INFLATION PERSISTENCE AND PRICE SETTING BEHAVIOUR IN THE EURO AREA

A SUMMARY OF THE IPN EVIDENCE *

By

Filippo Altissimo, Michael Ehrmann and Frank Smets

Introduction

The scope of this paper is to provide a summary of current knowledge on inflation persistence and price stickiness in the euro area. A thorough understanding of the patterns and determinants of inflation persistence is important for policymakers, as inflation persistence has immediate consequences for conducting monetary policy; for example, the appropriate response to shocks depends on the degree to which their effect on inflation is persistent. While it is the properties of aggregate inflation that are eventually of interest for policy making, it is crucial to understand the main features and determinants of the behavioural mechanisms underlying price setting, as these are an important factor in the way prices and inflation behave over time. Accordingly, this paper will be organised around three main questions:

- What are the characteristics of inflation dynamics in the euro area?
- What do micro data tell us about price setting behaviour in the euro area?
- What lessons can we draw for monetary policy making?

The paper draws mainly on results of the Eurosystem Inflation Persistence Network (hereafter IPN). The IPN has been a collaborative endeavour of all NCBs of the Eurosystem and the ECB, aimed at conducting an in-depth study of the patterns and determinants of inflation persistence. For these purposes, the IPN has availed itself of an unprecedented data set, covering a large amount of information on macroeconomic and sectoral variables and on price-setting behaviour at the individual firm level (see Annex for a more detailed overview). On the one hand, the individual price records underlying the construction of both

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* This paper heavily draws on the large number of research papers that have been produced in the context of the Inflation Persistence Network (IPN), a collaborative endeavour of all NCBs of the Eurosystem and the ECB, aimed at conducting an in-depth study of the patterns and determinants of inflation persistence. See www.ecb.int for a complete list. Moreover, the paper has benefited substantially from comments and input received by members of the IPN.

consumer and producer price indices have been made available in a large number of euro area countries, often covering a large fraction of the total databases constructed by the National Statistical Institutes. On the other hand, the IPN has conducted surveys on price setting behaviour in nine countries of the euro area. Taken together, these databases constitute a unique opportunity to understand the behaviour of price setters. They are unprecedented even in an international comparison, as the coverage of data available to the IPN extends beyond what is available for other economies, including the United States.

This paper has been written with an emphasis on information that can be of interest for the monetary policy debate and that has interesting policy implications. The work is structured as follows. Section 1 provides an overall summary of the results which will be presented in the rest of the paper. Section 2 explains the concept of inflation persistence in the context of a small, stylised model of inflation dynamics, and discusses to what extent inflation persistence is interrelated with price stickiness. After this, Section 3 reports the evidence on inflation persistence at the macroeconomic level for the euro area as well as at the country and sectoral level. The importance of administered prices and aggregation for inflation persistence is discussed, and the role of inflation expectations is analysed. Section 4 looks at the mechanics of individual price adjustment. Patterns of price setting (such as the frequencies at which prices are changed or their magnitudes), the rules followed by price setters as well as the reasons for sluggish price dynamics are presented and discussed, separately for producer and consumer prices. Finally, Section 5 discusses some policy implications of the findings, while Section 6 concludes.

1. Main findings of the Inflation Persistence Network

We can synthesize the main findings of the Inflation Persistence Network around five points.

Under the current monetary policy regime the estimated degree of inflation persistence in the euro area is moderate

While estimates of the degree of inflation persistence in the euro area over long time samples find that inflation behaves in a very persistent fashion, this result needs to be qualified substantially when looking at the current monetary policy regime, as done in Section 3. Long sample periods cover several monetary policy regimes, which often are characterised by different values of average inflation. Accordingly, the changes in regimes have brought about long-lasting changes in average inflation, which should not be mistaken for inflation persistence in response to other disturbances. Accounting for changes in monetary policy regimes either by restricting the sample to cover the current policy regime or by allowing for statistically significant changes in the mean of inflation, most studies arrive at the conclusion that inflation (measured as quarter-on-quarter inflation) is only moderately persistent. Moreover, there is some evidence that the degree of inflation persistence may have fallen over the last decade. There is, however, a considerable degree of uncertainty surrounding those estimates, which typically also depend on the inflation index used.

An important explanatory factor behind this moderate degree of inflation persistence is the anchoring of *inflation expectations* of economic agents. By conducting monetary policy such that inflation expectations of economic agents are well anchored, the central bank can ensure that actual inflation does not deviate for too long, and in a too persistent fashion from what it has announced as its medium-run objective for inflation. In economies where central banks have adopted explicit inflation objectives, long-run inflation expectations have been successfully anchored, and as a result inflation expectations are much less dependent on past inflation and actual inflation developments are less persistent.

Greater price stickiness in the retail sector in the euro area than in the US

The micro evidence of the IPN reported in Section 4 shows that *prices change infrequently*. Prices in sectors covered by the consumer price index are unchanged on average for 4 to 5 quarters. The frequency of price changes is somewhat lower in the retail sector compared to the producer sector, where the median firm changes its price once a year. This finding implies that prices in the consumer sector are substantially more sticky in the euro area than in the United States, where consumer prices have been found to change twice as often, i.e. every two quarters.

Price stickiness can arise due to various reasons. On the one hand, in a stable macroeconomic environment, where agents trust in price stability, there is less need to change prices. On the other hand, there might be structural inefficiencies that can prevent firms from changing prices. According to the price setting surveys, the most important reasons that prevent immediate price adjustment are i) long-run relationships with customers, ii) explicit contracts which are costly to re-negotiate; and iii) coordination problems arising from the fact that firms prefer not to change prices unless their competitors do so. Menu costs and costs of gathering information are reported to be less important. The reasons for the difference in the degree of price stickiness in the retail sector between the euro area and the United States are unclear and may be due to a number of factors such as differences in measurement, differences in the importance of long-run relationships, differences in the variability of the underlying costs such as wages and differences in the degree of competition.

There is significant sectoral heterogeneity in the degree of price stickiness

The micro evidence of the IPN also shows that there is a substantial degree of *heterogeneity in the degree of price stickiness across products*. Price changes are very frequent for energy and unprocessed food, while they are relatively infrequent for non-energy industrial goods and particularly services. Beyond such heterogeneity across product categories, there is also substantial heterogeneity of price-setting behaviour within product categories.

Various factors may drive this heterogeneity. One important factor is the variability of the input costs. For example, it has been found that prices change less frequently for products with a larger share of labour input and with a smaller share of intermediate energy inputs. This suggests that persistence in wage developments can be a cause for price stickiness. The IPN has also uncovered some evidence that larger

competition reduces price stickiness. For example, consumer prices are changed more often in supermarkets and hypermarkets compared to higher-priced corner-shops. Furthermore, the survey results have shown that firms in highly competitive markets respond more strongly to changes in underlying factors. Structural reforms to enhance competitiveness in labour and product markets might therefore help in reducing the importance of price stickiness. At the same time, it is also important to note that price stickiness need not necessarily be undesirable, e.g. if consumers prefer to purchase their goods in retail outlets that change prices less frequently, and particularly if retailers follow a pricing strategy of keeping prices fixed at a low level.

Price decreases are not uncommon

The micro evidence of the IPN shows that price *decreases* are not uncommon, with the notable exception of services. On average, around 40% of price changes are price reductions (whereas in services, this number stands at 20%). Looking at the magnitude of price changes, it turns out that price increases as well as decreases are sizeable compared to the inflation rate. The average consumer price increase is found to be in the order of 8%, and the average price decrease slightly larger at 10%.

The finding that overall price falls are very common has important implications for the optimal inflation objective. It has been argued that downward nominal price rigidities that are not matched by similar upward rigidities may justify a higher inflation objective in order to facilitate relative price adjustments. The IPN findings do not suggest that this is an important reason for such an inflation buffer. However, the exception of services is important in this respect, given its large weight in the HICP and the fact that services are largely non-tradable. To the extent that the services sector has a relatively large labour input share, another possible reason for its downward price rigidity is downward nominal wage rigidity, which in itself could be a relevant factor for maintaining an inflation buffer.

Monetary policy response, the degree of price level stickiness and the intrinsic inflation persistence

Based on the use of an estimated micro-founded DSGE model for the euro area, Section 6 also investigates the implications of those findings for the response of a medium-term orientated monetary policy to cost-push shocks. With a low degree of intrinsic inflation persistence, the immediate impact of an inflation shock will be smaller as agents anticipate a lower persistence of this inflation shock and therefore reduce their expectations of future inflation; therefore a low degree of inflation persistence improves the inflation-output variability trade-off and calls for a reduced policy response to cost-push shocks. Additionally, a higher degree of price stickiness implies that the overall sacrifice ratio involved in achieving this broadly similar inflation path is higher. With prices being stickier, inflation will not respond to developments in marginal costs and/or the output gap to the same extent and at the same pace as in an economy with flexible prices. Accordingly, stabilising inflation will be more costly in terms of output losses: for a targeted reduction in inflation, output needs to be reduced by more and in a more persistent manner than in the case of flexible prices. Therefore, a credible central bank has higher

incentive to smooth out its policy response. Overall, a low degree of intrinsic inflation persistence and a high degree of price level stickiness appear to justify a less aggressive response to cost-push shocks.

2. Definition and sources of inflation persistence

As discussed in the introduction, the main goal of the IPN was to understand the dynamic properties of inflation, notably the speed and pattern of inflation adjustment in response to shocks of different nature, and the role of the price setting process of firms and retailers in generating persistence. Whereas inflation can be moved persistently from target due to a *sequence* of shocks, the focus of this paper will be to shed light on the question how inflation behaves in response to a *given* shock. The notion of persistence used in this paper does not refer to situations where, in the absence of shocks, inflation remains persistently at target, but instead emphasises how quickly inflation returns to target once it has deviated from it. Accordingly, the *definition of inflation persistence* used by the IPN refers to *the tendency of inflation to converge slowly towards its long-run value following a shock* which has led inflation away from its long-run value.[1]

The practical relevance of this question can easily be seen by looking at the main factors that affected inflation in the euro area in the years since the introduction of the euro. Various shocks (related to strong exchange rate movements, animal diseases, adverse weather conditions, the cash changeover, fiscal measures and oil price shocks) have moved inflation away from the definition of price stability. At the same time, inflation has remained systematically above 2% for a prolonged period, despite relatively weak economic performance. In order to understand this pattern of inflation, it is important to disentangle whether this persistence has been due to i) a sequence of adverse shocks; ii) the inertial response of inflation following each of those shocks; or iii) other reasons, such as an over-estimation of the degree of slack in the economy, an insufficient response of firms' cost factors (such as wages) to the weak economic performance, or a larger than expected sacrifice ratio. Furthermore, looking ahead, it is important for the conduct of monetary policy to be able to assess *ex ante* how long inflation will be moved away from the definition of price stability in the aftermath of such shocks.

Various factors may lie behind a slow adjustment of inflation. The discussion in this section will highlight the most important ones, distinguishing between (i) persistence that is inherited from persistent fluctuations in the determinants of inflation such as marginal costs or the output gap ("extrinsic persistence"); (ii) the dependence of inflation on its own past ("intrinsic persistence"); and (iii) persistence due to the formation of inflation expectations ("expectations-based persistence"). Each of these three sources of inflation persistence can be associated with one of the three terms in a traditional

[1] See Angeloni et al. (2004).

New Keynesian Phillips curve which relates current inflation to its own lag, the expectation of future inflation, the output gap and a cost-push shock:[2]

$$\pi_t = \gamma\pi_{t-1} + (1-\gamma)E_t\pi_{t+1} + \kappa y_t + u_t \quad (1)$$

Although these sources of persistence will be discussed separately in the remainder of this section, it is important to emphasise that they may be difficult to distinguish, in theory as well as empirically, since they interact with each other, and their relative importance will also very much depend on the monetary policy regime and the policy reaction function.

In order to illustrate this, we will make use of a small stylised model of the economy which consists of a Phillips curve as described above, an IS relation, which links the current output gap to its own lagged and future expected value, the real interest rate and a demand shock, and an equation capturing the behaviour of the policy maker, who can either set policy according to a simple rule (such as the prominent Taylor rule), or in an "optimal" fashion depending on the structure of the economy. Despite the simplicity of the described model, it is rich enough to provide the proper intuition on the main link between inflation persistence, agents' expectations and policy design.[3]

Extrinsic Persistence

Firms generally do not reset prices on the products they sell every day. This could be for multiple reasons. For instance, it could simply be too costly to calculate a new price for a firm's entire range of products every day. This implies that over time prices could be out of line with the current economic situation (i.e. prices of inputs, demand situation etc.). Since firms realise that their prices will be fixed for a certain period, they will likely incorporate the expected future evolution of the economic variables that are relevant for the price setting decision, for instance the future prices of their raw materials. On the other hand, past developments will affect price setting if these are persistent (such as, e.g., wage settlements). So both the past and the expected future evolution of the economic situation will have an effect on price setting decisions. Since not all firms in the economy will react simultaneously to changes in the economic

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[2] Such a model of inflation dynamics can be derived from micro-foundations under the assumption that price setters operate in monopolistically competitive goods markets with so-called Calvo-style contracts, whereby there is a fixed probability that a firm resets its price in each period. This assumption will lead to a purely forward-looking model, however. The addition of a lagged inflation term can be justified, e.g., by assuming partial indexation of prices of those price setters that cannot re-optimise in a given period. The degree of price stickiness will affect the response of inflation to output, κ, as well as the variance of cost-push shocks, σ_u: the stickier prices are, the smaller κ, and the smaller σ_u.

[3] The simulations in this section are based on the following model:

$$\pi_t = \gamma\pi_{t-1} + (1-\gamma)E_t\pi_{t+1} + \kappa y_t + u_t \quad \text{(Phillips curve)}$$

$$y_t = \delta y_{t-1} + (1-\delta)E_t y_{t+1} - \sigma(r_t - E_t\pi_{t+1}) + \varepsilon_t \quad \text{(IS curve)}$$

$$r_t = \lambda r_{t-1} + (1-\lambda)(\alpha_\pi E_t\pi_{t+1} + \alpha_y E_t y_{t+1}) \quad \text{(Taylor rule)}$$

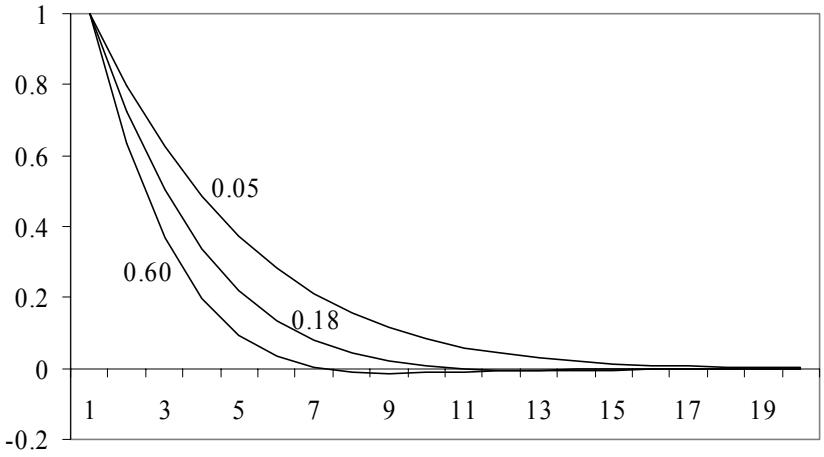
where π is inflation, y is the output gap, E denotes the expectations operator, u is a cost-push shock, ε a demand shock and r is the policy rate. The parameters are calibrated following Smets (2004): γ=0.48; κ=0.18; δ=0.44; σ=0.06; σ_ε=0.65; σ_u=0.7; α_π=1.5; α_y=0.5; λ=0.0. The simulations under learning assume that the private sector does not know the parameters of the model. Instead, agents have to learn the parameter values. This is done through so-called constant gain learning, whereby more distant observations are allotted smaller weights.

environment, this type of price setting behaviour can lead to persistence in inflation, especially if the economic environment (e.g. input prices) shows persistent changes. In such a case, inflation inherits the persistence of its proximate determinants such as the real marginal cost or the output gap. This is what is called "extrinsic inflation persistence".

The more rigid prices are, the less responsive inflation becomes to changes in its proximate determinants, such as the output gap. Accordingly, more price stickiness implies lower values of κ in the New Keynesian model. At the same time, however, it is important to note that this parameter is also affected by the degree of real rigidities, e.g. the sensitivity of real wages to changes in the degree of economic slack. Finally, the response of inflation to a shock will obviously furthermore depend on the inertia of the output gap itself. Figure 2.1 illustrates the importance of price stickiness by plotting the response of inflation to a cost-push shock, which initially increases inflation by 1%, for three different values of κ, proxying for different degrees of price stickiness. The experiment shows the response for a euro area benchmark model in the middle line, and then arbitrarily picks two other values for κ, one higher and one lower. The figure shows that the response of inflation becomes flatter with more sticky prices; i.e. it takes longer for inflation to return to the value it had before the shock occurred.[4] It is important to note that this positive relationship between the degree of inflation persistence and the degree of price stickiness also depends on the degree to which inflation depends on its own past and on the behaviour of the policy makers, as will be shown below.

[4] This experiment was conducted keeping constant the inertia in the drivers of inflation and the dependence of inflation on its own past. Note furthermore that more price stickiness will reduce the variance of the cost-push shock, u_t, which is not considered in the simulations performed here. While in this section, simulations will only be performed for cost-push shocks, the empirical evidence will generally not distinguish between the sources of shocks.

Figure 2.1: The response of inflation to a cost-push shock, for different values of price stickiness



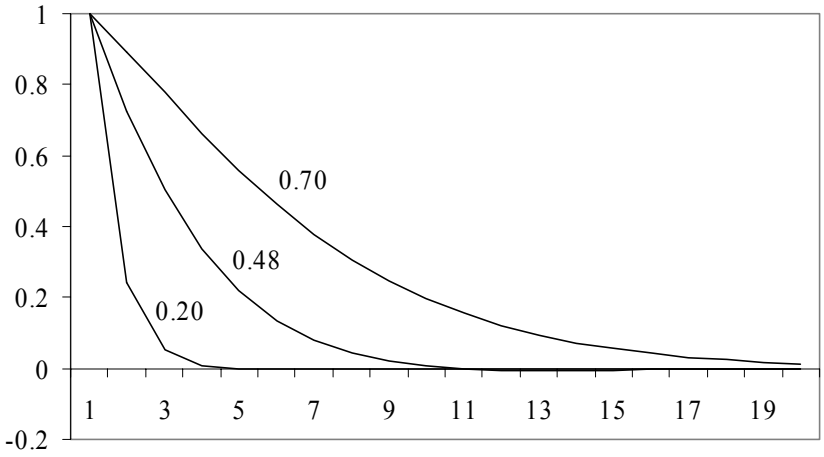
Note: The different impulse response functions are derived using the three reported values of κ (which itself depends on the degree to which prices are sticky in the economy) in the New Keynesian model described in footnote 5. Higher values of κ are related with lower price stickiness. Numbers on the x-axis denote quarters.

Intrinsic Persistence

Even in the presence of nominal rigidities, it is not clear why inflation should depend on its own past, once developments in the determinants of inflation have been accounted for. If firms can change prices less often, the sensitivity of inflation to changes in current and future marginal costs will be reduced, but it can not explain why inflation should depend on its own history. Such dependence can be generated in theoretical models through the assumption of indexation or rule-of-thumb behaviour on the part of the price setters.[5] An increase in the fraction of firms that set prices in a backward-looking fashion *ceteris paribus* raises inflation persistence. Similarly, an increase in the importance of backward-looking indexation will generally also increase the degree of inflation persistence. In the context of New-Keynesian Phillips curve discussed above, this implies that the parameter on lagged inflation becomes more important. Figure 2.2 illustrates this effect on the persistence of inflation in response to a cost-push shock, in analogy to the simulations performed in Figure 2.1. The degree to which larger coefficients on lagged inflation generate larger inflation persistence is immediately apparent from this figure.

[5] In the standard micro-founded macro models of inflation determination (Calvo, 1983, Taylor, 1999 or Rotemberg, 1982) there is generally no independent role for lagged inflation. A standard Taylor-contracting model even implies that inflation will depend negatively on past inflation, once the impact of the current and expected evolution of its determinants is taken into account (Whelan 2004).

Figure 2.2: The response of inflation to a cost-push shock, for different values of backward-lookingness



Note: The different impulse response functions are derived using the three reported values of γ in the New Keynesian model described in footnote 5. Numbers on the x-axis denote quarters.

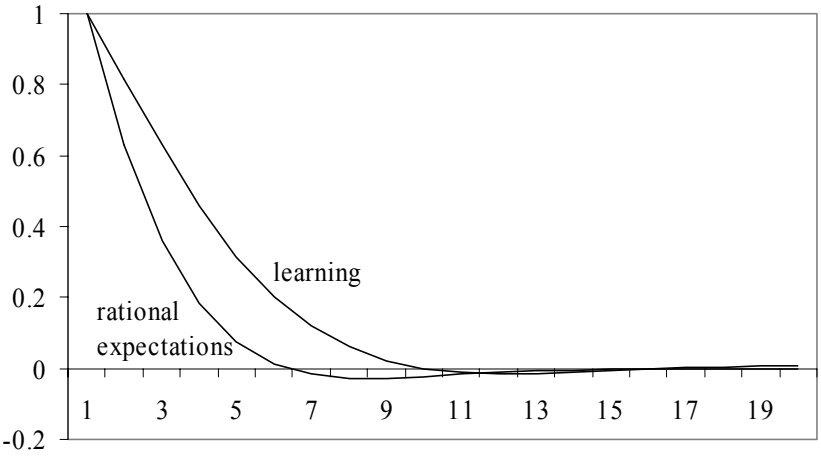
Expectations-based persistence

Most theories of inflation dynamics accord a significant role to inflation expectations in the determination of inflation. However, under the assumption of rational expectations, inflation expectations by themselves will not contribute to the persistence of the inflation process. This result changes, however, once relatively small deviations from the assumption of perfect information are allowed for. For example, imperfect information about the nature of shocks (e.g. whether they are temporary or permanent) that are affecting the economy may lead to more persistent and gradual responses of inflation to shocks, as economic agents need to learn about the underlying characteristics of a shock.[6] Similarly, when price setters do not know the precise structure of the economy, they may use simple reduced-form autoregressions to forecast inflation. This type of learning makes the perceived and actual degree of inflation persistence time-varying and a function of the history of shocks.[7] Figure 2.3 illustrates that this type of learning behaviour will also generally increase inflation persistence.

[6] For example, Ehrmann and Smets (2003) show that the effects of a cost-push shock become more persistent when the private sector can not distinguish between temporary cost-push shocks and permanent shocks to potential output. Similarly, Erceg and Levin (2004) explain the persistent effects of the Volker disinflation by the private sector's learning about whether the monetary policy induced fall in inflation is permanent or temporary.

[7] Gaspar, Smets and Vestin (2005).

Figure 2.3: The response of inflation to a cost-push shock, with and without learning



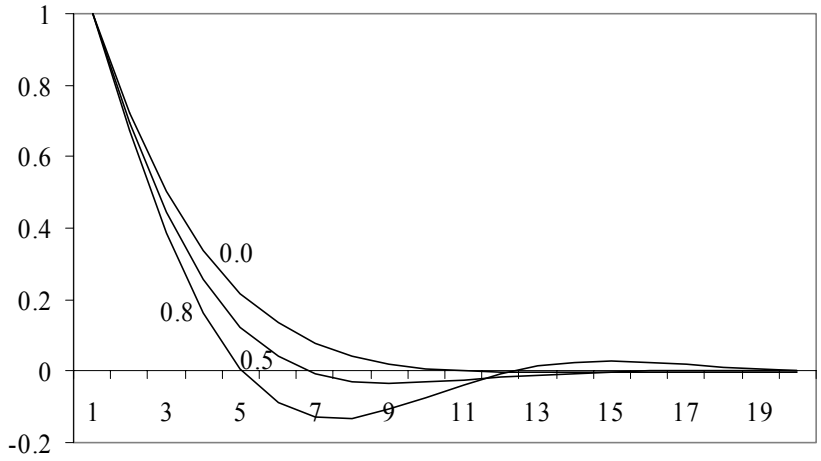
Note: The different impulse response functions from a model as described in footnote 5 (rational expectations case), and a model where the private sector needs to learn about the parameters in the model. This is done through so-called constant gain learning. Numbers on the x-axis denote quarters.

The role of monetary policy

Each of the factors discussed above will play an important role in determining the overall degree of inflation persistence. However, it is worth emphasising again that the monetary policy reaction function will also play a crucial role. To illustrate this, Figure 2.4 shows how for instance the degree of interest rate smoothing by the central bank will affect the speed with which inflation reverts back to its long-run level. With more smoothing, interest rates will react more slowly, but will also be higher for a prolonged period of time. In response to the latter, inflation expectations will be reduced more quickly, which leads to a quicker return of inflation to its earlier level.[8]

[8] This is comparable to a situation where the central bank conducts optimal policy under commitment. In such a situation, interest rates will be history-dependent, which resembles the interest rate smoothing in the current setup in that interest rates will respond less initially, but remain higher for a longer period of time than otherwise. The main effect of this policy is to steer inflation expectations. As in Figure 2.4, such a policy will tend to generate "undershooting" of inflation after a while, i.e. inflation will be lower than its initial level for some period of time.

Figure 2.4: The response of inflation to a cost-push shock, for different values of interest-rate smoothing



Note: The different impulse response functions are derived using the three reported values of λ in the New Keynesian model described in footnote 5. Numbers on the x-axis denote quarters.

3. Aggregate inflation dynamics

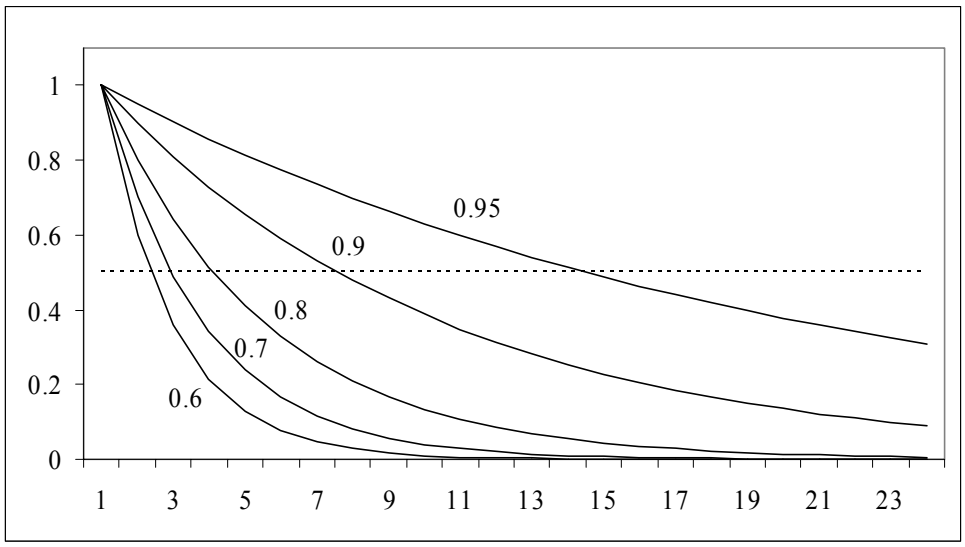
Having gone through the various determinants of inflation persistence, in this Section we document the evidence for the euro area based on macro and sectoral data. Section 3.1, first, presents the reduced-form evidence on macro inflation persistence. In light of the working definition of inflation persistence mentioned above, an important question is how to take into account shifts in the medium-term inflation objective of the central bank. Then, section 3.2 summarises the available evidence on the estimation of structural inflation equations like equation (1) above. Finally, section 3.3 discusses the evidence based on sectoral data and the aggregation effect.

3.1 Inflation persistence in the euro area: reduced-form estimates

The overall degree of inflation persistence can be measured in a large number of ways. The results reported here are based on the method that is most frequently used in the literature. In order to give an idea of how fast inflation returns back to its mean following a disturbance, it measures the dependence of inflation on its past values. Specifically, it calculates the sum of coefficients, denoted by ρ, in a regression

of inflation on its past values.[9] To give an illustration of the properties of this measure, Figure 3.1 shows how inflation behaves in response to a shock that initially increases inflation by 1% (assuming that inflation depends merely on its first lag). The speed with which inflation returns back towards the level before the shock depends strongly on ρ. The higher ρ, the longer it takes inflation to return. The horizontal line is drawn at a value of 0.5. Accordingly, inflation crosses this line at the point in time when half of the initial shock has been absorbed. The figure shows clearly that the speed of the absorption process decreases more than proportionally with increasing levels of ρ. For values of ρ below 0.7, half of the initial shock to inflation has been re-absorbed already within three quarters. Accordingly, such a process can be easily brought back to its target level in the medium term. It is important to note that the same process will appear more persistent if analysed in year-on-year changes as opposed to the quarter-on-quarter changes in this figure.

Figure 3.1: Decay of inflation following a shock, for different values of ρ



Note: Numbers on the horizontal axis refer to quarters.

Table 3.1 reports estimates of ρ from various studies on inflation persistence in the euro area. The upper panel reports results that have been obtained for relatively long time-spans, without allowing for potential changes in monetary policy regimes and the mean of inflation. It turns out that in this case most estimates

[9] In more detail, the sum of autoregressive coefficients in univariate time-series models $\pi_t = \mu + \sum_{j=1}^{K} \alpha_j \pi_{t-j} + \varepsilon_t$ is given as $\rho = \sum_{j=1}^{K} \alpha_j$. Other measures that can be obtained in univariate models include the largest autoregressive root or the half-life of innovations (e.g., Cogley and Sargent 2001, Pivetta and Reis 2002, Levin and Piger 2004). In addition, measures based on frequency-domain methods such as the spectral density at frequency zero (e.g. Benati, 2002) have been used. Various authors have also used multivariate methodologies to calculate the response of inflation to various disturbances (e.g., Batini and Nelson 2001; Batini 2002). Another alternative, that has also been employed in some studies mentioned in this paper exploits the idea that if inflation is not very persistent, it should cross its mean relatively frequently, and measures the number of these incidents (for the derivation of this estimator and a discussion of the advantages and disadvantages of several measures of persistence see Robalo Marques (2004) and Dias and Robalo Marques (2005)).

are not significantly different from one. This implies that inflation behaves in an extremely persistent fashion: if it were equal to one, a disturbance that moves inflation, even if temporary itself, would have a permanent effect on the level of inflation. The lower panel of Table 3.1 reports an alternative set of estimates for the euro area (often taken from the same studies). The main difference between the two panels lies either in the length of the time sample used, which is much shorter in the lower panel, or in whether the analysis allows for statistically significant breaks in the mean of inflation or some other sort of time-varying mean. Overall, most studies do find statistical evidence in favour of shifts in the mean of inflation. Moreover, once such shifts are allowed for, the ρ-estimates are considerably lower than those reported in the upper panel and generally statistically different from one, indicating that inflation is *not* highly persistent. However, it is important to stress that generally, these estimates are surrounded by a large margin of uncertainty, such that it is difficult to pin down the degree of persistence with precision. Another layer of uncertainty arises because different studies arrive at different numbers, due to diverse sample periods or methodological approaches, as highlighted in Table 3.1. Finally, there is also uncertainty about the appropriate measure to be applied for such tests.

Table 3.1: Estimated inflation persistence for the euro area

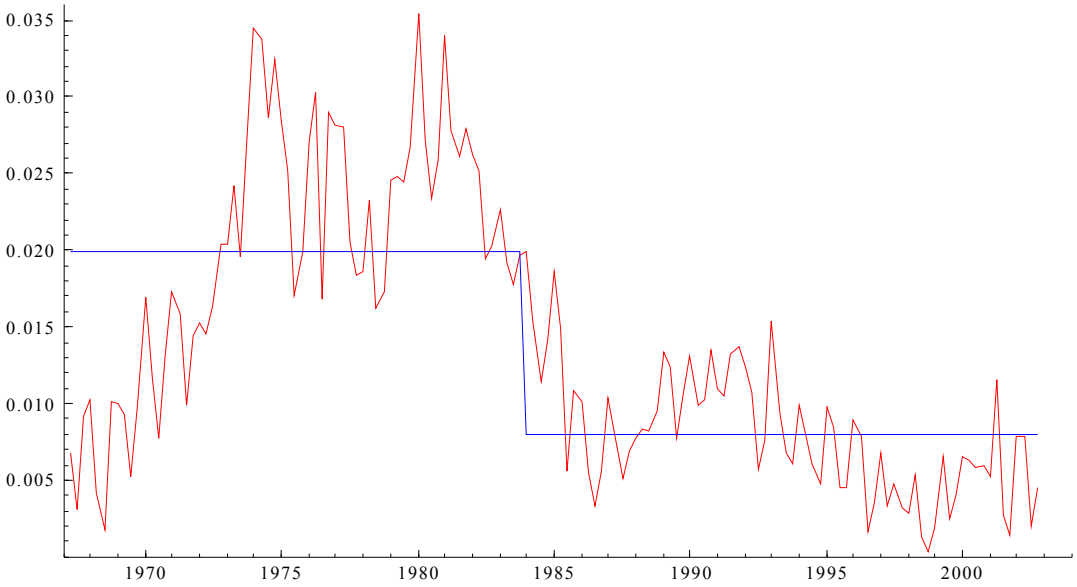
Source	ρ	**Sample**	**Inflation series analysed**
Simple estimates over long time samples			
Altissimo, Mojon & Zaffaroni (2004)	0.93	1985:I-2004:I	CPI
Batini (2002)	**0.74**	1984:III-2002:II	HICP
Gadzinski & Orlandi (2004)	1.02-1.04	1970:II-2003:III	GDP deflator, CPI, HICP and core inflation
O'Reilly & Whelan (2004)	0.96	1970:I-2002:IV	GDP deflator and HICP
Robalo Marques (2004)	0.85	1984:I-2002:IV	CPI
Estimates with time-variations in the mean of inflation or over short time samples			
Dossche & Everaert (2005)	**0.40**	1971:II-2003:IV	GDP deflator
Gadzinski & Orlandi (2004)	**0.60**-0.90	1984:I-2003:III	GDP deflator, CPI, HICP and core inflation
Lünnemann & Mathä (2004)	**0.40**	1995:1-2000:12	HICP
O'Reilly & Whelan (2004)	0.90	1991:I-2002:IV	HICP
Robalo Marques (2004)	**0.80**	1984:I-2002:IV	CPI

Note: Parameters in bold indicate that it is possible to reject statistically that ρ=1.

Given the working definition of inflation persistence as the tendency of inflation to converge slowly (or sluggishly) toward the long-run value implied by the monetary policy regime in place, it is from an economic point of view crucial to allow for persistent changes in the mean of inflation that are driven by shifts in the inflation objective when measuring the degree of persistence. However, from a purely statistical perspective, it is not easy to distinguish between a highly persistent inflation process and a less persistent one with occasional shifts in the mean. A failure to account for breaks in the mean could yield

spuriously high estimates of the degree of persistence.[10] On the other hand, highly persistent processes can easily lead a time series away from its overall mean for considerable amounts of time, such that the existence of true breaks is difficult to detect.[11] Moreover, there may be other reasons for a change in the mean of inflation such as changes in the measurement of inflation or changes in sectoral inflation rates. It is therefore important to check whether the timing of the estimated breaks is plausibly associated with shifts in monetary policy regimes.

Figure 3.2: Consumer price inflation in the euro area, 1967:II-2002:IV



Source: Robalo Marques (2004).

There are three pieces of evidence that suggest that the breaks in the mean of inflation could have been associated with shifts in the monetary policy regime. First, the timing of the breaks in the mean of inflation often corresponds to announced shifts in the monetary policy regime.[12] This is most clear in those countries where there was a clear break in monetary policy such as e.g. the announcement of an inflation targeting regime. As an illustration, Figure 3.2 shows the time profile of euro area inflation over time (where inflation is calculated quarterly, non-annualised), and estimates for its mean conditional on one break. There is strong evidence that the mean of inflation has changed in a highly persistent fashion.

[10] Robalo Marques (2004); Dossche and Everaert (2005); Cecchetti and Debelle (2005).

[11] O'Reilly and Whelan (2004) find that tests based on asymptotic distributions overstate the evidence for breaks in their sample, such that a careful econometric treatment of the break tests is called for. Gadea and Mayoral (2005) similarly argue that there is a danger of confusion between structural breaks and high persistence; using models of fractionally integrated processes (that do not explicitly control for changes in the mean, but model inflation as a process that can deviate for long time periods from its long-run mean, while returning to it eventually) they find that inflation is highly persistent in 21 OECD countries.

[12] See, for example, Levin and Piger (2004).

At the same time, the estimated breakpoint in 1984:I is suggestive, as it coincides with a changing attitude of policy makers towards the ERM – the start of what has often been called the "hard ERM". Estimating inflation persistence for the two subsamples yields 0.85 for the time until 1983, and 0.8 (as reported in the last row of Table 3.1) for the later sample.

Second, if changes in monetary policy are the driving force, one should expect to see breaks occurring in a similar fashion for most sectoral inflation series. This allows for a natural test for the role of monetary policy in bringing about the observed changes in the mean of inflation. Looking at long time-samples for Belgium and France, it is apparent that breaks occur at similar dates for most sectors. The timing of these breaks suggests that they are indeed driven by monetary policy. The break dates detected for overall inflation as well as a for sectoral subindices cluster around a few months in the mid-1980s, closely linked to the times when monetary policy tightened considerably, in France shortly after wage and price freezes in 1982 and in Belgium after wage moderations and the devaluation of the Belgian franc in 1982.[13]

Finally, looking at a large number of OECD countries, there appear to be mainly three "waves" of breaks in the mean of inflation: the first in the late 1960s or early 1970s, the second in the mid 1980s, and the third in the early 1990s. These waves are associated mainly with breaks in the mean of nominal rather than real variables, which can be taken as evidence that all three waves are related to monetary policy.[14] In sum, there is evidence that the breaks in the mean of inflation are (at least partly) related to changes in monetary policy regimes, such that estimates of inflation persistence for the current regime should explicitly address the existence of such breaks in order not to overestimate persistence.

These findings are robust to analysing different definitions of inflation. However, it is noteworthy that inflation persistence is considerably higher for measures of core inflation when compared to headline inflation – as, e.g., indicated by the last row in Table 3.2. This issue will be addressed further in an analysis of sectoral differences in persistence in Section 3.3 below.

Finally, there is evidence that inflation persistence has dropped in recent times, a development which has not been restricted to the euro area, but has also been noted in other countries.[15]

Overall, the evidence presented in this Section suggests that once shifts in the monetary policy regime are taken into account, the degree of inflation persistence in the euro area is not very high. However, the precise degree of persistence is difficult to assess due to the considerable uncertainty associated with it. These results are consistent with those found in the literature for other, non-euro area economies. It is important to account for structural breaks in the mean of inflation – for which there is ample statistical evidence. Doing so reduces the estimated degree of inflation persistence considerably, leading to a confirmation of the evidence for the euro area that inflation persistence is best described as moderate. Table 3.2 shows some results from models for a number of countries, allowing for a break in the mean of

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[13] See Aucremanne and Collin (2005) for Belgium, and Bilke (2005) for France.

[14] See Corvoisier and Mojon (2005).

[15] See Angeloni, Aucremanne and Ciccarelli (2005) for the euro area, as well as Benati (2002) and Cogley and Sargent (2001).

inflation and including a variety of inflation indicators for each of them. It is apparent that in most cases the hypothesis of the most extreme form of persistence can be rejected, and that most parameters are relatively low. Not unexpectedly, persistence is estimated to be higher for the "smoother" series of core inflation. As a matter of fact, it is only for core inflation in the United States and Switzerland that the most extreme form of persistence cannot be rejected.

Table 3.2: Estimated inflation persistence for various countries

Country	GDP deflator	CPI inflation	Core CPI inflation	PCE price inflation
Australia	**0.54**	**0.53**	**0.58**	**0.35**
Canada	**0.47**	**0.34**	**0.48**	**-0.09**
Japan	**0.59**	**0.04**	**0.81**	**0.72**
New Zealand	**0.16**	**0.57**	**0.61**	**0.60**
Sweden	**-0.06**	**0.35**	**0.82**	**0.39**
Switzerland	**0.73**	**0.74**	0.93	**0.92**
United Kingdom	**0.12**	**0.53**	**0.57**	**0.55**
United States	**0.37**	**0.39**	0.89	**0.39**
Memo: Euro Area	**0.60**	**0.60**	**0.80**	

Notes: Source: Levin and Piger (2004), Gadzinski and Orlandi (2004) for the euro area. 1984-2003. Parameters in bold indicate that it is possible to reject statistically that ρ=1. PCE denotes personal consumption expenditure.

3.2 Evidence from structural models of inflation dynamics

The estimates of inflation persistence reported in the preceding sections originated from simple univariate models of inflation. As such, these models cannot distinguish between the various types of inflation persistence defined in Section 2. More structural models of inflation persistence are necessary for this purpose. Interestingly, the finding of moderate persistence is also born out by estimates of the degree of intrinsic inflation persistence in structural models. In a structural time-series model, it has been shown that after correcting for changes in the long-run value of inflation, intrinsic persistence is moderate, and the major sources of persistence are expectations-based and extrinsic.[16] Results from estimating New Keynesian Phillips Curves like in the model introduced in section 2 are reported in Table 3.3. The table contains estimates for the degree to which inflation is backward-looking and as such intrinsically persistent.[17]

[16] See Dossche and Everaert (2005).

[17] The estimates relate to slightly different versions of the New Keynesian Phillips curve than used in Section 2 and explained in footnote 5. In particular, they model inflation rate as dependent on $\hat{\mu}_t$, the deviation of actual from desired mark-up and ξ_t, an exogenous mark-up shock. The model is therefore $\pi_t = \gamma\pi_{t-1} + (1-\gamma)E_t\pi_{t+1} - \lambda\hat{\mu}_t + \xi_t$ The table reports the parameter γ.

Several results emerge. First, under the assumption of rational expectations, all studies find that there is a significant role for backward-lookingness in inflation, and thus for intrinsic inflation persistence, but the coefficient is generally less than 0.5. Second, in line with the evidence reported above, also structural models find that the degree of intrinsic persistence drops when estimated over more recent samples, over stable monetary policy regimes, or when allowing for a time-varying inflation target.[18] Also, in the context of these models, there is evidence for an important role of labour markets in generating inflation persistence: by incorporating real wage rigidities, i.e. the slow adjustment of real wages to underlying labour market conditions, in the New Keynesian Phillips Curve framework, the model fits the data better.[19]

Table 3.3: Estimated inflation persistence in structural models

Country	Angeloni & Ehrmann	Benigno & Lopez-Salido	Galí, Gertler & Lopez-Salido	Jondeau & Le Bihan	McAdam & Willman	Paloviita	Rumler	Sondergaard
Belgium							0.46	
Germany		0.09; 0.04		0.15; 0.57			0.43	
Greece							0.42	
Spain		0.50					0.45	0.10
France		0.30; 0.31		0.35; 0.74			0.40	0.28
Ireland								
Italy		0.52; 0.55		0.52; 0.41			0.67	0.37
Luxembourg								
The Netherlands		0.37; 0.35					0.30	
Austria							0.54	
Portugal								
Finland							0.45	
Euro Area	0.46		0.04; 0.27	0.26; 0.26	0.22; 0.40	0.44; 0.64	0.49; 0.72	

Notes: Angeloni and Ehrmann (2004): 1998:I-2003:II. Benigno and Lopez-Salido (2002): 1970:I-1997:I. Galí, Gertler and Lopez-Salido (2001): 1970:I-1998:II. Jondeau and Le Bihan (2005): 1970:I-1999:IV. McAdam and Willman (2004): 1970:I-1997:IV. Paloviita (2004): 1977-2003. Rumler (2005): 1970:I-1998:IV. Sondergaard (2004): 1979:II-2001:III. Two parameters per country and study are provided if the studies offer alternative results.

These findings are consistent with the evidence from other countries such as the United States, that there is some role for backward-lookingness in inflation, which is reduced when looking at the more recent period. For example, for the US the weight on the backward-looking component becomes insignificant when the post-Volcker sample period is considered.[20] Furthermore, there is direct evidence for the United States and Canada that shifts in long-run inflation expectations have contributed significantly to inflation persistence, supporting the idea that breaks in the mean of inflation should be disentangled from the behaviour of inflation in other times.[21]

[18] Coenen and Wieland 2005; Coenen and Levin 2004; de Walque, Smets and Wouters 2004; Paloviita (2004).

[19] Blanchard and Gali (2005), Christoffel and Linzert (2005). Christoffel, Kuester and Linzert (2005) show that wage rigidities affect the dynamic response of inflation to a monetary policy shock.

[20] Gali and Gertler (1999).

[21] Kozicki and Tinsley (2002).

The role of inflation expectations

The estimates reported above assume that expectations are formed rationally. One explanation for the presence of backward-looking terms in a standard Phillips curve may be that expectations are partly based on lagged inflation. It has been shown that in economies where central banks have adopted explicit inflation objectives, long-run inflation expectations have been successfully anchored. Accordingly, inflation expectations are not related to past inflation in these economies, and actual inflation developments are less persistent. In this context, central bank transparency is a crucial factor. In contrast, inflation persistence is likely to be higher when private agents have limited information about the central bank's objectives. In such a setting, the agents will try to disentangle persistent shifts in the inflation objective from transitory disturbances, and will manage to do so more quickly, the more transparent and credible the central bank.[22]

A direct test of the importance of inflation expectations for the dynamics of inflation can be conducted in the framework of structural models of inflation dynamics by using direct measures of inflation forecasts (obtained, e.g., from the Survey of Professional Forecasters for the US and from the OECD for the euro area), rather than the assumption of rational (or model-consistent) expectations.[23] Such studies find that the role for explicit backward-looking inflation behaviour (and thus inflation persistence) is significantly further reduced, if one allows that expectations are not fully rational. Consistent with this overall picture, it is also found that inflation has become more forward-looking in the recent years, and that it has already been more forward-looking prior to the inception of EMU in the countries with low inflation. It also turns out that changes in expectations constitute a major source of the variability of actual inflation. Moreover, to the extent that inflation expectations adjust to new information only gradually, expectations-based persistence can be generated.[24]

These results suggest that it is important to understand what determines inflation expectations. A promising approach is to assume that private agents use relatively simple recursive learning algorithms to form inflation expectations in the presence of model uncertainty. It has been found that in particular activist central banks that care a lot about stabilising the output gap may slow down the learning process of agents and may thereby increase the persistence of the inflation process. In this case, the monetary policy regime will affect the formation of inflation expectations and through this channel also inflation persistence. Generally speaking, a credible policy regime focused on price stability will reduce the persistence of inflation. It is clear that under such learning schemes it is particularly important for a central bank to anchor inflation expectations.[25]

Overall, the evidence from structural estimation of the New Keynesian Phillips curve for the euro area suggests that the forward-looking term is dominant suggesting that inflation persistence is mostly

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22 Erceg and Levin 2004; Levin, Natalucci and Piger 2004; Ravenna 2002; van der Cruijsen and Demertzis (2005).

23 E.g., Roberts (1995, 1997); Adam and Padula (2003); Paloviita (2004).

24 Paloviita and Virén, 2005.

25 Orphanides and Williams 2002; Gaspar, Smets and Vestin 2005.

extrinsic or driven by persistence in its proximate determinants. There is evidence of a backward-looking component (intrinsic inflation persistence) but this backward-looking component may be partly due to the learning behaviour of price setters and therefore is not invariant to the monetary policy regime. In particular, when inflation expectations are well-anchored, past inflation developments are likely to be less important in shaping future inflation.

3.3 Heterogeneity across countries and sectors

Inflation persistence in the euro area countries

How does the evidence on the euro area compare with the one on the euro area countries? The answer to this question is given in table 3.4, which reports the results available at the country level. Given the findings reported above, the table includes only studies that allow for a change in the mean of inflation, or are estimated over a relatively short time sample. The table distinguishes between studies using CPI data and those using HICP data, as this distinction turns out to be important for the level of inflation persistence. Most likely due to the inclusion of sales prices in the HICP, measures of persistence are considerably lower for this index than for CPI data, an issue that will be looked at further below in the context of sectoral estimates.

Table 3.4: Estimated inflation persistence for the euro area countries

Country	CPI					HICP	
	Aucremanne & Collin	Bilke	Gadzinski & Orlandi	Hondroyiannis & Lazaretou	Levin & Piger	Cecchetti & Debelle	Lünnemann & Mathä
Belgium	**0.39**		**0.32**			**-0.11**	**-0.33**
Germany			0.82		**0.78**	**-0.34**	**-0.16**
Greece			0.82	**0.78**			**0.51**
Spain			0.93			**0.23**	**-0.50**
France		**0.76**	**0.54**		**0.74**	**0.25**	0.49
Ireland			0.79				**0.38**
Italy			**0.58**		**0.73**	**0.45**	**0.23**
Luxembourg			**0.47**			**-0.62**	**-0.17**
The Netherlands			**0.44**		**0.55**	**-0.02**	**0.28**
Austria			1.03			**0.33**	0.43
Portugal			**0.49**			**0.45**	**0.31**
Finland			**0.47**			**0.30**	**0.07**

Notes: Parameters in bold indicate that it is possible to reject statistically that ρ=1. Aucremanne and Collin (2005): 1978:II-2004:IV. Bilke (2004): 1973:1-2004:1. Hondroyiannis and Lazaretou (2004): 1991:I-2003:II. Levin and Piger (2004): 1984-2003. Cecchetti and Debelle (2005): Data starts in 1990. Gadzinski and Orlandi (2004): 1984:I-2003:III. Lünnemann and Mathä (2004): 1995:1-2003:12.

Three results emerge. First, there is a considerable degree of heterogeneity across countries – within each study, the estimates for inflation persistence vary markedly. Second, there is also a wide range of estimates across studies, and the studies disagree considerably on the country rankings. This sensitivity of results across studies (and thus to sample periods and econometric methods) implies that there is a considerable degree of uncertainty about the true degree of inflation persistence. Third, for the vast

majority of cases, it is possible to reject the hypothesis of extreme persistence, as indicated by the large number of parameters in bold print. Beyond that, the parameters reported are generally very low, pointing to a moderate level of persistence at the country level.

Inflation persistence at the sectoral level

Going down one more level of aggregation, it is possible to analyse the extent to which inflation is persistent in the different sectors of the economy. Table 3.3 contains a sectoral analysis for the euro area, estimated for the period 1995-2003. Overall, there are only very few sectors for which the hypothesis of extreme persistence cannot be rejected, as indicated by the large number of parameters in bold print. This table helps clarifying why some of the estimated persistence measures in the previous section were negative. The inclusion of sales prices into the compilation of the HICP affects the measured degree of inflation persistence substantially, particularly when estimated over the recent period, for which the observations affected by this methodological change are dominant. A sector which is heavily affected by end-of-season sales is clothing and footwear – which is also the sector that has a negative ρ in Table 3.5.

Table 3.5: Estimated inflation persistence at the sectoral level (1)

Sector	ρ
Food & non-alcoholic beverages	**0.46**
Alcoholic beverages, tobacco & narcotics	**0.16**
Clothing & footwear	**-0.99**
Housing, water, electricity, gas & other fuels	**0.20**
Furnishings & house-hold equipments	0.65
Health	**0.49**
Transportation	**0.04**
Communications	**0.43**
Recreation & culture	**0.19**
Education	0.59
Restaurants & hotels	**0.61**
Miscellaneous goods & services	0.77

Source: Lünnemann and Mathä (2004): 1995-2003. Parameters in bold indicate that it is possible to reject statistically that ρ=1.

Accordingly, it might be useful to repeat such an analysis for a more extended period of time and/or using CPI rather than HICP measures, to avoid the dominance of sales prices in estimates of persistence. The results of two such exercises are reported in table 3.6, at a slightly more aggregated sectoral breakdown. There is clear evidence for considerable heterogeneity across sectors. In most cases non-processed food and energy are little persistent on the one hand, and services and industrial goods are highly persistent on

the other. Comparing cross-country with cross-sector heterogeneity, it appears that the latter is more pronounced.

Table 3.6: Estimated inflation persistence at the sectoral level (2)

	Belgium	France		Germany	Italy	Euro Area
	AC	AMZ	Bilke	AMZ	AMZ	AMZ
Non-processed food	0.27	0.63	0.15	0.25	0.45	0.55
Energy	0.43	0.44	0.28	0.47	0.41	0.44
Processed food	0.24	0.34	0.34	0.60	0.69	0.61
Services	0.53	0.51	0.44	0.60	0.49	0.53
Industrial goods	0.75	0.68	0.72	0.65	0.70	0.68

Source: AC = Aucremanne & Collin (2005); AMZ = Altissimo, Mojon & Zaffaroni (2004): 1985-2003; Bilke (2004): 1973-2004.

The role of administered prices

The differences in inflation persistence across sectors most likely reflect in parts different price setting practices that depend on the various market structures in which firms operate. A potentially large difference in price setting practices can be expected if prices are not market-determined, but administered, which in itself might be an outcome of particular market structures or other relevant factors. However, in order to analyse this issue it is necessary to find a measure of administered prices, as there is no readily available index.[26] Various factors complicate the construction of such an index. First, there is a large variety of administrative measures. Second, some measures apply only at the regional or local level, or depend on characteristics of the consumer. A possible way forward is therefore to identify the subindices that are considered heavily influenced by administered price setting. In many instances, however, this implies aggregating administered prices as well as market-determined ones, a caveat that needs to be borne in mind when analysing results obtained at the sub-index level.

Although changes in administered prices can have a sizeable impact on the *level* of inflation,[27] this does not necessarily imply that goods and services with administered prices show a different degree of inflation *persistence*. It holds true that administered prices change less frequently and by larger amounts than market-determined ones. It is also the case that inflation measures excluding administered prices show a somewhat smaller degree of inflation persistence - however, the reduction is relatively small. For instance, at the euro area level, the estimate for ρ decreases from 0.61 to 0.59 when estimated over the time period from 1995Q2.[28] This might reflect the relatively small weight of goods and services with administered prices in the overall index. The evidence for the euro area is corroborated by evidence for

[26] See also ECB (2003, 2004).

[27] This has been shown, e.g. ,in ECB (2003, 2004).

[28] Lünnemann and Mathä (2005a).

the US economy. Also in the United States it is found that regulated prices are on average slower to respond to changes in cost and demand conditions.[29]

Aggregation effects

Comparing the sectoral results in table 3.3 with those at the country level in table 3.2, and again the country results with the euro area aggregate results, it is apparent that persistence of aggregated inflation series is typically higher than the average of the persistence of its subcomponents. These patterns illustrate how the time series properties of inflation can be subject to an aggregation effect. The aggregation of subindices to an aggregate series has mainly two effects that are relevant in our context. First, idiosyncratic shocks to the subindices will tend to wash out if there is a sufficiently large number of series that are aggregated. Accordingly, an analysis of the aggregate will not be affected by such idiosyncratic shocks, and make the series appear "smoother", as it is more likely to be dominated by the common shocks only. Second, the persistence of the aggregate is a complex function of the persistence of the subindices, where the more persistent series receive a relatively larger weight. It can be shown that both effects are present and important. For example, only around 30% of the variance of sectoral inflation rates is explained by a common factor, with the bulk of the remainder being driven by sector-specific idiosyncratic shocks. Aggregation of these sectoral inflation rates can thus potentially smoothen out the largest fraction in the variance of inflation. Furthermore, persistence of the aggregate will be higher due to the relatively larger weight of the more persistent subindices. [30] Accordingly, it is important to keep in mind that euro area inflation, the ultimate goal for monetary policy, might well exhibit higher persistence than its individual components.

4. The mechanics of individual price adjustments

This section brings together the results of the empirical analyses conducted at the micro level. The evidence comes from two main types of data sources, described in detail in the appendix. The first type of data consists of direct information on individual prices at the consumer and the producer level. Using these micro data, the IPN studies computed frequencies of price changes and implied measures of price duration. Moreover, they analyse how these frequencies are affected by the type of product, the type of outlet, the time span elapsed since the last price change and a variety of other variables including proxies of macro-economic or sectoral conditions, indirect tax changes, seasonal factors, etc. The size and the

[29] See Dexter et al. (2004).

[30] Altissimo, Mojon and Zaffaroni (2004). Conversely, if micro series are lumpy, aggregation can actually bias upwards estimates of the speed of adjustment, a point made by Caballero and Engel (2003).

sign of price changes are also analysed, as well as the issue whether price changes occur in a synchronized or in a staggered fashion.[31]

The second source of evidence consists of one-time surveys, conducted specifically for this project, on pricing policies followed by firms. Surveys have the comparative advantage that they can document, in qualitative terms, the underlying rationale of the observed pricing patterns. The usefulness of bringing together these different types of information in this section consists in potential synergies among the different angles from which different data look at the same (or closely related) phenomena. [32]

4.1 Patterns of price adjustments

A number of interesting stylised facts emerge from the analysis of individual price records.

Prices change infrequently

First, as shown in Tables 4.1 and 4.2, prices change infrequently. The share of prices that are changed each month (i.e., the frequency of price changes) is equal to 15% for consumer prices in the euro area and equals 15% to 23% for producer prices. The average duration of a consumer price spell ranges from 4 to 5 quarters, and is similar or somewhat lower for producer prices. The order of magnitude of these numbers is robust to variations in their calculation methods, to using larger datasets when available or to using weighted measures. Furthermore, it is also corroborated by the survey evidence, which shows that the median firm changes prices less than once a year.

Substantial degree of heterogeneity

Second, there is a substantial degree of heterogeneity in the frequency of price changes across products. This is illustrated in Figure 4.1, which shows the unweighted distribution of the calculated frequency of consumer price changes for each product in each country. The figure illustrates that most products cluster in the range of 2-22%, and thus around the calculated mean of 15.1%, but that there are also quite a few

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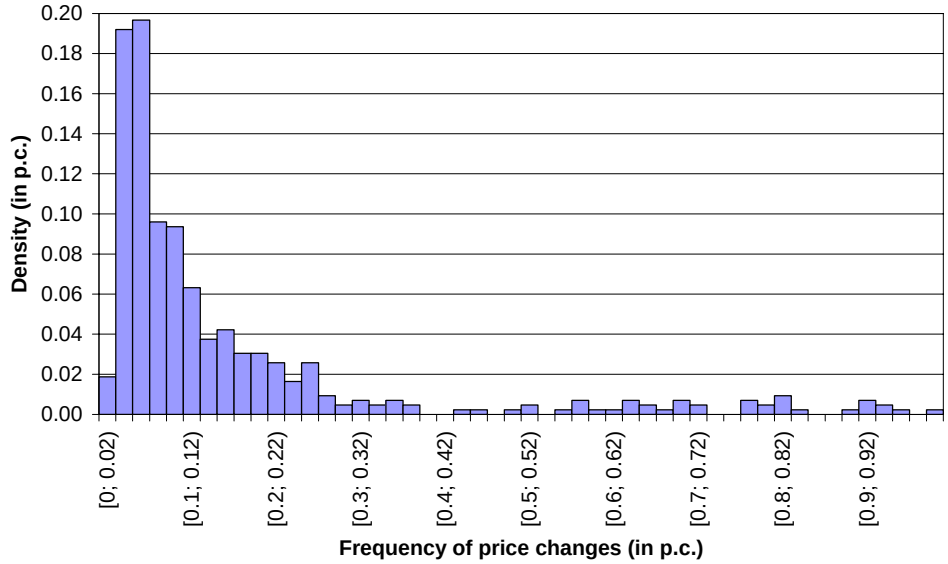
[31] The evidence regarding consumer price data is based on price records for a comparable sample of 50 product categories, which were selected to ensure that results are representative for the entire CPI to the maximum extent possible. The data description in the appendix provides the list of product categories in this sample. The CPI results reported here are taken from Dhyne et al. (2005); results from more extended datasets are provided in the various national papers produced in the IPN (Aucremanne and Dhyne (2004) for Belgium; Hoffmann and Kurz-Kim (2005) for Germany; Álvarez and Hernando (2004) for Spain; Baudry et al. (2004) for France; Veronese et al. (2005) for Italy; Jonker et al. (2004) for the Netherlands; Baumgartner et al. (2005) for Austria; Dias et al. (2004) for Portugal, Lünnemann and Mathä (2005b) and Vilmunen and Laakkonen (2005) for Finland). Furthermore, the paper by Angeloni, Aucremanne and Ciccarelli (2005) provides an overview of price setting practices before and after the formation of EMU. The PPI results are mainly based on Vermeulen et al. (2005). More detailed results are provided in the various national papers produced in the IPN (Dossche (2005) for Belgium, Stahl (2005) for Germany; Álvarez et al. (2005b) for Spain; Sabbatini et al. (2004) for Italy; Dias et al. (2004) for Portugal).

[32] The results are mainly based on Fabiani et al. (2005). More detailed results are provided in the various national papers produced in the IPN (Aucremanne and Druant (2005) for Belgium; Álvarez and Hernando (2005) for Spain; Loupias and Ricart (2004) for France; Fabiani et al. (2004) for Italy; Hoeberichts and Stokman (2004) for the Netherlands; Kwapil et al. (2005) for Austria and Martins (2005) for Portugal).

products which change prices very frequently, as indicated by the observations at the right end of the figure.

Figure 4.1: Distribution of product- and country-specific frequencies of price changes



Source: Dhyne et al. (2005).

Heterogeneity of price-setting behaviour is not only important *across* product categories, there is also substantial heterogeneity of price-setting behaviour *within* product categories. Finally, while there is a notable heterogeneity across countries, it is less important than cross-sector heterogeneity. The source of the cross-country variation is likely to be partly structural (differences in consumption structure or outlet composition), methodological (the treatment of sales and of quality adjustment by each NSI) or due to differences in the relative importance of regulated prices across countries.

Looking at the differences across sectors, there is a very clear pattern that price changes for consumer goods and services are very frequent for energy (oil products) and unprocessed food, while they are relatively infrequent for non-energy industrial goods and particularly services. This is illustrated in Table 4.1, which shows that the euro area countries share a common ranking of the 5 main components of the CPI according to their frequency of price change. Energy prices and unprocessed food prices change very often (78.0 and 28.3%, respectively), mostly in response to frequent changes in input prices. Given the relative importance of supply shifts in those sectors, this result is not surprising under the assumption that prices are reset in response to such shifts. These two product types are followed by processed food (13.7%) and non-energy industrial goods (9.2%). Prices of services change less often: their average frequency of price change equals 5.6%. Interestingly, there is also a mapping between price stickiness and gradualism in the sense that sectors changing prices infrequently exhibit furthermore a more gradual

adjustment pattern, whereby price increases are followed by further price increases (taking account of the longer time span that has elapsed since the last price change).[33]

Table 4.1: Frequency of consumer price changes by product type in %

Country	Unpro-cessed food	Processed food	Energy (oil products)	Non-energy industrial goods	Services	Total, country weights	Total, Euro area weights
Belgium	31.5	19.1	81.6	5.9	3.0	17.6	15.6
Germany	25.2	8.9	91.4	5.4	4.3	13.5	15.0
Spain	50.9	17.7	n.a.	6.1	4.6	13.3	11.5
France	24.7	20.3	76.9	18.0	7.4	20.9	20.4
Italy	19.3	9.4	61.6	5.8	4.6	10.0	12.0
Luxembourg	54.6	10.5	73.9	14.5	4.8	23.0	19.2
The Netherlands	30.8	17.3	72.6	14.2	7.9	16.2	19.0
Austria	37.5	15.5	72.3	8.4	7.1	15.4	17.1
Portugal	55.3	24.5	15.9	14.3	13.6	21.1	18.7
Finland	52.7	12.8	89.3	18.1	11.6	20.3	-
Euro Area	28.3	13.7	78.0	9.2	5.6	15.1	15.8

Source: Dhyne et al. (2005). Figures presented in this table are computed on the basis of the 50 product sample, with the only exception of Finland for which figures based on the entire CPI are presented. The total with country weights is calculated using country-specific weights for each item, the total with euro area weights using common euro area weights for each sub-index. No figures are provided for Finland because of lack of comparability of the sample of products used in this country.

A very similar pattern is found for producer prices, as shown in Table 4.2. It seems that there are frequent price changes for products that are simple and have not undergone a series of transformations. This implies that the costs of those products are closely linked to their raw material price. This can be seen for the example of flour and bread. The frequency of price changes for flour is 0.46 (0.42) in Italy (Portugal), whereas the frequency of price changes for bread is 0.06 (0.06) Other products with generally high frequency of price changes are e.g. textile fibres, paper and paper board, veneer sheets, plywood, dairy products, non-ferrous metals, metal wires, sugar, coffee, etc.. All these products have undergone little transformation from input to end product. On the other hand, capital goods generally consist of a whole series of inputs such as raw materials, labour, R&D, etc..

[33] Aucremanne and Dhyne (2005b).

Table 4.2: Frequency of producer price changes by product type in %

Country	Food	Non-durable non-food	Durables	Intermediate products	Energy	Capital goods	Total
Belgium	19	10	13	28	na	12	21
Germany	26	14	10	23	94	10	22
Spain	25	10	13	29	39	9	21
Italy	27	10	7	18	na	5	15
Portugal	21	5	18	12	66	na	23

Source: Vermeulen et al. (2005).

Price decreases are not uncommon

Third, and somewhat surprisingly, price decreases are not uncommon, except in services. On average, around 40% of both consumer and producer price changes are price reductions. Even though in some countries the National Statistical Institutes include sales for consumer prices, it is important to note that robustness tests show that excluding sales from this calculation has only limited effects. Looking at the breakdown for consumer prices according to sector in the first row of Table 4.3 it is apparent that unprocessed food, processed food and energy are characterised by almost perfect symmetry between price increases and price decreases. The difference is much larger in the services sector. In this sector, there exists an asymmetry between the frequency of increases and decreases as only two price changes out of ten are price decreases. This result may be partly related to the fact that the average sectoral inflation rate is higher in services and to the fact that the share of labour in the production costs of services is particularly important, such that rigidities in wage developments can translate into price rigidities, an issue that will be dealt with below. Looking at the magnitude of price changes, it turns out that price increases as well as decreases are sizeable compared to the inflation rate. Price reductions and price increases have a similar order of magnitude, though price reductions are on average larger: the average price increase is found to be in the order of 8%, and the average price decrease slightly larger at 10%, as shown in rows 2 and 3 of table 4.3. With respect to the average size of price changes, heterogeneity across countries is moderate, particularly when compared to the sectoral heterogeneity, which is also shown in rows 2 and 3 of Table 4.3. In the unprocessed food sector price changes are not only very frequent, they are also very large at 15 and 16%, respectively, for price increases and decreases. Price increases are thus slightly smaller but slightly more frequent, such that on average, price increases and decreases nearly offset each other. This is consistent with the notion that the pricing structure is dominated by supply-side factors such as the seasonal nature of many unprocessed food items. In a similar vein, the frequent price changes for energy goods are consistent with the variability of marginal costs (i.e., oil prices). The relatively smaller size of price changes might be related to the fact that prices of energy products change around three times as often than those for unprocessed food, as well as possibly differences in the size of the shifts in the underlying factors.

Table 4.3: Share of price increases in price changes and size of price in- and decreases in %, euro area consumer prices

	Unprocessed food	Processed food	Energy (oil products)	Non-energy industrial goods	Services	Total
Share of price increases	54	54	54	57	80	58
Size of price increases	15	7	3	9	7	8
Size of price decreases	16	8	2	11	9	10

Source: Dhyne et al. (2005).

The price adjustment process takes place in two steps

Fourth, price adjustments take place in two steps, namely a price *review* and a price *change*. These issues have been addressed in the surveys conducted by the IPN. The modal number of price *reviews* lies in the range of one to three times a year. Looking at actual price *changes*, most firms change their prices once a year. Hence, price reviews are conducted more frequently than price changes. At the euro area level, the share of firms changing their prices less than quarterly is 86%, compared with 57% of firms reviewing their prices with the same frequency. Also the surveys discover that services review and change their prices less frequently than other sectors. Furthermore, reviews and changes are more frequent, the higher the competitive pressures. The difference in frequency between price reviews and changes raises the question for its causes. Prices may be left unchanged after a review i) because there is no reason to change them or ii) because, even once firms have decided to incur the informational costs of the review, there are other factors preventing price adjustment. Such factors are addressed in Section 4.3.

A comparison with other economies

The economy for which most evidence on the patterns of price adjustment is available is the United States. The main difference between the euro area and the United States lies in the frequency of *consumer price* adjustment. Whereas the frequency of price changes for the euro area has been estimated at 15%, similar estimates for the United States are much higher, at 26% over the period from 1995 to 1997 (25%, considering only the 50 products sample for the euro area calculations).[34] The lower euro area figure for the frequency of price adjustment cannot be explained by differences in consumption structure, as euro area consumption is characterised by a larger share of food products (which change prices frequently) and a smaller share of services (with infrequent price changes). Therefore, the difference in the frequency of price changes would be even larger if both economies shared the same consumption structure. This

[34] Bils and Klenow (2004).

finding also translates into an analysis of price durations. The number for the euro area, 4 to 5 quarters, is much larger than the corresponding figure for the United States, which stands at 2 quarters. However, these large differences need not only reflect differences in the underlying patterns of price setting. It is not entirely clear whether the datasets are entirely comparable. Furthermore, if an economy is subject to larger and more frequent shocks, one should expect price changes to be relatively more frequent. Differences between the euro area and the United States could therefore to some extent also be related to differences in the importance of shocks over the time samples that have been analysed.

Other patterns are more similar. Also in the United States, there is a large heterogeneity across sectors, with energy products and unprocessed food standing out as the sectors with the most frequent price changes; furthermore, similarly to what is observed in the euro area, 45% of all price changes are price decreases in the United States, and price changes are large relative to the prevailing inflation rate, with 13% (8% when sales prices are not taken into account).[35]

Also when looking at the frequency of price changes for *producer prices*, the euro area is not very different from the United States. As there is no research using quantitative data on producer prices for the United States, comparisons need to be made using the survey results. The finding for the euro area that firms change prices around once a year is in line with those for Sweden, the United States and the United Kingdom, where the modal number of actual price changes has also been found to be at the yearly frequency. Results for Japan are somewhat different, though, as the modal firm changes its prices once to twice a year, according to survey results.[36]

The differences across sectors, with services firms changing prices less often than the others, apply also to Canada – as do the findings that firms in competitive markets and large firms change their prices more frequently.

4.2 Price-setting rules: time versus state-dependence

Following the exploration of the typical pattern of price changes, the micro databases have furthermore been used to assess the *determinants* for these patterns. This section will provide evidence on the relevance of various price-setting rules, whereas the subsequent section will highlight potential reasons for price stickiness.

An important aspect in this regard is to understand whether prices are set according to time- or state-dependent pricing rules. According to the former, firms review their prices periodically, i.e. the timing of

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[35] Klenow and Kryvtsov (2004).

[36] Survey results for Canada find a higher frequency of price changes, with around half of Canadian firms changing their prices at least once every three months. However, this difference needs qualifying, as the survey design for Canada differs from those conducted for the euro area. In the surveys conducted by the IPN, different prices charged to different customers due to price discrimination are not considered a price change, whereas they are in the Canadian survey. Given the importance of price discrimination in the euro area (see below), considering such price variations as price changes obviously increases the frequency of price changes. See Amirault et al. (2004) for Canada, Apel et al. (2001) for Sweden, Blinder et al. (1998) for the United States, Bank of Japan (2000) for Japan and Hall et al. (2000) for the United Kingdom.

the review is exogenous and does not depend on the state of the economy. By contrast, under state-dependent pricing rules firms review their prices as soon as a shock occurs. With price adjustment costs, state-dependent models assume that firms change their prices only when they deviate sufficiently strongly from the desired prices. Under state-dependence, price reviews are potentially more frequent than price changes, as firms want to be able to react as fast as possible to shocks. In time-dependent models, firms review and change their prices only on a periodic basis. Accordingly, time-dependent pricing rules might lead to stickier prices than state-dependent ones in the presence of shocks.

In all countries for which data has been available, there is clear evidence that price changes exhibit seasonal patterns. In general, price changes are more likely to take place during the first quarter (especially in January) or after the summer period (especially in September) and are less frequent in July and August (with the exception of France where price changes are less frequent in December). The higher frequency of price changes associated to January is particularly observed for services (for instance in Belgium, Portugal and Spain). It is difficult to determine, however, whether this pattern provides evidence for state-dependence or time-dependence, as the observed behaviour can either reflect changes in costs or in demand which themselves are subject to seasonal patterns, or be related to time-dependent behaviour on the side of price setters.

The probability that a retailer adjusts its price is likely to be affected by the time elapsed since the last price change.[37] Estimates of this probability generally find that it increases substantially at durations of 12, 24 and 36 months, indicating that a fraction of firms revise their prices on an annual basis.

Another useful distinction between time- and state-dependent price setting rules can be made by investigating the link between the frequency of price changes and inflation. With purely time-dependent pricing, the timing of price adjustment is exogenous, independent of the prevailing economic conditions in general and the inflation rate in particular. On the contrary, with state-dependent pricing one expects to find a positive relationship between the frequency of price adjustment on one hand and the prevailing inflation rate on the other hand. It is generally found that higher aggregate inflation is related to higher frequencies of price increases and reduced frequencies of price decreases. The same pattern also holds for the inflation rate computed at the sectoral level – in particular, it has been found that the probability to observe a price change for a specific product in a specific outlet is positively affected by the absolute

[37] This can be analysed by estimating hazard functions, which show the probability to adjust a price conditional on the price having been unchanged for a certain number of periods. Intuitively, one would expect that such a function is upward sloping in time: the longer a price has not been changed, the more likely it will be changed at a given point in time. Instead, the estimated hazard functions are generally decreasing over time. This can be reconciled, however, if the hazard functions have been obtained by aggregating heterogeneous populations. The large degree of heterogeneity of price-setting behaviour across and within products suggests that heterogeneity in the duration of the different prices could indeed be at the root of these declining hazards (Álvarez, Burriel and Hernando 2005a). Taking into account the heterogeneity of products indeed reduces the negative slope of the hazard function - estimating duration models at a very highly disaggregated level leads mostly to non-decreasing hazard functions (Aucremanne and Dhyne 2005a; Dias, Robalo Marques and Santos Silva 2005; Fougère et al. 2005).

value of accumulated product-specific inflation since the occurrence of the last price change for this product in the outlet.[38]

Special events like changes in indirect taxes can also be exploited to get a better understanding for the rules determining price setting behaviour; as these can be considered as exogenous cost shocks, any impact on the frequency of price changes can be interpreted as evidence in favour of state-dependent aspects in price setting. The evidence in this respect is very robust: changes in indirect taxes always lead to temporary increases in the frequency of price changes.

In sum, although there is some evidence for time-dependence (which would lead to stickier prices in the presence of shocks), there is at the same time a clear pattern that firms also change their prices in response to changes in underlying economic conditions, pointing to the importance of state-dependent pricing rules.

This finding is corroborated by the survey results, where firms were directly asked about their price-setting rules. Table 4.4 shows that less than 40% of the firms review their prices following "mainly" time-dependent rules; around half of them follow both time and state-dependent rules. The share of firms following mainly time-dependent rules generally increases slightly with the size of the firm; it is higher for services than for trade (except for Belgium) and higher for trade than for industry (except for Italy). There is, however, no clear-cut evidence on the relationship between pricing rules and the degree of market competition. To summarise, the evidence for producer prices corroborates what has been found for consumer prices, namely that price setting, even if partially time-dependent, is at the same time state-dependent in the presence of shocks.

Table 4.4: Importance of time- vs. state dependent pricing rules, in %

Country	Mainly time-dependent	Time- and state-dependent	Mainly state-depenent
Belgium	26	40	34
Germany	26	55	19
Spain	33	28	39
France	39	55	6
Italy	40	46	14
Luxembourg	18	32	50
The Netherlands	36	18	46
Austria	41	32	27
Portugal	35	19	46
Euro area	34	46	20

Source: Fabiani et al. (2005). Euro area figures have been estimated using GDP weights.

[38] More precisely, accumulating positive product-specific inflation increases the likelihood of a price increase, while it makes price reductions less likely; negative product-specific inflation increases the likelihood of a price decrease, while it makes price increases less likely. E.g., Aucremanne and Dhyne 2005a; Fougère et al. 2005; Dias, Robalo Marques and Santos Silva 2005.

4.3 Available evidence on the reasons of sluggish price dynamics

While the preceding sections have analysed the stylised facts of price changes and the rules that are followed by price setters, this section focuses on potential reasons why price dynamics are sluggish. The most direct evidence on this issue can be obtained from the surveys on pricing behaviour. Five of these (namely for Belgium, Italy, Luxembourg, Austria and Portugal) provide data on the information set on which firms base their pricing decisions when they review their prices. This is an important piece of evidence, as deviations from a fully optimising behaviour can be an additional source of stickiness in the response of inflation to shocks. As can be seen in Table 4.5, around half of the firms review their prices taking into account a wide range of information, including both past and expected economic developments; one third of them adopt a backward-looking behaviour. A large fraction of firms (about one-third), however, is not forward-looking, taking only historic data into account. Deviations from a fully optimising behaviour are also evident from the results available for four countries, which indicate that a "rule of thumb" (such as indexation based on the consumer price index, a fixed percentage adaptation, etc.) is used by 37% of firms in Belgium, 33% in Spain, 33% in Luxembourg and 25% in Portugal.

Table 4.5: Information set used in pricing decisions, in %

Country	Rule of thumb	Past/present context	Present/future context	Past, present and future
Belgium	37	29	34	-
Spain	33	39	29	-
Italy	-	32	68	-
Luxembourg	33	26	47	-
Austria	-	37	12	51
Portugal	25	33	42	-
Euro area	-	34	48	-

Source: Fabiani et al. (2005). Euro area figures have been estimated using GDP weights. Note that the precentages for the euro area do not add up to 100 as different answer-categories were allowed for in the various countries

Furthermore, all surveys contained a question which directly addressed the reasons for price stickiness. All surveys asked a question along the following lines: "If there are reasons for changing the price of your main product, which of the following factors may well prevent an immediate price adjustment?". The list following this question offers a series of statements, expressed in simple terms, based on different economic theories of price rigidities. The respondents could indicate their degree of agreement with each statement, choosing among four categories: unimportant (1), of minor importance (2), important (3) and very important (4), where the numbers in brackets indicate the scores attached to each category. The mean scores attached to the various theories by the firms in each country have been used to calculate a ranking of possible reasons for price stickiness. The results are shown in Table 4.6, which also provides the average ranking for the euro area. Based on this ranking, three groups of theories can be defined: the

first consists of those theories that have an average score well above two, the second contains those close to two, and the third covers the remaining ones. Using this grouping, implicit and explicit contracts, cost-based pricing and co-ordination failure are the most relevant explanations for sticky prices, while menu costs, pricing thresholds and costly information are not recognised as important by the respondents.[39]

Table 4.6: Ranking of theories explaining price stickiness

	Belgium	Germany	Spain	France	Italy	Luxem-bourg	Nether-lands	Austria	Portugal	Euro area
Implicit contracts	2.5		2.6	2.2		2.7	2.7	3.0	3.1	2.7
Explicit contracts	2.4	2.4	2.3	2.7	2.6	2.8	2.5	3.0	2.6	2.6
Cost-based pricing	2.4			2.5		2.7		2.6	2.7	2.6
Co-ordination failure	2.2	2.2	2.4	3.0	2.6	2.1	2.2	2.3	2.8	2.4
Judging quality by price	1.9		1.8			2.2	2.4	1.9	2.3	2.1
Temporary shocks	1.8	1.9	1.8	2.1	2.0	1.7	2.4	1.5	2.5	2.0
Change non-price factors	1.7		1.3			1.9	1.9	1.7		1.7
Menu costs	1.5	1.4	1.4	1.4	1.6	1.8	1.7	1.5	1.9	1.6
Costly information	1.6		1.3			1.8		1.6	1.7	1.6
Pricing thresholds	1.7		1.5	1.6	1.4	1.8	1.8	1.3	1.8	1.6

Source: Fabiani et al. (2005). Euro area figures are unweighted averages of country scores.

The theory of "implicit contracts" has the highest average score (2.7) and ranks first in four country questionnaires. The theory is based on the idea that firms establish long-run relationships with customers in order to make future sales more predictable; in other words, they try to win customer loyalty simply by changing prices as little as possible. Customers are attracted by a constant price because it helps them to minimise search costs (e.g. shopping time) with the result that they focus on the long-term average price rather than on the spot price. This is consistent with the fact that most of the firms in the survey have some sort of long-term relationship with their customers. "Explicit contracts" (firms have to re-negotiate a contract to change their prices) as an explanation for sticky prices is the second most important factor at the euro area level (with an average score of 2.6). The same average score is attributed to "cost-based pricing", which assumes that prices do not change if costs do not change or that they respond only with a lag to cost changes. In the case of "co-ordination failure", which earns an average score of 2.4, the idea is that firms prefer not to change their prices unless one of their competitors moves first. If a firm is the only

[39] These results are comparable to those obtained for Japan, Sweden, the United States and the United Kingdom. Compared to the United States, one difference regards the importance of changes in non-price factors, which has been found to be higher in the United States than in the euro area. In Canada, the low-ranked options were similar to those in the euro area, whereas some differences emerge for the options that emerged as the more important in the euro area. Notably, implicit contracts and co-ordination failure rank considerably lower in Canada.

one to increase its price after a shock, it may lose customers; on the other hand, a single-handed price reduction might spark off a price war, which could in the end be detrimental to the firm's profits. Without a co-ordinating mechanism that allows firms to move together, prices may remain fixed.

The importance attached to the various theories differs only slightly across sectors. In the goods sector, the ranking is very similar to the overall one, with small differences only within the group of low-ranked theories. This should not come as a surprise, since the goods sector is the dominant sector in nearly all country surveys. Similarly, in the services sector there seem to be only minor differences with respect to the overall ranking. Larger differences appear instead in the ranking given to the theories by firms in the trade sector: explicit contracts are of minor importance, while pricing thresholds and menu costs receive higher scores than in the other sectors.

The ranking given by firms to the various factors behind price stickiness provides some evidence on whether these factors have a greater bearing on the first or the second stage of price adjustment. With the most relevant impediments being implicit and explicit contracts, cost-based pricing and co-ordination failure, the main impediments to price adjustment seem to concern the second stage of price setting, i.e. actually *changing* prices. Costs of gathering relevant information, which should weigh more prominently in the price *review* stage, were generally not mentioned as important.

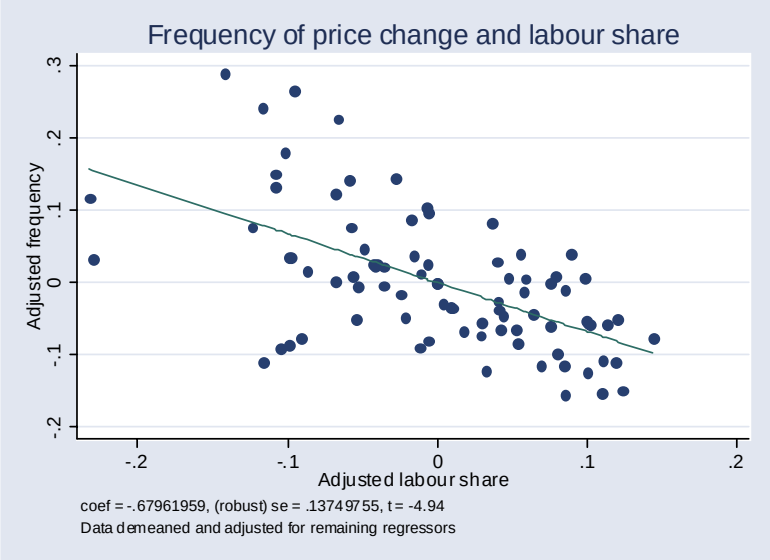
Finally, the survey results show another important regularity, namely an *asymmetry* in price adjustment. There is a general pattern that cost shocks are more relevant for price increases than for price decreases, while shocks to market conditions matter more when prices have to be decreased. On the cost side, it is in particular the development of labour and raw material costs which might lead to price increases, while financial costs are of minor importance; conversely, price decreases are mainly affected by weakening demand or decreasing prices of competitors. Firms in highly competitive markets react particularly strongly to price-decreasing shocks, especially on the demand side. These asymmetries can be important for the conduct of monetary policy, as they may imply, in the short term, different impacts of positive or negative shocks, which monetary policy might want to take into account in its reaction to these shocks.

To some extent, this asymmetry could be verified also for the consumer prices, using the micro price records for Germany. It has been found that input price inflation is an important determinant for the frequency of price increases, but not for price decreases. What matters for both increases and decreases, however, is the *variability* of input price inflation: the more volatile it is, the more frequently prices are adjusted up- and downwards. These patterns have been found for the full product sample, whereas the effects of input price inflation disappear statistically for a core measure of inflation, i.e. when excluding unprocessed food and energy. It is not clear, however, whether this is due to a statistical problem (input price inflation moves too little to find statistically significant effects), or whether the relationship is indeed absent for a basket that excludes unprocessed food and energy.[40] However, the role of the variability of input prices for the frequency of price changes is also observed when estimating structural

[40] See Hoffmann and Kurz-Kim (2005).

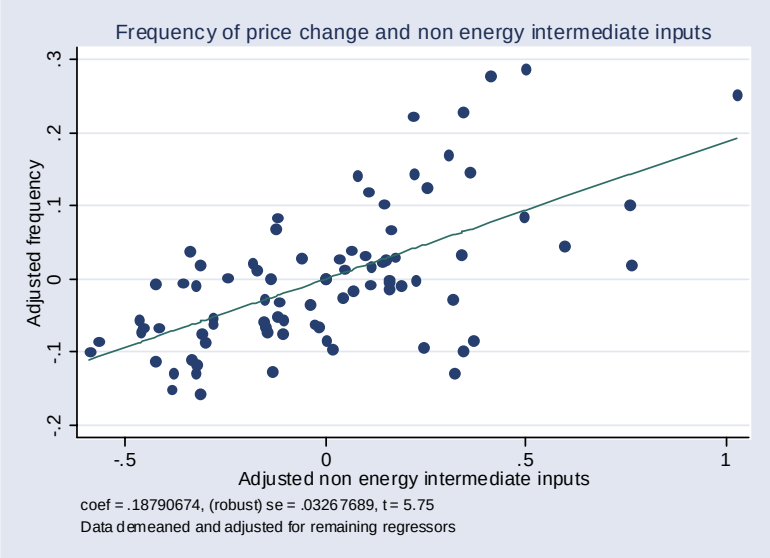
models of inflation dynamics at the aggregate level[41] and for producer prices. It has been found that higher shares of labour input imply lower frequencies of price changes and conversely that higher shares of raw material input are related to higher frequencies of price changes. These effects are illustrated in Figures 4.2 and 4.3, which show the relationships observed with the Spanish data, where it has been found that a 10% increase in the labour share for a product decreases the frequency of price changes by 6.8%. As wage costs are much less volatile than raw material prices, these patterns show a clear relationship between the volatility of input prices and the frequency of price changes.

Figure 4.2: Frequencies of price changes and the labour share in Spain



Source: Álvarez et al. (2005b).

Figure 4.3: Frequencies of price changes and the share of raw material inputs in Spain

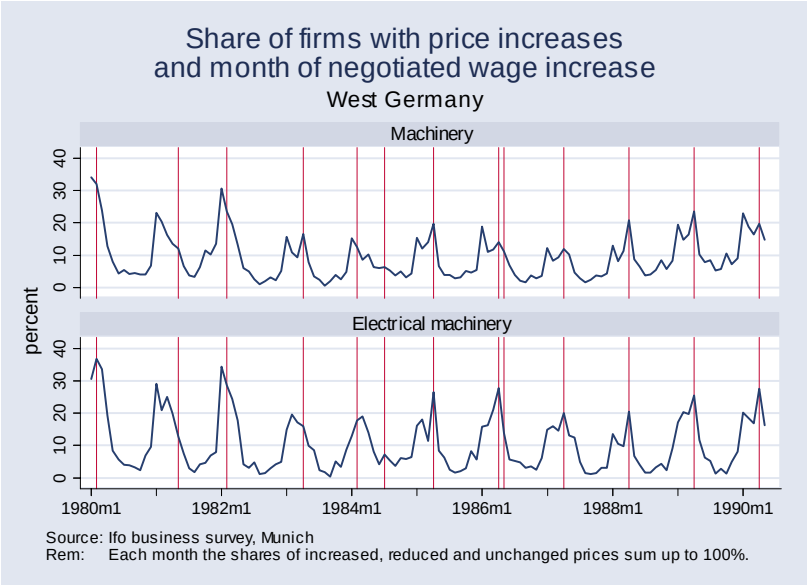


Source: Álvarez et al. (2005b).

[41] See Rumler (2005), who estimates open economy New Keynesian Phillips Curves for several euro area countries and finds that firms facing more variable input costs tend to adjust their prices more frequently.

The importance of wages for price setting has furthermore been illustrated for the case of Germany. As wage setting in Germany is highly synchronised, with trade unions being organised on a sectoral basis, it is possible to analyse whether firms change their prices in a synchronised fashion in the months of negotiated wage increases. As a matter of fact, the share of firms that increase prices generally shows peaks in such months, as illustrated in Figure 4.4.

Figure 4.4: Share of firms with price increases and months of negotiated wage increases in Germany



Source: Stahl (2005). The chart shows the share of firms that increases prices in a given month (blue line), for the machinery industry (Upper panel) and the electrical machinery industry (lower panel). The vertical lines denote months in which wages were increased according to the union-wide wage settlements for the respective industries.

The hypothesis that sluggish price dynamics are related to low competitiveness of product markets was also tested using the micro price observations. There is substantial evidence that the frequency of consumer price changes depends on the outlet type: it is significantly higher in super and hyper markets than in traditional corner shops.[42] This can reflect either differences in the degree of price competition, the relative importance of menu costs or different pricing strategies (every day low pricing versus high-low pricing) in those different types of stores. Looking at producer prices, competitiveness of the markets in which firms operate is similarly important: the more competitive the environment, the more frequently prices change.

Another reason for sluggish price dynamics in the retail sector has to be seen in the use of attractive pricing, which is a widespread practice in price setting in the euro area – more so for consumer prices than for producer prices, but even for the latter attractive pricing is observed and changes the frequency of

[42] Baudry et al. 2004; Dias, Dias and Neves 2004; Jonker et al. 2004; Veronese et al. 2005.

price changes. It is generally found that prices which are set at an attractive level are changed less frequently than other prices.[43] Attractive pricing could therefore be a source of rigidity, as a retailer may (temporarily) decide not to reset its price in response to a shock because the optimal response would be a non-attractive price.[44]

5. Inflation persistence and price stickiness: monetary policy implications

Several of the findings reported in the preceding section have implications for various economic policies. For example there are implications for structural policies that can be drawn. For instance, structural reforms that further enhance competition in goods and, in particular, services markets both at the producer and retailer level might be a useful step forward in order to reduce price stickiness and to facilitate the adjustment of prices to economic conditions. Also, labour market reforms geared at increasing the flexibility of wages and, where relevant, the abolishment of wage indexation clauses could help to reduce inflation persistence. Accordingly, the degree of inflation persistence and price stickiness might well be changing in the future, also in response to, e.g., more cross-border competition in the EU or globalisation.

This section explores the monetary policy implications of the IPN findings, with particular focus on the fact that the degree of intrinsic inflation persistence in the euro area is limited and similar to that in the United States, while the degree of price level stickiness is considerable and higher than in the United States. For this analysis we make use of an estimated micro-founded DSGE model of the euro area, as the one proposed by Smets and Wouters (2003). The main reason for using such a micro-founded model is that the micro empirical findings about the degree of price stickiness can be more easily incorporated, while being detailed enough to mimic the salient features of the euro area economy.

Section 5.1 investigates the implications for the response of a medium-term orientated monetary policy to cost-push shocks. The simulations show that high price stickiness primarily increases the persistence of output developments, whereas the persistence of inflation is not so much affected. The IPN findings are therefore consistent with the empirical observation that output persistence is higher in the euro area than in the United States, while inflation persistence is similar. Furthermore, a low degree of intrinsic inflation persistence and a high degree of price level stickiness appear to justify a less aggressive response to cost-push shocks. In such respect a number of caveats are also mentioned in Section 5.2. Finally, Section 5.3 addresses some other monetary policy implications stemming from the heterogeneity in price stickiness and the presence of downward price flexibility.

5.1 Implications for monetary policy

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[43] Álvarez and Hernando 2004; Aucremanne and Dhyne 2005a; Baumgartner et al. 2005.

[44] An interesting observation in this respect relates to the euro cash changeover, when euro area retailers had to convert prices from their national currency to the euro. Not unexpectedly, the frequency of price changes increased significantly in January 2002, as well as during a 6 months period before and/or after the conversion to the euro. See, e.g., Baudry et al. 2004; Baumgartner et al. 2005; Cornille 2003; Hoffmann and Kurz-Kim 2005; Jonker et al. 2004.

In order to understand the implications of a moderate degree of intrinsic inflation persistence and the high degree of price level stickiness for monetary policy, we investigate the response of a medium-term orientated monetary policy to cost-push shocks in the estimated euro area model of Smets and Wouters (2003), under different degrees of intrinsic inflation persistence and price stickiness.

A medium-term oriented monetary policy aims at stabilizing inflation over the medium term, thereby avoiding excessive fluctuations in the output gap and nominal interest rates. In the simulation exercise this is captured by a central bank loss function that puts a dominant weight on inflation stabilisation (0.85) and a small weight on the stabilisation of the output gap (0.075) and interest rate changes (0.075). As discussed in Svensson (1997) and Smets (2004), there is a correspondence between the horizon of a central bank and the weight on output gap and interest rate stabilisation. Moreover, it is assumed that the central bank acts under commitment: i.e. it can credibly commit to future state-dependent interest rate paths.[45]

The central equation for inflation, that captures the degree of intrinsic inflation persistence and price level stickiness in the Smets-Wouters model, takes the form of a hybrid New Keynesian Phillips curve (NKPC) similar to eq. (1). The degree of price stickiness affects the slope of Phillips curve or, in other words, the elasticity of inflation with respect to the marginal cost. In the baseline estimate, we assume that the average duration of prices is one year (in line with the micro-evidence reported above). This will be compared with lower average durations of three and two quarters, which is more in line with the micro evidence found for the United States.

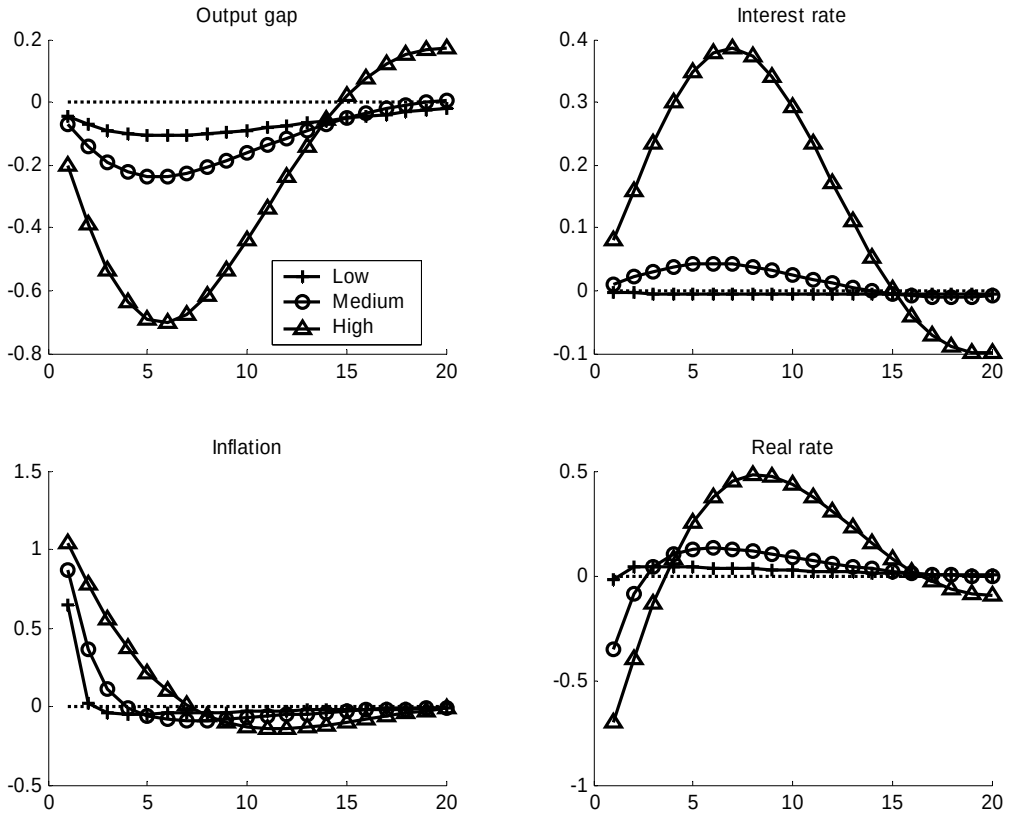
The Smets-Wouters model also allows for intrinsic inflation persistence by assuming that a fraction of price setters automatically refer to past inflation when setting their prices. This indexation parameter is captured by the coefficient of the lagged inflation rate in the NKPC. This implies that current inflation will depend not only on current and future expected fundamentals such as marginal costs, but also on lagged inflation. In the simulations reported below, we will vary the degree to which inflation depends on its own lags. In the baseline estimate, it is found that the dependence on lagged inflation is quite small (0.5), in line with most of the IPN macro analysis reported above. This is also broadly consistent with the survey evidence on the importance of rules-of-thumb in price setting. While the indexation parameters will be 0.1 and 0.9 in the low and high persistence case respectively.

Two factors motivate the focus on cost-push shocks. First, the euro area has been hit by a series of cost-push shocks over the past five years, for instance due to adverse weather conditions, animal diseases or shocks to oil prices. It is therefore interesting to see what the IPN findings imply for the appropriate

[45] Results are generally robust to variations in the loss function parameters, unless the weights on the output gap and interest rate changes are set to zero. In this latter case, monetary policy will attempt to counteract movements in inflation immediately and fully, thus creating an unreasonable amount of interest rate and output gap volatility; as a consequence, monetary policy would be more aggressive in an economy with stickier prices. The reported results are confirmed in a robustness check which considers the case in which monetary policy seeks to minimize a model-consistent loss function, properly derived from the utility of the representative consumer (as discussed in Altissimo, Curdia and Rodriguez-Palenzuela 2005). Finally, the results also appear robust to simpler variants of the New Keynesian model used.

policy response to such shocks.[46] Second, cost-push shocks generally put the central bank before a dilemma as they tend to change prices and output in different directions.

Figure 5.1: Intrinsic inflation persistence and the policy response to cost-push shocks



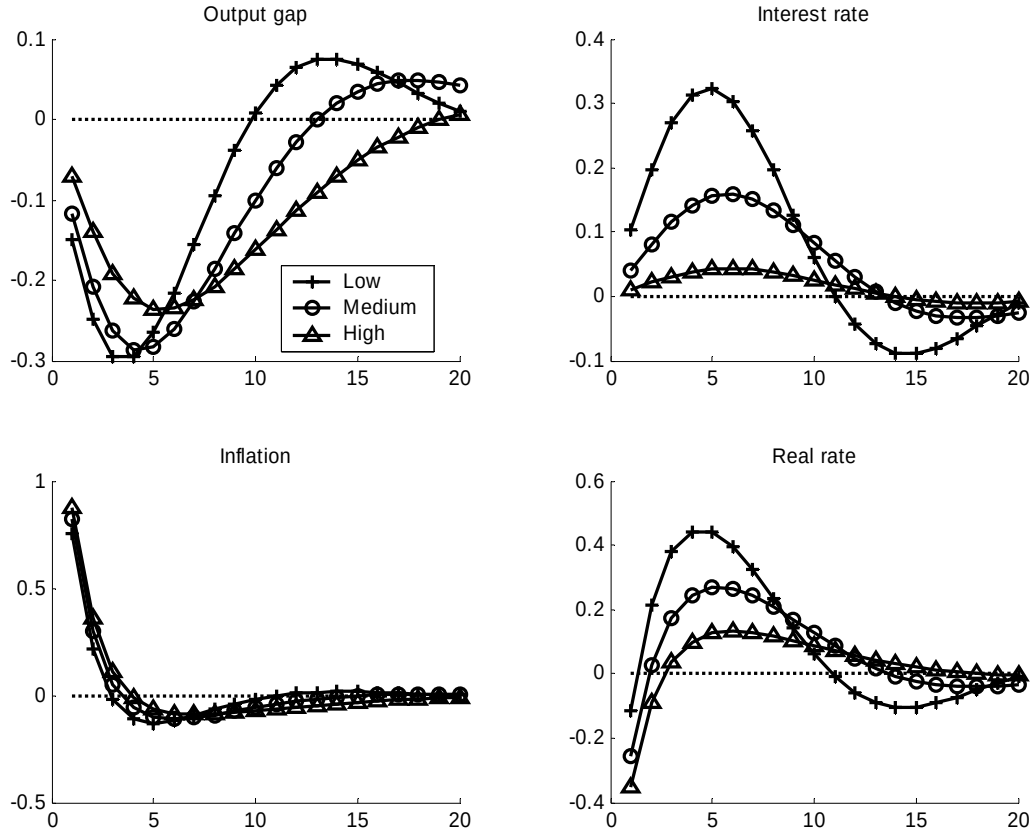
Notes: Impulse responses to a one-standard deviation cost-push shock in the Smets-Wouters model for low (0.1), medium (0.5) and high (0.9) levels of the indexation parameter under a medium-term orientated monetary policy. See footnote 7 for the specific characterisation of monetary policy in this simulation exercise.

Figures 5.1 and 5.2 respectively plot the responses of output, inflation and the nominal and real policy rate to a cost-push shock in presence of different degree of intrinsic inflation persistence and different price stickiness. A few observations are worth mentioning. First, Figure 5.1 shows that a smaller degree of intrinsic inflation persistence implies a much smaller response of policy rates to cost-push shocks both in terms of the size and the persistence of the response. The reasons are quite straightforward. First, with a lower degree of inflation persistence, the immediate impact of an inflation shock will be smaller as agents anticipate a lower persistence of this inflation shock and therefore reduce their expectations of future inflation. This has an immediate dampening effect on current inflation. Second, as the response of inflation is lower, also the negative response of the output gap will be lower. Finally, as the response of inflation is much less persistent, the response of the real rate will have to be much less persistent. In other

[46] In the Smets-Wouters model these various sources of cost-push shocks are not explicitly modelled, but are captured in the error term to the New Keynesian Phillips curve.

words, the benefit of a low degree of inflation persistence is an improved inflation-output variability trade-off and a much reduced need to respond to cost-push shocks.

Figure 5.2: Price stickiness and the policy response to cost-push shocks



Notes: Impulse responses to a one-standard deviation cost-push shock in the Smets-Wouters model for low (2 quarters), medium (3 quarters) and high (4 quarters) levels of the average duration of prices under a medium-term orientated monetary policy. See footnote 7 for the specific characterisation of monetary policy in this simulation exercise. Note also that in this figure the baseline case that corresponds to the medium-persistence case in Figure 3.2 is the high-stickiness case.

Next, Figure 5.2 illustrates the impact of the degree of price stickiness on the response of output, inflation and the nominal and real policy rate. A first thing to note is that a higher degree of price level stickiness leads to a more persistent output response, whereas the effect on the shape and the magnitude of the inflation response is relatively minor. This could provide one explanation of the - at first sight - puzzling evidence presented above that while price level stickiness is higher in the euro area than in the United States, reduced-form estimates of inflation persistence are similar in both regions. Higher price level stickiness does not necessarily lead to much higher inflation persistence. In contrast, it does lead to a higher degree of output persistence.[47][48]

[47] The same pattern also holds in an analysis of the response of inflation and output to other shocks such as a shift in monetary policy.

[48] For example, over the period 1993-2005 the autoregressive coefficient in an AR(1) estimation for consumer price inflation was 0.18 in the euro area and 0.12 in the United States. In contrast, the analogous coefficient for real GDP growth was much higher in the euro area than in the US (0.49 versus 0.18).

Under the optimal monetary policy considered here, the path for inflation does not depend very much on the degree of price stickiness. However, a higher degree of price stickiness implies that the overall sacrifice ratio involved in achieving this broadly similar inflation path is higher. This can be seen by noting that for similar profiles of inflation, the cumulative output loss is highest for the more sticky economy. However, a higher degree of price stickiness also implies a less aggressive monetary policy reaction, in the sense of smaller and fewer changes in the nominal policy-controlled interest rate. The main reason for this is twofold. With higher price stickiness a given change in the nominal interest rate will have a larger effect on the real rate and consequently output. In addition, with higher price stickiness a credible central bank has a greater incentive to smooth out its policy response. This results in a smaller initial, but more prolonged and persistent output gap response.

Overall, a low degree of intrinsic inflation persistence and a high degree of price stickiness therefore appear to justify a less aggressive interest rate response to cost-push shocks.

At this point it is worth mentioning two opposing factors that may modify the above-mentioned conclusions. First, in Figures 5.1 and 5.2 we assumed that the size of the cost-push shock is not affected by the alternative degrees of intrinsic inflation persistence and price stickiness. In theory (and probably also in practice), the effect of a given cost-push shock on the general price level will be less when a large share of prices, in particular in the sector affected by the cost-push shock, are sticky. This will tend to reinforce the result that a higher degree of price stickiness reduces the effects of cost-push shocks on inflation and economic activity. Of course, while this works to the benefit of the central bank in the case of cost-push shocks, it should be recognized that a higher degree of price stickiness will also lead to a slower economic adjustment process in response to other shocks such as changes in productivity, which will tend to be costly. Second, a higher degree of price stickiness will increase the costs of inflation. The reason is intuitive: as fewer prices adjust, higher inflation will tend to lead to bigger inefficient relative price changes. One important implication of this is that higher price stickiness strengthens the case for focusing on price stability. If, as a result, the central bank shortens its horizon for maintaining price stability, this may counterbalance the finding mentioned above that higher price stickiness leads to less aggressive responses to cost-push shocks, In the extreme, under the assumption that the central bank does not put any weight on the stabilisation of the output gap and interest rate changes (unlike, e.g., under a medium-term orientation), it would react more rather than less aggressively to cost-push shocks.

5.2 Some caveats

In this section, we discuss a number of caveats related to the discussion in the section above.

Uncertainty about the degree of inflation persistence and price level stickiness

From Table 3.1 it is clear that there is a considerable degree of uncertainty about the estimated degree of inflation persistence. Similarly, macro-economic estimates of the degree of price level stickiness vary quite considerably. In this section we discuss some of the implications of this uncertainty.

Uncertainty about the slope of the Phillips curve creates uncertainty about the effects of monetary policy. Brainard's (1967) classical analysis of multiplier uncertainty would suggest that the central bank needs to respond more gradually in the face of such uncertainty, strengthening the case for a less aggressive monetary policy. Indeed, when the central bank has only limited knowledge about the effects of its policy, it may want to move cautiously in order not to generate unnecessary fluctuations in the economy. A similar policy prescription calling for a more cautious response follows also in the presence of uncertainty on the state and exact cyclical position of the economy, as the one arising from the uncertainty on the size of the output gap in real time. More recent contributions have, however, highlighted that this policy advice is not universal. They show that a more aggressive policy response may be appropriate when uncertainty is related to the persistence of the inflation process.[49]

The recent literature has often focused on the robustness of policies in face of uncertainty on the model of the economy: monetary policy should be designed so that its stabilisation properties remain relatively good irrespective of the true model of the economy. Here again, the main finding is that a medium-term orientated policy-maker is well advised to set policy based on the assumption of a relatively high degree of intrinsic inflation persistence and price level stickiness, i.e. a relatively rigid economy.[50] The intuition is simple. If the true degree of persistence and rigidity in the economy is low but the policy-maker wrongly assumes the converse, the policy-maker will react too strongly to shocks, implying a welfare cost. However, this cost will be moderate as the economy is relatively flexible and the policy-maker can easily undo the mistake. On the contrary, if the persistence of inflation is high but the policy-maker wrongly assumes that it is low, the weak response of interest rates will allow the initial shock to be factored into the expectations of agents and will lead inflation to drift away. This will entail a much higher welfare cost because it will be less easy to undo the mistake in the relatively more rigid economy. To insure against this risk, the policy-maker is better off by assuming a relatively high degree of inflation inertia. Overall, this argument inserts some caution in the above-mentioned conclusion that lower inflation persistence allows for a more timid response to cost-push shocks.

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[49] For example, Craine (1979) and Söderström (2002).

[50] See Levin and Moessner (2005) and the references therein. ECB contributions to this literature include Angeloni, Coenen and Smets (2003), Coenen (2003) and Moessner (2005).

The endogeneity of inflation persistence and price stickiness

In the analysis of Section 5.1 above, the degree of intrinsic inflation persistence and price level stickiness was treated as exogenous to the monetary policy regime. In fact, it is very likely that neither of those features are regime independent. For example, it has been argued that the apparent fall in the degree of inflation persistence over the past decade in many countries, including the euro area, has been the result of a better anchoring of the private sector's inflation expectations to the central bank's price stability objective. Hence, estimates of inflation persistence are typically smaller for sample periods where the mean of inflation is stable than for sample periods including episodes of transition from high inflation regimes to low inflation ones[51]. Recent analysis has shown that if economic agents have imperfect knowledge of the structure of the economy and the expectation formation on the part of the private sector is based on some form of learning mechanism, there is a clear relationship between the monetary policy regime and the ex-post inflation persistence.[52] In particular, it has been found that policy should respond more aggressively to inflation under imperfect knowledge in order to properly steer the learning mechanism of the private agents. One of the benefits of assigning a greater weight to price stability is a reduction in inflation persistence.

The policy implications of the important role of expectations formation as a determinant of the degree of inflation persistence are straightforward. In order to benefit from reduced inflation persistence, the central bank needs to keep inflation expectations anchored to the inflation objective. As discussed above, this will allow the central bank to take a medium-term orientation and see through the temporary effects of various cost-push shocks. On the other hand, when a series of cost-push shocks in one direction risks increasing the perceived degree of persistence by the private sector, inflation expectations and inflation itself could become unanchored and costly to control. If communication by the central bank cannot alleviate this problem, it is advisable to respond quite aggressively and persistently to such shocks. An important insight from the realization that the degree of inflation persistence is endogenous is that the policy response becomes dependent on how well inflation and inflation expectations are anchored.

Similarly, it is likely that the degree of price level stickiness depends on the monetary policy regime. The IPN findings indeed confirm that sectors with a higher sectoral inflation rate and higher inflation variability typically do exhibit more frequent price changes as the costs of keeping prices unchanged outweigh menu costs and other costs of changing prices. A stability-oriented monetary policy regime could therefore be one explanation for a relatively high degree of price stickiness. This endogeneity of the degree of price stickiness again raises the question to what extent the policy advice of a less aggressive response to cost-push shocks may itself affect the degree of price stickiness.

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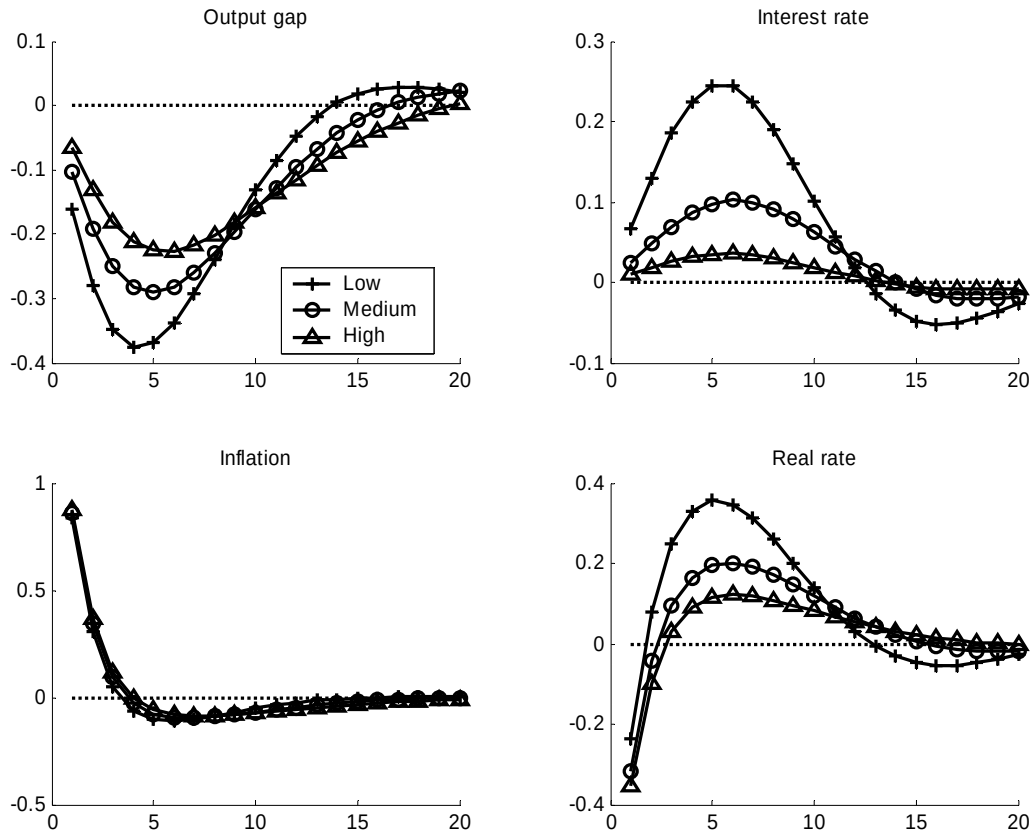
[51] See Corvoisier and Mojon (2005).

[52] See Orphanides and Williams (2002) and Gaspar, Smets and Vestin (2005).

Wage and price stickiness

In the analysis above, we have assumed that the lower frequency of price adjustment is associated with a higher degree of rigidity in the setting of nominal prices. This hypothesis is consistent with some of the structural macro findings reported above and with the finding of higher output persistence in the euro area. However, other explanations are possible. In particular, there is quite a bit of evidence that price stickiness may be related to wage stickiness. As mentioned in Section 3, sectors with a high labour share typically change their prices less often than other sectors. To the extent that wages are more rigid in the euro area than in the United States, this is a plausible alternative explanation of the lower frequencies of price adjustment in the euro area.

Figure 5.3: Wage stickiness and the policy response to cost-push shocks



Notes: Impulse responses to a one-standard deviation cost-push shock in the Smets-Wouters model for low (2 quarters), medium (3 quarters) and high (4 quarters) average length of wage contracts under a medium-term orientated monetary policy. See footnote 7 for the specific characterisation of monetary policy in this simulation exercise.

A full investigation of the policy implications of wage stickiness falls beyond the scope of this note, but it may be informative to do a similar simulation exercise as in Figures 5.1 and 5.2 for different degrees of wage stickiness. In the Smets-Wouters model, the average duration of wage contracts in the euro area is estimated to be about one year (which is similar to the average duration of prices). In analogy with Figure 5.2 above, Figure 5.3 shows the impact of lowering the average wage contract length to three and two

quarters respectively on the response of the output gap, inflation and the policy rate to a cost-push shock. Comparing with Figure 5.2, it is clear that the results are very similar. Higher wage stickiness leads to a less aggressive policy response to cost-push shocks. One apparent difference is that the impact of wage stickiness on the persistence of the output gap response is less pronounced.

5.3 Other implications for monetary policy

In this section, we briefly discuss the policy implications of two other IPN findings: the heterogeneity in price stickiness across sectors and the finding that, overall, one can observe many price falls.

Heterogeneity in price stickiness

Another robust finding coming from the micro evidence is the considerable degree of heterogeneity across sectors in the degree of price stickiness, with energy and non-processed food being quite flexible sectors, while the prices of services and non-energy industrial goods are considerably more sticky. Again, the sources of this heterogeneity will be important for drawing policy implications. Section 4.3 has summarised the available evidence on the possible reasons for sluggish price dynamics. One important result, which has been found both at the producer and the retailer level, is that larger competition reduces price stickiness. For the consumer prices, it has been found that prices are changed more often in supermarkets and hypermarkets compared to higher-priced corner-shops. This pattern might also explain parts of the large difference in pricing patterns with the United States. With a more competitive retail sector, the frequency of price adjustments can be expected to be considerably larger.[53] For producer prices, the survey results have shown that firms in highly competitive markets respond more strongly to changes in underlying factors, with the differences being most pronounced in the case of price-decreasing shocks, especially on the demand side, also suggesting that high competitiveness in product markets leads to lower price rigidities. Structural reforms to enhance competitiveness in product markets, both at the producer and retailer level, and exposing the service sector to more trade might therefore be a useful step in order to reduce the importance of price rigidities. However, it is also important to note that price rigidities as such need not necessarily be undesirable. It could be imagined that consumers prefer to purchase their goods in retail outlets that change prices less frequently. To the extent that prices remain unchanged at a very low level (an "all-time-low"-pricing strategy explicitly adopted and marketed by some retail chains), this can be beneficial to consumers.

The evidence in Section 4.3 also suggests that the variability of input costs may also play an important role in determining differences in price stickiness. For example, it has been found that the frequency of price changes for producer prices depends negatively on the share of labour in a firm's input. This

[53] Unfortunately, there is only very little data available that allows to directly compare the competitiveness of the retail sector across the euro area and the United States; furthermore, the scant data is relatively out of date. Pilat (1997) shows data on the number of retail outlets per 10,000 inhabitants and the retail sales per employee, both for 1990, for the United States and all euro area countries. It is apparent that there were far fewer outlets in the United States, pointing to a more concentrated market, and that retail sales per employee were considerably higher in the United States, pointing to a more efficient retail sector. See also Gordon (2004).

suggests that persistence in wage developments can be a cause for price rigidities. The importance of labour market rigidities for inflation persistence is furthermore corroborated by simulations using the various structural macroeconomic models for the euro area and its member countries that are used in the Eurosystem. In these models, inflation persistence is to a large part driven by labour markets.[54]

Recent contributions to the economic literature have highlighted that heterogeneity in the degree of price stickiness across sectors and/or countries may have implications for which price index to target.[55] In particular, according to these arguments, the central bank should target a price index that assigns a relatively larger weight to those sectors or regions where price developments are more sticky.

The rationale for this can be described as follows. In an economy with two sectors of equal sizes, one more rigid (i.e. featuring a higher degree of friction in the adjustment of relative prices following shocks) and the other more flexible, a monetary policy that does not take account of sectoral heterogeneity in the weighting of the price index implies that, upon the occurrence of an aggregate shock, the two sectors have to adjust in a similar way. However, the rigid sector bears a higher cost than the flexible sector in its adjustment to that macroeconomic shock. This imbalance leads to a welfare loss for the currency union that could be avoided. By weighting the more rigid sector to take into account more than just its overall size, monetary policy would thus make sure that the flexible sector responded to a higher degree to the shock, thus making a stronger contribution to the overall adjustment needed in the economy.

Applying these ideas to the context of the ECB, the IPN results would point to giving more prominence to a measure of HICP inflation excluding energy and unprocessed food given the large differences in price rigidities across energy and unprocessed food on the one hand and all other sectors on the other hand. The medium-term orientation of the ECB's monetary policy strategy allows for looking through the short-term effects of changes in flexible energy and food prices and concentrating on the more persistent components of the HICP without the need to change the index used in the definition of price stability. Using a modified HICP index as the underlying measure for the ECB's definition of price stability would have several drawbacks. First of all, excluding some sectors, but not others would introduce some element of arbitrariness and uncertainty in the conduct of monetary policy and could negatively affect the transparency of the objective pursued by the central bank. Secondly, the possibility cannot be ruled out that by assigning higher importance to a particular sector-specific development, monetary policy would in practice be accommodating behavioural or structural inefficiencies, ultimately creating perverse incentives and hampering the necessary progress towards more market-based adjustment mechanisms. Furthermore, the communication of monetary policy would face the challenge to explain why price developments felt by consumers would not necessarily coincide with those addressed by the central bank.

Regardless of these considerations, two important general conclusions follow from the existence of heterogeneous patterns of price rigidities. First, it implies that, when monitoring price developments in

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54 Berben et al. (2005).

55 See Benigno (2004), Aoki (2001) or Goodfriend and King (1997).

order to forecast future inflation, it is important for the central bank to analyse the sectoral sources of these price movements. Given the different degree of stickiness, understanding the source of the shocks will allow the central bank to better assess the persistence of those developments and thereby improve its forecast. Secondly, and related to the previous point, understanding the sectoral source of inflation developments is also important for the appropriate policy response to inflation shocks. When the inflation shocks originate from a relatively flexible sector such as the energy or food sector and are not overly persistent, a medium-term oriented central bank can look through the short-term inflation effects as long as there are no signs of significant second-round effects. Forcing a quick stabilisation of the general price level would put a too large burden of adjustment on the more sticky sectors. In contrast, inflation shocks that originate from those sectors, like services, that are characterised by a systematically longer adjustment process should be of greater concern to the policy-maker and may require a more pronounced policy response. To these conclusions we can add two further elements: first, the service sector is mainly composed by items which are non-tradable across countries (even inside the currency union) and this prevents international competitiveness, which could otherwise foster and speed-up the needed adjustment.[56] Second, a large share of the value added of the service sector is accounted for by employment compensation, hinting to a relationship between the nominal rigidity observed in the service sector and the wage-setting mechanisms.[57]

Downward price flexibility

Overall, there is little micro evidence that it is more difficult for firms to decrease prices than to increase them. As discussed above, both in the retail and the producer sector about 40% of price changes are price decreases. Moreover, the absolute size of those price decreases is large, and even somewhat larger than the size of price increases. The finding that overall price falls are very common could have implications for the optimal inflation objective. It has been argued that downward nominal price rigidities that are not matched by similar upward rigidities may justify a higher inflation objective in order to facilitate relative price adjustment in a monetary union following asymmetric sectoral or country shocks. Overall, the IPN findings would therefore not suggest that downward nominal price rigidities are an important reason for having such an inflation buffer. However, the sectoral heterogeneity is important in this respect. In the services sector, which constitutes a large fraction of items in the HICP, the frequency of price decreases is found to be relatively low. In this sector, only 20% of price changes are price decreases. This may in part be explained by higher inflation rates in this sector, which reduce the necessity to decrease nominal prices. However, to the extent that the services sector has a larger labour input share, another possible reason for this asymmetry is the more steady development of wages, which might go hand in hand with downward nominal wage rigidity. It remains to be investigated whether such downward rigidity in wages is a relevant factor for maintaining an inflation buffer. Furthermore, the asymmetry discovered in the

[56] See Altissimo, Benigno and Rodriguez (2005).

[57] On the importance of the wage setting mechanism in the policy design see Levin, Onatski, Williams and Williams (2005)

surveys points to the fact that there is little downward price rigidity in response to changes in demand, whereas this may be more important in response to changes in firms' costs.

6. Conclusions

The IPN has produced a wealth of information on price setting and inflation dynamics in the euro area. As already clear from this paper, the main findings mentioned above cover only a small fraction of this information. Some of the IPN findings on price setting practices challenge several of the assumptions currently used in micro-founded macroeconomic models of inflation dynamics. For example, in contrast to the assumption made in the most popular inflation models that firms only change their price as a function of time and in a staggered fashion, the IPN has uncovered ample evidence of state-dependence in price setting. The frequency of price changes depends on economic developments such as changes in VAT rates, the level of aggregate and sectoral inflation and collective wage agreements. Moreover, the large average size of price changes suggests that idiosyncratic shocks at the firm level are also important. Similarly, the IPN's survey evidence shows that long-term relationships with customers and strategic interactions amongst firms are important for price-setting in many industries.

This improved knowledge on price setting behaviour will allow researchers to build more realistic models, which eventually should lead to improved forecasting and simulation performance and a better basis for monetary policy making. For example, it will be important to investigate to what extent the evidence of significant state dependence in price setting will affect the macro behaviour of inflation in such models. Similarly, the implications of the importance of long-term relationships and strategic factors in price setting will be an important area for future research. To the extent that this research helps to base macro models on more adequate behavioural assumptions, the reliability of policy advice obtained with these models should also increase. At the same time, there are already a number of findings that can already be used to draw some tentative policy implications.

In closing this summary, two other issues for further research are worth mentioning. First, the reasons behind the differences between the euro area and the United States with respect to the frequency of price changes are not fully understood. Second, and maybe most importantly, the results reported here point to an important role of wage stickiness in generating price stickiness. In order to understand inflation dynamics, it will therefore be crucial to also gain a better understanding of the functioning of labour markets in the euro area.

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Annex: Description of the micro-data sets

This section describes the databases underlying the empirical analyses conducted by the IPN at the micro level. The evidence comes from two main types of data sources. The first type consists of direct information on individual prices at the consumer and the producer level, the second of one-time surveys on pricing policies followed by firms, conducted specifically for this project.

Table A1: Coverage of the micro data sources

Country	Consumer prices	Producer prices			Ad hoc surveys
			Quantitative PPI data	Qualitative data from business cycle surveys	
Belgium	Yes	Yes	Yes		Yes
Germany	Yes	Yes	Yes	Yes	Yes
Greece					
Spain	Yes	Yes	Yes		Yes
France	Yes	Yes		Yes	Yes
Ireland					
Italy	Yes	Yes	Yes		Yes
Luxembourg	Yes				Yes
The Netherlands	Yes				Yes
Austria	Yes				Yes
Portugal	Yes	Yes	Yes		Yes
Finland	Yes				
Euro area coverage (GDP weights)	97%	85%	63%	51%	94%

Individual prices at the consumer and producer level

The first type of data, observations on individual prices, was available both at the consumer and the producer level. For ***consumer prices***, the IPN research teams in several NCBs obtained large sets of elementary databases underlying the construction of the consumer price indices from the National Statistical Offices. These data are available in 10 euro area countries (Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, the Netherlands, Portugal and Spain), covering 97% of euro area GDP. Before the creation of the IPN, this type of data was only available to a limited extent and for specific purposes in Belgium, the Netherlands and Portugal. Data were typically made available on a bilateral basis between the respective National Statistical Offices and the national IPN teams in the NCBs of the corresponding countries. Due to confidentiality constraints, the databases can only be accessed by the specific national team, making it impossible to pool the national data sources and to conduct an analysis directly at the level of the euro area.

Table A2: Coverage of national CPI databases

Country	Percentage of CPI covered or number of product categories	Period covered
Belgium	68 p.c.	January 1989 - December 2001
Germany	52 product categories (20 p.c.)	January 1998 - January 2004
Spain	70 p.c.	January 1993 - December 2001
France	65 p.c.	July 1994 - February 2003
Italy	50 product categories (20 p.c.)	January 1996 - December 2003
Luxembourg	100 p.c.	January 1999-December 2004
The Netherlands	49 product categories (8 p.c.)	November 1998 - April 2003
Austria	90 p.c. (80 p.c. considered)	January 1996 – December 2003
Portugal	100 p.c. (95 p.c. considered)	January 1992 - January 2001
Finland	100 p.c.	January 1997 – December 2003

Source: Belgium: Aucremanne and Dhyne (2004). Germany: Hoffmann and Kurz-Kim (2005). Spain: Álvarez and Hernando (2004). France: Baudry, Le Bihan, Sevestre and Tarrieu (2004). Italy: Veronese, Fabiani, Gattulli and Sabbatini (2005). Luxembourg: Lünnemann and Mathä (2005). The Netherlands: Jonker, Folkertsma and Blijenberg (2004). Austria: Baumgartner, Glatzer, Rumler and Stiglbauer (2005). Portugal: Dias, Dias and Neves (2004). Finland: Vilmunen and Laakkonen (2005).

The CPI databases are typically large, unbalanced panels of price quotes at the very micro level, i.e. the price of a particular product sold in a given outlet. This means that these databases have two types of cross-sectional dimensions, as well as a temporal dimension. First, they cover a wide range of different product categories. The product coverage varies across countries: While 7 national research teams have at their disposal detailed price quotes for product categories which cover at least 65% of the consumption basket of their country (Austria, Belgium, Finland, France, Luxembourg, Portugal and Spain), a "minimum common sample" of 50 product categories was obtained for 3 other countries (Germany, Italy and the Netherlands).[58] This common sample was defined in the IPN, with the aim to allow comparison

[58] The 50 product categories selected are: 4 unprocessed food categories (steak, one type of fresh fish, lettuce and bananas), 7 processed food categories (milk, sugar, frozen spinach, mineral water, coffee, whisky and beer), 3 energy (oil) products (gasoline for heating purposes and two types of fuels), 17 non-energy industrial goods (socks, jeans, sport shoes, shirt, acrylic painting, cement, toaster, electric bulb, one piece of furniture, towel, car tyre, television set, dog food, tennis ball, Lego construction game, toothpaste and suitcase) and 19 services (dry cleaning, hourly rate of an electrician, hourly rate of a plumber, domestic services, hourly rate of a garage, car wash, balancing of wheels, taxi, cinema, fax machine, videotape rental, photo development, hotel room, glass of beer in a bar, one meal in a restaurant, hot dog, cola-based lemonade in a bar, men's haircut and ladies' hairdressing). If one product category was not available in one country, it had to be replaced by a close substitute. The period covered in each country has also been harmonized, even if a full harmonization was not possible, as it was decided to focus on the period starting in January 1996 and not to cover the period affected by the euro-cash changeover, since this could bias frequencies of price adjustment. However, countries such as Germany, Finland, and Luxembourg for which the period covered, excluding the euro-cash changeover period, would have been too short, also considered data after January 2001. This could bias upwards the average frequency of price changes in these countries and, consequently, in the euro area as a whole. A detailed presentation of this common sample can be found in Dhyne et al. (2005).

of results. Besides this inter-market dimension, the data also have a rich intra-market dimension, as, for a given product category, each month a large number of individual prices is recorded in different outlets.

The time dimension of the CPI databases varies across countries. They start at the end of the 1980's or the beginning of the 1990's in Belgium, Portugal, Spain and France. Italy and Austria have data available from 1996. For Finland, Germany, the Netherlands and Luxembourg shorter time spans are covered, starting in 1997, 1998 or 1999. A detailed overview of the datasets is provided in Dhyne et al. (2005).

For ***producer prices***, national research teams were able to gather comparable statistical information on the *micro data underlying the national producer price indices* for a few countries only (Germany, Spain, Italy and Portugal). These databases are, to a large extent, comparable to those described above for consumer prices. Price records relate to the ex-factory price including all duties and taxes except VAT. The prices are actual transaction prices, not list prices (with the exception of Portugal). The price collected in period *t* should refer to orders booked during period *t* (moment of order) and not be recorded at the moment when the commodities leave the factory. As far as the number of product categories is concerned, also these databases cover either nearly the complete set of data available to the National Statistical Institutes (Germany, Spain and Portugal), or a "minimum common sample", defined in the IPN (Italy). As far as the intra-market dimension is concerned, it is far less developed for the PPI than for the CPI, as the statistical information is typically obtained with production units, as opposed to outlets in the case of consumer prices. Although the time dimension of the databases is generally less developed than for CPI prices, available time spans still range from 6 to 8 years.

Table A3: Coverage of national PPI databases

Country	Percentage of PPI covered or number of product categories	Period covered
Belgium	100 p.c.	January 2001 - January 2005
Germany	100 p.c.	January 1997 - February 2003
Spain	99.4 p.c.	November 1991 - February 1999
Italy	60 products	January 1997- December 2002
Portugal	Almost 100 p.c.	January 1995 - August 2002

Source: Belgium: Dossche (2005). Germany: Vermeulen et al. (2005). Spain: Álvarez et al. (2005b). Italy: Sabbatini et al. (2004). Portugal: Dias, Dias and Neves (2004).

In some cases (Belgium, France and Germany), a second type of data on producer prices is available to the national IPN teams. These data relate to the *monthly business cycle surveys*; the available information at the plant level corresponds to qualitative answers to questions referring to the price changes during the month under review and anticipations of price changes in the coming months. While having only qualitative information on the sign of price changes (up, down or unchanged), this type of data allows linking the pricing behaviour of the firm to other variables in the same survey, such as variations in

demand. The countries where at least one of the two data sources on producer prices at the micro level is available represent approximately 85% of euro area GDP. A detailed overview of the datasets is provided in Vermeulen et al. (2005).

Ad hoc surveys on pricing behaviour of firms in the euro area

The second type of data comes from one-time surveys, conducted specifically for the IPN, on pricing policies followed by firms. Surveys were conducted in nine countries (Austria, Belgium, France, Germany, Italy, Luxembourg, the Netherlands, Portugal and Spain), covering 94 % of euro area GDP. The surveys were conducted by each NCB at the national level to take advantage of the existing knowledge in these NCBs on survey and sample design and/or to adapt the list of questions, the exact wording and the technical aspects of the survey to national specificities. Comparability across countries was achieved by means of coordination at the different stages of the project. In particular, a "minimum common sample" of questions was addressed in each survey and analysed subsequently.

Table A4: Survey coverage (percentages of country survey, number of respondents in brackets)

Country	Industry	Trade	Other services	Construction	Total
Belgium	38	24	18	20	100
	(753)	(478)	(364)	(384)	(1979)
Germany	100	-	-	-	100
	(1228)				(1228)
Spain	44	26	30	-	100
	(888)	(515)	(605)		(2008)
France	100	-	-	-	100
	(1662)				(1662)
Italy	65	14	20	1	100
	(215)	(46)	(68)	(4)	(333)
Luxembourg	20	22	37	22	100
	(67)	(73)	(125)	(74)	(339)
The Netherlands	18	22	60		100
	(219)	(271)	(756)		(1246)
Austria	76	-	24		100
	(661)		(212)		(873)
Portugal	84	-	16	-	100
	(1157)		(213)		(1370)
Euro area	62	13	21	4	100
	(6850)	(1383)	(2343)	(462)	(11038)

Source: Fabiani et al. (2005). Percentages for the euro area are computed on the basis of the absolute figures reported in brackets, which are the sum of the firms in each category over the nine countries.

As shown in Table A4, the number of respondents to the surveys ranged from 333 in Italy to 2,008 in Spain. Overall, more than 10,000 enterprises in the euro area participated in the survey. All surveys cover the manufacturing sector. Trade and other services are covered in 5 and 7 countries. However, as these sectors are not covered in the two largest economies of the euro area (Germany and France), the GDP

weights of the countries covering these sectors amount to approximately 40% only. Coverage of the construction sector is very incomplete, both in terms of number of countries (and corresponding GDP weights) and in terms of the number of individual firms in the samples.

The aim of the surveys was to collect qualitative information which could complement the results obtained on the basis of the databases outlined in the previous sub-section. Relative to these databases, ad hoc surveys have the comparative advantage that they can document, in qualitative terms, the underlying rationale of the observed pricing patterns. In particular, surveys can provide insights as to the relative importance of nominal versus real rigidities. Moreover, surveys can separately analyse the two stages in the price adjustment process, the price reviewing and the price changing stage. Finally, while CPI and PPI databases do not allow checking whether a newly set price is set in a fully optimising way, surveys can address this issue, by asking firms directly which type of information they use when prices are reviewed.

Surveys have as major drawback that the information they provide is mainly qualitative, implying that it is sometimes difficult to grasp the precise importance of a given statement. Moreover they typically relate to current or recent price-setting practices and do not allow addressing the question whether pricing patterns change over time. Finally, they are typically subjective and therefore results could be misleading to a certain extent. It is reassuring that the results obtained do apparently not depend on the way the survey was conducted, the number of questions addressed, the precise wording and the language of the questions, as well as the ordering of the questions and/or options within a particular question. Results therefore appear to be relatively robust. More details on these data are available in Fabiani et al. (2005).