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When do firms adjust prices? Evidence from micro panel data

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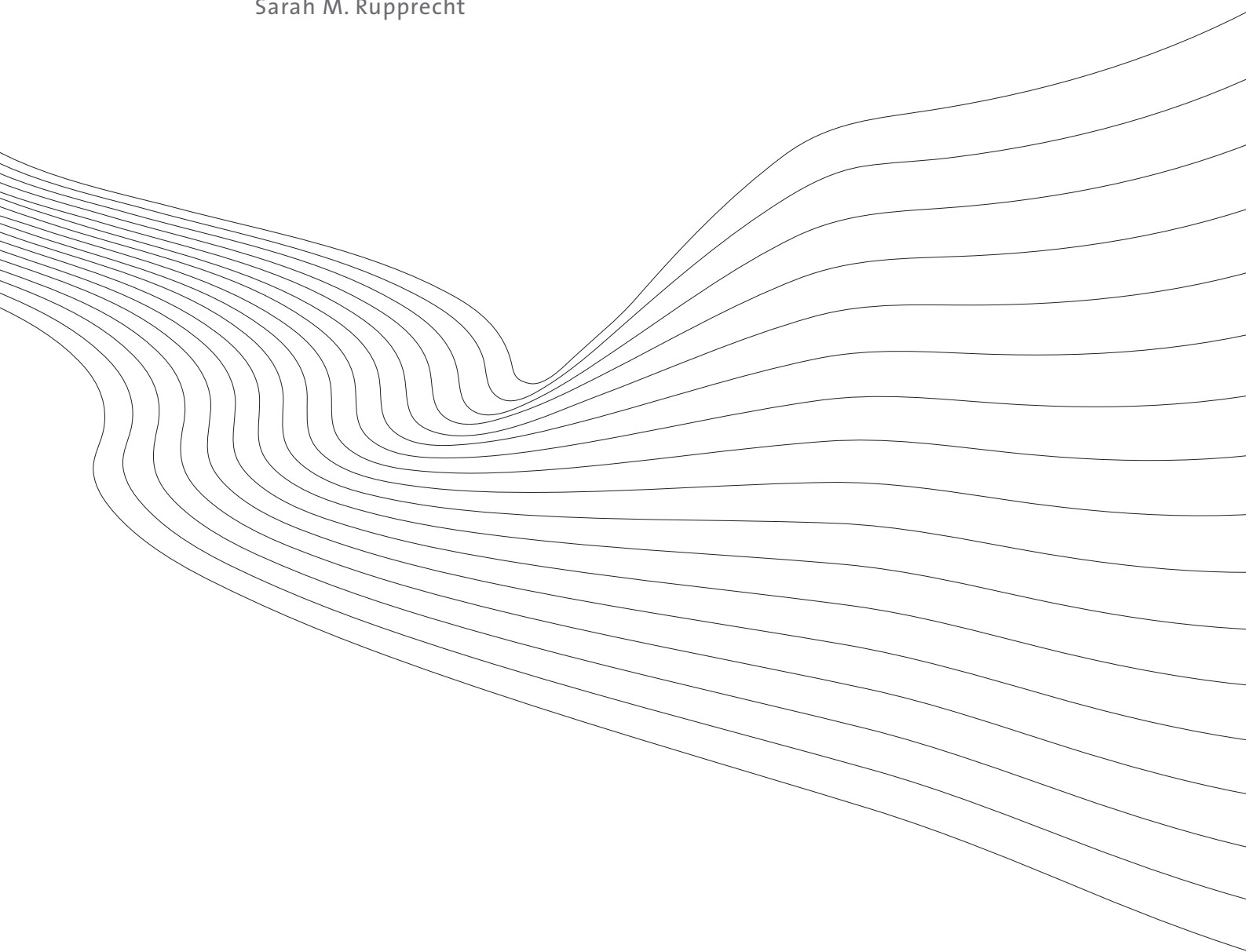
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KOF Working Papers

When Do Firms Adjust Prices?
Evidence from Micro Panel Data

Sarah M. Rupprecht



When do Firms Adjust Prices?

Evidence from Micro Panel Data*

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Abstract

Using a large panel of quarterly firm survey data from 1984 to 2007, which allow changes in firms' prices to be linked to several firm-specific variables, this paper finds that state-dependent pricing is clearly important in a low inflation environment and that variables measuring the current situation of the firm, especially costs for intermediate products, are important determinants of price adjustments. They add a lot to the explanatory power of a price adjustment probability model, compared to purely time-dependent features. Macroeconomic factors are significant but do not add much in terms of the goodness of fit. Furthermore, when taking into account sticky plan models by excluding possibly predetermined price changes, the importance of state-dependent factors becomes even larger.

JEL classification: E31, E32, E50.

Keywords: Price setting behavior, time-dependent pricing, state-dependent pricing, sticky plans, costs.

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1 Introduction

It is well documented in the empirical literature that prices are sticky at the microeconomic level. However, not much is currently known about the determinants of firms' price adjustment decisions. This paper attempts to shed some light on this issue by using a new data set from a quarterly survey of Swiss manufacturing firms. The data set contains qualitative information on firms' price changes, their price expectations, changes in costs of input products and several other factors describing firms' current income. In previous empirical studies, firms' current economic condition had to be proxied by aggregate variables such as inflation and demand factors. The advantage of this data set is that it contains firm-level information for firms' current condition. The data on changes in costs give especially valuable information, showing that the probability of price adjustments is around 30% higher when costs for intermediate products change in the same period. This paper contributes to the empirical price setting literature by focussing on the following three issues.

The first issue addressed is whether *time-dependent* or *state-dependent* features of price setting explain the frequency of price changes observed in the data. In time-dependent pricing models, firms choose the size of price adjustments but the timing is given exogenously, whereas in state-dependent models firms choose both size and timing of price adjustments (e.g. Dotsey et al., 1999). State-dependent pricing implies that the frequency of price changes (the extensive margin) reacts to the idiosyncratic and aggregate shocks firms are faced with, while in time-dependent pricing models the extensive margin is inactive and hence the frequency of price changes does not vary with the state of the economy. Furthermore, there is a selection effect in state-dependent models, as the firms which change their prices are those that gain most from doing so. For example, [Dotsey and King \(2005\)](#) show that state-dependent pricing has a quantitatively important effect for economic out-

comes in response to monetary shocks, even in periods of steady inflation. Although the framework of state-dependent pricing is intuitively more appealing, so far, empirical evidence has not found strong support for the existence of state-dependent pricing in low inflation environments. One reason for these findings might be that micro data on prices employed for examining this question are mostly data on single goods prices that underlie the calculation of the CPI. These data give a very precise picture of price adjustments at the micro level, but they cannot be matched with observations on firms' costs or current income. Researchers have to rely upon macroeconomic information or unobserved components to estimate the shocks that firms are faced with. This paper uses survey data to proxy for the microeconomic state of firms.¹ The results show that adding microeconomic state variables, especially the measure for costs, significantly improves the goodness of fit of a model specified as a purely time-dependent model. The estimated marginal effect of an increase (decrease) in the cost proxy on the probability of observing a price increase (decrease) is around 0.30. These findings show that state-dependent pricing is important. The relevant *state* is the change in firm-level costs for intermediate products, the capacity utilization rate and other firm-specific conditions. This result also suggests that the key reason why many studies have not found so much support for state-dependent pricing is that information on costs has not been observable in other commonly used data sets.

The second issue addressed is whether the macroeconomic developments with which firms are faced matter for the timing of price adjustments. To examine this question, time fixed effects are added to the model to evaluate the relative importance of aggregate fluctuations for price adjustments. [Klenow and Kryvtsov \(2008\)](#) and [Gagnon \(2009\)](#) show that the frequency of price adjustment correlates only weakly with aggregate inflation when inflation is at a low level. This is confirmed by the estimates in this paper, which show that aggregate factors improve the goodness of fit of the price adjustment model only

¹The term "microeconomic state" used here is adopted from [Dotsey et al. \(2006\)](#).

marginally. The firm-level information is much more important in explaining price changes at the micro level. These findings support the theoretical literature using state-dependent pricing rules to model price setting behavior, where idiosyncratic shocks firms are facing are the crucial factors in determining pricing decisions at the micro level (Dotsey et al., 2006; Gertler and Leahy, 2008; Golosov and Lucas, 2007; Midrigan, 2006).²

Third, the paper addresses the question of whether the results are influenced by price changes that might be part of pricing plans and therefore are predetermined. [Burstein \(2006\)](#) develops a so-called sticky plan model, where firms may set an entire sequence of future prices (price plans) rather than one fixed price at a time.³ Taking into account the possibility that the type of pricing plans developed in the Burstein model exist in reality, some price changes observed in micro data are determined in the past, not at the point in time they are recorded in the data. Thus, predetermined price changes cannot contain new information and a test for the correlation between the current state of the economy and the frequency of price adjustments may lead to the false conclusion that price adjustments are not state-dependent. Using survey data allows me to distinguish expected from unexpected price changes by comparing a firm's expectation about price changes in the next quarter with the realization of this price change in the subsequent quarter. Unexpected price changes cannot be predetermined, because predetermined price changes are known to the firm already before they are recorded in the data. The estimations show that the goodness of fit measure becomes about three times larger when adding the microeconomic state

²The finding that prices respond relatively quickly to firm-specific shocks but only weakly to macroeconomic shocks suggests that prices might respond less to macroeconomic fluctuations because macroeconomic shocks are less important for price setters than firm-specific shocks. They may be less important because the size of macroeconomic shocks is smaller ([Golosov and Lucas, 2007](#)) or because firms pay less attention to them ([Mackowiak and Wiederholt, 2009](#)), or both.

³In reality such pricing plans appear, for instance, in written contracts with customers, where prices are indexed to a constant growth rate. For example, [Stahl \(2006\)](#) reports that 50% of German manufacturing firms have fixed contracts with an average duration of nine months or longer. In a recent interview study among Swiss firms summarized in [Zurlinden \(2007\)](#), various firms indicated that they change prices more often than they review them. This might also be due to the fact that they follow price plans, which they review infrequently.

variables to a model with purely time-dependent explanatory variables. This suggests that state-dependence is even more pronounced when excluding possibly predetermined price changes from the data.

The remainder of this paper is organized as follows: section 2 describes the data and the methodology. Section 3 presents the results. Finally, the conclusions are given in section 4.

2 Data and methodology

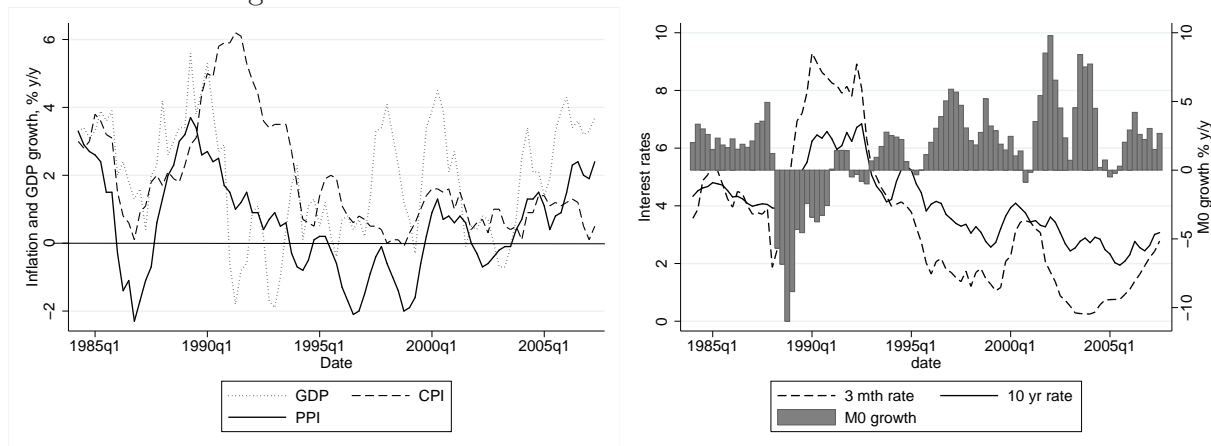
This section first briefly discusses macroeconomic developments in Switzerland during the period 1984–2007 to give an overview of the economic environment for Swiss manufacturing firms. It then describes the collection of the survey data used in the estimations, presents some summary statistics, states advantages and shortcomings of the data, and specifies the econometric model.

2.1 Macroeconomic context

Figure 1 illustrates macroeconomic developments during the period 1984–2007. As shown in the left panel, Swiss GDP grew by about 2% on average per year and the consumer price index (CPI) and the producer price index (PPI) grew by an annual average of 1.9% and 0.6%, respectively. After a period of robust economic growth in the second half of the 1980s, PPI inflation peaked in 1989 (3.7%) and CPI inflation in 1991 (6.2%). This was followed by a relatively long period of almost no economic growth, with low CPI inflation and even negative PPI inflation. Only towards the end of the observation period, PPI inflation picked up but CPI inflation remained moderate. In the short run, inflation was affected by changes in the value added tax (VAT). VAT was introduced in 1995 and raised

in 1999 and 2001.⁴

Figure 1: Swiss main macroeconomic indicators 1984–2007



The left panel shows GDP growth, CPI and PPI inflation in Switzerland 1984–2007. The right panel shows interest rates for 10-year government bonds and three-month money market rate (lhs), and the percentage year-on-year growth rate of the monetary base M0 (rhs). Sources for CPI and PPI: Swiss Federal Statistical Office (SFSO); GDP: Quarterly National Accounts, State Secretariat for Economic Affairs; interest rates and M0: Swiss National Bank.

Looking at the monetary policy framework, the Swiss National Bank (SNB) pursued a strategy of targeting monetary aggregates, announcing a target for the monetary base (M0) in the initial period under consideration. The growth rate of M0 and long and short-term interest rates are illustrated in the right panel in figure 1. In the period 1984–1990, the announced annual target for the growth rate of the monetary base amounted to 2% to 3%. Due to increasing instability in the demand for base money at the end of the 1980s, the SNB decided to adopt a medium-term growth target for the monetary base in 1989, amounting to 1% per year.⁵ Eventually, the SNB adopted its current monetary policy framework in December 1999, when it decided that it would no longer fix growth targets for the money supply, and that monetary policy decisions would be based mainly on an

⁴VAT replaced the turnover tax on goods (6.2%) in Q1 1995. Initially, the tax rate was set at 6.5% for most goods and services. In 1999 Q1 and 2001 Q1, it was raised to 7.5% and 7.6% respectively (see Kaufmann, 2008).

⁵Rich (1997) provides a detailed description of the change in the monetary policy strategy in Switzerland. See also Mishkin (2007, p.236–37).

inflation forecast. The SNB defines price stability as a rise in the CPI of less than 2% per year.

2.2 Description of the survey

This subsection describes the survey’s questionnaire and the data collection procedures. The data set underlying this paper consists of a large panel of firm surveys conducted on a quarterly basis in the Swiss manufacturing sector by the KOF Swiss Economic Institute.⁶ Data are available from the first quarter of 1984 to the third quarter of 2007. The purpose of the survey is to construct business tendency indicators. There are about 1,500 firms in the survey panel, which represents about 12.6% of all registered Swiss manufacturing firms and about 30% of employment in the manufacturing sector. The share of manufacturing value-added in GDP is at about 20% in Switzerland, a value which remained relatively stable over the observation period. The response rate is about 65% and the panel is not rotating. Firms are chosen on the basis of their industry affiliation and the region they are located in. The industries are defined in the general classification of economic activity (NOGA), by which they are coded in the Swiss Business Register.⁷ Using the NOGA code, the survey institute can distinguish 23 industries within the Swiss manufacturing sector. If firms do not respond for several quarters, they are replaced by new firms that are active within the same industry and, if possible, located within the same region.⁸ About 5% of the firms in the panel drop out each year and thus about 5% of the firms in the panel are new entrances. This procedure is chosen to keep the overall number of firms in

⁶See www.kof.ethz.ch.

⁷The NOGA corresponds to the NACE (statistical classification of economic activities in the European Community) in the EU and NAICS (North American Industry Classification System) in the U.S. It allows classification of the statistical units’ “businesses” and “local units” according to their economic activity, as well as their aggregations into coherent groups (see SFSO, 2002 for more details).

⁸If there is no other firm in the same region and the same industry, the firm is replaced by another one that has the same NOGA classification.

the panel stable. The sample used in this paper comprises 3,589 firms.⁹ KOF assigns an identification number to each firm, which is unique within the firm's industry and product group. If new firms enter, they are assigned a new identification number. If firms drop out of the survey, their identification numbers are not re-used. This allows the responses of each firm to be tracked over time and firm exits and entries out of and into the panel to be identified.¹⁰ The questionnaire refers to the principal product the firm produces. If a firm produces more than one principal product, it receives one questionnaire for each product. This, however, is the case for only 7.3% of the firms in the panel.¹¹

Firms receive the questionnaire on the first working day after the end of a quarter. The questions are both coincident, asking for the situation in the current quarter, and forward-looking, asking for expectations about the next three months. The data underlying this paper are the detailed responses of each firm to the questions in the survey. The possible responses are listed below each question. The respondents can tick a box to choose one of the response possibilities or leave the boxes blank if they are not able or not willing to respond to the question. Below, I show the translated questions and response categories in three blocks. The first block contains the questions that have been in the survey for the entire time period. The second shows the questions that were included in the questionnaire from 1984 to 1998, and dropped afterwards. The third block shows the question that was added in 1999.¹² Each bullet shows one question. The name of the variable assigned to each

⁹The panel is not rotating, however, as about 75 (5%) of the firms drop out each year, over the 23 years of observations, the number of new entrances and exits sums up to about 2,000. Together with the 1,500 firms that were in the survey initially, this yields the number 3,589 of firms in the entire panel from 1984 to 2007.

¹⁰In 1999, KOF changed the classification system from a previous version to the NOGA classification. Most of the product groups can be transferred to the NOGA classification system. However, some observations for the analysis had to be dropped out because their previous classification could not be identified with the NOGA.

¹¹92.7% of the firms in the survey receive only one questionnaire. The maximum number of questionnaires one firm receives is four, which applies to only one firm in the sample. Dropping these firms from the data did not change the results qualitatively.

¹²It should be noted that there are more questions in the questionnaire, such as regarding firms' export expectations. However, some of these questions have been re-formulated and thus are not comparable

question is placed before the question. Some of the questions are explained or expressions are defined at the bottom of the original questionnaire. In this paper, these definitions are placed right below the questions to which they refer. Some questions in the survey were replaced in 1999, others remained in the questionnaire for the entire period.

Data available from 1984 to 2007

- *Price*: the selling price you charged in the past three months has ...
 increased remained unchanged decreased.
- $E_t(\text{Price}_{t+1})$: you expect the selling price you are going to charge in the next three months to...
 increase remain unchanged decrease.
Note: selling prices are defined as the prices that are effectively charged (incl. discounts), not the products' list prices.
- $E_t(\text{Costs}_{t+1})$: you expect the costs for intermediate products and raw materials in the next three months to...
 increase remain unchanged decrease.
- *Technical Capacity*: technical capacities in your firm are ...
 more than sufficient sufficient not sufficient.
Note: technical capacity is defined as the amount and quality of equipment (incl. buildings). Technical capacities are more than sufficient if they currently cannot be utilized as desired due to too little demand for the product. They are not sufficient if expected demand for the product cannot be met without an increase in delivery lags due to shortage of technical capacity.
- *Capacity Utilization*: at what capacity has your firm been running in the past three months as a percentage of full capacity?
 50% 55% 60% 65% 70% 75% 80% 85% 90% 95% 100%
 105% 110%.
Note: the utilization of all production equipment during the usual number and length of shifts is defined as a utilization of 100% (full capacity). This should be set in proportion to the current utilization.
- *Revenue*: the revenue your firm earned in the past three months has ...
 increased remained unchanged decreased.
Note: revenue is defined as the mark-up times the number of products sold.

over time. For this reason, and also to keep the set of explanatory variables tractable, they are excluded from the empirical analysis. As will be shown in the following section, the main finding is that firms' price setting depends on their current costs for input products, and current business conditions. For the questions this paper seeks to answer, adding more variables would arguably not affect the results much.

Data available from 1984 to 1999

- *Costs*: the costs for intermediate products and raw materials in the past three months have ...
 increased remained unchanged decreased.

- *Employment*: employment in your firm is ...
 more than sufficient sufficient not sufficient.

Note: the current trend in employment should be related to the firms' current expected incoming orders and the stock of finished products.

- *Stocks*: the stocks of intermediate products are ...
 too high satisfactory too low.

Note: stocks of intermediate products are defined as the inventory holdings of raw materials and unfinished goods that are bought from other firms. Only the quantity of stocks should be taken into account when answering the question, not the current value. They are too high or too low when their current proportion to planned production exceeds the usual proportion. This proportion may vary due to seasonal factors.

Data available from 1999 to 2007

- *Competitiveness*: How has your competitive position on the domestic market developed over the past three months?
 improved remained unchanged deteriorated.

Note: the competitive position is defined as the competitiveness of the product, which is determined by production costs, innovative content, other product characteristics (e.g. quality), economic conditions and the legal framework.

Additionally, KOF asks firms about the *number of employees* every four years. Overall, the data comprise 49,942 observations.¹³

2.3 Descriptive statistics and data illustration

Table 1 shows summary statistics for the variables in the data set. The table is split up into three panels, one for each time period under consideration. The variable *Price* may take three possible values: it is equal to -1 if the firm decreased its selling price, equal to zero if

¹³All missing observations where firms did not respond to some of the questions used later in the econometric analysis as well as all left-censored price spells are already excluded.

Table 1: Summary statistics

Variable	Obs.	Mean	Med.	Std.	Obs. =-1	(Freq)	Obs. =0	(Freq)	Obs. =+1	(Freq)
Sample 1984–2007										
Price	49942	-0.07	0	0.55	9559	(19.14)	34322	(68.72)	6061	(12.14)
$E_t(\text{Price}_{t+1})$	49791	0.05	0	0.53	5905	(11.82)	35536	(71.15)	8350	(16.72)
$E_t(\text{Costs}_{t+1})$	49942	0.26	0	0.56	2972	(5.95)	31108	(62.29)	15862	(31.76)
Technical Capacity	49942	0.05	0	0.46	4041	(8.09)	39490	(79.07)	6411	(12.84)
Capacity Utilization	49942	0.83	0.85	0.13						
Revenue	49942	-0.15	0	0.63	14213	(28.46)	28960	(57.99)	6769	(13.55)
ln(Firmsize)	49942	4.15	4.11	1.35						
Sample 1984–1998										
Price	34059	-0.05	0	0.55	6004	(17.63)	23806	(69.9)	4249	(12.48)
$E_t(\text{Price}_{t+1})$	33980	0.06	0	0.53	3771	(11.07)	24430	(71.73)	5779	(16.97)
Costs	34059	0.17	0	0.59	3504	(10.29)	21207	(62.27)	9348	(27.45)
$E_t(\text{Costs}_{t+1})$	34059	0.25	0	0.55	1966	(5.77)	21728	(63.8)	10365	(30.43)
Technical Capacity	34059	0.05	0	0.46	2672	(7.85)	26896	(78.97)	4491	(13.19)
Capacity Utilization	34059	0.83	0.85	0.13						
Revenue	34059	-0.15	0	0.63	9641	(28.31)	19928	(58.51)	4490	(13.18)
ln(Firmsize)	34059	4.3	4.25	1.28						
Employment	34059	0.03	0	0.48	3437	(10.09)	26217	(76.98)	4405	(12.93)
Stocks	34059	0.11	0	0.4	1115	(3.27)	28114	(82.54)	4830	(14.18)
Sample 1999–2007										
Price	13360	-0.1	0	0.57	2945	(22.04)	8855	(66.28)	1560	(11.68)
$E_t(\text{Price}_{t+1})$	13301	0.03	0	0.54	1750	(13.16)	9339	(70.21)	2212	(16.63)
$E_t(\text{Costs}_{t+1})$	13360	0.29	0	0.58	840	(6.29)	7749	(58.00)	4771	(35.71)
Technical Capacity	13360	0.03	0	0.45	1153	(8.63)	10616	(79.46)	1591	(11.91)
Capacity Utilization	13360	0.82	0.85	0.14						
Revenue	13360	-0.13	0	0.64	3765	(28.16)	7619	(57.03)	1976	(14.79)
ln(Firmsize)	13360	3.83	3.87	1.45						
Competitiveness	13360	0.00	0	0.49	1597	(11.95)	10106	(75.64)	1657	(12.40)

The upper panel shows the summary statistics of the available variables for 1984–2007, the middle panel for 1984–1998, the lower panel for 1999–2007. The sample means, medians and standard deviations of the variables are reported in the third to fifth columns. The variables *Price*, $E_t(\text{Price}_{t+1})$, $E_t(\text{Costs}_{t+1})$, *Technical Capacity*, *Revenue*, *Employment*, *Stocks* and *Competitiveness* are trivariate, i.e. they can take the values -1 , 0 or 1 . The number of observations and the frequency (*Freq*) for each value are reported in the last six columns. The variables *Capacity Utilization* and *Firmsize* can take more than three values and thus only their mean, median and standard deviation is reported. The statistics correspond to the estimation sample for the baseline regressions, where missing values are already excluded. The variable $E_t(\text{Price}_{t+1})$ is not used in the baseline regression, therefore this variable still contains some missing values and the number of observations is lower than for the other variables.

the firm left its price unchanged and equal to $+1$ if the firm increased its price. The same applies to the variables $E_t(\text{Price}_{t+1})$, *Costs*, $E_t(\text{Costs}_{t+1})$, and *Revenue*. For *Technical Capacity*, *Employment* and *Stocks*, the variables take the value -1 if these are *too low* or *not sufficient*, zero if they are *satisfactory* or *sufficient*, and $+1$ if they are *too high* or *more than sufficient*. The variable *Competitiveness* takes the value $+1$ if the competitive position of the firm has *improved*, zero when the competitive position *remained unchanged* and -1 if it *deteriorated*. The first line in table 1 shows that on average 31.28% price

changes are recorded per quarter, 19.14% price decreases and 12.14% price increases. In the period 1999–2007, the frequency of price adjustments rises slightly to 33.72% because price reductions become more frequent than in the period 1984–1998.¹⁴

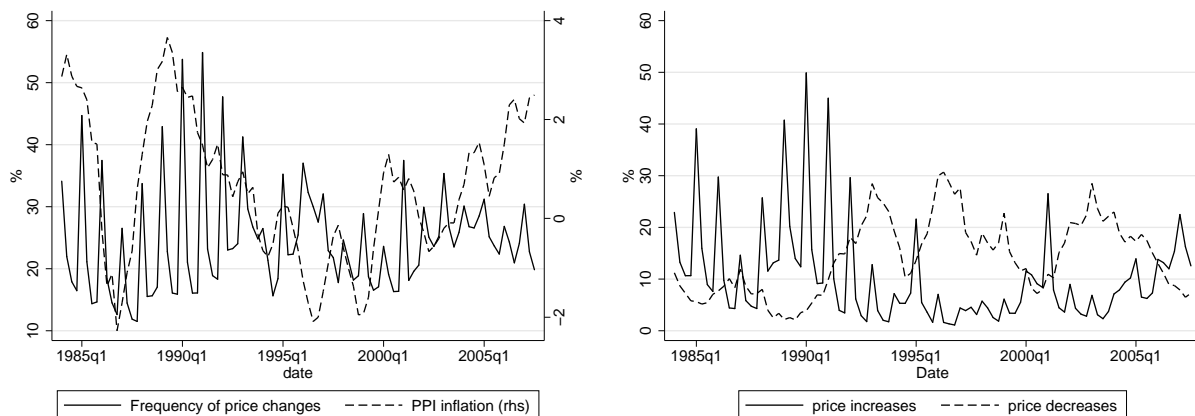
Figure 2 illustrates graphically the frequency of price changes. In the left panel, the frequency of price changes is represented by the solid line, together with PPI inflation, represented by the dashed line. The correlation of the frequency of price changes and PPI inflation is only 0.05. Meanwhile, the correlation between the frequency of price increases and PPI inflation is 0.53, and that between the frequency of price decreases and PPI inflation is -0.62 . Thus, the frequency of price increases and price decreases largely offset each other.¹⁵ The right panel shows the frequency of price increases and decreases as solid and dashed lines, respectively. Price increases are very seasonal, happening mostly in the first quarter of the year. This is especially apparent in the first higher inflation period from 1988 to 1993. Price decreases, on the other hand, do not display such a strong seasonal pattern. These features of the Swiss data are in line with the finding for U.S. producer prices that the frequency of price changes in January is almost twice as large as in the other months of the year (Nakamura and Steinsson, 2008).

Table 2 shows basic correlations between the variables in the data set. The upper panel shows the correlations for the data available from 1984–2007, the middle panel restricts the data to the observations available from 1984 to 1998, and the lower panel shows the correlations for the data for the period 1999–2007. The middle panel reveals that the correlation between the variables *Price* and *Costs* is 0.34. For a price adjustment in the current quarter and the expected cost change in the following quarter, it is only 0.16. This suggests that firms make price changes when costs change rather than reacting to future expected cost changes. Indeed, when looking at the correlation between an expected price

¹⁴The frequency of price changes is defined as the proportion of observations with a price change over the total number of observations.

¹⁵Gagnon (2009) notes similar offsetting effects for the low inflation period in Mexican CPI data.

Figure 2: Frequency of price changes and inflation



The left panel in the figure shows the frequency of price changes (lhs) and the percentage year-on-year change of producer price inflation (rhs). The right panel shows the frequency of price increases and price decreases. Sources: SFSO (PPI) and own calculations.

change in the next three months and an expected cost change in the next three months, the correlation coefficient rises to around 0.42. Also positively correlated with the price adjustment variable are *Capacity Utilization* (0.11 to 0.15), *Revenue* (0.29 to 0.42) and *Competitiveness* (0.2).

One of the advantages of the data set used in this paper is that it contains both the price changes carried out in the past three months and the price changes expected in the following three months. This allows the expected price changes in the previous period to be compared with the realized price change in the current period. For the period 1984–1998, the data also allow realized cost changes to be compared with expected cost changes. A straightforward way to illustrate these transition probabilities is by means of a three-state Markov transition matrix. The possible answers firms can give to the questions about their current and expected selling prices and costs can take three values: -1 if the prices or costs decrease, 0 when they are unchanged, and $+1$ if they increase. The matrix shows the probability $p_{j,k}$ of firm i giving the response $z_t = k$ to the variable z_t , with $k \in \{-1, 0, 1\}$, given that the response in the previous period to the variable \tilde{z}_t was

Table 2: Correlations

	Price	$E_t(\text{Price}_{t+1})$	Costs	$E_t(\text{Costs}_{t+1})$	Technical Capacity	Capacity Utilization	ln(Firm-size)	Revenue	Employment	Stocks	Competitiveness
Sample 1984–2007											
Price	1										
$E_t(\text{Price}_{t+1})$	0.39	1									
$E_t(\text{Costs}_{t+1})$	0.16	0.42		1							
Technical Capacity	-0.12	-0.11		-0.05	1						
Capacity Utilization	0.12	0.11		0.05	-0.33	1					
ln(Firmsize)	0.04	0.03		-0.04	0.02	0.17	1				
Revenue	0.33	0.2		0.06	-0.16	0.24	0.07	1			
Sample 1984–1998											
Price	1										
$E_t(\text{Price}_{t+1})$	0.37	1									
Costs	0.34	0.22		1							
$E_t(\text{Costs}_{t+1})$	0.16	0.42	0.37	1							
Technical Capacity	-0.12	-0.11	-0.06	-0.06	1						
Capacity Utilization	0.11	0.1	0.04	0.04	-0.34	1					
ln(Firmsize)	0.03	0.03	-0.05	-0.02	0.02	0.18	1				
Revenue	0.29	0.19	0.03	0.06	-0.16	0.22	0.07	1			
Employment	-0.15	-0.12	-0.09	-0.09	0.33	-0.23	0.04	-0.19	1		
Stocks	0.07	0.04	0.07	0.03	-0.04	0.08	0.01	0.06	-0.07	1	
Sample 1999–2007											
Price	1										
$E_t(\text{Price}_{t+1})$	0.4	1									
$E_t(\text{Costs}_{t+1})$	0.15	0.41		1							
Technical Capacity	-0.12	-0.11		-0.05	1						
Capacity Utilization	0.15	0.11		0.08	-0.32	1					
ln(Firmsize)	0.02	0.02		-0.08	0.01	0.12	1				
Revenue	0.42	0.22		0.06	-0.16	0.28	0.08	1			
Competitiveness	0.2	0.18		0.06	-0.13	0.19	0.06	0.32			1

The upper panel shows the correlations of the available variables for 1984–2007, the middle panel for 1984–1998, and the lower panel for 1999–2007.

$\tilde{z}_{t-1} = j$, with $j \in \{-1, 0, 1\}$.¹⁶ z_t stands for $Price_t$ or $E_t(Price_{t+1})$ and \tilde{z}_{t-1} stands for $Price_{t-1}$ or $E_{t-1}(Price_t)$. The transition probabilities are defined as

$$\begin{aligned}
 p_{j,k} &= \text{Prob}\{z_t = k | \tilde{z}_{t-1} = j\} \\
 \sum_{j=-1}^1 p_{j,k} &= 1 \quad \forall k \in \{-1, 0, 1\}, j \in \{-1, 0, 1\}.
 \end{aligned}
 \tag{1}$$

Analogously, the states are defined for the variables z_t referring to the states of the variables $Costs$ and $E_t(Costs_{t+1})$. Transition matrices are computed for each variable with its own

¹⁶The index i is dropped for simplicity.

lag and, for the contemporaneous variable, with its lagged expectation.

Table 3 shows the six Markov transition matrices. The first matrix in the upper left panel shows the probability of the variable $Price_t$ taking the value k , given that the firm expected $E_{t-1}(Price_t) = j$ in the previous period. For example, the probability that a firm will decrease its selling price in t , given that it also expected to decrease it in the next three months in the previous period $t - 1$, is 61.5%. The probability that it will leave its price unchanged in t , given that it expected to reduce it previously, is 36.8%. The probability that the firm will do the opposite of what it previously expected, i.e. raising the price when it expected to reduce it, is very low (1.7%). The highest probabilities in each row lie on the diagonal of the matrix, showing that firms are most likely to conduct the price adjustments they had expected three months earlier. Together with the fact that there are only few observations showing that firms expect to raise prices but reduce them in the following quarter and vice versa, these statistics suggest that the survey results are mostly reasonable. The upper right panel shows a comparable transition matrix for the cost variables. Here too, the probabilities on the diagonal are the highest in each row, showing that cost realizations in period t are most likely those that were expected in $t - 1$.

Table 3: Markov transition matrices

$\tilde{z}_{t-1} \setminus z_t$		$Price_t$				$Costs_t$					
		-1	0	1	Total	-1	0	1	Total		
$E_{t-1}(Price_t)$	-1	61.48	36.82	1.7	100	$E_{t-1}(Costs_t)$	-1	46.08	43.95	9.96	100
	0	14.87	79.18	5.95	100		0	10.24	74.73	15.03	100
	1	5.11	46.38	48.51	100		1	3.85	39.87	56.28	100
	Total	19.06	68.79	12.15	100		Total	10.26	62.3	27.44	100
		$Price_t$				$Costs_t$					
		-1	0	1	Total	-1	0	1	Total		
$Price_{t-1}$	-1	55.58	41.85	2.57	100	$Costs_{t-1}$	-1	45.07	44.11	10.82	100
	0	9.91	79.07	11.02	100		0	7.33	75.19	17.48	100
	1	3.98	67.33	28.69	100		1	4.34	42.3	53.36	100
	Total	19.14	68.72	12.14	100		Total	10.28	62.24	27.48	100
		$E_t(Price_{t+1})$				$E_t(Costs_{t+1})$					
		-1	0	1	Total	-1	0	1	Total		
$E_{t-1}(Price_t)$	-1	45.36	50.44	4.2	100	$E_{t-1}(Costs_t)$	-1	28.31	55.26	16.43	100
	0	8	77.52	14.47	100		0	5.42	72.7	21.89	100
	1	3.08	60.84	36.09	100		1	2.85	43.19	53.96	100
	Total	11.83	71.37	16.79	100		Total	5.93	62.29	31.78	100

The Markov transition matrices are calculated for the period 1984–1998.

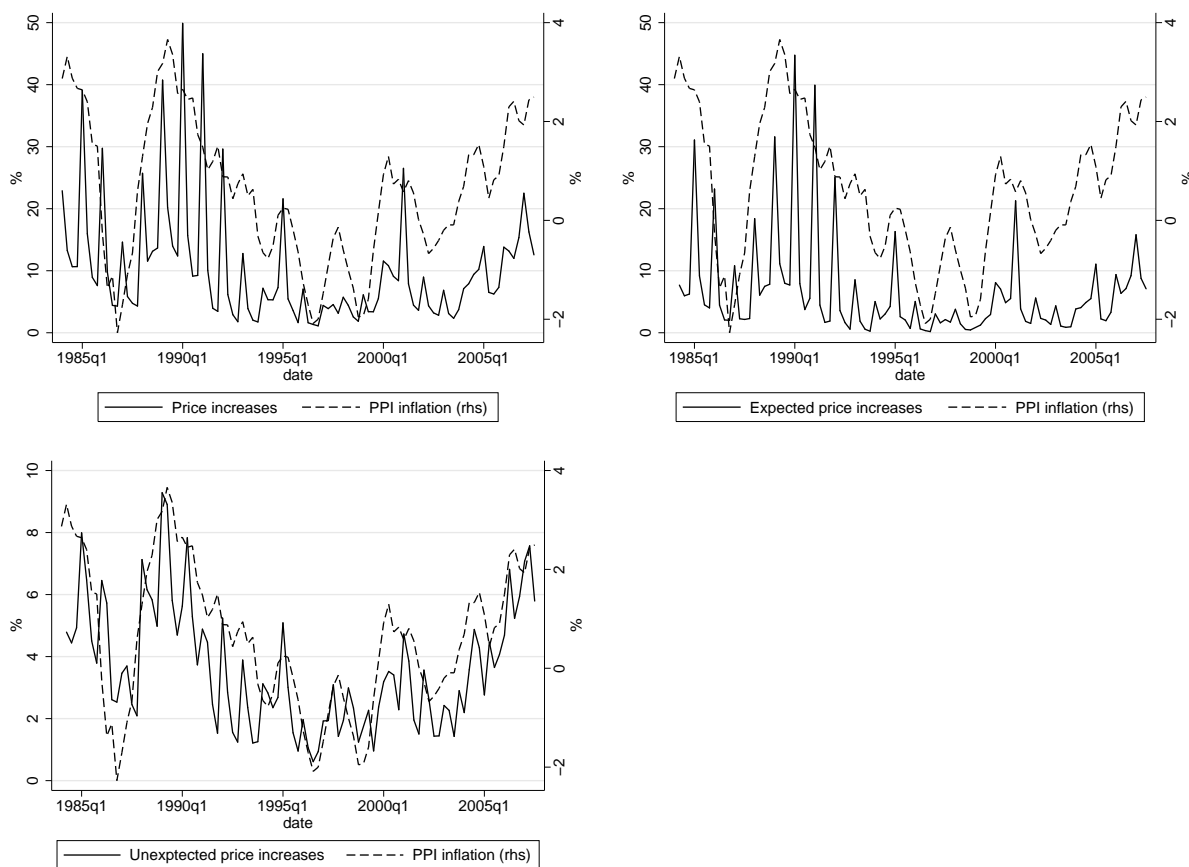
The middle left panel shows the transition probabilities for the variable *Price*, i.e. the probability that the variable $Price_t$ will take the value j , given that $Price_{t-1}$ takes the value k . Given that a firm increased its price in $t - 1$, it is most likely that it will leave the price unchanged in t . This finding is consistent with state-dependent pricing: once a firm has increased its price and paid the menu costs for changing it, it has already incorporated accumulated past and expected future shocks in the new price and thus is less likely to change the price again in the following period. This is not the case for price reductions, however. If a firm reduced its price already in $t - 1$, there is a high probability that it reduces the price again in t . An explanation for this finding might be that firms' response to negative shocks differs from firms' response to positive shocks.¹⁷

The lower left panel shows the probability of observing the response k to the question about expected prices in the next three months, conditional on having observed the response j to the same question one period earlier. Here, the highest probability is always to expect prices to remain unchanged, for all three possible previous answers.

One of the interesting observations is that it is not uncommon that firms do not follow through on their previously stated intentions. For example, in about 21% of the cases where firms intended to leave prices unchanged, they changed them in the following quarter. Such unexpected changes reflect solely non-predetermined price changes, and thus should be more responsive to the state of the economy if several firms follow state-dependent pricing plans. In figure 3, this point is illustrated graphically. The upper left panel shows the relationship between the frequency of price increases and inflation. The upper right panel of figure 3 illustrates the frequency of anticipated price increases, i.e. increases that were expected by firms, and PPI inflation. Expected price increase is defined as those observations where a price increase $Price_t = 1$ follows an expected price increase

¹⁷For example, Kwapil et al. (2005) report the results of an interview study among Austrian firms which shows that more firms adjust their prices downward in response to a drop in demand than upward in response to an increase in demand. This suggests that firms' motivations for reducing their prices might differ from their motivations for increasing them.

Figure 3: Frequency of price increases and inflation



The upper left panel in the graph shows the frequency of price increases (lhs) and the percentage year-on-year change in producer price inflation (rhs). The upper right panel shows the frequency of expected price increases (price increases that were anticipated by firms) and producer price inflation (rhs). The lower left panel shows the frequency of unexpected price increases (price increases that were not anticipated by firms) and producer price inflation. Sources: SFSO (PPI) and own calculations.

$E_{t-1}(Price_t) = 1$. The lower left panel shows the remaining price increases, i.e. those that were not anticipated ($Price_t = 1$ and $E_{t-1}(Price_t) \neq 1$). The correlation between inflation and anticipated price increases is 0.43, whereas it is 0.72 between inflation and unanticipated price increases.

2.4 Discussion of the data

This paragraph briefly discusses the advantages and limitations of the data set.

One shortcoming of the data set is that it cannot be observed by how much prices and costs are adjusted. In other words, the data only contain information about the extensive margin, not the intensive margin. As a consequence the contribution of the frequency of price adjustment to aggregate inflation movements cannot be evaluated. As the same is true for costs, the degree of pass-through of costs into prices cannot be estimated quantitatively. Nevertheless, the effect of a cost change on the probability of a price change can be estimated. The fact that the data only provide a measure for the extensive margin is not an obstacle for the questions addressed in this paper, because in time-dependent pricing models, firms decide only upon the size of their price adjustments, not the timing. So the timing should not relate to the state of the economy or the microeconomic state of the firm. The relevant information to test for state-dependent pricing is therefore in the extensive margin, rather than in the size of price adjustments. If the probability is significantly associated with state variables there is evidence for state-dependent pricing, as firms react to their economic state by adjusting the timing of price adjustments. Indeed, the importance of state-variables may be even larger than what the estimates in this paper suggest, as some of the shocks are arguably not large enough to push firms above the price adjustment threshold.¹⁸ This should be borne in mind when interpreting the estimates presented in the results section. A second shortcoming is that firms respond on a voluntary basis, but not all firms respond every quarter, which makes the data set unbalanced. Another limitation is that there may be cases where a firm produces more varieties of a good, such as one in green and one in blue, and the prices differ. There is no information about how firms treat this question and no note in the survey advising firms how to respond in this case. A similar problem could arise if firms price discriminate across different buyers or regions. It could well be that firms simply do not respond to the question in such a

¹⁸However, this problem would be present in a quantitative data set, too, as long as the threshold is unobserved. If firms face very high menu costs, even large accumulated cost changes might not be large enough to push firms above the threshold where they change prices.

case, as they cannot give a clear-cut answer. Thus these observations would drop out of the data set.

The most important advantage of the data set is that it contains firm-level information on prices, costs and other mostly qualitative aspects of the firm's environment. This is valuable information as it allows me to proxy for conditions that firms are facing when they change their prices. As, in particular, second generation state-dependent pricing models stress that idiosyncratic shocks play an important role in firms' pricing decisions, the data set is well suited to analyze whether firms react to their current microeconomic state, or whether they use time-dependent pricing rules. Such firm-level information is not available in most other data sets, where researchers have detailed information on price adjustments but often no further information about the firms that adjust prices. The current environment of firms is then proxied by the level of inflation. Furthermore, there is information in the qualitative data that is not necessarily observable in quantitative data. Some of the variables capture a situation which the firm judges as an imbalance, when the firm can respond with *insufficient* or *more than sufficient*. This is the case for the variables *Technical Capacities*, *Employment* and *Stocks*. They can thus be interpreted as a deviation from the desired level of the respective variable. In quantitative data sets, the desired level and the deviation from the desired level can only be inferred, as the desired level of, for example, employment is usually unobservable.

2.5 Specification of the Model

In the following paragraph the dependent and explanatory variables, and the methodology are described.

To estimate the probability of observing a price change, a logit model is employed

$$P(y_{it} = 1|\mathbf{x}_{it}) = \frac{\exp(\mathbf{x}_{it}\mathbf{b})}{1 + \exp(\mathbf{x}_{it}\mathbf{b})} \quad (2)$$

where y_{it} is the dependent variable, the vector \mathbf{x}_{it} contains the explanatory variables for firm i at time t and \mathbf{b} is the coefficient vector. Standard errors are clustered by firm to account for the panel structure of the data. This model additionally includes 23 industry fixed effects to control for heterogeneity across industries. There is no further control for unobserved heterogeneity as, unlike in many studies using CPI micro data, the data set employed in this paper allows firm characteristics to be observed and thus allows me to control for a lot of heterogeneity that would not be observed in other data sets.¹⁹

Three models are estimated, which differ by the definition of the dependent variables. First, the probability to observe a price change is modeled. Thus, the dependent variable y_{it} takes the value one if firm i indicates at date t that it either increased or decreased its selling price, and zero otherwise. This will be labeled *model I*.

Model I:

$$y_{it} = \begin{cases} 1, & \text{if } Price_t = 1 \\ 1, & \text{if } Price_t = -1 \\ 0, & \text{otherwise.} \end{cases} \quad (3)$$

Second, price increases and decreases are modeled separately to investigate whether asymmetries play a role in price setting behavior, i.e. whether price increases behave

¹⁹As the aim of this paper is to show the importance of firm-level conditions, not to estimate hazard rates, this methodology suffices. Nevertheless, the estimates were also reproduced using conditional logit, and the main conclusions remain unaffected. The random effects logit model is not a good option, because it relies on the assumption that the regressors are uncorrelated with the unobserved heterogeneity (random effects), an assumption that is likely to be violated, too. Adding more than four regressors in the Heckman-Singer model, as employed in Willis (2006), led to non-convergence.

differently in response to a change in the explanatory variables than price decreases. The dependent variable for *model II* is defined as

Model II:

$$y_{it}^+ = \begin{cases} 1, & \text{if } Price_t = 1 \\ 0, & \text{otherwise.} \end{cases} \quad (4)$$

The dependent variable for *model III* (price reductions) is defined as

Model III:

$$y_{it}^- = \begin{cases} 1, & \text{if } Price_t = -1 \\ 0, & \text{otherwise.} \end{cases} \quad (5)$$

Following [Aucremanne and Dhyne \(2005\)](#), the set of regressors is defined as a mixture of time-dependent and state-dependent variables. Three regressions are run for each time period and for each model. In a first step, the model is estimated using only variables that account for time-dependent pricing. In a second step, the microeconomic state variables from the survey are included. In a third step, time effects are added to account for current macroeconomic developments. The three sets of explanatory variables in \mathbf{x}_{it} are defined as follows:

- *Time-dependent variables:* first, the model accounts for time-dependent pricing rules. In previous empirical studies, Taylor pricing with an adjustment frequency of every four or eight quarters has been identified as the most important price setting behavior. Also, models that estimate durations show large spikes in hazard rates at durations of four and eight quarters (e.g. [Nakamura and Steinsson, 2008](#)). Following this line of the literature, Taylor dummies are defined, which indicate that the last price change occurred between one and eight quarters ago (*Taylor1–Taylor8*). The

dummies account for the observation that some firms reset their price at fixed time intervals, mainly every year or every two years. For example, if the last time a firm reported a price adjustment was four quarters ago, *Taylor4* takes the value one.²⁰ Furthermore, dummies for each quarter (season) are added. The seasonal dummies included in the regressions are the second quarter of the year (*spring*), the third quarter (*summer*), and the fourth quarter (*fall*) compared to the benchmark, which is the first quarter. Moreover, a dummy that is equal to one in the first quarters of 1995, 1999 and 2001 to control for changes in VAT rates and industry fixed effects are included, which are not reported in the results.

- *Proxies for the microeconomic state*: in a second step, the model is augmented with the firm-level information from the survey. To account for possible asymmetries, the qualitative variables are added for both positive and negative values separately, so that the baseline is always the response *no change* or *sufficient*. The explanatory variables are summarized in table 4. All variables are added that are available for a given sample. The first column shows the question stated in the questionnaire, the second the response possibilities, and the third the name of the variable used in the empirical analysis. The fourth column shows the values the variable can take.

The last column shows the years for which data are available. For example, the first

²⁰The aim of including duration dummies is to control for Taylor contracting. A common procedure in the empirical price setting literature is to estimate hazard rates to test for state-dependent pricing (e.g., Kaufmann, 2009). The idea is that, without idiosyncratic shocks, the gap between the firm's actual and desired prices increases with the age of the actual price because aggregate shocks accumulate over time. Thus, the age of the price, or the duration since the last price change, is a proxy for the accumulated shocks which create the deviation of the actual from the desired price, and hazard rates should be upward-sloping in first generation state-dependent pricing models. However, many state-dependent models do not necessarily produce upward-sloping hazard rates, so hazard rates by themselves are not an exclusive test for or against state-dependence. As the data set employed in this paper contains firm-level proxies for the shocks that create the gap between the actual and the desired price, I focus on the interpretation of duration dummies as proxies for Taylor contracting. Nevertheless, the logit model presented here has an interpretation of a discrete-time hazard model with flexible baseline hazard using a logit link function (Jenkins, 1995). Furthermore, the time frequency of the data is relatively low compared to other studies and, consequently, other data sets are much better suited for estimating hazard rates (e.g. Campbell and Eden, 2007).

question is “*You expect the costs for intermediate products in the next three months to ...*”. If firm i at date t responds that costs are expected to *increase*, the variable $E_t(\text{Costs}_{t+1})^+$ is equal to one, and the variable $E_t(\text{Costs}_{t+1})^-$ is equal to zero. Reversely, if the firm indicates that costs are expected to *decrease*, $E_t(\text{Costs}_{t+1})^-$ is equal to one, and $E_t(\text{Costs}_{t+1})^+$ is equal to zero. If respondents report that costs are expected to remain *unchanged*, both $E_t(\text{Costs}_{t+1})^+$ and $E_t(\text{Costs}_{t+1})^-$ equal zero.

Table 4: Explanatory variables from survey data

Question	Response	Variable	Scale	Availability
Costs expected for next 3 mths	increase	$E_t(\text{Costs}_{t+1})^+$	binary(0/1)	1984–2007
	decrease	$E_t(\text{Costs}_{t+1})^-$	binary(0/1)	1984–2007
Technical capacities	more than sufficient	Technical Capacity ^h	binary(0/1)	1984–2007
	not sufficient	Technical Capacity ^l	binary(0/1)	1984–2007
Capacity utilization	50%, 55%... 110%.	Capacity Utilization	ordinal(50,... 110)	1984–2007
Revenue	increased	Revenue ⁺	binary(0/1)	1984–2007
	decreased	Revenue ⁻	binary(0/1)	1984–2007
Number of employees	1,2,...	Firmsize	ordinal(1,2,...)	1984–2007
Costs in the past 3 mths	increased	Costs ⁺	binary(0/1)	1984–1998
	decreased	Costs ⁻	binary(0/1)	1984–1998
Employment	more than sufficient	Employment ^h	binary(0/1)	1984–1998
	not sufficient	Employment ^l	binary(0/1)	1984–1998
Stocks	too high	Stocks ^h	binary(0/1)	1984–1998
	too low	Stocks ^l	binary(0/1)	1984–1998
Competitive position in the past 3 m.	improved	Competitiveness ⁺	binary(0/1)	1999–2007
	deteriorated	Competitiveness ⁻	binary(0/1)	1999–2007

- *Proxies for the macroeconomic state*: the model above is augmented with time dummies (time fixed effects), which account for current macroeconomic conditions in a given quarter. The time dummies capture the aggregate shocks, which affect all firms’ prices in a given quarter. Arguably, inflation should be the aggregate variable that affects prices on the micro level. The estimated coefficients are illustrated together with the inflation rate in section 3.2 to show how they covary.

3 Results

This section presents the regression results. All results tables have the same structure. The tables show three panels of results corresponding to the samples 1984–2007, 1984–1998, or 1999–2007. The first column in each panel shows the results for the model that includes only the time-dependent variables, the second the results for the model that includes the firm-level variables in addition to the time-dependent variables, while the third additionally includes the time fixed effects to proxy for macroeconomic developments. All tables report marginal effects. As the marginal effects depend on the values of the covariates, they are evaluated setting capacity utilization and firm size to their sample averages and all other variables to zero. By setting the covariates to zero, each marginal effect is evaluated where the covariates are either *unchanged* (for *Costs* and *Revenue*) or *sufficient* (for *Employment*, *Technical Capacities*, and *Stocks*). Furthermore, with the exception of *Capacity Utilisation* and $\ln(\text{Firmsize})$, all variables are dummies. For the dummy variables, the marginal effects are calculated as the difference in the predicted probability of a price change as the dummy variable changes from 0 to 1.

3.1 Time-dependence versus state-dependence

Table 5 shows the results for *model I* with the dependent variable being equal to one if a firm changed its price and zero if the price remained unchanged. Column (1) reports the estimates for the time-dependent model with Taylor-contracting dummies and seasonal effects. It shows that the probability of observing a price change is significantly higher one to five and eight quarters after the last price change. Furthermore, the probability of observing a price change in the first quarter of the year is significantly higher than in the rest of the year. These seasonal effects are in line with the findings in [Nakamura and Steinsson \(2008\)](#) for the U.S.

In column (2) the firm-level state variables have been included. All firm-level variables are significant and positive. They all have the same sign, which is reasonable, as the qualitative variables measure either changes in conditions, one measuring increases and the other decreases in either costs or revenue, or they capture a deviation of the variable from the desired level. Both an increase and a decrease in expected costs, for example, may thus lead to a price change. Also, a higher level of capacity utilization is associated with a higher price adjustment probability. A one percent increase in firm size raises the probability of price adjustment by about one percent. The marginal effects of the variables *Revenue* and $E_t(Costs_{t+1})^-$ are sizeable, whereas the marginal effects of $E_t(Costs_{t+1})^+$ and *Technical Capacity* are rather small.

In column (3) the macroeconomic time fixed effects are added. Even though coefficients on the time fixed effects are not always significant, they are jointly significant. Most marginal effects for firm-specific variables are similar to the estimates in column (2). The goodness of fit of these models is evaluated by computing McFadden's adjusted Pseudo R^2 .²¹ When comparing the R^2 , the inclusion of macroeconomic variables contributes only marginally to the goodness of fit of the model. [Aucremanne and Dhyne \(2005\)](#), for example, conclude from this finding that the state-dependent component of the model is not very important. However, this might be due to the fact that firms react only little to variations in the macroeconomic environment because the shocks are relatively small ([Golosov and Lucas, 2007](#)) or because they do not pay much attention to macroeconomic shocks ([Mackowiak and Wiederholt, 2009](#)), or both. These theoretical arguments are corroborated by the finding that the firm-level state variables indeed improve the R^2 . It rises from 0.11 to 0.16 in column (2), whereas the inclusion of the variables capturing the macroeconomic environment raises the R^2 only from 0.16 to 0.17.

²¹The formula is $R^2 = 1 - \frac{\ln(\hat{L}_{Model}) - k}{\ln(\hat{L}_{interc})}$, where \hat{L}_{Model} is the likelihood of the respective model, \hat{L}_{interc} the likelihood of the model with intercept and k the number of regressors in the model, which penalizes for including too many explanatory variables.

Columns (4), (5) and (6) show the marginal effects for the sample 1984–1998, for which information is available on current costs for intermediate products, employment, and stocks of intermediate products. The marginal effect is 0.17 for an increase in costs and 0.20 for a decrease in costs. This result suggests that prices are about 20% more likely to change when costs change. The effect might even be larger when separating price increases and price decreases. Thus, there is evidence of cost-based pricing, which has also been ranked among the most commonly cited reasons for price rigidity by firms in interview studies (Fabiani et al., 2006). Interestingly, the effect of contemporaneous cost changes is substantially higher than the effect of expected cost changes, which is actually negative for expected cost increases (−0.04) and only 0.09 for expected cost decreases. This finding shows that most firms conduct price changes at the time when costs actually change, not before, which is another feature of state-dependent pricing (Dotsey and King, 2005). This might be due to the fact that firms can react more easily to cost shocks after they have actually materialized, as it is easier to explain price changes to their customers when they can be justified by cost changes.²² The result from the previous sample, that higher utilization raises the probability of adjusting prices, also holds when controlling for contemporaneous changes in costs for intermediate products. Also, larger firms adjust prices more often. For *Revenue*⁺ and *Revenue*[−] the marginal effects are relatively high, too, at 0.10 and 0.17, respectively. The effects for *Employment* and *Technical Capacity* are significant but small. There is no significant impact of the variable *Stocks*.²³

²²Firms' long-term relationships with their customers are among the main reasons for price stickiness according to the interview study conducted by Blinder et al. (1998).

²³However, the latter might hold for stocks of intermediate products only. Unfortunately there is no information in this survey on stocks of final products.

Table 5: Model I: Price changes

	Sample 1984-2007			Sample 1984-1998			Sample 1999-2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Taylor1	0.43*** (0.01)	0.29*** (0.02)	0.39*** (0.01)	0.39*** (0.01)	0.30*** (0.02)	0.29*** (0.02)	0.39*** (0.01)	0.28*** (0.03)	0.29*** (0.03)
Taylor2	0.22*** (0.02)	0.17*** (0.01)	0.24*** (0.01)	0.21*** (0.02)	0.17*** (0.02)	0.17*** (0.02)	0.26*** (0.02)	0.18*** (0.02)	0.20*** (0.03)
Taylor3	0.13*** (0.02)	0.11*** (0.01)	0.16*** (0.02)	0.14*** (0.02)	0.11*** (0.02)	0.12*** (0.02)	0.17*** (0.03)	0.12*** (0.03)	0.14*** (0.03)
Taylor4	0.31*** (0.02)	0.24*** (0.01)	0.29*** (0.01)	0.30*** (0.01)	0.25*** (0.02)	0.24*** (0.02)	0.24*** (0.03)	0.18*** (0.03)	0.20*** (0.03)
Taylor5	0.10*** (0.02)	0.09*** (0.02)	0.13*** (0.02)	0.12*** (0.02)	0.09*** (0.02)	0.10*** (0.02)	0.14*** (0.04)	0.10*** (0.03)	0.11*** (0.03)
Taylor6	0.03 (0.02)	0.01 (0.02)	0.05** (0.02)	0.01 (0.03)	-0.01 (0.03)	0.00 (0.03)	0.10** (0.04)	0.07* (0.04)	0.08** (0.04)
Taylor7	0.04** (0.02)	0.04* (0.02)	0.06*** (0.02)	0.02 (0.03)	0.01 (0.03)	0.03 (0.03)	0.11** (0.04)	0.09** (0.04)	0.10*** (0.04)
Taylor8	0.16*** (0.02)	0.15*** (0.02)	0.18*** (0.02)	0.17*** (0.02)	0.14*** (0.02)	0.15*** (0.02)	0.17*** (0.04)	0.14*** (0.04)	0.15*** (0.04)
Spring	-0.18*** (0.01)	-0.23*** (0.01)	-0.37*** (0.05)	-0.27*** (0.01)	-0.26*** (0.01)	-0.29*** (0.04)	-0.13*** (0.01)	-0.12*** (0.02)	-0.49*** (0.07)
Summer	-0.16*** (0.01)	-0.22*** (0.01)	-0.36*** (0.05)	-0.16*** (0.01)	-0.23*** (0.01)	-0.25*** (0.04)	-0.12*** (0.01)	-0.13*** (0.02)	-0.52*** (0.06)
Fall	-0.14*** (0.01)	-0.20*** (0.01)	-0.30*** (0.06)	-0.14*** (0.01)	-0.21*** (0.01)	-0.17*** (0.04)	-0.09*** (0.02)	-0.12*** (0.02)	-0.52*** (0.06)
Costs ⁺					0.17*** (0.01)	0.17*** (0.01)			
Costs ⁻					0.21*** (0.02)	0.20*** (0.02)			
$E_t(\text{Costs}_{t+1})^+$		0.02*** (0.01)	0.02*** (0.01)		-0.06*** (0.01)	-0.04*** (0.01)	0.07*** (0.01)	0.06*** (0.01)	
$E_t(\text{Costs}_{t+1})^-$		0.15*** (0.01)	0.17*** (0.01)		0.10*** (0.01)	0.09*** (0.01)	0.14*** (0.02)	0.16*** (0.02)	
Capacity Utiliz.		0.07*** (0.03)	0.08** (0.03)		0.08** (0.04)	0.10*** (0.04)	0.05 (0.05)	0.01 (0.05)	
Ln(Firmsize)		0.01*** (0.00)	0.02*** (0.00)		0.01** (0.00)	0.01** (0.00)	0.02*** (0.00)	0.03*** (0.00)	
Revenue ⁺		0.12*** (0.01)	0.13*** (0.01)		0.10*** (0.01)	0.10*** (0.01)	0.14*** (0.02)	0.14*** (0.02)	
Revenue ⁻		0.21*** (0.01)	0.25*** (0.01)		0.18*** (0.01)	0.17*** (0.01)	0.24*** (0.02)	0.25*** (0.02)	
Technical Capacity ^h		0.05*** (0.01)	0.04*** (0.01)		0.04*** (0.01)	0.03*** (0.01)	0.01 (0.02)	0.01 (0.02)	
Technical Capacity ^l		0.02* (0.01)	0.02* (0.01)		0.00 (0.01)	0.01 (0.01)	0.01 (0.02)	0.01 (0.02)	
Employment ^h					0.04*** (0.01)	0.03*** (0.01)			
Employment ^l					0.03** (0.01)	0.04*** (0.01)			
Stocks ^h					0.01 (0.01)	0.01 (0.01)			
Stocks ^l					0.02 (0.02)	0.01 (0.02)			
Competitiveness ⁺							0.04** (0.02)	0.05*** (0.02)	
Competitiveness ⁻							0.11*** (0.01)	0.12*** (0.02)	
Observations	49942	49942	49942	34059	34059	34059	13360	13360	13360
Pseudo R-squared	0.11	0.16	0.17	0.12	0.18	0.19	0.09	0.17	0.17
Time Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (3), (6) and (9), which are not included in the other columns and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero and firm size and capacity utilization to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

Columns (7), (8) and (9) report the marginal effects for the sample 1999–2007. The effect of the firm-level variables reported in column (8) and (9) remains mostly in line with the estimates in the previous columns. The effect of *Competitiveness*⁻ is with a marginal effect of 0.12 also economically significant.

These results suggest that both time-dependent and state-dependent pricing are present in the Swiss manufacturing sector. The probability of adjusting prices every quarter, every fourth or eighth quarter is relatively high, suggesting that Taylor pricing plays an important role. This results also holds when including firm-level variables. These have economically meaningful effects, whereas the inclusion of time dummies capturing macroeconomic developments does not add much in terms of goodness of fit to the model.

As firms' responses to negative shocks may differ from their responses to positive shocks, price increases are distinguished from price decreases in *model II* and *model III*.

Table 6 reports the results for price increases as a dependent variable. Column (1) reports the initial model with only Taylor and seasonal dummies. The marginal effects of the Taylor dummy *Taylor4* is large, compared to the other time-dependent factors, suggesting that Taylor pricing with firms adjusting prices every year is quite important for price increases. In column (2) the microstate variables available for the period 1984–2007 are added. All available variables have the expected signs and are significant.

Looking at the sample 1984–1998 in columns (4) to (6), the R^2 reported in column (5) more than doubles compared to the model with time-dependent factors in column (4). Interestingly, the marginal effect of an increase in costs on the probability of increasing the price is 0.27. This suggests that firms which face an increase in costs are almost 30% more likely to raise their selling price. Thus, there is a selection effect, as firms facing increases in costs are significantly more likely to raise prices. The effect of a contemporaneous cost increase is significantly different from unity, suggesting that there is no immediate pass-through from intermediate input costs to prices. Arguably, there are impediments

Table 6: Model II: Price increases

	Sample 1984-2007			Sample 1984-1998			Sample 1999-2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Taylor1	0.22*** (0.02)	0.16*** (0.02)	0.25*** (0.02)	0.22*** (0.02)	0.17*** (0.02)	0.19*** (0.02)	0.23*** (0.03)	0.19*** (0.04)	0.25*** (0.04)
Taylor2	0.11*** (0.02)	0.08*** (0.01)	0.12*** (0.02)	0.12*** (0.02)	0.10*** (0.02)	0.09*** (0.02)	0.08** (0.04)	0.07** (0.03)	0.11*** (0.04)
Taylor3	0.12*** (0.02)	0.08*** (0.02)	0.11*** (0.02)	0.14*** (0.02)	0.11*** (0.02)	0.10*** (0.02)	0.06 (0.04)	0.04 (0.04)	0.07* (0.04)
Taylor4	0.33*** (0.01)	0.21*** (0.02)	0.33*** (0.01)	0.35*** (0.01)	0.24*** (0.03)	0.27*** (0.03)	0.21*** (0.04)	0.17*** (0.04)	0.22*** (0.04)
Taylor5	0.04 (0.03)	0.04* (0.02)	0.07** (0.03)	0.04 (0.03)	0.04 (0.03)	0.05 (0.03)	0.07 (0.05)	0.06 (0.04)	0.08* (0.05)
Taylor6	-0.03 (0.03)	-0.02 (0.03)	-0.00 (0.03)	-0.07* (0.04)	-0.03 (0.04)	-0.03 (0.04)	0.03 (0.06)	0.05 (0.05)	0.06 (0.06)
Taylor7	0.04 (0.03)	0.03 (0.02)	0.06* (0.03)	0.04 (0.04)	0.04 (0.03)	0.05 (0.04)	0.05 (0.06)	0.04 (0.05)	0.04 (0.06)
Taylor8	0.20*** (0.02)	0.14*** (0.02)	0.22*** (0.02)	0.21*** (0.03)	0.17*** (0.02)	0.20*** (0.03)	0.13** (0.06)	0.11** (0.05)	0.13** (0.06)
Spring	-0.21*** (0.01)	-0.23*** (0.01)	-0.45*** (0.03)	-0.23*** (0.01)	-0.25*** (0.02)	-0.26*** (0.04)	-0.13*** (0.02)	-0.15*** (0.02)	-0.54*** (0.08)
Summer	-0.24*** (0.01)	-0.27*** (0.01)	-0.43*** (0.04)	-0.28*** (0.01)	-0.28*** (0.02)	-0.22*** (0.04)	-0.14*** (0.02)	-0.16*** (0.02)	-0.44*** (0.09)
Fall	-0.26*** (0.01)	-0.32*** (0.01)	-0.37*** (0.06)	-0.30*** (0.01)	-0.30*** (0.01)	-0.50*** (0.05)	-0.15*** (0.02)	-0.18*** (0.02)	-0.47*** (0.09)
Costs ⁺					0.25*** (0.03)	0.27*** (0.03)			
Costs ⁻					-0.08*** (0.02)	-0.10*** (0.03)			
$E_t(\text{Costs}_{t+1})^+$		0.10*** (0.01)	0.09*** (0.01)		-0.05*** (0.01)	-0.07*** (0.01)	0.15*** (0.02)	0.15*** (0.02)	
$E_t(\text{Costs}_{t+1})^-$		-0.10*** (0.02)	-0.09*** (0.02)		-0.09*** (0.03)	-0.07*** (0.03)	-0.01 (0.03)	0.02 (0.04)	
Capacity Utiliz.		0.18*** (0.03)	0.11** (0.04)		0.15*** (0.04)	0.12** (0.05)	0.10 (0.07)	-0.00 (0.08)	
Ln(Firmsize)		0.01*** (0.00)	0.01* (0.00)		0.01** (0.00)	0.01 (0.01)	0.02** (0.01)	0.02*** (0.01)	
Revenue ⁺		0.15*** (0.01)	0.24*** (0.01)		0.15*** (0.02)	0.19*** (0.02)	0.20*** (0.03)	0.24*** (0.03)	
Revenue ⁻		-0.15*** (0.01)	-0.15*** (0.01)		-0.17*** (0.02)	-0.17*** (0.02)	-0.21*** (0.03)	-0.20*** (0.03)	
Technical Capacity ^h		-0.06*** (0.02)	-0.03* (0.02)		-0.04** (0.02)	-0.02 (0.02)	-0.06 (0.03)	-0.03 (0.04)	
Technical Capacity ^l		0.05*** (0.01)	0.03** (0.02)		0.01 (0.02)	0.00 (0.02)	0.07*** (0.03)	0.05* (0.03)	
Employment ^h					-0.08*** (0.02)	-0.04** (0.02)			
Employment ^l					0.08*** (0.01)	0.05*** (0.02)			
Stocks ^h					-0.01 (0.02)	-0.00 (0.02)			
Stocks ^l					0.01 (0.02)	0.03 (0.03)			
Competitiveness ⁺							0.04** (0.02)	0.06*** (0.02)	
Competitiveness ⁻							-0.06* (0.03)	-0.04 (0.04)	
Observations	49942	49942	49942	34059	34059	34059	13360	13360	13360
Pseudo R-squared	0.08	0.15	0.20	0.11	0.25	0.29	0.05	0.15	0.17
Time Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (3), (6) and (9), which are not included in the other columns, and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero, and firm size and capacity utilization to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

like menu costs to immediate price adjustments. Another interesting observation is that expected increases and decreases in costs both have a small but negative marginal effect. Thus, after controlling for contemporaneous cost changes, an expected increase in costs in the next period lowers the probability of observing a price increase today. This suggests that if there is no cost change today (as the marginal effects are evaluated with all other variables set to zero), but firms expect a cost increase for the next quarter, they will elect to delay increasing their price, instead of increasing it in advance of the actual realization of the cost increase. The marginal effect of *Revenue* is significant, implying that higher (lower) revenue is associated with a higher (lower) likelihood of increasing prices. Also, a higher level of capacity utilization, which is correlated with higher real marginal costs (Rotemberg and Woodford, 1999), is associated with a larger probability of increasing prices. An increase in the capacity utilization rate by one standard deviation raises the probability of a price increase by about 2%. Further, if firms state that their current employment is too low, price increases are more likely, too. The two variables *Stocks* are again insignificant. Thus, inventories of intermediate products do not seem to play a role for the timing of price increases.

The last three columns (7), (8) and (9) show the estimates for the period 1999–2007. The results in column (9) show that improved competitiveness raises the probability of observing a price increase, although only by about 6%. Again, there is a substantial improvement in the goodness of fit of the model when the firm-level state variables are included.

Table 7 reports the estimated marginal effects for *model III*, where the dependent variable is equal to one when there is a price reduction and zero otherwise. Column (1) shows that the probability of observing a price reduction is highest one quarter after the last price change was carried out. This differs from the model for price increases, where the largest probability is after four quarters. The marginal effects of the firm-level state

Table 7: Model III: Price decreases

	Sample 1984-2007			Sample 1984-1998			Sample 1999-2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Taylor1	0.41*** (0.01)	0.39*** (0.03)	0.32*** (0.03)	0.41*** (0.01)	0.38*** (0.04)	0.32*** (0.04)	0.42*** (0.01)	0.35*** (0.04)	0.33*** (0.05)
Taylor2	0.27*** (0.01)	0.26*** (0.02)	0.24*** (0.02)	0.25*** (0.02)	0.23*** (0.02)	0.23*** (0.03)	0.33*** (0.03)	0.27*** (0.04)	0.26*** (0.04)
Taylor3	0.16*** (0.02)	0.15*** (0.02)	0.16*** (0.02)	0.12*** (0.03)	0.11*** (0.03)	0.15*** (0.02)	0.25*** (0.04)	0.21*** (0.04)	0.21*** (0.04)
Taylor4	0.13*** (0.02)	0.10*** (0.02)	0.13*** (0.02)	0.07** (0.03)	0.05 (0.03)	0.09*** (0.03)	0.25*** (0.04)	0.21*** (0.04)	0.21*** (0.04)
Taylor5	0.16*** (0.02)	0.14*** (0.03)	0.14*** (0.02)	0.17*** (0.03)	0.13*** (0.03)	0.15*** (0.03)	0.19*** (0.05)	0.16*** (0.05)	0.16*** (0.05)
Taylor6	0.09*** (0.03)	0.06* (0.03)	0.07*** (0.03)	0.07** (0.04)	0.03 (0.04)	0.06* (0.03)	0.16*** (0.05)	0.11** (0.06)	0.13** (0.05)
Taylor7	0.07* (0.03)	0.05 (0.03)	0.08** (0.03)	0.02 (0.04)	-0.00 (0.04)	0.04 (0.04)	0.17*** (0.06)	0.16*** (0.06)	0.17*** (0.05)
Taylor8	0.10*** (0.03)	0.08** (0.04)	0.09*** (0.03)	0.07 (0.04)	0.04 (0.04)	0.07 (0.04)	0.19*** (0.06)	0.17*** (0.06)	0.16*** (0.06)
Spring	-0.15*** (0.01)	-0.12*** (0.01)	-0.12*** (0.04)	-0.19*** (0.01)	-0.16*** (0.01)	0.01 (0.06)	-0.08*** (0.01)	-0.06*** (0.02)	-0.59*** (0.06)
Summer	-0.08*** (0.01)	-0.08*** (0.01)	-0.60*** (0.04)	-0.10*** (0.01)	-0.11*** (0.01)	0.05 (0.05)	-0.06*** (0.01)	-0.06*** (0.02)	-0.57*** (0.07)
Fall	-0.04*** (0.01)	-0.02** (0.01)	-0.60*** (0.04)	-0.06*** (0.01)	-0.07*** (0.01)	0.22*** (0.04)	-0.02 (0.02)	-0.02 (0.02)	-0.58*** (0.06)
Costs ⁺					-0.17*** (0.01)	-0.11*** (0.02)			
Costs ⁻					0.29*** (0.02)	0.26*** (0.03)			
$E_t(\text{Costs}_{t+1})^+$		-0.10*** (0.01)	-0.05*** (0.01)		-0.04*** (0.01)	0.00 (0.01)		-0.05*** (0.02)	-0.03* (0.02)
$E_t(\text{Costs}_{t+1})^-$		0.23*** (0.01)	0.23*** (0.01)		0.14*** (0.02)	0.12*** (0.02)		0.19*** (0.02)	0.18*** (0.02)
Capacity Utiliz.		-0.05 (0.05)	0.04 (0.05)		0.02 (0.06)	0.08 (0.06)		-0.03 (0.07)	-0.00 (0.07)
Ln(Firmsize)		0.01** (0.01)	0.02*** (0.01)		0.00 (0.01)	0.01* (0.01)		0.02*** (0.01)	0.03*** (0.01)
Revenue ⁺		-0.10*** (0.02)	-0.11*** (0.01)		-0.09*** (0.02)	-0.11*** (0.02)		-0.14*** (0.03)	-0.13*** (0.03)
Revenue ⁻		0.34*** (0.02)	0.35*** (0.01)		0.32*** (0.02)	0.27*** (0.03)		0.33*** (0.04)	0.31*** (0.04)
Technical Capacity ^h		0.09*** (0.01)	0.06*** (0.01)		0.07*** (0.02)	0.04*** (0.01)		0.02 (0.02)	0.00 (0.02)
Technical Capacity ^l		-0.05*** (0.02)	-0.03 (0.02)		-0.03 (0.02)	-0.00 (0.02)		-0.08*** (0.03)	-0.06** (0.03)
Employment ^h					0.08*** (0.01)	0.04*** (0.01)			
Employment ^l					-0.08*** (0.02)	-0.02 (0.02)			
Stocks ^h					0.04** (0.02)	0.02 (0.02)			
Stocks ^l					0.00 (0.03)	-0.03 (0.03)			
Competitiveness ⁺								0.02 (0.02)	0.02 (0.02)
Competitiveness ⁻								0.15*** (0.02)	0.15*** (0.02)
Observations	49942	49942	49942	34059	34059	34059	13360	13360	13360
Pseudo R-squared	0.12	0.25	0.29	0.13	0.29	0.33	0.09	0.27	0.28
Time Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (3), (6) and (9), which are not included in the other columns, and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero, and firm size and capacity utilization to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

variables reported in column (2) show that an expected reduction in costs and a reduction in revenue have a substantial effect on the probability of reducing prices. Again, adding firm-level information improves the goodness of fit measure of the model, raising the Pseudo- R^2 from 0.12 to 0.25. When the time fixed effects are added in column (3), the Pseudo- R^2 improves rather marginally, to 0.29.

For the sample 1984–1998, the results are reported in columns (4) to (6). The contemporaneous cost variable in column (6) is again significant. The marginal effect of a cost reduction on a selling price reduction is 0.26, which is remarkably similar to the marginal effect of a cost increase on a selling price increase. However, the variable *Revenue* seems to play a larger role for price reductions than for price increases. The estimates suggest that a decline in revenue raises the probability of a price reduction by about 30%, while an increase in revenue raises the probability of a price increase by only about 15%. The capacity utilization rate is insignificant for price decreases, but not for price increases. This might be due to the fact that utilization is an imperfect proxy for real marginal costs, and that the under-utilization of capacities is not necessarily as well correlated with real marginal costs as an over-utilization.

The last three columns in table 7 show the estimates for the second sample 1999–2007. Again, the reduction in revenue is economically significant. A worsening in the competitive position of a firm is also associated with a higher likelihood of observing a price reduction, and the effect is more than twice as large as that of an improvement in the competitive position for price increases.

The results above show that cost changes have quantitatively important effects on price adjustment probabilities. The effects of a cost change might even be higher, as the accumulated cost changes since the last price adjustment should be measured rather than only the contemporaneous change. For the observation period 1984–1998, it is possible to construct a measure of accumulated cost changes by counting the number of cost changes

since the last price change. As cost increases and decreases may cancel each other out, they are accumulated separately. Accumulated cost changes are defined as

$$AccumCosts^+n = \begin{cases} 1, & \text{if } \sum_{s=0}^S Costs_{i,t-s}^+ = n \\ 0, & \text{otherwise} \end{cases} \quad (6)$$

$$AccumCosts^-n = \begin{cases} 1, & \text{if } \sum_{s=0}^S Costs_{i,t-s}^- = n \\ 0, & \text{otherwise.} \end{cases} \quad (7)$$

where S is the number of quarters since the last price adjustment, or, in other words, the length of the price spell of a price of firm i in period t . We estimate *models I, II and III*, corresponding to the results in column (6) in tables 5, 6 and 7, but replace the variables $Cost^+$ and $Cost^-$ by dummies that are equal to one if the number of cost changes is equal to n and zero otherwise. Both, $AccumCosts^+n$ and $AccumCosts^-n$ are included in the vector of explanatory variables \mathbf{x}_{it} , replacing the contemporaneous cost changes $Costs^+$ and $Costs^-$.

The results are shown in table 8, where only the marginal effects of the accumulated cost changes are reported. All other covariates are included, comparable to column (6) in tables 5, 6 and 7 above. As the marginal effects of the covariates do not change substantially, they are not reported, to keep the size of the table tractable. The results reported in the first column for *model I* show that the probability of observing a price change with one past cost increase is 0.12. The effect with eight past cost changes is larger, at 0.19, but the increase in probability is not as pronounced as one might expect. On the contrary, for accumulated cost decreases, the marginal effect of one past cost change is 0.15, whereas it rises to 0.34 when eight past cost reductions have accumulated.

Table 8: Accumulated cost changes

Dependent variable	<i>Model I</i>	<i>Model II</i>	<i>Model III</i>
$AccumCosts^+ = 1$	0.12*** (0.01)	0.25*** (0.02)	-0.07*** (0.01)
$AccumCosts^+ = 2$	0.15*** (0.01)	0.26*** (0.03)	-0.08*** (0.02)
$AccumCosts^+ = 3$	0.15*** (0.02)	0.25*** (0.03)	-0.07* (0.04)
$AccumCosts^+ = 4$	0.16*** (0.02)	0.22*** (0.03)	0.04 (0.04)
$AccumCosts^+ = 5$	0.11*** (0.04)	0.27*** (0.03)	-0.28*** (0.09)
$AccumCosts^+ = 6$	0.14*** (0.04)	0.28*** (0.04)	-0.13 (0.09)
$AccumCosts^+ = 7$	0.12** (0.05)	0.27*** (0.04)	-0.28* (0.14)
$AccumCosts^+ = 8$	0.19*** (0.05)	0.30*** (0.04)	-0.09 (0.14)
$AccumCosts^- = 1$	0.15*** (0.01)	-0.10*** (0.02)	0.23*** (0.02)
$AccumCosts^- = 2$	0.09*** (0.02)	-0.08** (0.04)	0.20*** (0.03)
$AccumCosts^- = 3$	0.13*** (0.03)	0.03 (0.05)	0.22*** (0.04)
$AccumCosts^- = 4$	0.15*** (0.04)	-0.17** (0.07)	0.28*** (0.04)
$AccumCosts^- = 5$	0.18*** (0.06)	0.00 (0.09)	0.27*** (0.06)
$AccumCosts^- = 6$	-0.29 (0.24)	-0.13 (0.32)	-0.13 (0.35)
$AccumCosts^- = 7$	0.18** (0.07)	-0.08 (0.06)	0.22*** (0.09)
$AccumCosts^- = 8$	0.34*** (0.04)	-0.18** (0.07)	0.37*** (0.05)
Observations	34059	34059	34059
Pseudo R-squared	0.19	0.28	0.33
Time Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes

Robust standard errors in parentheses *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$. The results correspond to the models reported in columns (6) in tables 5, 6 and 7. The dependent variable in the first column is equal to one if a price adjustment is recorded and zero otherwise (*model I*), as defined in equation (3). The dependent variable in the second column is equal to one if a price increase is recorded and zero otherwise (*model II*), as defined in equation (4). The dependent variable in the third column is equal to one if a price decrease is recorded and zero otherwise (*model III*), as defined in equation (5). The effects of the covariates are not reported to keep the size of the table tractable. Marginal effects are reported, setting all variables at their mean and fixed effects to zero, and firm size and capacity utilization to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

In the second column, the marginal effects are reported for *model II*. Similarly, the marginal effect of one cost increase is 0.25, which is comparable to the estimates for the contemporaneous cost increase. The marginal effect increases to 0.30 when there are eight past cost changes. The marginal effects for $AccumCosts^-$ are negative or insignificant, which is in line with the intuition that the more cost reductions have accumulated since the last price adjustment, the lower the probability of observing a price increase. The last column reports the estimates for price reductions as a dependent variable, as defined in *model III*. With more cost decreases accumulated, the marginal effect of the n -th cost reduction remains almost of the same magnitude for $n = 1, 2, 3, 4, 5$ and rises to 0.37 for eight accumulated cost decreases. In most cases the effect of the accumulated cost change is not much higher than the effect of a contemporaneous cost change. However, it should be borne in mind that the cost variable is of a qualitative nature. Arguably, firms respond to cost changes immediately if they are large enough. Thus, the cost changes that they did not respond to in the past might be relatively small in quantitative terms. This induces a form of a selection bias. Furthermore, firms might use other means of adjustment, such as changing the production quantity.²⁴

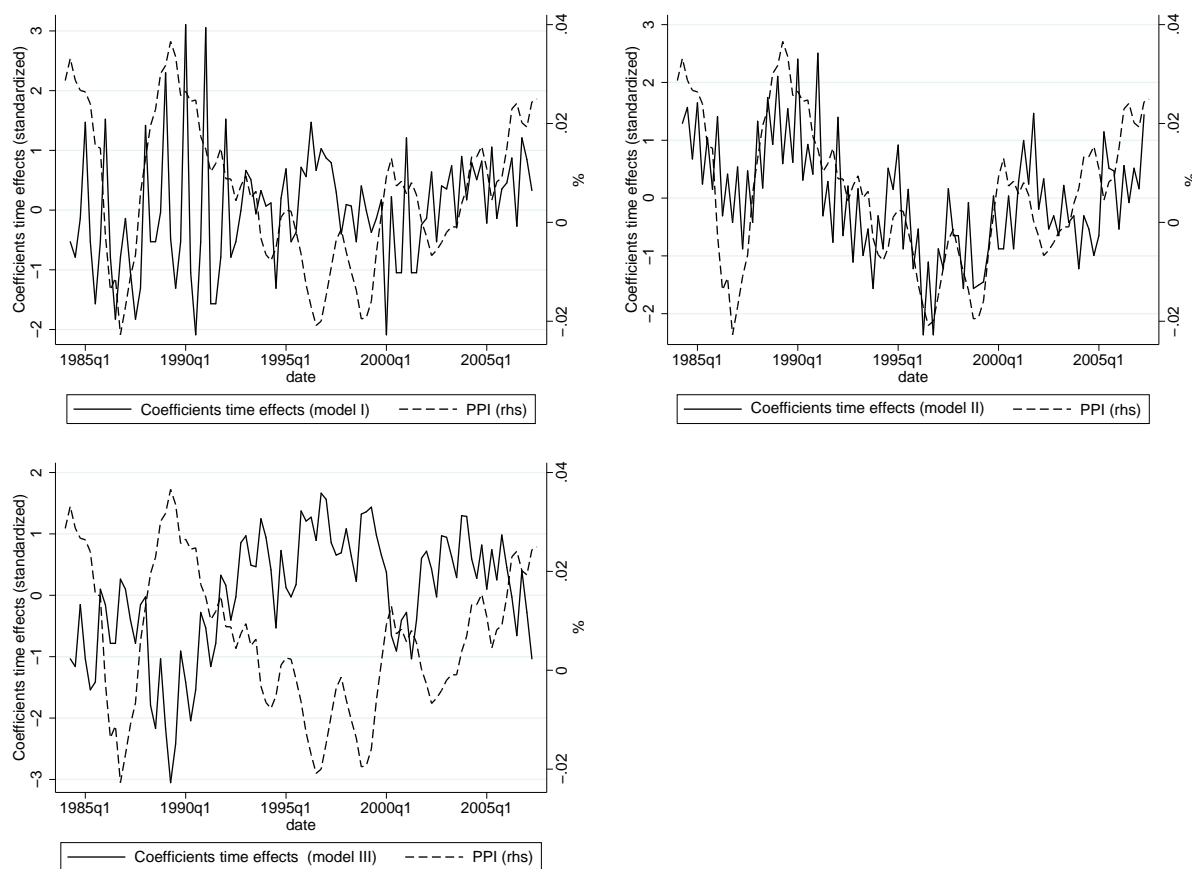
3.2 Influence of macroeconomic factors

This section discusses the results related to the question whether aggregate factors matter for the timing of price adjustments. Aggregate factors are introduced into the econometric model by including time fixed effects. As shown in the previous section, adding the aggregate factors does not improve the goodness of fit measures for the models of individual price adjustments by a large amount.²⁵ The coefficients give an estimate of the impact

²⁴For example, [Wolman \(2007\)](#) points out that, especially in the presence of long-term relationships, price adjustment might not be the only way to clear markets. Efficient allocations may be achieved at lower cost by varying other characteristics, such as quality or delivery time.

²⁵Adding the macroeconomic variables before adding the firm-level variables does not change this conclusion. The results are reported in the supplementary material.

Figure 4: Estimated aggregate factors and inflation



The upper left panel in the graph shows the estimated coefficients (rescaled to mean zero and variance one) of the time fixed effects in *model I* (dependent variable: price changes) with PPI inflation (percentage year-on-year). The upper right panel shows the estimated coefficients of the time fixed effects in *model II* (dependent variable: price increases), the lower panel the coefficients for *model III* (dependent variable: price decreases). Source PPI inflation: SFSO.

of aggregate factors in a given quarter on price adjustments. In state-dependent pricing models, the frequency of price increases (decreases) should be positively (negatively) correlated with inflation. I therefore test for a correlation between the estimated coefficients of the time fixed effects and aggregate inflation. The estimated standardized coefficients of the three models are plotted together with the aggregate PPI inflation in figure 4. The coefficients correspond to the regressions reported in column (3) of tables 5, 6 and 7, as these cover the entire time span.

Table 9: Correlation of estimated aggregate effects and inflation

Estimated coefficients of aggregate effects for	Correlation with	Regression on π_t	
	π_t	β	Std. error
Model I	0.00	0.03	0.12
Model II	0.61	0.23	0.05
Model III	-0.69	-0.28	0.05

OLS coefficients and standard errors for the regression of the estimated coefficients of the time dummies on PPI inflation denoted by π_t .

The upper left panel reveals that the estimated aggregate effects for *model I* are not correlated with the frequency of price changes. The correlation coefficient, which is reported in table 9, is 0.00. When regressing the estimated coefficients on inflation, the coefficient is not significantly different from zero. This is not the case for *model II*. The upper right panel suggests that inflation is closely correlated with the estimated aggregate effects. The correlation coefficient reported in table 9 is 0.61 and the slope coefficient of a regression of the coefficients on inflation is positive and significant. Finally, for *model III*, the model for price reductions, the correlation and the regression slope are negative and significant. These findings can be related to [Klenow and Kryvtsov \(2008\)](#) and [Gagnon \(2009\)](#). They find that the frequency of price increases covaries with aggregate inflation and the frequency of price decreases is negatively correlated with inflation. However, in periods of low inflation, positive and negative price changes largely offset each other, such that the frequency of all price changes is not correlated with inflation.

The finding that prices respond relatively strongly to changes in costs and other firm-specific variables but less so to aggregate factors suggests that shocks at the firm level are substantial. This result can be related to further findings reported by [Klenow and Kryvtsov \(2008\)](#), who show that the average price changes are small but average absolute price changes are large. Also, the finding that sectoral inflation rates are too transient and too volatile to be consistent with the Calvo model ([Bils and Klenow, 2004](#)) suggests that there

are substantial idiosyncratic shocks to marginal cost and desired markups.²⁶

3.3 Non-predetermined price changes

Interview studies conducted to investigate the pricing behavior of firms show that while most firms review their prices more often than they change them, some firms indicate that they review prices less often than they change them (Zurlinden, 2007). So there must be some price changes without price reviews. Furthermore, many manufacturing firms have fixed contracts with their customers over a longer period of time (e.g., Stahl, 2006). This suggests that firms may use pricing plans, such as in the sticky plan model. If price changes observed in the data contain prices that are already set in the past, these price changes do not respond to current economic conditions. Thus, when including them in the analysis of price changes, one may falsely conclude that there is no relationship between current conditions and the timing of price changes. In this section, the price expectations from the survey are used to construct the measure of a non-predetermined change by examining whether a firm deviates from its previously expected price. If a price changed in quarter t , and there was no price change expected in $t - 1$, this is treated as a non-predetermined price change.²⁷ Analogous to the models presented above, the results for non-predetermined price changes are presented first, then for increases and decreases separately. The dependent variable is defined as

²⁶These finding can also be related to the results obtained in Boivin et al. (2007), who show that sectoral inflation rates respond only slowly to macroeconomic disturbances but very flexibly to sector-specific shocks.

²⁷Many price changes that were previously expected are likely to be non-predetermined, too, because firms correctly predict them. Thus, most likely more price changes than necessary are excluded. However, this way we can ensure that the price changes in the sample of unexpected price adjustments are only those that are non-predetermined.

Model IV:

$$\tilde{y}_{it} = \begin{cases} 1, & \text{if } Price_t = -1 \quad \wedge \quad E_{t-1}(Price_t) \neq -1 \\ 1, & \text{if } Price_t = 1 \quad \wedge \quad E_{t-1}(Price_t) \neq 1 \\ 0, & \text{otherwise.} \end{cases} \quad (8)$$

For price increases, the dependent variable is equal to one if a firm increased its selling price in t , but expected to either leave it unchanged or decrease it when queried about its expectation in the previous quarter, and zero otherwise:

Model V:

$$\tilde{y}_{it}^+ = \begin{cases} 1, & \text{if } Price_t = 1 \quad \wedge \quad E_{t-1}(Price_t) \neq 1 \\ 0, & \text{otherwise.} \end{cases} \quad (9)$$

Accordingly, for price decreases:

Model VI:

$$\tilde{y}_{it}^- = \begin{cases} 1, & \text{if } Price_t = -1 \quad \wedge \quad E_{t-1}(Price_t) \neq -1 \\ 0, & \text{otherwise.} \end{cases} \quad (10)$$

The results for *model IV* are presented in table 10. Again, microeconomic state variables are important. Changes in cost have a particularly strong impact on the probability of unexpected price changes.

Table 10: Model IV: Non-predetermined price changes

	Sample 1984–2007			Sample 1984–1998			Sample 1999–2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Taylor1	0.20*** (0.02)	0.14*** (0.01)	0.14*** (0.01)	0.16*** (0.02)	0.01 (0.02)	0.01 (0.02)	0.32*** (0.02)	0.21*** (0.03)	0.22*** (0.03)
Taylor2	0.14*** (0.02)	0.11*** (0.02)	0.10*** (0.02)	0.10*** (0.02)	0.04* (0.02)	0.04 (0.02)	0.28*** (0.03)	0.20*** (0.03)	0.21*** (0.03)
Taylor3	0.07*** (0.02)	0.05*** (0.02)	0.05*** (0.02)	0.04* (0.02)	-0.01 (0.02)	-0.01 (0.02)	0.19*** (0.04)	0.14*** (0.03)	0.15*** (0.03)
Taylor4	0.05*** (0.02)	0.04** (0.02)	0.04** (0.02)	0.03 (0.02)	-0.11*** (0.03)	-0.10*** (0.03)	0.20*** (0.04)	0.15*** (0.03)	0.16*** (0.03)
Taylor5	0.05** (0.02)	0.04* (0.02)	0.04** (0.11)	0.04* (0.03)	0.02 (0.03)	0.01 (0.03)	0.16*** (0.04)	0.12*** (0.04)	0.13*** (0.04)
Taylor6	0.01 (0.02)	0.01 (0.02)	0.01 (0.02)	-0.01 (0.03)	0.00 (0.04)	-0.00 (0.04)	0.13*** (0.05)	0.10** (0.04)	0.11** (0.04)
Taylor7	0.02 (0.02)	0.01 (0.02)	0.02 (0.02)	0.01 (0.03)	0.03 (0.04)	0.01 (0.04)	0.08 (0.06)	0.07 (0.05)	0.08 (0.05)
Taylor8	0.04 (0.03)	0.03 (0.03)	0.02 (0.03)	0.02 (0.03)	-0.05 (0.04)	-0.07* (0.04)	0.15** (0.06)	0.12** (0.05)	0.12** (0.05)
Spring	-0.02** (0.01)	-0.01 (0.01)	-0.29*** (0.11)	-0.01 (0.01)	0.18*** (0.01)	-0.57*** (0.04)	-0.03** (0.02)	-0.02 (0.02)	-0.48*** (0.08)
Summer	-0.01* (0.01)	-0.01 (0.01)	-0.30*** (0.11)	0.01 (0.01)	0.18*** (0.01)	-0.57*** (0.04)	-0.06*** (0.02)	-0.05*** (0.02)	-0.48*** (0.08)
Fall	-0.03*** (0.01)	-0.03*** (0.01)	-0.32*** (0.10)	-0.02* (0.01)	0.13*** (0.02)	-0.57*** (0.04)	-0.06*** (0.02)	-0.06*** (0.02)	-0.48*** (0.08)
Costs ⁺					0.46*** (0.04)	0.43*** (0.04)			
Costs ⁻					0.46*** (0.04)	0.43*** (0.04)			
$E_t(\text{Costs}_{t+1})^+$		0.05*** (0.01)	0.04*** (0.01)		-0.16*** (0.01)	-0.16*** (0.01)		0.02** (0.01)	0.01 (0.01)
$E_t(\text{Costs}_{t+1})^-$		0.13*** (0.01)	0.15*** (0.01)		-0.19*** (0.02)	-0.19*** (0.02)		0.04** (0.02)	0.05** (0.02)
Capacity Utiliz.		0.09*** (0.03)	0.08** (0.03)		0.06 (0.05)	0.10** (0.05)		0.10** (0.05)	0.08 (0.05)
Ln(Firmsize)		0.01*** (0.00)	0.01*** (0.00)		-0.00 (0.01)	-0.00 (0.01)		0.01*** (0.01)	0.02*** (0.01)
Revenue ⁺		0.05*** (0.01)	0.06*** (0.01)		-0.01 (0.01)	-0.02 (0.01)		0.09*** (0.02)	0.09*** (0.02)
Revenue ⁻		0.13*** (0.01)	0.16*** (0.01)		-0.01 (0.01)	-0.02 (0.01)		0.22*** (0.02)	0.23*** (0.02)
Technical Capacity ^h		-0.00 (0.01)	0.00 (0.01)		-0.02 (0.02)	-0.02 (0.02)		-0.01 (0.02)	-0.01 (0.02)
Technical Capacity ^l		-0.01 (0.01)	-0.02 (0.01)		-0.03* (0.02)	-0.03 (0.02)		-0.01 (0.02)	-0.01 (0.02)
Employment ^h					0.02 (0.02)	-0.01 (0.02)			
Employment ^l					-0.02 (0.02)	-0.00 (0.02)			
Stocks ^h					-0.01 (0.02)	-0.01 (0.02)			
Stocks ^l					-0.03 (0.03)	-0.03 (0.03)			
Competitiveness ⁺								0.04** (0.02)	0.04** (0.02)
Competitiveness ⁻								0.09*** (0.02)	0.09*** (0.02)
Observations	49585	49585	49585	33962	33962	33962	13111	13111	13111
Pseudo R-squared	0.03	0.04	0.05	0.03	0.51	0.52	0.03	0.09	0.09
Time Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$. The logit is estimated using time dummies for every quarter in columns (3), (6) and (9), which are not included in the other columns, and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero, and firm size and capacity utilization to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

The goodness of fit of the models improves substantially with the addition of the cost variables, implying that firm-level shocks play an important role for price adjustment decisions. Furthermore, unexpected price changes are more likely to happen in the first quarter of the year. This may be explained by the fact that firms often review their prices only once per year (Fabiani et al., 2006), often at the end of the year.

The results for *models V and VI* are reported in tables 11 and 12, respectively. The goodness of fit is very low in the columns (1), (4), and (7), suggesting that time dependence is less present.²⁸ Adding the firm-level variables, especially the measure for costs, again raises the goodness of fit substantially. The R^2 triples in *model V* and more than doubles in *model VI*. The size of the estimated marginal effects is also comparable to the effects for *models II and III* suggesting that changes in costs, capacity utilization and revenue are the economically most meaningful variables explaining price adjustments. Summing up, the conclusions from section 3.1 are robust to the exclusion of possibly predetermined price changes. The importance of state-dependent factors for the goodness of fit of the models becomes even larger, compared to purely time-dependent factors.

²⁸This is not the case for expected price changes. The R^2 is substantially higher when only the time dependent variables are included. This suggests that Taylor pricing is important empirically, as price changes that are conducted in fixed time intervals are most likely to be included in expected price changes. The results for expected price changes, increases, and decreases can be found in the supplementary material.

Table 11: Model V: Non-predetermined price increases

	Sample 1984–2007			Sample 1984–1998			Sample 1999–2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Taylor1	0.30*** (0.02)	0.18*** (0.03)	0.31*** (0.02)	0.33*** (0.02)	0.21*** (0.04)	0.23*** (0.04)	0.22*** (0.05)	0.15*** (0.04)	0.20*** (0.05)
Taylor2	0.20*** (0.03)	0.13*** (0.02)	0.20*** (0.03)	0.23*** (0.04)	0.15*** (0.03)	0.15*** (0.03)	0.13** (0.06)	0.09** (0.04)	0.14*** (0.05)
Taylor3	0.18*** (0.03)	0.11*** (0.02)	0.18*** (0.03)	0.24*** (0.04)	0.16*** (0.03)	0.16*** (0.03)	0.08 (0.07)	0.06 (0.05)	0.09* (0.05)
Taylor4	0.23*** (0.03)	0.15*** (0.02)	0.22*** (0.03)	0.26*** (0.03)	0.16*** (0.03)	0.16*** (0.03)	0.16*** (0.06)	0.11*** (0.04)	0.15*** (0.05)
Taylor5	0.11** (0.04)	0.08*** (0.03)	0.13*** (0.04)	0.12** (0.06)	0.09** (0.04)	0.09** (0.04)	0.11 (0.07)	0.08* (0.05)	0.11** (0.05)
Taylor6	0.08 (0.05)	0.06* (0.03)	0.09* (0.05)	0.05 (0.07)	0.06 (0.05)	0.06 (0.06)	0.09 (0.08)	0.08 (0.06)	0.10 (0.06)
Taylor7	0.05 (0.06)	0.04 (0.04)	0.06 (0.06)	0.12* (0.07)	0.09* (0.05)	0.09* (0.05)	-0.12 (0.12)	-0.11 (0.12)	-0.11 (0.12)
Taylor8	0.20*** (0.04)	0.13*** (0.03)	0.20*** (0.04)	0.25*** (0.04)	0.17*** (0.04)	0.18*** (0.04)	0.10 (0.10)	0.08 (0.06)	0.10 (0.07)
Spring	-0.02 (0.02)	-0.03** (0.01)	-0.49*** (0.01)	-0.04** (0.02)	-0.02 (0.02)	-0.67*** (0.06)	0.01 (0.03)	-0.00 (0.02)	-0.55*** (0.10)
Summer	-0.07*** (0.02)	-0.07*** (0.02)	-0.48*** (0.01)	-0.09*** (0.02)	-0.05** (0.02)	-0.66*** (0.06)	-0.04 (0.03)	-0.04 (0.03)	-0.65*** (0.09)
Fall	-0.12*** (0.02)	-0.12*** (0.02)	-0.49*** (0.01)	-0.15*** (0.02)	-0.09*** (0.02)	-0.66*** (0.06)	-0.06** (0.03)	-0.06** (0.03)	-0.54*** (0.10)
Costs ⁺					0.19*** (0.03)	0.20*** (0.03)			
Costs ⁻					-0.07** (0.03)	-0.08** (0.03)			
$E_t(\text{Costs}_{t+1})^+$		0.07*** (0.01)	0.06*** (0.01)		-0.04** (0.02)	-0.06*** (0.02)		0.09*** (0.02)	0.09*** (0.02)
$E_t(\text{Costs}_{t+1})^-$		-0.05** (0.03)	-0.04 (0.03)		-0.04 (0.03)	-0.03 (0.03)		0.01 (0.04)	0.03 (0.04)
Capacity Utiliz.		0.25*** (0.03)	0.24*** (0.06)		0.22*** (0.04)	0.20*** (0.05)		0.24*** (0.05)	0.18** (0.07)
Ln(Firmsize)		-0.00 (0.00)	-0.00 (0.01)		0.00 (0.01)	-0.00 (0.01)		0.00 (0.01)	0.00 (0.01)
Revenue ⁺		0.13*** (0.02)	0.21*** (0.01)		0.12*** (0.02)	0.14*** (0.02)		0.16*** (0.04)	0.18*** (0.04)
Revenue ⁻		-0.16*** (0.02)	-0.15*** (0.02)		-0.16*** (0.02)	-0.16*** (0.02)		-0.17*** (0.05)	-0.17*** (0.04)
Technical Capacity ^h		0.00 (0.02)	0.03 (0.02)		0.01 (0.02)	0.02 (0.02)		0.02 (0.03)	0.03 (0.04)
Technical Capacity ^l		0.03* (0.02)	0.01 (0.02)		0.02 (0.02)	0.01 (0.02)		0.02 (0.03)	0.02 (0.03)
Employment ^h					-0.07** (0.03)	-0.05* (0.03)			
Employment ^l					0.04** (0.02)	0.02 (0.02)			
Stocks ^h					0.02 (0.02)	0.03 (0.02)			
Stocks ^l					-0.00 (0.03)	-0.00 (0.03)			
Competitiveness ⁺								0.01 (0.02)	0.03 (0.03)
Competitiveness ⁻								-0.04 (0.04)	-0.02 (0.05)
Observations	49467	49467	49467	33882	33882	33882	13081	13081	13081
Pseudo R-squared	0.03	0.08	0.09	0.04	0.12	0.13	0.02	0.08	0.09
Time Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (3), (6) and (9), which are not included in the other columns, and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero, and firm size and capacity utilization to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

Table 12: Model VI: Non-predetermined price decreases

	Sample 1984–2007			Sample 1984–1998			Sample 1999–2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Taylor1	0.32*** (0.01)	0.28*** (0.02)	0.25*** (0.02)	0.32*** (0.02)	0.26*** (0.02)	0.24*** (0.02)	0.34*** (0.03)	0.25*** (0.04)	0.24*** (0.04)
Taylor2	0.26*** (0.02)	0.24*** (0.02)	0.23*** (0.02)	0.24*** (0.02)	0.22*** (0.02)	0.22*** (0.02)	0.32*** (0.03)	0.26*** (0.04)	0.25*** (0.04)
Taylor3	0.16*** (0.02)	0.15*** (0.02)	0.16*** (0.02)	0.14*** (0.03)	0.13*** (0.03)	0.16*** (0.02)	0.23*** (0.04)	0.18*** (0.04)	0.18*** (0.04)
Taylor4	0.12*** (0.03)	0.10*** (0.03)	0.12*** (0.02)	0.08** (0.03)	0.07** (0.03)	0.11*** (0.03)	0.21*** (0.04)	0.17*** (0.04)	0.17*** (0.04)
Taylor5	0.15*** (0.03)	0.14*** (0.03)	0.13*** (0.02)	0.16*** (0.03)	0.13*** (0.03)	0.14*** (0.03)	0.18*** (0.05)	0.15*** (0.05)	0.15*** (0.05)
Taylor6	0.07** (0.03)	0.05 (0.03)	0.06** (0.03)	0.05 (0.04)	0.03 (0.04)	0.05 (0.04)	0.15** (0.06)	0.11* (0.06)	0.12** (0.05)
Taylor7	0.06* (0.04)	0.06 (0.04)	0.07** (0.03)	0.02 (0.05)	0.01 (0.04)	0.04 (0.04)	0.16** (0.07)	0.14** (0.06)	0.15** (0.06)
Taylor8	0.09** (0.04)	0.07* (0.04)	0.08** (0.03)	0.07 (0.04)	0.05 (0.04)	0.07* (0.04)	0.17** (0.07)	0.14** (0.07)	0.14** (0.07)
Spring	-0.08*** (0.01)	-0.05*** (0.01)	-0.58*** (0.04)	-0.10*** (0.01)	-0.06*** (0.02)	-0.61*** (0.04)	-0.05** (0.02)	-0.02 (0.02)	-0.54*** (0.07)
Summer	-0.06*** (0.01)	-0.05*** (0.01)	-0.56*** (0.04)	-0.06*** (0.01)	-0.06*** (0.01)	-0.62*** (0.04)	-0.06*** (0.02)	-0.05** (0.02)	-0.54*** (0.07)
Fall	-0.05*** (0.01)	-0.03*** (0.01)	-0.54*** (0.04)	-0.06*** (0.01)	-0.06*** (0.01)	-0.62*** (0.04)	-0.05** (0.02)	-0.05** (0.02)	-0.56*** (0.06)
Costs ⁺					-0.13*** (0.02)	-0.08*** (0.02)			
Costs ⁻					0.21*** (0.02)	0.20*** (0.02)			
$E_t(\text{Costs}_{t+1})^+$		-0.08*** (0.01)	-0.04*** (0.01)		-0.04*** (0.01)	-0.01 (0.01)		-0.02 (0.02)	-0.02 (0.02)
$E_t(\text{Costs}_{t+1})^-$		0.11*** (0.01)	0.10*** (0.02)		0.04** (0.02)	0.03* (0.02)		0.05* (0.03)	0.05* (0.03)
Capacity Utiliz.		-0.04 (0.04)	0.02 (0.04)		0.02 (0.05)	0.07 (0.05)		0.00 (0.07)	0.01 (0.07)
Ln(Firmsize)		0.01*** (0.00)	0.02*** (0.00)		0.01 (0.01)	0.01** (0.01)		0.02*** (0.01)	0.02*** (0.01)
Revenue ⁺		-0.08*** (0.02)	-0.09*** (0.02)		-0.06*** (0.02)	-0.08*** (0.02)		-0.12*** (0.03)	-0.12*** (0.03)
Revenue ⁻		0.28*** (0.01)	0.28*** (0.01)		0.24*** (0.02)	0.20*** (0.02)		0.29*** (0.03)	0.28*** (0.03)
Technical Capacity ^h		0.02 (0.01)	-0.00 (0.01)		0.01 (0.02)	-0.01 (0.02)		-0.02 (0.02)	-0.03 (0.02)
Technical Capacity ^l		-0.03** (0.02)	-0.02 (0.02)		0.01 (0.02)	0.03 (0.02)		-0.05* (0.03)	-0.04 (0.03)
Employment ^h					0.05*** (0.01)	0.03** (0.01)			
Employment ^l					-0.09*** (0.02)	-0.05** (0.02)			
Stocks ^h					0.02 (0.02)	0.02 (0.02)			
Stocks ^l					-0.01 (0.03)	-0.04 (0.03)			
Competitiveness ⁺								0.04* (0.02)	0.05** (0.02)
Competitiveness ⁻								0.11*** (0.02)	0.11*** (0.02)
Observations	49498	49498	49498	33882	33882	33882	13084	13084	13084
Pseudo R-squared	0.05	0.12	0.14	0.05	0.13	0.16	0.04	0.16	0.16
Time Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (3), (6) and (9), which are not included in the other columns, and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero, and firm size and capacity utilization to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

4 Conclusion

This paper examines the price setting behavior of firms, using qualitative firm-level data for Swiss manufacturing firms from 1984–2007. The data allow me to keep track of firms’ price changes and their price expectations. Furthermore, the survey contains a large set of information regarding firms’ current economic condition, such as changes in costs for intermediate products, capacity utilization rates, and several other firm-specific variables. This allows me to link the price adjustment decision of firms to firm-level information about their current and expected cost changes, changes in other firm-specific economic conditions, and firm characteristics, providing a large set of information about firms’ current environment. The empirical results can be summarized as follows.

First, in line with other empirical studies, both time- and state-dependent features are present in the data. However, compared to previous studies, which only include macroeconomic variables as determinants of price adjustments, the inclusion of firm-specific state variables substantially improves the goodness of fit of the model. In particular, changes in firms’ costs for intermediate goods trigger price adjustments. Also, the change in revenue is robustly related to price adjustments. These findings suggest that state-dependent pricing is important.

Second, macroeconomic information explains individual price adjustments only to a small extent. These findings suggest that it is necessary to add idiosyncratic shocks to state-dependent models, as for example in [Goloso and Lucas \(2007\)](#), to correctly identify microeconomic adjustments.

Third, the importance of the state-dependent variables becomes even larger when excluding possibly predetermined price changes.

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Supplementary material for When do Firms Adjust Prices? Evidence from Micro Panel Data

Summary statistics by industry

Table [A.1](#) presents the 23 industries in the Swiss manufacturing sector. The number of observations and the number of price changes, increases and decreases are reported. As the data set is confidential, some statistics cannot be reported to guarantee anonymity.

Expected price changes

This section of the supplementary material presents the estimation results for price changes which are expected by firms. These price changes contain both, predetermined and non-predetermined price changes. The dependent variable is defined as

Model VII:

$$\hat{y}_{it} = \begin{cases} 1, & \text{if } Price_t = -1 \quad \wedge \quad E_{t-1}(Price_t) = -1 \\ 1, & \text{if } Price_t = 1 \quad \wedge \quad E_{t-1}(Price_t) = 1 \\ 0, & \text{otherwise.} \end{cases}$$

For price increases, the dependent variable is equal to one if a firm increased its selling price in t , and also expected to increase it in the previous quarter, and zero otherwise:

Model VIII:

$$\hat{y}_{it}^+ = \begin{cases} 1, & \text{if } Price_t = 1 \quad \wedge \quad E_{t-1}(Price_t) = 1 \\ 0, & \text{otherwise.} \end{cases}$$

Accordingly, for price decreases:

Model IX:

$$\hat{y}_{it}^- = \begin{cases} 1, & \text{if } Price_t = -1 \quad \wedge \quad E_{t-1}(Price_t) = -1 \\ 0, & \text{otherwise.} \end{cases}$$

The results for the estimates of the three models are presented in Tables [A.2](#) (*model VII*), [A.3](#) (*model VIII*) and [A.4](#) (*model IX*).

Table A.1: Price adjustments by industry

	NOGA	Observations	(Percent of total)	Price=-1	(Freq)	Price=0	(Freq)	Price=1	(Freq)
Manufacturing industry									
Food products and beverages	15	3470	(6.95)	618	(17.81)	2472	(71.24)	380	(10.95)
Tobacco products	16	190	(0.38)	1	(0.53)	159	(83.68)	30	(15.79)
Textiles and textile products	17	3225	(6.46)	557	(17.27)	2222	(68.9)	446	(13.83)
Wearing apparel, dressing and dyeing of fur	18	732	(1.47)	91	(12.43)	509	(69.54)	132	(18.03)
Tanning and dressing of leather, footwear	19	267	(0.53)	29	(10.86)	179	(67.04)	59	(22.1)
Wood and wood products, articles of straw and plaiting materials	20	3044	(6.1)	931	(30.58)	1858	(61.04)	255	(8.38)
Pulp, paper and paper products	21	1133	(2.27)	348	(30.71)	531	(46.87)	254	(22.42)
Publishing, printing and reproduction of recorded media	22	6002	(12.02)	1475	(24.58)	3994	(66.54)	533	(8.88)
Coke, refined petroleum products and nuclear fuel	23								
Chemicals and chemical products	24	2573	(5.15)	320	(12.44)	1895	(73.65)	358	(13.91)
Rubber and plastic products	25	3510	(7.03)	615	(17.52)	2431	(69.26)	464	(13.22)
Other non-metallic mineral products	26	2475	(4.96)	623	(25.17)	1611	(65.09)	241	(9.74)
Basic metals	27	2181	(4.37)	547	(25.08)	1171	(53.69)	463	(21.23)
Fabricated metal products, except machinery and equipment	28	6799	(13.61)	1324	(19.47)	4597	(67.61)	878	(12.91)
Machinery and equipment n.e.c.	29	5678	(11.37)	718	(12.65)	4314	(75.98)	646	(11.38)
Office machinery, data processing devices	30								
Electrical machinery and apparatus n.e.c.	31	1074	(2.15)	299	(27.84)	664	(61.82)	111	(10.34)
Radio, TV and communication equipment and apparatus	32	692	(1.39)	131	(18.93)	518	(74.86)	43	(6.21)
Medical, precision and optical instruments, watches and clocks	33	3857	(7.72)	423	(10.97)	3024	(78.4)	410	(10.63)
Motor vehicles, trailers and semi-trailers	34								
Transport equipment	35	586	(1.17)	97	(16.55)	412	(70.31)	77	(13.14)
Furniture, jewelry, musical instruments,									
sports goods, games, toys and other goods	36	2314	(4.63)	368	(15.9)	1678	(72.52)	268	(11.58)
Recycling	37								
Total		49942	(100)	9559	(19.14)	34322	(68.72)	6061	(12.14)

Note: (Freq) refers to the frequency of price increases, decreases and stable prices as a share of all observations by industry, the (percent of total) refers to the number of observations for each industry as a share of all observations. Sample 1984–2007, only observations from the sample used in the regressions included. For NOGA 23, 30, 34 and 37 there too few observations, thus they cannot be reported in the table as the firms are guaranteed to stay anonymous and that none of their responses can be identified.

Table A.2: Model VII: Expected price changes

	Sample 1984-2007			Sample 1984-1998			Sample 1999-2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
d1	0.23*** (0.01)	0.30*** (0.02)	0.32*** (0.02)	0.22*** (0.01)	0.31*** (0.02)	0.31*** (0.02)	0.25*** (0.03)	0.36*** (0.02)	0.36*** (0.04)
d2	0.06*** (0.01)	0.09*** (0.02)	0.11*** (0.02)	0.05*** (0.01)	0.08*** (0.02)	0.09*** (0.02)	0.08*** (0.03)	0.11** (0.05)	0.13*** (0.04)
d3	0.04*** (0.01)	0.06*** (0.02)	0.06*** (0.02)	0.03** (0.01)	0.05** (0.03)	0.05* (0.03)	0.06** (0.03)	0.09* (0.05)	0.10** (0.05)
d4	0.26*** (0.02)	0.28*** (0.02)	0.29*** (0.02)	0.27*** (0.02)	0.30*** (0.02)	0.29*** (0.02)	0.17*** (0.04)	0.24*** (0.04)	0.25*** (0.04)
d5	0.01 (0.01)	0.02 (0.03)	0.03 (0.03)	0.01 (0.02)	0.01 (0.03)	0.02 (0.04)	0.04 (0.03)	0.05 (0.06)	0.06 (0.06)
d6	-0.02 (0.01)	-0.05 (0.03)	-0.03 (0.04)	-0.02* (0.01)	-0.07* (0.04)	-0.06 (0.04)	0.02 (0.03)	0.02 (0.07)	0.04 (0.07)
d7	0.01 (0.02)	0.02 (0.03)	0.04 (0.03)	0.00 (0.02)	-0.02 (0.04)	0.00 (0.04)	0.08* (0.04)	0.14** (0.06)	0.14** (0.06)
d8	0.12*** (0.02)	0.18*** (0.02)	0.19*** (0.02)	0.10*** (0.02)	0.16*** (0.03)	0.18*** (0.03)	0.11** (0.05)	0.18*** (0.06)	0.17*** (0.06)
Spring	-0.10*** (0.00)	-0.28*** (0.01)	-0.56*** (0.03)	-0.12*** (0.00)	-0.29*** (0.02)	-0.53*** (0.04)	-0.07*** (0.01)	-0.16*** (0.02)	-0.52*** (0.06)
Summer	-0.09*** (0.00)	-0.24*** (0.01)	-0.56*** (0.03)	-0.10*** (0.00)	-0.25*** (0.01)	-0.52*** (0.04)	-0.05*** (0.01)	-0.13*** (0.02)	-0.52*** (0.06)
Fall	-0.07*** (0.00)	-0.21*** (0.01)	-0.56*** (0.03)	-0.09*** (0.00)	-0.21*** (0.01)	-0.52*** (0.04)	-0.03*** (0.01)	-0.10*** (0.02)	-0.51*** (0.06)
Increase cost					0.21*** (0.01)	0.20*** (0.01)			
Decrease cost					0.15*** (0.01)	0.15*** (0.01)			
E(Increase cost)		0.04*** (0.01)	0.04*** (0.01)		-0.04*** (0.01)	-0.03** (0.01)		0.09*** (0.02)	0.08*** (0.02)
E(Decrease cost)		0.13*** (0.01)	0.14*** (0.01)		0.10*** (0.02)	0.10*** (0.02)		0.17*** (0.02)	0.18*** (0.02)
Capacity Utilis.		0.05 (0.04)	0.03 (0.04)		0.02 (0.05)	0.02 (0.05)		-0.05 (0.07)	-0.08 (0.07)
Ln(Firmsize)		0.01*** (0.00)	0.01*** (0.00)		0.01 (0.00)	0.01 (0.01)		0.02*** (0.01)	0.02*** (0.01)
Revenue ⁺		0.12*** (0.01)	0.12*** (0.01)		0.10*** (0.01)	0.11*** (0.02)		0.15*** (0.02)	0.15*** (0.02)
Revenue ⁻		0.14*** (0.01)	0.15*** (0.01)		0.13*** (0.01)	0.13*** (0.01)		0.16*** (0.02)	0.16*** (0.02)
Technical Capacity ^h		0.04*** (0.01)	0.05*** (0.01)		0.04*** (0.01)	0.05*** (0.01)		0.02 (0.02)	0.03 (0.02)
Technical Capacity ^l		0.03** (0.01)	0.02 (0.01)		-0.01 (0.02)	-0.01 (0.02)		0.04 (0.02)	0.03 (0.02)
Employment ^h					0.03* (0.01)	0.02 (0.01)			
Employment ^l					0.06*** (0.02)	0.06*** (0.02)			
Stocks ^h					-0.01 (0.01)	-0.01 (0.01)			
Stocks ^l					0.02 (0.02)	0.03 (0.02)			
Competitiveness ⁺								0.02 (0.02)	0.03 (0.02)
Competitiveness ⁻								0.05*** (0.02)	0.06*** (0.02)
Observations	49498	49498	49498	33882	33882	33882	13125	13125	13125
Pseudo R-squared	0.11	0.13	0.15	0.13	0.16	0.18	0.09	0.12	0.12
Time Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (3), (6) and (9), which are not included in the other columns and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero and firm size and capacity utilisation to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

Table A.3: Model VIII: Expected price increases

	Sample 1984-2007			Sample 1984-1998			Sample 1999-2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
d1	0.04*** (0.01)	0.13*** (0.02)	0.17*** (0.02)	0.03*** (0.01)	0.10*** (0.02)	0.10*** (0.03)	0.05*** (0.01)	0.23*** (0.04)	0.25*** (0.05)
d2	0.01** (0.01)	0.05** (0.02)	0.06** (0.03)	0.02** (0.01)	0.05** (0.03)	0.04 (0.03)	0.01 (0.01)	0.04 (0.05)	0.05 (0.06)
d3	0.02*** (0.01)	0.05** (0.02)	0.05* (0.03)	0.02*** (0.01)	0.07*** (0.03)	0.05 (0.03)	0.01 (0.01)	0.01 (0.06)	0.02 (0.06)
d4	0.15*** (0.01)	0.24*** (0.03)	0.31*** (0.03)	0.17*** (0.02)	0.27*** (0.03)	0.30*** (0.03)	0.07*** (0.02)	0.23*** (0.04)	0.24*** (0.05)
d5	0.00 (0.01)	0.01 (0.03)	0.04 (0.03)	0.00 (0.01)	0.01 (0.04)	0.02 (0.04)	0.01 (0.02)	0.04 (0.07)	0.04 (0.07)
d6	-0.02*** (0.01)	-0.07* (0.04)	-0.05 (0.04)	-0.02*** (0.01)	-0.10* (0.05)	-0.09* (0.05)	0.00 (0.02)	0.00 (0.08)	0.00 (0.09)
d7	0.01 (0.01)	0.03 (0.03)	0.05 (0.04)	0.00 (0.01)	0.01 (0.04)	0.02 (0.05)	0.03 (0.02)	0.12* (0.07)	0.11 (0.07)
d8	0.06*** (0.01)	0.15*** (0.02)	0.20*** (0.03)	0.05*** (0.01)	0.17*** (0.03)	0.20*** (0.03)	0.04 (0.03)	0.15** (0.07)	0.14* (0.08)
Spring	-0.05*** (0.00)	-0.32*** (0.01)	-0.55*** (0.05)	-0.05*** (0.00)	-0.31*** (0.02)	-0.56*** (0.05)	-0.04*** (0.00)	-0.21*** (0.02)	-0.50*** (0.09)
Summer	-0.06*** (0.00)	-0.34*** (0.01)	-0.56*** (0.05)	-0.06*** (0.00)	-0.35*** (0.02)	-0.51*** (0.06)	-0.03*** (0.00)	-0.20*** (0.02)	-0.49*** (0.09)
Fall	-0.06*** (0.00)	-0.37*** (0.01)	-0.55*** (0.05)	-0.06*** (0.00)	-0.34*** (0.02)	-0.54*** (0.06)	-0.03*** (0.00)	-0.21*** (0.02)	-0.49*** (0.09)
Increase cost					0.28*** (0.03)	0.30*** (0.03)			
Decrease cost					-0.06* (0.03)	-0.08** (0.03)			
E(Increase cost)		0.12*** (0.01)	0.10*** (0.01)		-0.03** (0.02)	-0.05*** (0.02)		0.20*** (0.02)	0.17*** (0.02)
E(Decrease cost)		-0.14*** (0.03)	-0.12*** (0.03)		-0.12*** (0.04)	-0.11*** (0.04)		-0.02 (0.05)	0.01 (0.05)
Capacity Utilis.		0.12*** (0.04)	0.01 (0.05)		0.07 (0.06)	0.02 (0.07)		-0.04 (-0.1)	-0.15 (0.11)
Ln(Firmsize)		0.02*** (0.00)	0.01** (0.01)		0.02*** (0.01)	0.01* (0.01)		0.03*** (0.01)	0.03*** (0.01)
Revenue ⁺		0.15*** (0.02)	0.20*** (0.02)		0.15*** (0.02)	0.18*** (0.02)		0.23*** (0.02)	0.22*** (0.03)
Revenue ⁻		-0.14*** (0.02)	-0.14*** (0.02)		-0.14*** (0.02)	-0.14*** (0.02)		-0.20*** (0.03)	-0.19*** (0.03)
Technical Capacity ^h		-0.11*** (0.02)	-0.07*** (0.02)		-0.07*** (0.03)	-0.05* (0.03)		-0.12*** (0.04)	-0.09** (0.04)
Technical Capacity ^l		0.06*** (0.02)	0.03* (0.02)		0.01 (0.03)	-0.01 (0.03)		0.08** (0.03)	0.06* (0.04)
Employment ^h					-0.07*** (0.02)	-0.04 (0.02)			
Employment ^l					0.09*** (0.02)	0.06*** (0.02)			
Stocks ^h					-0.03 (0.02)	-0.03 (0.02)			
Stocks ^l					0.02 (0.03)	0.03 (0.03)			
Competitiveness ⁺								0.06** (0.03)	0.08*** (0.03)
Competitiveness ⁻								-0.06 (0.04)	-0.04 (0.04)
Observations	49498	49498	49498	33882	33882	33882	13125	13125	13125
Pseudo R-squared	0.11	0.16	0.22	0.15	0.27	0.30	0.06	0.14	0.17
Time Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (3), (6) and (9), which are not included in the other columns and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero and firm size and capacity utilisation to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

Table A.4: Model IX: Expected price decreases

	Sample 1984-2007			Sample 1984-1998			Sample 1999-2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
d1	0.47*** (0.01)	0.47*** (0.04)	0.40*** (0.04)	0.46*** (0.01)	0.47*** (0.06)	0.40*** (0.06)	0.48*** (0.01)	0.47*** (0.02)	0.45*** (0.08)
d2	0.30*** (0.03)	0.28*** (0.04)	0.27*** (0.04)	0.27*** (0.04)	0.25*** (0.05)	0.24*** (0.04)	0.39*** (0.06)	0.36*** (0.07)	0.35*** (0.08)
d3	0.19*** (0.05)	0.18*** (0.05)	0.19*** (0.04)	0.10 (0.06)	0.10 (0.06)	0.12** (0.06)	0.37*** (0.07)	0.35*** (0.08)	0.34*** (0.09)
d4	0.18*** (0.05)	0.15*** (0.06)	0.16*** (0.05)	0.06 (0.07)	0.05 (0.07)	0.08 (0.07)	0.37*** (0.07)	0.35*** (0.08)	0.34*** (0.08)
d5	0.13* (0.07)	0.10 (0.07)	0.11* (0.06)	0.11 (0.08)	0.07 (0.08)	0.09 (0.07)	0.22 (0.14)	0.20 (0.15)	0.20 (0.14)
d6	0.18*** (0.06)	0.15** (0.07)	0.15*** (0.06)	0.16** (0.07)	0.13* (0.08)	0.14** (0.07)	0.27** (0.12)	0.23* (0.14)	0.24* (0.13)
d7	0.13* (0.07)	0.12 (0.07)	0.13** (0.07)	0.07 (0.09)	0.06 (0.09)	0.08 (0.08)	0.29** (0.12)	0.27** (0.13)	0.27** (0.13)
d8	0.20*** (0.06)	0.18*** (0.07)	0.18*** (0.06)	0.13 (0.08)	0.11 (0.09)	0.12 (0.08)	0.31** (0.12)	0.29** (0.13)	0.28** (0.12)
Spring	-0.19*** (0.01)	-0.16*** (0.01)	-0.57*** (0.05)	-0.23*** (0.01)	-0.19*** (0.02)	0.11 (0.08)	-0.09*** (0.02)	-0.07*** (0.02)	-0.52*** (0.09)
Summer	-0.09*** (0.01)	-0.08*** (0.01)	-0.57*** (0.05)	-0.11*** (0.02)	-0.11*** (0.02)	0.05 (0.08)	-0.05** (0.02)	-0.04 (0.03)	-0.52*** (0.09)
Fall	-0.01 (0.01)	0.00 (0.01)	-0.57*** (0.05)	-0.04*** (0.01)	-0.04** (0.02)	0.08 (0.08)	0.04* (0.02)	0.04 (0.03)	-0.52*** (0.09)
Increase cost					-0.15*** (0.02)	-0.09*** (0.02)			
Decrease cost					0.21*** (0.02)	0.19*** (0.02)			
E(Increase cost)		-0.10*** (0.01)	-0.04*** (0.01)		-0.03* (0.02)		-0.06** (0.02)		-0.02 (0.03)
E(Decrease cost)		0.22*** (0.02)	0.19*** (0.02)		0.14*** (0.02)	0.13*** (0.02)	0.21*** (0.02)		0.21*** (0.03)
Capacity Utilis.		-0.03 (0.06)	0.04 (0.06)		-0.01 (0.08)	0.06 (0.08)	-0.10 (-0.1)		-0.04 (0.11)
Ln(Firmsize)		0.00 (0.01)	0.01 (0.01)		0.00 (0.01)	0.00 (0.01)	0.01 (0.01)		0.01 (0.01)
Revenue ⁺		-0.10*** (0.02)	-0.10*** (0.02)		-0.09*** (0.03)	-0.09*** (0.03)	-0.12*** (0.04)		-0.12*** (0.04)
Revenue ⁻		0.31*** (0.02)	0.27*** (0.02)		0.31*** (0.02)	0.27*** (0.03)	0.30*** (0.01)		0.28*** (0.04)
Technical Capacity ^h		0.12*** (0.01)	0.09*** (0.01)		0.11*** (0.02)	0.08*** (0.02)	0.07** (0.03)		0.05 (0.03)
Technical Capacity ^l		-0.06*** (0.02)	-0.04* (0.02)		-0.07** (0.03)	-0.06* (0.03)	-0.06 (0.04)		-0.05 (0.04)
Employment ^h					0.06*** (0.02)	0.03* (0.02)			
Employment ^l					-0.02 (0.02)	0.01 (0.03)			
Stocks ^h					0.02 (0.02)	0.01 (0.02)			
Stocks ^l					0.03 (0.04)	0.01 (0.04)			
Competitiveness ⁺							-0.04 (0.04)		-0.05 (0.04)
Competitiveness ⁻							0.08*** (0.02)		0.07*** (0.02)
Observations	49498	49498	49498	33882	33882	33882	13125	13125	13125
Pseudo R-squared	0.17	0.26	0.29	0.19	0.30	0.33	0.13	0.23	0.24
Time Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (3), (6) and (9), which are not included in the other columns and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero and firm size and capacity utilisation to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

Influence of macroeconomic factors: additional results

To evaluate the importance of macroeconomic factors for explaining individual price adjustments, time fixed effects are added to the model including the firm-level information in section 3.2. This section shows that the order of including the variables does not affect the conclusions. When the time fixed effects are added *before* adding the firm-level variables, the conclusion that the firm-level variables improve the goodness of fit of the model explaining individual price changes more than adding the macroeconomic time fixed effects remains valid. This is shown in Table A.5 for *model I*, in Table A.6 for *model II* and in Table A.7 for *model III*.

Table A.5: Model I: Price changes

	Sample 1984-2007			Sample 1984-1998			Sample 1999-2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
d1	0.43*** (0.01)	0.40*** (0.01)	0.39*** (0.01)	0.39*** (0.01)	0.40*** (0.01)	0.29*** (0.02)	0.39*** (0.01)	0.40*** (0.01)	0.29*** (0.03)
d2	0.22*** (0.02)	0.25*** (0.01)	0.24*** (0.01)	0.21*** (0.02)	0.25*** (0.01)	0.17*** (0.02)	0.26*** (0.02)	0.25*** (0.01)	0.20*** (0.03)
d3	0.13*** (0.02)	0.16*** (0.01)	0.16*** (0.02)	0.14*** (0.02)	0.16*** (0.01)	0.12*** (0.02)	0.17*** (0.03)	0.16*** (0.01)	0.14*** (0.03)
d4	0.31*** (0.02)	0.29*** (0.01)	0.29*** (0.01)	0.30*** (0.01)	0.29*** (0.01)	0.24*** (0.02)	0.24*** (0.03)	0.29*** (0.01)	0.20*** (0.03)
d5	0.10*** (0.02)	0.13*** (0.02)	0.13*** (0.02)	0.12*** (0.02)	0.13*** (0.02)	0.10*** (0.02)	0.14*** (0.04)	0.13*** (0.02)	0.11*** (0.03)
d6	0.03 (0.02)	0.06*** (0.02)	0.05** (0.02)	0.01 (0.03)	0.06*** (0.02)	0.00 (0.03)	0.10** (0.04)	0.06*** (0.02)	0.08** (0.04)
d7	0.04** (0.02)	0.07*** (0.02)	0.06*** (0.02)	0.02 (0.03)	0.07*** (0.02)	0.03 (0.03)	0.11** (0.04)	0.07*** (0.02)	0.10*** (0.04)
d8	0.16*** (0.02)	0.18*** (0.02)	0.18*** (0.02)	0.17*** (0.02)	0.18*** (0.02)	0.15*** (0.02)	0.17*** (0.04)	0.18*** (0.02)	0.15*** (0.04)
Spring	-0.18*** (0.01)	-0.44*** (0.02)	-0.37*** (0.05)	-0.27*** (0.01)	-0.44*** (0.02)	-0.29*** (0.04)	-0.13*** (0.01)	-0.44*** (0.02)	-0.49*** (0.07)
Summer	-0.16*** (0.01)	-0.43*** (0.02)	-0.36*** (0.05)	-0.16*** (0.01)	-0.43*** (0.02)	-0.25*** (0.04)	-0.12*** (0.01)	-0.43*** (0.02)	-0.52*** (0.06)
Fall	-0.14*** (0.01)	-0.41*** (0.03)	-0.30*** (0.06)	-0.14*** (0.01)	-0.41*** (0.03)	-0.17*** (0.04)	-0.09*** (0.02)	-0.41*** (0.03)	-0.52*** (0.06)
Increase cost						0.17*** (0.01)			
Decrease cost						0.20*** (0.02)			
E(Increase cost)			0.02*** (0.01)			-0.04*** (0.01)			0.06*** (0.01)
E(Decrease cost)			0.17*** (0.01)			0.09*** (0.01)			0.16*** (0.02)
Capacity Utilis.			0.08** (0.03)			0.10*** (0.04)			0.01 (0.05)
Ln(Firmsize)			0.02*** (0.00)			0.01** (0.00)			0.03*** (0.00)
Revenue ⁺			0.13*** (0.01)			0.10*** (0.01)			0.14*** (0.02)
Revenue ⁻			0.25*** (0.01)			0.17*** (0.01)			0.25*** (0.02)
Technical Capacity ^h			0.04*** (0.01)			0.03*** (0.01)			0.01 (0.02)
Technical Capacity ^l			0.02* (0.01)			0.01 (0.01)			0.01 (0.02)
Employment ^h						0.03*** (0.01)			
Employment ^l						0.04*** (0.01)			
Stocks ^h						0.01 (0.01)			
Stocks ^l						0.01 (0.02)			
Competitiveness ⁺									0.05*** (0.02)
Competitiveness ⁻									0.12*** (0.02)
Observations	49942	49942	49942	34059	34059	34059	13360	13360	13360
Pseudo R-squared	0.11	0.12	0.17	0.12	0.12	0.19	0.09	0.12	0.17
Time Fixed Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$. The logit is estimated using time dummies for every quarter in columns (2), (3), (5), (6), (8) and (9), which are not included in the other columns and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero and firm size and capacity utilisation to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

Table A.6: Model II: Price increases

	Sample 1984-2007			Sample 1984-1998			Sample 1999-2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
d1	0.22*** (0.02)	0.25*** (0.02)	0.25*** (0.02)	0.22*** (0.02)	0.25*** (0.02)	0.19*** (0.02)	0.23*** (0.03)	0.25*** (0.02)	0.25*** (0.04)
d2	0.11*** (0.02)	0.13*** (0.02)	0.12*** (0.02)	0.12*** (0.02)	0.13*** (0.02)	0.09*** (0.02)	0.08** (0.04)	0.13*** (0.02)	0.11*** (0.04)
d3	0.12*** (0.02)	0.11*** (0.02)	0.11*** (0.02)	0.14*** (0.02)	0.11*** (0.02)	0.10*** (0.02)	0.06 (0.04)	0.11*** (0.02)	0.07* (0.04)
d4	0.33*** (0.01)	0.33*** (0.01)	0.33*** (0.01)	0.35*** (0.01)	0.33*** (0.01)	0.27*** (0.03)	0.21*** (0.04)	0.33*** (0.01)	0.22*** (0.04)
d5	0.04 (0.03)	0.07*** (0.03)	0.07** (0.03)	0.04 (0.03)	0.07*** (0.03)	0.05 (0.03)	0.07 (0.05)	0.07*** (0.03)	0.08* (0.05)
d6	-0.03 (0.03)	-0.01 (0.03)	-0.00 (0.03)	-0.07* (0.04)	-0.01 (0.03)	-0.03 (0.04)	0.03 (0.06)	-0.01 (0.03)	0.06 (0.06)
d7	0.04 (0.03)	0.08** (0.03)	0.06* (0.03)	0.04 (0.04)	0.08** (0.03)	0.05 (0.04)	0.05 (0.06)	0.08** (0.03)	0.04 (0.06)
d8	0.20*** (0.02)	0.22*** (0.02)	0.22*** (0.02)	0.21*** (0.03)	0.22*** (0.02)	0.20*** (0.03)	0.13** (0.06)	0.22*** (0.02)	0.13** (0.06)
Spring	-0.21*** (0.01)	-0.44*** (0.02)	-0.45*** (0.03)	-0.23*** (0.01)	-0.44*** (0.02)	-0.26*** (0.04)	-0.13*** (0.02)	-0.44*** (0.02)	-0.54*** (0.08)
Summer	-0.24*** (0.01)	-0.48*** (0.01)	-0.43*** (0.04)	-0.28*** (0.01)	-0.48*** (0.01)	-0.22*** (0.04)	-0.14*** (0.02)	-0.48*** (0.01)	-0.44*** (0.09)
Fall	-0.26*** (0.01)	-0.46*** (0.01)	-0.37*** (0.06)	-0.30*** (0.01)	-0.46*** (0.01)	-0.50*** (0.05)	-0.15*** (0.02)	-0.46*** (0.01)	-0.47*** (0.09)
Increase cost						0.27*** (0.03)			
Decrease cost						-0.10*** (0.03)			
E(Increase cost)			0.09*** (0.01)			-0.07*** (0.01)			0.15*** (0.02)
E(Decrease cost)			-0.09*** (0.02)			-0.07*** (0.03)			0.02 (0.04)
Capacity Utilis.			0.11** (0.04)			0.12** (0.05)			-0.00 (0.08)
Ln(Firmsize)			0.01* (0.00)			0.01 (0.01)			0.02*** (0.01)
Revenue ⁺			0.24*** (0.01)			0.19*** (0.02)			0.24*** (0.03)
Revenue ⁻			-0.15*** (0.01)			-0.17*** (0.02)			-0.20*** (0.03)
Technical Capacity ^h			-0.03* (0.02)			-0.02 (0.02)			-0.03 (0.04)
Technical Capacity ^l			0.03** (0.02)			0.00 (0.02)			0.05* (0.03)
Employment ^h						-0.04** (0.02)			
Employment ^l						0.05*** (0.02)			
Stocks ^h						-0.00 (0.02)			
Stocks ^l						0.03 (0.03)			
Competitiveness ⁺									0.06** (0.02)
Competitiveness ⁻									-0.04 (0.02)
Observations	49942	49942	49942	34059	34059	34059	13360	13360	13360
Pseudo R-squared	0.08	0.16	0.20	0.11	0.16	0.29	0.05	0.16	0.17
Time Fixed Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (2), (3), (5), (6), (8) and (9), which are not included in the other columns and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero and firm size and capacity utilisation to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.

Table A.7: Model III: Price decreases

	Sample 1984-2007			Sample 1984-1998			Sample 1999-2007		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
d1	0.41*** (0.01)	0.42*** (0.01)	0.32*** (0.03)	0.41*** (0.01)	0.42*** (0.01)	0.19*** (0.02)	0.42*** (0.01)	0.42*** (0.01)	0.33*** (0.05)
d2	0.27*** (0.01)	0.30*** (0.01)	0.24*** (0.02)	0.25*** (0.02)	0.30*** (0.01)	0.09*** (0.02)	0.33*** (0.03)	0.30*** (0.01)	0.26*** (0.04)
d3	0.16*** (0.02)	0.20*** (0.02)	0.16*** (0.02)	0.12*** (0.03)	0.20*** (0.02)	0.10*** (0.02)	0.25*** (0.04)	0.20*** (0.02)	0.21*** (0.04)
d4	0.13*** (0.02)	0.16*** (0.02)	0.13*** (0.02)	0.07** (0.03)	0.16*** (0.02)	0.27*** (0.03)	0.25*** (0.04)	0.16*** (0.02)	0.21*** (0.04)
d5	0.16*** (0.02)	0.18*** (0.02)	0.14*** (0.02)	0.17*** (0.03)	0.18*** (0.02)	0.05 (0.03)	0.19*** (0.05)	0.18*** (0.02)	0.16*** (0.05)
d6	0.00*** (0.03)	0.12*** (0.03)	0.07*** (0.03)	0.07** (0.04)	0.12*** (0.03)	-0.03 (0.04)	0.16*** (0.05)	0.12*** (0.03)	0.13** (0.05)
d7	0.07* (0.03)	0.07** (0.03)	0.08** (0.03)	0.02 (0.04)	0.07** (0.03)	0.05 (0.04)	0.17*** (0.06)	0.07** (0.03)	0.17*** (0.05)
d8	0.10*** (0.03)	0.11*** (0.03)	0.09*** (0.03)	0.07 (0.04)	0.11*** (0.03)	0.20*** (0.03)	0.19*** (0.06)	0.11*** (0.03)	0.16*** (0.06)
Spring	-0.15*** (0.01)	-0.47*** (0.01)	-0.62*** (0.04)	-0.19*** (0.01)	-0.47*** (0.01)	-0.26*** (0.04)	-0.08*** (0.01)	-0.47*** (0.01)	-0.59*** (0.06)
Summer	-0.08*** (0.01)	-0.46*** (0.01)	-0.60*** (0.04)	-0.10*** (0.01)	-0.46*** (0.01)	-0.22*** (0.04)	-0.06*** (0.01)	-0.46*** (0.01)	-0.57*** (0.07)
Fall	-0.04*** (0.01)	-0.42*** (0.03)	-0.60*** (0.04)	-0.06*** (0.01)	-0.42*** (0.03)	-0.50*** (0.05)	-0.02 (0.02)	-0.42*** (0.03)	-0.58*** (0.06)
Increase cost						-0.11*** (0.02)			
Decrease cost						0.26*** (0.03)			
E(Increase cost)			-0.05*** (0.01)			0.00 (0.01)			-0.03* (0.02)
E(Decrease cost)			0.23*** (0.01)			0.12*** (0.02)			0.18*** (0.02)
Capacity Utilis.			0.04 (0.05)			0.08 (0.06)			-0.00 (0.07)
Ln(Firmsize)			0.02*** (0.01)			0.01* (0.01)			0.03*** (0.01)
Revenue ⁺			-0.11*** (0.01)			-0.11*** (0.02)			-0.13*** (0.03)
Revenue ⁻			0.35*** (0.01)			0.27*** (0.03)			0.31*** (0.04)
Technical Capacity ^h			0.06*** (0.01)			0.04*** (0.01)			0.00 (0.02)
Technical Capacity ^l			-0.03 (0.02)			-0.00 (0.02)			-0.06** (0.03)
Employment ^h						0.04*** (0.01)			
Employment ^l						-0.02 (0.02)			
Stocks ^h						0.02 (0.02)			
Stocks ^l						-0.03 (0.03)			
Competitiveness ⁺									0.02 (0.02)
Competitiveness ⁻									0.15*** (0.02)
Observations	49942	49942	49942	34059	34059	34059	13360	13360	13360
Pseudo R-squared	0.12	0.18	0.29	0.13	0.18	0.33	0.09	0.18	0.28
Time Fixed Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. The logit is estimated using time dummies for every quarter in columns (2), (3), (5), (6), (8) and (9), which are not included in the other columns and clustered standard errors by firm. Marginal effects are reported, setting all variables at their mean and fixed effects to zero and firm size and capacity utilisation to their sample averages. For binary explanatory variables the reported marginal effect is for a discrete change from 0 to 1.