Inflation, Price Dispersion, and Monetary Search: Evidence from the European Union

Sascha S. Becker and Dieter Nautz *
Department of Money and Macroeconomics
Goethe University Frankfurt

February 27, 2009

Abstract

Recent monetary search models suggest that the real effects of inflation via its impact on price dispersion are non-linear and depend on the level of market integration. Based on a panel data set consisting of consumer price data for the 27 European Union member states, this paper investigates the impact of market integration on the inflation-price dispersion nexus. In line with theoretical predictions, our results show that the relationship between inflation and price dispersion breaks down for highly integrated markets of the Euro-area, whereas for less integrated markets the relationship gets asymmetrically V-shaped.

Keywords: Inflation; Relative price variability; Monetary search models; Market integration.

JEL classification: E31, C23

*Financial support by the Monetary Stability Foundation is gratefully acknowledged. E-mail: sascha.becker@wiwi.uni-frankfurt.de; nautz@wiwi.uni-frankfurt.de.

1 Introduction

In macroeconomic theory, the impact of inflation on price dispersion is a major channel of real effects of inflation. According to menu-cost (Benabou, 1992) or Lucas-type misperception models (Barro, 1976) inflation increases relative price variability (RPV), distorts the information content of prices, and, thereby, impedes the efficient allocation of resources. Since these models imply a monotonous inflation-RPV nexus, the early empirical evidence is typically based on linear models (see e.g. Parsley, 1996, Grier and Perry, 1996, Debelle and Lamont, 1997, and Jaramillo, 1999).

However, more recent monetary search models predict that the impact of inflation on price dispersion might be more complex. According to Head and Kumar (2005) the inflation-RPV nexus might be asymmetrically V-shaped (implying a positive optimal rate of inflation) if market integration is sufficiently low, whereas for high market integration the real effects of inflation can be neglected. In fact, recent empirical evidence suggest that the inflation-RPV nexus is non-linear, see e.g. Lastrapes (2006), Caraballo, Dabús, and Usabiaga, (2006), and Bick and Nautz (2008). Surprisingly, the empirical relevance of the level of market integration on the inflation-RPV nexus which is a distinguishing feature of monetary search models has not been explored so far. Based on consumer price data for the 27 European Union (EU) member states, this paper tries to fill this gap by investigating the impact of market integration on the relationship between inflation and RPV.

Since monetary search models focus mainly on situations with low or moderate inflation rates (see Head and Kumar, 2005, p.535), the member states of the European Union seem to be natural candidates for an empirical application of monetary search models. First of all because inflation rates remained relatively low and stable in EU member states over the last decade and secondly because there exist notable differences in goods market integration across Europe. In our empirical analysis, we primarily focus on two different country samples. A panel of Euro-area countries in which the level of market integration is relatively high and the huge EU-27 economy consisting of a very heterogeneous group of countries. Compared to the Euro-area group integration is significantly lower within this group. In the Euro-area much progress on the issue of market integration and price transparency has been made with the Single Market Programme of 1992 and the introduction of the Euro in 1999. Using price data across different Euro-area countries, Engel and Rogers (2004) find evidence for an advanced integration of Eurozone consumer markets caused by the efforts to reduce economic barriers initiated in the 1990s. Furthermore, Parsley and Wei (2008) show that market integration among the countries in the Eurozone is uniformly higher than in non-Euro countries. Overall, these results suggest that the EU goods market is more integrated across Euro-area countries compared to the other EU member states.

In line with the Head and Kumar monetary search model, our panel-estimation results indicate that the non-linear effect of inflation on price dispersion strongly depends on the level of goods market integration. When only Euro-area countries are included, which exhibit a high level of market integration, there is no evidence for a significant impact in the inflation-RPV nexus. In contrast, focusing on the EU-27 economy, with less integrated markets, price dispersion is initially decreasing in inflation and increasing thereafter.

The paper is organized as follows. Section 2 discusses the Head and Kumar monetary search model and presents a simulation study for varying levels market integration. Section 3 describes the data and specifies the price variability and inflation measures. In Section 4 the empirical results, as well as some sensitivity analysis, are presented. Section 5 concludes.

2 The Monetary Search Model

2.1 General Survey

Monetary search models emphasize that buyers have only incomplete information about the prices offered by different sellers. In these models the inflation-RPV linkage is determined by the combination of two opposing effects (see Head and Kumar, 2005). On the one hand, higher expected inflation lowers the value of fiat money, increases demand and, thereby, sellers' market power. Furthermore, the increase in demand is associated with higher price dispersion which is driven by differences in market power across sellers. On the other hand, higher expected inflation also raises the gains of search, which lowers sellers market power and, thus, price dispersion. At low levels of inflation, the latter effect can dominate, leading to a reduction of price dispersion whereas at high levels of inflation the former, RPV increasing effect, dominates. As a result, the relationship between expected inflation and price dispersion can be captured by a V-shaped specification where the vertex occurs at positive levels of inflation. Furthermore, for standard assumptions on the buyer's preferences the model predicts an asymmetric response of RPV to expected inflation (see also simulation presented below).

2.2 Search Costs and the Real Effect of Inflation: Results from a Simulation Study

This Section starts with computing a benchmark simulation of the Head and Kumar monetary search model. In addition, we will consider the welfare costs of inflation and determine an optimal inflation rate, Π^*, which can be approximated by the vertex of the inflation-RPV nexus. The last part of this Section investigates the importance of search costs, i.e. the level of market integration, for the relationship between inflation and RPV.

2.2.1 The Inflation-RPV Nexus and Welfare

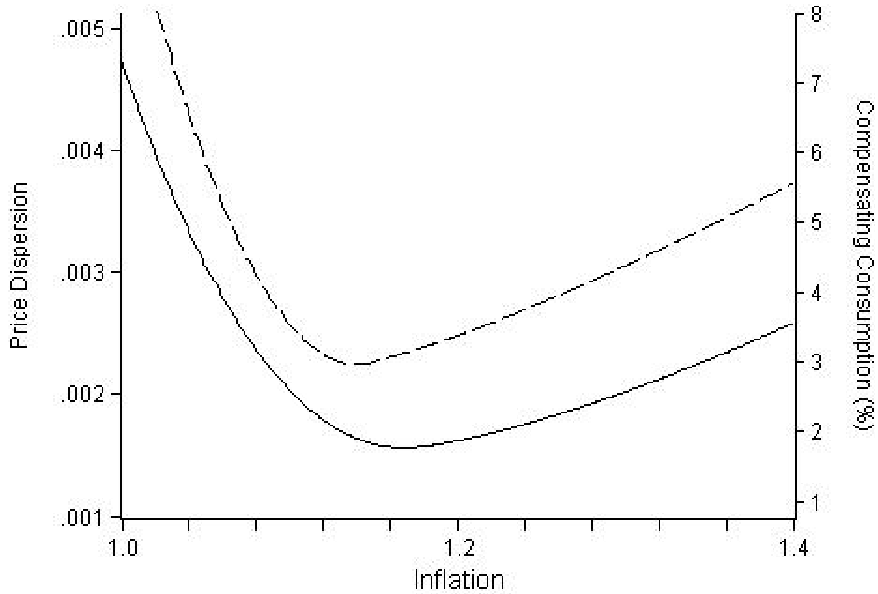
Note that in the Head and Kumar model an utility maximizing household consists of a continuum of buyers and sellers. A representative buyer of this household receives utility from consuming the preferred consumption good and receives disutility from search intensity which comes at a cost μ for each price quote observed. In addition, seller of this household produce a consumption good at marginal costs ϕ which can be sold to other household. Trade is facilitated by the existence of fiat money. In this model the source of inflation is the deterministic growth of the money stock, γ. So, inflation is unambiguously overall inflation. Furthermore, households maximize their utility over an infinite horizon and, thus, they care about expected future money growth, i.e. overall expected inflation.

In order to compute a benchmark simulation the parameter values need to be defined. Hence, we use a CRRA utility function with the coefficient of relative risk aversion equal to 1.5 and set the discount factor, β, equal to 0.95, consistent with an annual interest rate of 4%. To achieve an average mark-up of prices over marginal costs of 10%, we set $\phi = 0.1$ and $\mu = 0.028$.[1] Furthermore, we allow γ, the growth rate of the money stock (the inflation rate), to range between 1 and 1.5. The solid line in Figure 1 depicts the relationship between inflation and price dispersion for this benchmark scenario. In contrast to menu cost and misperception models, the effect of inflation on price dispersion is non-linear. While for lower inflation rates price dispersion is decreasing in inflation, the inflation effect gets positive thereafter. This is driven by the occurrence of two opposing effects on sellers' market power (see Section 2.1).

In the following, the welfare costs of inflation are considered. In line with Head and Kumar (2005), we introduce the function $D(\gamma)$ which denotes the quantity of consumption required to give a representative household the same utility as she would

[1] This mark-up value is consistent with plausible estimates from the literature (see e.g. Gali, Gertler, and Lopez-Salido, 2001). Note that the results presented here are robust with respect to many other parameter constellations.

Figure 1: Price dispersion and welfare in the monetary search model



Notes: Price dispersion (solid line - left scale, $D(\gamma)$ (dashed line - right scale).

receive in the optimum (when search costs are zero) as a percentage of optimum consumption. The fact that inflation induces search adds two dimensions to its effect on welfare. First, the search induced by inflation is costly. And second, because it induces search, inflation increases information and, thereby, weakens market power. The dashed line in Figure 1 illustrates that at low inflation rates, the reduction of market power resulting from increased search in response to an increase in inflation is sufficient to lower welfare losses. However, at sufficiently high rates of inflation increases in the inflation rate have only little effects on search, and, thus, the effects of the rise in sellers' market power dominate. Note that the welfare maximizing inflation rate Π^*, which is determined by the minimum of $D(\gamma)$, is located below but very close to the vertex of the inflation-RPV nexus. So, the vertex of the inflation-RPV nexus serves as a proxy for Π^*.

2.2.2 The Role of Search Costs and Market Integration

The relationship between RPV and inflation strongly depends on the amount of search costs a buyer has to pay in order to observe more prices. To demonstrate how search costs affect the inflation-RPV nexus, we compute model simulations with varying levels of search costs. Recall, that the benchmark simulation is based on search costs equal to 0.028. This generates a mark-up of prices over marginal costs of 10%. Lowering search costs to 0.019 and, thereby, also lowering the average mark-up to 7% causes the inflation-RPV relationship to shift downwards. With $\mu = 0.019$ and holding γ fixed, the proportion of buyer's observing only one price quote is lower compared to the benchmark scenario, simply because households pay less search costs for any given level of search intensity. This holds for all $\gamma \in [1, 1.5]$, i.e. for all levels of inflation. It follows that seller's market power diminishes resulting in a lower level of price dispersion at all inflation rates. However, if search costs fall below a certain threshold value, it is optimal to set the probability of buyer's observing only one price quote equal to zero. In this situation the only possible price distribution is concentrated at the "marginal cost" price. Hence, the distorting effect of inflation on price dispersion vanishes and the classical dichotomy holds. Next, consider an increase in the level search costs ($\mu = 0.0035$; mark-up equal to 15%). Compared to the low search costs scenario sellers' market power now increases at any given inflation rate. So, the inflation-RPV nexus shifts upwards resulting in stronger distortionary effects of inflation on price dispersion.

Note that search costs are closely related to the degree of market integration. A market characterized by a high level of integration enhances the free movement of goods, people, capital, and services, promotes greater transparency in prices, and lowers transaction costs. As a result search cost should decrease in such a market, whereas for less integrated markets search costs should increase.

Overall, these results indicate that the distorting effects of inflation on RPV depends on the level of search costs, i.e. the level of goods market integration. The Sections presented below will, therefore, analyze the impact of different levels of market integration within the European Union for the relationship between inflation and RPV.

3 Data and Measurement

So far, the empirical literature has intensely analyzed the impact of different aspects of inflation on *intermarket* RPV, which is defined as the standard deviation of the rates of inflation of various products of goods and services around the average inflation rate in a given city or country, see e.g. Debelle and Lamont (1997) and Jaramillo (1999). However, the *intramarket* side (deviations of individual product specific inflation rates with respect to the product average inflation rate across cities or countries) seems to be underresearched. Our study focuses on the non-linear effect of inflation on RPV suggested by the MS model. In fact, search models are specifically designed to account for price dispersion within a given market and need to be modified in order to draw implications for price dispersion across markets. Therefore, this paper analyze the empirical relation between inflation and price variability in Europe within the *intramarket* side.[2]

We use monthly data for various subcategories of the Harmonized Index of Consumer Prices (HICP) provided by the Eurostat database. The data set runs from January 1996 to August 2008. It includes seasonally adjusted observations of the twelve major HICP subcategories for all 27 EU member states.[3] In the Head and Kumar monetary search

[2]Additionally, the menu cost models address the price setting behavior of different sellers of the same good and so their predictions are also more about *intramarket* price variability. In contrast, Signal-extraction models are constructed in such a way that the relevant dimension along which prices are compared is the product dimension. So, the relevant concept is the variability of prices of different goods around an aggregate price level, which is referred as the *intermarket* RPV.

[3]These HICP subcategories are: food and non-alcoholic beverages (CP01); alcoholic beverages, tobacco and narcotics (CP02); clothing and footwear (CP03); housing, water, electricity, gas and other fuels (CP04); furnishing, household equipment and routine maintenance of the house (CP05); health (CP06); transport (CP07); communication (CP08); recreation and culture (CP09); education (CP10); restaurants and hotels (CP11); miscellaneous goods and services (CP12).

model, consumer market integration crucially affects the relationship between inflation and price dispersion (see Section 2). Since there are notable differences in market integration across Europe, the member states of the European Union are natural candidates for analyzing the implications of the monetary search model. Parsley and Wei (2008) conclude that market integration across Euro-area countries is uniformly higher compared to non-Euro countries. Therefore, our first group of countries represent the Euro-area. Within this group, markets are highly integrated (see also Engel and Rogers, 2004). By contrast, the second group includes all 27 EU member states. Apparently, this group exhibits a lower degree of market integration. First of all because the number of countries in this group by far exceeds those of the Euro-area group and, secondly, because this group contains a very heterogeneous group of countries.[4]

Following the empirical literature, we define *intramarket* relative price variability as:

$$RPV_{it} = \left[\sum_{j=1}^{N} w_{jt} (\pi_{ijt} - \pi_{it})^2 \right]^{0.5}, \tag{1}$$

where π_{ijt} is the rate of change in the price index of the ith subcategory in country j at time period t and π_{it} is the average rate of change in product category i's price index ($\pi_{it} = \sum_{j=1}^{N} w_{jt}\pi_{ijt}$). w_{jt} is the weight of country j at time t in the overall HICP index ($\sum_{j=1}^{N} w_{jt} = 1$) and N refers to the number of countries under consideration. Due to the implications of the Head and Kumar MS model, we include, in addition to the product specific inflation rates π_{it}, also a measure for overall HICP inflation $\Pi_t = \sum_{j=1}^{N} w_{jt}\Pi_{jt}$, where Π_{jt} is overall inflation in country j in time period t. Panel Unit root tests clearly indicate that all inflation and RPV measures are stationary.[5]

Table 2 in the Appendix presents some summary statistics on the RPV and inflation

[4] Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain are grouped together in Euro-area, whereas the EU-27 group consists of the Euro-area countries plus Bulgaria, Czech Republic, Denmark, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Romania, Slovenia, Slovakia, Sweden and United Kingdom. Although Slovenia, Cyprus and Malta adopted the Euro in 2007 and 2008, respectively, we do not include them into the Euro-area group, because our sample already starts in 1996. This implicates that Slovenia, Cyprus and Malta did not participate in the EMU for the major part of our sample period.

[5] Results of the Panel Unit Root tests are not presented but are available on request.

measures for both set of countries. Additionally, Figures 2 and 3 display the monthly product specific inflation rates and RPV measures for the two panels under investigation. For the EU-27 sample, it is worth mentioning that beginning with the new century inflation rates seem to have stabilized on a lower level (see Figure 3). This might be primarily caused by the enlargement of the European Union within the last five years. Twelve of the twenty-seven countries collected in the EU-27 group joined the EU during this time period. As part of the entry requirements to the EU, each new EU member has the obligation to join the Economic and Monetary Union, subject to the country fulfilling the Maastricht convergence criteria. These convergence criteria, i.e., impose conditions on the price performance of a country such that the joining countries were encouraged to lower and stabilize their inflation rates.

The theories on the relation between inflation and RPV point out the different roles of expected and unexpected inflation. In line with the empirical literature, we base our measures of expected inflation on a time series representation of inflation. Specifically, we estimate an AR(12) model for π_{it} and Π_t.[6] Expected inflation is derived as the one period-ahead inflation forecast while unexpected inflation is the resulting forecast error. Note that beating the forecasting performance of univariate time series models of inflation is not an easy task, particularly over a monthly forecast horizon, see e.g. Elliott and Timmermann (2008).

4 Empirical Results

4.1 The Inflation-RPV nexus: Effects of Market Integration in the EU

This Section studies the implications given by recent monetary search models. Recall that expected inflation in the Head and Kumar model stems from growth in the stock of fiat money. So, our analysis should focus on overall expected inflation (Π^e).

[6]Additionally to the autoregressive parts in the π_{it} forecast model, we also include past values of overall HICP inflation (up to 3 lags).

Furthermore, to control for the predictions of menu-cost and signal extraction models, we follow the empirical literature on the *intramarket* inflation-RPV relationship and include the absolute values of expected (π_i^e) and unexpected ($\pi_i - \pi_i^e$) product specific inflation into our fixed-effects panel equation:

$$RPV_{it} = \alpha_i + \sum_{t=1}^{T} \lambda_t + \beta_1 |\pi_{it}^e| + \beta_2 |(\pi_{it} - \pi_{it}^e)| + \beta_3 |\Pi_t^e - a| + \beta_4 D |\Pi_t^e - a| + \epsilon_{it} \quad (2)$$

The simulations presented in Section 2 are suggestive of capturing the relationship between overall expected inflation and price dispersion by a V-shaped specification where the vertex occurs at positive levels of expected HICP inflation. Therefore, we include the term $|\Pi_t^e - a|$ (with $a \geq 0$) instead of $|\Pi_t^e|$ into our regression model. For $a > 0$ the vertex of the V-shaped inflation-RPV relation shifts away from the origin towards positive values of expected overall inflation. Furthermore, the Head and Kumar model simulation suggests the response of RPV to expected inflation to be highly asymmetric. On that account, the term $D|\Pi_t^e - a|$ is included into Equation (3). D is a dummy variable which equals one when $\Pi_t < a$ and zero otherwise. Finally, our specification also includes a product fixed effect which controls for product heterogeneity and monthly time dummies. To determine the best fitting model specification by means of minimizing the sum of squared residuals SSR, we use a grid search procedure for a.[7] In addition, recall from Section 2 that the parameter value of a which identifies the vertex of the inflation-RPV nexus can be used as a proxy for the optimal welfare maximizing inflation rate Π^*.

The results for the best fitting model specifications are shown in Table 1. In contrast to the Euro-area countries where $a^* = 0$, the optimal a in the EU-27 panel is greater than zero resulting in a right shift of the V-shaped inflation-RPV nexus. For this country group, the null hypothesis $a = 0$ is rejected at the 1% significance level. The parame-

[7] The starting point of our grid search is $a = 0$. Subsequently, we increase a in increments of 0.00025 up to $a = 0.0075$. Note that the average values of monthly overall inflation for our two country samples are 0.001723 and 0.002703 (0.021 and 0.032 in annual terms), respectively (see Table 2). So, $a = 0.0075$ seems to be a reasonable endpoint.

Table 1: The relationship between relative price variability and inflation: Predictions of the Head and Kumar monetary search model

	$RPV_{it} = \alpha_i + \sum_{t=1}^{T} \lambda_t + \beta_1 \lvert \pi^e_{it} \rvert + \beta_2 \lvert (\pi_{it} - \pi^e_{it}) \rvert$ $+ \beta_3 \lvert \Pi^e_t - a \rvert + \beta_4 D \lvert \Pi^e_t - a \rvert + \epsilon_{it}$	
	$Euro-area$	$EU-27$
$\widehat{\beta}_1$	0.333^{**} (0.022)	1.616^{**} (0.183)
$\widehat{\beta}_2$	0.283^{**} (0.004)	0.560^{**} (0.041)
$\widehat{\beta}_3$	0.023 (0.029)	0.343^{**} (0.082)
$\widehat{\beta}_4$	0.132 (0.131)	0.543^{*} (0.251)
a^*	0	0.00250
$H_0: \widehat{\beta}_3 = \widehat{\beta}_4 = 0$	0.874 [0.42]	9.714 [0.00]
$H_0: a = 0$	–	7.891 [0.00]
NOB	1632	1632
Product Groups	12	12
Countries	12	27

Notes: Expected and unexpected inflation series are based on an AR forecast model (see Section 3.1). a^* is an estimated parameter minimizing the sum of squared residuals. Heteroskedasticity-consistent standard errors in parentheses, p-values in brackets. D is a dummy variable equal to 1 when $\Pi^e_t < a$ and zero otherwise. *, ** indicate significance at the 5% and 1% significance level. Sample: 05/1997-08/2008.

ter estimates for these optimal specifications also depend on the country panel under consideration. β_3, the coefficient on overall expected inflation, is not statistically different from zero in the Euro-area model. But, with all EU-27 countries included, β_3 is significant at the 1% significance level. In addition, β_4, the coefficient on $D|\Pi_t^e - a|$, is significantly different from zero in the EU-27 regression, whereas in the Euro-area model no significant effects of β_4 can be found. This implies an asymmetric V-shaped relationship between RPV and expected HICP inflation in the EU-27 model where the vertex occurs at a level of 0.25% monthly inflation, 3% in annual terms. Note that this asymmetric V-shaped relation confirms the theoretical predictions shown in Section 2. In contrast, Caglayan et al. (2008) present evidence in favor of a symmetric relationship between price dispersion and expected overall inflation in Turkey. A value of a^* equal to 0.0025 for the EU-27 economy implies that the optimal annual inflation rate Π^* should be below but close to 3% in theses countries. This value seems reasonable as it almost corresponds with the European Central Bank's definition of price stability. For the Euro-area, however, no real effects of expected HICP inflation on price dispersion can be found. Furthermore, as predicted by menu-cost and misperception models, we find a significant positive effect of expected and unexpected product specific inflation on price dispersion for both country samples. Adding a measure of overall unexpected inflation ($\Pi - \Pi^e$) to Equation (3) does not influence these results. Moreover, the parameter estimates on overall unexpected inflation are insignificant in all models.[8]

Summing up, we do not find significant effects of overall expected inflation on RPV if market integration is high (when only Euro-area countries are included into our regression models). But, if the degree of market integration decreases, e.g. due to different currency areas, price dispersion is decreasing in expected inflation up to the 3% annual level, and is increasing thereafter. These results are in line with the predic-

[8]For a panel consisting of EU-15 countries (Euro-area plus Denmark, Sweden, and the United Kingdom) the results do not qualitatively differ from those presented for the Euro-area.

tions of recent monetary search models in which the inflation-RPV nexus is strongly affected by the level goods market integration. For a less transparent price mechanism, the model predicts a non-linear relation between expected overall inflation and price dispersion. If, however, market integration rises, then the distorting effects of inflation on RPV diminish. Furthermore, when the degree of market integration lies above a certain threshold no real effects of inflation via its impact on price dispersion are present.

4.2 Sensitivity Analysis

The results presented in the previous section indicate the importance of market integration for the relationship between inflation and price dispersion in Europe. Apparently, there is little room for discussion whether Euro-area countries art more integrated compared to all EU-27 member states. But, for the sample period considered here, there may have been some changes in the level of market integration within each country panel. The EU enlargement in 2004 may have influenced the market integration within the EU-27 sample. Alternatively, in the Euro-area sample the introduction of the Euro may have had an effect on the level of market integration (see e.g. Rose, 2000). This section accounts for possible variations in the degrees of market integration within each group by splitting the sample periods according to major political changes.

4.2.1 The Effect of the 2004 EU Enlargement

On the first of May 2004, the European Union saw its biggest enlargement to date when ten countries joined the EU. This may have had significant consequences for market integration within Europe. Due to the relative small economic weight of the acceding countries, however, the effect of the EU enlargement in 2004 may be small for the EU-27 group, but it should implicate major effects for the acceding countries. To analyze the effect of the 2004 EU enlargement on market integration and, thereby, on the relationship between inflation and price dispersion, we introduce a new country panel, called acc-2004, which includes all countries involved in the 2004 EU enlargement.[9]

The results for the pre- and post-05/2004 regressions are shown in Table 3. Again, in line with menu cost and misperception models the impact of expected and unexpected product specific inflation is highly significant for both country groups. This holds for the pre- and post-2004 period. But, there are notable differences with respect to overall expected inflation. In the pre-2004 regressions, we find evidence of a significant asymmetric V-shaped relation between overall expected inflation and RPV, where the vertex occurs at positive levels of inflation. By contrast, the results for the post-2004 period indicate no significant relationship between overall expected inflation and price dispersion for the acceding countries group, whereas for the EU-27 group the effect is still significant. Note, however, that in the post-2004 EU-27 specification we find no evidence for an asymmetric effect of inflation on price dispersion. In addition, the null hypothesis $a = 0$ can not be rejected. In view of the Head and Kumar monetary search model, these results suggest that there exist also notable differences in market integration across different time periods. Especially, when considering the acceding countries where the EU enlargement of 2004 had the strongest impact on market integration. For these countries, we conclude that markets are more integrated in the post-2004 period which causes the distorting effects of HICP inflation on price dispersion to disappear.

4.2.2 The Introduction of the Euro

Within the Euro-area group, the introduction of the Euro might have affected market integration. Note, that in monetary search models search costs are certainly more

[9] So, acc-2004 consists of Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia, and Slovakia.

affected by all price quotes given in a common currency instead of a currency in non-physical form where price comparisons come at the cost of using fixed exchange rates. For this reason and furthermore because of possible small sample problems, we consider the introduction of the Euro in 2002 instead of 1999 and split the sample period into the pre-Euro part (05/1997-12/2001) and the post-Euro part (01/2002-08/2008).

Table 4 summarizes the results for the two sub-samples. Because the introduction of the Euro may have had only minor and negligible effects on market integration within the EU-27 countries, we focus on the Euro-area only. For this country panel, however, the results do qualitatively not differ to those presented in Section 4. While the effects of expected and unexpected product specific inflation rate are significant different from zero, overall expected inflation has no impact on price dispersion. This holds for both, the pre- and post-Euro samples. Furthermore, the shift of the V-shaped inflation-RPV nexus is not statistically different from zero in both sub-samples. So, the introduction of the Euro in 2002 had no impact on the relationship between inflation and RPV. Even before the Euro was introduced, there is no evidence for an significant impact of overall expected inflation on RPV. These results are in line with Engel and Rogers (2004) and Parsley and Wei (2008) who find no evidence for an significant change in the integration of Eurozone consumer markets after the introduction of the Euro. They conclude that market integration in Europe occurred already throughout the decade of the 1990s.

5 Conclusion

Based on recent monetary search models, we analyze the empirical relationship between relative price variability and inflation in Europe. There is evidence that the relation between RPV and expected HICP inflation is V-shaped, where the vertex occurs at positive values of inflation. But, the significance of the inflation-RPV nexus strongly depends on the integration of consumer markets. We show that with less integrated markets, inflation can be welfare improving over the range where price dispersion is decreasing in expected inflation, whereas for markets with a high level of market integration no real effects of expected inflation on RPV can be found. Furthermore, we also present evidence in favor of a changing degree of market integration over time. Especially for the acceding countries, the EU enlargement of 2004 had an important impact on the relation between inflation and RPV. Before 2004 the distorting effects of inflation on RPV are significant whereas after 2004 these effects vanish. Overall, our empirical results confirm the predictions of recent monetary search models in which the non-linear impact of inflation on RPV depends on the level of market integration.

References

Barro, Robert J. 1976. Rational Expectations and the Role of Monetary Policy. *Journal of Monetary Economics* 2:1-32.

Benabou, Roland J. 1992. Inflation and Efficiency in Search Markets. *Review of Economic Studies* 59:299-329.

Bick, Alexander and Dieter Nautz. 2008. Inflation Threshold and Relative Price Variability: Evidence from U.S. Cities. *International Journal of Central Banking* 4:61-76.

Caglayan, Mustafa, Alpay Filiztekin and Michael T. Rauh. 2008. Inflation, price dispersion, and market structure. *European Economic Review* 52:1187-1208.

Caraballo, M. Ángeles, Carlos Dabús and Carlos Usabiaga. 2006. Relative prices and inflation: new evidence from different inflationary contexts. *Applied Economics* 38:1931-44.

Debelle, Guy and Owen Lamont. 1997. Relative Price Variability and Inflation: Evidence from US Cities. *Journal of Political Economy* 105: 132-52.

Elliott, Graham and Allan Timmermann. 2008. Economic Forecasting. *Journal of Economic Literature* 46:3-56.

Engel, Charles and John H. Rogers. 2004. European market integration after the Euro. *Economic Policy* 19:347-84.

Fielding, David and Paul Mizen. 2000. Relative Price Variability and Inflation in Europe. *Economica* 67:57-78.

Gali, Jordi, Gertler, Mark and J. David Lopez-Salido. 2001. European Inflation Dynamics. *European Economic Review* 45:1237-70-

Grier, Kevin B. and Mark J. Perry. 1996. Inflation, Inflation Uncertainty and Relative Price Dispersion: Evidence from bivariate GARCH-M Models. *Journal of Monetary Economics* 38: 391-405.

Head, Allen and Alok Kumar. 2005. Price Dispersion, Inflation, and Welfare. *International Economic Review* 46:533-72.

Jaramillo, Carlos F. 1999. Inflation and Relative Price Variability: Reinstating Parks' Results. *Journal of Money, Credit, and Banking* 31: 375-85.

Lastrapes, William D. 2006. Inflation and the Distribution of Relative Prices: The Role of Productivity and Money Supply Shocks. *Journal of Money, Credit and Banking* 38:2159-198.

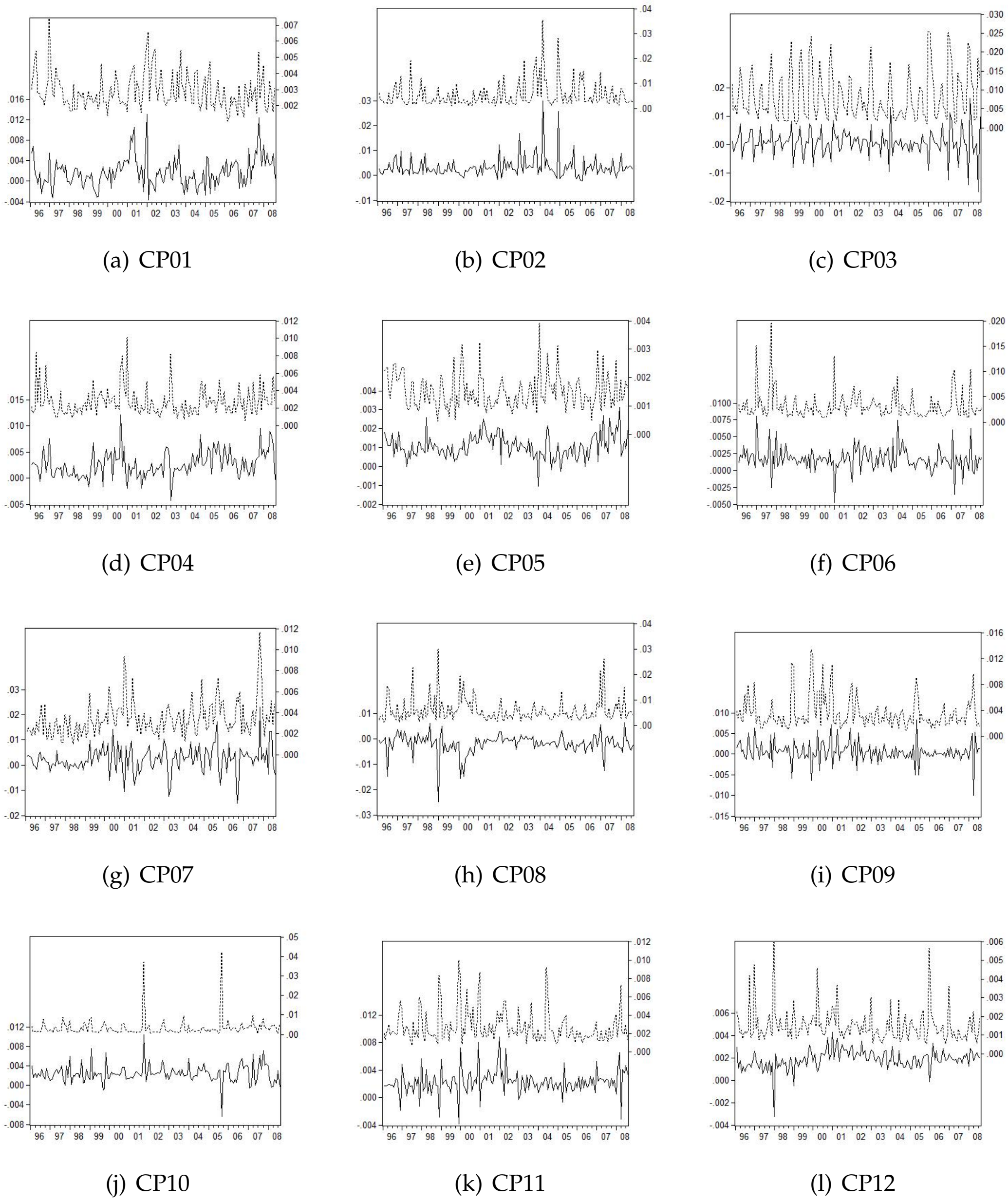
Parsley, David C. 1996. Inflation and Relative Price Variability in the Short and Long Run: New Evidence from the United States. *Journal of Money, Credit and Banking* 28:323-41.

Parsley, David and Shang-Jin Wei. 2008. In search of a euro effect: Big lessons from a Big Mac Meal?. *Journal of International Money and Finance* 27:260-76.

Rose, Andrew K. 2000. One money, one market: estimating the effect of common currencies on trade. *Economic Policy* 30:9-48.

Silver, Mick and Christos Ioannidis. 2001. Intercountry Differences in the Relationship between Relative Price Variability and Average Prices. *Journal of Political Economy* 109:355-74.

Figure 2: Product specific inflation and RPV (Euro-area)



(a) CP01 (b) CP02 (c) CP03

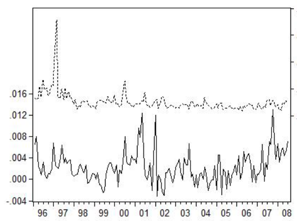
(d) CP04 (e) CP05 (f) CP06

(g) CP07 (h) CP08 (i) CP09

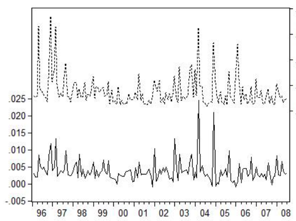
(j) CP10 (k) CP11 (l) CP12

Notes: Monthly HICP product specific inflation rates (left scale). Monthly product specific RPV (right scale). 1996.02-2008.08.

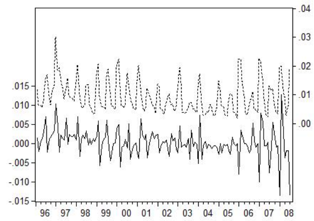
Figure 3: Product specific inflation and RPV (EU-27)



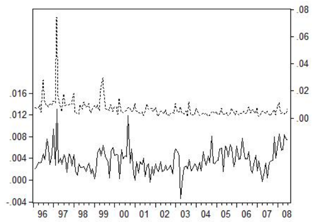
(a) CP01



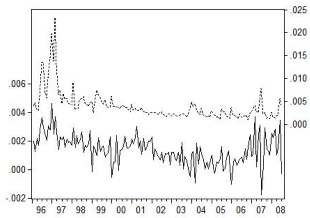
(b) CP02



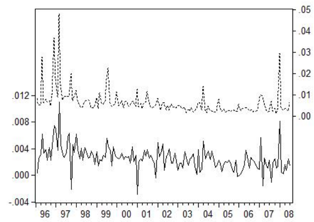
(c) CP03



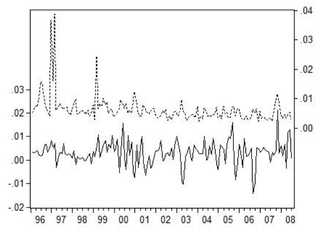
(d) CP04



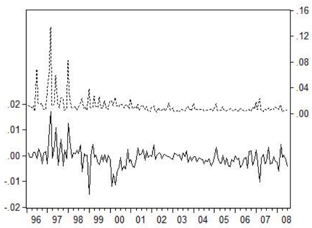
(e) CP05



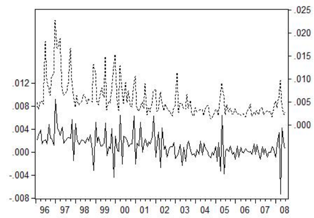
(f) CP06



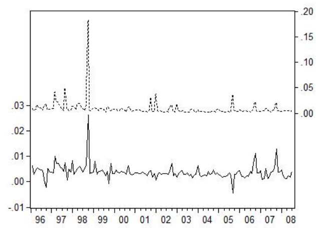
(g) CP07



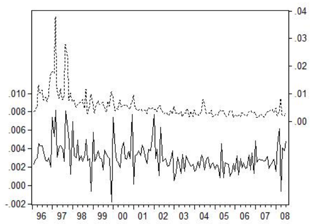
(h) CP08



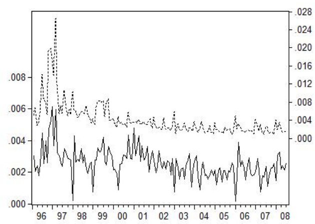
(i) CP09



(j) CP10



(k) CP11



(l) CP12

Notes: Monthly HICP product specific inflation rates (left scale). Monthly product specific RPV (right scale). 1996.02-2008.08.

Table 2: Summary Statistics

	Mean	Standard Deviation	Minimum	Maximum	Countries	Product Groups	NOB
Euro-area							
Π_t	0.001723	0.002573	-0.005985	0.009748	12	12	151
RPV_{it}	0.003763	0.004623	0.000460	0.097040	12	12	1812
EU-27							
Π_t	0.002703	0.003162	-0.004868	0.025044	27	12	151
RPV_{it}	0.006790	0.008490	0.000845	0.182809	27	12	1812

Notes: Monthly overall HICP inflation is denoted by Π_t and RPV_{it} measures monthly product specific relative price variability (see Section 3.1 for further explanations). Sample: 1996.02-2008.08.

Table 3: The relationship between relative price variability and inflation:
Effects of the EU enlargement in 2004

$$RPV_{it} = \alpha_i + \sum_{t=1}^{T} \lambda_t + \beta_1|\pi^e_{it}| + \beta_2|(\pi_{it} - \pi^e_{it})| + \beta_3|\Pi^e_t - a| + \beta_4 D|\Pi^e_t - a| + \epsilon_{it}$$

	05/1997 – 04/2004		05/2004 – 08/2008	
	$acc-2004$	$EU-27$	$acc-2004$	$EU-27$
$\widehat{\beta}_1$	1.104** (0.146)	2.373** (0.266)	0.327* (0.148)	0.823** (0.251)
$\widehat{\beta}_2$	0.458** (0.157)	0.984** (0.085)	0.262** (0.016)	0.391** (0.004)
$\widehat{\beta}_3$	0.341** (0.102)	0.213** (0.052)	0.154 (0.116)	0.331* (0.131)
$\widehat{\beta}_4$	0.308** (0.078)	0.478* (0.234)	0.226 (0.334)	0.328 (0.447)
a^*	0.00575	0.00225	0.00335	0.00250
$H_0:\ \widehat{\beta}_3 = \widehat{\beta}_4 = 0$	6.917 [0.00]	5.721 [0.00]	0.785 [0.46]	3.242 [0.04]
$H_0:\ a = 0$	7.363 [0.00]	6.853 [0.01]	0.759 [0.38]	2.427 [0.12]
NOB	1008	1008	624	624
Product Groups	12	12	12	12
Countries	10	27	10	27

Notes: Expected and unexpected inflation series are based on an AR forecast model (see Section 3.1). a^* is an estimated parameter minimizing the sum of squared residuals. Heteroskedasticity-consistent standard errors in parentheses, p-values in brackets. D is a dummy variable equal to 1 when $\Pi^e_t < a$ and zero otherwise. *, ** indicate significance at the 5% and 1% significance level.

Table 4: The relationship between relative price variability and inflation: Effects of the Euro introduction in 2002

$$RPV_{it} = \alpha_i + \sum_{t=1}^{T} \lambda_t + \beta_1|\pi_{it}^e| + \beta_2|(\pi_{it} - \pi_{it}^e)| + \beta_3|\Pi_t^e - a| + \beta_4 D|\Pi_t^e - a| + \epsilon_{it}$$

	05/1997-12/2001	01/2002-08/2008
$\widehat{\beta}_1$	0.175** (0.040)	0.382** (0.029)
$\widehat{\beta}_2$	0.139** (0.028)	0.280** (0.051)
$\widehat{\beta}_3$	0.155 (0.127)	0.066 (0.058)
$\widehat{\beta}_4$	−0.531 (0.900)	0.193 (0.161)
a^*	0.0015	0.001
$H_0: \widehat{\beta}_3 = \widehat{\beta}_4 = 0$	0.975 [0.38]	1.527 [0.22]
$H_0: a = 0$	1.691 [0.19]	1.425 [0.23]
NOB	672	960
Product Groups	12	12
Countries	12	12

Notes: Euro-area panel used. Expected and unexpected inflation series are based on an AR forecast model (see Section 3.1). a^* is an estimated parameter minimizing the sum of squared residuals. Heteroskedasticity-consistent standard errors in parentheses, p-values in brackets. D is a dummy variable equal to 1 when $\Pi_t^e < a$ and zero otherwise. *, ** indicate significance at the 5% and 1% significance level.