The impact of unconventional monetary policy shocks on energy prices

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Abstract

We examine the effect of ECB's unconventional monetary policy measures on energy prices. Our results indicate that the non-standard ECB monetary policies during the recent financial crises had a significant and negative impact on energy prices. For example, we find that these policies accounted for approximately 10% of the price variance for the Light Crude Oil Futures Contract. Impulse Response Functions suggest that an increase in the ECB's propensity to unconventional policy decreases energy prices for all five energy price proxies during the first two months after the monetary shock. Since these policies have now become part of a central bank's arsenal during financial turmoil and may be used in future crises, these results shed light on their potential impact energy prices.

Keywords: Unconventional Monetary Policy, Qual-VAR, Panel-VAR, Commodity prices, oil prices, energy futures prices, GSCI Index, Bloomberg Commodity Index

1. Introduction

During the financial crisis in the US (2007-2009) and the financial crisis in the EU (2010-2013) central bank rates, an important conventional (standard) monetary policy tool which has an impact on economic expectations and prices, reached their zero lower bound; thus, becoming ineffective as a policy tool in dealing with the crisis and the financial turmoil. The response of many major central banks was to adopt unconventional (non-standard) monetary policy actions [see, among others, Fawley and Neely, 2013]. For instance, the European Central Bank (ECB) initiated procedures where liquidity at the main refinancing rate was provided to euro-area financial institutions via currency swaps, collateral extensions, and covered bond purchases, (Supplementary Long Term Refinancing Operations (SLTROs), and "Very" Long Term Refinancing Operations (VLTROs)). In addition, between 2010 and 2012 the ECB announced the Securities Markets Programme (SMP), i.e. direct purchases of Greek, Portuguese and Irish government bonds, and the Outright Monetary Transactions (OMTs), i.e. purchases of bonds from countries in adjustment programmes.

In this chapter, we address a gap in the relevant literature, and examine the effect of ECB's unconventional monetary policy measures on energy prices; that is, we examine if, and to what extent, ECB's expansionary unconventional monetary policy shocks affected energy prices. We focus on ECB's policy since recent studies examine Fed's monetary policy effects on energy and commodity prices: Rosa [2014], with an event study methodology, examines the impact of both Fed's standard and non-standard policy measures on energy futures prices and finds that monetary policy surprises have a significant impact both the level and the volatility of prices trading volume; Basistha and Kurov [2015] find that energy prices exhibit a negative and significant intraday response to Fed funds target changes subsequent to policy announcements. This response, however, becomes insignificant for the days following the announcement and, in addition, using a VAR methodology they find an insignificant effect of monetary policy on oil prices.

Note that many authors have argued that monetary conditions affect commodity prices. For instance, Frankel [1986] demonstrates that there is a theoretical link between interest rates and oil, while Bernanke, Gertler and Watson [1997] suggest that monetary policy could be used to eliminate any recessionary consequences of an oil price shock, while Barsky and Kilian [2004] find that oil price increases in the 1970s were also due to monetary policy regime changes and global liquidity, a result consistent with the findings of Taghizadeh and Yoshino [2014a]. Frankel [2008] shows that there is a significant and relation between commodity prices and interest rates, while Yoshino and Taghizadeh [2014b] find that following the 2007-2009 financial crisis in the US and the quantitative easing policy, the weaker dollar pushed oil prices upwards [see also, Anzuini et al., 2010; among others]. Note also that, recently, Lutz [2015] documents a link between monetary policy and investor sentiment.

We propose an alternative way to estimate the effects of unconventional monetary policy on commodity/oil prices, which combines binary information about ECB's announcements with an otherwise standard monetary policy VAR. Although VAR models are widely used by macroeconomists, their inability to handle unconventional monetary policy measures such as SMP, OMT and LTROs actions as endogenous factors constitutes a major disadvantage of conventional VAR modelling. We produce dynamic forecasts and employ a Qual VAR [Dueker, 2005] model that is based on the single-equation dynamic ordered probit model of Eichengreen, Watson and Grossman [1985] and Dueker [1999].

The main advantage of the Qual VAR is its capability to handle a binary variable as endogenous, allowing the use of unconventional monetary policy announcements as an endogenous factor of the system, after modelling the interaction with business cycle variables. The continuous latent variable deriving from the model mirrors the propensity to unconventional monetary policy, and results after the estimation of the dynamic probit model through Markov Chain Monte Carlo (MCMC) techniques. The continuous series on monetary policy's propensity to ECB's unconventional measures deriving from the model is then entering a Panel VAR as a regressor with the capability of delivering Forecast Error

Variance Decompositions (FEVDs) and Impulse Response Functions (IRFs). This approach allows the combination of traditional VAR procedures with a panel-data approach [see, Love and Zicchino, 2006].

Our results indicate that the non-standard ECB monetary policies during the recent financial crises had a significant and negative impact on energy prices. For example, we find that these policies accounted for approximately 10% of the price variance for the Light Crude Oil Futures Contract, during the crises. The second more important contribution has been to the Bloomberg Commodity Index where 8.42% of price volatility is explained. In addition, Impulse Response Functions suggest that an increase in the ECB's propensity to unconventional monetary policy decreases energy prices for all five energy price proxies during the first two months after the monetary shock.

These results have implications for monetary policy makers, market participants, and investors, since they shed further light on the impact of non-standard monetary policy tools on energy prices, which in turn affect consumer prices, inflation, and output. Also, since unconventional monetary policies have now become part of a central bank's arsenal during financial turmoil and crisis, and thus may be used in future crises, these results shed light on the potential impact of these policies on important economic variables, such as energy prices.

The rest of the chapter is organized as follows: section 2 presents the data and the testing methodologies, section 3 presents the results, whilst section 4 concludes the chapter.

2. Data and Testing Methodology

For the empirical analysis, we employ monthly data on oil prices, macroeconomic aggregates, investor sentiment proxy and financial variables (see, among others, Galariotis et al. 2016), for the period between May 2007 and October 2012. All data are obtained from EIKON and Bloomberg. More specifically, our sample consists of nine Eurozone countries, Germany, France, Netherlands, Belgium, Austria, Spain, Portugal, Italy, and Greece. For these countries, we collect data on Industrial Production (IP), Stock Returns (Stock_Ret, main equity indexes), Consumer Prices (HICP), and Economic Sentiment (ESI). As a proxy for energy price developments we use the future prices for Brent (ICE, continuous settlement price - U$/BL) denoted as *ICE_BCO*, the futures prices for Light Crude Oil (NYM, continuous settlement price - U$/BL) denoted as *NYM_LCO*, the futures prices for Natural Gas (ICE, continuous settlement price - SP/TE) denoted as *ICE_NG*, the Standard and Poor's GSCI Index (S&P GSCI) denoted as *GSCI*, and the Bloomberg Commodity Index denoted as *BCOM*.

2.1. Measuring Unconventional Monetary Policy: A Qual VAR approach

Recent studies that examine the effect of unconventional monetary policies employ a binary variable which takes the value of one in the month of a surprise (unexpected) monetary policy announcement and zero otherwise. One way to ensure that the events employed are significant and unexpected one can focus only on events and announcements related to SLTROs, SMP, and OMT that appeared in the front page of financial newspapers (e.g. the Financial Times) on the day following the announcements. Appendix A presents a list the unexpected events related to non-standard policies employed in this study [for more details and a discussion see Fratzscher et al., 2014; Fratzscher et al., 2013]. Fratzscher et al. [2014] examine the global effect of ECB policies and find that these policies have a positive spill-over effect on global markets (higher equity prices, lower risk aversion, lower risk).

With these announcements, we construct a binary variable, which we then transform to a continuous latent variable with the use of Qual VAR model of Dueker [2005]. This model is based on the single-equation dynamic ordered probit model [see Eichengreen et al., 1985; Dueker, 1999]. The latent variable that is derived from the Qual VAR model mirrors the propensity to non-standard monetary policy and is obtained following the estimation of a dynamic probit model through MCMC techniques. Thus, we are able to employ non-standard monetary policy announcements as an endogenous factor in a Panel VAR system. This way, all variables constitute the same vector autoregressive system, and the only variable needed to produce multi-step forecasts is the dependent variable's own history [see for more details Meinusch and Tillmann, 2016; Assenmacher-Wesche and Dueker, 2010].

To describe the model more formally [see Dueker, 2005; Assenmacher-Wesche and Dueker, 2010] suppose y^* is a latent variable (eq. (1)) that captures non-standard monetary policies. The binary variable y_t takes the value one if unconventional policy actions occur in period *t* and zero otherwise. That is, the value of the binary variable y_t takes the form:

$$y_t = \begin{cases} 0 & if\ y_t^* \leq 0 \\ 1 & if\ y_t^* \geq 0 \end{cases} \tag{1}$$

The latent variable is estimated as in eq. (2):

$$y_t^* = \delta + \sum_{l=1}^{\rho} \varphi_l y_{t-l}^* \sum_{l=1}^{\rho} \beta_l X_{t-l} + e_t, \qquad e_t \sim N(0,1) \tag{2}$$

It is an autoregressive process of order ρ that depends on the constant δ, a set of explanatory variables X_{t-P} (lagged), and own past values. The terms φ and β are coefficient vectors, while e_t is the random error term from a standard normal distribution. Finally, the time index is denoted as t = 1,…T. The second component of the model, is a VAR (ρ) process for the dynamics of *k* regressors:

$$Y_t = \mu + \sum_{l=1}^{\rho} \Phi^l Y_{t-l} + \nu_t, \qquad \nu_t \sim N(0, \Sigma) \tag{3}$$

In (3) there is a k ×1 vector $Y_t = (X_t, y_t^*)'$. $k-1$ time series of observed macroeconomic data constitute the X_t while y_t^* complements a vector of the latent variable. The set of VAR coefficients are shown as:

$$\Phi^l = \begin{bmatrix} \Phi_{XX}^{(l)} & \Phi_{Xy^*}^{(l)} \\ \Phi_{y^*X}^{(l)} & \Phi_{y^*y^*}^{(l)} \end{bmatrix} \tag{4}$$

In (4) μ is a k ×1 vector of constants and ν_t comprises the k ×1 error vector and the covariance matrix of the errors is Σ. The complete Qual VAR system is derived from the linear relation between the regressors and the latent variable.

MCMC techniques (Gibbs Sampling) can be employed to estimate the model. This makes possible the generation of posterior samples by sweeping through each variable and/or block of variables, in order to sample from its conditional distribution, while keeping the remaining variables fixed. [See for details, Dueker, 2005; Assenmacher-Wesche and Dueker, 2010]. Next, Kalman Smoothing techniques allow the derivation of the different states mean and variance, in other words, the latent variable (which is conditional on its own previous and future values and the rest of the variables). In a second stage, from the binary data and the OLS coefficient estimates (given the binary data) initial values are obtained for use in the Smoother, and then a latent variable is drawn from the truncated Normal. In a third stage, the estimation of the VAR model takes place utilizing the sampled time series of the latent variable and OLS estimates for Φ and Σ (denoted by $\hat{\Phi}$ and $\hat{\Sigma}$).

The assumed Jeffrey's prior and the above information conduct a draw for Σ from the inverted Wishart distribution with $T-k$ degrees of freedom. Note that T mirrors the number of observations, k the number of explanatory variables and $(T\hat{\Sigma})^{-1}$ describes the covariance from OLS:

$$\Sigma \sim IW\left\{((T\hat{\Sigma})^{-1}, T-k\right\} \tag{5}$$

The latent variable's variance equals unity and thus the appropriate element in Σ is adjusted and a normalization of the rest of the elements in the corresponding column takes place.

We next add the OLS estimates mean to the draw, following a multivariate Normal distribution with a covariance matrix which stands for the Kronecker product, draws for Φ ,given Σ ,and derive of the draw for Σ and $(Y'Y)^{-1}$:

$$\Phi \sim N\left\{\widehat{\Phi}, \Sigma \otimes (Y'Y)^{-1}\right\} \tag{6}$$

If a sufficiently large number of iterations takes place (we run 10,000 iterations and discard the first 5,000 for convergence towards the posterior distribution; Dueker, 2005], then the draw from either conditional distribution represents a draw from the joint posterior distribution.

Then the VAR coefficients and variance are derived from the resulting sample. The binary variable enters the model as y_t {0, 1} and, along with the remaining variables in the X_t vector, is employed in order to derive are used to derive the latent propensity to non-standard monetary policy of ECB unconventional monetary policy measures ECB, i.e.y_t^*, (*y*-star).

As discussed above, the variables that we include in the model proxy for energy prices, the Eurozone business cycle, the financial markets' response on ECB's unconventional monetary policy stance, and expectations (OIL, IP, HICP, Stock_Ret, ESI, respectively). We conclude to a six-variable Qual VAR model i.e.: OIL, IP, HICP, ystar, Stock_Ret, ESI. We adopt five different Qual VAR models for each one of the countries of our sample, since we investigate the effects of monetary policy on energy prices by using five different proxies, namely the future prices for Brent, the futures prices for Light Crude Oil, the futures prices for Natural Gas, the Standard and Poor's GSCI Index and the Bloomberg Commodity Index.

The model is estimated in first differences in order the variables to be stationary and thus consistent with the assumptions in the MCMC estimations, as well as with the concept of the latent variable. To identify monetary policy shocks, we follow Christiano et al. [1999] recursive ordering. We use a Cholesky decomposition based on the following ordering of variables for the model: O*IL*, *IP*, *HICP*, *ystar*, *Stock_Ret*, *ESI*.

We list first in the ordering as the most exogenous variable in the system, the oil prices, since it is a global factor and affects all variables in the system contemporaneously. We considered alternative orderings, but the change in ordering does not affect our analysis and conclusions. As lag selection criteria are not defined for binary data we choose to use three lags in our Qual VAR system, which is appropriate for a short sample according to Meinusch and Tillmann [2016]. We also implement multivariate Q-tests which confirm the absence of serial correlation in the residuals of each estimated model.

In order to study the effects on a regional basis, Eurozone as a whole, we enter the latent variable filtered out of the Qual VAR model in a panel VAR model. In this setting, all variables in the system are treated as endogenous, while allowing for unobserved individual heterogeneity.

With this approach we are now able to apply the panel-data approach based on the PVAR routine written by I. Love [Love and Zicchino, 2006]. First, a first-order 6-variable VAR model is specified:

$$Z_{i,t} = \gamma_o + \gamma_1 Z_{i,t-1} + f_i + u_t \quad i = 1,....,N \quad t = 1,...T \tag{7}$$

The time invariant fixed effects in (7) are expressed with $u_t \sim$ *i.i.d. (0,Σ)* and f_i.

We present results from (7) based on Impulse Response Functions (IRFs) and Variance Decompositions (VDs), and utilize a Cholesky decomposition of the variance-covariance matrix of residuals, i.e.

orthogonality is ensured. In order to identify unconventional monetary policy shocks, we adopt the recursive ordering of Christiano et al. [1999], i.e.: *OIL*, *IP*, *HICP*, *ystar*, *Stock_Ret*, *ESI*. We also consider alternative orderings; however, the results remain qualitative the same.

Since we have five different proxies for energy prices, we estimate five different Panel-VAR models one for each proxy: the future prices for Brent, the futures prices for Light Crude Oil, the futures prices for Natural Gas, the Standard and Poor's GSCI Index and the Bloomberg Commodity Index. We allow for individual heterogeneity in levels by introducing fixed effects, however, simple-mean differencing will provide biased estimators, as fixed effects are correlated with the regressors due to lags of the dependent variables. In order to avoid that, we follow Love and Zicchino [2006] and introduce the forward mean-differencing procedure of Helmert transformation and estimate coefficients with system GMM.

To analyze the impulse response functions we calculate the standard errors of the impulse-response functions and generate confidence intervals using Monte Carlo simulations with 200 replications. Therefore, whenever the zero line lies outside the confidence bands there is evidence of a statistically significant response to the shock inflicted.

3. Results

In Table 1, Panel A, we present descriptive statistics for the main variables. The panel unit root tests of; IPS test suggest that we strongly reject the null hypothesis of a unit root, for all sample variables (available upon request). The next step is the lag selection for the PVAR model. In order to decide on the lag structure, we use Hansen's [1982] *J*-statistic and corresponding *p*-value, and moment model selection criteria developed by Andrews and Lu [2001] based on the *J*-statistic (available upon request).

The results indicate that the optimal lag structure is one lag. Nevertheless, in order to enhance a 6–variable VAR model with richer dynamics, we choose a panel VAR model with four lags (the results after using the lags proposed by the model selection criteria remain qualitatively the same).

Table 1
Descriptive Statistics

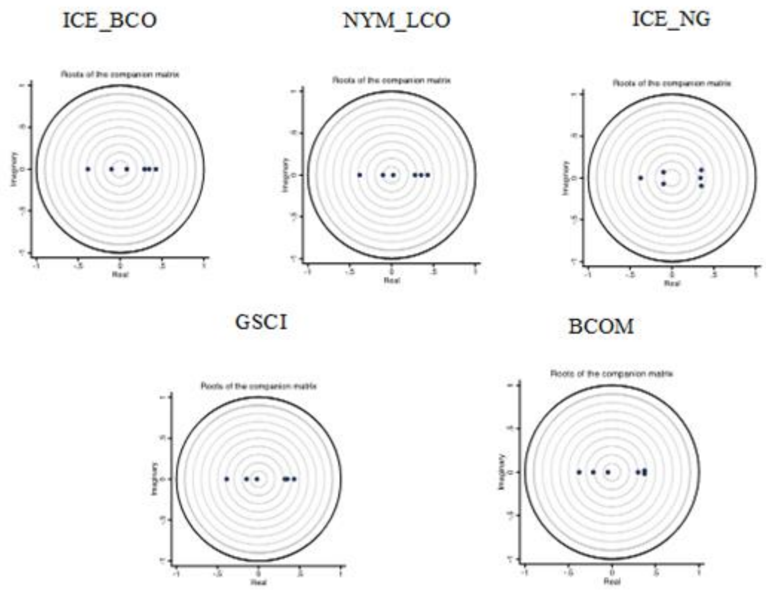
Descriptive Statistics					
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
ESI	594	-0.3936	2.5906	-10.8	7.2
IP	594	-0.0015	0.0230	-0.0846	0.0894
HICP	594	0.0065	0.4220	-1.6	2.3
STOCK	594	-0.0064	0.0713	-0.2782	0.2192
ICE_BCO	594	0.0071	0.0965	-0.4074	0.2544
NYM_LCO	594	0.0041	0.1039	-0.3948	0.2601
ICE_NG	594	0.0205	0.1505	-0.6190	0.4361
GSCI	594	-0.0029	0.0812	-0.3312	0.1795
BCOM	594	-0.0029	0.0632	-0.2400	0.1221

Notes to Table 1

Panel A presents descriptive statistics for the following variables: The Stock market returns (denoted as Stock_Ret), the Industrial Production index (denoted as IP), the Harmonised Index of Consumer Prices (denoted as HICP) and the Economic Sentiment Indicator (denoted as ESI), the future prices for Brent (ICE, continuous settlement price - U$/BL), the futures prices for Light Crude Oil (NYM, continuous settlement price - U$/BL), the futures prices for Natural Gas (ICE, continuous settlement price - SP/TE), the Standard and Poor’s GSCI Index (S&P GSCI), and the Bloomberg Commodity Index. All-time series are transformed to ensure stationarity; Harmonised Index of Consumer Prices and Economic Sentiment Indicator are used in first differences, Stock market returns, Industrial Production, the future prices for Brent, the futures prices for Light Crude Oil, the futures prices for Natural Gas, the Standard and Poor’s GSCI Index and the Bloomberg Commodity Index in log differences. All data are monthly and obtained from EIKON and Bloomberg. The sample covers the period between May 2007 and October 2012.

In Figure 1 we report evidence on the stability properties of each one of the five estimated PVAR models, which requires the moduli of the eigenvalues of the dynamic matrix to lie within the unit circle, which is the case in our estimated model.

Figure 1
Roots of Companion Matrix



Notes to Figure 1
The stability of the panel VAR requires the moduli of the eigenvalues of the dynamic matrix to lie within the unit circle. Panel VAR for all five models (first, second, third, fourth and fifth model the one including ICE_BCO, NYM_LCO, ICE_NG, GSCI and BCOM prices, respectively) satisfies stability condition as all eigenvalues lie inside the unit circle.

As discussed above, to identify monetary policy shocks, we follow Christiano et al. [1999] and use a Cholesky decomposition based on the following ordering (note that, as Lutkepohl and Poskitt [1991] argue, that the ordering of the variables makes little difference when the residual correlation is small) of the variables with oil prices listed first as the most exogenous variable in the system: OIL, IP, HICP, ystar, Stock_Ret, ESI. Note that we also employ alternative orderings and the results (available upon request) remain qualitatively the same. We focus and present results on the underlying moving average (MA) representation of the VAR model, i.e. the impulse response functions (IRFs) and the associated Forecast Error Variance Decompositions (FEVDs). These two combined, convey information on how each variable responds to a surprise change (a shock) to another variable in the system.

As discussed above, we employ the Qual VAR model in order to derive the ECB's latent propensity to unconventional monetary policy measures, (ystar), based on our initial binary variable. We then employ this continuous variable in our Panel VAR model for all variables and for each one of the five different oil prices in a panel data set. Figure 1, 2, 3, 4, 5 and 6 present this variable for each country for each one of the five different energy proxies, i.e. the estimated latent propensity to unconventional monetary policy measures for each one of the sample countries. During the announcement dates (shaded areas) this series is required to be positive [Meinusch and Tillmann, 2016]. The ECB's latent propensities appear very similar for countries, an expected result since ECB's monetary stance is common. The sharp increases underline their magnitude.

Table 2
Panel-VAR and FEVDs with Latent Variable from Qual Var

Panel A (Brent Futures Prices)						
Impulse variable / ystar	Response variables					
	ICE_BCO	IP	HICP	ystar	Stock_Ret	ESI
EUROPE	6.78	5.04	9.18	80.75	12.92	3.28
Panel B (Light Crude Oil Futures Prices)						
Impulse variable / ystar	Response variables					
	NYM_LCO	IP	HICP	ystar	Stock_Ret	ESI
EUROPE	10.06	4.44	8.5	76.68	11.53	2.28
Panel C (Natural Gas Futures Prices)						
Impulse variable / ystar	Response variables					
	ICE_NG	IP	HICP	ystar	Stock_Ret	ESI
EUROPE	7.92	5.97	5.76	74.7	12.6	9.71
Panel D (Standard and Poor's GSCI Index)						
Impulse variable / ystar	Response variables					
	GSCI	IP	HICP	ystar	Stock_Ret	ESI
EUROPE	6.56	5.82	11.57	81.58	11	4.73
Panel E (Bloomberg Commodity Index)						
Impulse variable / ystar	Response variables					
	BCOM	IP	HICP	ystar	Stock_Ret	ESI
EUROPE	8.42	6.16	10.15	83.04	14.6	5.46

Notes to Table 2

The Table presents results (4 lags) for the contribution of ECB's latent propensity to unconventional measures (ystar) to the variance in each column variable (OIL, IP, HICP, ystar, Stock_Ret, and ESI) for the Eurozone countries. The results are computed from a panel VAR with 4 lags. Note that we report here only the results for the response variables after a ystar shock (the rest of the results are available upon request).

Figure 2
ECB announcements (shaded) and latent propensity for ECB unconventional monetary measures (dash line) for Eurozone countries, ICE_BCO

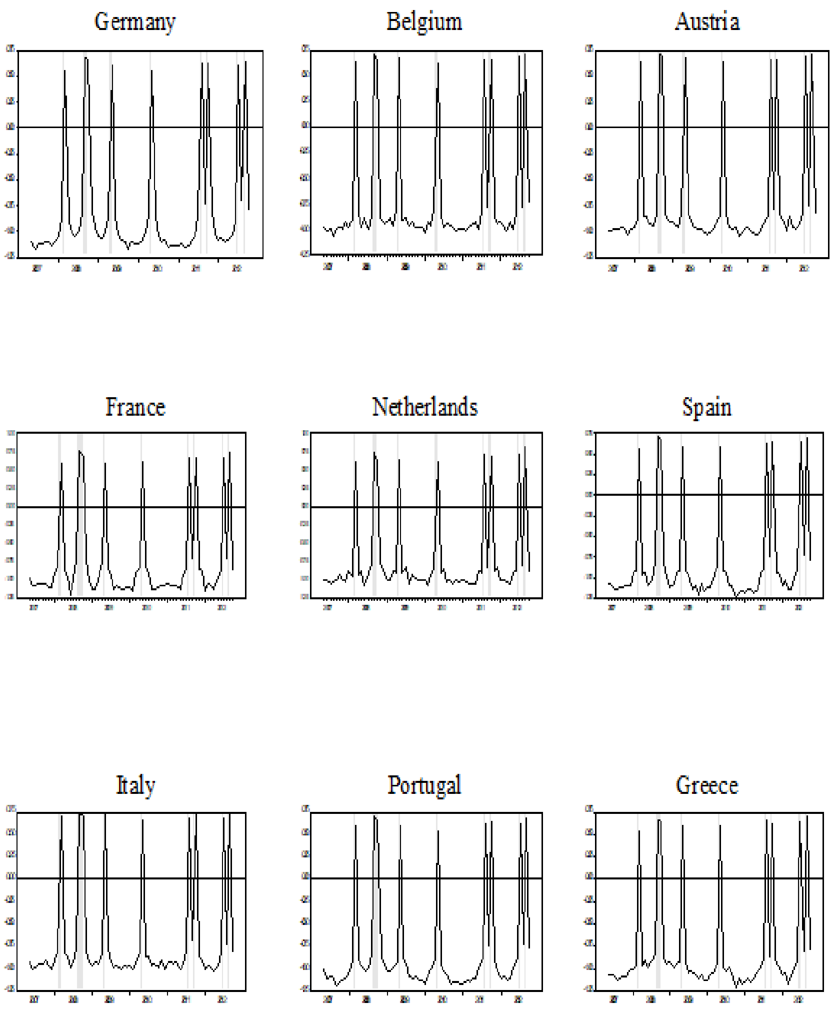


Figure 3
ECB announcements (shaded) and latent propensity for ECB unconventional monetary measures (dash line) for Eurozone countries, NYM_LCO

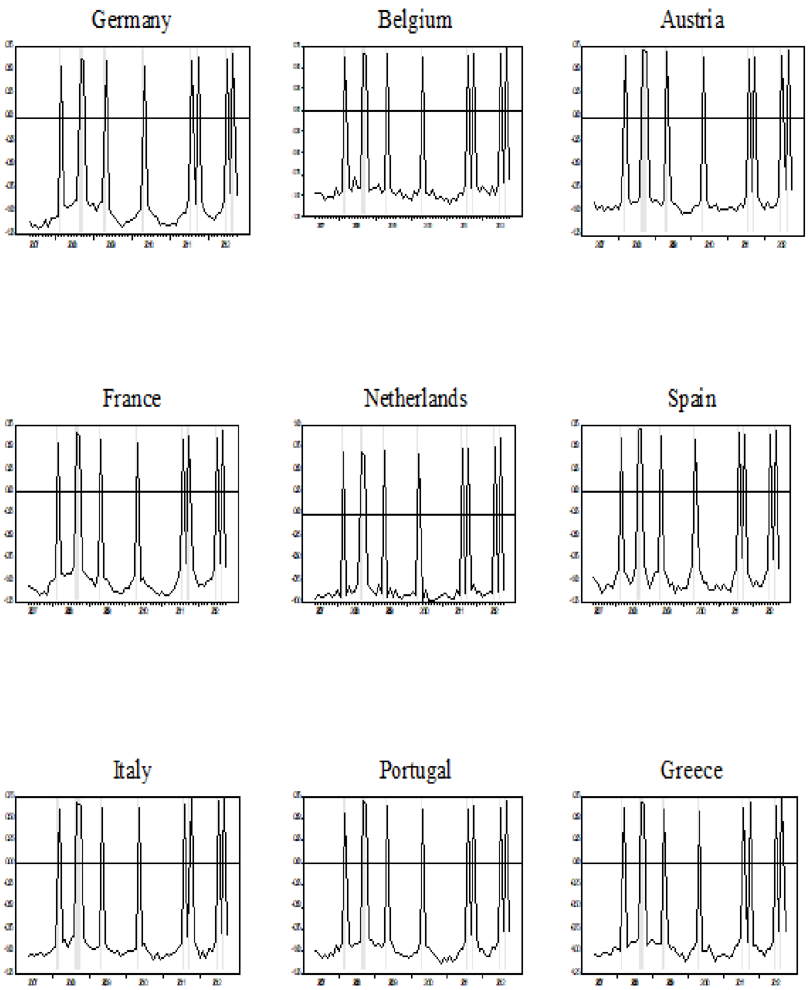


Figure 4
ECB announcements (shaded) and latent propensity for ECB unconventional monetary measures (dash line) for Eurozone countries, ICE_NG

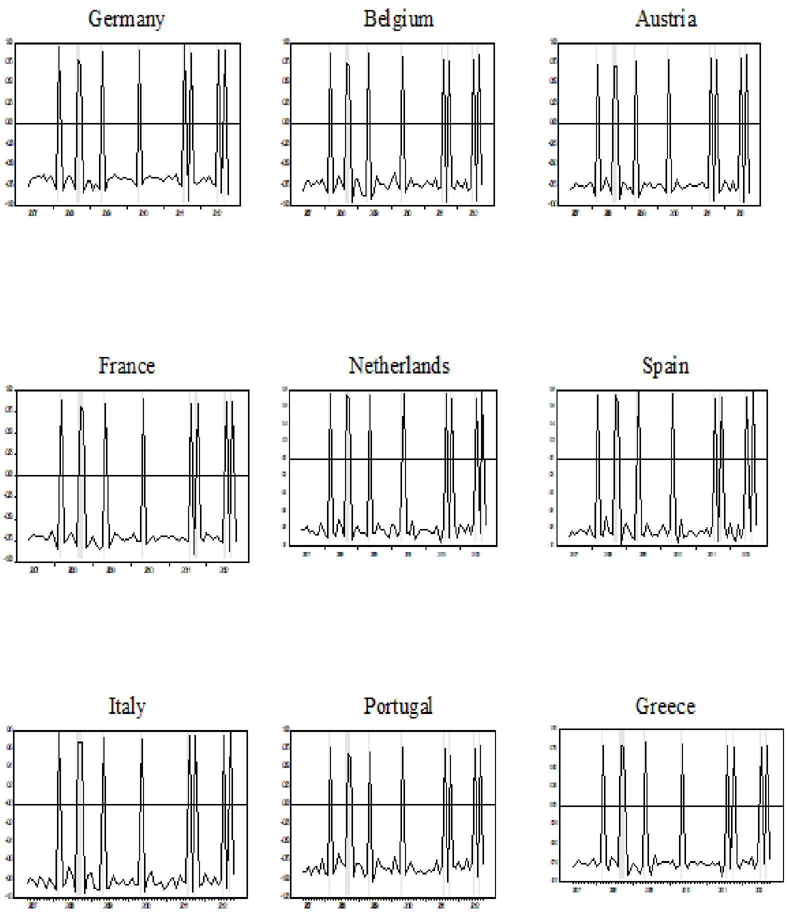


Figure 5
ECB announcements (shaded) and latent propensity for ECB unconventional monetary measures (dash line) for Eurozone countries, GSCI

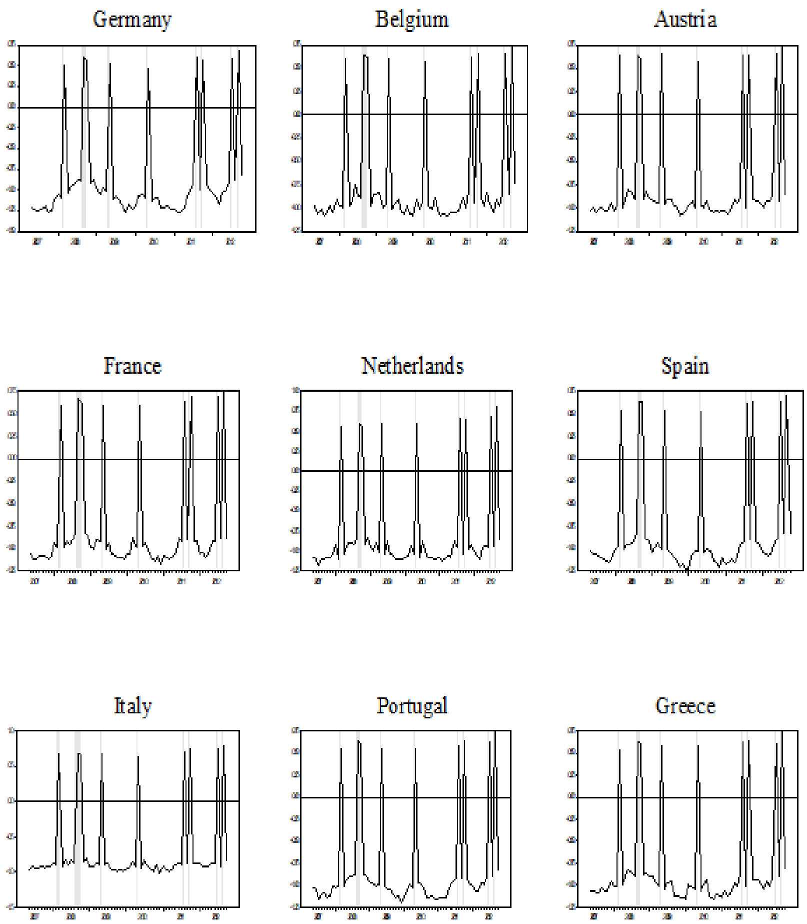


Figure 6
ECB announcements (shaded) and latent propensity for ECB unconventional monetary measures (dash line) for Eurozone countries, BCOM

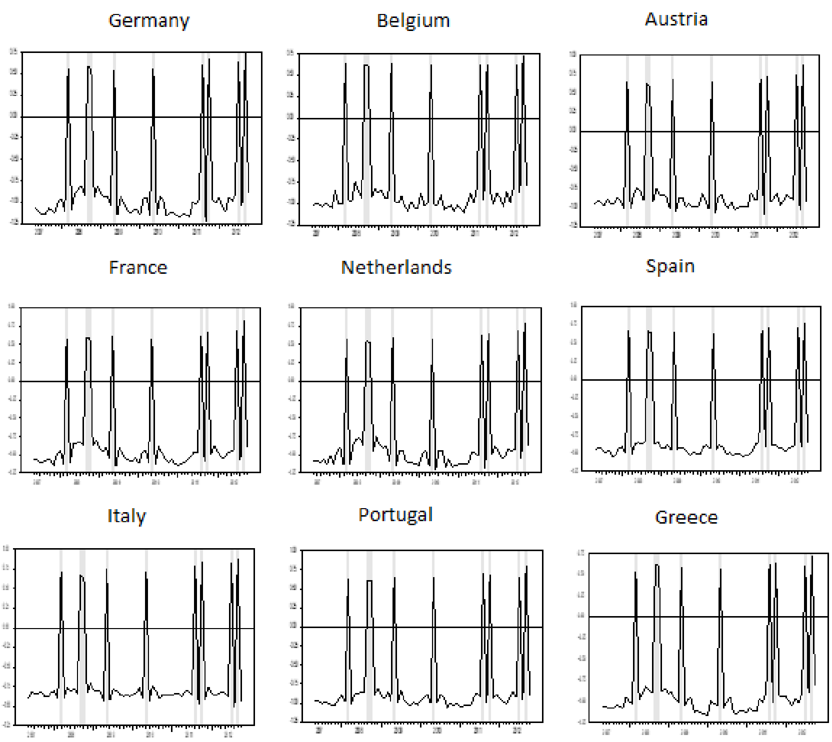
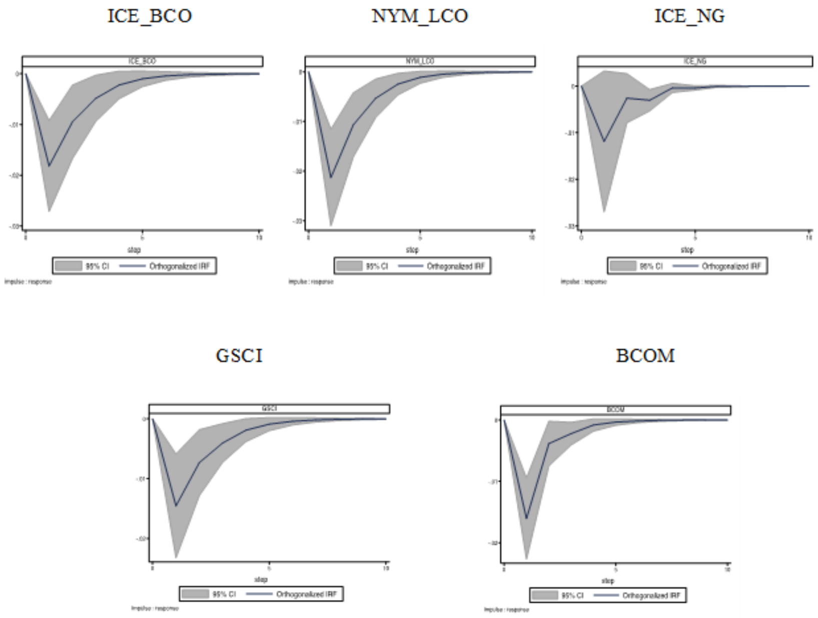


Table 2 presents the FEVD results for the Eurozone countries after running a panel VAR with 4 lags for each one of the five different proxies employed, that is for the future prices for Brent, the futures prices for Light Crude Oil, the futures prices for Natural Gas, the Standard and Poor's GSCI Index and the Bloomberg Commodity Index (Panel A, B, C, D and E respectively).

The results indicate that unconventional measures had a significant effect to energy prices, where 6.78%, 10.06%, 7.92%, 6.56% and 8.42% of the total variance of each variable is explained, for the future prices for Brent, the futures prices for Light Crude Oil, the futures prices for Natural Gas, the Standard and Poor's GSCI Index and the Bloomberg Commodity Index, respectively. Unconventional policy shocks account more for the future prices for Light Crude Oil where 10.06% of price volatility is explained. The second more important contribution is to the Bloomberg Commodity Index where 8.42% of price volatility is explained.

Figure 7 presents orthogonalized Impulse Response Functions (IRFs) and the 95% error bands generated by Monte Carlo simulation (200 repetitions) obtained with the Panel VAR model on the effect of Unconventional Monetary Policy on energy prices. Note that the response is similar for all energy price proxies, that is, there is a negative response to a shock in ECB's unconventional monetary policy. More specifically, the results indicate that an increase in the ECB's propensity to unconventional monetary policy decreases energy prices for all five energy price proxies during the first two months after the monetary shock.

Figure 7
The effect of a shock of ECB's unconventional policy stance on Energy Prices



5. Conclusion

In order to deal with the financial crisis in the US (2007-2009) and the financial crisis in the EU (2010-2013), many central banks implemented a number of unconventional (non-standard) monetary measures, since standard policies were not adequate to tackle the magnitude of these crises. Many previous studies suggest that monetary conditions affect energy and commodity prices [see, among others, Barsky and Kilian, 2004; Taghizadeh and Yoshino, 2014a; Frankel, 2008; Anzuini et al., 2010]. Most of these studies, however, examine conventional monetary policies. Only recently, Rosa [2014] examines the impact of both Fed's standard and non-standard policy measures on energy futures prices [see also Basistha and Kurov, 2015].

In this chapter, we address a gap in the relevant literature, and examine the effect of ECB's unconventional monetary policy measures on energy prices; that is, we examine if, and to what extent, ECB's expansionary unconventional monetary policy shocks affected energy prices. We propose an alternative way to estimate the effects of unconventional monetary policy on energy prices, which combines binary information about ECB's announcements with an otherwise standard monetary policy VAR. We produce dynamic forecasts and employ a Qual VAR [Dueker, 2005] model that is based on the single-equation dynamic ordered probit model of Eichengreen, Watson and Grossman [1985] and Dueker [1999]. The main advantage of the Qual VAR is its capability to handle a binary variable as endogenous, allowing the use of unconventional monetary policy announcements as an endogenous factor of the system, after modelling the interaction with business cycle variables.

Our results indicate that the non-standard ECB monetary policies during the recent financial crises had a significant and negative impact on energy prices. For example, we find that these policies accounted for approximately 10% of Light Crude Oil Futures price variance during the crises. The second more important contribution has been to the Bloomberg Commodity Index where 8.42% of price volatility is explained. In addition, Impulse Response Functions suggest that an increase in the ECB's propensity to unconventional monetary policy decreases energy prices for all five energy price proxies during the first two months after the monetary shock.

Since unconventional monetary policies have now become part of a central bank's arsenal during financial turmoil and crisis, and thus may be used in future crises, these results shed light on the potential impact of these policies on important economic variables, such as energy prices.

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APPENDIX A: Press coverage of ECB actions

Date	Event	Financial Times Headline	Headline Article	Front page	VIX	Dummy
28/3/2008	6 month SLTROs	*US back-up for Iraqi offensive*	No	No	-0.17	AN_SLTROs
4/9/2008	Roll over of the outstanding 6 month SLTROs	*US stock s suffer on fear for economy*	No	No	2.6	AN_SLTROs
15/10/2008	6 month SLTROs and other measures	*Fresh squall rattles mark ets*	No	No	14.12	AN_SLTROs
7/5/2009	12 month SLTROs and other measures (including covered bond purchases)	*Us banks must add $74.6bn in equity*	No	text	0.99	AN_SLTROs
4/6/2009	Details for the purchase programme of covered bonds	*Obama appeal to muslims*	No	No	-0.84	
10/5/2010	SMP and other measures	*Markets rally on EU bail-out*	main text	-	-12.11	AN_SMP
30/6/2010	Completion of covered bond purchases	*EU bank bonus rules sow confusion*	No	No	0.41	
4/8/2011	SLTROs and other measures	*Stock markets plunge worldwide*	main text	-	8.28	
7/8/2011	SMP reactivation	*Traders braced for more turmoil*	main text	-	16	AN_SMP
6/10/2011	12 month SLTROs and covered bond purchases	*ECB raids policy cupboard*	title	-	-1.54	AN_SLTROs
8/12/2011	36 month VLTROs and other measures	*European banks' shortfall at €115bn*	-	-	1.92	
26/7/2012	Mr. Draghi's Speech "Whatever it takes"	*Nomura axe falls on top staff*	No	title	-1.81	AN_OMT
6/9/2012	Details for the OMT	*ECB signals resolve to save euro*	title	-	-2.14	AN_OMT

Notes to Appendix AQ Column "Event" describes the policy announcement; "Financial Times Headline" indicates the title of the "top story" on the front page of the Financial Times; "Headline Article" indicates where the ECB action is mentioned in the top story on the front page of the Financial Times (title, subtitle or text); "Front page" indicates where the ECB action is mentioned on the front page of the Financial Times, if not in the "top story" (title, subtitle, main text).

Short bios

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