Macroeconomic implications of oil price fluctuations: a regime-switching framework for the euro area

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Abstract

We use a Markov-switching VAR, estimated with Bayesian methods, to study the response of the euro area economy to oil price shocks. The model identifies two regimes that are characterized by different effects of oil price fluctuations on economic activity and inflation. In the *normal regime*, oil price shocks exert only limited and short-lived effects on these variables. In the *adverse regime*, by contrast, oil price shocks trigger sizeable and sustained macroeconomic effects, with inflation and economic activity moving in the same direction as the oil price. The response of inflation expectations points to second-round effects as a potential driver of the dynamics characterising the adverse regime. By delivering (conditional) probabilities for being (staying) in either regime, the model helps interpret oil price fluctuations and assess their monetary policy implications in real-time.

JEL Classification: E31,E 52, C32

Keywords: *Markov Switching models, time-varying transition probabilities, oil prices, inflation expectations, inflation*

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Cheaper oil is a rare piece of good news for (...) the euro currency area, since [it] should boost the spending power of Europe's consumers (...) amid the eurozone's long slump.

(The Wall Street Journal, November 14, 2014)

[A] danger [of the oil-price slump] is that an even deeper dip in inflation (...) may have an unwelcome second-round effect by dragging down inflation expectations.

(The Economist, December 4, 2014)

1 Introduction

How has the sharp oil price decline since mid-2014 affected macroeconomic prospects in the euro area? Like in previous episodes of major oil price fluctuations, this question has generated substantial debate – and strongly divergent assessments – in the economics profession. Adopting a benign view, several observers have argued that the lower oil price will support the economic recovery by raising real disposable incomes and profits of euro area households and firms. Others, instead, have cautioned that the oil price slump may become entrenched in inflation expectations, thus leading to second-round effects that reinforce the prevailing disinflationary pressures and potentially dampen the recovery.[1]

From a monetary policy perspective, it is crucial to establish the relative merit of these different assessments. Judging by public statements of policy-makers in various jurisdictions, central banks would typically consider changes in the monetary policy stance only in the latter scenario, in which oil price fluctuations feed through to inflation expectations, hence risking to exert long-lasting effects on inflation. By contrast, absent such second-round effects, central

[1] An analogous debate took place, for instance, in the context of the steep upward trend in oil prices starting in end-2003 and accelerating from early-2007 to mid-2008, when some observers expressed concerns that second-round effects may lead to sustained inflationary pressures, whereas others contested this claim. For a summary of the debate, see Hannon (2008).

banks would tend to preserve the prevailing monetary policy stance, thus 'looking through' the oil price fluctuations.[2]

To operationalise this nuanced reaction function, central banks in turn have to take a stand on which scenario they consider more likely to prevail; and, since the occurrence of second-round effects may be an episodic phenomenon, they may have to update this assessment on a regular basis. At the same time, a large body of literature has shown that policy mistakes in either direction (*i.e.* overly activist monetary policy responses to oil price fluctuations that may prove to be transient, as well as overly inertial monetary policy that allows inflation expectations to become unanchored) may severely hamper macroeconomic performance.[3]

The aim of the current paper is to examine whether the notion of episodic changes in the macroeconomic effects of oil price fluctuations finds empirical support in the euro area context. To this end, we use a Markov-switching vector autoregression (MS-VAR) model, estimated with Bayesian methods, that allows for time-variation in model coefficients, thus helping to detect regime-dependent differences in the transmission of oil price shocks to economic activity and inflation (henceforth referred to as *coefficient switching*). The model also allows for time-variation in shock variances (*variance switching*) since regime-dependent differences in macroeconomic dynamics could also result from unusual sequences of shocks in certain episodes. Accounting for variance switching helps avoid that these differences are wrongly

[2]See for instance ECB President Mario Draghi before the European Parliament on June 23, 2011: *In principle, if commodity price changes are of a temporary nature, one can look through the volatility in inflation triggered by their first-round effects. However, the risk of second round effects must be contrasted (...) to prevent that they have a lasting impact on medium-term inflation expectations. (...) In such cases, an adjustment of the monetary policy stance would be required to preserve price stability and keep inflation expectations well-anchored.* A similar distinction emerges from Chair Yellen's assessment in the December 12, 2015 press conference: *For a number of years between 2004 and 2008, we had a series of increases in oil prices that (...) raised inflation (...) and we judged those increases to be transitory as well and looked through them. We do monitor inflation expectations very carefully. If we saw in a meaningful way that inflation expectations were either moving up in a way that made them seem unanchored or down, that would be of concern. And we have called attention to some slight downward movements in survey measures. We are watching that, but I still judge that inflation expectations are reasonably well anchored.*

[3]In an early contribution to this literature, Bernanke et al. (1997) find that the US recessions that occurred between the 1960s to 1980s were largely driven by the systematic monetary policy tightening in response to the oil price increases that preceded these recessions, rather than by the oil price increases per se. Reinforcing this assessment, Barsky and Kilian (2001) argue that not only was tight monetary policy a major contributor to the economic downturns in the stagflation episodes of the 1970s; but the loose monetary policy prior to these downturns also was a major driver of the increase in the price of oil (and other commodities) that heralded stagflation. Vice versa, Nakov and Pescatori (2010) and Blanchard and Galí (2007) identify improved monetary policy, leading to a better anchoring of inflation expectations, as an important explanation for why macroeconomic volatility, since the mid-1980s, has declined compared to the 1970s. In contrast, other studies have found that it was mainly a change in the volatility of the shock and less a change in monetary policy that led to the Great Moderation and the concomitant lower and less volatile inflation dyanmics (e.g. Sims and Zha, 2006, Primiceri 2005). However, those studies do not include oil prices or inflation expectations.

attributed to coefficient switching, which is the key hypothesis in the debate on second-round effects.

In terms of methodology, we employ the MS-VAR model developed in Hubrich, Waggoner and Zha (2015). In contrast to earlier MS-VAR models, such as those proposed in Sims, Waggoner and Zha (2008) and Hubrich and Tetlow (2015), this framework allows for time-varying transition probabilities that depend on the state of the economy. The method developed in Hubrich, Waggoner and Zha (2015) is to our knowledge the first to allow for time-varying transition probabilities in a VAR framework. We discuss related authoregressive and single equation regression models suggested in the literature in section 2.

The analysis provides evidence of two regimes that are characterized by different effects of oil price fluctuations on economic activity and inflation. In the *normal regime*, oil price shocks lead to only transitory and moderate declines in inflation and a small increase in economic activity, which may attenuate the initial disinflationary effect of the oil-price declines. In the *adverse regime*, by contrast, the responses of economic activity and inflation are much more sizeable and sustained than in the normal regime and both variables move in the same direction as the oil price shock. Market-based measures of inflation expectations, which we include in the MS-VAR since their behavior may act as a symptom for the presence of second-round effects, also show striking differences across regimes. While, in both regimes, inflation expectations initially adjust in the same direction as the oil price shock, this impact is again moderate and transitory in the normal regime whereas it is markedly stronger and persistent in the adverse regime. Overall, the dynamics characterising the adverse regime are consistent with the patterns to be expected in the presence of second-round effects that may amplify and prolong the impact of an oil price shock on inflation.

The analysis also delivers time-varying probabilities for the economy to be in one of the regimes, as well as the conditional probability of staying in that regime, given it is currently prevailing. These features help us comment, *inter alia*, on the recent debate on the macroeconomic implications of the oil-price declines observed since mid-2014 until early-2015. Our model indicates that the euro area economy was in an adverse regime at that time and hence favours the cautious assessment of their implications for the strength of the euro area economy. In fact, counterfactual experiments conducted using our model show that real GDP growth, inflation and inflation expectations would have shown a much more modest decline over the second half of 2014 than observed in the data, had the euro area not been mired in the adverse regime.

Our paper contributes to an active literature aiming to shed light on how the implications of oil price shocks may differ depending on macroeconomic circumstances. One strand of this literature focuses on the *sources* of the underlying oil price shocks as a determinant of its macroeconomic implications. In the seminal contributions to this literature, Kilian (2009) and Peersman and Van Robays (2009) develop structural VAR frameworks to model the global crude oil market and find that the macroeconomic consequences of oil price fluctuations differ depending on whether they originate from an oil supply shock, an increase in aggregate demand, or an increase in the precautionary demand for oil.[4] The second strand of this literature, including Blanchard and Galí (2007) and Nakov and Pescatori (2008), focuses on differences in the *transmission* of oil price shocks, either by comparing pre-defined historical episodes;[5] or, as in Van Robays (2012) and Baumeister and Peersman (2013), by developing models that explicitly allow for time-variation in impact of oil shocks.[6] Our paper is closest to the latter strand, in that it also explicitly models time-variation in a Markov-switching BVAR framework. But, to our knowledge, it is the first paper to: *(i)* account for such time variation in the euro area context; *(ii)* grant an explicit role to inflation expectation in the propagation of oil price shocks; and *(iii)* use a Markov-switching model with endogenous switching to analyse oil price shocks.

The remainder of the paper is organized as follows. Section 2 presents the methodology underlying the regime-switching model. Section 3 shows how the estimated economic

[4]The variables included in these VARs comprise measures of global crude oil production, the price of oil, and (in Kilian, 2009) a measure of the part of global economic activity that is particularly relevant for the demand for industrial commodities. More recent papers also include measures of global oil inventories in the VAR to help identify the forward-looking aspect of price formation in global oil markets; see for instance Kilian and Murphy (2014) and Baumeister and Kilian (2015). An alternative approach to disentangle oil demand and supply shocks, proposed *e.g.* by Groen, McNeil, and Middledorp (2013) and by Groen and Russo (2015), exploits the cross-correlation of oil price movements with a range of financial assets. This literatures builds on ex ante assumptions on how the reaction in the price of these financial assets should be expected to differ, depending on the source of the oil price fluctuation; but it does not assess whether the shocks in this manner have different macroeconomic consequences.

[5]Nakov and Pescatori (2008) analyse changes in oil price effects on the US economy before and after the Great Moderation in an estimated DSGE model, splitting the sample in the year 1984; Blanchard and Galí (2007) adopt a similar sample-split, but also consider VAR over rolling time windows.

[6]Van Robays (2012) uses a threshold VAR model to assess how macroeconomic uncertainty changes the impact of oil price shocks. Baumeister and Peersman (2013) use a time-varying BVAR to assess whether the prevalence of different sources of oil price shocks and their macroeconomic implications have changed over time.

responses to oil price shocks differ depending on the prevailing regime; reports how the estimated (conditional) probability of being (staying) in a certain regime has evolved since the introduction of the euro; and zooms in on the episode of collapsing oil prices since mid-2014, using counterfactual experiments to trace out how the euro area economy would have been expected to behave, had it not been mired in the adverse regime. We also investigate the robustness of our results to changes in specification. Section 4 concludes.

2 The methodology

We employ the Markov-Switching Vectorautoregressive (MS VAR) model with time-varying transition probabilities developed in Hubrich, Waggoner and Zha (2015) (henceforth HWZ15).

Most of the methodological literature focusses on models with constant probabilities of Markov switching, including the seminal paper by Hamilton (1989), and Chauvet (1998), Kim and Nelson (1999), Fruehwirth-Schnatter (2004), Sims and Zha (2006), Sims, Waggoner, Zha (2008) and Hubrich and Tetlow (2015).

Some papers provide extensions to time-varying probability Markov switching regression models: Filardo (1994), Diebold, Lee and Weinbach (1994), Kim (2004), Kim, Piger and Startz (2008), Amisano and Fagan (2010), Chang, Choi and Park (2014) as well as Bazzi, Blasques, Koopman and Lucas (2014). In these papers the probability of regime switching depends on certain variables of interest, but given the univariate or regression set-up no feedback effects among the endogenous variables are allowed. Hubrich, Waggoner and Zha (2015) propose a Markov-Switching Vectorautoregressive (MS VAR) model with time-varying transition probabilities that allows to model the interdependencies of the endogenous variables of the model and to impose structural identifying assumptions, building on and extending the framework presented in Sims, Waggoner, Zha (2008) (henceforth SWZ08); see also Hubrich and Tetlow (2015).

2.1 Model

For $1 \leq t \leq T$, let y_t be an n-dimensional vector of endogenous variables, let z_t be an m-dimensional vector of exogenous variables, and let s_t be a discrete latent variable variable taking h distinct values. Let Θ be a vector of parameters controlling the distribution of y_t and q be a vector of parameters controlling the process s_t. We will denote $\{y_1, \cdots, y_t\}$ by Y_t, $\{z_1, \cdots, z_t\}$ by Z_t, and $\{s_1, \cdots, s_t\}$ by S_t. We assume the distribution of the exogenous variable z_t satisfies

$$p(z_t | s_t, Y_{t-1}, Z_{t-1}, \Theta, q) = p(z_t | Z_{t-1}). \tag{1}$$

In this paper, we consider the time varying structural vector autoregression (SVAR) defined by

$$A_0(s_t^c) y_t = A_+(s_t^c) x_t + \Xi^{-1}(s_t^v) \varepsilon_t,$$

where

$$x_t' = \left[y_{t-1}', \cdots, y_{t-p}', 1 \right],$$

ε_t is a standard normal vector of shocks, and s_t^c and s_t^v take on values in $\{1, \cdots, h^c\}$ and $\{1, \cdots, h^v\}$, respectively. In the above notation, $s_t = (s_t^c, s_t^v)$, $h = h^c h^v$, and the only exogenous variable is a constant, $z_t = 1$. The vector Θ consists of the elements of $A_0(s_t^c)$, $A_+(s_t^c)$, and $\Xi(s_t^v)$.

2.2 The Transition Matrix

We denote $p(s_{t+1} = i | s_t = j, Y_t, Z_t, \Theta, q)$ by $p_{i,j,t}$. We assume that the diagonal elements are of the form,

$$p_{j,j,t} = \frac{1}{1 + e^{-u_j}}$$

where

$$u_j = c_j + \gamma_j y_{t,t-k+1}.$$

where $y_{t,t-k+1}' = [y_t', \cdots y_{t-k+1}']$. In practice, k will be one and most of the elemets of γ_j will be restricted to zero. The off diagonal will be of the form

$$p_{i,j,t} = (1 - p_{j,j,t}) \hat{p}_{i,j}$$

where $\sum_{i \neq j} \hat{p}_{i,j} = 1$. The prior on the parameters c_j and γ_j will be normal.

2.3 Estimation procedure, data and identification

We present our empirical results in terms of estimates at posterior mode. The posterior mode is estimated via a blockwise BFGS optimization algorithm following SWZ08. We have experimented with different blocking schemes, though.

The MS-VAR includes the change in industrial production (as a measure of industrial production), the change in the Harmonized Index of Consumer Prices (HICP; as a measure of inflation), the Brent crude oil price (in USD), the bilateral US-Dollar/Euro exchange rate (since global oil prices are quoted in US-Dollar, whereas the other variables in the VAR are expressed in Euro), 5-year/5-year break-even inflation rates (as a market-based measure of long-term inflation expectations), and 3-month EURIBOR (as short-term interest rate). For identification, we apply a Cholesky scheme, with the variables being ordered as in the previous sentence.

The sample includes euro area data at monthly frequency over the period from February 2004 to January 2015. The starting point of the sample is dictated by the availability of data on break-even inflation rates, which were not recorded in a consistent manner prior to February 2004 (neither were any other market-based measures of long-term inflation expectations).

3 Oil price changes, inflation expectations and the macroeconomy - regime-dependent dynamics

The results, shown in Figure 1, provide evidence of two regimes that are characterized by very different effects of oil price fluctuations on economic activity and inflation. In the *normal regime* (slashed blue line) oil price shocks only trigger small macroeconomic effects. Inflation briefly declines after the shock, but only by a few basis points and the decline is fully reversed over the 24-months horizon for which we computed impulse response functions. Inflation expectations follow a similar path as actual inflation, declining slightly after the shock but then recovering after a few months. Economic activity, in turn, increases slightly in response to the shock (in line with the benign interpretation of the oil price shock as supporting domestic demand) – and so does the short-term interest rate, consistent with the more dynamic economic conditions observed in the aftermath of the oil price shock.

In the *adverse regime* (solid red line), the oil price shock is slightly larger on impact (calculated also as a one standard deviation shock, but from a different regime), but then recovers more quickly than in the normal regime and, overall, does not display strikingly different patterns across regimes. The impact of the shock on the other variables in the system does, however, differ in relevant ways. Instead of rising, as in the normal regime, economic activity declines, hitting a trough after two quarters that is almost a percentage point below steady state and, despite some recovery, remains below steady state levels until the end of the horizon. In contrast to the benign regime, where economic activity acts as a stabiliser, this downward effect of the oil price shock on economic activity thus tends to amplify the disinflationary forces. As a consequence, actual HICP inflation undergoes a pronounced and persistent decline, settling almost 0.2 percentage points below steady state by the end of the horizon. This decline is also reflected in inflation expectations, which show a similarly modest drop on impact as in the benign regime, but then continue to drift down over the entire horizon.

Overall, the dynamics observed in the adverse regime are consistent with second round effects exerting a protracted adverse impact on the economy, translating into declines in actual as well as expected inflation. While the short-term interest rate declines in response to the shock, the resultant monetary loosening is not sufficient to offset the disinflationary forces.[7]

Failing to account for these regime-dependent dynamics may lead observers to miss important characteristics of the growth and inflation process. This becomes clear when comparing the impulse response functions from a constant parameter VAR (also plotted in Figure 1, dotted black line) with those from regime-switching model. In particular, restricting coefficients and variances to be constant may lead observers to underestimate the pronounced and persistent effects of oil price shocks on economic activity and inflation; at the same time, it may provide the wrong sign for output and inflation response in the normal regime. Both types of misjudgement may, in turn, contribute to policy mistakes in the response of central banks to oil price shocks.

– Figure 1: Impulse responses to oil price shock (one standard deviation shock), slashed

[7] Exchange rates do not play a major role in the adjustment dynamics, possibly reflecting the countervailing effects of the declining oil price, which would tend to induce an appreciation of the Euro versus the US-Dollar, and the weakening euro area economy, which would induce a depreciation.

blue: normal regime, solid red: adverse regime —

Figure 2 displays smoothed probabilities of being in a normal regime, shaded in grey, and the time-varying conditional probabilities of staying in a normal regime, depicted with the solid black line. The smoothed probabilities show that the euro area economy entered the adverse regime at various occasions since the start of the sample. Typically, regime-switches occurred after a sequence of pronounced, unidirectional oil price changes – for instance in the episodes of strong oil price declines and increases over the period 2008-2011. In August-2014, the euro area economy again switched to the adverse regime and, after a short period in the normal regime in the last quarter of 2014, returned to the adverse regime by the turn of the year. Meanwhile, the conditional probability of staying in a normal regime (given the economy was in that regime) declined steeply in the second half of 2014, approaching zero by January 2015. Taken together, the analysis thus favors the adverse interpretation of that episode of oil price declines, indicating that it is likely to have reinforced the prevailing disinflationary pressures via second-round effects.

— Figure 2 Time-varying probability being in a normal regime (grey-shaded area) and conditional probability of staying in that regime (black line) —

To gain further insight into this episode, and to illustrate for a concrete example how the dynamics of the system differ across regimes, Figure 3 presents a counterfactual experiment around the switch to an adverse regime in August 2014. The basic set-up of this counterfactual experiment is to plot how the different variables would have evolved if the euro area economy had not been mired in an adverse regime. Moreover, the experiment assumes that inflation expectations had not drifted down and instead stabilised at the levels recorded in July-2014, *i.e.* before the switch to the adverse regime. This assumption is motivated by the prominent role of inflation expectations in the policy narrative on second-round effects adopted by several major central banks. Finally, the experiment imposes that short-term interest rates (on average) are the same across regime. The latter assumption serves to isolate the differences in key macroeconomic aggregates that derive from the change in regimes and from alternative paths for inflation expectations, while avoiding that the comparison is "contaminated" by differences in monetary policy. The counterfactual points to striking differences in economic outcomes across regimes. In fact, according to our estimates, economic activity and inflation would have been almost 1 percentage point higher than observed by the end of 2014, had the euro area economy not been mired in an adverse regime and had inflation expectations not drifted down as they did.

– Figure 3: Counterfactual Experiment: Normal regime instead of volatile oil price regime (green dashed line: actual data, red solid line: counterfactual path) —

To assess the robustness of our key findings, we estimated an alternative specification which – instead of including oil prices in US dollars and the USD/EUR bilateral exchange rate – expresses oil prices in euro and omits the exchange rate. This specifications helps us reduce the relatively large size of the VAR and may be motivated by the fact that, ultimately, it is the oil price in euro that matters for euro area consumers and firms. As apparent from Figures 4 and 5, this robustness check confirms the key results of the baseline specification. In particular, the impulse response functions show nearly identical patterns for growth, inflation, and inflation expectations. Notably, the difference in the reaction of those variables between the different regimes is similarly pronounced, and in the case of this alterative specification the negative oil price shock is of the same size across regimes. Also, the assignment of periods to different regimes is broadly unchanged, although there are some more switches to the adverse regime over the period 2010-2012 than in the baseline specification. The period around the turn of the year 2014 to 2015 is again assigned to the adverse regime and the drop in the conditional probability of staying in normal regime in the second half of 2014 is also confirmed by this alternative specification.

4 Conclusions

In this paper, we have analysed whether the transmission of oil price shocks to the euro area economy undergoes episodic changes. To this end, we used a Markov-switching BVAR with endogenous switching following a novel approach developed by Hubrich, Waggoner and Zha (2015). We find that oil price fluctuations typically exert only limited effects on inflation and economic activity, a situation we refer to as a normal regime. Occasionally, however, the economy enters into an adverse regime where oil price shocks trigger sizeable and sustained macroeconomic effects, with inflation (actual and expected), as well as economic activity, moving in the same direction as the oil price shock. Overall, the dynamics observed in the adverse regime are consistent with the presence of second-round effects of oil price shocks on growth and inflation. We also show that VARs restricting their parameters to be constant fail to pick up these differences in the response of the euro area economy to oil price shocks.

Zooming in on the episode of collapsing oil prices from mid-2014 to early-2015 – which generated a lively debate among central bank observers on whether or not it warranted a monetary policy response – our model indicates that the adverse regime is likely to have prevailed. Accordingly, concerns of negative second-effects reinforcing the prevailing dis-inflationary pressures appeared warranted at that time. In fact, according to our estimates, economic activity and inflation would have been almost 1 percentage point higher than observed, had the euro area economy not been mired in an adverse regime and had inflation expectations not drifted down as they did.

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Figure 1: Impulse responses to oil price shock (one standard deviation shock), slashed blue: normal regime, solid red: adverse regime

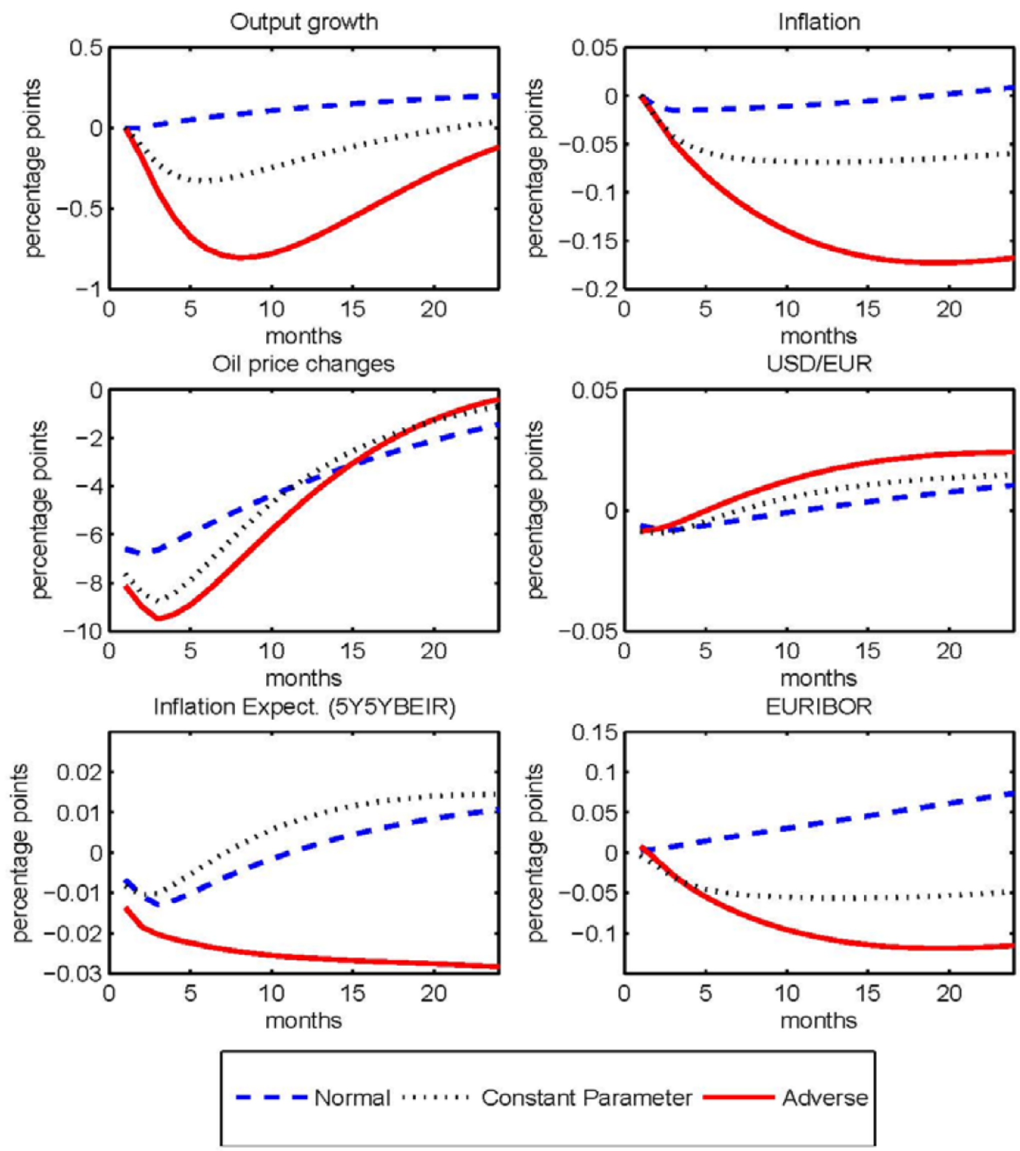


Figure 2: Time-varying probability being in a normal regime (grey-shaded area) and conditional probability of staying in that regime (black line)

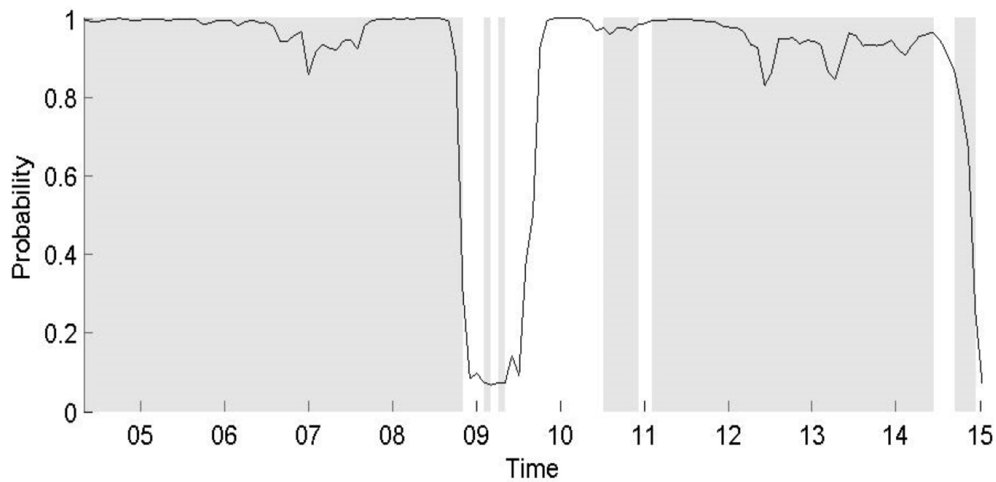
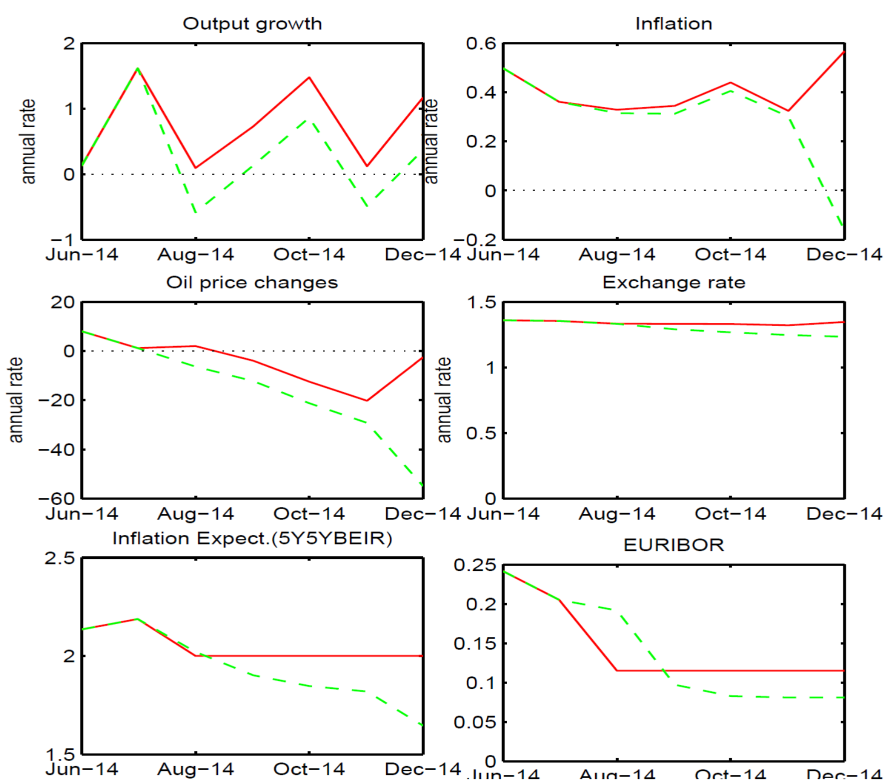


Figure 3: Counterfactual Experiment: Normal regime instead of volatile oil price regime (green dashed line: actual data, red solid line: counterfactual path)



Appendix

A: Documentation of data

- IP $STS.M.I7.Y.PROD.NS0020.3.000$ Euro area 18 (fixed composition) - Industrial Production Index, Total Industry (excluding construction) - NACE Rev2; European Central Bank; Working day and seasonally adjusted

- HICP $ICP.M.U2.S.000000.3.ERX$ Dataset name: Indices of Consumer Prices ; Frequency: Monthly ; Reference area: Euro area (changing composition) ; Adjustment indicator: Seasonally adjusted, not working day adjusted ; Classification - ICP context: HICP - Overall index ; Institution originating the data flow: European Central Bank ; Series variation - ICP context: Monthly index, backdated, fixed euro conversion rate used for weights

- EURIBOR $FM.M.U2.EUR.RT.MM.EURIBOR3MD_{.}HSTA$ Euro area (changing composition) - Money Market - Euribor 3-month - Historical close, average of observations through period - Euro, provided by Reuters

- EONIA $FM.B.U2.EUR.4F.MM.EONIA.HST$ Dataset name: Financial market data (Other data) ; Frequency: Business ; Reference area: Euro area (changing composition) ; Currency: Euro ; Financial market provider: ECB ; Financial market instrument: Money Market ; Financial market provider identifier: Eonia rate ; Financial market data type: Historical close

- $IE_5Y5YBEIR$ $BEIR.B.5Y5Y.DAILY$ 5Y market based inflation expectations

- OILUSD $msy'MSY.IFSFM.M.A.99.OILBRENTUSD$ Oil prices in USD

- OILEUR $msy'MSY.IFSFM.M.A.99.OILBRENTEUR$ Oil prices in EUR

- USDEUR $MSY.BIS.M.A.99.USDEUR$ nominal US dollar / euro exchange rate

Figure 4: Time-varying probability being in a normal regime (grey-shaded area) and conditional probability of staying in that regime (black line)

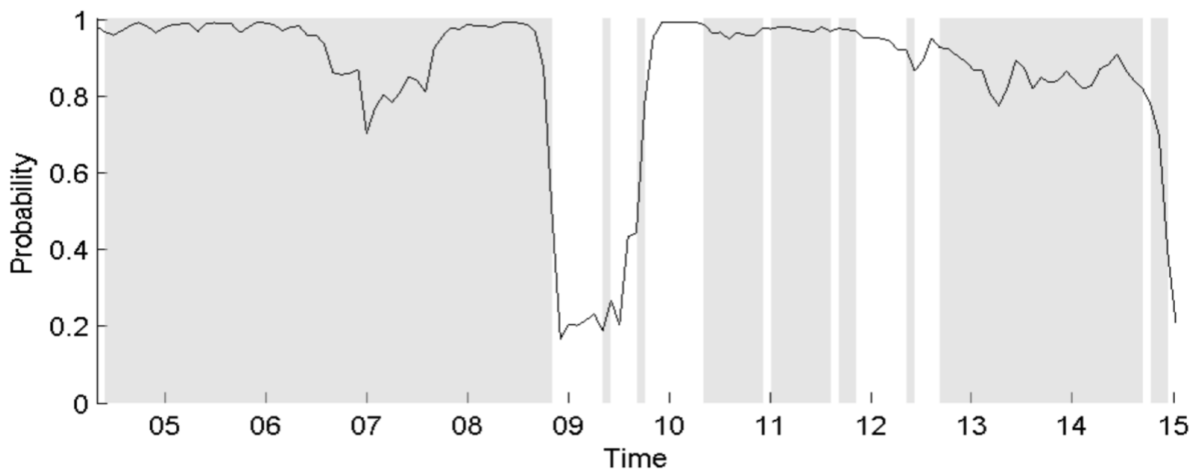


Figure 5: Impulse responses to oil price shock (one standard deviation shock), slashed blue: normal regime, solid red: adverse regime