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# Consumer and asset prices – some recent evidence

**Section 1: Modeling inflation** – Models for inflation are of key importance for central banks trying to pursue the mandate of price stability. Moreover, given the existence of long and variable lags, it could be argued that, for the monetary policy decision-makers, it is more important to predict the turning points in inflation rather than the exact value of inflation to materialize in the following month(s). Against this background, it seems to be of key importance to choose an empirical approach that allows for the modeling of different phases (or regimes). In other words, the use of non-linear time series methods seems to be well-grounded. In this respect, a number of methods have been used in the literature, such as Threshold Models (TAR), Smooth Transition Autoregressive (STAR) Models or Markov Switching (MS) Models.

### Markov Switching models

Markov Switching models have (to our best knowledge) first been introduced in the literature for the modelling of business cycles and, since then, this methodology has been widely used for the analysis of the dating and forecasting of turning points in such constellations.[1)] MS models offer a number of appealing features. Probably the most interesting feature can be found in its key characteristic that the variable of interest is regarded as having a certain probability of switching abruptly among different regimes. Indeed, seen from the perspective of a monetary policy-maker, inflationary and non-inflationary phases must be seen as representing two different regimes that necessitate different responses.

A second remarkable feature of MS models consists of the fact that no prior information is needed regarding the exact dates of the economy being in a specific regime. Instead, the probability of being in a particular regime can be inferred entirely from the data. This is in stark contrast with other approaches which depend upon an exact a priori dating of the regimes.

### Structure of the paper

In this paper, we model the inflationary process in the euro area by means of an MS model. In line with the empirical literature focusing on the interactions between consumer and asset prices, the set of explanatory variables includes house prices, oil prices and also the exchange rate. Stock prices were also tested in the set of explanatory variables but proved to be insignificant in both regimes.[2)] The outline of the paper is as follows: the next section will summarize some theoretical aspects of the link between asset and consumer prices. In Section 3, the MS technique is explained. Section 4 provides an overview of the results and Section 5 concludes.

**Section 2: Asset prices and consumer prices – some considerations** – In the recent decade, different approaches have been used to study the empirical link of asset prices for inflation. From a technical perspective, the range of the methods employed covers, on the one hand, rather simple approaches testing for an impact of asset on consumer prices in a rather simple time series framework as well as, on the other hand, more sophisticated procedures, such as, for instance, large factor model approaches incorporating more than 100 data series to forecast inflation, including different kinds of asset price variables.[3)]

### Cross-section analysis

Using a sample of 11 countries and an OLS framework, the predictive power for inflation can be improved by adding other asset price variables to the standard framework (i.e. the changes in housing and equity prices and a yield spread, see Goodhart and Hofmann, 2000). Similarly, based on a sample of eight countries, the study by Sekine (2009) finds substantial effects from declines in wage costs and import prices (in addition to the output gap and the policy interest rate) for global disinflation.

On the basis an extensive empirical factor analysis and a sample of seven countries,

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*Das Mandat der EZB beinhaltet das Ziel der Preisstabilität. Angesichts langer und variabler Wirkungsverzögerungen gilt es dabei vorausschauend zu agieren und mögliche Wendepunkte in der Inflationsentwicklung frühzeitig zu erkennen. In der vorliegenden Studie beleuchten die Autoren eingehender die Zusammenhänge zwischen Konsumentenpreisen und Vermögenspreisen für das Eurogebiet. Im Rahmen sogenannter „Regime-Switching-Modelle" zeigen sie, dass den Hauspreisen sowohl in einem Regime hoher als auch in einem Regime niedriger Inflationsraten Bedeutung zukommt, wohingegen Ölpreise und Wechselkurse nur in einem Regime hoher Inflationsraten signifikant zur Entwicklung der Konsumentenpreise beitragen. Sie bewerten diese Ergebnisse als nicht unerheblich für den geldpolitischen Entscheidungsprozess. (Red.)*

Stock and Watson (2008) conclude that Phillips curve forecasts (broadly interpreted as forecasts using an activity variable) perform generally better than other multivariate forecasts, but some asset prices seem to predict either inflation or output growth in some countries for some periods quite well.

Using a large panel data set (consisting of hundreds of macroeconomic time series for the main countries of the euro area), Forni et al. (2003) find that, first, multivariate methods outperform univariate methods for forecasting inflation and industrial production over various time horizons and, second, that financial variables do help forecasting inflation, but do not help forecasting industrial production.

**Panel approaches**

In a similar approach to forecast inflation based on a large set of variables, Monteforte and Moretti (2008) apply a mixed-frequency model (the Mixed Data Sampling Regression Models). The results show that daily financial variables seem to help to improve inflation forecasts considerably.

In their study, Ciccarelli and Mojon (2005) derive national inflation equations depending on global factors for 22 industrialised OECD countries. It turns out that inflation in industrialized countries is largely a global phenomenon. Besides, global inflation is, consistently with standard models of inflation, a function of real developments at short-term horizons and monetary developments at longer horizons. Finally, a very robust "error correction mechanism" can be found that brings national inflation rates back to global inflation.

In a more recent paper, Assenmacher-Wesche and Gerlach (2009) study the relationships between inflation, economic activity, credit, monetary policy, and residential property and equity prices in 18 OECD countries. Using a panel VAR, plausible and significant responses to a monetary policy shock are found. Shocks to asset prices have a positive, significant effect on GDP and credit after three to four quarters, whereas prices start to increase much later.

A slightly different approach based on frequency decomposition techniques is followed in a study by Andersson (2011), which builds on two studies by Assenmacher-Wesche and Gerlach (2008b, 2008c), and analyzes the relationship between money growth and different price indices for eight developed countries. Using a panel data approach, the results show that money growth is correlated with financial asset price inflation in the short, medium and long run. Real asset price inflation and money growth are correlated over the medium and long term, while consumer inflation and money growth only over the long term.

**Tranquil and heated periods to be distinguished**

As becomes quite clear from these considerations, the relationship between consumer and asset prices seems to be subject to changes over time and, therefore, a role model for regime-switching techniques since there are tranquil and heated periods to be distinguished.

**Section 3: A Markov Switching model** – In this section, euro area inflation will be modelled using an MS approach. More precisely, the annual change in the (log of) the price level (i.e. $\Delta p = \log(p_t) - \log(p_{t-4})$), depending on a non-observable status variable $S_t$, is modelled, conditional on being in a specific regime at each point in time.[4] The modelling of the differences implies that the change in the price level, i.e. the inflation rate, is observed. The results would then allow for an assessment of whether a movement in inflation denotes a regime change or, instead, is still compatible with the current regime. For instance, notwithstanding the fact that the economy is in an upswing phase, a decline in inflation can still represent a "normal" correction and, therefore, represent normal fluctuation within the upswing regime. At the same time, it could also signal a change in regime. MS models can prove particularly helpful for such an assessment.

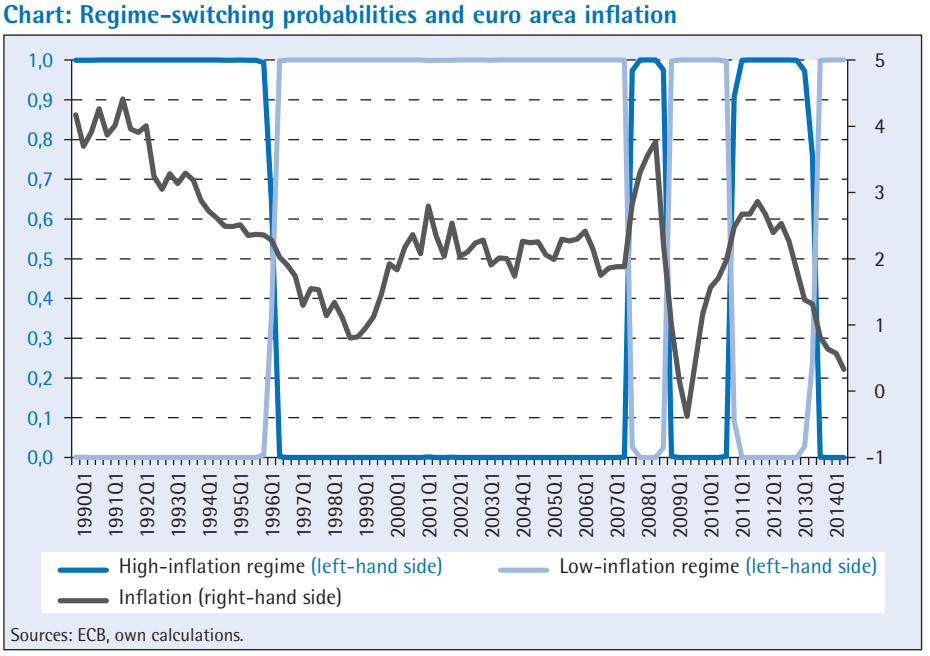
In our case, the basic setup of the model can be shown as follows:[5]

(i) $\gamma_t = c_{St} + \rho\gamma_{t-1} + \sigma_{St}\,\varepsilon_t$
(ii) $\varepsilon_t \sim NID\,(0,1)$
(iii) $c_{St} = (1-\rho)\,\mu_{St}$
(iv) $S_t = 1,2$

In other words, $\gamma_t$ is modelled as reflecting two finite states, each of which is represented by a regime-specific intercept and shock variable. Moreover, $S_t$ denotes a Markov Switching discrete process describing the inflation regime. The corresponding states are $S_t = 1$ (high inflation) and $S_t = 2$ (low inflation). Transition probabilities across regimes are time-varying and reflected in a (2 x 2) transition probability matrix, which is defined as follows:

(v) $\Pr(S_t = i \mid S_{t-1} = j) = p_{ij}$
where $i,j = 1,2$

**Chart: Regime-switching probabilities and euro area inflation**




Sources: ECB, own calculations.

$$P_t = \begin{bmatrix} p_{11,t} & p_{12,t} \\ p_{21,t} & p_{22,t} \end{bmatrix}$$

and $p_{ij,t} = Pr(S_t = i \mid S_{t-1} = j, z_t)$

**Section 4: Main results** – The dataset used for the analysis consists of quarterly data for euro area consumer and house prices, spanning a period from 1980Q1 to 2014Q4. The results are shown in Table 1 below.

### Two different inflation regimes

Quite obviously, the assumption of two different inflation regimes can be justified by the data: a high inflation period (with a mean of 2.39%) comprising mainly the period from the early 1980s to the end of 1998 and a low inflation period (with a mean of 1.11%), spanning mainly the period from 1999 onwards. The results show that the high-inflation regime is characterised by a strong impact of asset price and exchange rate developments (Table 1).

**Table 1: Results of an MS model for euro area inflation**

| Variable | Coefficient | Prob. |
|---|---|---|
| **High-inflation regime** | | |
| Constant | 2.39 | 0.00 |
| House prices (-1) | 0.19 | 0.00 |
| Oil prices | 0.01 | 0.00 |
| Exchange rate | -0.03 | 0.00 |
| **Low-inflation regime** | | |
| Constant | 1.11 | 0.00 |
| House prices (-1) | 0.15 | 0.00 |
| Oil prices | 0.01 | 0.07 |
| Exchange rate | -0.01 | 0.30 |

By contrast, the low-inflation rate regime does not entail a significant influence of oil prices and exchange rate. The house prices prove to be significant in both regimes. This is in line with the view that the Stage Three of the Economic and Monetary Union seems to have brought about a change in inflation. The transition probabilities can be shown to be as follows (Table 2):

**Table 2: Transition probabilities of MS model**

| | Regime 1 | Regime 2 |
|---|---|---|
| Regime 1 | 0.93 | 0.06 |
| Regime 2 | 0.05 | 0.95 |

Residual diagnostics show overall satisfying properties. It can be concluded that the probability for staying in a low inflation regime is 0.93 at the current stage. This can also be expressed in graphical terms in the chart above.

It is also worth noting that the persistence of the regime changes. Up to 2007, only one regime change can be observed. More recently, however, from 2007 onwards, three regime changes seem to emerge. This speaks in favour of the hypothesis that the financial crisis has introduced a considerable amount of volatility into the economic fundamentals and, thus, has rendered the task of monetary policy more difficult (Chart).

**Section 5: Important policy conclusions** – In this paper, euro area inflation has been modelled with a two-state first-order MS regime. The transition probabilities are estimated with (lagged) house prices, the exchange rate and oil prices as explanatory variables. The results indicate two distinct phases, these being low and high inflation phases. One of the most important issues for monetary policy-makers when taking decisions about monetary policy actions is to predict when most likely the next turning point in inflation would occur. The MS model is able to accurately predict the historical turning points of euro area inflation. This finding has important policy implications, since it can be of help in the monetary policy decision-making process.

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**Footnotes**

1) See Hamilton (1989).
2) See Gerdesmeier, Reimers and Roffia (2014), but also the considerations outlined in Detken, Gerdesmeier and Roffia (2010).
3) This review draws heavily on the more detailed summary in Gerdesmeier, Reimers and Roffia (2014 and 2015).
4) See Gerdesmeier, Reimers and Roffia (2015) for more details on MS models.
5) See Amisano et al. (2013, 2014).