

## ASYMMETRIES IN THE RELATIONSHIP BETWEEN INFLATION AND ACTIVITY

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### Introduction

Studying changes in the way inflation responds to fluctuations in activity and the possible dependence of this response on the course of the business cycle is of interest as this sensitivity is a key factor in the monetary policy transmission mechanism. Analysing price flexibility is also fundamental to determining the extent to which adjustments to shocks affecting an economy have an impact on activity and employment.

Since the introduction of the common currency, inflation in the Spanish economy has behaved in a way that clearly differs depending on the course of the business cycle. Thus, during periods of expansion, demand pressures have caused inflation rates averaging over 2% (see Chart 1). The recession that began in 2008 translated into a substantial slowing of the pace at which consumer prices rose in the Spanish economy, with inflation dropping well below 2%, even after stripping out the impact of cheaper oil prices. Consequently, the increase in the CPI excluding unprocessed food and energy prices, corrected for changes in indirect taxation and regulated prices, averaged less than 0.5% in the periods of recession.

The slowing of the Spanish inflation rate during the recession is partly explained by the contraction of aggregate demand, although inflation can also be seen to be more sensitive to changes in activity [see Álvarez and Urtasun (2013) and Banco de España (2015)].<sup>1</sup> This increase in the elasticity of inflation to the degree of slack in the economy is consistent with a reduction in nominal rigidities during periods of crisis, which manifests itself in more frequent price adjustments than in the past. The information from the Banco de España's survey on wage and price formation offers evidence of this [see Izquierdo and Jimeno (2015)].<sup>2</sup> According to the survey, the lower nominal rigidity would be mainly attributable to greater variability of demand and a higher level of market competition, together with more frequent price changes by competitors.

Most recent empirical evidence from other European economies also suggests that inflation is more sensitive to the point in the business cycle [see Oinonen and Paloviita (2014) and Riggi and Venditti (2015)]. By contrast, a significant number of recent studies on the economy of the United States show inflation to be less sensitive to changes in activity [see Matheson and Stavrev (2013), IMF (2013)].<sup>3</sup>

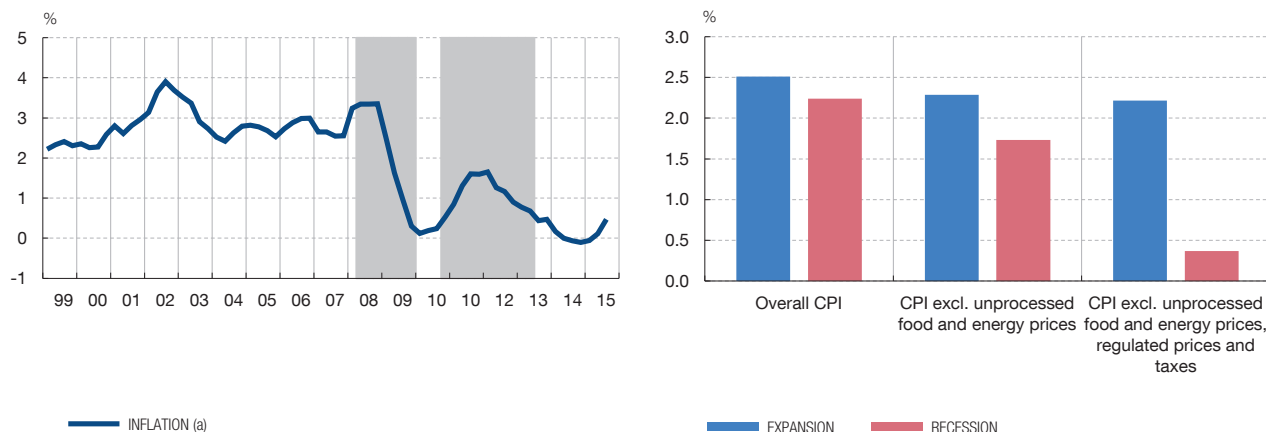
Moreover, survey data suggest asymmetries exist in the way inflation responds to activity. Thus, Álvarez and Hernando (2007) find that Spanish firms respond more to the falling demand typical of recessions than to increases in expansionary periods.

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1 Álvarez and Urtasun (2013) estimate two Phillips curve models. These models relate current inflation to expected inflation and the degree of slack in the economy. The greater (lesser) the expected inflation, the greater (lesser) is current inflation. The greater (lesser) the slack, the lesser (greater) the inflationary pressures. This work has been extended in Banco de España (2015), which presents the results of a thousand Phillips curve models, produced by considering the combination of ten inflation measures, ten measures of expectations, and ten measures of slack. In 73% of the specifications estimated, cyclical sensitivity increased in the post-crisis period.

2 Thus, weighted by level of employment, more than 40% of firms state that they have increased the frequency with which they change their prices compared with their behaviour before 2010, while 10% stated that they have decreased the frequency. The remaining firms had not changed the frequency with which they update their prices.

3 Although there is also evidence that the slope of the curve has increased in the U.S. [see Stella and Stock (2012)].



SOURCE: Banco de España.

a CPI excl. unprocessed food and energy prices, corrected for regulated prices and taxes. Periods of recession, as defined by the Asociación Española de Economía (AEE), are shaded.

Although this evidence seems to suggest that inflation behaves differently over the course of the economic cycle, there is a shortage of formalised analysis considering this feature. In general, the literature assumes that inflation’s response to activity remains constant, regardless of the point in the cycle. Nevertheless, it is worth exploring the extent to which inflation responds differently in different business cycle phases, and it is also pertinent to assess whether the behaviour of inflation during the current recovery differs from that in other expansionary phases. In this context, this article describes empirical specifications of the relationship between inflation and output that allow the response of prices to changes in activity to be asymmetric over expansionary and recessionary phases, as suggested by Chart 1. Specifically, in the second section various estimates of asymmetric Phillips curves are presented that take into account the effect of inflation expectations on current inflation. The article ends with some concluding remarks.

**Analysis of the asymmetric response of inflation**

In what follows we present an analysis of how the behaviour of inflation in Spain differs across business cycle phases. To do so, firstly the traditional approach to estimating augmented Phillips curves with inflation expectations is generalised to allow for asymmetries in the relationship between inflation and activity. The explanatory capacity of the different specifications is also explored.

According to the traditional Phillips curve approach, current inflation ( $\pi_t$ ) depends on expected inflation  $\pi_t^e$ , the degree of cyclical slack in the economy ( $h_t$ ), and an error term ( $e_t$ ). Current inflation is greater (lesser) if expected inflation increases (decreases), and lesser (greater) if the degree of slack in the economy increases (decreases). The cyclical sensitivity of inflation is given by the coefficient  $\alpha$ . The estimated relationship is as follows:

$$\pi_t = \pi_t^e + \alpha h_{t-1} + e_t \tag{1}$$

Based on this specification the response to inflation can be allowed to vary over business cycle phases. This may be done simply by introducing a dummy variable ( $d_t$ ) that takes a value of 1 during a recession and 0 during an expansion. The differing sensitivity of inflation in recessions would be given by the coefficient  $\alpha_r$ :

$$\pi_t = \pi_t^e + \alpha h_{t-1} + \alpha_r h_{t-1} d_t + e_t \tag{2}$$

When using this equation it should be borne in mind that expected inflation is not an observable variable, so it is necessary to make some assumptions about its path. In the estimates given below, the approach of Ball and Mazumder (2011) has been used. These authors consider inflation expectations to be a combination of forward-looking and backward-looking components. The forward-looking component is identified with medium-term inflation expectations, which should be close to the central bank's inflation target ( $\pi^o$ ), and the backward-looking component with the previous year's average inflation. The formula used to approximate inflation expectations at the quarterly frequency is:

$$\pi_t^e = \gamma \pi^o + (1 - \gamma) \frac{1}{4} (\pi_{t-1} + \pi_{t-2} + \pi_{t-3} + \pi_{t-4}) \quad [3]$$

The estimation of the Phillips curve seeks to factor in the effect of changes in demand on inflation. Therefore, to mitigate the impact of supply-side shocks (which affect inflation and activity in opposite directions), the measure of inflation used is the (seasonally adjusted) CPI excluding unprocessed food and energy prices, regulated prices and taxes.<sup>4</sup> For its part, the degree of cyclical slack in the economy is proxied using the GDP quarter-on-quarter rate, and the periods of recession and expansion are determined by the business cycle dating information published by the *Asociación Española de Economía* (2015).<sup>5</sup>

Table 1 shows the results of the estimates of the symmetrical Phillips curve<sup>6</sup> model yielded by equation [1]. The cyclical sensitivity coefficient  $\alpha$  is statistically significant and shows inflation responding to the position in the cycle in a similar way to that found by Álvarez and Urtasun (2013). In particular, an increase (decrease) in GDP growth of 1 percentage point (pp) translates into an inflation rate 0.1 pp higher (lower). According to this estimation, inflation expectations are determined both by forward-looking and backward-looking elements, although past inflation is more important than medium-term expectations in determining price fluctuations.

Table 1 also presents the estimates for the asymmetric model of equation [2]. According to these estimates, the sensitivity of inflation depends on the position in the cycle, the response being greater in recessions than expansions. In other words, the coefficient  $\alpha_r$ , which measures the differential response in expansions and recessions, is positive and statistically significant. Specifically, in a recession, a 1 pp reduction in GDP reduces inflation by 0.3 pp, while in an expansion, the rise in inflation associated with a 1 pp increase in GDP is less than 0.1 pp. These results are consistent with the analysis by Álvarez and Hernando (2007), who found the prices set by Spanish businesses to be more flexible on the downside than the upside in the event of demand shocks. Similarly, Izquierdo and Jimeno (2015) describe more frequent prices changes in response to negative demand shocks, which is in line with an increase in cyclical sensitivity during these periods.

An alternative way of analysing the evolution of the cyclical sensitivity of inflation is to estimate a version of the model in which the coefficients of the degree of cyclical slack

4 The implicit assumption in this approach is that the shocks eliminated from the price measurement used did not have lasting effects on inflation expectations.

5 The dating is similar to that obtained applying the methodology proposed by Bry and Boschan (1971).

6 The literature has considered the effect of globalisation and imported low inflation [Chatelais *et al.* (2015)] in explaining recent low inflation. In this respect the results do not change if a version of the open economy Phillips curve is used. Similarly, the measure of imported inflation (the import price deflator) is barely significant.

	Estimated coefficients	<i>p</i> -value
Equation [1]. Model with symmetrical response to GDP and forward- and backward-looking inflation expectations		
Inflation expectations ( $\gamma$ )	0.22	0.015
GDP growth ( $\alpha$ )	0.10	0.002
Adjusted R <sup>2</sup>	0.64	
Equation [2]. Model with asymmetrical response to GDP and forward- and backward-looking inflation expectations		
Inflation expectations ( $\gamma$ )	0.24	0.005
GDP growth ( $\alpha$ )	0.06	0.063
Recession dummy( $\alpha_r$ )	0.27	0.001
Adjusted R <sup>2</sup>	0.70	
Equation [3]. Model with cyclical phases and backward-looking inflation expectations		
Expansion dummy (1991 Q1 - 2008 Q1) ( $\alpha_1$ ) (a)	0.02	0.517
Recession dummy(2008 Q2 - 2013 Q2) ( $\alpha_2$ ) (a)	0.29	0.000
Expansion dummy (2013 Q3 - 2015 Q3) ( $\alpha_3$ )	0.16	0.154
Adjusted R <sup>2</sup>	0.66	

SOURCE: Banco de España.

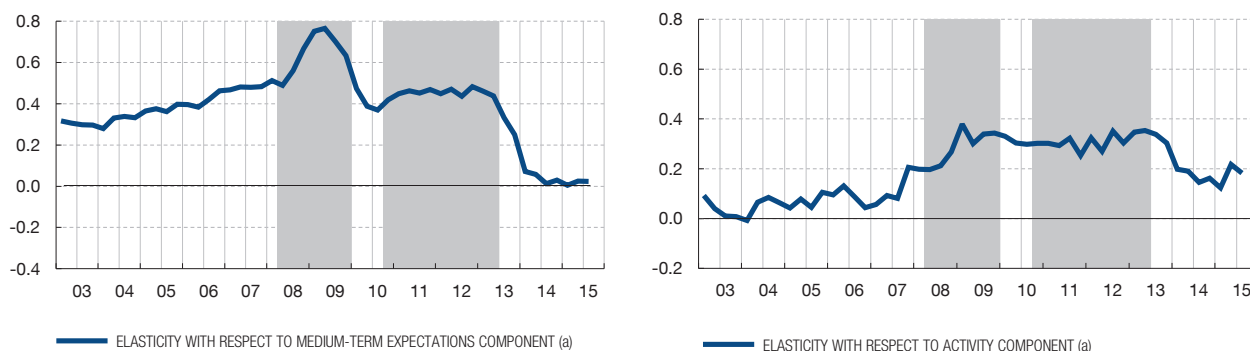
a The expansion between 2010 Q1 and 2010 Q3 is included in the first dummy variable.

are allowed to vary over time rather than remain constant.<sup>7</sup> Chart 2 (right-hand panel) clearly shows the point in the cycle to have had a bigger impact on price changes during the recession.

Similarly, the relative weight of forward- and backward-looking elements in the determination of inflation expectations does not have to be constant over time. For example, a prolonged period of low inflation, such as that which we are currently experiencing, may trigger a process in which expectations are revised, such that they may come to be dominated by the short term. This effect would be reflected in the above empirical model by including an estimated value of the parameter for the expected weight of medium-term expectations ( $\gamma$ ) close to zero. The left-hand panel of Chart 2 shows the value of these coefficients in the sample period considered, and it can be seen that inflation maintains a significant backward-looking component. A slight relative loss of weight of the forward-looking component in recent years can be observed, with the consequent increased significance of current inflation, which comes to dominate clearly in the more recent period. This change in the process by which agents form their expectations is consistent with the analysis of Buseti *et al.* (2015), who found that economic agents in the euro area have recently been attaching more importance to current inflation when determining their inflation expectations.

In order to assess whether inflation's response in the current expansion is different from how it has behaved historically, a model allowing cyclical sensitivity to take three different values over the course of the sample, depending on the point in the cycle, was used. For this estimation, a set of dummy variables was included in equation [2]. The first dummy variable (d1) covers the expansion between the first quarter of 1999 and the first quarter of 2008 and the expansion between the first and third quarters of 2010. The second

<sup>7</sup> This dynamic estimator of the effect of slack on inflation was obtained using a Kalman filter.



SOURCE: Banco de España.

a Periods of recession, as defined by the Asociación Española de Economía (AEE), are shaded.

dummy variable ( $d_2$ ) is associated with the recession between the second quarter of 2008 and the fourth quarter of 2009 and that between the fourth quarter of 2010 and the second quarter of 2013. The third variable ( $d_3$ ) covers the current recovery, which began in the third quarter of 2013.

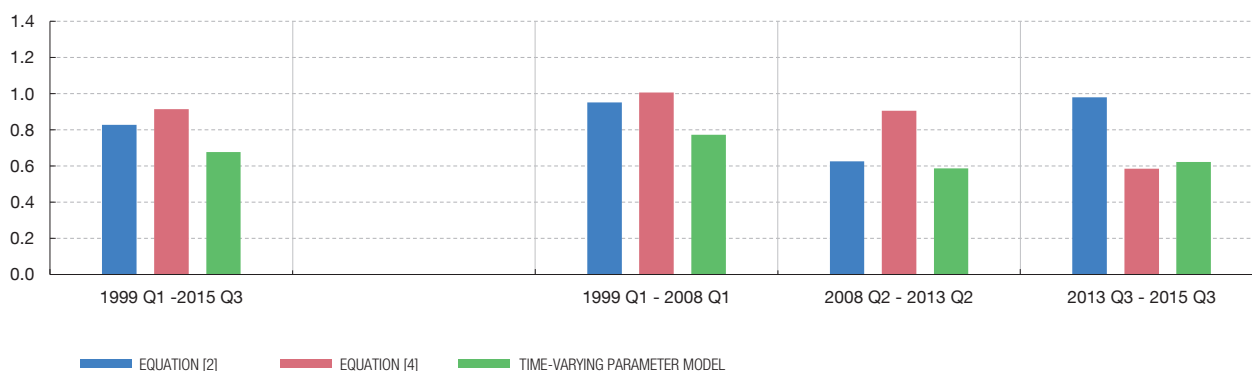
$$\pi_t = \frac{1}{4}(\pi_{t-1} + \pi_{t-2} + \pi_{t-3} + \pi_{t-4}) + \alpha_1 d_1 h_{t-1} + \alpha_2 d_2 h_{t-1} + \alpha_3 d_3 h_{t-1} + e_t \quad [4]$$

It should be borne in mind that the recent period of recovery is so far relatively short, so the results of this estimation must be interpreted with care. Likewise, in line with the results set out above, in this empirical model it is assumed that expectations are based solely on recent inflation. The analysis performed suggests a possible increase in cyclical sensitivity in the current recovery compared to historical sensitivity, but less than that seen in the recent recession (see bottom panel of Table 1). This result is in line with that obtained using the time-varying parameters model. Specifically, during the current recovery, an increase in GDP growth of 1 pp translates into an inflation rate 0.15 pp higher. However, this result will need to be confirmed when additional evidence is available.

Logically, the significance of the above results depends on the explanatory power of the models put forward. To assess this, the mean squared error relative to the symmetrical model of the Phillips curve of equation [1] was calculated for various periods. The smaller the value of the statistic presented in Chart 3, the greater the model's improvement compared to the symmetrical model.

Analysing the whole period, models allowing asymmetry (models [2] and [4]) show a much greater explanatory power than those using a symmetrical specification. Similarly, the models based on hybrid expectations perform more satisfactorily than equation [4], which is exclusively backward looking. In any event, the model with the greatest explanatory power is the time-varying parameters one, as shown in Chart 2.

An analysis of the fit in each sub-period was also performed. Specifically, as might be expected, when analysing the period up to 2008 the asymmetric model was not found to offer any improvement over the symmetrical one. However, in the predominantly recessionary period between the second quarter of 2008 and the second quarter of 2013,



SOURCE: Banco de España.

model [2] fits particularly well, as it captures the asymmetry in the way inflation responds to the point in the cycle, as does the time-varying parameter model. Lastly, the analysis of the current expansionary period highlights the good fit of the model in which expectations centre on the short term (equation [4]), which is more accurate than even the time-varying parameter model. This finding is in line with the hypothesis of a recent break in the process of expectation formation.

### Concluding remarks

In recent years inflation has moderated considerably in Spain. This article has presented quantitative evidence indicating that Spanish inflation responds differently in expansions and recessions, being more responsive to shocks in the contractionary phases of the cycle. It has also offered preliminary evidence suggesting that cyclical sensitivity during the current expansion is greater than that habitual in previous recoveries, although the cyclical sensitivity of inflation is, however, limited. The results seem to suggest that this greater responsiveness of prices in the current recovery relative to previous expansionary phases could, at least in part, be permanent in nature, arising out of certain recent structural and regulatory changes [see Banco de España (2015)]. This would suppose an improvement in the Spanish economy's capacity to adjust to aggregate demand shocks, given that an economy with more flexible prices allows adjustments to adverse shocks to be less costly in terms of activity and employment.

At the same time, even taking into account the existence of asymmetries in the relationship between inflation and activity, price growth in the current recovery has remained at very moderate levels. This article also finds evidence of a certain change in the process by which expectations are formed, which is a factor that can help explain the low price growth seen in the current context of expanding activity. In this respect, it is possible that the prolonged period of low inflation which the Spanish economy, and the euro area in general, is currently undergoing has induced agents to reorient their inflation expectations, focusing more on short-term price developments and less on the medium term. In this regard, it is particularly important in the current economic climate to monitor the processes of de-anchoring of agents' inflation expectations.

18.11.2015.

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