dataset at hand allows to examine the relative importance of the different regressors for the *frequency* of price changes. It will thus be analysed whether variables measuring the state of the firm such as changes in the business volume, the number of orders or the expected business development as well as aggregated indicators like the rate of inflation, changes in the oil price or the exchange rate, accumulated since the last price change, are important for the price adjustment probability. Analysing the effects of the firm-specific variables will furthermore show whether idiosyncratic conditions are indeed more important for price setting than aggregate factors as implied by the imperfect information model of Mackowiak and Wiederholt (2009). Results show that while elements such as Taylor contracts and seasonality are present in the data, a purely time-dependent pricing model can not be supported by the results. State-dependent factors such as changes in the rate of inflation or the oil price, accumulated since the last price change, are highly significant and have quantitatively important effects on the price adjustment decision. Moreover, factors characterizing the firm-specific environment have significant effects. Even though idiosyncratic factors are important, they do not have quantitatively larger effects compared to aggregate variables.

The second main issue addressed is concerned with the price setting mechanism at different production stages. The question of whether the retail sector or preceding stages of production are dominant for the timing of price adjustment can have important implications for modeling price stickiness[3]. In price setting models assuming an input-output production structure, intermediate inputs raise the degree of price stickiness because the pricing decisions of different firms become strategic complements (Nakamura and Steinsson, 2008b). Similarly, in models that assume a vertical in-line production structure as, for instance, in Basu (1995) and Huang and Liu (2001), nominal rigidity at the retail level is increased just because stickiness "adds up" through the production chain. In these models, prices of primary goods quickly adjust to macroeconomic shocks. In contrast, prices of goods at later stages of processing show a sluggish response to aggregate shocks but respond immediately to input price changes. Analysing the degree of *additional* rigidity at the retail level should thus help to evaluate the predictions of these models. The survey dataset allows to analyze the effects of input prices on the probability of price adjustment in the retail and wholesale sector and thus to draw conclusions about the pass-through of price shocks. In particular, the responses of the wholesale- and retail price adjustment probability in reaction to price changes in the respective preceding production stages are described and compared. Empirical results suggest first, that input price changes are indeed among the most important determinants for the timing of price adjustment for both retail and wholesale firms; the variables measuring changes in the input price indices are highly significant and have large marginal effects. Second, adding lags of input price measures shows that the effect of input price changes on the probability of price adjustment in retail is rather immediate compared to the respective response in wholesale. This suggests that firms at the last stage of processing quickly respond to price changes within the preceding production stage. Thus, there is not much additional rigidity at the retail level, which confirms the main implications of the above mentioned models.

[3] See Nakamura (2008) for a discussion.

The remainder of the paper is organized as follows. Section 2 gives a short review of the literature related to these issues. In section 3, the empirical strategy is outlined including a description of the business survey data, the empirical specification as well as the estimated price setting equations. In section 4, the main results as well as robustness checks are given. Section 5 concludes.

2. Related Literature

Within the empirical literature analysing the relative importance of time- versus state-dependence, there are three main approaches. One strategy, initiated by the seminal contribution of Cecchetti (1986) using data on magazine prices, is to analyse individual price records. More recent studies make use of large sets of price data on a broad range of goods collected by national statistical offices to calculate the Consumer-/ Producer Price Index (CPI/PPI). Overall, however, results from these studies concerning the price adjustment process remain rather inconclusive. Klenow and Kryvtsov (2008), for instance, find that neither time- nor classical state-dependent frameworks are consistent with micro data features. They suggest that, instead, models incorporating real rigidities as economies of scope (Midrigan, 2007) or a Poisson distribution of idiosyncratic shocks (Gertler and Leahy, 2008), are better able to reflect the size and frequency of price changes observed in the data. Nakamura and Steinsson (2008a) find evidence for the importance of state-dependence as the frequency of price changes strongly reacts to inflation. For Belgium CPI data, Aucremanne and Dhyne (2005) show that while time-dependent factors are most important for price setting, state-dependent variables such as the rate of inflation, accumulated since the last price change, are significant as well. Furthermore, Dhyne et al. (2005) and Vermeulen et al. (2007), summarizing empirical findings of the Inflation Persistence Network (IPN) using CPI and PPI data respectively, find support for both time- and state-dependent elements. For

Germany, Hoffmann and Kurz-Kim (2006) find that while Taylor pricing and seasonality are present in the data, the significant reaction of prices to institutional changes suggests an important role for state-dependence. Moreover, the probability of price adjustment is strongly related to product-specific inflation as well as input price changes.

Another approach has been to use one-time firm-surveys asking firms explicitly for the timing of and reasons for price adjustment. Seminal work by Blinder (1991) for the U.S. has been followed by interview studies on European firms conducted by the IPN and summarized by Fabiani et al. (2006). The latter study finds that the majority of firms in the Euro area adjust prices taking into account state-dependent elements. Yet a different strategy to empirically explain price adjustment has been to use business survey data on prices and other firm-specific variables. Rupprecht (2007), using survey data of Swiss manufacturing firms, documents evidence for the importance of state-dependent elements next to time-dependent features. Moreover, the idiosyncratic environment of firms is suggested to be an important driver of price adjustment relative to aggregate factors.

As far as the transmission of price shocks through the production chain is concerned, theoretical models using either a roundabout production structure (Basu, 1995; Nakamura and Steinsson, 2008b) or a vertical chain of production (Blanchard, 1983; Huang and Liu, 2001) suggest that price stickiness "adds up" through the production chain. Due to the inclusion of intermediate inputs, the price adjustment decisions of different firms become strategic complements. So far, empirical evidence on these models' impliciations are rather mixed. Clark (1999) estimates a VAR model for the U.S. to analyze the effects of a monetary shock on prices set by firms across different stages of production and finds that input prices move much faster in response to a monetary shock than output prices at early stages of processing. The difference between input and output prices shrinks for subsequent stages suggesting that the retail sector does not add additional stickiness but that price rigidity rather accumulates. On the other hand, Nakamura (2008) studies the comovement of prices across products and firms using detailed U.S. price data and finds some evidence for retail firms playing the dominant role in the timing of price adjustment as retail-level shocks seem to drive a wedge between the observed price level and costs at the wholesale level.

3. Empirical Strategy

3.1. Business Survey Data

The dataset consists of a large panel of business surveys for the retail and wholesale sector conducted by the Ifo Institute for Economic Research. A summary of the variables used is given in table 1. The econometric sample constructed from this dataset covers 930 retail and 1,000 wholesale firms. Because some of the firms responded to several questionnaires for different product groups, the observation unit is firm-products leading to a total of 2,017 and 2,600 observation units for the retail and wholesale sector, respectively. The sample runs from January 1990 to January 2006 yielding a total of about 179,600 observations for the retail- and 243,200 observations for the wholesale sector. As firms take part in the survey on a voluntary basis, not every firm responded every month resulting in an unbalanced dataset. Each retail firm can be allocated to one of nine sectors according to the 4-digit WZ08 classification of the Federal Bureau of Statistics. Wholesale firms are classified into six different sectors in line with the WZ08 classification.

Amongst other questions, both retail and wholesale firms are asked whether they changed the price of their products in the last month (denoted $prvpm_{it}$ for firm i in period t). The answers are coded as 1 ("increased"), 0 ("not changed") and -1 ("decreased"). Further questions considered in the analysis include variables concerning the state of the firm. For instance, firms are asked how they appraise the current state of business ($statebus_{it}$) as well

Table 1: Dependent and Independent Variables

Dependent variable	
prvpm	price versus previous month
Firm-specific variables	
busvoly	business volume versus previous year
ords	orders versus previous year
statebus	state of business (appraisal)
feedst	stock of inventory (appraisal)
busdev	business development
Wholesale/manufacturing prices	
pr_ws	net price incr. in wholesale (sector-specific)
pr_m	net price incr. in manufact. (weighted average)
Macroeconomic variables	
cpi/ppi	consumer/producer price inflation rate
ip	change in industrial production
exchrate	change in Euro/USD exchange rate
oil	change in the oil price
metals	change in the price index of metals
m3	change in monetary aggregate
intr	short-term interbank deposit rate
Institutional dummies	
euro	introduction of euro (+/- 3 months)
vat	change in vat rate (+/- 3 months)
"Time-dependent" variables	
taylIncr_j	Taylor dummy - price incr. j months ago
taylDecr_j	Taylor dummy - price decr. j months ago
winter/summer/fall	seasonal dummies

Note: all macroeconomic variables are cumulative changes since the last price adjustment.

as their feedstock supplies ($feedst_{it}$). Moreover, there are questions related to their business volume ($busvoly_{it}$) as well as their orders ($ords_{it}$) versus the same month in the previous year. Finally, firms are asked about their expectations concerning the overall business development in the coming six months ($busdev_{it}$).

As has been mentioned above, using micro data to analyse price setting behavior is not new. However, while detailed price data underlying the CPI give precise results on the frequency and size of price adjustments, it is hard to disentangle which particular factors explain price setting because the individual price data cannot be matched with firm-specific variables. In contrast, business survey data gives information on price changes of every individual firm and, at the same time, on a range of different idiosyncratic variables of that specific firm. Furthermore, the dataset allows to analyze the effects of changes in the input prices

Figure 1: Aggregated Micro Retail Price Data and Retail Price Index

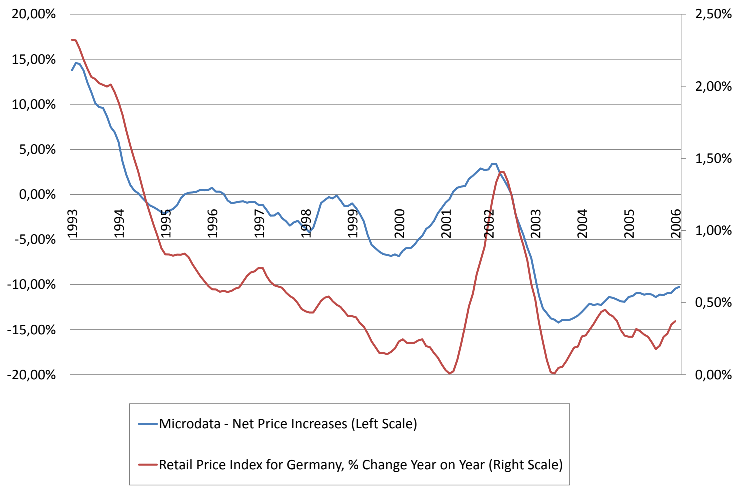
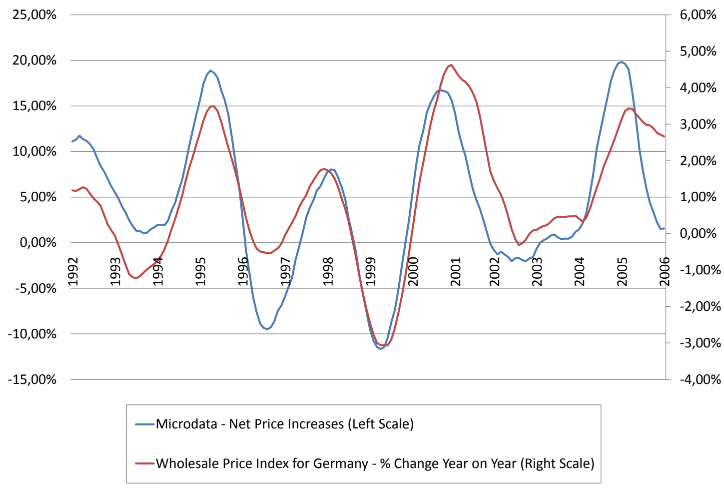


Figure 2: Aggregated Micro Wholesale Price Data and Wholesale Price Index



on the probability of price adjustment for the respective stages of production. A further advantage of the data is that firms are not asked directly on their pricing strategies as it is the case for the one-time interview studies conducted by, for instance, Blinder (1991) for the US and Fabiani et al. (2006), for the euro area. Such an interview method is likely to produce biased responses as firms might be unwilling to respond truthfully to questions regarding their pricing strategies. Moreover, in contrast to the one-time interviews, firms are asked every month which better reveals their pricing behavior over time. Despite these advantages it should be kept in mind that due to the qualitative nature of the questionnaires the data does not allow to make an inference concerning the size of price changes. However, constructing an aggregate time series from the micro data shows that the price data quite nicely reflects movements in the official aggregate price indices. Figures 1 and 2 display the comovement of the aggregated net price increases in the retail and wholesale sector with the German retail and wholesale price indices constructed by the Federal Bureau of Statistics, respectively [4].

3.2. Econometric Model

The dependent price variable $prvpm_{it}$ has three discrete outcomes: -1 for a price decrease, 0 if there is no price change and +1 for a price increase. A latent variable specification is assumed to underly the data generating process with an unobserved quantitative price variable y_{it}^* depending on a set of explanatory variables:

$$y_{it}^* = \mathbf{x_{it}}\boldsymbol{\beta} + u_{it}. \tag{1}$$

Following the canonical target-threshold approach suggested by Cecchetti (1986) and applied by, for instance, Aucremanne and Dhyne (2005), Loupias and Sevestre (2010) or Dhyne et al.

[4] The aggregation of micro data is conducted by the following formula:

$$F_{jt}^+ = \frac{\sum_{i=1}^{n_j} y_{ijt}^+ - \sum_{i=1}^{n_j} y_{ijt}^-}{\sum_{i=1}^{n_j} y_{ijt}^+ + \sum_{i=1}^{n_j} y_{ijt}^- + \sum_{i=1}^{n_j} y_{ijt}^0},$$

where y_{ijt}^+ and y_{ijt}^- indicate a price increase and a price decrease of firm i belonging to sector j at time t, respectively, and y_{ijt}^0 indicates that the price was not changed. All time series are included as moving 13 month averages.

(2007), a menu cost interpretation is applied to this specification. In particular, a fixed cost of price adjustment is assumed that prevents firms from changing prices every period. This assumption can be stated in simple form as:

$$p_{it} = \begin{cases} p_{it-1} \text{ if } |p^*_{it} - p_{it-1}| \leq c_{it} \\ p^*_{it} \text{ if } |p^*_{it} - p_{it-1}| > c_{it} \end{cases},$$

where p_{it} is the actual price of firm i at time t, p^*_{it} denotes the optimal price the firm would set if there were no menu costs, and c_{it} stands for the firm's threshold beyond which price adjustment is profitable. Thus, c_{it} can be interpreted as the cost of price adjustment; if the absolute difference between the actual and the optimal price exceeds the threshold, the firm changes its price. Based on this representation, one can distinguish price increases and decreases:

$$p_{it} < p_{it-1} \text{ if } (p^*_{it} - p_{it-1}) < 0 \text{ and } |p^*_{it} - p_{it-1}| > \alpha_{1it}$$
$$p_{it} > p_{it-1} \text{ if } (p^*_{it} - p_{it-1}) > 0 \text{ and } |p^*_{it} - p_{it-1}| > \alpha_{2it}.$$

Thus, the firm decreases (increases) its price if the difference between the actual and optimal price is negative (positive) *and* the absolute distance from the optimal price exceeds thresholds α_{1it} or α_{2it}, respectively. These thresholds are positively related to the "menu cost" c_{it} given in equation (2). Intuitively, the higher the cost of price adjustment and thus the larger the values of the thresholds c_{it}, α_{1it} and α_{2it}, the more the firm's actual price is allowed to travel away from the optimal price until the firm decides to adjust prices. To derive an econometric specification, I assume the latent variable y^*_{it} to be equal to the difference between the actual and optimal price, such that $y^*_{it} = \Delta p^d = (p^*_{it} - p_{it-1})$. Moreover, the two thresholds are assumed to be invariant across time and units of observation; $\alpha_{1it} = \alpha_1$ and $\alpha_{2it} = \alpha_2$. This leads to the following observation rule for the observed discrete price variable y_{it}:

$$y_{it} = \begin{cases} -1 \text{ if } y_{it}^* \leq \alpha_{1y} \\ 0 \text{ if } \alpha_{1y} \leq y_{it}^* \leq \alpha_{2y} \\ 1 \text{ if } \alpha_{2y} < y_{it}^* \end{cases}. \tag{2}$$

This model can be estimated by means of an ordered probit specification implying an ordinal interpretation of the dependent variable, i.e. the outcome increases/decreases in the underlying latent variable but does not have a cardinal ordering. The ordinal interpretation applies to the structure of the price data at hand because, for instance, a higher outcome of the dependent variables implies a larger difference between the underlying unobserved price and the optimal price of the firm.

3.3. Price Setting Equations

Following, for instance, Aucremanne and Dhyne (2005), $\mathbf{x_i'}\boldsymbol{\beta}$ in equation (1) represents a mix of the time-dependent and state dependent variables. For the baseline specification, the following price setting equation is assumed:

$$y_{it}^* = I_{it}\beta_1 + M_{it}\beta_2 + D_{it}^t\beta_3 + D_{it}^s\beta_4 + u_{it}. \tag{3}$$

Using this baseline specification it will be analyzed whether, next to time dependent variables, measures reflecting the state of the firm have a significant effect on the probability of price adjustment. I_{it} denotes a vector of the firm-specific variables described in the previous section. In order to more conveniently interpret the effects of these measures, two different dummy variables are constructed of all of them. The first dummy, labeled $^+$, equals 1 if there is an increase or if the situation is good, respectively, and 0 otherwise. The second dummy, labeled $^-$, equals 1 if there is a decrease or if the situation is bad, and 0 otherwise. Furthermore, a set of time-dependent variables, indicated by D^t_{it}, is added to the specification. To investigate whether firms in the dataset employ Taylor-type pricing, Taylor dummies are constructed indicating that the last price increase/decrease occured a fixed period ago. Recent studies on the frequency of price changes as, for instance Hoffmann and Kurz-Kim (2006) for Germany, show that there are large spikes in hazard rates at six, 12 and 24 months. This indicates that the probability of a firm to reprice conditional on having set a new price six, 12 or 24 months ago is particularly high. Therefore, dummy variables are defined accordingly as $TaylIncr6_{it}/\ TaylDecr6_{it}$, $TaylIncr12_{it}/\ TaylDecr12_{it}$ and $TaylIncr24_{it}/\ TaylDecr24_{it}$. Furthermore, seasonal dummies are constructed to examine whether the probability of repricing according to fixed time intervals is increased. As is often stressed in the empirical literature on price setting, a large degree of heterogeneity is observed, both between and within product groups. Observable differences between sectors are accounted for by including sector-specific dummy variables, indicated by D^s_{it}. However, heterogeneity within different sectors is unobserved in the data. Since the "pooled" ordered probit specification given above does not account for individual-specific effects, the results might be biased. To account for this problem of unobserved heterogeneity, a vector M_{it} of firm-specific averages of the idiosyncratic variables is added to the specification as suggested by, for instance, Mundlak (1978).

To analyse the importance of the aggregate state of the economy for price setting, a vector of macroeconomic variables, indicated by Mac_{it}, is included in the set of regressors. In standard menu cost models, the likelihood of price adjustment depends on the distance of the actual to the optimal price. Because the optimal price itself varies with the state of the economy, this distance depends on changes in macroeconomic factors, accumulated since the last price change. Hence, cumulative values of all macroeconomic variables since the last price adjustment are considered. Furthermore, a set of dummy variables, D_{it}^{i}, controlling for important institutional events is added. This leads to the following augmented price setting equation:

$$y_{it}^{*} = I_{it}\beta_1 + M_{it}\beta_2 + D_{it}^{t}\beta_3 + D_{it}^{s}\beta_4 + Mac_{it}\beta_5 + D_{it}^{i} + u_{it}. \tag{4}$$

According to, for instance, Dotsey et al. (1999), an increase in inflation leads to a faster erosion of the relative prices of particular firms which should increase the probability of repricing. Thus, the cumulative consumer- and producer price inflation rates since the last price change are included as regressors (CPI_t / PPI_t)[5]. Furthermore, cumulative changes in the oil price (oil_t) and in the price index for metals ($metals_t$) are included to account for changes in raw material costs. To account for the overall state of the economy and thus changes in the demand situation, the growth rate of the economy is approximated by the cumulative change in industry production (IP_t). Moreover, the cumulative USD/Euro exchange rate ($exchrate_t$) is added to the set of independent variables to capture changes in foreign demand. Finally, as a measure of the monetary policy stance, cumulative changes in M3 and in the short-term interest rate are considered ($m3_t$, i_t). Moreover, a set of dummies reflecting important institutional events are added to the price setting equation (D_{it}^{i}). Events that might influence the decision to adjust prices are the introduction of the Euro in 2002 as well as changes in the level of the value added tax in 1993 and 1998. The dummies take on the value 1 in the month of the change as well as in the prior and following three months.

[5]Because the survey price data for the retail sector approximately reflects CPI data while the wholesale price data strongly comoves with PPI data, to avoid endogeneity, changes in the PPI and CPI are included as regressors for the retail and wholesale regressions, respectively.

To account for possible endogeneity problems associated with the cumulative variables, the first individual observation of the dependent variable is included as an additional regressor, as has been suggested by Wooldridge (2005) and applied by Loupias and Sevestre (2010)[6].

In order to shed more light on how price shocks are transmitted through the chain of production, variables measuring changes in the input prices for the respective sectors are included in the specification. Moreover, adding lags of these variables allows to analyse the length of the adjustment process to input price changes. Thus, the following two specifications are estimated:

$$\begin{aligned} y^*_{it} &= I_{it}\beta_1 + M_{it}\beta_2 + D^t_{it}\beta_3 + D^s_{it}\beta_4 + Mac_{it}\beta_5 + D^i_{it}\beta_6 \\ &\quad + P_{it}\beta_7 + u_{it} \end{aligned} \tag{5}$$

$$\begin{aligned} y^*_{it} &= I_{it}\beta_1 + M_{it}\beta_2 + D^t_{it}\beta_3 + D^s_{it}\beta_4 + Mac_{it}\beta_5 + D^i_{it}\beta_6 \\ &\quad + P_{it}\beta_7 + lP_{it}\beta_8 + u_{it}. \end{aligned} \tag{6}$$

In equations (5) and (6), P_{it} indicates a vector of input price variables. In the regressions for the retail sector, both wholesale and manufacturing price developments are considered, because retail firms use products of both sectors as inputs[7]. For the analysis of the wholesale sector, only a measure of changes in manufacturing prices is considered. As both datasets are classified according to the same internal classification scheme of the Ifo institute, wholesale price data could exactly be matched to the retail data on a product group-specific basis [8].

[6] Card and Sullivan (1988) show that cumulative variables may lead to endogeneity issues and thus to biased estimators, because they can be expressed as $x_{it} = 1 + (1 - y_{it-1})x_{it-1}$

[7] Because according to the input-output table of the Federal Bureau of Statistics retail products make up for only about 1% of all inputs used by the wholesale sector, the wholesale price variable is assumed to be exogeneous in the retail price equation, i.e. the wholesale sector does not use retail products.

[8] According to the internal Ifo classification scheme, the term "product group" implies an ordering according to the first three digits of the five-digit product code.

The frequency of net price increases in the wholesale sector was calculated as an average of all firms of a particular three-digit product category for every month in every year. Thus, for every product category, the frequency of net price increases was constructed according to:

$$F_{jt}^{ws,+} = \frac{\sum_{i=1}^{n_j} y_{ijt}^{ws,+} - \sum_{i=1}^{n_j} y_{ijt}^{ws,-}}{\sum_{i=1}^{n_j} y_{ijt}^{ws,+} + \sum_{i=1}^{n_j} y_{ijt}^{ws,-} + \sum_{i=1}^{n_j} y_{ijt}^{ws,0}}$$

where $F_{jt}^{ws,+}$ denotes the frequency of net price increases of a particular product-group j within the wholesale sector, $y_{ijt}^{ws,+}$ and $y_{ijt}^{ws,-}$ indicate a price increase and a price decrease of firm i belonging to sector j at time t, respectively, and $y_{ijt}^{ws,0}$ indicates that the price was not changed. These "time series" for the different product groups could then be matched to every retail firm belonging to the same category. Such an exact match was possible for about 67% of the retail firms. To construct a measure of changes in manufacturing prices, a business survey dataset for German manufacturing firms has been used. Unfortunately, a sector-specific match of input prices was not possible because this dataset has been coded differently. To construct a measure of the price development, therefore, a weighted average of net price increases of all sectors was constructed for every time unit: $F_t^{m,+} = \sum_{j=1}^{J} \omega_j F_{jt}^{m,+}$. $F_{jt}^{ws,+}$ denotes the weighted average of net price increases within the manufacturing sector and $F_{jt}^{m,+}$ indicates the frequency of net price increases within each particular manufacturing sector. The ω_js are the respective weights that are chosen according to their respective usage within the retail and wholesale sector given in the official input-output table of the Federal Bureau of Statistics.

4. Results

4.1. Time-Dependence Versus the Menu Cost Approach

Results for the baseline price setting equation (1) as well as equation (2) including aggregate variables for the retail sector are shown in table A2. For specification (1), coefficients and marginal effects for the outcome "price increase" are given in columns 2 and 3, respectively[9]. It can be seen that all time-dependent variables have highly significant effects on the probability of price adjustment. Moreover, the effects are sizeable; absolute marginal effects for the Taylor dummies range from 6.7% to 15.9%. Thus, for instance, a firm that raised it's price exactly four quarters ago is 15.9% more likely to increase it's price in a given period. Furthermore, seasonal patterns seem to be important for price setting; all seasonal dummies are significant. Next to the time-dependent variables, most of the firm-specific measures show highly significant effects as well. With the exception of the dummy indicating an unexpected increase in the state of business, which is, however, insignificant, all idiosyncratic variables have the expected signs. For instance, decreases in the business volume and orders as well as a deterioration of the expected business development significantly decrease the probability of a price increase (and similarly, raise the probability of a price decrease). Moreover, increases in the former two idiosyncratic variables lead to a significantly higher chance of a firm to increase its price. Thus, results from the estimation of equation (1) appear to be rather mixed: while time-dependence clearly is important for price setting, most of the variables measuring the state of the firm are highly significant, too. Finally, as far as the observable component of heterogeneity is concerned, table 2 shows that most of the sector-specific dummies are significant. Thus, heterogeneity across sectors is important and needs to be controlled for.

[9] Marginal effects for the outcome "price decrease" are not reported to save space, but are available on request.

Adding the cumulative macroeconomic variables as well as the institutional dummies (columns 4 and 5, table A2) further reinforces the evidence in favor of state-dependence. Most of the aggregate variables are highly significant, show the expected signs and have large marginal effects. As expected, an increase in the rate of inflation, accumluated since the last price change, significantly raises the chance of observing a price increase because higher overall inflation erodes the relative price of an individual firm. Relative to the other regressors, the effect is extremely large: a 1 unit increase in cumulative inflation raises the probability of price adjustment by as much as 83%. Moreover, cumulative changes in the oil price, changes in the VAT rate as well as the introduction of the euro have highly significant effects. Furthermore, an appreciation of the Euro/US-Dollar exchange rate significantly decreases the likelihood of observing a price increase. This is in line with economic theory, since a higher value of the euro reduces import prices.

Results for specifications (1) and (2) for the wholesale sector are given in table A3. Regarding specification (1), as for the retail sector, time-dependent elements are important; all Taylor- as well as seasonal dummies are highly significant. Marginal effects of the Taylor dummies are relatively large ranging from, in absolute terms, about 5% to 11%. Moreover, almost all idiosyncratic variables are significant, have the expected sign and show relatively high marginal effects. For instance, a decrease in orders decreases the probability of a price increase by almost 5%. As for the retail sector, adding the cumulative aggregate variables reinforces the evidence in favor of state-dependence. Cumulative changes in the CPI, the oil price as well as the price of metals significantly increase the probability of observing a price increase (and vice versa reduce the probability of a price decrease). In contrast to the retail sector, the dummies indicating changes in institutional events enter with a negative coefficient, which is unexpected. However, marginal effects are rather small suggesting that the introduction of the euro as well as changes in the VAT rate are not very important for price setting in wholesale.

All in all, the results suggest that time-dependent elements such as Taylor pricing and seasonality are important for the price adjustment decision for both retail- and wholesale firms. However, a pure time-dependent representation of pricing is clearly rejected; most of the factors characterizing both the firm-specific and aggregate state of the firms are highly significant and have large effects. In contrast to Rupprecht (2007), even though firm-specific variables are significant, the regression results do not suggest a more important role for idiosyncratic variables compared to aggregate factors. Compared to macro variables such as the cumulative rate of inflation, most of the firm-specific variables have relatively small marginal effects.

4.2. Adding Intermediate Inputs

Adding measures of changes in the wholesale- and manufacturing prices shows that intermediate input prices are important determinants for price adjustment of retail firms. As can be seen in table A4, in specification (3) both variables enter with highly significant coefficients and have large marginal effects. While a 1% increase in the "manufacturing price index" constructed from the survey data leads to a 7.1% higher adjustment probability, the effect of wholesale price measure is even about 17.2%. In price setting equation (4), six lags of the respective input prices have been added to the specification in order to analyse the speed of price adjustment to input cost disturbances. As far as the product group-specific "wholesale price index" is concerned, the first two lags are highly significant, while lags three, four and five are insignificant. This suggests the price adjustment process to a wholesale input price change to be virtually over after three months. Adding up the marginal effects from lag zero to lag two yields a total effect of 0.195; a positive change in wholesale prices thus leads to a higher probability of observing a price increase in the retail sector of almost 20%, accumulated within the first quarter after the change. Adjustment to manufacturing prices seems to be more sluggish; almost all lags of the manufacturing price index are significant indicating that the effect on the retail price adjustment probability is still existent after six months following the input price change. The accumulated effect is about 10%.

Similarly, intermediate input prices are important for the adjustment probability of wholesale firms as is shown in table A5. In specification (3), the measure of manufacturing prices is highly significant and has a rather large marginal effect of 9.5%. In contrast to the retail sector, estimation results of specification (4) show that, with the exception of lag two, all lags of the manufacturing price variable are highly significant and most of them have relatively large marginal effects. Compared to the effect of input price changes on the probability of a price increase in retail, the accumulated effect of manufacturing prices for wholesale firms is rather small; accumulated over six months, a rise in input prices changes the probability of a price increase by only 3.2%.

Two main conclusions emerge from these estimation results. First, while intermediate input prices are important determinants of price adjustment in both retail and wholesale, the length of the adjustment process to input cost changes seem to differ. Results suggest that retail firms quickly and strongly respond to prices of products within the preceding production stage while the effect of price changes of products within the more primary manufacturing sector lasts longer. This is in line with predictions of theoretical price setting models with a vertical production structure of, for instance, Huang and Liu (2001). Furthermore, the results coincide with empirical evidence by Clark (1999) indicating that prices of goods at late stage of processing, such as retail prices, react relatively slowly to changes in the economy or to prices at early stages of production, but respond quickly to price changes of immediate input goods. Second, the fact that intermediate input prices are among the most important determinants for the price adjustment probability in both retail and wholesale further reinforces the conclusion that state-dependence clearly matters for price setting. Moreover, tables A4 and A5 show that most of the state-dependent variables are robust to the inclusion of the input price variables and their lags[10]. More specifically, for the retail sector, in specifications (3) and (4), the rate of inflation, changes in the oil price, changes in the interest rate as well as both institutional dummies are still significant. For the wholesale sector, cumulative changes in the price of oil and metals as well as in the short-term interest rate are still significant and show the expected sign after the inclusion of the input price variable. In specification (4), the oil price variable as well as the euro dummy are still significant and enter with the expected sign.

4.3. Robustness Checks

In order to check for robustness of the results, several variations of specification (3) are estimated. To control for possible endogeneity problems associated with the cumulative variables, the first observation of the dependent variable has been added (regression (1) in tables A6 and A7). The main results for both retail and wholesale are robust to this variation. Moreover, results are robust to the exclusion of the firm-specific means of the idiosyncratic variables (equation (2) in tables A6 and A7). To account for possible endogeneity of the idiosyncratic variables, in regression (3), these measures enter in first lags. The results are robust to this variation suggesting that endogeneity problems associated with these variables are unlikely. Finally, equations (6) and (7) show that the main results are still valid if the macroeconomic variables enter as month-on-month and year-on-year changes, respectively.

Furthermore, to check for robustness under a different estimation strategy, specification (3) is additionally estimated using a linear regression model with fixed effects. In contrast to the "pooled" ordered probit model, this method allows for individual-specific effects that capture unobserved heterogeneity. While the more structural nonlinear index models like

[10] In particular, the effects of the vast majority of firm-specific variables are robust both regarding statistical significance and the quantitative effects for both retail and wholesale. To save space, results for these variables are not included. Detailed results are available on request.

ordered probit lead to more efficient estimators if the distributional assumptions are correct, results are inconsistent if the assumed distribution does not reflect the true data generating process (Angrist and Pischke, 2009). In contrast, estimators obtained by using the linear model are always consistent. Table A8 reports the coefficients from the linear regression as well as the marginal effects of the ordered probit model for the retail and wholesale sector. Qualitatively, the main results are unaffected by using a different estimation method. Moreover, the marginal effects calculated for the ordered probit coefficients show a similar order of magnitude as the coefficients from the linear model further reinforcing the validity of the key conclusions stated above.

5. Conclusion

This paper addresses two main questions concerning the price setting behaviour of German retail and wholesale firms, using qualitative firm-level data over the period 1990-2006. The first main question asked is whether the mechanism underlying the price adjustment decision by firms is driven by time- or state-dependence. While implications of menu cost models are intuitively more appealing compared to the predictions of time-dependent models implying that the price adjustment probability is invariant to changes in the economic environment, so far, empirical results are rather mixed. This paper adds to the existing literature on price setting in Germany by regressing the price adjustment probability not only on time-dependent variables and macroeconomic factors, but also on variables characterizing the idiosyncratic conditions of firms. In line with the previous literature the results suggest that both time- and state-dependent elements are important. However, some of the aggregate variables, such as, most notably, the cumulative rate of inflation, have much larger effects on the repricing probability than time-dependent variables such as Taylor contracts. Additionally, cumulative changes in the price of oil and the exchange rate as well as institutional events significantly affect the timing of price adjustment. These results clearly point to a more important role of state-dependence.

Moreover, most of the variables describing the state of the firm turn out to be highly significant. In particular, increases in orders and business volume as well as improvements in the expected business development significantly increase the probability to observe a price increase and, vice versa, decreases the chance of a price decrease. This confirms the important role of state-dependence for price adjustment. However, idiosyncratic variables are not found to be more important determinants for the timing of price adjustment than aggregate variables, accumulated since the last price change. This may be interpreted as evidence against price setting models that imply a stronger and more immediate reaction of prices to idiosyncratic shocks compared to aggregate disturbances as, for instance, Golosov and Lucas (2007) or Mackowiak and Wiederholt (2009).

The second issue addressed was to evaluate implications of price setting theories that explicitely include intermediate inputs in production. In sticky price models, these inputs act as multipliers for price rigidity since the price adjustment decision of firms across stages of processing become strategic complements. One implication of these models is that price stickiness is accumulated through the production chain; firms at the last stage of processing thus quickly adjust their prices in response to input price changes but adjust slowly to remaining shocks. Regression results show first, that input price variability is indeed among the most important determinants for price adjustment in both retail and wholesale. Furthermore, in line with predictions of pricing models with a vertical production structure (Huang and Liu, 2001), retail firms quickly and strongly respond to wholesale prices while the effect of price changes of products within the more primary manufacturing sector lasts longer. Additionally, this is in accordance with Clark (1999), who suggests a limited role for "additional rigidity" at the retail level. Hence, according to these results, explicitely including intermediate inputs in sticky price models seems to be a more realistic strategy than modeling the timing of price adjustment to react mostly to idiosyncratic shocks. Second, the fact that the price adjustment probability significantly reacts to changes in input costs further confirms that the timing of price change varies with economic conditions.

Appendix A. Regression Results

Table A.2: Retail Sector - Results I

	(1)		(2)	
price	Coef.	ME (1)	Coef.	ME (1)
s_bus^-	-0.003	-0.001	-0.004	-0.001
$feedst^-$	-0.015	-0.003	-0.019*	-0.004
$busvol^-$	-0.123***	-0.023	-0.124***	-0.023
$ords^-$	-0.139***	-0.026	-0.136***	-0.025
$busdev^-$	-0.111***	-0.020	-0.117***	-0.021
s_bus^+	-0.005	-0.001	-0.007	-0.001
$feedst^+$	-0.002	0.000	-0.003	-0.001
$busvol^+$	0.064***	0.012	0.061***	0.012
$ords^+$	0.082***	0.016	0.081***	0.016
$busdev^+$	0.023**	0.004	0.022*	0.004
ppi			4.435***	0.831
exchr			-0.123***	-0.023
ip			-0.019	-0.004
oil			0.126***	0.024
metals			-0.438***	-0.082
m3			-0.966***	-0.181
intr			-0.005	-0.001
euro			0.079***	0.015
vat			0.139***	0.028
taylIncr6	0.523***	0.122	0.506***	0.117
taylDecr6	-0.708***	-0.094	-0.721***	-0.094
taylIncr12	0.650***	0.159	0.639***	0.155
taylDecr12	-0.721***	0.067	-0.730***	-0.095
taylIncr24	0.309***	-0.094	0.309***	0.066
taylDecr24	-0.605***	-0.083	-0.611***	-0.083
season	3/3	0.01-0.02	3/3	0.01-0.02
sector	6/9	0.01-0.07	6/9	0.01-0.07
m_fs	3/5	¡0.01	3/5	¡0.01
Log-Lik.	-108236		-108007	
Obs.	166093		166093	
Adj. Ps.-R2	0.197		0.199	

*** p¡0.01 ** p¡0.05*p¡0.1. Variable notations: season (D^t_{it}) - seasonal dummies, sector (D^s_{it}) - sector dummies, m_fs (M_{it}) - firm specific averages of idiosyncratic variables. m/n - m of n variables in the vector are significant at the 5%-level. Columns 3 and 5 report marginal effects for the outcome "price increase", setting all variables at their mean. For binary regressors, the effect is for discrete change from 0 to 1.

Table A.3: Wholesale Sector - Results I

	(1)		(2)	
price	Coef.	ME (1)	Coef.	ME (1)
s_bus$^-$	-0.029***	-0.006	-0.031***	-0.007
feedst$^-$	0.012	0.003	0.007	0.002
busvol$^-$	-0.174***	-0.039	-0.170***	-0.038
ords$^-$	-0.223***	-0.048	-0.221***	-0.048
busdev$^-$	-0.206***	-0.044	-0.199***	-0.043
s_bus$^+$	-0.016*	-0.004	-0.013	-0.003
feedst$^+$	0.027***	0.006	0.024***	0.006
busvol$^+$	0.181***	0.043	0.173***	0.041
ords$^+$	0.145***	0.036	0.140***	0.034
busdev$^+$	0.275***	0.070	0.265***	0.067
cpi			0.693***	0.158
exchr			0.063*	0.014
ip			0.102	0.023
oil			0.071***	0.016
metals			0.363***	0.083
m3			-0.648***	-0.148
intr			0.135***	0.031
euro			-0.079***	-0.017
vat			-0.095***	-0.021
taylIncr6	0.416***	0.110	0.397***	0.104
taylDecr6	-0.522***	-0.094	-0.541***	-0.096
taylIncr12	0.251***	0.063	0.243***	0.060
taylDecr12	-0.242***	-0.050	-0.261***	-0.053
taylIncr24	0.354***	0.093	0.352***	0.092
taylDecr24	-0.224***	-0.046	-0.233***	-0.048
season	3/3	0.02-0.03	3/3	0.02-0.03
sector	5/6	0.01-0.07	5/6	0.01-0.07
m_fs	3/5	0.02-0.07	3/5	¡0.01
Log-Lik.	-174066		-173607	
Obs.	243261		243261	
Adj. Ps.-R2	0.093		0.096	

*** p¡0.01 ** p¡0.05*p¡0.1. Variable notations: season (D^t_{it}) - seasonal dummies, sector (D^s_{it}) - sector dummies, m_fs (M_{it}) - firm specific averages of idiosyncratic variables. m/n - m of n variables in the vector are significant at the 5%-level. Columns 3 and 5 report marginal effects for the outcome "price increase", setting all variables at their mean. For binary regressors, the effect is for discrete change from 0 to 1.

Table A.4: Retail Sector - Results II

	(3)		(4)	
price	Coef.	ME (1)	Coef.	ME (1)
pr_m	0.348***	0.071	0.276***	0.058
pr_ws	0.851***	0.172	0.777***	0.163
l_pr_ws			0.243***	0.051
l2_pr_ws			-0.089***	-0.01
l3_pr_ws			0.010	0.002
l4_pr_ws			-0.040	-0.008
l5_p_ws			-0.016	-0.003
l6_pr_ws			-0.228***	-0.048
l_pr_m			0.134***	0.028
l2_pr_m			-0.085*	-0.018
l3_pr_m			-0.162***	-0.034
l4_pr_m			-0.012	-0.003
l5_pr_m			0.118***	0.025
l6_pr_m			0.208***	0.044
ppi	2.760***	0.559	1.343*	0.282
exchr	-0.043	-0.009	0.002	0.000
ip	-0.246	-0.050	-0.320	-0.067
oil	0.212***	0.043	0.206***	0.043
metals	-0.764***	-0.155	-0.479***	-0.101
m3	-0.710***	-0.144	-0.582***	-0.122
intr	-0.030***	-0.006	-0.025***	-0.005
euro	0.103***	0.022	0.037	0.008
vat	0.169***	0.037	0.118	0.026
taylIncr6	0.471***	0.114	0.475***	0.117
taylDecr6	-0.629***	-0.094	-0.609***	-0.098
taylIncr12	0.593***	0.149	0.607***	0.155
taylDecr12	-0.722***	-0.102	-0.707***	-0.107
taylIncr24	0.332***	0.077	0.309***	0.073
taylDecr24	-0.605***	-0.090	-0.598***	-0.094
season	1/3	0.00-0.01	0/3	¡0.01
sector	3/6	0.00-0.05	2/6	0.01-0.02
m_fs	1/5	¡0.01	1/5	¡0.01
Log-Lik.	-69011		-36748	
Obs.	106434		56569	
Adj. Ps.-R2	0.216		0.229	

*** p¡0.01 ** p¡0.05*p¡0.1. Variable notations: season (D_{it}^t) - seasonal dummies, sector (D_{it}^s) - sector dummies, m_fs (M_{it}) - firm specific averages of idiosyncratic variables. m/n - m of n variables in the vector are significant at the 5%-level. Columns 3 and 5 report marginal effects for the outcome "price increase", setting all variables at their mean. For binary regressors, the effect is for discrete change from 0 to 1.

Table A.5: Wholesale Sector - Results II

	(3)		(4)	
price	Coef.	ME (1)	Coef.	ME (1)
pr_m	0.418***	0.095	0.630***	0.142
l_pr_m			0.217***	0.049
l2_pr_m			0.022	0.005
l3_pr_m			-0.079***	-0.018
l4_pr_m			-0.135***	-0.030
l5_pr_m			-0.149***	-0.034
l6_pr_m			-0.341***	-0.077
cpi	-0.499***	-0.113	-0.284	-0.064
exchr	-0.018	-0.004	0.142***	0.032
ip	-0.385***	-0.087	-0.774***	-0.174
oil	0.058***	0.013	0.062***	0.014
metals	0.176***	0.040	-0.122***	-0.027
m3	-0.375***	-0.085	-0.150**	-0.034
intr	-0.147***	-0.033	0.079***	0.018
euro	-0.068***	-0.015	0.026**	0.006
vat	-0.057***	-0.013	0.011	0.002
taylIncr6	0.385***	0.100	0.408***	0.106
taylDecr6	-0.519***	-0.093	-0.533***	-0.094
taylIncr12	0.245***	0.061	0.271***	0.067
taylDecr12	-0.245***	-0.050	-0.269***	-0.054
taylIncr24	0.376***	0.098	0.337***	0.086
taylDecr24	-0.234***	-0.048	-0.247***	-0.050
season	3/3	0.01-0.02	2/3	¡0.01
sector	5/6	0.01-0.07	5/6	0.01-0.07
m_fs	4/5	0.01-0.07	3/5	0.01-0.07
Log-Lik.	-172824		-171622	
Obs.	243261		243261	
Adj. Ps.-R2	0.100		0.106	

*** p¡0.01 ** p¡0.05*p¡0.1. Variable notations: season (D^t_{it}) - seasonal dummies, sector (D^s_{it}) - sector dummies, m_fs (M_{it}) - firm specific averages of idiosyncratic variables. m/n - m of n variables in the vector are significant at the 5%-level. Columns 3 and 5 report marginal effects for the outcome "price increase", setting all variables at their mean. For binary regressors, the effect is for discrete change from 0 to 1.

Table A.6: Retail Sector - Robustness

price	(1)	(2)	(3)	(4)	(5)
s_bus$^-$	-0.005	-0.001	0.017	-0.008	-0.009
feedst$^-$	-0.020	-0.020	0.029*	-0.027*	-0.025
busvol$^-$	-0.065***	-0.068***	-0.038***	-0.057***	-0.056***
ords$^-$	-0.100***	-0.103***	-0.086***	-0.090***	-0.085***
busdev$^-$	-0.088***	-0.090***	-0.062***	-0.088***	-0.081***
s_bus$^+$	-0.004	-0.004	-0.045	-0.004***	-0.004
feedst$^+$	-0.007	-0.009	-0.008***	-0.006	-0.009
busvol$^+$	0.050***	0.056***	0.031**	0.044***	0.041***
ords$^+$	0.009	0.025	0.054***	0.005	0.002
busdev$^+$	-0.036**	-0.029**	-0.013	-0.037*	-0.039***
ppi	2.787***	2.790***	2.115***	0.060***	0.130***
exchrate	-0.034	-0.044	-0.015	-0.019***	-0.002***
industry	-0.281*	-0.256	-0.172	-0.005*	-0.022***
oil	0.225***	0.210***	0.252***	0.009***	0.005***
metals	-0.763***	-0.766***	-0.718***	-0.029***	-0.032***
m3	-0.706***	-0.715***	-0.680***	0.001***	0.010***
int_rate	-0.029***	-0.030***	-0.028***	0.023***	
y_1i	0.219***				
pr_m	0.346***	-0.715***	0.351***	0.236***	0.334***
pr_ws	0.842***	-0.030***	0.841***	0.814***	0.817***
euro	0.105***	0.102***	0.095***	0.122***	0.002
vat	0.173***	0.169***	0.148***	0.115***	0.140***
TaylIncr2	0.451***	0.474***	0.458***	0.459***	0.453***
TaylDecr2	-0.619***	-0.629***	-0.616***	-0.618***	-0.628***
TaylIncr4	0.577***	0.596***	0.599***	0.580***	0.582***
TaylDecr4	-0.712***	-0.721***	-0.723***	-0.715***	-0.719***
TaylIncr8	0.312***	0.336***	0.323***	0.346***	0.371***
TaylDecr8	-0.598***	-0.603***	-0.606***	-0.584***	-0.588***
season	1/3	1/3	1/3	2/3	1/3
sector	2/6	3/6	3/6	3/6	3/6
m_fs		1/5	1/5	1/5	1/5
Log-Lik.	-68715	-69027	-60198	-68841	-68828
Obs.	106434	106434	106434	106434	106434
Adj. Ps.-R2	0.216	0.219	0.215	0.218	0.218

*** p¡0.01 ** p¡0.05*p¡0.1. Variable notations: season (D^t_{it}) - seasonal dummies, sector (D^s_{it}) - sector dummies, m_fs (M_{it}) - firm specific averages of idiosyncratic variables. m/n - m of n variables in the vector are significant at the 5%-level. (1): including first observation of dependent variables, (2): excluding firm-specific means of idiosyncratic variables, (3): idiosyncratic variables enter in first lags, (4): macroeconomic variables included as month-on-month changes, (5): macroeconomic variables included as year-on-year changes.

Table A.7: Wholesale Sector - Robustness

price	(1)	(2)	(3)	(4)	(5)
s_bus^{-}	-0.037***	-0.054***	-0.017	-0.038***	-0.038***
feedst^{-}	0.003	-0.006	0.028**	0.006	0.005
busvol^{-}	-0.160***	-0.164***	-0.108***	-0.154***	-0.151***
ords^{-}	-0.217***	-0.210***	-0.193***	-0.208***	-0.207***
busdev^{-}	-0.190***	-0.129***	-0.145***	-0.180***	-0.183***
s_bus^{+}	-0.007	0.001	0.025***	-0.008	-0.010
feedst^{+}	0.023***	0.015*	-0.014	0.026***	0.026***
busvol^{+}	0.159***	0.160***	0.104***	0.163***	0.157***
ords^{+}	0.118***	0.115***	0.137***	0.130***	0.145***
busdev^{+}	0.258***	0.208***	0.218***	0.253***	0.249***
cpi	-0.905***	-0.896***	-1.077***	0.058***	0.221***
exchrate	0.056**	-0.040	0.029	0.025***	0.004***
industry	-0.521***	-0.425***	-0.290***	0.005***	0.045***
oil	0.034	0.035	0.020	-0.001*	0.013***
metals	0.140***	0.043***	0.110**	0.033***	0.034***
m3	-0.133*	-0.199**	-0.216**	0.000***	-0.003**
int_rate	-0.020***	-0.023***	-0.023***	-0.005***	
y_1i	0.263***				
pr_m	0.425***	0.433***	0.432***	0.415***	0.134***
euro	-0.061***	-0.075***	-0.096***	-0.050***	0.143***
vat	-0.072***	-0.071***	-0.084***	-0.022**	0.022***
TaylIncr2	0.366***	0.384***	0.390***	0.406***	0.388***
TaylDecr2	-0.490***	-0.522***	-0.520***	-0.507***	-0.493***
TaylIncr4	0.226***	0.243***	0.233***	0.266***	0.273***
TaylDecr4	-0.213***	-0.248***	-0.236***	-0.245***	-0.261***
TaylIncr8	0.346***	0.373***	0.367***	0.374***	0.363***
TaylDecr8	-0.195***	-0.238***	-0.231***	-0.234***	-0.251***
season	3/3	3/3	3/3	3/3	3/3
sector	5/6	4/6	5/6	5/6	5/6
m_fs	3/5		4/5	3/5	5/5
Log-Lik.	-171646	-173215	-153178	-172562	-171701
Obs.	243261	243261	243261	243261	243261
Adj. Ps.-R2	0.098	0.106	0.093	0.101	0.106

*** p¡0.01 ** p¡0.05*p¡0.1. Variable notations: season (D^t_{it}) - seasonal dummies, sector (D^s_{it}) - sector dummies, m_fs (M_{it}) - firm specific averages of idiosyncratic variables. m/n - m of n variables in the vector are significant at the 5%-level. (1): including first observation of dependent variables, (2): excluding firm-specific means of idiosyncratic variables, (3): idiosyncratic variables enter in first lags, (4): macroeconomic variables included as month-on-month changes, (5): macroeconomic variables included as year-on-year changes.

Table A.8: Different Estimation Method

	Retail sector		Wholesale sector	
price	xtreg, fe	oprobit	xtreg, fe	oprobit
constant	0.064***		0.099***	
s_bus$^-$	0.003	-0.001	-0.013***	-0.008***
feedst$^-$	-0.001	-0.004	0.004	0.001
busvol$^-$	-0.025***	-0.013***	-0.062***	-0.035***
ords$^-$	-0.035***	-0.019***	-0.087***	-0.045***
busdev$^-$	-0.029***	-0.017***	-0.079***	-0.040***
s_bus$^+$	0.003	-0.001	-0.005	-0.002
feedst$^+$	-0.001	-0.002	0.007**	0.005***
busvol$^+$	0.014***	0.010***	0.073***	0.038***
ords$^+$	0.004	0.003	0.051***	0.030***
busdev$^+$	-0.010*	-0.007**	0.098***	0.065***
ppi/cpi	1.524***	0.559***	0.099	-0.113***
exchrate	-0.075***	-0.009***	0.042***	-0.004
industry	-0.316***	-0.050	-0.323***	-0.087***
oil	0.076***	0.043***	0.032***	0.013***
metals	-0.321***	-0.155***	0.045***	0.040***
m3	-0.385***	-0.144***	-0.145***	-0.085***
int_rate	-0.011***	-0.006***	-0.041***	-0.033***
euro	0.039***	0.022***	-0.007	-0.015***
vat	0.062***	0.037***	-0.022***	-0.013***
pr_ws	0.381***	0.172***		
pr_m	0.105***	0.071***	0.184***	0.095***
winter	0.006	0.001	0.041***	0.020***
summer	-0.005	-0.003	-0.036***	-0.021***
fall	0.016***	0.010***	-0.031***	-0.015***
TaylIncr2	0.087***	0.114***	0.073***	0.100***
TaylDecr2	-0.178***	-0.094***	-0.096***	-0.093***
TaylIncr4	0.158***	0.149***	0.036***	0.061***
TaylDecr4	-0.223***	-0.102***	0.010***	-0.050***
TaylIncr8	0.056***	0.077***	0.071***	0.098***
TaylDecr8	-0.183***	-0.090***	0.027***	-0.048***

*** p¡0.01 ** p¡0.05*p¡0.1. Columns 2 and 4 report coefficients from a linear regression with fixed effects, columns 3 and 5 show marginal effects for the outcome ”price increase”, setting all variables at their mean, from an ordered probit regression. For binary regressors, the effect is for discrete change from 0 to 1.

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