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"Consumer and asset prices – some recent evidence"

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Contents

Abstract

This paper models the relationship between consumer and asset prices (approximated by house prices, oil prices and the exchange rate) by means of a Markov Switching model (MS model). It can be shown that house prices appear to play a significant role in the determination of consumer prices in a high-inflation and a low-inflation regime, whereas oil prices and the exchange rate only unfold an impact in a high-inflation regime. Taken together, these results can be seen as being of help for the monetary policy decision-making process.

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1. Introduction

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 for 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, for instance, Threshold Models (TAR), Smooth Transition Autoregressive Models (STAR) or Markov Switching Models (MS).

Markov Switching models (MS 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.[4] 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.

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 are excluded from the set of explanatory variables since previous studies have shown that

[4] See Hamilton (1989).

the do not unfold a significant influence.[5] 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.

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.[6]

The study by Goodhart and Hofmann (2000) might serve as an ideal starting point. The authors test for the influence of asset prices in a consumer price inflation framework for a sample of 11 countries in an OLS framework. They find that the predictive power for inflation using a reduced-form equation and standard explanatory variables can be improved by adding other asset price variables, i.e. the changes in housing and equity prices and a yield spread. In their cross-country time series exercise, the authors find that housing price movements do provide useful extra information on future inflation, with equity prices and the yield spread being somewhat less informative.

A broadly similar approach, although with a focus on a more global perspective, is used by Sekine (2009). The framework used by the latter is based on the observation that relative price adjustments taking place in the global economy are important sources of the lower levels of inflation rates observed in the recent decades. Using basically a mark-up model, it shows substantial effects from declines in wage costs and import prices relative to consumer prices. The author then estimates single-equation models for eight countries (United States, Japan, Germany, United Kingdom, France, Canada, Sweden, Australia)

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5 See Gerdesmeier, Reimers and Roffia (2014) but also the considerations outlined in Detken, Gerdesmeier and Roffia (2010)

6 This review draws heavily on Gerdesmeier, Reimers and Roffia (2014).

and finds that the two mark-up terms (import and wages) are important to explain the average disinflation. In a subsequent step, the approach is extended to a system perspective in order to endogenise developments of the two markups and the interest rate and then also includes the output gap and the policy interest rate as explanatory variables. The author finds that out of the 5 percentage point decline in the inflation rates in eight OECD countries from 1970-1989 to 1990-2006, global shocks to two relative prices seem to have accounted for more than 1.5 percentage points, while a monetary policy shock accounts for another 1 percentage point.

Turning towards different approaches, Stock and Watson (2008) conduct an extensive empirical factor analysis that recapitulates and clarifies the literature on pseudo out-of-sample evaluation of inflation forecasts using a consistent data set and methodology. The empirical results indicate that Phillips curve forecasts (broadly interpreted as forecasts using an activity variable) are better than other multivariate forecasts, but their performance is episodic (i.e. sometimes better than and sometimes worse than a corresponding univariate benchmark). The countries under analysis are Canada, France, Germany, Italy, Japan, United Kingdom and United States. According to the results of the analysis, some asset prices seem to predict either inflation or output growth in some countries for some periods quite well.

Along the same lines, Forni et al. (2003) consider a large data set, consisting of hundreds of macroeconomic time series for the main countries of the euro area in order to simulate out-of-sample predictions of the euro-area industrial production and the harmonized inflation index and to evaluate the role of financial variables in forecasting. Based on two models which allow forecasting using large panels of time series, and comparing these models with the forecasts of a simple univariate autoregressive (AR) model, the authors find that multivariate methods outperform univariate methods for forecasting inflation at one, three, six, and twelve months and industrial production at one and three months, while financial variables do help forecasting inflation, but do not help forecasting industrial production.

A similar approach to forecast inflation based on a large set of variables has been used by Monteforte and Moretti (2008). As a novelty of their approach, the authors construct models based on monthly variables that are highly correlated with (future) inflation, as well as financial indicators that are available on a daily basis and that, in principle, give some timely information about changes in inflation expectations. For the analysis the authors use a mixed-frequency model (the Mixed Data Sampling Regression Models). The results of the analysis suggest that predictions stemming from this type of model outperform those of standard benchmark models based only on monthly variables. Besides, simply daily forecasts are more accurate that those implied in financial market expectations extracted from the euro area HICP future contracts and help to reduce the forecasting errors with respect to models with only monthly variables. In this respect, daily financial variables seem to help to improve inflation forecasts.

Finally, Ciccarelli and Mojon (2005) derive a national inflation equation depending on global factors. The authors test the common factors for 22 industrialised OECD countries using the following variables: industrial production growth rate, nominal wages inflation, unit labour cost growth rate, import prices inflation, broad monetary aggregate growth rate, money market interest rates, long-term interest rates, the yield curve and oil prices. Inflation in industrialized countries turns out to be largely a global phenomenon. First, a simple average of 22 OECD countries inflation accounts for 70% of the variance of inflation in these countries between 1960 and 2003. This large variance share is not only due to the trend components of inflation (up from 1960 to 1980 and down thereafter) but also to fluctuations at business cycle frequencies. 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, there is a very robust "error correction mechanism" 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 quarterly data for 1986-2008. 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. When modelling the transmission of shocks from the US to the other economies more explicitly, it can be deducted that, while monetary policy and equity price shocks are directly transmitted internationally, property price and credit shocks affect the other countries through their indirect effects on US interest rates and equity prices.

A slightly different approach based on frequency decomposition techniques is followed in a study by Andersson (2011), which builds on Assenmacher-Wesche and Gerlach (2008b, 2008c), and analyzes the relationship between money growth and different price indices such as the consumer price index, GDP deflator, share price index and house price index for eight developed countries (i.e. Australia, Canada, the Euro Area, Japan, Switzerland, Sweden, the United Kingdom and the United States) and a sample ranging from the end of 1977 to the end of 2009. 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. Since all movements in money growth, short term and long term, are associated with price changes, the paper also concludes that money growth may serve as a useful proxy for the overall inflation rate.

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, quite obviously, there are tranquil and heated periods to be distinguished.

3. Markov switching models

Assume that there are two regimes that are represented by an unobservable process denoted as S_t. Let S_t takes the values 1 and 2, depending on the prevailing regime.[7] In this case, the data generating process (DGP) of the series being modelled, Y_t, will be different in each regime, for example,

(1) $$Y_t = \alpha_{0,1} + \alpha_{1,1} Y_{t\text{-}1} + ... + \alpha_{p,1} Y_{t\text{-}p} + \varepsilon_{t,1} \qquad \text{if } S_t = 1$$

(2) $$Y_t = \alpha_{0,2} + \alpha_{1,2} Y_{t\text{-}1} + ... + \alpha_{p,2} Y_{t\text{-}p} + \varepsilon_{t,2} \qquad \text{if } S_t = 2$$

Following Hamilton (1989), it is further assumed that S_t is a first-order Mar-

[7] See the more detailed description presentation in Hamilton (1994), pp. 677 *ff*. For an application to the IFO index, see also the deliberations outlined in Abberger and Nierhaus (2010).

kov-process, which implies that the current regime depends only on the regime in the preceding period (S_{t-1}). The model is then completed by defining the transition probabilities of moving from one regime to another (referred to as 'the transition probabilities'):

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

Note that with a Markov process based on two states, a total of four transition probabilities needs to be estimated and $p_{11} + p_{12} = p_{22} + p_{21} = 1$ applies. The distribution of the annual change in euro area consumer prices (Δp for a given state of i) can then be described by the following density function:

(4) $$f(\Delta p_t \mid s_t = i, \mu_1, \sigma^2) = 1/(2\pi\sigma^2)^{1/2} \exp\left[-(1/2)(\Delta p_t - \mu_1)^2 / \sigma^2\right]$$

i.e., Δp is normally distributed with a state-dependent mean value μ_1 and a constant variance σ^2. The above conditional density holds for state 1. For state 2, the same equation applies, but with μ_2 instead of μ_1 and $\mu_2 \neq \mu_1$.
Taken together, the vector of the total parameters to be estimated consists of $\theta = (p_{11}, p_{22}, \mu_1, \mu_2, \sigma^2)$. The model can be estimated with the maximum-likelihood method, whereby numeric optimisation methods are employed due to non-linearities.[8]

4. Results

In the following sections, 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. 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 up-

8 See Krolzig (1997).

swing regime. At the same time, it could also signal a change in regime. MS models can prove particularly helpful for such an assessment.

The assumption that the transition probabilities are time-invariant may, however, not be a very realistic feature of the model as it would imply that the conditional expected durations do not vary over the cycle. This would imply that exogenous shocks, macroeconomic policies and an economy's inherent propagation mechanisms do not affect the expected duration of high- and low-inflationary periods.[9] One possible solution is to consider time-varying transition probabilities (TVTP) in the model, by using a specification for the transition probabilities that reflects information about where the economy is heading. The variations in the transition probabilities will generate variations in the expected durations. In this case, the basic setup of the model can be shown as follows:[10]

(5) $$y_t = c_{st} + \rho\, y_{t-1} + \sigma_{ST}\, \varepsilon_t$$

(6) $$\varepsilon_t \sim NID(0,1)$$

(7) $$c_{st} = (1-\rho)\, \mu_{st}$$

(8) $$s_t = 1, 2$$

In other words, y_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 (low inflation) and s_t=2 (high inflation). Transition probabilities across regimes are time-varying and reflected in a (2x2) transition probability matrix, which is defined as follows:

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

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

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

The dataset used for the analysis consists of quarterly data for euro area consumer and house prices, spanning a period from 1980Q1 to 2014Q4. When applying this procedure to euro area inflation, the estimation output is as fol-

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9 See Filardo (1994).

10 See Amisano et. al. (2013, 2014).

lows:

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

Sources: own calculations.

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 strong impacts of asset price and exchange rate developments. 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: Transition probabilities of MS model

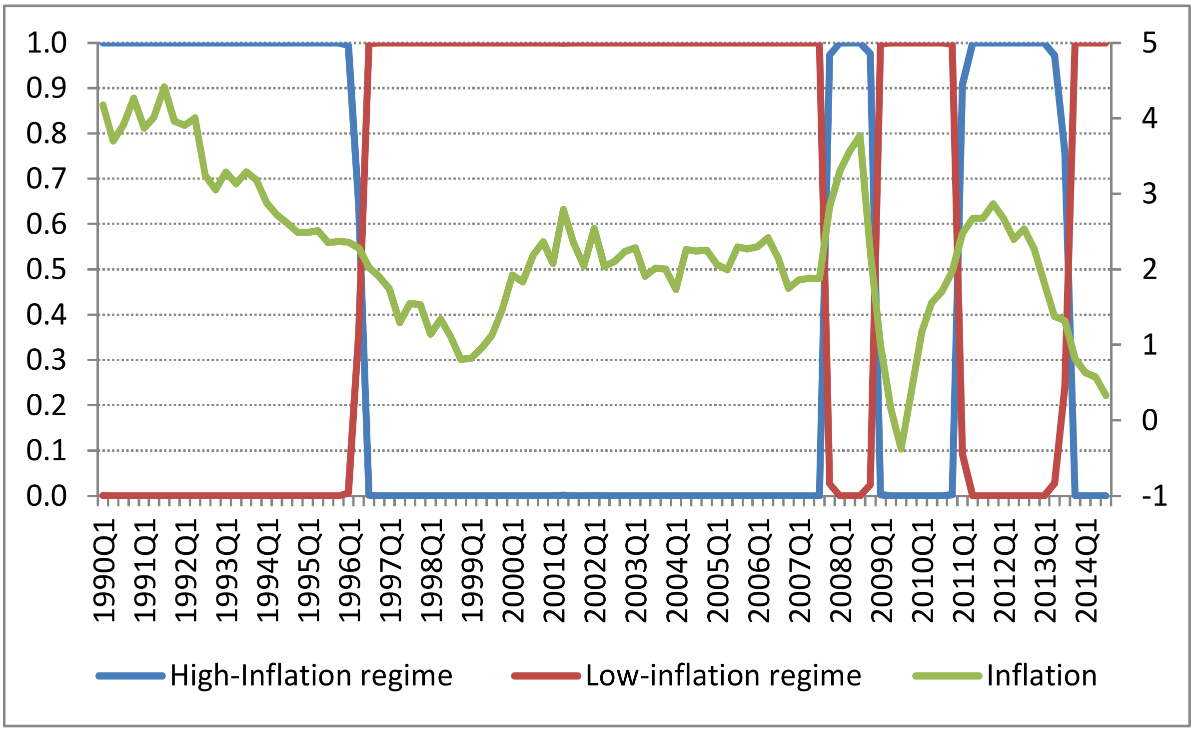
	Regime 1	Regime 2.
Regime 1	0.93	0.06
Regime 2	0.05	0.95

Sources: own calculations.

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 below.
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 1: Regime-switching probabilities and euro area inflation



Sources: ECB, own calculations.

5. Conclusion

In this paper, euro area inflation is 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 that 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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