Energy and non-energy commodity prices and the Eurozone macroeconomy: a SVAR approach

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Abstract

This paper deals with the links between the real and financial processes in the euro area and energy and non-energy commodity prices. We use monthly data spanning from 1997:1 to 2013:9 and the structural VAR model to analyse the relations between global commodity prices and the Eurozone economy. The analysis is performed for three sub-periods in order to capture potential changes in the reactions in time. Our main finding is that though commodity prices are indeed related to real and financial processes in the euro area macroeconomy, the relations have not been stable in time: energy prices and interest rates have departed from the real processes in the pre-crisis period, whereas the relative importance of real and financial factors have changed for non-energy prices. Additionally, the relations between commodity prices have gradually become tighter, especially the ones running from energy to non-energy prices.

Keywords: *commodity prices, real economy, financial market, SVAR*

JEL Classification: C3, E37, E47, Q17 Q43

1. Introduction

Recent decades have been marked by considerable fluctuations in commodity prices, which, according to Frankel and Rose (2009), might have been caused by several factors including strong global growth (especially in China and India), easy monetary policy (low real interest rates or expected inflation), a speculative bubble and risk (geopolitical uncertainties). There are numerous articles devoted to the connections between commodity prices and financial or macroeconomic indicators. In most of them commodity prices are represented by oil prices and agricultural prices, while macroeconomic fundamentals include interest rates, inflation, exchange rates, industrial production or economic growth. Some researchers investigate the relationship between oil prices and economic growth (Cologni and Manera, 2009), between oil prices and inflation rates (Chen, 2009), and between oil prices and exchange rates (Śmiech and Papież, 2013). Akram (2009) and Frankel (1986, 2006) find evidence of a negative impact of interest rates on commodity prices, but Frankel and Rose (2009) and Alquist et al.

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(2011) do not find statistically significant relationships between real interest rates and oil prices. Tiwari (2013) argues that the relationship between oil prices and German industrial production is ambiguous. Papież and Śmiech (2012) analyze dependencies between the prices of crude oil and other commodities and financial investments. However, to the best of our knowledge, relationships between international commodity prices and Eurozone macroeconomy have not been addressed in any research paper so far.

The aim of the paper is the analysis of the relations between global commodity prices and the Eurozone economy in the period from 1997:1 to 2013:9. We want to include the elements of the real economy and financial indicators in Europe. That is why we analyse interdependencies between commodity prices and economic activity in the Eurozone (represented by industrial production) and financial conditions (represented by interest rates). The structural VAR model is used to investigate the relations, as it allows for their interpretation in economic terms.

It is assumed that relations between commodity prices and particular branches of economy are not stable. That is why the sample is divided into three sub-periods during which commodity prices behave differently. The period of the most drastic drops of prices caused by the global financial crisis is excluded from the analysis.

The paper contributes to the existing literature in several aspects. Firstly, it assesses mutual relations of international commodity prices and one of the biggest global economies – the Eurozone – which, to the best of our knowledge, has not been investigated so far. Secondly, it offers the comparison of the results obtained for various sub-periods, which allows for additional analysis and interpretations. Moreover, the analysis acknowledges the global financial crisis, which considerably influences the relations between commodity price and Eurozone macroeconomy. Finally, the analysis takes into account the prices of non-energy commodities, including dynamically developing market of biofuels and its impact on the relations investigated.

2. Data

To explore relationships between commodity prices, real economy and financial indicators in the Eurozone, we use monthly data from 1997:1 to 2013:9. The analysis is based on 4 series of variables. The first one is industrial production index (IP) in the Eurozone, which describes real economy in Europe. The second one is the 3-month interest rate in the Eurozone (IR), which describes financial economy. The data for both variables are taken from Eurostat database. The remaining two variables are commodity price indexes, that is the energy price index (PEN) and the non-energy price index (PNEN). The data for these variables are taken from the World Bank database. The energy price index (world trade-base weights) consists of crude oil (84.6%), natural gas (10.8%) and coal (4.6%). The non-energy price index consists of metals (31.6%), fertilizers (3.6%), and agriculture (64.8%). All series are expressed as indices with their average values in 2010 equalling 100, seasonally adjusted and specified in natural logarithms.

The whole sample period is divided into three sub-periods: 1997:1-2003:4, 2003:5-2008:9, and 2009:1-2013:9. The division is motivated by the disparate behaviour of commodity prices in these sub-periods. In the first sub-period the energy price index increases by 2.4%, while the non-energy price index decreases by 6.3%. In the second sub-period the energy price index increases by 12.3%, and non-energy price index increases by 23.1%. In the last period the corresponding changes are: 12.9% and 2.5% respectively. The division adopted is justified by certain important events. The end of our first period coincides with Bush's declaration that major combat operations in Iraq are over (May 1, 2003). The middle sub-period is the one of considerable increase in the nominal and real prices of commodities. The last sub-period starts at the beginning of 2009, since we have decided to omit the period of huge and sudden decrease in commodity prices (by 50 percent between September and December 2008), as it was related to the global financial crisis.

3. Methodology and empirical results

The empirical analysis is based on structural vector autoregression (SVAR) models proposed by Sims (1980). SVAR model can be written in the following form:

$$Ay_t = A_1 y_{t-1} + A_2 y_{t-2} + ... + A_p y_{t-p} + B\varepsilon_t , \qquad (1)$$

where $\varepsilon_t \sim (0, I_k)$, A is $k \times k$ invertible matrix of structural coefficients, which describes contemporaneous relationship among the variables in y_t, A_i $(i = 1,2,..., p)$ are $k \times k$ coefficient matrices describing dynamic interactions between the k-variables, and B is ($k \times k$) matrix of structural coefficients representing effects of k structural shocks.

3.1. Time series properties of the data

A preliminary analysis of the series is carried out before estimations of the main model. The standard augmented Dickey–Fuller (ADF) and KPSS unit root tests for both the intercept and the trends specifications[4] demonstrate that all variables have unit roots for each analysed sub-period[5]. Next, the presence of long-term relationship between integrated variables is investigated. The trace test statistics proposed by Johansen and Juselius (1990) is used[6]. Test results demonstrate some evidence of the presence of cointegration only in the first period. Since the length of the sample is not long, and there are four series in a vector of interests, a Monte Carlo experiment is performed and the empirical critical values of trace test are determined. We find that in such case null hypothesis of no cointegration is rejected too often[7]. Since the results of cointegration tests are at best ambiguous (if not suggesting the lack of cointegration), and the variables used are I(1), we use a VAR for first differences in our four variables[8].

3.2. Structural impulse response analysis

In order to identify SVAR model, we use the Choleski decomposition of the reduced form and assume that *A* is an identity matrix, while *B* is a lower triangular matrix. A four variable VAR is estimated with industrial production (ΔIP), real interest rate (ΔIR), energy prices index (ΔPEN) and non-energy price index (ΔPNEN). Industrial production index is set as the first variable in VAR because its adjustments to changes in other variables are assumed to require some time. Since the aim of this study is to examine the response of commodity prices to real and financial processes, we have decided to place them after industrial production and real interest rate. Here, we follow the ordering proposed by Akram (2009), although we have also checked the more conventional ordering with financial variable coming after commodity prices (for example, Hanson, 2004). Fig. 1-3 show the impulse responses results for structural one standard deviation innovations of industrial production index, real interest rates, energy price index and non-energy price index respectively for each analysed sub-period. For example, the first column of Fig. 1-3 illustrates the impulse response of each variable in the system to an innovation in industrial production index. The dashed lines correspond to plus or minus two standard errors around the impulse responses.

[4] The numbers of lags in the unit root and cointegration test (e.g. number of lags in VAR models) are established using AIC criterion.
[5] Detailed test results are available from the authors upon request.
[6] If the variables are co-integrated, the VAR in first difference would not be correctly specified, and the long run result would be very helpful in exploring the efficient parameters of short run dynamics.
[7] For detailed information contact the authors.
[8] For each sub-period number of lags for SVAR was established by AIC criterion - the lag length is one for the first and second sub-periods and two for the third sub-period.

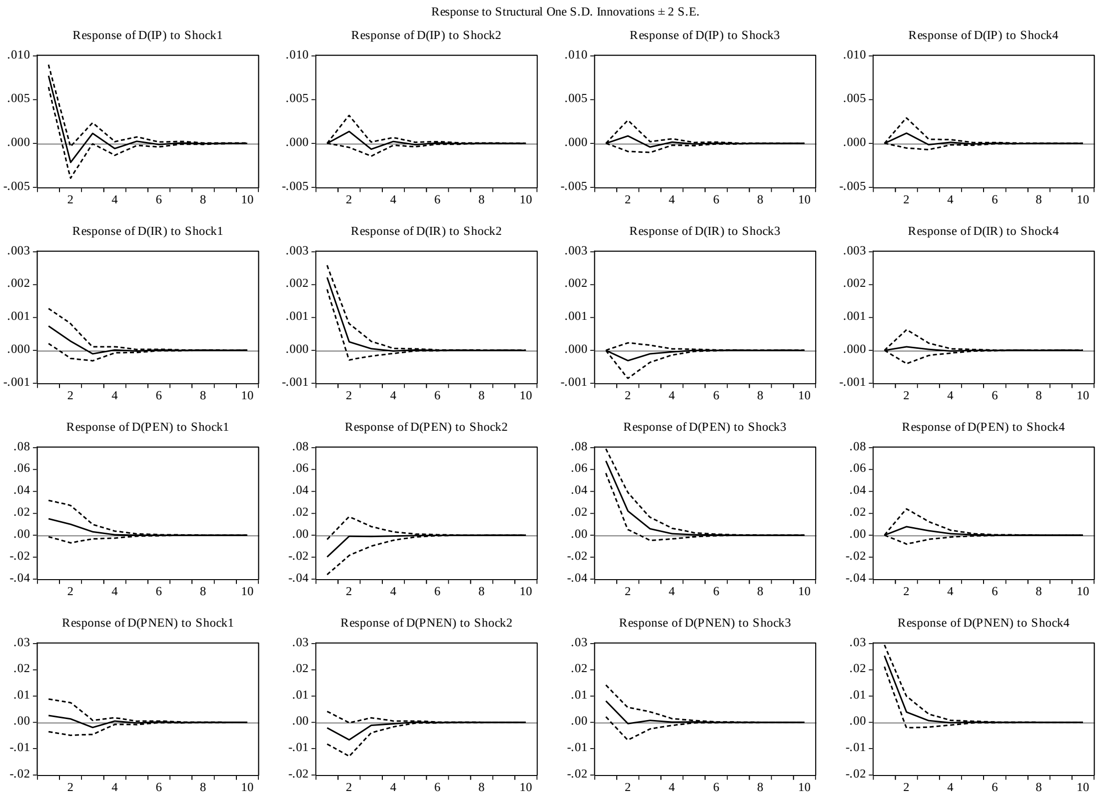

Fig. 1. The impulse-responses results in sub-period 1997:1-2003:4.

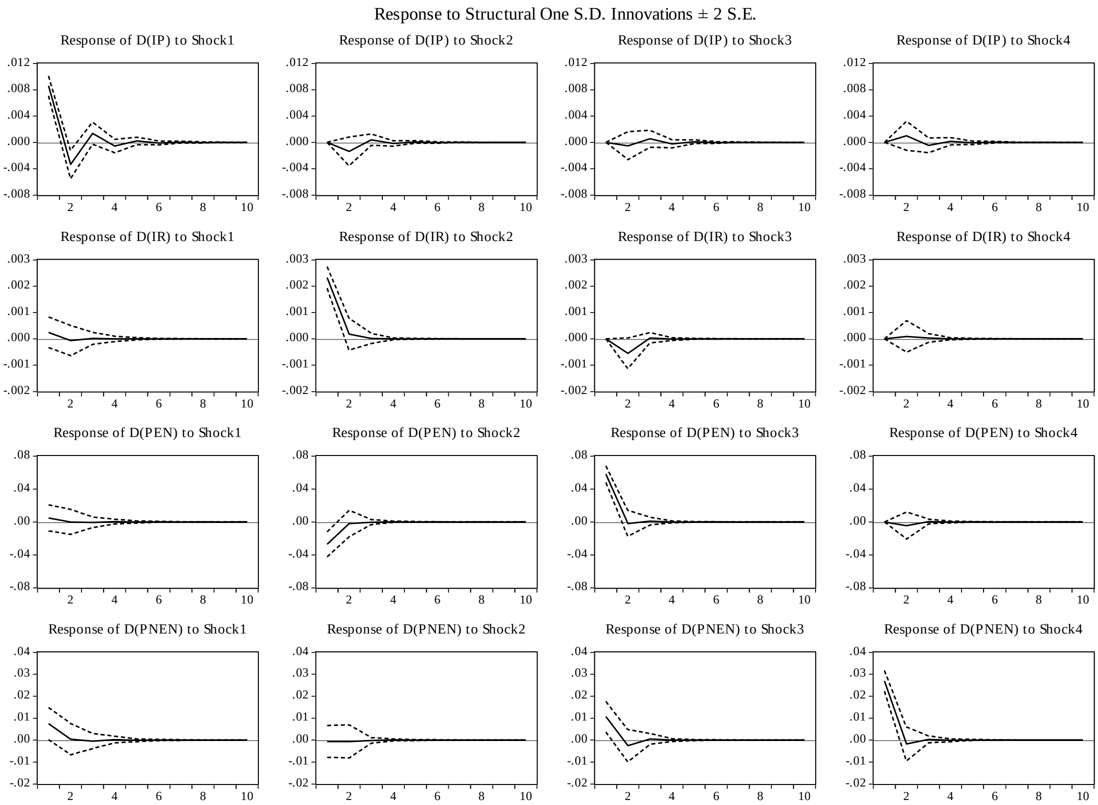

Fig. 2. The impulse-responses results in sub-period 2003:5 – 2008:9.

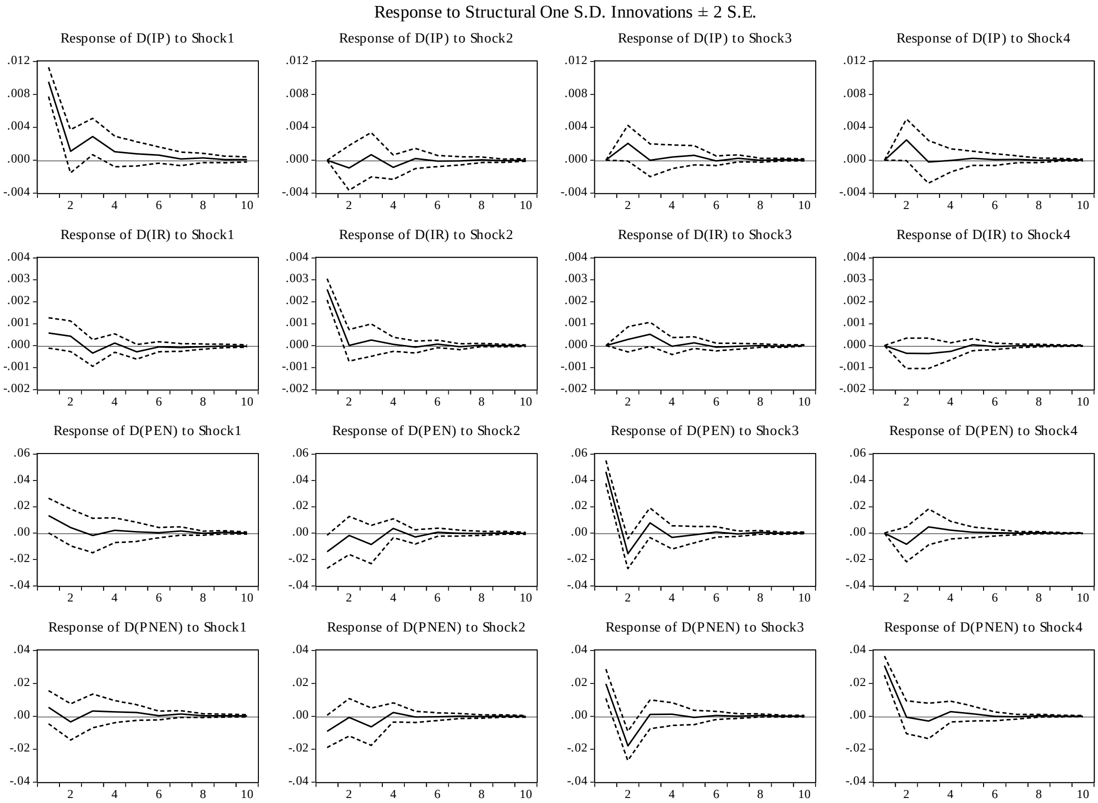

Fig. 3. The impulse-responses results in sub-period 2009:1 - 2013:9.

High economic activity triggered by a positive output shock leads to an increase in real interest rates and the price index of energy commodities. The former can be explained by an anti-inflationary orientation of the monetary authority: as output increases unexpectedly, the risk of inflation grows and monetary policy needs to be tightened. The latter is also a reasonable result, since the Eurozone can be treated as a large economy, so the developments in it are significant for the price of commodities.

Shocks to real interest rates do not depress industrial output (the response is statistically insignificant), yet they decrease the price index of energy commodities. This is consistent with Hotelling's rule that revaluation gains from storing a commodity (net of storage costs) are equal to nominal interest rates (Akram, 2009). Thus, an increase in the rate of interest, given expected future commodity prices, lowers the current commodity price. In other words, commodity prices can, to a large extent, be seen as asset prices (Svensson, 2006). It is interesting to observe that Hotelling's rule implies a negative correlation between commodity prices and interest rates, whereas the response to an output shock suggests a positive correlation. Thus, the relation is 'shock dependent' (Akram, 2009).

The non-energy price index responds positively to shocks in prices of energy commodities and to own shocks. Since the response ‘in the opposite direction’ is statistically insignificant (although positive as well), it can be concluded that the prices of non-energy commodities to a certain extent follow prices of energy commodities, but not vice versa.

Responses in the third sub-period are essentially the same. The only difference is that non-energy price index responds to real interest rate shocks, which makes them similar to the price index of energy commodities. There are more differences in the middle sub-period. Responses to output shocks of both real interest rates and prices of energy commodities are negligible. It seems that the importance of real shocks decreases in this period (although the non-energy price index reacts to output shocks), and that the price index of energy commodities and interest rates depart from the real processes, although not from one another. In fact, the response of the price of energy commodities to interest rate shocks is stronger in this period than in the two remaining periods.

One more observation can be derived from Fig. 1-3. The reaction of the price of non-energy commodities to shocks in the price of energy commodities has gradually increased from 0.008 to 0.020. This can be an indication of the developments in the biofuel market. Currently, the share of biofuels in transport fuel consumption in the EU is estimated at 5-6% (Demirbas, 2011).

Since it is well-known that ordering of variables can exert a considerable influence on the results, we have performed additional robustness check. Thus, we have adopted a conventional ordering with the rate of interest as the last variable. The results, however, have been basically the same[9].

3.3. Variance decomposition

Forecast error variance decompositions are presented in Table 1 for monthly changes in two commodity price indexes at three different time horizons (1, 3, and 12 months) in three sub-periods[10]. For both commodity price indexes own shocks account for the major part of the forecast error variance at all forecasting horizons. Output shocks and interest rate shocks make comparable contribution to fluctuations in the energy price index in the first and last sub-periods. This, however, is not the case in the middle sub-period, in which financial shocks

[9] Detailed results are available from the authors upon request.

[10] Results for longer time horizons do not differ from the 12 months horizon. Decompositions for (changes in) industrial production and interest rate are available from the authors upon request.

clearly dominate over real shocks. Since the proportion of forecast error variance of real interest rates account for output shocks, which also decrease substantially in this period in comparison to the previous one (10 versus 1 per cent; this is not reported in Table 1), the results lend support to our hypothesis that the price of energy commodities and interest rates depart from the real processes.

Sub-period	**Month**	**Variance decomposition of the real prices of energy ΔPEN**				**Variance decomposition of the real prices of non-energy ΔPNEN**			
		ΔIP	ΔIR	ΔPEN	ΔPNEN	ΔIP	ΔIR	ΔPEN	ΔPNEN
1997:1 – 2003:4	1	4.4	7.7	87.9	0.0	1.0	0.6	9.2	89.2
	3	5.7	6.8	86.2	1.3	1.6	6.3	8.5	83.6
	12	5.7	6.8	86.1	1.4	1.6	6.4	8.5	83.5
2003:5 – 2008:9	1	0.5	18.0	81.5	0.0	6.2	0.0	12.7	81.0
	3	0.5	17.9	81.1	0.5	6.2	0.1	13.3	80.4
	12	0.5	17.9	81.0	0.5	6.2	0.1	13.3	80.4
2009:1 – 2013:9	1	6.7	7.6	85.7	0.0	2.0	5.7	27.0	65.3
	3	6.2	8.9	81.8	3.1	2.9	6.8	38.8	51.5
	12	6.4	9.4	81.0	3.2	3.6	6.9	38.3	51.2

Table 1 Variance decomposition of the energy price index and the non-energy price index for each sub-period.

Interest rate shocks explain a similar proportion of variance of non-energy and energy price indexes in the first and last sub-periods. Again, the middle sub-period looks special in this respect: the relative role of production and financial shocks is a mirror image of that for energy prices. Perhaps the most interesting observation for fluctuations in non-energy prices is that the importance of energy price shocks more than quadruples between the first and last sub-periods. It seems that links between prices of non-energy and energy commodities have become tighter, which can possibly be connected with the rising importance of biofuels or/and heightened interest of investors in non-energy commodities. Because of the latter, the price of non-energy commodities might resemble asset prices.

Conclusion

We have used the SVAR model to examine the relations between commodity prices and both economic activity and financial conditions in the Eurozone. The latter is a large open economy, so it can be expected that the developments in the Eurozone will influence commodity prices.

Our main findings can be summarized in two observations. Firstly, commodity prices, as expected, are related to real and financial processes in the Eurozone macroeconomy. These relations, however, are stable in time. The link between energy price index and industrial production was quite loose before the global financial crisis and dominated by financial factors. It seems that the price of energy commodities and interest rates have departed from the real processes, although not from one another in this sub-period. Prices of non-energy commodities, in turn, are less influenced by financial factors than energy prices. Secondly, the relations between prices of non-energy and energy commodities have become tighter. A plausible explanation is connected with the rising importance of biofuels or/and heightened interest of investors in non-energy commodities.

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