# Price variability and price dispersion in a stable monetary environment: Evidence from German retail markets*

**Matthias R. Fengler**
Sonderforschungsbereich 373, Humboldt-Universität zu Berlin
fengler@wiwi.hu-berlin.de

**Joachim K. Winter**
Sonderforschungsbereich 504, Universität Mannheim
Department of Economics, University of California, Berkeley
winter@econ.berkeley.edu

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**Abstract:** We investigate the relationship between inflation and price variation using highly disaggregated, weekly price data for consumption goods recorded in Germany during 1995, a low inflation period. We find a significant positive correlation between the rates of price change and price dispersion, both at the level of individual products and product groups. However, we find no correlation between the rates of price change and price variability. Together with results from similar studies, Tommasi (1993) and Parsley (1996), a remarkable pattern emerges: When aggregate nominal shocks are small, only price dispersion is correlated with price changes. As the rate of inflation rises, both variability and dispersion become affected. During hyperinflation, systematic movements of price dispersion seem to disappear. We conclude that price dispersion is best explained by microeconomic frictions in price adjustment, whereas price variability appears to be related to costly price search and information problems.

**Keywords:** price dispersion, price variability, inflation

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*Address for correspondence:* Joachim Winter
Department of Economics
University of California, Berkeley
Berkeley, CA 94720-3880

## 1. Introduction

The hypothesis that dispersion and variability of individual prices depend on changes in the aggregate price level, that is on the rate of inflation, is rather old.[1] Building on early results by Mills (1927), a large number of studies such as Vining and Elwertowski (1976) and Fischer (1981) confirmed a positive relationship between price variability and rates of price change in aggregate data. More recently, empirical research focused on more disaggregated data in order to avoid potential aggregation biases (e.g., Domberger, 1987; Parsley, 1996; Debelle and Lamont, 1997). In addition, the relationship between price dispersion, the static counterpart of price variability, and price changes has been investigated (e.g., Lach and Tsiddon, 1992; Tommasi, 1993). The overwhelming majority of empirical studies in this area found a positive relationship between either price variability or price dispersion and the rate of price change.[2]

Although such a positive relationship seems to be a widely accepted stylized fact, its theoretical foundation is surprisingly weak, which in turn makes the empirical result itself hard to interpret. Fischer (1981) and later Lach and Tsiddon (1992) link price dispersion to menu costs and (s,S)-type price rigidities, whereas price variability is typically related to price search and investigated in information models (e.g., Cukierman, 1983). However, at closer inspection, this seemingly clear-cut theoretical distinction is ambiguous (Caplin and Spulber, 1987; Danziger, 1987)[3]. Moreover, existing empirical studies do not explicitly discriminate between price dispersion and price variability; we discuss this issue shortly. Last, but not least, the econometric specifications used in the literature have been criticized for methodological reasons. Hartman (1991) and Bryan and Cecchetti (1999) question the stylized facts as such, arguing that the correlations documented in the literature might be statistical artifacts without any economic meaning.

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[1] To fix terminology, we call the variation of prices around their cross-sectional mean at a given point in time *price dispersion*. In contrast, *price variability* denotes the variation of the rates of price change around their cross-sectional mean at a given point in time. In using this terminology, we follow Lach and Tsiddon (1992); formal definitions will be given below.

[2] An exception is Reinsdorf (1994). Other empirical studies in this area are, *inter alia*, Sheshinski and Weiss (1977, 1983), Parks (1978), Marquez and Vining (1983), Danziger (1987), and Chang and Cheng (2000) for the United States, and for Germany, Franz (1985) and Gahlen (1988).

[3] Caplin and Spulber (1987) is an excellent example: In their model, price variability increases inflation, whereas price dispersion should actually be constant, i.e., prices remain uniformly distributed.

In our view, controversial economic interpretations of regression results arise because the concepts of price dispersion and price variability can rarely be investigated within the same sample. Most data sets that have been analyzed in earlier studies are contaminated with the effects of inflation. However, when inflation is sufficiently high, it affects both dimensions of price variation. Hence, it is difficult to empirically discriminate between (s,S)-type pricing patterns (which result from micro-economic frictions in price adjustment, following Fischer, 1981) and mechanisms related to costly price search and information problems (e.g., Lucas, 1976; Barro, 1977; Fischer, 1981).

In this paper, we try to disentangle these issues by using highly disaggregated, high-frequency data taken from the *Consumer Panel* by the *Gesellschaft für Konsumforschung*. This data set was recorded in 1995 in Germany, a period in which the monetary environment was exceptionally stable (the German annual rate of inflation dropped from 2.0% in January 1995 to 1.5% in January 1996).

More specifically, our data set has three major advantages over the data used in previous studies. First, our data set is unique (at least in this literature) in that price data are recorded for individual products, i.e., they are differentiated by brand and product characteristics. Therefore, we can avoid any spurious price variation resulting from product differentiation. Second, our data allow us to pursue both concepts, price dispersion and price variability, simultaneously. Third, and in contrast to studies using data from high-inflation periods such as Lach and Tsiddon (1992) or Tommasi (1993), the fact that we restrict our analysis to a low-inflation period helps us obtain sharp empirical results. Search and information issues that naturally arise when inflation is high or even moderate are not relevant in our study; hence we can exclude nominal disturbances as a potential cause for any correlation between price change, price dispersion, and price variability. Moreover, we do not have to distinguish between expected and unexpected inflation, an issue that plagues many empirical studies in this area. As opposed to previous studies, these unique features of our data set, together with the results by Hartman (1991), allow us to give our regression results an meaningful economic interpretation.

In our econometric analysis of the relationship between price dispersion or variability and price change, we confirm the Hartman critique of the commonly used quadratic or absolute value specifications, and concentrate on a parsimonious linear specification instead. Our central result is a positive relationship between price dispersion and the rate of price change while the relationship between price variability and the rate of price change turns out to be statistically insignificant. These results, which are obtained using data from a low-inflation period, together with results from earlier studies by Tommasi (1993) and Parsley (1996),[4] strongly support the hypothesis by Lach and Tsiddon (1992): Price dispersion seems to be related to (s,S)-type pricing behavior resulting from frictions in price adjustment, whereas variability seems to be explained best by price search and information models.

The remainder of this paper is structured as follows. In Section 2, we discuss the source of our price data and present descriptive statistics. The results of our regression analysis are reported and interpreted in Sections 3 and 4, respectively. Section 5 concludes.

## 2. Data source, construction of price measures, and descriptive statistics

This study is based on data on individual supermarket purchases obtained from the 1995 wave of the Consumer Panel administered by the *Gesellschaft für Konsumforschung* (GfK), Nürnberg. This data set was designed for household demand analysis from a marketing perspective. In total, it covers some 7000 households, but there is considerable attrition over time.[5] We focus exclusively on the price data available in the GfK Consumer Panel and ignore all other information (such as household characteristics which are recorded once a year).

For each transaction (i.e., each purchase of an individual product), the data set provides detailed information such as product group, brand, size, type of retailer, and price. This allows to extract daily price data for a vast number of fast-moving consumption goods covering the entire year of 1995. The GfK Consumer Panel therefore constitutes a unique source of high-frequency, micro-level price data. Most importantly, since we have price data at the level of individual products, we can avoid all problems related to product differentiation – when prices at the product-group

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[4] Tommasi (1993) reports a positive correlation of price changes with price variability, but no correlation with price dispersion; his data are taken from a high-inflation period in Argentina. Parsley (1996) reports positive and significant coefficients for both his price variability and dispersion models using data from the United States.

[5] Further details on the GfK Consumer Panel can be found in Fengler and Winter (2000a). The 1995 wave was made available to academic research for the first time as part of a pilot project initiated by the *Zentrum für Umfragen und Analysen* (ZUMA), Mannheim.

level rather than individual prices are used, product differentiation might result in spurious price dispersion.

While these features make our data set unique in the literature on price dispersion and price variability, there is one qualification. Since the data are recorded on a transaction basis from the household's perspective, prices can only be traced to four different types of retailers but, unfortunately, not to a specific retailer (such as a specific store). This implies that we cannot construct time series of prices quoted by a unique retailer, and thus price changes are not directly observable, but have to be computed based on average product prices. Therefore, our analysis is restricted to the dynamics of the whole distribution of prices over time.

In order to obtain a sufficiently broad basis for meaningful statistical inference, we restrict our sample to those product groups in which prices for at least six products are observed at least 650 times during 1995. This leaves us with 23 product groups with between 6 and 62 products, and with a total of 560 products.[6] We combine daily observations to obtain weekly samples of prices; these weekly empirical distribution functions are unbiased when pricing decisions are made by retailers on a weekly basis, an assumption that seems very natural. In the following, periods are therefore understood to be the calendar weeks of 1995 (with $t = 1, 2, ..., 52$). In total, we have 28522 weekly price observations.

We construct three measures of price variation: price dispersion within the individual product market, price dispersion within the whole product group, and price variability within the whole product group. Let $P_{tkij}$ denote the $k$th price observation of product $i$ in product group $j$ during period $t$, $K_{ti}$ the number of price observations for product $i$ during period $t$, and $I_j$ the number of products in product group $j$. Following the general procedure in this literature, the definitions of our price variation measures can then be stated as follows[7]:

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[6] The exact definitions of these product groups, including details such as package sizes, are available on request.

[7] Some authors prefer to use the coefficient of variation rather than the variance since it is a more robust measure, preventing dispersion from rising when the mean is changes drastically over time. This approach is useful when the data is inflation-ridden, but not relevant for our data.

- $V^1_{tij}$, the price dispersion of product *i* in product group *j* at time *t* = 1, 2, ..., 52:

$$V^1_{tij} = \sqrt{\frac{1}{K_{ti}-1}\sum_{k=1}^{K_{ti}}(P_{tkij}-\overline{P}_{tij})^2}, \qquad \overline{P}_{tij} = \frac{1}{K_{ti}}\sum_{k=1}^{K_{ti}}P_{tkij} \tag{1}$$

- $V^2_{tj}$, the price dispersion in product group *j* at time *t* = 1, 2, ..., 52:

$$V^2_{tj} = \sqrt{\frac{1}{N_t-I}\sum_{i=1}^{I_j}\sum_{k=1}^{K_{ti}}(P_{tkij}-\overline{P}_{tj})^2}, \qquad N_t = \sum_{i=1}^{I_j}K_{ti}, \qquad \overline{P}_{tj} = \frac{1}{N_t}\sum_{i=1}^{I_j}\sum_{k=1}^{K_{ti}}P_{tkij} \tag{2}$$

- $V^3_{tj}$, the price variability in product group *j* at time *t* = 1, 2, ..., 51:

$$V^3_{tj} = \sqrt{\frac{1}{I_j-1}\sum_{i=1}^{I_j}(\pi_{tij}-\overline{\pi}_{tj})^2}, \qquad \pi_{tij} = \Delta\ln(P_{tij}), \qquad \overline{\pi}_{tj} = \frac{1}{I_j}\sum_{i=1}^{I_j}\pi_{tij} \tag{3}$$

Note that there is no within-group analogue to the price variability measure $V^3$. Price variability (in contrast to price dispersion) is only defined at the level of product groups, not at the level of individual products because – as mentioned earlier – we cannot compute rates of change for individual products. All components enter the cross-sectional measures with equal weights since previous research has shown that results are typically insensitive to weighting (e.g., Domberger, 1987, p. 553).

We do not provide tabulations of the rate of price change and the measure of price dispersion, $V^1$, for the 560 individual products in our data set (but they are available on request). At the level of the 23 product groups, the rates of price change and the measures of price dispersion, $V^2$, and price variability, $V^3$, are reported in Tables 1 through 3.

As Table 1 shows, there is some variation in the mean of the rate of price change between product groups: On average, the market for roasted coffee exhibits a price decrease of 0.3% per week, and the market for cooking fat an 0.1% price increase per week. For the entire panel, the (unweighted) average weekly rate of price change is -0.02%, which corresponds to the decrease of

0.5 percentage points in the aggregate rate of inflation over 1995. The distribution of the rates of price change is not skewed but exhibits excess curtosis (which is a common observation for rates of price change).

Tables 2 and 3 suggest that across product groups, there is also considerable heterogeneity with respect to price dispersion and price variability. As a piece of preliminary evidence, note that a comparison of tables 2 and 3 with Table 1 reveals that product groups with low average rates of price change also exhibit low values of price dispersion (Table 2), while a similar relationship does not hold for the rates of price changes and price variability, again at the level of averages for product groups (Table 3).

## 3. Econometric methodology and estimation results

Using the weekly measures described in the previous section, the nature of our data set allows us to estimate the effects of price changes on price variation in three ways:

(i) regressing price variability across all 23 product groups on the rates of change of cross-sectional average prices (i.e., one pooled between-groups regression);

(ii) regressing price dispersion across all 23 product groups on the rates of change of cross-sectional average prices (i.e., one pooled between-groups regression);

(iii) regressing price dispersion within each of the 23 product groups on the rates of change of cross-sectional average prices (i.e., 23 within-group regressions).

In all regressions, we employ a random effects panel-data method, controlling both for random product (or product group) specific effects and for fixed time effects[8]. Most generally, one may state the model as

$$V_{tk}^{n} = f(\beta, \pi_{tk}) + \sum_{l=1}^{T} \lambda_l I(l = t) + \varepsilon_{tk} + v_k . \tag{4}$$

The dependent variable is one of the three measures of price variation, $V^n$, $n = \{1, 2, 3\}$. The explanatory variables are the rates of cross-sectional price changes, $\pi_{tk}$, and a set of week dummies,

[8] Controlling for time effects was suggested by Parsley (1996). Hausman tests do not reject any of our random effects models.

$\lambda_t I(l=t)$.[9] Note that $T$ = 51 for $V^1$ and $V^2$, and $T$ = 50 for $V^3$. The functional form of $f(\beta,\pi_{tk})$ is assumed *a priori* (see below), and the parameters $\beta$ are unknown. Finally, $\varepsilon_{tk}$ is an i.i.d. error term, and $v_k$ is an product or product group specific random effect. In all regressions, we impose the restrictions $E[\varepsilon_{tk}]=0$, $E[\varepsilon_{tk}^2]=\sigma_\varepsilon^2$, $E[\varepsilon_{tk}v_k]=0$, $E[v_k]=\alpha$, and $E[v_k^2]=\sigma_v^2$; these restrictions are based on initial trial estimations with unrestricted covariance matrices.

In the existing literature, common functional forms of $f$ are $f(x) = \beta x^2$, $f(x) = \beta_1 x+\beta_2 x^2$, and $f(x) = \beta|x|$. Researchers consistently report a positive sign for $\beta$; see Domberger (1987), Lach and Tsiddon (1992), Debelle and Lamont (1997), among others.[10] These findings are interpreted as evidence for a convex and sometimes even asymmetric relationship between inflation and price variability or price dispersion. Therefore costs of inflation, such as search costs, should also be a nonlinear function in price changes.

However, with respect to price *variability*, this view has been challenged by Hartman (1991)[11]. In a very parsimonious model of price changes with normal innovations, he shows that the least squares estimator for $\beta$ *always* generates a positive sign. He argues that "since the model does not depend on misperceptions, rigidities, or asymmetries, it follows that the regression results [...] will have little power in testing economic models that do" (Hartman, 1991, p. 186). Only for a simple linear specification of $f$, i.e. $f(x)= \beta x$, the sign is not determined *a priori*. Hartman concludes that any economic interpretation of most of the results in the literature should be dismissed. Hartman's study helps us understand the economic nature of our regression results.

We start our analysis by replicating the specifications criticized by Hartman (1991), i.e., we have the rates of price change enter the price variability equations in absolute and quadratic terms, referred to as models (i.a) and (i.b), respectively. Coefficient estimates are displayed in Table 4, together with robust (White) standard errors. As can readily be seen, the estimated coefficients are positive and statistically significant at the 1 percent level in both models (i.a) and (i.b), which is in line with previous findings in the literature. Interestingly, the linear component in model (i.b)

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[9] I($A$) is the indicator function; its value is one when the event $A$ is true.

[10] Reinsdorf (1994) is, to our knowledge, the only one to report a negative sign; however, his data set covers the period of the Volcker disinflation, a period in the U.S. monetary history that is generally referred to as a structural break. So it is not clear whether his result can be generalized.

[11] Indeed, Hartman's arguments do not apply to price *dispersion*.

is insignificant. We also estimate a combined version of the first two models, model (i.c). It turns out that the coefficient of the absolute value still remains significant at the 10 percent level. However, according to Hartman's analysis, these results have no economic interpretation, and they should not be taken as evidence for a convex relationship between rates of price change and price variability.

When we restrict our analysis to the linear model that does not suffer from the Hartman critique, we do not obtain significant parameters, see Table 5, model (i.d). This is in contrast to Parsley (1996) who finds a strong positive correlation between price variability and rates of price change in a quite similar specification, using a panel data set with both a cross-sectional dimension across U.S. cities and across products. However, his results might be affected by product differentiation, and they might be biased because of skewness in the price distribution. As Bryan and Cecchetti (1999) show, the estimation bias of the correlation between mean and variance is negligible only when the skewness is close to zero (in small samples). Indeed, Parsley (1996) reports both low and substantial skewness for his inflation data (0.337 and -8.10 respectively). However, these problems are mitigated by Parsley's uniquely large data set, and we believe in his study as an important benchmark. We will relate our results to Parsley's in Section 4.

As discussed in detail in the previous section, our data are not subject to some of the potential biases that might have biased results in earlier work. First, our data are not affected by aggregate nominal disturbances and by product differentiation. Second, note that mean skewness is only 0.02 in our data, and overall skewness 0.02, which is about an order of magnitude lower than the numbers commonly reported (e.g., Vining and Elwertowsky, 1976; Ball and Mankiw, 1995). We can therefore quite confidently conclude that there is no correlation between price variability and rates of price change in our data.

Matters become different, however, as we inspect price dispersion. For comparability, we estimate linear models in this case as well; results are reported in Table 5. Model (ii) is a pooled regression across all 23 product groups similar to model (i.d), now with price dispersion as the dependent variable. The coefficient of the rate of price change is positive and significant. Since our data allow to analyze price dispersion at a lower aggregation level, we can also perform within-group regressions for each of the 23 product markets; see model (iii). The main finding – a positive coefficient of the rate of price change – remains the same, and with very few exceptions, the coefficients of the rates of price change are positive and significant at the 10 percent level. We cannot reject the null hypothesis of a zero coefficient for a few product groups; typically, these product groups have low numbers of products (such as coffee extract which has just 6 different products). Also, the slope coefficients exhibit substantial heterogeneity in magnitude. This result, together with the less precise estimates in model (ii), indicates that the assumption of identical slope parameters across product groups imposed in model (ii) might be too restrictive.

Before turning to the economic interpretation of our findings, we end this section with a suggestive illustration of the empirical regularities which our regressions exploit. To this end, it is helpful to look at the price dynamics of one product group over this 52-week period with very low aggregate inflation. We show figures for toothpaste, but similar patterns emerge for many other products. In Figure 1, we show average prices (in levels, not rates of change) for one individual toothpaste product over the year of 1995 together with the within-product market measure of price dispersion, $V^1$. During late spring and summer, this product's average price dropped considerably while price dispersion in the product market first increased, then dropped. In Figure 2, we plot the average rates of price change in the entire product group and within-group price dispersion which tend to move together. Figure 3, in contrast, seems ambiguous and does not suggest a positive correlation of the average rate of price change and price variability in this particular product group. Our econometric analysis confirms that such patterns, which are present with many products, determine price dynamics in a low-inflation regime.

## 4. Economic interpretation

What conclusions may be drawn from our empirical results with respect to economic theory? Parsley (1996) reports positive and significant coefficients in both his variability and dispersion models. In contrast to our findings, Tommasi (1993) reports a positive correlation of price changes with price variability, but no or statistically very weak correlations with price dispersion. In our view, these seemingly contradictory results have a natural economic interpretation.

Tommasi's (1993) data stem from a high-inflation period in Argentina with weekly rates of inflation of between 1% and 9%, while our data are from a stable monetary environment. In a high-inflation monetary regime, price dispersion is substantial, but might – despite frequent price changes – not change significantly over time. Typically, producers and consumers have poor information about relative prices, and errors in price adjustment occur more frequently, as indicated by a substantial fraction of prices changes in the opposite direction than the current weekly trend (Tommasi, 1993, p. 505). Since higher rates of inflation increase uncertainty in the markets, so does price variability, while price dispersion is unaffected.

Parsley's (1996) study can be thought of as taking an intermediate position: His data are from the United States and cover the 1975-1992 period which exhibited moderate levels of inflation.[12] Therefore, price dispersion becomes sensitive to shocks, while there is still a significant amount of uncertainty in the market, causing price variability to rise also. Note also the large number of both price decreases and increases in his sample (Parsley, 1996, p. 326).

Finally, turning to our results, inflation is negligible in the stable monetary environment of Germany during 1995, and firms and households are well informed about relative prices. If shocks occur, these are likely to be relative disturbances affecting only local markets. Consequently, the information content of these shocks is quite high. In such a situation, price dispersion is sensitive to relative shocks when price adjustment is subject to rigidities (see Carlton, 1986, for an overview, and for recent empirical evidence on price rigidities, Slade, 1998, 1999).[13] Pricing behavior of the (s,S)-type, combined with staggered adjustment, causes the distribution of prices to move (e.g., Ball et al., 1989; Caplin and Leahy, 1991). But since price changes are relatively homogeneous in this setting, price variability does not react sensitively to price changes when they occur.

This interpretation of our empirical findings, and of earlier results by Tommasi (1993) and Parsley (1996), also sheds new light on the theoretical foundations of the price dispersion and price variability literature. From our results, it is evident that price dispersion should be linked to New Keynesian (s,S)-type pricing behavior that emerges when microeconomic frictions such as menu costs or psychological pricing points are present (Fischer, 1981). Price variability, in contrast,

[12] At a first sight, this seems to contradict the almost zero average rates of inflation (across time and across cities/products) reported by Parsley (1996). But this result arises because ups and downs in prices tend to cancel out over time, and the goods analyzed are highly tradeable (as was pointed out by David Parsley in private communication). However, aggregate disturbances that affect Parsley's U.S. 1975-1992 data were, overall, much more severe than in our German data from 1995.

[13] Also based on the GfK Consumer Panel, Fengler and Winter (2000b) show that price-setting behavior in German retail is heavily influenced by psychological pricing points. Such price-setting behavior is likely to cause price rigidities. Unfortunately, this data set does not allow to test directly for price rigidities.

seems to be related to price search and information models first fostered by Lucas (1976) and Barro (1977). This differentiation was initially proposed by Lach and Tsiddon (1992), based on earlier work by Fischer (1981), but empirical support for this hypothesis has, so far, been weak.

## 5. Conclusions

The empirical analysis presented in this paper shows that in retail prices quoted in Germany during 1995, there is a robust positive relationship between price dispersion and the rate of price change. However, the relationship between price variability and the rate of price change turns out not to be statistically significant. The structure of our data set – high frequency and low level of aggregation – allows us to avoid some methodological problems encountered in earlier studies of these relationships. We use a linear specification which is robust to Hartman's (1991) critique of functional forms, and since the distribution of price changes in our data from a low-inflation period is not skewed, our results are not subject to the small-sample biases pointed out by Bryan and Cecchetti (1999).

The empirical evidence reported in this paper yields two substantive conclusions. First, in an attempt to understand the economic nature of the price dispersion versus the price variability debate, we interpret our findings as supporting the hypothesis that the positive relationship between price dispersion and the rate of price change is due to (s,S)-type pricing behavior that emerges when microeconomic frictions such as menu costs are present. We may draw this conclusion since price-search and information issues can be assumed to be not relevant in our low-inflation data. Together with two earlier studies, Tommasi (1993) and Parsley (1996), our findings reveal a remarkable pattern in empirical work on price dispersion and price variability: When aggregate nominal shocks are absent, only price dispersion is correlated with price changes. As inflation rises, both variability and dispersion become affected. In a hyperinflation episode, systematic price dispersion changes tend to disappear. This supports the hypothesis formulated by Lach and Tsiddon (1992) that links price dispersion to New Keynesian arguments and price variability to Lucas-Barro-type information models .

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**Table 1:** Weekly average rates of price change by product group

| Product group | Mean | St. dev. | Min | Max |
|---|---|---|---|---|
| Beer | 0,07% | 0,67% | -1,12% | 1,66% |
| Cereals | 0,01% | 1,36% | -3,58% | 3,66% |
| Cocktail snacks | -0,02% | 2,28% | -6,57% | 5,07% |
| Coffee cream, canned | -0,01% | 0,49% | -1,01% | 1,04% |
| Coffee, extract | -0,03% | 0,96% | -1,84% | 1,86% |
| Coffee, roasted | -0,31% | 0,69% | -2,04% | 0,87% |
| Cooking fat | 0,10% | 0,68% | -1,13% | 1,44% |
| Curds | -0,04% | 1,76% | -4,37% | 3,79% |
| Dairy cream | 0,04% | 1,40% | -2,84% | 3,27% |
| Dish-washing detergent | -0,05% | 1,72% | -4,58% | 2,88% |
| Frozen meals | 0,05% | 1,73% | -3,55% | 3,65% |
| Hard cheese | -0,07% | 2,19% | -4,44% | 4,32% |
| Ice cream | 0,00% | 2,07% | -5,21% | 4,29% |
| Laundry detergent | 0,01% | 2,65% | -5,01% | 6,71% |
| Milk | 0,00% | 0,76% | -1,39% | 2,34% |
| Mineral water | 0,02% | 0,98% | -2,08% | 1,95% |
| Non-alcoholic beverages | 0,03% | 1,53% | -4,05% | 3,89% |
| Non-alcoholic beverages, carbonated | -0,03% | 1,56% | -2,72% | 3,28% |
| Potato meals, ready-to-serve | 0,05% | 1,66% | -4,26% | 3,82% |
| Soft cheese | -0,08% | 1,24% | -3,89% | 2,84% |
| Sparkling wine | -0,06% | 2,69% | -5,30% | 5,79% |
| Toothpaste | 0,02% | 1,36% | -3,25% | 2,77% |
| Yoghurt | -0,08% | 1,29% | -4,08% | 2,69% |
| Min | -0,31% | 0,49% | | |
| Max | 0,10% | 2,69% | | |

*Source:* GfK Consumer Panel 1995; own calculations.

**Table 2:** Weekly measure of price dispersion by product group

| Product group | Mean | St. dev. | Min | Max |
|---|---|---|---|---|
| Beer | 0,05 | 0,001 | 0,05 | 0,05 |
| Cereals | 0,42 | 0,024 | 0,38 | 0,48 |
| Cocktail snacks | 0,66 | 0,035 | 0,59 | 0,74 |
| Coffee cream, canned | 0,15 | 0,005 | 0,14 | 0,16 |
| Coffee, extract | 1,57 | 0,127 | 1,28 | 1,98 |
| Coffee, roasted | 0,23 | 0,014 | 0,20 | 0,27 |
| Cooking fat | 0,24 | 0,006 | 0,23 | 0,26 |
| Curds | 0,21 | 0,012 | 0,18 | 0,23 |
| Dairy cream | 0,22 | 0,039 | 0,12 | 0,30 |
| Dish-washing detergent | 0,22 | 0,014 | 0,19 | 0,26 |
| Frozen meals | 0,69 | 0,041 | 0,62 | 0,83 |
| Hard cheese | 0,41 | 0,023 | 0,37 | 0,47 |
| Ice cream | 0,42 | 0,045 | 0,27 | 0,53 |
| Laundry detergent | 0,21 | 0,023 | 0,17 | 0,26 |
| Milk | 0,03 | 0,002 | 0,02 | 0,03 |
| Mineral water | 0,03 | 0,001 | 0,03 | 0,03 |
| Non-alcoholic beverages | 0,08 | 0,026 | 0,06 | 0,23 |
| Non-alcoholic beverages, carbonated | 0,05 | 0,004 | 0,04 | 0,06 |
| Potato meals, ready-to-serve | 0,46 | 0,016 | 0,43 | 0,51 |
| Soft cheese | 0,46 | 0,031 | 0,38 | 0,53 |
| Sparkling wine | 0,29 | 0,024 | 0,23 | 0,34 |
| Toothpaste | 1,68 | 0,096 | 1,46 | 1,90 |
| Yoghurt | 0,11 | 0,003 | 0,11 | 0,12 |
| Min | 0,03 | 0,001 | | |
| Max | 10,14 | 0,536 | | |

*Source:* GfK Consumer Panel 1995; own calculations.
*Note:* All prices expressed as per-unit values (0,01 DM per 1 g or 1 ml).

**Table 3:** Weekly measure of price variability by product group

| Product group | Mean | St. dev. | Min | Max |
|---|---|---|---|---|
| Beer | 3,41% | 0,60% | 2,28% | 4,93% |
| Cereals | 4,14% | 1,07% | 1,50% | 7,24% |
| Cocktail snacks | 7,21% | 2,86% | 3,25% | 16,46% |
| Coffee cream, canned | 3,22% | 0,69% | 1,99% | 4,55% |
| Coffee, extract | 3,20% | 1,23% | 1,15% | 7,33% |
| Coffee, roasted | 4,61% | 0,83% | 3,08% | 6,46% |
| Cooking fat | 4,71% | 0,95% | 3,18% | 7,62% |
| Curds | 8,02% | 2,70% | 4,09% | 19,47% |
| Dairy cream | 5,37% | 1,82% | 2,29% | 10,29% |
| Dish-washing detergent | 5,68% | 1,60% | 2,48% | 10,17% |
| Frozen meals | 9,39% | 1,72% | 5,69% | 14,01% |
| Hard cheese | 6,85% | 2,38% | 2,90% | 15,12% |
| Ice cream | 9,93% | 2,41% | 6,31% | 18,76% |
| Laundry detergent | 5,39% | 1,75% | 2,54% | 10,96% |
| Milk | 4,68% | 1,28% | 3,10% | 9,24% |
| Mineral water | 6,47% | 0,98% | 4,36% | 8,48% |
| Non-alcoholic beverages | 8,58% | 3,16% | 4,58% | 23,14% |
| Non-alcoholic beverages, carbonated | 7,94% | 1,71% | 4,96% | 14,61% |
| Potato meals, ready-to-serve | 6,17% | 1,85% | 3,17% | 11,90% |
| Soft cheese | 4,76% | 1,54% | 2,97% | 9,47% |
| Sparkling wine | 7,96% | 2,07% | 4,62% | 14,97% |
| Toothpaste | 4,95% | 0,87% | 3,50% | 7,69% |
| Yoghurt | 5,98% | 1,32% | 3,89% | 9,57% |
| Min | 3,20% | 0,60% | | |
| Max | 9,93% | 3,16% | | |

*Source:* GfK Consumer Panel 1995; own calculations.

**Table 4:** Pooled panel regressions of price variability on the rate of price change, alternative specifications

| | Coefficient, linear term | Coefficient, absolute term | Coefficient, squared term | Hausman test, P-value | Number of product groups | Number of observa-tions |
|---|---|---|---|---|---|---|
| Model (i.a) | - | **0.557** | - | 1.000 | 23 | 1173 |
| | - | (0.099) | - | | | |
| Model (i.b) | 0.031 | - | **12.951** | 1.000 | 23 | 1173 |
| | (0.044) | - | (2.678) | | | |
| Model (i.c) | - | **0.220** | **8.414** | 1.000 | 23 | 1173 |
| | - | (0.118) | (3.585) | | | |

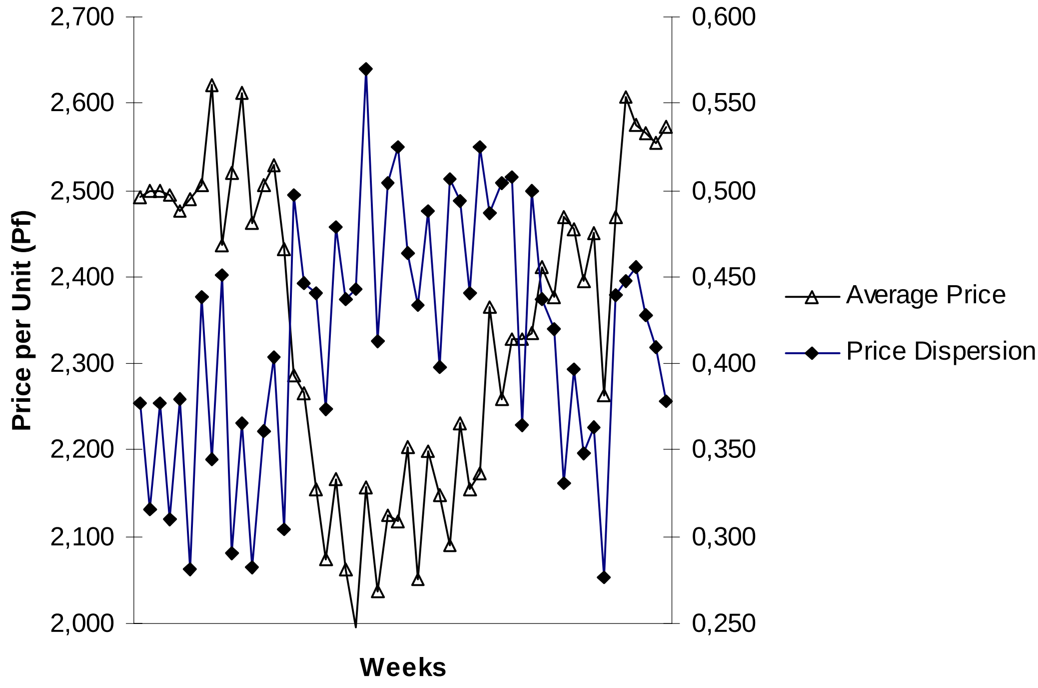
*Source:* GfK Consumer Panel 1995; own calculations.
*Notes:* Parameters in bold face are significant at the 10% level. All models contain a full set of week dummies and random effects. Robust (White) standard errors in parentheses.

**Table 5:** Panel regressions of price variability and price dispersion on the rate of price change, linear specifications

| | Coefficient, linear term | Standard error | Hausman test, P-value | Number of product groups or products | Number of observations |
|---|---|---|---|---|---|
| Model (i.d), dependent variable: price variability | | | | | |
| Pooled | 0,021 | 0,028 | 1,000 | 23 | 1173 |
| Model (ii), dependent variable: price dispersion | | | | | |
| Pooled | **0,34** | 0,060 | 1,000 | 23 | 1173 |
| Model (iii), dependent variable: price dispersion | | | | | |
| Beer | **0,034** | 0,011 | 1,000 | 29 | 1479 |
| Cereals | **0,445** | 0,163 | 1,000 | 8 | 408 |
| Cocktail snacks | **0,299** | 0,046 | 1,000 | 13 | 663 |
| Coffee cream, canned | **0,085** | 0,024 | 1,000 | 33 | 1683 |
| Coffee, extract | 0,043 | 0,267 | 1,000 | 6 | 306 |
| Coffee, roasted | **0,183** | 0,065 | 1,000 | 40 | 2040 |
| Cooking fat | **0,162** | 0,033 | 1,000 | 62 | 3151 |
| Curds | **0,182** | 0,012 | 1,000 | 15 | 765 |
| Dairy cream | **0,253** | 0,056 | 1,000 | 8 | 407 |
| Dish-washing detergent | 0,025 | 0,020 | 1,000 | 14 | 714 |
| Frozen meals | **0,296** | 0,062 | 1,000 | 61 | 3108 |
| Hard cheese | **0,473** | 0,110 | 1,000 | 10 | 508 |
| Ice cream | **0,165** | 0,057 | 1,000 | 16 | 814 |
| Laundry detergent | -0,010 | 0,018 | 1,000 | 7 | 356 |
| Milk | **0,049** | 0,010 | 1,000 | 20 | 1020 |
| Mineral water | **0,027** | 0,004 | 1,000 | 47 | 2397 |
| Non-alcoholic beverages | **0,203** | 0,047 | 1,000 | 43 | 2193 |
| Non-alcol. beverages, carb. | **0,133** | 0,015 | 1,000 | 35 | 1785 |
| Potato meals, ready-to-serve | 0,086 | 0,088 | 0,470 | 15 | 765 |
| Soft cheese | **0,429** | 0,092 | 1,000 | 17 | 863 |
| Sparkling wine | **0,289** | 0,039 | 1,000 | 13 | 663 |
| Toothpaste | **0,498** | 0,115 | 1,000 | 23 | 1173 |
| Yoghurt | **0,062** | 0,023 | 1,000 | 25 | 1261 |
| Mean of significant coefficients | 0,225 | 0,148 | | | |

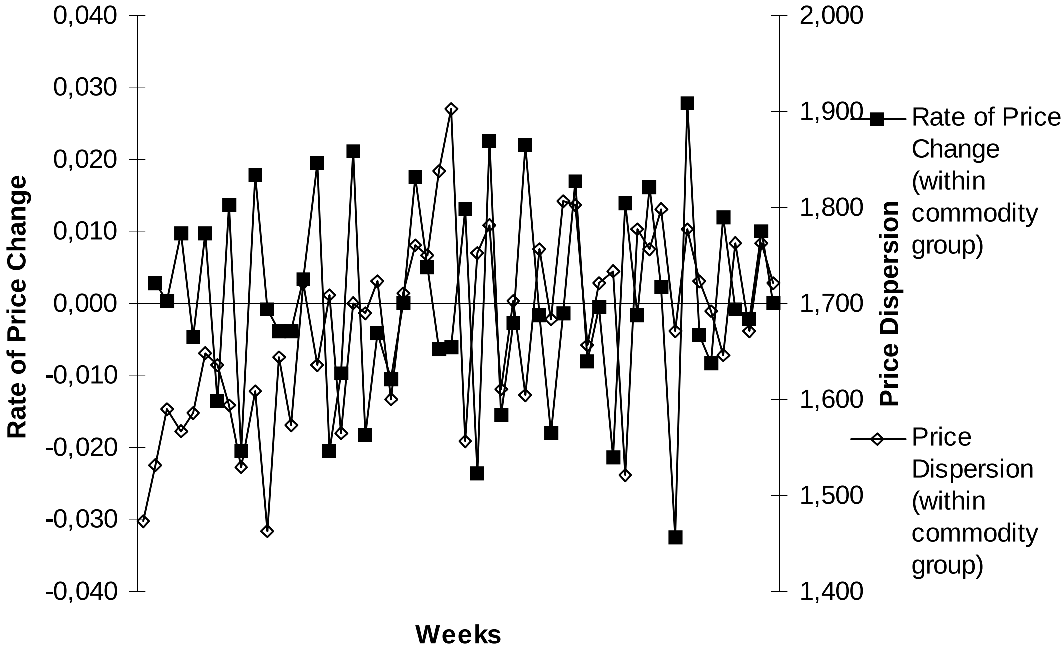
*Source:* GfK Consumer Panel 1995; own calculations.
*Notes:* Parameters in bold face are significant at the 10% level. All models contain a full set of week dummies and random effects. Robust (White) standard errors.

**Figure 1:** Average retail price and price dispersion for one individual tooth paste product



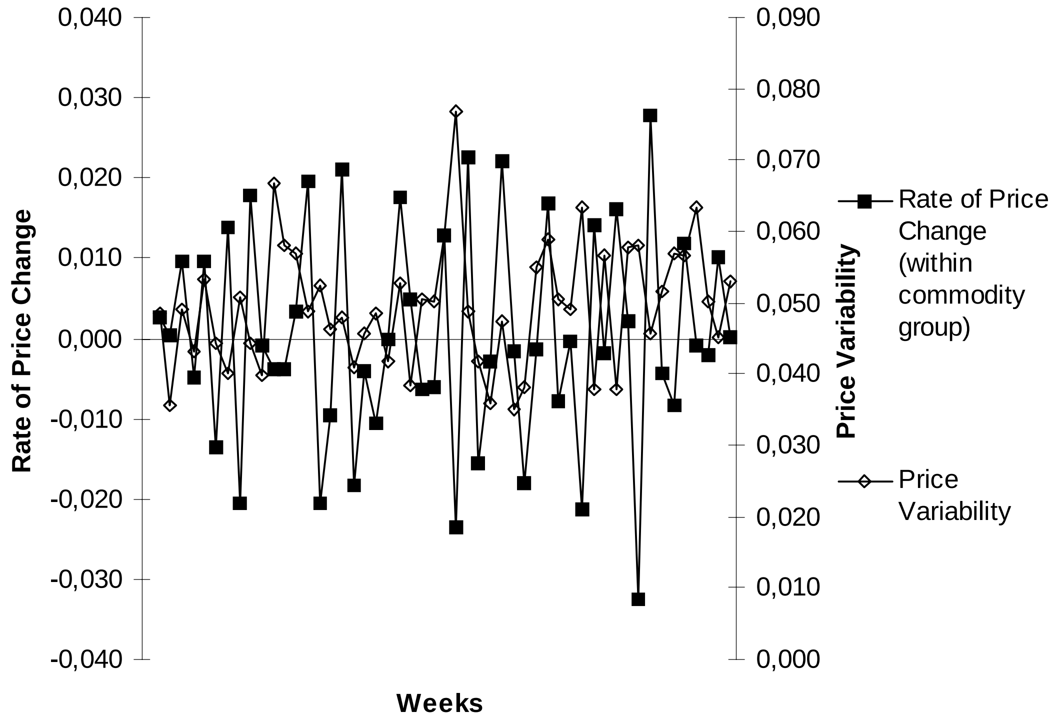

*Source:* GfK Consumer Panel 1995 (commodity group 12, product ID 24199); own calculations.

**Figure 2:** Average rates of price change and price dispersion for product group “tooth paste”




*Source:* GfK Consumer Panel 1995 (product group 11); own calculations.

**Figure 3:** Average rates of price change and price variability for product group “tooth paste”




*Source:* GfK Consumer Panel 1995 (product group 11); own calculations.