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# Asymmetries in Price-Setting Behavior: New Microeconomic Evidence from Switzerland\*

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## Abstract

In this paper we follow the recent empirical literature that has specified reduced-form models for price setting that are closely tied to  $(S, s)$ -pricing rules. Our contribution to the literature is twofold. First, we propose an estimator that relaxes distributional assumptions on the unobserved heterogeneity. Second, we use the estimator to examine asymmetries in price-setting behavior. Using micro price data underlying the Swiss CPI we find that a substantial share of asymmetries in the frequency of price changes can be traced back to a rising aggregate price level. We show that asymmetries would be reduced substantially in the absence of aggregate inflation.

*JEL classification:* E31, E4, E5, C3, C23

*Keywords:* Asymmetric price setting, downward nominal price rigidity, front loading, menu-cost model, heterogeneity, CPI micro data, panel data

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# 1 Introduction

A common pattern in micro data on consumer prices is that price increases are more frequent than price decreases. For example, in Switzerland 66.6% of all price changes are price increases. Similar asymmetries are documented for other countries (see, e.g., Álvarez et al., 2006; Klenow and Kryvtsov, 2008). One potential explanation for these asymmetries is downward nominal price rigidity. This implies that firms cannot reduce their nominal prices as often as they would like to and that some inflation may be beneficial because it “greases” the wheels of product markets by facilitating relative price cuts (see, e.g., Tobin, 1972; Akerlof et al., 1996).

However, the observation that prices increase more often than they fall is not sufficient to justify a positive inflation target. Another potential explanation of the observed asymmetry in price changes is trend inflation. Seminal contributions by Tsiddon (1993) and Ball and Mankiw (1994) show that asymmetries arise endogenously in a menu-cost model of price setting with trend inflation. This is because firms front load future inflation into the prices they currently set. It is thus an optimal choice to react less to negative shocks than to positive shocks of the same size, because inflation does part of the job of cutting relative prices without forcing firms to pay price adjustment costs. In these models, the asymmetry is endogenous and would disappear with zero trend inflation. A central bank should then optimally stabilize inflation at zero because inflation has a “sand” effect: positive inflation is inefficient because, with sticky prices, relative price variability lowers output and the distorted price signal does not allocate resources efficiently.

Thus, the policy implications depend on the source of the asymmetry. The extent to which aggregate inflation explains asymmetric price adjustments is not yet well established empirically. So far, most studies have focused on the response of output prices to changes in input prices (see Peltzman, 2000), on high-inflation environments (see Gagnon, 2009) or on downward rigidities in wages (see Fehr and Goette, 2005; ECB, 2009). One exception analyzing consumer prices is the working paper by Dhyne et al. (2007), who find that asymmetries in price-setting behavior are related to trends in marginal costs or desired markups.

In this paper we follow the recent empirical literature, that has specified reduced-form

models for price setting that are closely tied to  $(S, s)$ -pricing rules, which relate the probability of observing a price adjustment to the deviation between the actual and the desired price. Our contribution to this literature is twofold. First, we propose an estimator that relaxes distributional assumptions on the price adjustment thresholds. We use a fixed effects approach, which does not make any assumptions on the relationship between the explanatory variables and the unobserved heterogeneity. Thus, the estimation of the parameters will not be contaminated by incorrect distributional assumptions concerning the unobserved heterogeneity. Second, our empirical application uses Swiss micro price data during a period of low inflation and examines how much of the asymmetry would be left over in a zero inflation environment.

Our results may be summarized as follows. A substantial share of asymmetries in the frequency of price changes can be traced back to a rising aggregate price level. Our counterfactual analysis shows that only a small share of the asymmetries would persist in the absence of aggregate inflation. According to our estimates, the share of price increases in all price changes would fall from 66.6% to 56.6% if aggregate inflation was zero. This finding is robust to different specifications of the model and covariates. It suggests that even in Switzerland, where aggregate inflation is on average below 1% over the sample period, already mild trend inflation implies that prices rise more frequently than they fall.

The remainder of this paper is structured as follows. Section 2 describes the model and Section 3 the data. Section 4 presents the results and Section 5 offers some conclusions.

## 2 A model of asymmetric price adjustment

In this paper we follow the recent empirical literature that has specified reduced-form models for price setting that are closely tied to  $(S, s)$ -pricing rules. The main idea of an  $(S, s)$ -policy is that the probability of observing an adjustment at the microeconomic level is an increasing function of the gap between the actual value of a variable and its desired target level (Caballero and Engel, 1993a).<sup>1</sup> Such an adjustment behavior results

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<sup>1</sup>Caballero and Engel (1993a) present a generalized  $(S, s)$ -adjustment policy and show the implications for aggregate dynamics using the example of employment adjustment. Caballero and Engel (1993b) show the aggregate implications of the adjustment policy for pricing decisions. Estimates of these rules based on microeconomic data can be found in Caballero et al. (1995) for investment decisions, in Caballero et al. (1997) for employment adjustment decisions, and in Eberly (1994) and Attanasio (2000) for households' durable purchases.

from the assumption of non-convex adjustment costs. In the case of price setting, the estimated adjustment rule states that a price change occurs when the deviation between the desired price and the current one crosses an upper or lower adjustment threshold (see e.g. Fehr and Goette, 2005; Fougère et al., 2010; Dhyne et al., 2011a).<sup>2</sup> These thresholds are motivated by assuming that firms have to pay menu costs for changing prices (see Sheshinski and Weiss, 1977) or that setting the desired price is prone to errors (see Costain and Nakov, 2011). Simple specifications of such a model can be thought of as generalizations of well-understood limited dependent variables models, such as the censored regression model.<sup>3</sup>

The empirical approach used here is to use insights from the literature concerned with estimation of limited dependent variables models to cast new light on the asymmetries in price adjustments. Since one of the primary focuses will be on unobserved heterogeneity, the literature concerned with estimation of panel data limited dependent variables models will be especially relevant.<sup>4</sup>

Let  $p_{it}^*$  denote the log of the unobserved desired price for a product  $i$  at time  $t$ . We assume that this price can be modeled as a desired markup  $\mu_i$  over nominal marginal cost  $x'_{it}\beta$  and an idiosyncratic shock:<sup>5</sup>

$$p_{it}^* = \mu_i + x'_{it}\beta + \varepsilon_{it}. \quad (1)$$

In the spirit of an  $(S, s)$ -pricing rule, there is an interval for the desired price change,  $p_{it}^* - p_{i,t-1}$ , over which firms do not adjust prices. We denote this interval by  $(\theta_{it}^-, \theta_{it}^+)$  and model the thresholds as

$$\theta_{it}^+ = z'_{it}\delta^+ + u_i^+ \quad (2)$$

$$\theta_{it}^- = z'_{it}\delta^- + u_i^-, \quad (3)$$

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<sup>2</sup>See also Midrigan (2010) and Midrigan (2011) for calibration results of  $(S, s)$ -pricing rules.

<sup>3</sup>See, for example, Amemiya (1985) for a general discussion of limited dependent variables models, and Rosett (1959) for an early discussion of how transaction costs can lead to generalizations of the censored regression model.

<sup>4</sup>See, for example, Arellano and Honoré (2001) for an overview of that literature.

<sup>5</sup>We model the desired price – the price the firm sets once it pays the menu cost – rather than the optimal frictionless price. However, in structural models such as the one presented in Sheshinski and Weiss (1977), the desired price equals the optimal frictionless price plus a positive constant if trend inflation is positive (see Gautier and Le Bihan, 2011).

where  $z_{it}$  denotes time-varying factors affecting the thresholds and  $u_i^+$  and  $u_i^-$  denote product-specific heterogeneity. Thus, the thresholds can vary over time and differ across products. It is implicit in (2)–(3) that  $\theta_{it}^+ \geq \theta_{it}^-$  for all  $t$  with probability 1. This is a serious restriction on the possible values of  $u_i^+$  and  $u_i^-$  when the number of time periods for a product is large.

With this specification, the decision rule can be written as

$$p_{it} = \begin{cases} p_{it}^* & \text{if } p_{it}^* < p_{it-1} + \theta_{it}^- \\ p_{it-1} & \text{if otherwise} \\ p_{it}^* & \text{if } p_{it}^* > p_{it-1} + \theta_{it}^+. \end{cases} \quad (4)$$

In a cross-sectional model, this is the model proposed by Rosett (1959).<sup>6</sup> In a panel data setting, it is closely related to a censored regression model with fixed effects of the form  $p_{it} = \max\{0, \mu_i + x'_{it}\beta + \varepsilon_{it}\}$ . Estimation of  $\beta$  in this model was considered in Honoré (1992). The main challenge in (4) relative to the censored regression model is the presence of the fixed effect in the threshold as well as in the outcome equation. This makes a trivial extension of the ideas in Honoré (1992) impossible.

The model defined by (1)–(3) can be estimated by maximum likelihood if one is willing to make distributional assumptions on  $(\{\varepsilon_{it}\}, \mu_i, u_i^+, u_i^-)$ . However, it is also possible to make progress without distributional assumptions. Specifically, let  $y_{1it}$  be 1 if there is a price increase for product  $i$  in time period  $t$  and 0 otherwise. Then

$$\begin{aligned} y_{1it} &= 1\{\Delta p_{it} > 0\} = 1\{\mu_i + x'_{it}\beta + \varepsilon_{it} > p_{it-1} + z'_{it}\delta^+ + u_i^+\} \\ &= 1\{x'_{it}\beta - z'_{it}\delta^+ - p_{it-1} + \mu_i - u_i^+ + \varepsilon_{it} > 0\} \end{aligned} \quad (5)$$

where  $1\{A\}$  equals 1 if  $A$  is true and 0 otherwise. Equation (5) has the structure of a discrete choice model with fixed effects. Manski (1987) shows how to consistently estimate the parameters  $\beta$  and  $\delta^+$  of such a model with a fixed number of time periods for each  $i$ .<sup>7</sup> His approach allows  $\mu_i - u_i^+$  to be a “fixed effect” that can be arbitrarily correlated with the explanatory variables and the only real assumption is that  $\{\varepsilon_{it}\}_{t=1}$  is stationary

<sup>6</sup>See also Udry (1994).

<sup>7</sup>Formally, Manski (1987) showed how to estimate the parameters of such a model up to scale. Here, the scale is identified from the fact that the coefficient on  $p_{it-1}$  is  $-1$ .

conditional on the explanatory variables for each  $i$ . The weakness of this approach is that the resulting estimator is not asymptotically normal and converges to the true parameter values at a rate that is slower than the usual  $\sqrt{n}$ , where  $n$  is the number of products. On the surface, this then seems like a poor estimator. However, Chamberlain (2010) showed that even with a parametric distributional assumption on  $\varepsilon_{it}$ , it is essentially impossible to estimate the parameters of a fixed effect version of (5) at the usual  $\sqrt{n}$  rate unless  $\varepsilon_{it}$  is i.i.d. logistic.

Inspired by Chamberlain's (2010) finding that root- $n$  consistent estimation of (5) is impossible unless  $\varepsilon_{it}$  is i.i.d. logistic, we proceed by specifying

$$\begin{aligned} y_{1it} &= 1 \{x'_{it}\beta - z'_{it}\delta^+ - p_{it-1} + \mu_i - u_i^+ + \varepsilon_{it} > 0\} \\ &= 1 \{x'_{it}\beta/\kappa - z'_{it}\delta^+/\kappa - p_{it-1}/\kappa + (\mu_i - u_i^+)/\kappa + \varepsilon_{it}/\kappa > 0\} \end{aligned} \quad (6)$$

where  $\{\varepsilon_{it}/\kappa\}$  is i.i.d. with a standard logistic distribution. With this assumption  $\beta/\kappa$ ,  $\delta^+/\kappa$  and  $1/\kappa$  can be estimated by the conditional maximum likelihood estimator introduced by Rasch (1960) and studied by Andersen (1970). Note that with this parameterization,  $V[\varepsilon_i] = \frac{\pi^2\kappa^2}{3}$ . For this reason, we also define  $\sigma_\varepsilon = \frac{\pi\kappa}{\sqrt{3}}$ .

Rather than focusing on price increases, we could also consider whether a price decreases in time period  $t$ . Let  $y_{2it}$  be 1 if the price of product  $i$  does not decrease in time period  $t$  and 0 otherwise. Then

$$\begin{aligned} y_{2it} &= 1 \{\Delta p_{it} \geq 0\} = \{\mu_i + x_{it}\beta + \varepsilon_{it} \geq p_{it-1} + z'_{it}\delta^- + u_i^-\} \\ &= 1 \{x_{it}\beta - z'_{it}\delta^- - p_{it-1} + \mu_i - u_i^- + \varepsilon_{it} \geq 0\} \\ &= 1 \{x_{it}\beta/\kappa - z'_{it}\delta^-/\kappa - p_{it-1}/\kappa + (\mu_i - u_i^-)/\kappa + \varepsilon_{it}/\kappa \geq 0\} \end{aligned}$$

which can be estimated as above.

The conditional likelihood approach of Rasch (1960) and Andersen (1970) can be computationally burdensome if each product is observed over many time periods. It is therefore useful to proceed by using a slightly less efficient approach that uses all pairs of time periods  $(t, s)$  for a given  $i$  (rather than the whole series simultaneously). Writing (6) as  $y_{it} = 1 \{w_{it}^+ \gamma^+ + \alpha_i^+ + v_{it} > 0\}$  where  $v_{it} = \varepsilon_{it}/\kappa$  is logistic,  $w_{it}^+ = (x_{it}, z_{it}, p_{it-1})$ ,



$\gamma^+ = (\beta/\kappa, \delta^+/\kappa, 1/\kappa)$  and  $\alpha_i^+ = (\mu_i - u_i^+)/\kappa$ , we have

$$P(y_{1it} = 1 | w_{it}^+, w_{is}^+, \alpha_i) = \frac{\exp(w_{it}^{+'} \gamma^+ + \alpha_i^+)}{1 + \exp(w_{it}^{+'} \gamma^+ + \alpha_i^+)}$$

and

$$\begin{aligned} & P(y_{1it} = 1, y_{1is} = 0 | y_{1it} + y_{1is} = 1, w_{it}^+, w_{is}^+, \alpha_i) \\ &= \frac{P(y_{1it} = 1, y_{1is} = 0 | w_{it}^+, w_{is}^+)}{P(y_{1it} = 1, y_{1is} = 0 | w_{it}^+, w_{is}^+) + P(y_{1it} = 0, y_{1is} = 1 | w_{it}^+, w_{is}^+)} \\ &= \frac{\frac{\exp(w_{it}^{+'} \gamma^+ + \alpha_i^+)}{1 + \exp(w_{it}^{+'} \gamma^+ + \alpha_i^+)} \frac{1}{1 + \exp(w_{is}^{+'} \gamma^+ + \alpha_i^+)}}{\frac{\exp(w_{it}^{+'} \gamma^+ + \alpha_i^+)}{1 + \exp(w_{it}^{+'} \gamma^+ + \alpha_i^+)} \frac{1}{1 + \exp(w_{is}^{+'} \gamma^+ + \alpha_i^+)} + \frac{1}{1 + \exp(w_{it}^{+'} \gamma^+ + \alpha_i^+)} \frac{\exp(w_{is}^{+'} \gamma^+ + \alpha_i^+)}{1 + \exp(w_{is}^{+'} \gamma^+ + \alpha_i^+)}} \\ &= \frac{\exp((w_{it}^+ - w_{is}^+)' \gamma^+)}{1 + \exp((w_{it}^+ - w_{is}^+)' \gamma^+)} \end{aligned}$$

Since the right-hand side does not depend on  $\alpha_i$ , this allows one to estimate  $\gamma^+ = (\beta/\kappa, \delta^+/\kappa, 1/\kappa)$  without assumptions on  $\alpha_i$ . In practice this is done by maximizing the pseudo log-likelihood for all pairs of observations for which  $y_{1it} + y_{1is} = 1$ .

Likewise,  $(\beta/\kappa, \delta^-/\kappa, 1/\kappa)$  can be estimated by considering  $y_{2it}$ . We impose the constraint that  $\beta/\kappa$  and  $1/\kappa$  should be the same when using  $y_{1it}$  and when using  $y_{2it}$  by maximizing the sum of the two pseudo log-likelihood functions. Specifically, we can estimate  $\beta, \kappa, \delta^+$  and  $\delta^-$  by maximizing the pseudo log-likelihood function

$$\begin{aligned} & \sum_{i=1}^n \sum_{1 \leq s \leq t \leq T_i} q_{ist}^1(\beta, \delta^+, \delta^-, \kappa) + q_{ist}^2(\beta, \delta^+, \delta^-, \kappa) \\ & + q_{ist}^3(\beta, \delta^+, \delta^-, \kappa) + q_{ist}^4(\beta, \delta^+, \delta^-, \kappa) \end{aligned} \quad (7)$$

where

$$q_{ist}^1(\beta, \delta^+, \delta^-, \kappa) = 1 \{ \Delta p_{it} \geq 0, \Delta p_{is} < 0 \} \\ \log \left( \frac{\exp((x_{it} - x_{is})' \beta / \kappa - (z_{it} - z_{is})' \delta^- / \kappa - (p_{it-1} - p_{is-1}) / \kappa)}{1 + \exp((x_{it} - x_{is})' \beta / \kappa - (z_{it} - z_{is})' \delta^- / \kappa - (p_{it-1} - p_{is-1}) / \kappa)} \right),$$

$$q_{ist}^2(\beta, \delta^+, \delta^-, \kappa) = 1 \{ \Delta p_{it} < 0, \Delta p_{is} \geq 0 \} \\ \log \left( \frac{1}{1 + \exp((x_{it} - x_{is})' \beta / \kappa - (z_{it} - z_{is})' \delta^- / \kappa - (p_{it-1} - p_{is-1}) / \kappa)} \right),$$

$$q_{ist}^3(\beta, \delta^+, \delta^-, \kappa) = 1 \{ \Delta p_{it} > 0, \Delta p_{is} \leq 0 \} \\ \log \left( \frac{\exp((x_{it} - x_{is})' \beta / \kappa - (z_{it} - z_{is})' \delta^+ / \kappa - (p_{it-1} - p_{is-1}) / \kappa)}{1 + \exp((x_{it} - x_{is})' \beta / \kappa - (z_{it} - z_{is})' \delta^+ / \kappa - (p_{it-1} - p_{is-1}) / \kappa)} \right),$$

and

$$q_{ist}^4(\beta, \delta^+, \delta^-, \kappa) = 1 \{ \Delta p_{it} \leq 0, \Delta p_{is} > 0 \} \\ \log \left( \frac{1}{1 + \exp((x_{it} - x_{is})' \beta / \kappa - (z_{it} - z_{is})' \delta^+ / \kappa - (p_{it-1} - p_{is-1}) / \kappa)} \right).$$

Assuming random sampling across  $i$ , the asymptotic variance of this estimator can be derived and calculated using standard methods for extremum estimators. See, for example, Amemiya (1985).

This approach can be generalized in a number of ways. For example, Honoré and Powell (2005) use the same basic insight to estimate a partially linear logit model of the type

$$P(y = 1 | x, z) = \frac{\exp(x' \beta + g(z))}{1 + \exp(x' \beta + g(z))}$$

where  $\beta$  is the parameter of interest,  $g$  is an unknown and unspecified smooth function, and  $z$  is a vector of possibly continuous explanatory variables. The approach in Honoré and Powell (2005) is to identify observations,  $i$  and  $j$ , with similar values of  $z$ , and hence similar values of  $g(z)$ , and then treat  $g(z)$  as a fixed effect for that pair. In

practice this is done by using all pairs of observations and then weighting each pair by a kernel weight of the type  $K\left(\frac{z_i - z_j}{h}\right)$  where  $K$  is a kernel and  $h$  is an appropriately chosen bandwidth, which in principle depends on the sample size. Inspired by this, we estimate  $\beta$ ,  $\kappa$ ,  $\delta^+$  and  $\delta^-$  by maximizing a modification of (7) that only uses pairs of time periods that differ by less than some number:

$$\sum_{i=1}^n \sum_{\substack{1 \leq s \leq t \leq T_i \\ t-s \leq k}} q_{ist}^1(\beta, \delta^+, \delta^-, \kappa) + q_{ist}^2(\beta, \delta^+, \delta^-, \kappa) + q_{ist}^3(\beta, \delta^+, \delta^-, \kappa) + q_{ist}^4(\beta, \delta^+, \delta^-, \kappa) \quad (8)$$

If the model above is correctly specified then this estimator is still consistent and asymptotically normal, but it is likely to be less efficient than that defined by maximizing (7).<sup>8</sup> However, the intuition is that the estimator defined by (8) is likely to be much more robust to a misspecification in which  $\mu_i$ ,  $u_i^-$  and  $u_i^+$  change (slowly) over time.

## 3 Data

### 3.1 Empirical specification

We obtained micro price data underlying the Swiss CPI.<sup>9</sup> The sampling decisions leave us with more than 3 million quarterly price quotes from Q1 1994 to Q4 2007 covering roughly 43% of the CPI basket at average expenditure weights (see Table 1).<sup>10</sup>

**Table 1:** *Sample*

	Weight	Sectors	Products	Individual products	Observations
All sectors	42.7	67	990	189,714	3,157,606
Non-durable	22.1	38	560	116,969	2,132,911
Semi-durable	4.5	11	181	32,528	469,635
Durable	7.9	10	179	32,366	379,605
Services	8.2	8	70	7,851	175,455

The data set comprises price quotes of individual products; an individual product has

<sup>8</sup>Since both (7) and (8) are pseudo log-likelihood functions, it is not guaranteed that estimation based on (8) will lead to a less efficient estimator even though it uses strictly less information than (7)

<sup>9</sup>Source: Swiss Federal Statistical Office: data collection for the Swiss CPI 1993–2007.

<sup>10</sup>A detailed description of the data set is given in Kaufmann (2009). In what follows, we limit the discussion to the most relevant issues.

a particular quality and quantity, and is on offer in a particular outlet.<sup>11</sup> When individual products are out of stock, the statistical office collects prices for close substitutes. We call these close substitutes ‘products.’ The statistical office provides a variable that indicates whether the price quotes of close substitutes can be linked directly because they are of the same quality. If this is not the case, a new individual product starts.

The data set comprises less than 50% of the CPI basket because the statistical office uses other data sources to construct some of the price indices. The largest of these sectors are rents, telecommunication and books. Furthermore, some sectors drop out of the sample because they are not available over the whole sample period. We also only include products that were surveyed at least on a quarterly basis.<sup>12</sup> Finally, we remove a few individual products with price changes larger than 200% and with missing data.

We restrict the analysis to permanent rather than temporary price changes because they are more important for aggregate predictions of menu-cost models (see Kehoe and Midrigan, 2007). A temporary price change is followed by the nominal price returning to its pre-period level.<sup>13</sup> This definition identifies temporary price increases as well as decreases. In addition, the statistical office provides an indicator variable for sales. In periods with either temporary price changes or sales, we carry forward the pre-period price.

The micro price data give us the desired price conditional on observing a price change. For periods with no price changes, we model the desired price according to equation (1). We follow Cecchetti (1986) and use the accumulated sectoral inflation rate as a proxy for the change in nominal marginal costs.<sup>14</sup> We match the inflation rates with the micro data at the three-digit COICOP level, which gives us 67 sectors.<sup>15</sup>

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<sup>11</sup>An example is a 600 ml family-size package of ice cream of a certain brand and flavor in a particular outlet.

<sup>12</sup>In our sample period, prices for some food items are available on a monthly basis. We use the last month of the quarter as the quarterly observation.

<sup>13</sup>For other ways of identifying temporary price changes, see Nakamura and Steinsson (2008) and Kehoe and Midrigan (2007).

<sup>14</sup>The sectoral inflation rate is not necessarily a good approximation to changes in nominal marginal costs for two reasons. First, desired prices may change because of aggregate inflation, real aggregate demand and productivity shocks (see, e.g., Nakamura and Steinsson, 2010). However, the sectoral inflation rate by itself does not allow us to disentangle the three. Fougère et al. (2010) use changes in minimum wages and producer price indices to model marginal costs for restaurants. However, we were not able to match our 67 sectors with corresponding producer price indices or wage indices. Second, the sectoral inflation rate is an average of changing prices and constant prices. An alternative would be to follow Bils et al. (2012) and calculate a measure of reset price inflation. This, however, we leave for future research.

<sup>15</sup>For a full list of these sectors, see Table 6 in the Appendix.

We decompose the sectoral inflation rate into a sectoral inflation trend and sector-specific deviations from trend. On the one hand, this decomposition allows us to extract a persistent component of sectoral inflation that captures macroeconomic factors and sector-specific productivity trends. This accounts for the fact that price trends may be an important factor in explaining why price increases are more frequent than price decreases (see Tsiddon, 1993; Ball and Mankiw, 1994). On the other hand, the non-persistent component captures sector-specific productivity shocks that are unrelated to macroeconomic factors. We include these sector-specific shocks separately for positive and negative values because desired prices may react less to negative than to positive shocks of the same size if firms face an asymmetric profit function (see Ellingsen et al., 2006; Devereux and Siu, 2007). All variables are accumulated since the beginning of each individual product and therefore the empirical specification reads

$$p_{it}^* = \mu_i + \beta_1 \Sigma \bar{\pi}_{jt} + \beta_2 \Sigma \hat{\pi}_{jt}^+ + \beta_3 \Sigma \hat{\pi}_{jt}^- + \varepsilon_{it} \quad , \quad (9)$$

where  $\bar{\pi}_{jt}$  denotes the sectoral inflation trend and  $\hat{\pi}_{jt}^{+/-}$  denote positive and negative sector-specific shocks.

To decompose the inflation rates, we follow Boivin et al. (2009) and use a principal components approach.<sup>16</sup> We extract a vector of four factors ( $\mathbf{C}_t$ ) from a large macroeconomic data set including our sectoral inflation rates and estimate the corresponding factor loadings for each variable ( $\lambda_j$ ). Each sectoral inflation rate can be decomposed into an average ( $\bar{\pi}_j$ ), a common component ( $\lambda_j \mathbf{C}_t$ ) and an idiosyncratic component ( $e_{jt}$ ):

$$\pi_{jt} = \underbrace{\bar{\pi}_j + \lambda_j \mathbf{C}_t}_{\bar{\pi}_{jt}} + \underbrace{e_{jt}}_{\hat{\pi}_{jt}} \quad . \quad (10)$$

The sectoral inflation trend for sector  $j$  is then defined as the sum of the common component of the sectoral inflation rate and its mean.<sup>17</sup> The sector-specific shocks are measured by the idiosyncratic component of the sectoral inflation rate. According to the

<sup>16</sup>The detailed approach and the macroeconomic data set are described in Kaufmann and Lein (2011).

<sup>17</sup>This differs from Dhyne et al. (2011a), who estimate a sector-specific price trend directly from micro price data.

models in Tsiddon (1993) and Ball and Mankiw (1994), firms front load future inflation in the prices they currently set. Therefore, the persistent component is most likely the component on which firms front load.<sup>18</sup>

The price adjustment thresholds are modelled by including the non-accumulated rate of trend inflation ( $\bar{\pi}_{jt}$ ), seasonal time dummies and dummies for periods with VAT changes. This reflects the fact that menu costs may differ not only across individual products but also over time. Trend inflation is included in the threshold equation because the thresholds may vary with the level of inflation. This is because positive trend inflation makes it optimal to react more readily to positive shocks than to negative shocks of the same size, as future inflation erodes relative prices and thereby automatically leads to a relative price cut (see Ball and Mankiw, 1994). Thus, higher inflation reduces the upper threshold and raises the lower threshold (see also Gautier and Le Bihan, 2011). We include dummies for periods with VAT changes because such events give firms an opportunity to change prices as managerial and customer costs are particularly low (see Zbaracki et al., 2004; Fougère et al., 2010; Karadi and Reiff, 2010). Similarly, the seasonal dummies reflect the fact that menu costs may be low in certain months because of end-of-season sales or seasonal product replacements.

### 3.2 Descriptive statistics

The micro price data show that positive price changes are more frequent than negative price changes (see Table 2).<sup>19</sup> On average, the relative frequency of price increases, that is, the share of price increases in all price changes, is 66.4%.<sup>20</sup> However, there are considerable differences across product types. For services, we find a relative frequency of price increases of 78.2%. For non-durable goods, this frequency is lower, at 63.3%. Price increases are even more frequent if we focus on small price changes. The average relative frequency of small price increases exceeds 70%. This is consistent with the findings in Chen et al. (2008).

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<sup>18</sup>In the spirit of Boivin et al. (2009), Kaufmann and Lein (2011) show that the sector-specific component is not persistent, while the common component is highly persistent.

<sup>19</sup>These statistics broadly repeat the findings in Kaufmann (2009). Some differences emerge because of different sampling decisions. In particular, the %fpc<sup>+</sup> is higher than in the earlier study (1993–2000: 56.2%; 2000–2005: 58.7%).

<sup>20</sup>The descriptive statistics for all sectors can be found in Table 6 in the Appendix.

**Table 2:** *Frequency of positive and negative price changes*

	All price changes			Small price changes		
	fpc <sup>+</sup>	fpc <sup>-</sup>	%fpc <sup>+</sup>	fpc <sup>+</sup>	fpc <sup>-</sup>	%fpc <sup>+</sup>
All sectors	8.8	4.6	66.4	3.3	1.3	71.5
Non-durable	9.2	5.3	63.3	3.1	1.6	66.0
Semi-durable	6.4	3.6	64.2	2.6	1.1	71.4
Durable	9.7	5.4	64.2	4.1	1.4	74.5
Services	8.0	2.2	78.2	3.2	0.6	83.2

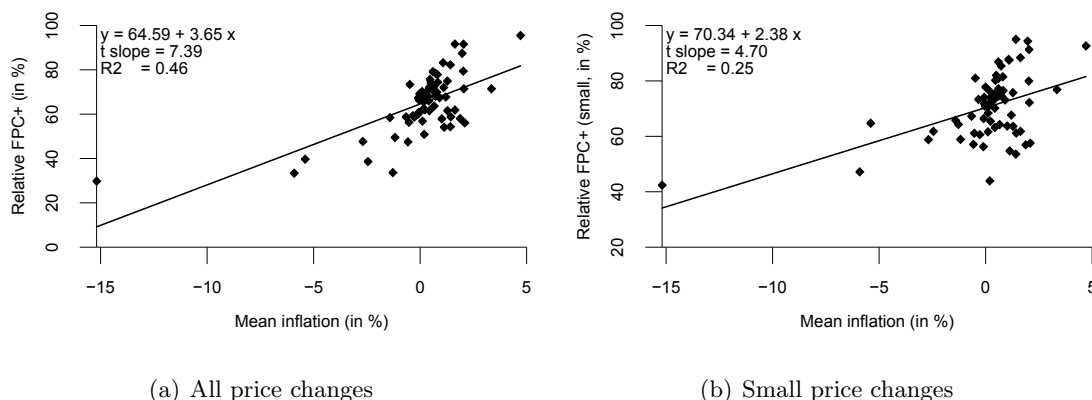
Note: The table gives statistics on the frequency of price changes. fpc<sup>+</sup>, fpc<sup>-</sup>: positive, negative frequency of price changes; %fpc<sup>+</sup>: relative fpc<sup>+</sup> = 100 × fpc<sup>+</sup> / (fpc<sup>+</sup> + fpc<sup>-</sup>). Following Midrigan (2011) a ‘small’ price change is smaller than half of the average absolute price change in the corresponding sector. The statistics are calculated for 67 sectors and then aggregated using average expenditure weights.

Figure 1 shows in a scatter plot the relationship between the relative frequency of price changes and the mean inflation rate for each sector. We find a significantly positive relationship (Panel a). The  $R^2$  suggests that the sectoral inflation rate explains more than 40% of the cross-sectional variation in the %fpc<sup>+</sup>. The relationship is weaker for small price changes. This is at odds with the prediction of the Ball and Mankiw (1994) model. Theory predicts that positive trend inflation mainly leads to more small price increases relative to small price decreases because trend inflation is most relevant in sectors with small idiosyncratic shocks and large menu costs (see, e.g., Gagnon, 2009). Therefore, positive trend inflation may not be the only reason why price increases are more frequent than decreases.<sup>21</sup>

The scatter plot is a simple way to gauge the relative frequency of positive price changes for a sector with zero mean inflation. According to the intercept of the regression line, a sector with zero inflation displays a relative frequency of positive price changes of 64.6%. For small price changes, the intercept is higher, which emphasizes that small price increases would be frequently observed even in the absence of sectoral price trends. Using this cross-sectional regression to explain the prevalence of positive price changes has a major disadvantage. If we set the sectoral inflation rate to zero, we assume that both, the aggregate inflation rate and sectoral productivity growth are zero. However, the scatter plot shows that there is a large heterogeneity in the mean of the sectoral inflation rates,

<sup>21</sup>The weak relationship may also stem from sampling error and quality adjustments. Eichenbaum et al. (2012) show for US micro data that the prevalence of small price changes is largely due to sampling error and quality adjustment. They argue that the importance of small price changes for evaluating macroeconomic models is therefore overrated.

**Figure 1:** *Relative frequency and sectoral trend inflation*



Note: The figures give scatter plots and regressions of the relationship between the relative frequency of price changes and the sectoral trend inflation rate. Panel (a) shows the results for all price changes, panel (b) for small price changes. Following Midrigan (2011) a ‘small’ price change is smaller than half of the average absolute price change in the corresponding sector.

which points to different productivity trends. For policy purposes, we have to disentangle the effect of aggregate inflation from these relative price trends. We are interested in the question: would asymmetry disappear in an environment with zero aggregate inflation? Therefore, we use our model estimates and make counterfactual predictions.

## 4 Results

This section examines to what extent the relative frequency of positive price changes can be explained by trend inflation. We first discuss the estimation results and which covariates are most important to explain the frequency of positive and negative price changes. We then perform a counterfactual analysis showing by how much the relative frequency of positive price changes would fall if aggregate inflation was zero. Finally, we offer some robustness checks.

### 4.1 Estimation results

We estimate the coefficients of the desired price equation controlling for heterogeneity at the level of individual products. As discussed in Section 2, it is potentially desirable to use only pairs of time periods that are fairly close. We therefore use pairs that differ by no more than 12 quarters. This makes the results more robust to the assumption



that the fixed effects in the thresholds and in the pricing equation are constant over the whole sample period. An alternative way would be to introduce a stochastic term in the adjustment thresholds, as, for example, in Gautier and Le Bihan (2011). They emphasize that this is necessary to allow for time-varying stochastic price adjustment thresholds because otherwise  $(S, s)$ -pricing rules have difficulty in matching the prevalence of small price changes.<sup>22</sup> In particular, the price adjustment thresholds tend to be too wide and the variance of the idiosyncratic shocks tends to be too large (see Dhyne et al., 2011b).

Table 3 reports the estimation results for our 67 sectoral models. The first panel summarizes the estimates of the desired price equation. For each model and for each coefficient, we perform a one-sided test with the alternative hypothesis that the coefficient is larger than zero. The table reports the weighted average of the coefficients across all sectors conditional on this alternative hypothesis.<sup>23</sup> As a measure of significance, we report the share of sectors for which we reject the null hypothesis at the 5% level in brackets. All statistics are weighted by the corresponding average CPI expenditure weights. The second panel tests whether the reaction to positive sector-specific shocks is significantly different from the reaction to negative sector-specific shocks. The third panel gives averages of the estimated variance and of the price adjustment thresholds.

In almost all sectors, relative price trends have a significantly positive impact on desired prices. At the 5% level, the share of sectors with a positive coefficient amounts to 94%. On average, a 1% increase in the sectoral price trend raises the firm's desired price by 1.16%. This suggests that, in the long run, desired prices move one-for-one with the sectoral price trend. This finding is common across product types. For three out of four product types, the share of sectors that significantly react to the sectoral price trend is larger than 90% and the average coefficient is close to 1 (non-durable goods, durable goods and services). For semi-durable goods, the share of significant coefficients amounts to only 63%, because, for some semi-durable goods, the coefficient is not significantly different from zero or even negative.<sup>24</sup>

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<sup>22</sup>See Dotsey et al. (1999) and Midrigan (2011) for theoretical frameworks and Fougère et al. (2010) and Dhyne et al. (2011a) for empirical applications.

<sup>23</sup>Detailed estimates for each model can be found in the Appendix in Tables 8 – 14.

<sup>24</sup>See Table 7 in the Appendix for more tests of hypotheses. One problem for semi-durable goods may be that the sectoral inflation rates are not very good proxies. We use an alternative proxy as a robustness check in the last section of this chapter.

**Table 3:** *Estimates of desired price equation*

	Product types				
	All sectors	Non-durable	Semi-durable	Durable	Services
$\Sigma \bar{\pi}_{jt}$ (sectoral price trends)					
Avg. $\beta_1   \beta_1 > 0$	1.16 (0.94)	1.12 (0.97)	0.99 (0.63)	1.53 (0.97)	0.98 (1.00)
$\Sigma \hat{\pi}_{jt}^+$ (positive sector-specific shocks)					
Avg. $\beta_2   \beta_2 > 0$	1.68 (0.70)	1.37 (0.78)	2.25 (0.87)	2.00 (0.46)	2.06 (0.63)
$\Sigma \hat{\pi}_{jt}^-$ (negative sector-specific shocks)					
Avg. $\beta_3   \beta_3 > 0$	1.24 (0.58)	1.08 (0.76)	1.10 (0.56)	0.95 (0.14)	2.35 (0.54)
$\Sigma \hat{\pi}_{jt}^+, \Sigma \hat{\pi}_{jt}^-$ (positive and negative sector-specific shocks)					
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 > 0$	2.05 (0.43)	1.34 (0.39)	1.65 (0.42)	2.84 (0.51)	3.97 (0.46)
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 < 0$	-1.21 (0.30)	-0.88 (0.31)	-0.91 (0.00)	-1.83 (0.36)	-1.43 (0.36)
$\bar{\pi}_{jt}$ (sectoral inflation trend upper threshold $\theta^+$ )					
Avg. $\delta_1^+   \delta_1^+ < 0$	-4.94 (0.67)	-3.43 (0.61)	-8.85 (0.20)	-7.90 (0.76)	-5.79 (0.97)
$\bar{\pi}_{jt}$ (sectoral inflation trend lower threshold $\theta^-$ )					
Avg. $\delta_1^-   \delta_1^- < 0$	-5.49 (0.59)	-5.44 (0.61)	-6.01 (0.56)	-5.44 (0.57)	-5.25 (0.57)
Avg. $\sigma_\varepsilon$	13.24	14.68	16.05	12.31	8.74
Avg. fit (positive)	0.83	0.83	0.84	0.82	0.83
Avg. fit (negative)	0.63	0.66	0.62	0.55	0.63
Sectors	67	38	11	10	8
Observations	3,157,816	2,132,911	469,807	379,643	175,455

Note: The table summarizes the estimation results for 67 sectoral models. The first panel gives the estimates for the desired price equation ( $p_{it}^* = \mu_i + \beta_1 \Sigma \bar{\pi}_{jt} + \beta_2 \Sigma \hat{\pi}_{jt}^+ + \beta_3 \Sigma \hat{\pi}_{jt}^- + \varepsilon_{it}$ ). All explanatory variables are measured in logarithms multiplied by 100. For each model, we perform tests for which the alternative hypothesis is given in the first column. We then report averages of the coefficients, weighted by the sectoral expenditure weight, conditional on this alternative hypothesis. We report in brackets the share of sectors where we reject the null hypothesis at the 5% level. The second panel tests whether the reaction to positive sector-specific shocks is significantly different from the reaction to negative sector-specific shocks. The third panel shows the estimates of the average coefficient on the sectoral inflation trend in the threshold equation ( $\theta_{it}^{+/-} = \delta_1^{+/-} \bar{\pi}_{jt} + \dots$ ). The fourth panel gives averages of the estimated variance of idiosyncratic shocks and some summary statistics. The measure of fit uses pairs of time periods for a given product where there is a price change in one period but not in the other. The measure of fit for positive changes is defined as the fraction of pairs for which the model predicts a higher probability of a price increase in the period with the price increase. The measure of fit for negative price changes is defined accordingly.

The coefficients are also mostly significant for positive and for negative sector-specific shocks. In 70% of the sectors, firms' desired prices react significantly to positive sector-specific shocks. The share of sectors with a significant reaction to negative shocks is somewhat smaller (58%). In addition, the average coefficient on positive sector-specific shocks (1.68) is larger than the average coefficient on negative sector-specific shocks (1.24). This is a common pattern across all product types and suggests that desired prices usually react more to positive than to negative shocks.<sup>25</sup> We therefore test whether the reaction coefficients are significantly different from each other.

The second panel shows that the share of sectors for which we find a stronger reaction to positive than to negative shocks (43%) is somewhat higher than the share of sectors for which we find the opposite (30%). Even though the average coefficient on positive shocks is larger, we cannot conclude that there is broad-based evidence that desired prices react more strongly to positive than to negative sector-specific shocks. Indeed, there are differences across product types. For non-durable goods and services, the share of sectors that respond more to positive shocks is only slightly higher than the share of sectors that respond more to negative shocks. Differences are more pronounced for semi-durable and durable goods.

The thresholds vary with the level of inflation. Theoretical predictions suggest that both the upper and the lower threshold shift downwards with a higher level of inflation, making the range of inaction smaller for price increases and larger for price decreases. This prediction is largely supported by our results reported in the third panel. In almost 70% of all sectors, sectoral trend inflation has a significantly negative impact on the level of the upper thresholds. Likewise, in about 60% of the sectors, inflation shifts the lower threshold downwards. The effect of inflation on the upper threshold is almost always significantly negative for services, but in 20% of the semi-durable goods sectors. Meanwhile, the effect on the lower threshold is relatively homogeneous across sectors.

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<sup>25</sup>The only exception is services, where we find a slightly higher average coefficient for negative shocks than for positive shocks.

## 4.2 The relative importance of price trends and sector-specific shocks

In our empirical specification, desired prices may rise more often than they fall because of sectoral price trends or because of asymmetric reactions to positive and negative shocks. We now ask which of the three components is most important for explaining the cross-sectional variation in the relative frequency of positive price changes. We calculate for each observation the probability of a price increase and decrease at actual sample values. The simulated relative frequency of positive price changes ( $\%fpc^+$ ) is then given by the average probability of a price increase divided by the average probability of a price change.

To simulate the relative frequency of price increases, we have to obtain a value of the fixed effects. In fact, we only need to know  $(\mu_i - u_i^+)$  and  $(\mu_i - u_i^-)$  instead of all three fixed effects separately.<sup>26</sup> We calibrate the two differences to match the frequency of positive and negative price changes. This boils down to re-estimating the model by maximum likelihood and restricting all coefficients to the values from the fixed effects estimator. Calibrating a different fixed effect for each individual product is problematic because for some individual products we observe only price increases or price decreases. We therefore calibrate the fixed effects for the aggregation level of products rather than for individual products.<sup>27</sup>

In the first column of Table 4 we regress the  $\%fpc^+$  on the model predictions at actual sample values. The  $R^2$  equals almost 1 by construction because we calibrated the fixed effects to match the positive and negative frequency of price changes. In the remaining columns we set one of the covariates to zero to simulate the relative frequency of positive price changes. The size of the drop in the  $R^2$  gives us an idea of to what extent the corresponding covariate helps to explain the cross-sectional variation of the relative frequency of positive price changes.

Sectoral price trends explain a large share of the cross-sectional variation in the  $\%fpc^+$ . If we set the sectoral price trend to zero, the remaining variables in the model explain only 48% of the cross-sectional variation ( $\Sigma \bar{\pi}_{jt} = 0$ ). If we set the positive and negative

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<sup>26</sup>Unfortunately, we cannot simulate the size of price changes without knowing  $\mu_i$ .

<sup>27</sup>The advantage of this procedure is that our estimates of the desired price equation are not contaminated by any distributional assumptions about the fixed effects.

**Table 4:** *Explanatory power of %fpc<sup>+</sup>*

	Model	$\Sigma\bar{\pi}_{jt} = 0$	$\Sigma\hat{\pi}_{jt}^+ = 0$	$\Sigma\hat{\pi}_{jt}^- = 0$
Constant	-1.01	8.81	11.86	8.29
Slope	1.02	0.91	0.83	0.86
$R^2$	0.99	0.48	0.96	0.94
Sectors	67	67	67	67

Note: The table shows coefficients and the  $R^2$  from a regression of the actual relative frequency of positive price changes (%fpc<sup>+</sup>) on the simulated %fpc<sup>+</sup> ( $\widetilde{\%fpc}^+$ ) and a constant. The first column shows the results at actual sample values. In the subsequent columns we repeat the regression with a simulated %fpc<sup>+</sup> where the corresponding covariate shown in the first row is set to zero.

sector-specific shocks to zero, the  $R^2$  falls only slightly, to 96% and 94%, respectively ( $\Sigma\hat{\pi}_{jt}^+ = 0$  and  $\Sigma\hat{\pi}_{jt}^- = 0$ ). This suggests that the sectoral price trend is more important for fitting the cross-sectional variation in the relative frequency of positive price changes than is the asymmetric reaction to positive and negative sector-specific shocks.

### 4.3 Asymmetries in the absence of aggregate inflation

The descriptive statistics and the model estimates suggest that sectoral price trends explain a considerable share of the relative frequency of positive price changes. We now use our estimated price-setting rules to show whether the relative frequency of positive price changes is mainly driven by positive aggregate inflation. In particular, we make counterfactual predictions, which tell us by how much the asymmetry would be reduced if aggregate inflation was zero. We emphasize this counterfactual, because aggregate inflation can be influenced by monetary policy and thus bears important policy implications. In addition, we examine the counterfactual of zero sectoral inflation for all sectors.

Table 5 gives model predictions for various paths of the desired price. The first two columns give the actual %fpc<sup>+</sup> and the model predictions at actual sample values, respectively. The third and fourth columns assume that aggregate inflation is zero. We show the counterfactuals in two steps because trend inflation has two effects on asymmetry. First, desired prices rise on average with positive aggregate inflation. We examine this first effect in the third column by subtracting the accumulated aggregate inflation rate from the sectoral inflation trend ( $\beta_1[\Sigma\bar{\pi}_{jt} - \Sigma\pi_t]$ ) in the desired price equation, but we leave the threshold equation unchanged.<sup>28</sup> Second, the price adjustment thresholds become

<sup>28</sup>We assume that firms' desired price is a markup over nominal marginal costs. By subtracting accumulated aggregate inflation from the sectoral price trend we therefore evaluate the prediction of the model if firms' real marginal costs are equal to their nominal marginal costs.

asymmetric with positive trend inflation because higher trend inflation continuously reduces relative prices if prices remain unchanged. Thus, the upper thresholds become smaller and the lower thresholds larger in absolute terms. We examine this second effect in the fourth column by subtracting the accumulated aggregate inflation rate from the sectoral inflation trend in the desired price equation and subtracting the level of aggregate inflation from the level of sectoral inflation in the threshold equation ( $\delta_1[\bar{\pi}_{jt} - \pi_t]$ ). The last two columns predict the relative frequency assuming that all sectoral inflation rates are zero. The two counterfactuals are analogous to the ones described above.

**Table 5:** *Counterfactual predictions %fpc<sup>+</sup>*

	Data	Model	$\pi_t = 0^{(1)}$	$\pi_t = 0^{(2)}$	$\pi_{jt} = 0^{(1)}$	$\pi_{jt} = 0^{(2)}$
All sectors	66.4	66.1	61.0	56.6	62.6	60.3
Non-durable	63.3	63.0	57.3	53.1	60.3	56.1
Semi-durable	64.2	63.5	61.9	59.2	63.0	64.1
Durable	64.2	64.2	58.4	49.7	62.9	64.0
Services	78.2	77.7	73.1	71.2	68.1	65.8

Note: The table gives model predictions for various paths of the desired price. The first two columns give the actual %fpc<sup>+</sup> and the model predictions at actual sample values, respectively. The third and fourth columns assume that aggregate inflation is zero by subtracting aggregate inflation from the sectoral inflation trend ( $\beta_1[\Sigma\bar{\pi}_{jt} - \Sigma\pi_t]$ ). <sup>(1)</sup> assumes that the thresholds remain fixed with zero inflation. <sup>(2)</sup> takes into account that the thresholds vary endogenously with changes in inflation by additionally setting inflation to zero in the threshold equation ( $\delta_1[\bar{\pi}_{jt} - \pi_t]$ ). Columns five and six replicate the previous two counterfactuals but assume that the sectoral inflation rate is zero, i.e.,  $\bar{\pi}_{jt} + \hat{\pi}_{jt}^+ + \hat{\pi}_{jt}^- = 0$  for all  $j, t$ .

The relative frequency of price increases would drop significantly with zero aggregate inflation. But we would still observe more price increases than decreases. The third column shows the results with zero aggregate inflation if we assume that the thresholds remain unchanged, that is, we set aggregate inflation to zero in the desired price equation but not in the threshold equation ( $\pi_t = 0^{(1)}$ ). On average, over all sectors, we find that the %fpc<sup>+</sup> drops by almost 5.5 pp, to 61.0%, if we set aggregate inflation to zero. Thus, the fact that desired prices rise on average with positive trend inflation already explains a substantial part of the observed asymmetries. The effect is somewhat smaller for semi-durable goods and about equally large for non-durable goods, durable goods and services.

It is important to take into account that the thresholds also vary with inflation. In the fourth column, we set aggregate inflation to zero in the threshold equation.<sup>29</sup> The

<sup>29</sup>The threshold equation contains the sectoral inflation trend. Thus, we subtract the aggregate inflation rate from the sectoral inflation rate for both the desired price equation and the threshold equation.

asymmetry reduces by another 4.4 pp to 56.6%. Thus, in the absence of aggregate inflation, the asymmetries would be significantly reduced. This result also shows that the endogeneity in the estimated thresholds is non-negligible.

The counterfactuals derived from our estimated models differ from the predictions of the scatter plot in Figure 1. The fifth column in Table 5 shows why. If we set all sectoral inflation rates to zero for calculating the desired price, we assume not only that aggregate inflation is zero but also that productivity remains constant in all sectors, or in other words, the desired price remains on average unchanged. Price changes are then triggered exclusively by idiosyncratic shocks that are on average zero and have an estimated variance  $\sigma_\varepsilon$ . Consistent with the scatter plot, our models predict the relative frequency of positive price changes at 62.6% if sectoral inflation is set to zero. Taking the endogeneity of the thresholds into account would reduce the asymmetry to 60.3%, again suggesting that the endogeneity of the threshold matters. This, however, can also not be captured by the simple intercept prediction in Figure 1.

Even though asymmetries are substantially reduced in a zero inflation environment, we still find somewhat more price increases than decreases. This remaining asymmetry may reflect deep downward rigidity, which may be a result of asymmetric price adjustment thresholds. A theoretical explanation for asymmetric adjustment thresholds can also be found in Golosov and Lucas (2007). They show that the region of inaction is cone-shaped as a function of productivity. For low levels of productivity, the band of inaction is wider than it is for high levels of productivity because high-productivity firms have low prices and sell high quantities, while the opposite is the case for low-productivity firms. Klenow and Kryvtsov (2008) show that the  $(S, s)$ -band becomes increasingly asymmetric with higher elasticity of demand, which implies that the profit function is more asymmetric. Thus, price decreases become less frequent and larger in absolute terms than price increases, a result that is not related to the level inflation.<sup>30</sup>

The result that asymmetries can, to a large extent, be related to trend inflation is also in line with evidence from Japan. During the period when inflation was low or even negative, workers started to accept nominal wage cuts (see Kuroda and Yamamoto, 2003). This may

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<sup>30</sup>This would imply that sectors with high productivity should have a relatively narrow range of inaction, while sectors with low productivity have a wide range of inaction. Exploring this further is beyond the scope of the paper.

be because they did not expect any inflation or productivity growth in the medium term. Also, consumer price decreases were common during this period, and asymmetry in the frequency of price increases and decreases disappeared. Higo and Saita (2007) show that during this period, the frequency of price increases is almost equivalent to that of price decreases.<sup>31</sup>

#### 4.4 Robustness tests

To examine the robustness of our results, we estimated four alternative specifications.<sup>32</sup> First, we estimated the models using all price changes, not only those within a range of 12 quarters. Second, we added aggregate variables to our empirical specification of the desired price. Third, we used an alternative measure of the sectoral price trend. Finally, we approximated the desired price change by the average price change observed in our data set instead of the sectoral inflation rate.

Our main specification compared only price changes within a range of 12 quarters. Now, we assume that the fixed effects remain constant over a period of 14 years.<sup>33</sup> The estimated standard deviation of the idiosyncratic shock gets unrealistically large. Moreover, the average price adjustment thresholds increase in absolute size. This is an undesirable feature of the more restrictive model because it implies that the size of price changes would on average increase. Therefore, we are unlikely to fit the prevalence of small price changes observed in the data.<sup>34</sup> Nevertheless, the counterfactual predictions with respect to the relative frequency of positive price changes are not qualitatively affected by using the more restrictive model.<sup>35</sup> Intuitively, the variance of idiosyncratic shocks scales all parameters by the same amount so that the probability of observing a price increase or decrease is not greatly affected even though the size of price adjustments may well be (see

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<sup>31</sup>The result is also not inconsistent with findings in the literature that aggregate inflation explains only a tiny fraction of the variation in nonzero nominal price changes (see Eden, 2001). This is because idiosyncratic factors are most important in explaining individual price changes (see Lein, 2010). Nevertheless, the small fraction of the variation that aggregate factors explain may still be important in the aggregate because these aggregate shocks affect all firms, especially those that are just at the margin of adjustment.

<sup>32</sup>All results of the robustness tests are available in the Appendix.

<sup>33</sup>See Table 15 in the Appendix

<sup>34</sup>Dhyne et al. (2011a) note that: “[using binary response models] neglects the information contained in the magnitude of price changes. However, this information is crucial for identifying the volatility of the idiosyncratic component and for disentangling the idiosyncratic component of the optimal price from the idiosyncratic threshold variable.”

<sup>35</sup>See Table 19 in the Appendix.



Equation 6).

As a second robustness check, we added accumulated aggregate inflation as well as aggregate accumulated personal consumption expenditures to our empirical specification. Even though the effect of aggregate inflation on the desired price is significantly larger than zero in only about one-fourth of the sectors, sectoral trend inflation remains significant in almost 70% of all sectors.<sup>36</sup> This suggests that aggregate inflation is already captured in the sectoral inflation trends. Indeed, the counterfactual predictions of this specification imply that the relative frequency of positive price changes falls to 57.7% at zero aggregate inflation, taking into account the endogenous thresholds.<sup>37</sup>

As a third robustness check, we repeated the analysis using a Hodrick-Prescott filter to obtain an alternative estimate of the price trend. With this alternative decomposition, deviations from this trend are not necessarily sector-specific. Most of the results prove robust to this alternative.<sup>38</sup> The effect of aggregate inflation on the  $\%fpc^+$  in the counterfactual analysis is even larger than in our baseline specification.<sup>39</sup> This, however, is driven mainly by durable goods, where the counterfactual frequency drops substantially when subtracting aggregate inflation from the thresholds.

One puzzling result of our main specification is that some coefficients on the sectoral price trends, especially for semi-durable goods, are negative. This would imply that desired prices decline if the average sectoral price increases. In particular, this affected our results for semi-durable goods. Our main specification uses the sectoral inflation rates published by the statistical office. Because of our sampling decisions described above, these official inflation rates do not have to fully correspond to our micro data set. Prices may be included in the calculation of the sectoral inflation rate that are not in our micro data set. We therefore use the average price change observed in each sector as a proxy for changes in nominal marginal costs instead of the sectoral inflation rate. As a consequence, the share of sectors where we find a negative sign in the desired price equation is zero.<sup>40</sup> This affects our counterfactual predictions only marginally. If we set aggregate inflation to zero and take the endogeneity of the price adjustment thresholds into account we find a  $\%fpc^+$  at

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<sup>36</sup>See Table 16 in the Appendix.

<sup>37</sup>See Table 20 in the Appendix.

<sup>38</sup>See Table 17 in the Appendix.

<sup>39</sup>See Table 21 in the Appendix.

<sup>40</sup>See Table 18 in the Appendix.

55.5%.<sup>41</sup>

## 5 Conclusions

Prices increase but they do not fall. This is a popular preconception with a germ of truth. Price data underlying the Swiss CPI tell the same story as price data for many other countries; price increases are usually more frequent than price decreases. In this paper, we relate this finding to economic theory.

One explanation may be that there is a deep downward price rigidity and that firms cannot reduce prices, even if they would like to. However, our results support a second explanation. Trend inflation is the key factor explaining asymmetries observed in the data, even in a low inflation environment. Our findings support the view that the asymmetry is endogenous; counterfactual analysis shows that if aggregate inflation was be zero, the asymmetries would be reduced substantially.

The policy implications of our empirical results follow from Ball and Mankiw (1994) – at least to the extent that the asymmetries are explained by trend inflation. Most of the asymmetries would disappear if inflation was stabilized at zero. Such a stabilization policy is optimal for product markets because positive inflation increases relative price variability and lowers output, as the distorted price signal does not allocate resources efficiently. This stands in contrast to the argument put forward by Tobin (1972) and Akerlof et al. (1996), for example, that a central bank should adopt a positive inflation target if prices are downwardly rigid in nominal terms.

Nevertheless, the scope of these policy implications is limited. A positive inflation target may still be optimal. First, even though consumer prices may not be downwardly rigid in the absence of inflation, wages may well be. Thus, inflation may have a sand effect in the product market but a grease effect in the labor market. Second, a positive inflation target may take into account quality improvements, which are not captured in the calculation of the aggregate inflation rate.

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<sup>41</sup>See Table 22 in the Appendix.

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## A Appendix

### A.1 Additional tables



**Table 6: Sectoral descriptive statistics**

Description	Label	fpc	fpc <sup>+</sup>	fpc <sup>-</sup>	%fpc <sup>+</sup>	Size	Size <sup>+</sup>	Size <sup>-</sup>	fpc <sup>sm</sup>	fpc <sup>+sm</sup>	fpc <sup>-sm</sup>	%fpc <sup>+sm</sup>	$\bar{\pi}_j$	Weight	Observ.
<b>Non-durable goods</b>															
Rice	A001	11.8	8.0	3.9	67.3	8.9	9.4	8.1	3.4	2.3	1.1	66.4	-0.1	0.041	12136
Flour	A002	10.9	5.2	5.7	47.5	8.5	10.1	7.1	3.8	2.2	1.6	57.1	-0.6	0.069	9859
Bread and pastries	A003	7.8	5.6	2.2	72.1	7.9	7.7	8.4	2.5	1.8	0.8	70.2	0.4	1.476	145572
Pasta	A004	10.6	7.4	3.2	70.2	11.3	11.7	10.4	3.3	2.3	1.0	70.5	0.1	0.127	21086
Other cereal products	A005	9.8	6.6	3.2	67.3	9.2	9.9	7.8	4.2	2.9	1.3	68.4	0.1	0.179	26754
Beef	A006	32.8	19.3	13.5	58.8	9.8	10.5	8.8	11.3	6.9	4.4	61.1	1.4	0.516	47397
Veal	A007	41.9	24.3	17.6	58.0	8.4	8.9	7.7	13.2	7.5	5.7	56.9	1.9	0.234	31993
Pork	A008	40.6	22.0	18.5	54.3	11.4	12.9	9.7	13.1	7.1	6.1	53.8	1.4	0.533	42500
Lamb	A009	13.0	9.3	3.7	71.5	10.6	11.2	9.4	4.9	3.6	1.4	72.2	2.0	0.096	24109
Poultry	A010	14.0	10.4	3.6	74.4	11.3	11.7	10.1	5.5	4.2	1.3	76.5	0.8	0.306	30515
Other meat	A011	13.0	8.8	4.2	67.7	10.8	11.1	10.3	4.9	3.3	1.6	67.7	1.2	1.487	127677
Fish	A012	25.3	15.6	9.6	61.9	12.4	12.9	11.6	8.7	5.4	3.3	61.8	1.6	0.590	33544
Milk	A013	10.4	3.5	6.9	33.6	6.3	6.3	6.3	2.2	1.4	0.8	64.3	-1.3	0.976	29794
Cheese	A014	11.5	6.9	4.6	59.9	8.6	9.8	6.7	5.0	2.8	2.2	56.3	-0.1	0.454	113567
Other dairy products	A015	8.4	4.7	3.7	56.3	9.8	10.7	8.7	3.0	1.9	1.2	61.1	-0.5	0.196	58462
Cream	A016	12.8	4.9	7.8	38.6	7.9	8.0	7.8	4.1	2.5	1.6	61.8	-2.5	0.224	29017
Eggs	A017	13.3	8.3	5.1	62.0	8.2	8.4	7.8	4.5	3.0	1.6	65.5	0.2	0.205	13361
Fats and edible oils	A018	14.2	8.3	5.9	58.7	7.6	8.0	7.1	5.7	3.5	2.3	60.6	-0.3	0.475	61611
Fruits	A019	31.9	17.9	14.0	56.1	22.7	22.7	22.8	11.1	6.4	4.7	57.7	2.1	1.063	163461
Vegetables and potatoes	A020	52.3	28.3	24.0	54.1	24.9	24.9	24.9	15.9	8.7	7.2	54.8	1.1	0.423	183793
Dried, frozen, tinned vegetables	A021	9.9	6.6	3.3	66.5	8.4	7.9	9.3	3.6	2.7	0.9	74.1	-0.1	1.004	31678
Sugar, jam, honey/other sugary foods	A022	9.7	6.6	3.1	68.1	8.7	8.7	8.7	3.2	2.3	0.9	73.2	0.4	0.745	80924
Other food products	A023	9.0	6.4	2.6	70.7	7.8	7.3	8.8	3.3	2.5	0.8	77.2	0.6	0.544	49932
Coffee, tea, cocoa and nutritional beverages	A024	13.8	8.5	5.3	61.6	9.6	10.4	8.3	4.3	2.7	1.6	63.2	0.4	0.287	55834
Mineral waters, soft drinks and juices	A025	8.6	5.7	2.9	66.0	7.7	7.2	8.8	2.5	1.9	0.6	75.2	0.4	0.834	53191
Spirits	B001	11.1	6.5	4.6	58.8	7.5	5.3	10.6	4.8	3.2	1.6	67.3	-0.7	0.177	38698
Wine	B002	11.6	7.9	3.7	68.1	7.3	6.9	8.4	3.8	2.8	1.0	74.7	0.7	0.877	116664
Beer	B003	9.6	6.7	2.9	69.7	7.2	6.8	8.3	2.8	2.1	0.7	74.2	0.3	0.183	19131
Tobacco	B004	23.3	22.2	1.0	95.5	4.4	4.4	4.3	5.9	5.5	0.4	92.6	4.7	0.691	6860

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Description	Label	fpc	fpc <sup>+</sup>	fpc <sup>-</sup>	%fpc <sup>+</sup>	Size <sup>+</sup>	Size <sup>-</sup>	fpc <sup>sm</sup>	fpc <sup>+sm</sup>	fpc <sup>-sm</sup>	%fpc <sup>+sm</sup>	$\bar{\pi}_j$	Weight	Observ.	
Products for housing maintenance and repair	D002	9.9	7.4	2.5	74.9	8.6	8.2	9.8	3.5	2.6	0.8	75.8	1.3	0.159	14409
Electricity	D003	6.7	3.4	3.3	50.9	8.2	7.9	8.6	0.9	0.4	0.5	43.9	0.2	1.933	12585
Natural gas	D004	10.5	7.5	3.0	71.5	17.3	17.4	17.0	1.4	1.1	0.3	76.9	3.3	0.444	11181
Goods for routine household maintenance	E012	10.6	6.7	3.8	63.7	8.7	8.4	9.3	3.3	2.1	1.2	64.2	0.7	0.817	108510
Plants and flowers	I007	14.1	8.2	5.9	57.9	16.4	15.6	17.6	3.9	2.5	1.4	63.9	1.0	0.749	58131
Pets and related products	I008	8.3	5.5	2.9	65.5	8.0	7.3	9.3	3.1	2.2	0.9	71.5	0.2	0.429	19617
Daily newspapers and periodicals	I010	11.3	10.4	1.0	91.6	5.8	5.5	9.7	3.9	3.6	0.3	91.3	2.0	1.035	10351
Writing and drawing materials	I011	10.7	7.5	3.2	69.9	8.2	7.4	10.1	3.9	3.0	0.9	76.3	0.8	0.225	47004
Articles for personal hygiene	I014	9.0	6.5	2.5	72.2	8.7	8.6	8.8	3.4	2.5	0.9	74.6	0.6	1.259	189750
<b>Semi-durable goods</b>															
Clothing	C001	8.4	5.7	2.7	68.4	14.4	14.9	13.3	2.9	2.0	0.8	71.6	0.2	1.303	91502
Other articles of clothing/fabrics	C002	6.5	5.1	1.3	79.2	10.3	9.6	12.8	2.3	2.0	0.3	86.9	0.6	0.330	23534
Household textiles	E007	5.3	3.6	1.7	68.0	10.1	8.5	13.3	1.8	1.4	0.4	77.8	0.0	0.417	32576
Smaller electric household appliances	E009	9.5	5.5	3.9	58.5	7.6	6.6	9.0	3.7	2.5	1.3	65.8	-1.4	0.300	24727
Glassware, tableware and household utensils	E010	9.5	7.4	2.1	77.9	7.8	7.0	10.6	3.1	2.5	0.6	81.5	0.8	0.401	54359
Spare parts	G003	23.9	16.2	7.8	67.5	5.8	4.6	8.3	11.6	8.8	2.7	76.3	0.2	0.310	59694
Tyres and accessories	G004	30.4	15.1	15.4	49.5	6.1	5.0	7.2	10.7	6.3	4.4	58.9	-1.2	0.110	25988
Recording media	I004	9.6	4.6	5.0	47.7	11.0	8.9	12.9	3.4	2.0	1.4	58.8	-2.7	0.385	40895
Games, toys and hobbies	I005	10.6	6.4	4.1	60.8	10.5	8.5	13.6	3.7	2.7	1.0	71.8	-0.1	0.442	23171
Equipment for sport, camping and open-air recreation	I006	8.3	4.7	3.6	56.9	10.1	9.7	10.6	2.6	1.6	1.0	61.6	0.1	0.416	59945
Personal care appliances, electric	I013	7.8	5.4	2.4	69.2	9.4	9.4	9.5	2.8	2.0	0.8	70.9	0.0	0.086	33244
<b>Durable goods</b>															
Furniture, furnishings, floor coverings and carpets	E006	8.5	6.5	2.1	75.7	6.6	5.8	9.3	3.0	2.4	0.6	80.2	0.5	2.090	110352
Major electric household appliances	E008	18.2	13.4	4.8	73.4	4.0	3.2	5.9	6.0	4.8	1.1	81.0	-0.5	0.273	28978
Tools, equipment and accessories for house and garden	E011	9.9	6.7	3.2	67.5	8.4	7.7	10.0	3.5	2.5	0.9	73.1	0.9	0.546	37311
Medical products	F002	9.6	6.0	3.6	62.2	6.9	5.7	8.9	3.9	2.8	1.1	71.9	0.1	0.384	12091
New cars	G001	21.6	16.0	5.6	74.3	2.2	1.8	3.4	8.7	7.1	1.6	82.0	0.5	2.350	11242
Motorcycles and bicycles	G002	10.6	6.3	4.3	59.3	7.3	6.5	8.5	3.7	2.7	1.0	73.3	-0.3	0.391	46092

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**Table 6** – continued from previous page

Description	Label	fpc	fpc <sup>+</sup>	fpc <sup>-</sup>	%fpc <sup>+</sup>	Size <sup>+</sup>	Size <sup>-</sup>	fpc <sup>sm</sup>	fpc <sup>+sm</sup>	fpc <sup>-sm</sup>	%fpc <sup>+sm</sup>	$\bar{\pi}_j$	Weight	Observ.	
Television sets and audiovisual appliances	I001	14.9	5.9	9.0	39.7	11.8	8.5	14.0	4.4	2.8	1.5	64.7	-5.4	0.589	41271
Photographic, cinematographic equipment and optical instruments	I002	21.4	7.1	14.2	33.4	12.6	10.6	13.5	5.8	2.7	3.1	47.2	-5.9	0.123	23101
Personal computers and accessories	I003	39.1	11.6	27.5	29.8	11.3	8.2	12.7	13.0	5.5	7.5	42.4	-15.2	0.382	31601
Watches and other personal effects	I015	8.0	5.9	2.2	73.0	10.4	10.3	10.9	2.7	2.2	0.5	80.9	0.6	0.797	37566
<b>Services</b>															
Dry-cleaning and repair of garments and shoes	C003	5.3	4.4	0.9	83.2	9.6	9.1	12.0	1.8	1.6	0.2	87.7	1.1	0.307	49982
Rental of garages, parking spaces	D001	7.6	4.7	2.9	61.6	2.5	2.7	2.2	5.1	3.2	1.8	63.6	1.3	0.744	6511
Health services	F003	8.3	6.5	1.8	78.4	7.8	5.5	16.4	4.6	4.0	0.7	85.4	0.7	1.982	28954
Repair services and work	G006	22.7	16.4	6.4	72.0	4.1	3.6	5.6	6.9	6.0	0.9	87.5	1.1	1.240	6650
Repair services and work	G007	5.5	4.5	1.0	82.3	10.2	9.4	13.6	1.6	1.5	0.1	95.0	1.4	0.090	2575
Transport services	G008	9.6	8.8	0.8	91.6	6.6	6.4	9.1	2.7	2.3	0.3	88.4	1.6	1.773	6830
Sports, leisure, cultural and other services	I009	7.3	5.8	1.5	79.4	9.7	9.2	11.6	2.3	1.8	0.5	79.9	2.0	1.897	66900
Beverages in canteens	I012	5.2	4.5	0.7	87.4	11.5	10.9	15.8	0.8	0.7	0.0	94.3	2.0	0.211	7053

Note: The table gives descriptive statistics at the sectoral level. fpc: frequency of price changes; fpc<sup>+</sup>: frequency of positive price changes; fpc<sup>-</sup>: frequency of negative price changes; %fpc<sup>+</sup>: relative frequency of positive price changes; Size<sup>+</sup>: absolute size of price changes; Size<sup>-</sup>: absolute size of positive price changes; Size<sup>-</sup>: absolute size of negative price changes; fpc<sup>sm</sup>: frequency of small price changes;  $\bar{\pi}_j$ : average sectoral inflation. Following Midrigan (2011) a 'small' price change is smaller than half of the average absolute price change in the corresponding sector.

**Table 7:** *Estimates of desired price equation (complete results)*

	Product types				
	All sectors	Non-durable	Semi-durable	Durable	Services
$\Sigma \bar{\pi}_{jt}$ (sectoral price trends)					
Avg. $\beta_1   \beta_1 > 0$	1.16 (0.94)	1.12 (0.97)	0.99 (0.63)	1.53 (0.97)	0.98 (1.00)
Avg. $\beta_1   \beta_1 > 1$	1.47 (0.27)	1.38 (0.31)	1.47 (0.18)	1.73 (0.41)	1.28 (0.07)
Avg. $\beta_1   \beta_1 < 0$	-1.11 (0.02)	– (0.00)	-1.39 (0.19)	-0.24 (0.00)	– (0.00)
$\Sigma \hat{\pi}_{jt}^+$ (positive sector-specific shocks)					
Avg. $\beta_2   \beta_2 > 0$	1.68 (0.70)	1.37 (0.78)	2.25 (0.87)	2.00 (0.46)	2.06 (0.63)
Avg. $\beta_2   \beta_2 > 1$	2.32 (0.47)	1.99 (0.43)	2.31 (0.54)	2.86 (0.39)	2.68 (0.61)
Avg. $\beta_2   \beta_2 < 0$	-0.88 (0.06)	-0.83 (0.01)	-0.14 (0.00)	-1.10 (0.26)	-0.64 (0.01)
$\Sigma \hat{\pi}_{jt}^-$ (negative sector-specific shocks)					
Avg. $\beta_3   \beta_3 > 0$	1.24 (0.58)	1.08 (0.76)	1.10 (0.56)	0.95 (0.14)	2.35 (0.54)
Avg. $\beta_3   \beta_3 > 1$	1.88 (0.27)	1.67 (0.32)	1.36 (0.07)	2.56 (0.10)	2.46 (0.42)
Avg. $\beta_3   \beta_3 < 0$	-0.97 (0.09)	-0.80 (0.04)	-0.55 (0.00)	-0.76 (0.12)	-1.36 (0.24)
$\Sigma \hat{\pi}_{jt}^+, \Sigma \hat{\pi}_{jt}^-$ (positive and negative sector-specific shocks)					
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 > 0$	2.05 (0.43)	1.34 (0.39)	1.65 (0.42)	2.84 (0.51)	3.97 (0.46)
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 < 0$	-1.21 (0.30)	-0.88 (0.31)	-0.91 (0.00)	-1.83 (0.36)	-1.43 (0.36)
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 \neq 0$	0.66 (0.70)	0.39 (0.66)	1.32 (0.42)	0.63 (0.88)	1.03 (0.81)
$\bar{\pi}_{jt}$ (sectoral inflation trend upper threshold $\theta^+$ )					
Avg. $\delta_1^+   \delta_1^+ > 0$	3.55 (0.05)	2.11 (0.01)	3.08 (0.29)	6.39 (0.07)	0.73 (0.00)
Avg. $\delta_1^+   \delta_1^+ < 0$	-4.94 (0.67)	-3.43 (0.61)	-8.85 (0.20)	-7.90 (0.76)	-5.79 (0.97)
$\bar{\pi}_{jt}$ (sectoral inflation trend lower threshold $\theta^-$ )					
Avg. $\delta_1^-   \delta_1^- > 0$	7.94 (0.16)	0.86 (0.04)	1.17 (0.00)	4.84 (0.33)	19.44 (0.40)
Avg. $\delta_1^-   \delta_1^- < 0$	-5.49 (0.59)	-5.44 (0.61)	-6.01 (0.56)	-5.44 (0.57)	-5.25 (0.57)
Avg. $\sigma_\varepsilon$	13.24	14.68	16.05	12.31	8.74
Avg. $\theta_{it}^+ - \mu_i$	24.58	24.90	30.52	21.88	23.07
Avg. $\theta_{it}^- - \mu_i$	-29.80	-30.09	-36.69	-24.69	-30.19
Avg. fit (positive)	0.83	0.83	0.84	0.82	0.83
Avg. fit (negative)	0.63	0.66	0.62	0.55	0.63
Sectors	67	38	11	10	8
Observations	3,157,816	2,132,911	469,807	379,643	175,455

Note: See Table 3.

**Table 8:** *Estimates sector level*

	A001	A002	A003	A004	A005	A006	A007	A008	A009	A010
$p_{it}^*$										
$\sum \hat{\pi}_{jt}^-$	0.27 [0.46]	0.71*** [0.18]	1.10*** [0.07]	0.13 [0.20]	0.05 [0.49]	1.61*** [0.05]	1.25*** [0.04]	0.86*** [0.03]	1.02*** [0.10]	1.71*** [0.17]
$\sum \hat{\pi}_{jt}^+$	1.33*** [0.14]	2.05*** [0.48]	3.34*** [0.20]	1.54*** [0.18]	0.22 [0.49]	0.93*** [0.09]	0.97*** [0.13]	1.41*** [0.08]	1.81*** [0.54]	-0.37 [0.36]
$\sum \hat{\pi}_{jt}^-$	0.27* [0.15]	1.98*** [0.42]	0.95*** [0.23]	0.34 [0.28]	0.27 [0.47]	1.27*** [0.06]	1.23*** [0.07]	0.65*** [0.04]	1.18*** [0.36]	1.31*** [0.45]
$\sigma_\varepsilon$	11.83*** [1.00]	11.41*** [1.16]	10.33*** [0.39]	18.10*** [1.43]	18.44*** [1.41]	18.04*** [0.47]	15.15*** [0.53]	17.31*** [0.41]	19.58*** [1.25]	19.84*** [1.17]
$\theta_{it}^+$										
$\hat{\pi}_{jt}$	8.74*** [2.41]	-5.66*** [1.54]	-3.08*** [0.38]	-3.45*** [0.88]	-4.30** [2.19]	-4.89*** [0.41]	-1.87*** [0.31]	-1.92*** [0.25]	3.81*** [1.24]	-0.36 [1.40]
$Q_2$	-3.00*** [0.80]	4.13*** [1.17]	3.39*** [0.29]	1.70* [0.89]	-2.10** [0.99]	-0.74 [0.49]	-0.08 [0.53]	-9.95*** [0.50]	-0.56 [0.80]	-0.27 [0.66]
$Q_3$	-2.45*** [0.81]	6.22*** [1.19]	4.39*** [0.31]	3.13*** [0.93]	-1.54 [0.99]	-4.18*** [0.47]	-6.79*** [0.60]	-2.61*** [0.47]	0.03 [0.81]	0.72 [0.70]
$Q_4$	-2.14*** [0.81]	7.05*** [1.25]	2.76*** [0.28]	1.90** [0.87]	-2.08** [0.97]	-4.27*** [0.45]	-13.50*** [0.74]	1.73*** [0.47]	1.55* [0.79]	0.39 [0.68]
$vat_{95}$	-6.59*** [1.39]	-0.15 [3.35]	-5.91*** [0.81]	-10.68*** [1.65]	-21.92*** [2.85]	-20.06*** [1.51]	-8.70*** [1.58]	-7.84*** [1.78]	-10.45*** [2.05]	-6.20*** [1.57]
$vat_{99}$	-3.57*** [1.27]	1.49 [2.07]	-3.42*** [0.44]	2.37 [1.68]	-6.36*** [1.75]	5.02*** [1.25]	1.00 [1.52]	3.77*** [1.21]	5.04** [2.26]	0.56 [1.80]
$vat_{01}$	7.46** [3.78]	1.62 [5.02]	-1.99*** [0.51]	-0.76 [2.24]	-8.61*** [2.43]	-6.67*** [1.38]	-7.12*** [1.32]	-3.22** [1.27]	-2.73 [2.37]	-12.04*** [1.62]
$\theta_{it}^-$										
$\hat{\pi}_{jt}$	3.19 [3.13]	-11.98*** [1.92]	-6.67*** [0.57]	-0.95 [1.59]	3.39 [2.81]	-3.82*** [0.44]	-3.40*** [0.39]	-2.76*** [0.26]	-4.65** [1.97]	-1.75 [2.74]
$Q_2$	-2.11* [1.22]	-3.27*** [0.92]	-1.98*** [0.35]	0.09 [1.27]	1.21 [1.22]	3.23*** [0.51]	-3.19*** [0.47]	-9.19*** [0.61]	1.97 [1.24]	4.62*** [1.17]
$Q_3$	-1.74 [1.20]	-4.14*** [1.00]	-2.72*** [0.39]	-2.03 [1.37]	1.40 [1.19]	-2.90*** [0.57]	-10.51*** [0.71]	-0.17 [0.47]	2.25* [1.27]	2.69** [1.21]
$Q_4$	-0.25 [1.04]	0.41 [0.74]	0.40 [0.31]	-0.88 [1.34]	2.95** [1.20]	-3.91*** [0.54]	-20.03*** [1.07]	4.21*** [0.48]	4.95*** [1.29]	4.02*** [1.19]
$vat_{95}$	0.23 [1.73]	17.45*** [4.31]	12.51*** [1.30]	-4.93 [3.18]	2.81 [3.01]	-6.34*** [1.37]	-11.81*** [1.59]	-8.93*** [1.52]	7.88*** [3.00]	4.87** [2.42]
$vat_{99}$	-2.49 [3.34]	-9.10* [5.03]	0.04 [0.94]	-0.91 [3.11]	4.06* [2.42]	5.39*** [0.95]	3.17*** [1.03]	1.12 [0.99]	12.83*** [2.39]	10.05*** [2.59]
$vat_{01}$	1.16 [4.15]	-3.07 [3.06]	2.19 [1.37]	4.04 [4.98]	-4.52 [5.09]	0.09 [1.48]	-2.67** [1.29]	-6.23*** [1.87]	6.18 [3.94]	11.23*** [3.10]
Avg. $\theta_{it}^+ - \mu_i$	20.83	23.22	21.92	30.43	29.83	21.86	16.14	17.67	30.10	27.78
Avg. $\theta_{it}^- - \mu_i$	-24.80	-23.82	-30.59	-38.22	-38.96	-19.55	-14.36	-16.18	-38.39	-41.94
Fit (positive)	0.75	0.73	0.89	0.80	0.84	0.55	0.67	0.77	0.71	0.80
Fit (negative)	0.58	0.68	0.69	0.59	0.63	0.57	0.70	0.74	0.61	0.62
Estim. range	12	12	12	12	12	12	12	12	12	12
Observations	12136	9859	145572	21086	26754	47404	31993	42514	24109	30526

Note: See Table 3.

**Table 9:** *Estimates sector level (contd.)*

	A011	A012	A013	A014	A015	A016	A017	A018	A019	A020
$P_{it}^*$										
$\sum \bar{\pi}_{jt}$	1.15*** [0.06]	0.88*** [0.12]	0.90*** [0.03]	0.50*** [0.12]	1.00*** [0.13]	1.13*** [0.05]	0.21 [0.38]	0.78*** [0.08]	1.01*** [0.05]	1.25*** [0.06]
$\sum \hat{\pi}_{jt}^+$	0.92*** [0.10]	2.47*** [0.35]	1.41*** [0.09]	0.73** [0.31]	2.59*** [0.44]	1.32*** [0.16]	0.27 [0.97]	1.38*** [0.16]	1.21*** [0.10]	0.86*** [0.07]
$\sum \hat{\pi}_{jt}^-$	1.53*** [0.16]	0.77** [0.35]	0.26** [0.12]	4.06*** [0.41]	1.16*** [0.44]	1.56*** [0.30]	3.59*** [0.74]	2.08*** [0.23]	1.05*** [0.09]	0.95*** [0.05]
$\sigma_\varepsilon$	21.22*** [0.65]	26.80*** [1.05]	4.92*** [0.34]	14.58*** [0.51]	15.42*** [0.99]	14.44*** [0.92]	14.15*** [1.08]	15.98*** [0.64]	35.59*** [0.43]	32.82*** [0.31]
$\theta_{it}^+$										
$\bar{\pi}_{jt}$	-3.45*** [0.39]	-2.77*** [0.74]	-1.19** [0.53]	-4.97*** [0.60]	-7.91*** [1.22]	0.18 [1.10]	-0.90 [1.88]	-0.51 [0.41]	-3.08*** [0.44]	-2.23*** [0.36]
$Q_2$	0.63 [0.42]	0.95 [0.79]	-0.39 [0.49]	0.24 [0.36]	0.38 [0.73]	-2.00* [1.06]	5.00*** [1.05]	-2.34*** [0.43]	-11.58*** [0.60]	0.81** [0.40]
$Q_3$	0.51 [0.40]	2.30*** [0.82]	0.03 [0.51]	0.20 [0.36]	0.76 [0.77]	-2.69** [1.13]	7.09*** [1.18]	1.54*** [0.48]	-10.28*** [0.61]	12.44*** [0.44]
$Q_4$	-1.22*** [0.40]	1.48* [0.78]	-0.37 [0.49]	0.49 [0.36]	-0.06 [0.75]	-2.95*** [1.06]	-2.01** [0.85]	1.13** [0.48]	-0.07 [0.55]	11.93*** [0.40]
$vat_{95}$	-16.01*** [0.85]	-14.52*** [1.75]	-8.15*** [1.38]	-13.78*** [0.87]	-12.43*** [2.13]	-26.17*** [3.23]	-12.50*** [2.39]	-17.45*** [1.03]	-10.33*** [1.06]	-3.40*** [0.74]
$vat_{99}$	1.00 [0.96]	2.51 [2.00]	-2.68*** [0.79]	-4.46*** [0.68]	-4.75*** [1.27]	-11.31*** [1.79]	6.21*** [2.39]	-4.03*** [0.76]	7.02*** [1.17]	-1.60** [0.69]
$vat_{01}$	-6.57*** [0.97]	-1.34 [2.00]	-5.39*** [1.01]	-7.64*** [0.78]	-11.23*** [1.80]	-18.07*** [2.58]	-9.21*** [2.34]	-10.64*** [1.23]	-6.86*** [1.37]	-4.70*** [1.11]
$\theta_{it}^-$										
$\bar{\pi}_{jt}$	-3.43*** [0.62]	-2.94*** [0.92]	-1.89*** [0.29]	-10.32*** [0.78]	-6.60*** [1.05]	-2.16*** [0.74]	-0.33 [2.25]	-9.30*** [0.72]	-0.70 [0.50]	-3.10*** [0.38]
$Q_2$	3.42*** [0.57]	1.57 [0.99]	1.44*** [0.22]	3.76*** [0.44]	6.33*** [0.67]	4.95*** [0.64]	6.86*** [1.19]	-2.94*** [0.60]	6.68*** [0.70]	3.51*** [0.49]
$Q_3$	1.89*** [0.60]	0.58 [1.04]	-2.18*** [0.28]	6.06*** [0.45]	2.11*** [0.65]	-1.16* [0.65]	3.19*** [1.20]	1.29** [0.54]	20.38*** [0.73]	15.05*** [0.50]
$Q_4$	3.33*** [0.58]	0.76 [0.96]	-2.82*** [0.32]	4.44*** [0.43]	0.09 [0.68]	-3.64*** [0.72]	-0.78 [1.28]	2.29*** [0.54]	14.69*** [0.62]	17.11*** [0.45]
$vat_{95}$	3.93*** [1.18]	-1.31 [2.47]	-1.40 [0.97]	14.72*** [1.16]	8.25*** [2.16]	2.32 [2.09]	-5.17 [3.84]	-11.25*** [1.39]	-0.67 [1.39]	2.27** [0.95]
$vat_{99}$	7.59*** [1.14]	4.44* [2.34]	-2.04** [0.83]	3.62*** [0.96]	2.90** [1.45]	-1.92 [1.49]	-9.26** [4.25]	-0.79 [1.35]	6.18*** [1.22]	-4.22*** [0.99]
$vat_{01}$	6.51*** [1.92]	-0.21 [2.86]	-1.36 [1.66]	7.87*** [1.49]	8.38*** [2.69]	0.96 [2.61]	0.56 [3.66]	-1.50 [2.49]	-0.73 [1.96]	1.52 [1.37]
Avg. $\theta_{it}^+ - \mu_i$	35.59	30.94	10.25	22.68	28.46	20.97	20.81	22.75	42.07	17.85
Avg. $\theta_{it}^- - \mu_i$	-40.87	-39.26	-14.33	-30.26	-35.15	-32.37	-31.04	-31.30	-42.95	-34.48
Fit (positive)	0.79	0.75	0.86	0.82	0.84	0.84	0.81	0.74	0.75	0.79
Fit (negative)	0.63	0.67	0.84	0.66	0.70	0.71	0.64	0.54	0.73	0.78
Estim. range	12	12	12	12	12	12	12	12	12	12
Observations	127699	33550	29794	113567	58462	29017	13361	61611	164700	184709

Note: See Table 3.

**Table 10:** *Estimates sector level (contd.)*

	A021	A022	A023	A024	A025	B001	B002	B003	B004	C001
$P_{it}^*$										
$\sum \bar{\pi}_{jt}$	2.41*** [0.50]	0.97*** [0.10]	0.90*** [0.11]	0.59*** [0.05]	1.02*** [0.14]	0.29** [0.14]	0.86*** [0.09]	1.29*** [0.22]	0.90*** [0.02]	1.35*** [0.23]
$\sum \hat{\pi}_{jt}^+$	0.85 [0.57]	1.77*** [0.14]	1.26*** [0.28]	0.58*** [0.05]	0.69*** [0.23]	0.97*** [0.19]	1.55*** [0.19]	-1.59* [0.86]	1.09*** [0.06]	1.80*** [0.30]
$\sum \hat{\pi}_{jt}^-$	0.00 [0.32]	0.82*** [0.17]	-0.85*** [0.22]	1.07*** [0.08]	0.80*** [0.21]	1.09*** [0.16]	1.00*** [0.21]	0.45 [0.75]	0.20* [0.11]	1.25*** [0.25]
$\sigma_\varepsilon$	15.86*** [1.16]	12.26*** [0.44]	9.97*** [0.47]	12.41*** [0.43]	11.17*** [0.54]	13.02*** [0.63]	12.41*** [0.32]	10.75*** [0.73]	3.64*** [0.29]	16.74*** [0.63]
$\theta_{it}^+$										
$\bar{\pi}_{jt}$	-10.49*** [3.17]	-4.43*** [0.49]	-4.32*** [0.61]	0.12 [0.20]	-2.01*** [0.58]	-3.82*** [0.68]	-2.13*** [0.51]	-4.14*** [1.23]	-0.14 [0.20]	4.71*** [1.02]
$Q_2$	3.60*** [0.68]	-1.88*** [0.34]	0.68* [0.35]	-1.40*** [0.40]	-0.43 [0.40]	0.38 [0.52]	-2.03*** [0.27]	3.14*** [0.59]	0.72*** [0.20]	-4.83*** [0.51]
$Q_3$	4.26*** [0.72]	-0.90** [0.35]	1.29*** [0.35]	-1.96*** [0.41]	1.13*** [0.43]	1.18** [0.54]	-1.30*** [0.26]	4.74*** [0.66]	0.94*** [0.21]	1.15** [0.52]
$Q_4$	4.02*** [0.69]	0.43 [0.37]	1.73*** [0.36]	-0.98** [0.42]	0.50 [0.42]	2.21*** [0.55]	-0.51* [0.27]	5.42*** [0.75]	1.54*** [0.24]	-7.97*** [0.55]
$vat_{95}$	-21.31*** [2.18]	-9.50*** [0.69]	-14.30*** [1.12]	-9.76*** [0.76]	-11.03*** [0.78]	1.25 [1.57]	-5.39*** [0.52]	-4.97*** [1.29]	-2.77*** [0.55]	-8.38*** [0.92]
$vat_{99}$	-4.87*** [1.80]	-2.67*** [0.72]	-5.79*** [0.85]	-5.61*** [0.73]	-5.72*** [0.84]	-10.85*** [1.13]	-10.17*** [0.49]	-3.80*** [1.07]	-7.53*** [1.09]	-3.59*** [0.95]
$vat_{01}$	-6.22*** [1.18]	-5.85*** [0.77]	-5.31*** [0.64]	-4.49*** [1.04]	-6.89*** [0.88]	-1.22 [1.23]	-7.16*** [0.61]	-5.92*** [1.25]	-5.71*** [0.64]	2.70 [1.71]
$\theta_{it}^-$										
$\bar{\pi}_{jt}$	-13.35*** [4.45]	0.14 [0.71]	-1.47 [0.94]	-1.66*** [0.27]	-0.44 [0.93]	-5.49*** [0.84]	1.52** [0.72]	-1.96 [1.77]	-1.24 [1.02]	-7.00*** [1.66]
$Q_2$	-0.09 [0.84]	-0.41 [0.46]	-0.87* [0.49]	-0.13 [0.43]	-0.40 [0.51]	1.56** [0.67]	0.31 [0.37]	-0.90 [0.85]	3.36*** [1.13]	5.73*** [0.71]
$Q_3$	-1.52* [0.90]	-0.33 [0.46]	-1.66*** [0.49]	-1.40*** [0.45]	-0.79 [0.52]	4.21*** [0.64]	0.09 [0.36]	-0.10 [0.85]	-1.39 [1.39]	1.35* [0.75]
$Q_4$	-0.96 [0.90]	-0.19 [0.43]	-1.24*** [0.48]	1.08*** [0.39]	-0.57 [0.53]	4.31*** [0.66]	0.42 [0.36]	-0.97 [0.87]	0.02 [1.33]	7.03*** [0.71]
$vat_{95}$	-1.37 [2.97]	2.29** [0.97]	0.11 [2.62]	-2.61* [1.54]	0.50 [1.11]	10.20*** [2.09]	3.66*** [0.69]	2.83 [1.93]	1.51 [1.58]	2.37 [1.64]
$vat_{99}$	2.66 [3.29]	0.62 [1.12]	0.07 [2.00]	-1.46 [1.06]	-0.29 [1.29]	0.75 [1.88]	0.52 [0.83]	3.15* [1.88]	-32.12*** [2.90]	1.46 [1.59]
$vat_{01}$	1.20 [2.30]	-0.16 [1.61]	-1.64 [1.35]	4.11*** [1.38]	-1.31 [1.88]	7.22*** [1.97]	0.71 [1.12]	2.68 [2.37]	-2.31 [2.76]	2.62 [2.92]
Avg. $\theta_{it}^+ - \mu_i$	26.61	21.84	20.16	17.87	21.48	25.38	20.76	18.25	11.79	31.44
Avg. $\theta_{it}^- - \mu_i$	-36.12	-29.89	-25.81	-29.26	-26.97	-25.85	-27.70	-27.74	-12.61	-41.14
Fit (positive)	0.85	0.84	0.88	0.84	0.89	0.78	0.80	0.88	0.80	0.84
Fit (negative)	0.62	0.56	0.53	0.71	0.59	0.70	0.52	0.61	0.59	0.65
Estim. range	12	12	12	12	12	12	12	12	12	12
Observations	31678	80924	49932	55834	53191	38698	116664	19131	6860	91598

Note: See Table 3.

**Table 11:** *Estimates sector level (contd.)*

	C002	C003	D001	D002	D003	D004	E006	E007	E008	E009
$\rho_{it}^*$										
$\sum \bar{\pi}_{jt}$	0.58*** [0.16]	1.37*** [0.10]	0.61*** [0.20]	0.45*** [0.17]	0.85*** [0.09]	0.57*** [0.07]	1.95*** [0.15]	-1.00* [0.60]	-0.24 [0.20]	0.13 [0.17]
$\sum \hat{\pi}_{jt}^+$	1.39*** [0.31]	-0.21 [0.54]	-0.53 [0.43]	2.16*** [0.47]	0.92*** [0.19]	1.90*** [0.15]	-1.31*** [0.32]	4.84*** [1.03]	0.21 [0.43]	1.85*** [0.61]
$\sum \hat{\pi}_{jt}^-$	-0.10 [0.32]	0.87*** [0.29]	1.26** [0.49]	0.06 [0.31]	1.75*** [0.14]	0.71*** [0.20]	0.25 [0.37]	1.39* [0.73]	0.98*** [0.29]	1.85*** [0.42]
$\sigma_\varepsilon$	12.62*** [1.55]	9.15*** [0.66]	5.01*** [0.99]	12.69*** [0.99]	5.13*** [0.35]	11.27*** [0.67]	10.90*** [0.40]	12.57*** [0.83]	11.60*** [0.58]	15.80*** [1.13]
$\theta_{it}^+$										
$\bar{\pi}_{jt}$	0.97 [0.87]	-1.77** [0.87]	-0.78 [2.46]	5.72*** [1.30]	-2.75*** [0.58]	-4.70*** [0.61]	-6.79*** [1.04]	-14.47*** [4.01]	-3.97*** [1.20]	-13.42*** [3.45]
$Q_2$	-3.08*** [0.87]	1.28*** [0.37]	-0.96 [0.71]	1.94** [0.75]	3.91*** [1.12]	10.24*** [1.61]	1.48*** [0.27]	5.97*** [0.87]	9.63*** [0.61]	8.05*** [0.90]
$Q_3$	-0.56 [0.80]	4.22*** [0.54]	0.70 [0.64]	2.88*** [0.77]	10.09*** [1.54]	13.19*** [1.77]	3.27*** [0.30]	1.98*** [0.71]	14.26*** [0.81]	8.58*** [0.92]
$Q_4$	-3.88*** [0.90]	3.79*** [0.50]	-1.57* [0.90]	3.81*** [0.90]	-2.34*** [0.79]	-1.37 [1.04]	6.88*** [0.40]	5.21*** [0.86]	17.18*** [1.01]	7.72*** [0.95]
$vat_{95}$	-11.17*** [1.80]	-4.85*** [0.99]	-2.92* [1.62]	-4.27** [1.67]	-0.02 [2.66]	-22.70*** [4.08]	-4.69*** [0.46]	-2.33 [1.55]	-0.45 [1.66]	1.64 [2.14]
$vat_{99}$	-11.21*** [1.79]	-7.89*** [0.85]	2.16 [1.96]	-7.86*** [1.63]	-5.13*** [1.30]	-0.38 [3.34]	-7.36*** [0.57]	-8.37*** [1.37]	-2.91*** [0.86]	-5.24*** [1.55]
$vat_{01}$	-6.64*** [1.86]	-2.39*** [0.72]	-2.70 [1.87]	-0.86 [2.47]	51.61*** [3.55]	-2.83* [1.68]	-5.08*** [0.55]	-3.31** [1.39]	-3.92*** [1.02]	-0.55 [1.59]
$\theta_{it}^-$										
$\bar{\pi}_{jt}$	-1.08 [1.55]	-5.87*** [1.89]	-6.82*** [2.34]	-4.34** [1.87]	-1.73*** [0.54]	-1.22*** [0.44]	5.66*** [1.70]	-14.67** [6.24]	-9.25*** [1.67]	-9.54** [4.40]
$Q_2$	2.59* [1.32]	0.92 [0.84]	-0.06 [0.70]	-2.47** [1.24]	-1.48** [0.58]	-7.92*** [1.61]	-0.43 [0.44]	-3.66*** [1.12]	0.15 [0.56]	-0.96 [0.95]
$Q_3$	-0.97 [1.48]	-2.06** [1.03]	0.56 [0.68]	-1.72 [1.19]	-3.31*** [0.89]	-13.93*** [2.25]	1.05** [0.44]	1.91* [0.98]	-1.70*** [0.57]	-3.32*** [0.95]
$Q_4$	0.33 [1.43]	-1.32 [0.91]	0.35 [0.90]	-3.78*** [1.27]	3.83*** [0.46]	2.64** [1.04]	-1.91*** [0.48]	-3.34*** [1.14]	-4.58*** [0.70]	-1.25 [0.89]
$vat_{95}$	4.28 [3.07]	5.79** [2.84]	-1.35 [2.15]	-9.72** [4.74]	4.86** [2.28]	-5.31 [5.14]	2.55*** [0.87]	-1.70 [4.06]	13.41*** [2.32]	4.51* [2.35]
$vat_{99}$	1.77 [2.90]	2.48 [2.08]	1.03 [1.92]	-1.84 [3.91]	-42.29*** [3.27]	4.95** [2.22]	-2.77** [1.40]	0.03 [2.93]	-7.01*** [2.38]	1.35 [2.77]
$vat_{01}$	0.64 [3.91]	0.79 [2.96]	3.83** [1.62]	-7.15 [4.85]	-47.16*** [3.33]	-0.18 [7.62]	3.71*** [0.93]	2.40 [1.98]	8.21*** [1.32]	0.07 [2.58]
Avg. $\theta_{it}^+ - \mu_i$	27.12	23.89	17.39	22.18	21.36	28.33	22.31	34.39	14.93	28.90
Avg. $\theta_{it}^- - \mu_i$	-36.58	-33.92	-15.49	-34.66	-21.21	-39.90	-28.59	-35.43	-25.98	-34.93
Fit (positive)	0.89	0.86	0.74	0.86	0.97	0.94	0.85	0.84	0.90	0.85
Fit (negative)	0.54	0.49	0.59	0.68	0.85	0.85	0.48	0.61	0.72	0.63
Estim. range	12	12	12	12	12	12	12	12	12	12
Observations	23540	49982	6511	14409	12585	11181	110362	32588	28978	24727

Note: See Table 3.



**Table 12:** *Estimates sector level (contd.)*

	E010	E011	E012	F002	F003	G001	G002	G003	G004	G006
$P_{it}^*$										
$\sum \bar{\pi}_{jt}$	1.46*** [0.13]	0.80*** [0.19]	1.74*** [0.13]	2.02*** [0.76]	1.19*** [0.13]	1.02*** [0.17]	1.31*** [0.16]	2.07*** [0.25]	1.20*** [0.09]	0.76*** [0.13]
$\sum \hat{\pi}_{jt}^+$	1.62*** [0.46]	0.98 [0.89]	2.89*** [0.33]	5.16*** [1.28]	3.58*** [0.94]	2.74*** [0.45]	1.72*** [0.38]	1.88*** [0.29]	0.33 [0.51]	3.15*** [0.39]
$\sum \hat{\pi}_{jt}^-$	-0.44 [0.49]	-2.82*** [0.97]	-0.19 [0.35]	1.02 [1.15]	-2.55*** [0.96]	-0.26 [0.26]	0.45 [0.30]	0.33 [0.27]	1.21*** [0.44]	3.48*** [0.59]
$\sigma_\varepsilon$	10.47*** [0.47]	13.63*** [0.77]	14.06*** [0.44]	14.28*** [1.13]	11.03*** [2.23]	4.12*** [0.39]	12.18*** [0.53]	21.76*** [0.79]	16.44*** [0.50]	9.93*** [0.59]
$\theta_{it}^+$										
$\bar{\pi}_{jt}$	1.30 [1.00]	0.96 [2.29]	-4.91*** [0.87]	-1.53 [2.99]	-12.31*** [4.43]	-5.01*** [1.04]	-12.33*** [1.03]	1.85 [1.19]	-5.98*** [0.68]	-3.95*** [1.45]
$Q_2$	-0.40 [0.29]	-0.42 [0.48]	0.23 [0.32]	-9.10*** [1.42]	1.13** [0.50]	0.84*** [0.23]	0.84** [0.41]	-4.64*** [0.55]	-5.99*** [0.67]	1.18* [0.69]
$Q_3$	2.84*** [0.38]	1.30** [0.51]	0.75** [0.32]	-5.63*** [1.28]	8.93*** [2.06]	0.65*** [0.20]	11.47*** [0.69]	1.02* [0.53]	0.04 [0.67]	6.70*** [0.85]
$Q_4$	4.05*** [0.42]	2.19*** [0.54]	1.89*** [0.34]	-1.26 [1.37]	6.38*** [1.48]	1.41*** [0.26]	7.67*** [0.60]	2.33*** [0.52]	-5.69*** [0.66]	6.38*** [0.95]
$vat_{95}$	-3.62*** [0.53]	-3.04** [1.20]	-8.07*** [0.69]	-8.96*** [2.92]	-1.01 [0.98]	-4.08*** [0.72]	-7.24*** [1.17]	-28.68*** [1.94]	5.55*** [1.95]	1.64 [2.31]
$vat_{99}$	-2.64*** [0.66]	-6.71*** [1.18]	-9.88*** [0.61]	-18.70*** [2.55]	-0.87 [1.05]	-6.69*** [0.82]	-6.97*** [0.88]	-28.07*** [1.48]	-9.35*** [1.36]	-2.83* [1.56]
$vat_{01}$	-5.20*** [0.70]	-6.02*** [1.09]	-3.68*** [0.76]	-8.30*** [2.39]	-2.91*** [0.93]	-4.35*** [0.65]	-1.50* [0.82]	-19.88*** [1.45]	-17.37*** [1.41]	-4.41*** [1.38]
$\theta_{it}^-$										
$\bar{\pi}_{jt}$	-3.04 [1.92]	6.53** [3.06]	-0.53 [1.19]	-9.72** [4.19]	29.52*** [10.58]	-4.31** [1.81]	-3.04*** [1.16]	-5.85*** [1.34]	-3.00*** [0.67]	6.29*** [2.12]
$Q_2$	-0.81 [0.58]	-0.39 [0.71]	-0.03 [0.40]	5.01*** [1.33]	14.73*** [3.65]	0.08 [0.31]	-2.92*** [0.44]	6.94*** [0.67]	9.85*** [0.75]	1.10 [0.85]
$Q_3$	-1.66*** [0.59]	-0.79 [0.70]	-0.07 [0.42]	2.69** [1.32]	9.52*** [2.82]	-0.84** [0.35]	-12.99*** [0.86]	-0.87 [0.68]	0.05 [0.73]	-7.19*** [1.43]
$Q_4$	-3.20*** [0.64]	-2.50*** [0.76]	-1.03** [0.44]	-2.80* [1.54]	11.98*** [3.11]	-0.89*** [0.33]	-9.12*** [0.67]	2.84*** [0.68]	8.46*** [0.67]	0.69 [0.83]
$vat_{95}$	0.82 [1.19]	1.53 [1.60]	2.42** [0.94]	-14.80* [7.89]	14.77*** [4.49]	1.91** [0.75]	-4.93*** [1.39]	6.64*** [2.18]	5.36** [2.34]	-22.38*** [5.89]
$vat_{99}$	-2.96 [1.84]	-0.49 [2.36]	2.53** [1.12]	0.57 [3.16]	27.29*** [6.09]	0.36 [0.69]	-4.34*** [1.36]	12.00*** [1.48]	-3.69* [2.10]	16.19*** [1.89]
$vat_{01}$	-0.79 [1.62]	-3.35 [2.38]	1.32 [1.47]	4.69 [3.65]	7.20 [4.93]	-0.09 [1.10]	-2.73* [1.41]	10.96*** [1.63]	-1.31 [1.78]	11.61*** [2.26]
Avg. $\theta_{it}^+ - \mu_i$	20.39	27.52	28.88	32.59	33.87	6.48	22.79	26.43	20.69	12.79
Avg. $\theta_{it}^- - \mu_i$	-27.45	-30.38	-28.21	-28.22	-29.18	-6.71	-29.49	-33.62	-18.70	-27.51
Fit (positive)	0.83	0.81	0.79	0.81	0.80	0.81	0.84	0.78	0.71	0.79
Fit (negative)	0.49	0.49	0.45	0.67	0.56	0.55	0.72	0.58	0.66	0.63
Estim. range	12	12	12	12	16	12	12	12	12	12
Observations	54359	37311	108521	12091	28954	11242	46092	59703	25988	6650

Note: See Table 3.

**Table 13:** *Estimates sector level (contd.)*

	G007	G008	I001	I002	I003	I004	I005	I006	I007	I008
$p_{it}^*$										
$\sum \bar{\pi}_{jt}$	2.08*** [0.41]	0.89*** [0.07]	0.93*** [0.08]	0.79*** [0.08]	0.63*** [0.04]	0.34*** [0.11]	0.24 [0.45]	-1.79*** [0.39]	1.02*** [0.18]	3.07*** [0.69]
$\sum \hat{\pi}_{jt}^+$	-3.09*** [1.04]	1.51*** [0.28]	0.05 [0.47]	1.60*** [0.36]	0.50** [0.22]	-0.03 [0.39]	1.22*** [0.37]	4.54*** [1.14]	0.19 [1.34]	3.33** [1.39]
$\sum \hat{\pi}_{jt}^-$	4.50*** [1.48]	-0.04 [0.21]	0.56 [0.49]	0.63 [0.43]	-0.88*** [0.33]	0.79* [0.41]	0.75 [0.50]	-1.00 [1.21]	0.10 [0.97]	-1.90* [1.04]
$\sigma_\varepsilon$	9.17** [3.59]	5.93*** [0.94]	27.77*** [1.22]	37.16*** [1.88]	31.00*** [1.16]	22.33*** [1.60]	17.80*** [1.27]	13.47*** [0.47]	27.49*** [0.91]	11.91*** [1.01]
$\theta_{it}^+$										
$\bar{\pi}_{jt}$	-1.79 [8.35]	-2.47*** [0.58]	11.41*** [2.59]	-0.97 [1.32]	-4.89*** [0.76]	4.72 [4.76]	-0.97 [2.31]	0.76 [2.28]	-5.60** [2.71]	-6.59* [3.81]
$Q_2$	3.56 [3.07]	2.84*** [0.61]	8.11*** [0.96]	3.33* [1.72]	10.38*** [1.03]	-1.05 [1.01]	-0.52 [0.87]	-1.49*** [0.57]	4.80*** [0.85]	0.34 [0.72]
$Q_3$	2.57 [2.61]	4.50*** [0.89]	11.05*** [1.09]	5.49*** [1.65]	8.01*** [0.97]	-2.58*** [1.00]	3.51*** [0.92]	1.37** [0.59]	8.54*** [0.91]	0.88 [0.76]
$Q_4$	5.78* [2.99]	2.41*** [0.66]	12.80*** [1.06]	3.51** [1.63]	2.43*** [0.94]	0.04 [1.00]	1.46 [0.89]	-7.54*** [0.56]	2.63*** [0.80]	2.15*** [0.78]
$vat_{95}$	-3.64 [4.77]	-3.77* [2.27]	29.32*** [6.53]	15.13* [9.09]	-14.20*** [4.12]	-4.68** [2.30]	-1.42 [2.82]	0.54 [1.53]	-9.48*** [2.04]	-8.47*** [2.59]
$vat_{99}$	-10.26** [4.20]	-8.59*** [2.52]	0.92 [2.57]	12.49** [5.83]	3.77 [4.21]	-5.83*** [2.05]	-5.52*** [1.74]	-2.97** [1.38]	-1.72 [1.85]	-6.43*** [1.45]
$vat_{01}$	-0.57 [3.69]	6.16*** [2.05]	14.26*** [2.45]	10.04** [4.31]	1.33 [3.08]	-5.04** [2.13]	-2.75 [1.84]	1.02 [1.51]	0.84 [1.72]	-3.75** [1.50]
$\theta_{it}^-$										
$\bar{\pi}_{jt}$	14.85* [7.70]	-5.65** [2.28]	-8.91*** [2.64]	-3.43*** [1.14]	-3.18*** [0.62]	1.17 [5.01]	-3.40 [3.05]	-1.25 [2.61]	0.81 [3.15]	-13.21*** [4.73]
$Q_2$	1.57 [4.77]	-3.32* [1.85]	9.05*** [0.99]	3.93*** [1.27]	-2.78*** [0.73]	1.12 [0.95]	1.42 [1.11]	1.40** [0.61]	6.42*** [0.96]	2.69*** [0.99]
$Q_3$	1.30 [4.71]	-2.82* [1.57]	4.28*** [0.93]	-0.83 [1.25]	-2.25*** [0.72]	0.24 [0.98]	-0.35 [1.14]	-1.46** [0.65]	4.60*** [0.97]	1.12 [1.04]
$Q_4$	5.01 [4.92]	-0.41 [1.76]	5.31*** [0.94]	3.78*** [1.29]	-4.90*** [0.79]	1.70* [0.92]	1.37 [1.09]	6.42*** [0.57]	-5.10*** [1.04]	1.41 [1.01]
$vat_{95}$	-88.64*** [31.68]	-51.06*** [7.19]	-7.81** [3.34]	-7.98 [5.33]	-11.85*** [3.19]	-9.39*** [3.54]	-6.46* [3.85]	-3.04* [1.78]	2.31 [2.58]	12.85*** [3.49]
$vat_{99}$	-79.72*** [30.20]	10.01*** [2.35]	6.78*** [2.11]	-7.54 [5.16]	7.66*** [2.80]	3.36 [2.26]	-0.89 [3.43]	1.63 [1.67]	0.30 [2.53]	4.86** [2.18]
$vat_{01}$	-67.18** [27.14]	-46.61*** [7.10]	-0.87 [2.47]	-5.43* [3.23]	1.52 [2.57]	3.37 [2.39]	4.38* [2.43]	-1.35 [1.60]	3.60 [2.27]	1.91 [2.66]
Avg. $\theta_{it}^+ - \mu_i$	22.65	12.89	42.38	53.56	35.97	42.94	32.86	29.44	47.15	24.84
Avg. $\theta_{it}^- - \mu_i$	-41.50	-33.46	-49.54	-51.23	-28.30	-44.33	-37.87	-31.75	-50.27	-28.44
Fit (positive)	0.88	0.89	0.82	0.77	0.75	0.88	0.84	0.81	0.78	0.86
Fit (negative)	0.73	0.70	0.67	0.61	0.64	0.67	0.61	0.64	0.62	0.58
Estim. range	12	16	12	12	12	12	12	12	12	12
Observations	2575	6830	41271	23102	31604	40896	23171	59993	58166	19617

Note: See Table 3.

**Table 14:** *Estimates sector level (contd.)*

	I009	I010	I011	I012	I013
$p_{it}^*$					
$\sum \bar{\pi}_{jt}$	0.96*** [0.05]	1.19*** [0.13]	1.28*** [0.15]	1.59*** [0.13]	0.52 [0.66]
$\sum \hat{\pi}_{jt}^+$	0.34 [0.34]	0.93 [1.36]	2.66*** [0.84]	1.41*** [0.38]	-0.65 [0.40]
$\sum \hat{\pi}_{jt}^-$	2.04*** [0.40]	0.27 [1.10]	4.08*** [0.89]	3.53*** [0.82]	0.72 [0.64]
$\sigma_\varepsilon$	9.89*** [0.45]	8.90*** [1.81]	14.85*** [0.79]	5.90*** [0.84]	16.65*** [1.21]
$\theta_{it}^+$					
$\bar{\pi}_{jt}$	-6.07*** [0.59]	-1.48 [3.74]	-14.47*** [1.32]	0.73 [0.94]	-9.90*** [3.63]
$Q_2$	-1.38** [0.56]	9.74*** [1.99]	1.21** [0.51]	-2.65*** [0.79]	-0.49 [0.71]
$Q_3$	-10.20*** [0.70]	11.24*** [2.39]	3.93*** [0.58]	-0.26 [0.61]	1.70** [0.76]
$Q_4$	-4.76*** [0.58]	13.29*** [2.85]	4.59*** [0.59]	4.26*** [1.29]	1.14 [0.77]
$vat_{95}$	-1.98** [0.94]	-3.69* [2.22]	6.46*** [1.32]	-10.88*** [2.96]	-3.66** [1.82]
$vat_{99}$	-0.90 [1.16]	-4.01*** [1.25]	-5.65*** [1.01]	-2.39** [1.14]	-3.55** [1.66]
$vat_{01}$	-3.18*** [0.88]	-2.53** [1.21]	4.33*** [1.06]	1.50 [3.01]	5.07** [2.11]
$\theta_{it}^-$					
$\bar{\pi}_{jt}$	-4.16*** [1.43]	-31.49*** [8.39]	-3.86*** [1.47]	4.04 [3.31]	-10.35** [4.74]
$Q_2$	3.10*** [0.91]	-8.33*** [3.03]	-0.49 [0.72]	2.54 [1.89]	-0.78 [1.05]
$Q_3$	9.75*** [0.91]	-1.64 [1.90]	-0.18 [0.70]	-3.29 [2.02]	-0.42 [1.05]
$Q_4$	2.40*** [0.92]	-11.59*** [3.72]	-1.12 [0.71]	-4.19* [2.30]	1.61 [1.01]
$vat_{95}$	2.47 [1.95]	23.31*** [6.26]	-11.47*** [3.33]	-54.17*** [10.05]	4.31 [3.09]
$vat_{99}$	-9.72* [5.14]	3.14 [2.85]	1.65 [1.71]	-46.89*** [6.69]	-3.91 [4.07]
$vat_{01}$	6.23*** [1.79]	5.65 [4.05]	0.34 [1.95]	-49.44*** [6.89]	0.34 [3.03]
Avg. $\theta_{it}^+ - \mu_i$	29.48	24.32	26.62	28.72	28.57
Avg. $\theta_{it}^- - \mu_i$	-35.04	-27.39	-33.33	-25.89	-42.68
Fit (positive)	0.85	0.88	0.83	0.83	0.89
Fit (negative)	0.67	0.77	0.56	0.59	0.69
Estim. range	12	12	12	12	12
Observations	66900	10351	47004	7053	33244

Note: See Table 3.

## A.2 Robustness tests

**Table 15:** *Estimates of desired price equation (full estimation range)*

	Product types				
	All sectors	Non-durable	Semi-durable	Durable	Services
$\Sigma \bar{\pi}_{jt}$ (sectoral price trends)					
Avg. $\beta_1   \beta_1 > 0$	1.22 (0.92)	1.26 (0.96)	1.07 (0.47)	1.48 (0.97)	0.90 (1.00)
Avg. $\beta_1   \beta_1 > 1$	1.52 (0.41)	1.50 (0.52)	1.66 (0.36)	1.68 (0.46)	1.16 (0.07)
Avg. $\beta_1   \beta_1 < 0$	-1.09 (0.03)	– (0.00)	-1.04 (0.19)	-2.00 (0.03)	– (0.00)
$\Sigma \hat{\pi}_{jt}^+$ (positive sector-specific shocks)					
Avg. $\beta_2   \beta_2 > 0$	2.26 (0.77)	1.70 (0.85)	2.59 (0.87)	2.73 (0.41)	3.39 (0.86)
Avg. $\beta_2   \beta_2 > 1$	2.67 (0.51)	2.10 (0.40)	2.89 (0.61)	3.20 (0.41)	3.39 (0.84)
Avg. $\beta_2   \beta_2 < 0$	-1.29 (0.06)	-0.62 (0.02)	-0.59 (0.00)	-1.75 (0.26)	-0.95 (0.01)
$\Sigma \hat{\pi}_{jt}^-$ (negative sector-specific shocks)					
Avg. $\beta_3   \beta_3 > 0$	1.65 (0.54)	1.36 (0.60)	1.28 (0.47)	1.65 (0.40)	3.15 (0.54)
Avg. $\beta_3   \beta_3 > 1$	2.12 (0.28)	1.83 (0.36)	1.68 (0.36)	1.99 (0.10)	3.15 (0.19)
Avg. $\beta_3   \beta_3 < 0$	-1.24 (0.09)	-0.65 (0.04)	-0.46 (0.00)	-0.85 (0.12)	-2.38 (0.24)
$\Sigma \hat{\pi}_{jt}^+, \Sigma \hat{\pi}_{jt}^-$ (positive and negative sector-specific shocks)					
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 > 0$	2.63 (0.45)	1.66 (0.44)	3.35 (0.42)	3.32 (0.53)	4.08 (0.46)
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 < 0$	-1.63 (0.22)	-1.10 (0.24)	-0.32 (0.00)	-3.38 (0.36)	-2.05 (0.16)
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 \neq 0$	0.88 (0.57)	0.53 (0.53)	1.57 (0.33)	0.15 (0.78)	2.15 (0.58)
$\bar{\pi}_{jt}$ (sectoral inflation trend upper threshold $\theta^+$ )					
Avg. $\delta_1^+   \delta_1^+ > 0$	4.58 (0.04)	2.11 (0.01)	3.08 (0.29)	6.39 (0.07)	0.73 (0.00)
Avg. $\delta_1^+   \delta_1^+ < 0$	-8.81 (0.68)	-3.43 (0.61)	-8.85 (0.20)	-7.90 (0.76)	-5.79 (0.97)
$\bar{\pi}_{jt}$ (sectoral inflation trend lower threshold $\theta^-$ )					
Avg. $\delta_1^-   \delta_1^- > 0$	15.76 (0.16)	0.86 (0.04)	1.17 (0.00)	4.84 (0.33)	19.44 (0.40)
Avg. $\delta_1^-   \delta_1^- < 0$	-7.33 (0.58)	-5.44 (0.61)	-6.01 (0.56)	-5.44 (0.57)	-5.25 (0.57)
Avg. $\sigma_\varepsilon$	20.82	21.61	24.16	18.91	18.71
Avg. $\theta_{it}^+ - \mu_i$	34.88	34.55	41.73	31.09	35.68
Avg. $\theta_{it}^- - \mu_i$	-42.50	-40.85	-50.13	-35.36	-49.62
Avg. fit (positive)	0.82	0.82	0.82	0.80	0.83
Avg. fit (negative)	0.63	0.65	0.61	0.56	0.67
Sectors	67	38	11	10	8
Observations	3,157,816	2,132,911	469,807	379,643	175,455

Note: See Table 3.

**Table 16:** *Estimates of desired price equation (aggregate price level and personal consumption)*

	Product types				
	All sectors	Non-durable	Semi-durable	Durable	Services
$\Sigma \bar{\pi}_{jt}$ (sectoral price trends)					
Avg. $\beta_1 \beta_1 > 0$	0.87 (0.68)	1.05 (0.88)	0.66 (0.49)	0.78 (0.43)	0.47 (0.47)
Avg. $\beta_1 \beta_1 > 1$	1.54 (0.13)	1.64 (0.23)	1.63 (0.09)	1.27 (0.00)	1.06 (0.00)
Avg. $\beta_1 \beta_1 < 0$	-0.41 (0.04)	-0.21 (0.01)	-0.99 (0.25)	-0.90 (0.03)	-0.14 (0.00)
$\Sigma \hat{\pi}_{jt}^+$ (positive sector-specific shocks)					
Avg. $\beta_2 \beta_2 > 0$	1.51 (0.62)	1.07 (0.63)	1.72 (0.78)	1.83 (0.49)	2.69 (0.61)
Avg. $\beta_2 \beta_2 > 1$	2.24 (0.32)	1.74 (0.27)	2.67 (0.32)	2.45 (0.36)	2.90 (0.39)
Avg. $\beta_2 \beta_2 < 0$	-0.59 (0.06)	-0.72 (0.01)	-0.26 (0.02)	-1.00 (0.26)	-0.16 (0.01)
$\Sigma \hat{\pi}_{jt}^-$ (negative sector-specific shocks)					
Avg. $\beta_3 \beta_3 > 0$	1.44 (0.59)	1.27 (0.75)	1.11 (0.56)	1.28 (0.21)	2.58 (0.54)
Avg. $\beta_3 \beta_3 > 1$	1.90 (0.26)	1.66 (0.30)	1.40 (0.07)	2.21 (0.10)	2.70 (0.42)
Avg. $\beta_3 \beta_3 < 0$	-0.63 (0.06)	-0.29 (0.00)	-0.18 (0.00)	-0.84 (0.12)	-0.91 (0.22)
$\Sigma \pi_t$ (aggregate price level)					
Avg. $\beta_4 \beta_4 > 0$	0.97 (0.24)	0.81 (0.23)	0.86 (0.43)	1.33 (0.14)	1.28 (0.25)
Avg. $\beta_4 \beta_4 > 1$	2.45 (0.09)	2.63 (0.07)	1.76 (0.07)	1.89 (0.03)	2.57 (0.22)
Avg. $\beta_4 \beta_4 < 0$	-0.65 (0.15)	-1.01 (0.23)	-0.73 (0.09)	-0.28 (0.10)	-0.03 (0.00)
$\Sigma c_t$ (personal consumption expenditures)					
Avg. $\beta_5 \beta_5 > 0$	0.61 (0.65)	0.71 (0.64)	0.55 (0.56)	0.47 (0.88)	0.51 (0.52)
Avg. $\beta_5 \beta_5 > 1$	1.54 (0.07)	1.55 (0.13)	1.31 (0.00)	0.00 (0.00)	1.66 (0.00)
Avg. $\beta_5 \beta_5 < 0$	-0.89 (0.17)	-0.82 (0.19)	-0.66 (0.07)	-1.62 (0.12)	-0.83 (0.22)
$\Sigma \hat{\pi}_{jt}^+, \Sigma \hat{\pi}_{jt}^-$ (positive and negative sector-specific shocks)					
Avg. $\beta_2 - \beta_3 \beta_2 - \beta_3 > 0$	1.95 (0.33)	1.16 (0.24)	1.58 (0.26)	2.50 (0.48)	3.77 (0.46)
Avg. $\beta_2 - \beta_3 \beta_2 - \beta_3 < 0$	-1.32 (0.30)	-1.04 (0.32)	-0.74 (0.02)	-1.95 (0.36)	-1.78 (0.36)
Avg. $\beta_2 - \beta_3 \beta_2 - \beta_3 \neq 0$	0.28 (0.60)	-0.01 (0.55)	0.61 (0.28)	0.40 (0.83)	0.75 (0.72)
$\bar{\pi}_{jt}$ (sectoral inflation trend upper threshold $\theta^+$ )					
Avg. $\delta_1^+ \delta_1^+ > 0$	3.07 (0.07)	4.14 (0.01)	2.58 (0.45)	3.95 (0.07)	1.59 (0.03)
Avg. $\delta_1^+ \delta_1^+ < 0$	-4.62 (0.62)	-3.49 (0.65)	-8.01 (0.20)	-7.15 (0.41)	-4.91 (0.97)
$\bar{\pi}_{jt}$ (sectoral inflation trend lower threshold $\theta^-$ )					
Avg. $\delta_1^- \delta_1^- > 0$	8.49 (0.16)	0.86 (0.04)	0.00 (0.00)	5.30 (0.33)	19.55 (0.40)
Avg. $\delta_1^- \delta_1^- < 0$	-5.53 (0.54)	-5.48 (0.62)	-6.84 (0.56)	-5.03 (0.27)	-4.95 (0.57)
$\pi_t$ (aggregate inflation in the upper threshold $\theta^+$ )					
Avg. $\delta_2^+ \delta_2^+ > 0$	1.89 (0.11)	1.88 (0.06)	0.81 (0.00)	3.29 (0.05)	1.86 (0.37)
Avg. $\delta_2^+ \delta_2^+ < 0$	-2.64 (0.51)	-2.56 (0.64)	-3.60 (0.52)	-3.08 (0.33)	-1.67 (0.31)
$\pi_t$ (aggregate inflation in the lower threshold $\theta^-$ )					
Avg. $\delta_2^- \delta_2^- > 0$	3.04 (0.34)	3.57 (0.49)	3.47 (0.52)	1.02 (0.08)	3.50 (0.07)
Avg. $\delta_2^- \delta_2^- < 0$	-3.16 (0.18)	-2.83 (0.15)	-0.76 (0.00)	-2.56 (0.30)	-3.83 (0.24)
Avg. $\sigma_\varepsilon$	13.09	14.53	15.67	12.24	8.62
Avg. $\theta_{it}^+ - \mu_i$	26.04	27.45	31.64	22.03	23.06
Avg. $\theta_{it}^- - \mu_i$	-28.87	-28.73	-34.40	-24.29	-30.60
Avg. fit (positive)	0.81	0.81	0.80	0.81	0.81
Avg. fit (negative)	0.60	0.63	0.56	0.54	0.62
Sectors	67	38	11	10	8
Observations	3,157,816	2,132,911	469,807	379,643	175,455

Note: See Table 3.

**Table 17:** Estimates of desired price equation (HP filter for calculating the trend)

	Product types				
	All sectors	Non-durable	Semi-durable	Durable	Services
$\Sigma \bar{\pi}_{jt}$ (sectoral price trends)					
Avg. $\beta_1   \beta_1 > 0$	1.37 (0.94)	1.38 (0.96)	1.70 (0.75)	1.45 (0.92)	1.08 (1.00)
Avg. $\beta_1   \beta_1 > 1$	1.58 (0.47)	1.61 (0.53)	2.09 (0.47)	1.69 (0.36)	1.18 (0.39)
Avg. $\beta_1   \beta_1 < 0$	-2.78 (0.03)	– (0.00)	-1.30 (0.09)	-5.34 (0.08)	– (0.00)
$\Sigma \hat{\pi}_{jt}^+$ (positive sector-specific shocks)					
Avg. $\beta_2   \beta_2 > 0$	1.40 (0.72)	1.51 (0.90)	1.40 (0.70)	1.49 (0.52)	0.76 (0.34)
Avg. $\beta_2   \beta_2 > 1$	1.77 (0.30)	1.76 (0.45)	1.92 (0.14)	1.91 (0.17)	1.28 (0.03)
Avg. $\beta_2   \beta_2 < 0$	-0.50 (0.02)	-0.22 (0.02)	-1.46 (0.10)	-0.48 (0.00)	-0.37 (0.01)
$\Sigma \hat{\pi}_{jt}^-$ (negative sector-specific shocks)					
Avg. $\beta_3   \beta_3 > 0$	1.28 (0.71)	1.09 (0.72)	1.04 (0.44)	1.71 (0.66)	1.66 (0.95)
Avg. $\beta_3   \beta_3 > 1$	1.72 (0.32)	1.72 (0.33)	1.77 (0.09)	1.76 (0.31)	1.68 (0.48)
Avg. $\beta_3   \beta_3 < 0$	-0.31 (0.01)	-0.32 (0.00)	-0.27 (0.07)	-0.33 (0.00)	0.00 (0.00)
$\Sigma \hat{\pi}_{jt}^+, \Sigma \hat{\pi}_{jt}^-$ (positive and negative sector-specific shocks)					
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 > 0$	0.95 (0.26)	1.09 (0.38)	1.04 (0.43)	0.35 (0.00)	0.39 (0.00)
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 < 0$	-0.98 (0.24)	-0.67 (0.22)	-1.80 (0.10)	-0.94 (0.13)	-1.29 (0.59)
Avg. $\beta_2 - \beta_3   \beta_2 - \beta_3 \neq 0$	0.03 (0.41)	0.44 (0.52)	0.39 (0.54)	-0.34 (0.13)	-1.24 (0.28)
$\bar{\pi}_{jt}$ (sectoral inflation trend upper threshold $\theta^+$ )					
Avg. $\delta_1^+   \delta_1^+ > 0$	6.85 (0.22)	5.56 (0.35)	12.78 (0.18)	11.52 (0.02)	1.05 (0.05)
Avg. $\delta_1^+   \delta_1^+ < 0$	-11.93 (0.40)	-8.02 (0.23)	-8.68 (0.34)	-24.70 (0.74)	-5.19 (0.62)
$\bar{\pi}_{jt}$ (sectoral inflation trend lower threshold $\theta^-$ )					
Avg. $\delta_1^-   \delta_1^- > 0$	7.29 (0.13)	4.29 (0.15)	7.97 (0.14)	18.91 (0.18)	14.22 (0.00)
Avg. $\delta_1^-   \delta_1^- < 0$	-16.98 (0.55)	-12.98 (0.42)	-20.99 (0.67)	-23.16 (0.63)	-17.84 (0.79)
Avg. $\sigma_\varepsilon$	13.54	14.98	15.76	12.86	7.73
Avg. $\theta_{it}^+ - \mu_i$	24.77	25.79	31.17	22.63	19.29
Avg. $\theta_{it}^- - \mu_i$	-29.82	-30.12	-35.77	-25.71	-29.69
Avg. fit (positive)	0.81	0.81	0.81	0.81	0.81
Avg. fit (negative)	0.64	0.66	0.61	0.56	0.67
Sectors	66	38	11	10	7
Observations	3,128,862	2,132,911	469,807	379,643	146,501

Note: See Table 3.

**Table 18:** *Estimates of desired price equation (average price change instead of sectoral inflation)*

	Product types				
	All sectors	Non-durable	Semi-durable	Durable	Services
$\overline{\Sigma \Delta p_{ijt}}$ (sectoral price trends)					
Avg. $\beta_1   \beta_1 > 0$	1.02 (0.97)	0.95 (1.00)	1.02 (1.00)	0.90 (0.95)	1.35 (0.91)
Avg. $\beta_1   \beta_1 > 1$	1.34 (0.26)	1.22 (0.17)	1.48 (0.22)	1.32 (0.09)	1.46 (0.67)
Avg. $\beta_1   \beta_1 < 0$	– (0.00)	– (0.00)	– (0.00)	– (0.00)	– (0.00)
$\overline{\Delta p_{ijt}}$ (sectoral inflation trend upper threshold $\theta^+$ )					
Avg. $\delta_1^+   \delta_1^+ > 0$	1.97 (0.05)	1.12 (0.01)	– (0.00)	– (0.00)	2.04 (0.24)
Avg. $\delta_1^+   \delta_1^+ < 0$	-5.59 (0.71)	-5.17 (0.82)	-4.74 (0.62)	-6.43 (0.74)	-6.58 (0.43)
$\overline{\Delta p_{ijt}}$ (sectoral inflation trend lower threshold $\theta^-$ )					
Avg. $\delta_1^-   \delta_1^- > 0$	2.43 (0.06)	1.95 (0.00)	0.19 (0.00)	3.47 (0.10)	3.66 (0.23)
Avg. $\delta_1^-   \delta_1^- < 0$	-4.65 (0.69)	-4.47 (0.82)	-4.27 (0.62)	-4.05 (0.64)	-6.15 (0.44)
Avg. $\sigma_\varepsilon$	13.94	15.36	16.04	12.62	10.28
Avg. $\theta_{it}^+ - \mu_i$	25.66	26.87	30.80	21.76	23.36
Avg. $\theta_{it}^- - \mu_i$	-30.69	-29.89	-36.31	-25.58	-34.68
Avg. fit (positive)	0.81	0.79	0.82	0.82	0.82
Avg. fit (negative)	0.61	0.61	0.57	0.60	0.64
Sectors	67	38	11	10	8
Observations	3,157,816	2,132,911	469,807	379,643	175,455

Note: See Table 3.

**Table 19:** *Counterfactual predictions (full estimation range)*

	Data	Model	$\pi_t = 0^{(1)}$	$\pi_t = 0^{(2)}$	$\pi_{jt} = 0^{(1)}$	$\pi_{jt} = 0^{(2)}$
All sectors	66.4	66.1	62.6	57.2	63.8	61.8
Non-durable	63.3	63.0	58.9	54.7	61.2	58.9
Semi-durable	64.2	63.7	62.8	59.2	63.2	64.6
Durable	64.2	64.2	60.4	48.1	63.4	63.4
Services	78.2	77.7	74.7	71.8	71.5	66.2

Note: See Table 5.

**Table 20:** *Counterfactual predictions (aggregate price level and personal consumption)*

	Data	Model	$\pi_t = 0^{(1)}$	$\pi_t = 0^{(2)}$	$\pi_{jt} = 0^{(1)}$	$\pi_{jt} = 0^{(2)}$
All sectors	66.4	66.1	62.5	57.7	61.7	58.9
Non-durable	63.3	62.8	59.0	54.8	59.4	55.0
Semi-durable	64.2	64.0	62.7	59.4	60.9	62.6
Durable	64.2	64.0	62.2	53.8	61.9	61.5
Services	78.2	78.0	71.9	68.3	68.4	64.9

Note: See Table 5.



**Table 21:** *Counterfactual predictions (HP filter for calculating the trend)*

	Data	Model	$\pi_t = 0^{(1)}$	$\pi_t = 0^{(2)}$	$\pi_{jt} = 0^{(1)}$	$\pi_{jt} = 0^{(2)}$
All sectors	66.4	65.9	60.0	47.7	61.4	51.4
Non-durable	63.3	62.9	55.7	51.5	59.9	57.1
Semi-durable	64.2	63.8	59.9	55.1	61.8	60.4
Durable	64.2	63.5	58.7	29.7	61.4	44.2
Services	78.2	77.6	73.0	50.8	65.4	38.1

Note: See Table 5.

**Table 22:** *Counterfactual predictions (average price change instead of sectoral inflation)*

	Data	Model	$\pi_t = 0^{(1)}$	$\pi_t = 0^{(2)}$	$\pi_{jt} = 0^{(1)}$	$\pi_{jt} = 0^{(2)}$
All sectors	66.4	66.0	60.7	55.5	62.3	56.7
Non-durable	63.3	62.8	58.4	53.9	58.4	51.1
Semi-durable	64.2	63.8	58.2	54.6	62.2	60.7
Durable	64.2	63.7	58.3	50.7	64.1	63.7
Services	78.2	78.0	70.6	64.8	70.9	62.7

Note: See Table 5.

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