The Macroeconomics Outcome of Oil Shocks in the Small Eurozone Economies

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Abstract. In this work we provide an analysis over the period 1999 - 2015 of the effects of oil shocks on prices and GDP in a group of small Euro-area economies. The group includes Austria, Belgium, Finland, Greece, Ireland, Italy, Netherlands, Portugal and Spain. We use the structural near-VAR methodology and are thus able to model the joint interaction of area-wide macroeconomic variables and national variables. We find that under the EMU oil price shocks have been important drivers of business cycle fluctuations in almost all these countries. Moreover, an increase in oil prices produces significant recessionary effects in all the countries included in the investigation. Thus, although there are different sizes in the responses of output in the investigated countries, our main conclusion is that oil prices (still) matter for European economies.

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1. Introduction

Recent years have experienced, once more, a large turmoil in the oil market. For, during the second semester of 2014 oil was still being sold at 110 dollars per barrel but by the end of 2015 the same commodity had lost more than 60 percent of its previous value and was traded at the minimum of 40 dollars per barrel. Even now, despite the recent price recovery, oil is still quoted between 50 and 60 dollars per barrel.

This sharp decline might be ascribed to factors acting through both supply and demand channels, and in fact researchers underline different aspects of the issue. Increased US production due to investments on fracking, sustained production in Libya and Iraq in spite of the unrests in these countries, the suppression of economic sanctions against Iran and, further, the stagnating European demand jointly with the slowdown of the Chinese economy all appear to be important factors capable of explaining the recent, sharp decrease in oil prices.

Demand side elements are, for instance, at the core of Baumeister and Kilian (2015). In this recent article the authors argue that the lower global economic activity of late 2014 is the main driver of the current movements in the price of oil. Others, like Davig *et al.* (2015), address the question to what is called "precautionary demand", *i.e.* the expectations over future supply and demand conditions, as news of persistently high future production might lower this kind of demand.

Oil shock effects have in fact been investigated since the first price rallies of the seventies. However, old but still open important macroeconomic questions, also in the light of the recent collapse of oil prices, are: How strong will the boost for GDP be? How long is the downward pressure on inflation going to last?

In this paper we investigate the macroeconomic outcomes of oil shocks in a group of small open Euro-area countries in the European Monetary Union (EMU) period. Indeed, there is a huge literature studying the effects of oil price shocks for the US economy, and to a lesser extent for OECD countries, but only very few papers have investigated the dynamic effects of oil price shocks in the national economies of the Eurozone.

Thus, in the present work we try to fill this gap in current literature by providing an analysis of the effects of oil shocks on the price level and on GDP for the small economies that founded the Eurozone. These countries include Austria, Belgium, Finland, Greece, Ireland, Italy, Netherlands, Portugal and Spain. Our dataset, based on quarterly data, goes from 1999 to 2015.

For this purpose, we make use of a structural near-VAR (vector autoregression) model in the spirit of Cavallo and Ribba (2015). This near-VAR structure implies that a first group of equations, *i.e.* the exogenous block, only includes the lags of the oil price and Euro-area variables. Instead, the second block consists of full-VAR equations, since it also includes national variables. In addition, in order to control for the global business cycle, we employ as exogenous variable the economic activity index developed by Kilian (2009). The structural disturbances are identified by imposing a causal structure, with contemporaneous restrictions in a Cholesky fashion.

It should be noted that this representation has the implication that each country is subject to the same set of oil and Euro-area shocks. Nevertheless, it is also important to stress that our assumption is that there is unidirectional, Granger-causation going from the

Euro-area variables to the national ones. For this reason, we exclude from our analysis large economies such as France and Germany for which the same hypothesis is somewhat more difficult to sustain.

Our findings show that oil price innovations transfer their effects on the consumer price index (CPI) very rapidly in the Euro area. The estimated maximum effect on CPI of a 10 percent unexpected increase in oil prices goes from 0.17 percent in Austria to 0.64 percent in Greece. On the other hand, the negative consequences on GDP come with some more delay but they are rather persistent.

Another important finding concerns the notable degree of heterogeneity in the responses of GDP in the Eurozone countries, since three years after a 10 percent increase in the price of oil, Austria and Belgium show a reduction of GDP, respectively, of 0.14 and 0.23 percentage points, whereas the same appreciation seems to be a more severe problem for Greece (-1.63 percent), Ireland (-1.13 percent), Spain (-1.40 percent) and Portugal (-0.52 percent). Somewhat in the middle we find the responses of Italy, Finland and the Netherlands.

As already stressed by Cunado and Perez de Gracia (2003), heterogeneous effects of oil shocks may pose some problems for the smooth functioning of the currency area, in particular for the difficulties of the central bank in fitting a common monetary policy in response to inflationary (or disinflationary) concerns ascribable to oil shocks.

Indeed our estimated effects seem to be consistent with the boost to the economy experienced in Spain and Ireland following the sharp decline of oil price over 2014 and the first months of 2015.

In regard of a medium economy like Italy, we also undertake a sensitivity analysis based on the estimation of a traditional VAR model with full interaction between local and area-wide variables and in which the structural shocks are identified by imposing sign restrictions on the responses of some variables. Indeed, the results obtained under this alternative approach are similar to those obtained by using the near-VAR approach (and the Cholesky strategy of identification).

We interpret this similarity of results as an indication that the block exogeneity restriction, imposed on the other Euro-area economies smaller than Italy included in this investigation, allows an appreciable characterization of the dynamic interaction of the national variables with the aggregate, Euro area variables and world variables.

The rest of this paper is structured as follows. Section 2 introduces a selected review of oil price shocks literature. The third section presents some descriptive statistics and stylized facts concerning the co-movements between the price of oil and the Euro-area countries macroeconomic variables. In section 4 we present the empirical model, based on the near-VAR methodology, and the identification strategy followed in order to recover the structural disturbances. Sections 5 and 6 are devoted, respectively, to the presentation of the impulse-response functions and the forecast error variance decomposition. In section 7 we undertake a robustness analysis, identifying by sign restrictions an alternative structural VAR model for Italy which allows full interaction between Euro-area and national variables.

Section 8 concludes.

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2. Literature review

An early and widely accepted explanation of the 70s stagflation comes from Blinder (1979). Blinder argues that a negative supply shift caused by an exogenous event like the Yom Kippur war or the Iranian revolution provides a good explanation for the stagflation, *i.e.* the simultaneous increase of inflation and unemployment and the associated decrease of output.

This has proven to be the most widely accepted interpretation of the facts of the midseventies, with a large number of academics endorsing this explanation, among whom may be quoted Hamilton (2003) for his influence on the topic. However, some authors have advanced critiques. For example, Barsky and Kilian (2002) maintain that the ultimate cause of inflation in the 1970s was an expansionary monetary policy. In other words, the oil shocks of the seventies are considered endogenous by the authors.

Other papers in line with the interpretation provided by Barsky and Kilian are, among others, Bodenstein *et al.* (2012), Kilian and Murphy (2012), Lippi and Nobili (2012) and Baumeister and Peersman (2013).

Prominently, Blanchard and Gali (2007) do not seem to worry too much about the question of possible endogeneity of oil price movements. In particular, in order to study the effects of oil price shocks on the economy of some selected OECD countries, they develop a six-variables VAR model, including the price of oil in dollars (expressed in log differences), CPI inflation, GDP deflator inflation, wage inflation, and the log changes in GDP and employment. Their oil-shock identification strategy is similar, in spirit, with other well-known papers (*e.g.* Bernanke *et al.* 1997) and consists in the assumption that unexpected variations in the price of oil are exogenous with respect to the contemporaneous values of the remaining macroeconomic variables contained in the VAR model.

Although they state that this identification strategy is surely incorrect if the examined countries affect the global price of oil, either because of the large size of their economies or because the path followed by their economy is strongly correlated with global developments, Blanchard and Gali are confident with this approach, since they find that the residuals in the oil price equations are correlated with "identifiable episodes of large supply disruptions or, in the more recent past, with increases in demand from emerging countries" (cf. Blanchard and Gali, 2007). For instance, an oil price increase driven by higher Chinese demand is thus taken as an exogenous oil supply shock for the other countries.

On the opposite side can be found Kilian (2009). The aim of the paper is in fact to give more attention to the issues of reverse causality from macroeconomic aggregates to oil prices and to deal in a different way with the fact that oil price is driven by both demand and supply shocks.

The author develops the VAR model using an index of global real economic activity that captures the demand for all the industrial commodities.

Kilian finds that an oil supply disruption causes a sharp decline in global oil production, while the increase in oil prices as well as the decrease of economic activity are only temporary and of small entity. Aggregate demand innovations lead to a higher level of economic activity for all the 15 months considered. Another important finding is that oil-specific demand shocks prove to have the largest and most persistent effect on oil prices and the impact on real activity is also significant until the 12th month.

Thus the research casts some doubts on macroeconomic models that are built on the assumption of exogenous oil prices and on the emphasis given to supply side shocks determining oil prices.

Cavallo and Wu (2009) stress the importance of the endogenous component of oil price shocks and suggest a new combination of the narrative and the quantitative approach. Their method is similar to Hamilton (1983).

The impulse response functions show that in response to the oil-price shock GDP declines steadily and in a significant manner whit the greatest response after 18 months; the consumer price level goes up immediately and remains constantly high for all the 24 months taken into consideration.

Cointegration techniques in order to study the long-run relation between energy consumption, real GDP growth and oil prices, have been used by Belke *et al.* (2011). Based on a sample of 25 OECD countries and by adopting panel-econometric methods, the authors conclude that international factors give the main explanation for the long-run equilibrium relation between energy consumption and GDP.

In a very recent article, Ratti and Vespignani (2016) investigate the interaction among oil prices and a set of global macroeconomic variables. By estimating and identifying a factor model with cointegrating relations, the authors find that an increase in oil price produces a significant increase in global interest rates. Moreover, there is evidence of bidirectional Granger causality between China and global economy.

To draw a temporary conclusion, a brief analysis of (part of) recent economic literature seems to illustrate that there is no strong consensus among researchers on how to deal with oil price endogeneity and on how far this effect accounts for the overall oil price fluctuations.

Instead, as far as the European economies are concerned, Blanchard and Gali (2007) show that with respect to the US economy, a positive oil shock (an unexpected increase in oil price) immediately reduces output in France, Germany, Italy and UK. The effect is significant and reaches its peak after 10 quarters.

The authors present estimates for two different samples, 1970:1-1983:4 and 1984:1-2005:4, under the hypothesis of a structural break around the mid-eighties. As for inflation, it rises and remains positive both pre- and post-1984.

Blanchard and Gali find some differences between the US and European countries, with France and UK exhibiting responses which are similar to those obtained for the US economy and, instead, with the responses of Italy and Germany that do not seem to fit the conventional wisdom so well.

Another study that investigates the role of oil price shocks for a large number of OECD countries, including European countries, is the one by Jimenez-Rodriguez and Sanchez (2005). The authors apply a VAR model comprehending seven variables whose measurements were gathered quarterly from 1972 to 2001. At first, the model is linearly estimated and the structural shocks are recovered by means of the Cholesky decomposition. The authors also allow for three different kinds of non-linear specifications. However, they show that the impulse-response functions in the linear and non-linear specification are qualitatively similar, with the former exhibiting, in the whole, a lower effect.

Thus, the results of Jimenez-Rodriguez and Sanchez (2005) are fairly in line with those seen in Blanchard and Gali (2007): on the whole, European countries face a lower reduction

of GDP than the US and the response of inflation varies widely across the sample with the UK and Germany being on the opposite sides.

Another contribution comes from Kilian (2008). In this paper, the effects of oil price shocks are examined for the G7 counties, and the identification of exogenous supply shocks is based on the following strategy. At first, Kilian recognizes that major oil price fluctuations are usually caused by exogenous political events in the Middle East. Kilian uses therefore as source of identification the observable changes in the production levels for oil-producing countries (both OPEC and non-OPEC ones) that are caused by exogenous events. These comprehend the Yom Kippur war of October 1973, the Arab oil embargo, the Iranian revolution, and so on until the Iraqi war of March 2003. In order to build a measure of exogenous oil supply shocks he then generates a counterfactual oil production level based on the extrapolation of "its pre-war production level based on the average growth rate of production in other countries that are subject to the same global macroeconomic conditions and economic incentives, but are not involved in the war" (cf. Kilian, 2008).

Impulse response functions are shown in the last part of his paper and assess the impact of a 10 percent exogenous reduction in global oil production on real GDP and CPI inflation. Kilian states that real GDP reaches the lowest value about 11 quarters after the shock, with a median cumulative effect for all countries being -5.9 percent. Moreover the median inflation peak comes three quarters after the exogenous oil supply disruption with a magnitude of 1.25 percent.

Kilians results thus match, in the whole, the conventional wisdom though with some peculiarities. For example, the effects on inflation obtained by Kilian contrasts the findings of both Jimenez-Rodriguez and Sanchez (2005) and Blanchard and Gali (2007): the price level of Germany is, in fact, the most reactive to oil shocks among European countries, while the UK is the last.

It is also worth quoting the work of Cunado and Perez de Gracia (2003). This is one of the very few papers that analyses the effect of oil price shocks focusing explicitly on a large number of European countries. The sample group comprehends all the current EU-15 countries, i.e. all the EU Member countries prior to 2004. Nevertheless, data collection goes from 1960 to 1999 with the sole exception of Portugal (1988-1999) and Denmark (1968-1999). Thus, the authors consider the pre-EMU period.

Cunado and Perez de Gracia estimate a trivariate VAR model using industrial production, inflation and the net oil price specification as a proxy for oil shocks. The structural model is identified by using the Cholesky decomposition. From analysis of the impulse response functions the following pattern emerges: countries of the ex-DeMark zone (Germany and its close neighbours), the UK and Ireland experience the sharpest reduction of industrial production, while the reduction of industrial production is more modest in France.

In the Southern-European countries instead the effect is significant only in a short span between the fourth and the sixth period, with the exception of Italy where the response function is never significant. Results for the Scandinavian countries of the sample (Finland and Sweden) also show an insignificant response function.

3. Some facts on the relation between oil prices and national macroeconomic aggregates

In this section we present, and briefly discuss, some descriptive statistics covering the period 1999 - 2015 and characterizing the relations between oil prices and national macroeconomic variables.

As shown in table 1, the correlation between the Brent price and the price level in all included countries and in the Euro area is very high: values range in fact from 0.79 to 0.96 in case of contemporaneous correlation and remain between 0.17 and 0.46 when we apply 16 lags. Indeed, for every country the highest correlation values are found at zero lags. Belgium and Greece show the highest values of correlation at almost every horizon. Another group of countries, represented by Spain, Portugal and Italy shows a very high correlation in all the five horizons of lags and leads. Austria, Finland, Netherlands and Ireland exhibit lower values with the notable case of Ireland that has the lowest contemporaneous correlation but the highest one after 16 lags.

Table 2 shows instead the correlations at various leads and lags for Brent price and real GDP growth.

The table shows that, in general, the correlations are lower than in the previous case. However in every country the numbers are negative to indicate that a higher oil price is associated with a lower output growth. Further, Brent price and GDP usually show their highest correlation from 8 to 12 lags. These results seem quite reasonable as oil price increases take some time to spread their full effects over the economy. Finally, cross comparison reveals that the countries under investigation are no longer concentrated in a small interval, as in the previous correlogram. Greece is still the country that exhibits the greatest correlation at all the horizons, whereas Belgium displays more moderate values of correlation. Again Spain, Portugal, Italy with the addition of Ireland, express notable levels of correlation while Austria, Finland and the Netherlands appear in the bottom-range group.

After observing, of course, the important co-movements between the price of oil and the selected macroeconomic variables at country level, the question of identifying the causal nexus among them remains open. To this end, in the next section we aim to undertake a more structural analysis in order to isolate oil price shocks and to quantify their relative importance in driving business cycle fluctuations both in the Euro area and in the small open economies included in the investigation.

Insert Table 1 about here

Insert Table 2 about here

4. The econometric approach

We estimate a near-VAR which includes seven endogenous variables. The reduced-form, near-VAR model is given by:

$$X_t = A(L)X_{t-1} + e_t \qquad [1]$$

where X_t is a 7×1 vector of macroeconomic variables, including both Euro-area and national variables, and e_t is the 7×1 vector of error terms, such that $E(e_t) = 0$ and $E(e_t e_t') = \Sigma_e$. More precisely, and in order to fix the notation, we have:

$$X_t' = (\, oil_t \;\; p_t \;\;\; y_t \;\;\; i_t - i_t^* \;\;\; \epsilon_t \;\;\; p_{it} \;\;\; y_{it} \,)$$

$A(L)$, the 7×7 matrix polynomial in the lag operator L, has the following structure:

$$
\begin{pmatrix}
A_{11}(L) & A_{12}(L) & A_{13}(L) & A_{14}(L) & A_{15}(L) & 0 & 0 \\
A_{21}(L) & A_{22}(L) & A_{23}(L) & A_{24}(L) & A_{25}(L) & 0 & 0 \\
A_{31}(L) & A_{32}(L) & A_{33}(L) & A_{34}(L) & A_{35}(L) & 0 & 0 \\
A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) & A_{45}(L) & 0 & 0 \\
A_{51}(L) & A_{52}(L) & A_{53}(L) & A_{54}(L) & A_{55}(L) & 0 & 0 \\
A_{61}(L) & A_{62}(L) & A_{63}(L) & A_{64}(L) & A_{65}(L) & A_{66}(L) & A_{67}(L) \\
A_{71}(L) & A_{72}(L) & A_{73}(L) & A_{74}(L) & A_{75}(L) & A_{76}(L) & A_{77}(L)
\end{pmatrix}
$$

We use quarterly data and the sample covers the period $1999 - 2015$.

This is a near-VAR model since there are two distinct blocks: in the first block, the equations of the Euro-area variables do not include lags of the national, macroeconomic variables; in the second block, the equations of the national variables instead include lags of all the variables of the dynamic system. Thus, this block exogeneity restriction implies that the national variables are unidirectionally caused by the Euro-area variables.[1]

In particular, the first block includes the following macroeconomic variables: the real price of oil, oil_t, Euro-area consumer price index, p_t; the real gross domestic product, y_t; the differential between the Eonia and the federal funds rate, $i_t - i_t^*$; the nominal exchange rate, ϵ_t, defined as US dollars per currency units.

The VAR equation concerning the differential between the Euro area and US short-term interest implies the adoption of a monetary policy reaction function of the ECB which takes into account the feature of open economy for the Euro area and the consequent, significant interaction with the monetary policy decisions made by the US central bank.[2] The stance

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[1] Cushman and Zha (1997) used a near-VAR to model the interaction between Canada and United States and in order to identify monetary politicy shocks. Peersman (2004) adopted this approach to study the effects of monetary policy shocks in a group of European countries in the pre-EMU period.

[2] Evidence of the significant interaction between the ECB and the Fed in the EMU period is provided, among others, in Scotti (2011) and Ribba (2014).

of monetary policy is measured by the short-term interest rates (cf. Bernanke and Mihov, 1998 and Taylor, 1999).

We point out that although we estimate nine different VAR models, one for each country, the set of the identified external, common shocks is invariant. This also allows the domestic dynamics, conditional on common disturbances, to be investigated.

The second block of the model comprises national series. These are the Consumer Price Index, p_{it}, and the real gross domestic product, y_{it}.

Oil prices, output, the consumer price index and the exchange rate enter the model in natural logs while the interest rate differential enters in basis points.

The estimated system also includes a constant and the global real economic activity index developed by Kilian (2009), as an exogenous variable which accounts for global business cycle.

The lag length is set to one, a choice consistent with the amount of observations available.

System [1] is estimated by using Seemingly Unrelated Regressions (SUR) methods (Zellner 1962). The impulse response functions together with the confidence bands are based on Monte Carlo integration techniques and the Gibbs sampling (cf. Doan, 2010).

Having obtained the reduced-form moving average representation of system [1]:

$$X_t = C(L)e_t \qquad [2]$$

where $C(0) = I$.

the structural near-VAR representation is recovered by imposing a contemporaneous recursive structure to the estimated VAR model:

$$X_t = B(L)\eta_t \qquad [3]$$

Where $B(L) = C(L)B$ and $\eta_t = B^{-1}e_t$. B is the Cholesky factor of Σ_e, $i.e.$ is the unique lower triangular matrix such that $BB' = \Sigma_e$.

As far as the exogenous block of the model is concerned, we impose that a monetary policy shock exerts a delayed effect on oil prices, the Euro-area price level and GDP; the demand shock has its effects on oil and Euro-area CPI restricted to zero in the contemporaneous period; the exchange rate does not exert a contemporaneous effect on all the other variables included in the first block of the VAR model.

As for the national block, our imposed restrictions imply that national prices do not react to change in the national aggregate output.

Thus, in order to identify oil price shocks, we adopt an identification strategy of the shocks similar to Blanchard and Gali (2007) and in the spirit of Bernanke *et al.* (1997).

5. Responses of prices and output to oil shocks

The responses of Euro-area and national variables to oil shocks are collected in two figures. Figure 1 reports the response of Euro-area prices and aggregate output and the responses concerning the same variables for the largest national economy included in our investigation, *i.e.* Italy. Figure 2 instead reports the responses of prices and GDP for the remaining countries.

As shown in figure 1, a positive oil price shock[3] causes an increase in the CPI, both in the Euro-area and in Italy, which lasts for around three years. Moreover, a 10 percent increase in oil prices produces its maximum effect on the CPI after one year following the shock, with a 0.22 percent increase in the Euro area and a 0.24 percent increase in Italy (cf. Table 3).

As for the response of aggregate output, there are significant recessionary effects associated with the oil shock: starting from the third quarter following the shock, output begins to decrease. These recessionary effects seem to be persistent, both in the Euro area and in Italy, since they last for a period of four years. The maximum effect on GDP is recorded twelve quarters after the increase in oil price, with negative values, respectively, of 0.33 and 0.38 (cf. Table 4).

Figure 2 presents the responses to positive oil shocks for all the other small Euro-area economies. The results are similar to those obtained for Italy and the Eurozone. More precisely, the response of national prices follows a quite similar pattern in all countries: in response to an unexpected increase in oil prices, there is a quick increase in the national CPI, which lasts from a minimum of one year (in Austria) to a maximum of four years (in Finland). Then, the response of prices becomes statistically non-significant. The effects on CPI are particularly notable in Greece, where at the horizon of nine quarters, a ten percent increase in the real oil price causes an increase in the CPI of 0.64 percent.

Instead, as far as the response of output is concerned, we find that more heterogeneity characterizes the Euro-area economies. Clear recessionary effects are shown in Ireland, Netherlands, Portugal and Spain. In Ireland after eighteen quarters there is a contraction around one percentage point in aggregate output, whereas in Spain, following a ten percent increase in oil price, after fourty months the economy shrinks by 1.40 percent. In the Netherlands and in Portugal the dynamic effects associated with the oil shock are unambiguously recessionary though characterized by a weaker decrease of aggregate output.

Although recessionary effects are also found in the other four national economies, for some quarters following the positive oil shock there is an increase, rather than a decrease, of GDP. In the case of Greece, the positive effects on output are statistically-significant for around two years. Nevertheless, Greece also exhibits the worst result in term of output contraction, since after twenty quarters GDP has a contraction equal to 1.63 percent.

On the whole, our results confirm the traditional interpretation of the dynamic effects exerted by oil shocks on nominal and real variables: following an increase in oil price, the associated increase in the price index of oil importing economies is almost immediate while the negative impact on output comes with some delay.

Maybe more surprisingly, the magnitude of the oil price shock effect is similar to those

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[3]The size of the shock is a 10 percent increase in real oil Brent price.

obtained by other researchers for sample periods preceding the start of the euro. For example Jimenez-Rodriguez and Sanchez (2005) by applying a non-linear model found that, after 12 quarters from a 10 percent increase in the price of oil, Italian GDP drops by 0.27 percent.

Our near-VAR structural model shows indeed that for the same time horizon, but for a more recent sample period covering the EMU, there is a decrease of 0.38 percent of GDP. Also the timing at which oil price shocks exert their maximum effect is similar to other papers in this area of research. For instance, Kilian (2008) found that the effect of a 10 percent exogenous reduction in global oil production on the real GDP of the G7 countries reaches its lowest level 11 quarters after the shock. In addition, the effect on inflation reaches its highest level around 3 quarters after the exogenous oil supply disruption. Instead, in our estimations the maximum effect of an oil price shock comes, for the majority of countries, after 12-15 quarters for GDP and after 2-3 quarters for the CPI. Although we observe some minor differences among countries we have again two close results.

Turning now to a comparison across countries we have already discussed the results by Cunado and Perez de Garcia (2003) who, over the period 1960 - 1999, found a higher response of output to oil shocks in the Northern-European countries such as Belgium, the Netherlands, UK and Ireland, a more modest reaction in Southern-European states. For the Scandinavian countries the effect was not significant.

Indeed, our results, covering a more recent sample data, are different: Ireland exhibits one of the strongest and most persistent output reduction after an oil shock and countries like Spain and Portugal follow suit. These differences might, at least partially, be explained by the adoption of alternative output measures (real GDP in our investigation and industrial production in Cunado and Perez de Gracia). However, one should consider that we are investigating over a sample period (1999 - 2015) in which all countries included in the VAR estimations shared a common currency and a common, single monetary policy regime, whereas Cunado and Perez de Gracia conducted their investigation over the pre-EMU period.

Insert Figure 1 about here

Insert Figure 2 about here

Insert Table 3 about here

Insert Table 4 about here

6. The relative importance of oil shocks as drivers of business cycle fluctuations

In this section we use the forecast-error variance decomposition to measure the relative importance of oil shocks as drivers of fluctuations in prices and output in the small Euro-area economies.

The error in forecasting X_t, for each horizon k, starting from structural representation [3], is given by:

$$X_{t+s} - E_t X_{t+s} = B_0 \eta_{t+s} + B_1 \eta_{t+s-1} + B_2 \eta_{t+s-2} + ... + B_{s-1} \eta_{t+1} \qquad [4]$$

Thus the variance of the forecasting error is given by the following equation:

$$Var(X_{t+s} - E_t X_{t+s}) = B_0 B_0' + B_1 B_1' + B_2 B_2' + ... + B_{s-1} B_{s-1}' \qquad [5]$$

In particular, we seek to investigate if oil shocks, among the various sources of fluctuations underlying our structural model, play a notable role in explaining the variability in domestic prices and output.

According to the overall results shown in tables 5 and 6, oil price shocks are an important component of both CPI and GDP fluctuations at the different horizons in all the investigated countries. For Austria, Italy, the Netherlands, Portugal and Spain, oil price shocks explain an important fraction of CPI fluctuations. Nevertheless they never account for more than 27 percent of total variance. On the contrary, in Greece, Ireland and Finland, although the peak is reached at alternative horizons, this percentage almost doubles.

As for the overall Euro area, at the horizon of four quarters around 26 percent of the variance of CPI is explained by oil shocks. Undoubtedly, a notable though not a pre-eminent part of the variability.

Table 6 shows instead the fraction of the forecast error variance of GDP that is attributable to oil price shocks. The (almost) surprising result is the pre-eminent role played by oil shocks as drivers of business cycle fluctuations in the small open Eurozone economies in the last 16 years. More precisely, in the Mediterranean countries and in Ireland, at horizons of six years from around 43 (in the case of Italy) to around 57 percent (in the case of Spain) of the variability of GDP is explained by unexpected movements in the prices of oil.

As far as the northern countries are concerned, they seem more aligned to the Euro-area average results, with a significant but not dominant part of the fluctuations attributable to oil shocks.

At the aggregate Euro-area level we find that a significant amount of the variablity of output, one-third, is explained by oil shocks.

Insert Table 5 about here

Insert Table 6 about here

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7. An alternative identification strategy based on sign restrictions

In this section we estimate a VAR model including the five variables of the exogenous block jointly with prices and output for the Italian economy. Thus we estimate a traditional VAR model, since the estimation of the equations for the price of oil and Euro-area variables now include lags of Italian variables. Having estimated the reduced-form VAR model, we will proceed to identify the oil shock by imposing sign restrictions on the responses of some variables.[4]

A presentation of the sign restrictions approach, in the context of a discussion of alternative identification schemes, is given in Canova (2007, chapter 4).

Let us start with the estimation of the reduced form of a VAR model of order 1:

$$X_t = A_1 X_{t-1} + e_t \qquad\qquad [6]$$

where vector X_t includes the five endogenous variables related to oil prices and the Euro area, $i.e.$ real Brent oil price, prices, aggregate output, the differential between the Eonia rate and the federal funds rate, the exchange rate, and the two Italian variables, $i.e.$ prices and aggregate output.

The covariance matrix of the vector of residuals, e, is given by Σ_e.

Then, the matrix Σ_e is randomly drawn from the posterior distribution of the matrix of the VAR coefficients. It is worth recalling that, in general, the relation between the vector of error terms, e_t, and the vector of exogenous shocks, ϵ_t, is given by: $e_t = F\epsilon_t$. Following Uhlig (2005), given $FF' = \Sigma_e$, we aim to identify an impulse vector, f, such that $f = F\alpha$, where $\|\alpha\| = 1$, by imposing sign restrictions consistent with some standard macroeconomic model. The important implication is that there exists a space of impulse vectors which are not at odds with the selected macroeconomic model. However, it is possible to restrict the set of impulse vectors by adopting a penalty function approach. In this estimation we will use a penalty function which is similar to the one introduced by Uhlig (2005).

In order to identify the oil shock, we impose a weak restriction and hence identify a positive increase in oil prices which lasts for two periods. Instead, the responses of the Euro-area and Italian variables are left free. Clearly, we are far from imposing a particular strait jacket on data.

As shown in figure 4, a positive oil shock shock provokes a recession both in the Euro area and in Italy. A persistent increase in prices is also detected. It is important to stress that both the qualitative profile of impulse-response functions and the size of the dynamic effects exerted by the oil shock on macroeconomic variables, are similar to those obtained in section 4.

Further, the forecast-error variance analysis (not reported) reveals that also the relative importance of oil shocks as drivers of business fluctuations, both in the Euro area and in Italy, does not significantly change by adopting the sign restrictions approach in the context of a full VAR specification of the model.

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[4]This approach was pioneered by Faust (1999), Canova and De Nicoló (2002) and Uhlig (2005).

Summing up: the robustness analysis conducted in this section on the dynamic effects of oil shocks seem to confirm the reliability of the results obtained by using the Near-VAR approach and the recursive identification strategy.

Insert Figure 3 about here

6. Conclusion

In this work we have tried to cast some light on the effects of oil price shocks on a selected group of small and medium Eurozone economies. As we have seen, oil price shocks and their consequences have been thoroughly investigated in modern economics. However, the peculiar case of the effects for Euro-area countries and a cross-comparison between them has been little investigated so far, in particular by isolating the EMU period.

We have contributed to this field of the economic literature by using a near-VAR model in the spirit of Cavallo and Ribba (2015). By applying this model, we have identified a set of common and invariant macroeconomic shocks and we have analysed the effects exerted by oil price shocks on national economies. We have thus chosen a linear and symmetrical model, trying to tackle the issue of potential oil price endogeneity using the global real economic activity index developed by Kilian (2009) as an exogenous variable which enters the near-VAR model. Moreover, we have also corroborated our findings by identifying oil price shocks for Italy applying a different VAR model that allows full interaction among variables.

The main finding of our empirical investigation is that oil prices still matters for the small European economies: business fluctuations are significantly influenced by fluctuations in oil prices.

Impulse response functions show that the pass-through from oil price innovations to the consumer price index is very fast in almost every European country. Differently, the negative impact on GDP is more delayed but quite persistent. In addition, as for the size of the dynamic effects on GDP, the Eurozone countries show a greater heterogeneity. The gross domestic product of Austria and Belgium shrinks after an increase in the price of oil, but the same appreciation can be a more serious problem for Ireland, Spain or Portugal. In between, we find the responses of Italy, Greece, Finland and the Netherlands.

The complementary analysis of the forecast error variance decomposition tends to reinforce the conclusion on the importance of oil shocks in explaining the variability of prices GDP in the various European countries under the EMU. In particular, as far as the aggregate output is concerned, in Ireland and the Mediterranean countries, at horizons of six years around half of variability of GDP is explained by oil shocks.

Nevertheless, we stress that our results seem to fit well with some recent economic facts, since after the sharp oil price decline going from mid-2014 to the beginning of 2015, Ireland and Spain have in fact experienced among the highest GDP growth rates in the first two quarters of 2016 of the Eurozone economies.

Our results partially differ from those obtained in some other previous works, as per Cunado and Perez de Gracia (2003). The authors, investigating a group of countries largely

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coincident with the one included in our investigation, but for the pre-EMU period, 1960 - 1999, found a modest response to oil shocks in Mediterranean countries. In our analysis, in fact, Spain, Portugal and Greece, in addition to some northern European countries such as Ireland, may potentially suffer the most from an oil price increase. However, one of the most important findings of Cunado and Perez de Gracia is largely confirmed by our study: the different size of the responses of output among the economies of EMU member-countries.

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Table 1. Measuring the co-movements between prices and oil prices.

	Lag					Lead				
	0	4	8	12	16	0	4	8	12	16
Euro Area	.85	.68	.56	.42	.27	.85	.83	.69	.51	.30
Austria	.82	.63	.50	.36	.20	.82	.85	.73	.57	.35
Belgium	.96	.60	.54	.39	.23	.96	.85	.71	.54	.34
Finland	.81	.61	.47	.32	.17	.81	.86	.74	.58	.38
Greece	.88	.75	.65	.49	.31	.88	.79	.63	.45	.26
Ireland	.79	.66	.62	.56	.46	.79	.69	.51	.30	.09
Italy	.85	.67	.55	.41	.26	.85	.83	.69	.51	.30
Netherlands	.82	.64	.53	.42	.28	.82	.81	.65	.47	.27
Portugal	.84	.69	.59	.46	.32	.84	.80	.62	.43	.24
Spain	.84	.70	.59	.46	.31	.84	.82	.66	.47	.26

Note: Cross correlations of Euro-area and national prices (HCPI) with the oil Brent price expressed in euro, at various leads and lags are reported for the period $1999:4 - 2015:4$.

Table 2. Measuring the co-movements between output and oil prices.

	Lag					Lead				
	0	4	8	12	16	0	4	8	12	16
Euro Area	-.24	-.25	-.38	-.41	-.28	-.24	-.48	-.23	-.13	-.08
Austria	-.11	-.09	-.26	-.32	-.24	-.11	-.43	-.27	-.22	-.14
Belgium	-.24	-.17	-.28	-.28	-.20	-.24	-.50	-.17	-.20	-.09
Finland	-.28	-.24	-.36	-.35	-.25	-.29	-.57	-.35	-.27	-.19
Greece	-.69	-.72	-.63	-.46	-.10	-.69	-.59	-.43	-.39	-.33
Ireland	-.41	-.46	-.58	-.61	-.51	-.41	-.37	-.16	-.03	-.07
Italy	-.33	-.30	-.38	-.38	-.29	-.33	-.59	-.28	-.12	-.09
Netherlands	-.25	-.30	-.40	-.39	-.28	-.25	-.37	-.17	-.04	-.10
Portugal	-.50	-.47	-.50	-.37	-.16	-.50	-.48	-.12	-.06	-.04
Spain	-.76	-.68	-.67	-.62	-.52	-.76	-.63	-.45	-.24	-.06

Note: Cross correlations of Euro-area and national aggregate output (real GDP growth) with the oil Brent price expressed in euro, at various leads and lags are reported for the period $1999:4 - 2015:4$.

Table 3. Estimated maximum effect of an oil price shock on Euro-area and national CPI.

	EA	AU	BE	ES	FI	GR	IR	IT	NE	PO
Maximum effect	0.22	0.17	0.25	0.33	0.33	0.64	0.25	0.24	0.17	0.25
Quarters	2	5	2	2	10	9	2	3	5	1

Note: The first row reports the maximum responses of prices in each country and in the Euro area to an oil shock. The size is a ten percent increase in the real oil Brent price. The second row indicates the number of quarters required to reach the maximum effect.

Table 4. Estimated maximum effect of an oil price shock on Euro-area and national GDP.

	EA	AU	BE	ES	FI	GR	IR	IT	NE	PO
Maximum effect	-0.33	-0.14	-0.23	-1.40	-0.48	-1.63	-1.13	-0.38	-0.26	-0.52
Quarters	13	13	12	40	15	20	18	13	13	15

Note: The first row reports the maximum responses of output in each country and in Euro area to an oil shock. The size is a ten percent increase in the real oil Brent price. The second row indicates the number of quarters required to reach the maximum effect.

Table 5. Fraction of the forecast error variance of prices attributable to the oil shock at different horizons.

Horizon	EA	AU	BE	ES	FI	GR	IR	IT	NE	PO
1	23.7	13.3	24.2	15.2	21.0	1.7	31.6	4.8	12.9	19.5
4	26.4	18.5	30.0	25.4	30.9	9.2	33.8	17.6	14.0	21.6
8	24.7	19.6	27.4	22.7	38.2	24.3	25.7	20.5	15.8	20.1
12	20.4	17.5	22.9	19.0	41.2	32.2	21.8	18.9	15.3	16.5
24	19.1	15.4	19.1	22.6	43.3	30.9	30.7	18.8	16.6	17.6

Note: For each country, the total variance of the forecast error for prices is computed and then decomposed in the part attributable to each structural shock (cf. formula [5]). The table presents the fraction of variability at various horizons which is due to the oil shock.

Table 6. Fraction of the forecast error variance of output attributable to the oil shock at different horizons.

Horizon	EA	AU	BE	ES	FI	GR	IR	IT	NE	PO
1	4.9	23.4	15.1	5.2	6.1	12.5	1.6	4.8	1.9	0.4
4	4.0	19.3	9.2	31.0	7.9	14.7	16.5	4.1	2.8	10.1
8	14.9	12.6	18.3	45.8	11.1	8.8	28.4	16.3	11.6	31.1
12	25.7	12.6	23.6	51.6	20.1	9.2	35.1	29.9	20.5	43.4
24	33.2	14.3	23.8	57.2	33.8	26.6	44.2	42.6	25.6	53.5

Note: For each country, the total variance of the forecast error for output is computed and then decomposed in the part attributable to each structural shock (cf. formula [5]). The table presents the fraction of variability at various horizons which is due to the oil shock.
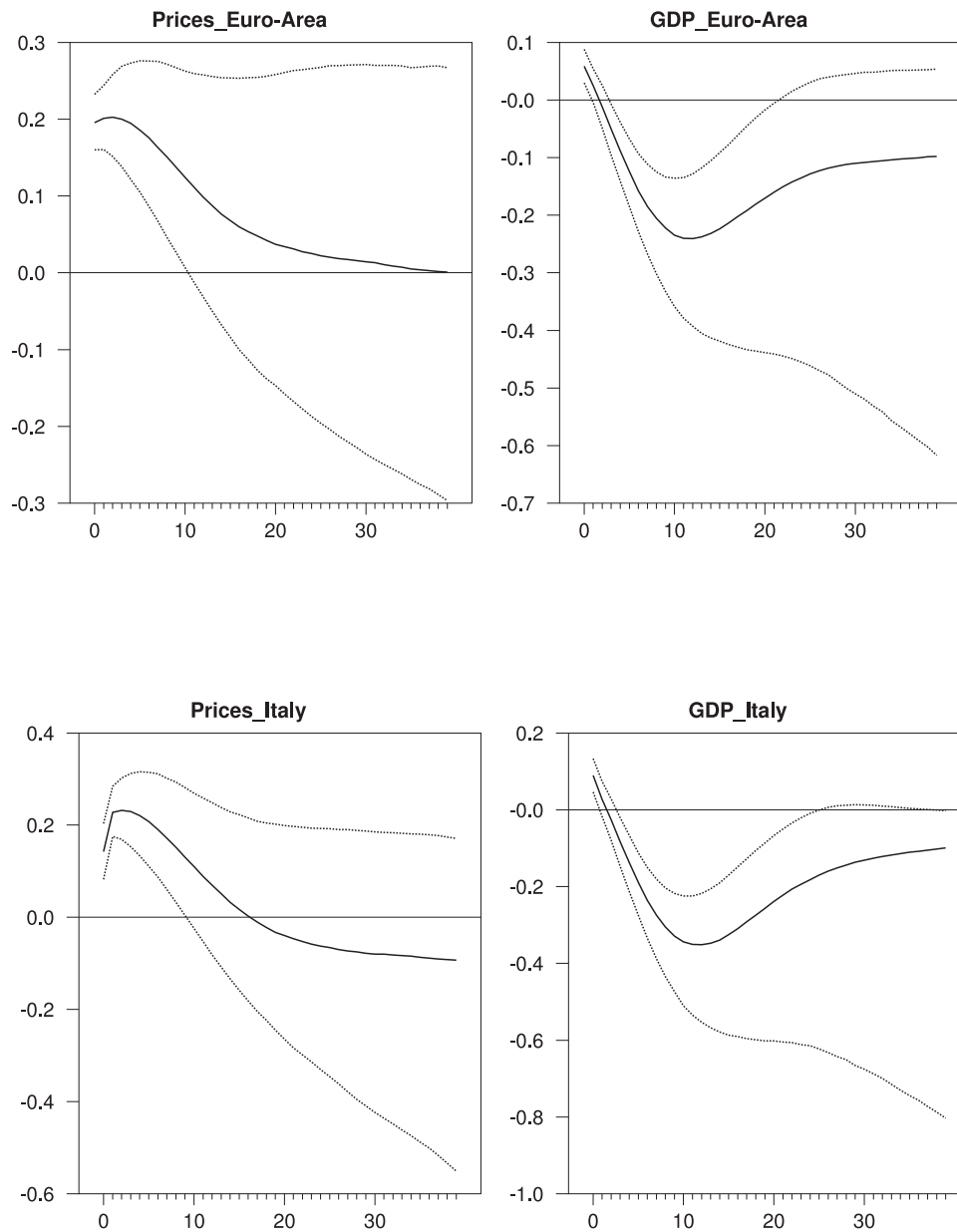
Figure 1. Responses of prices and aggregate output to a common, oil price shock. Results for the Euro area and Italy. Solid line: median estimate; dashed lines: 68th percent confidence interval.
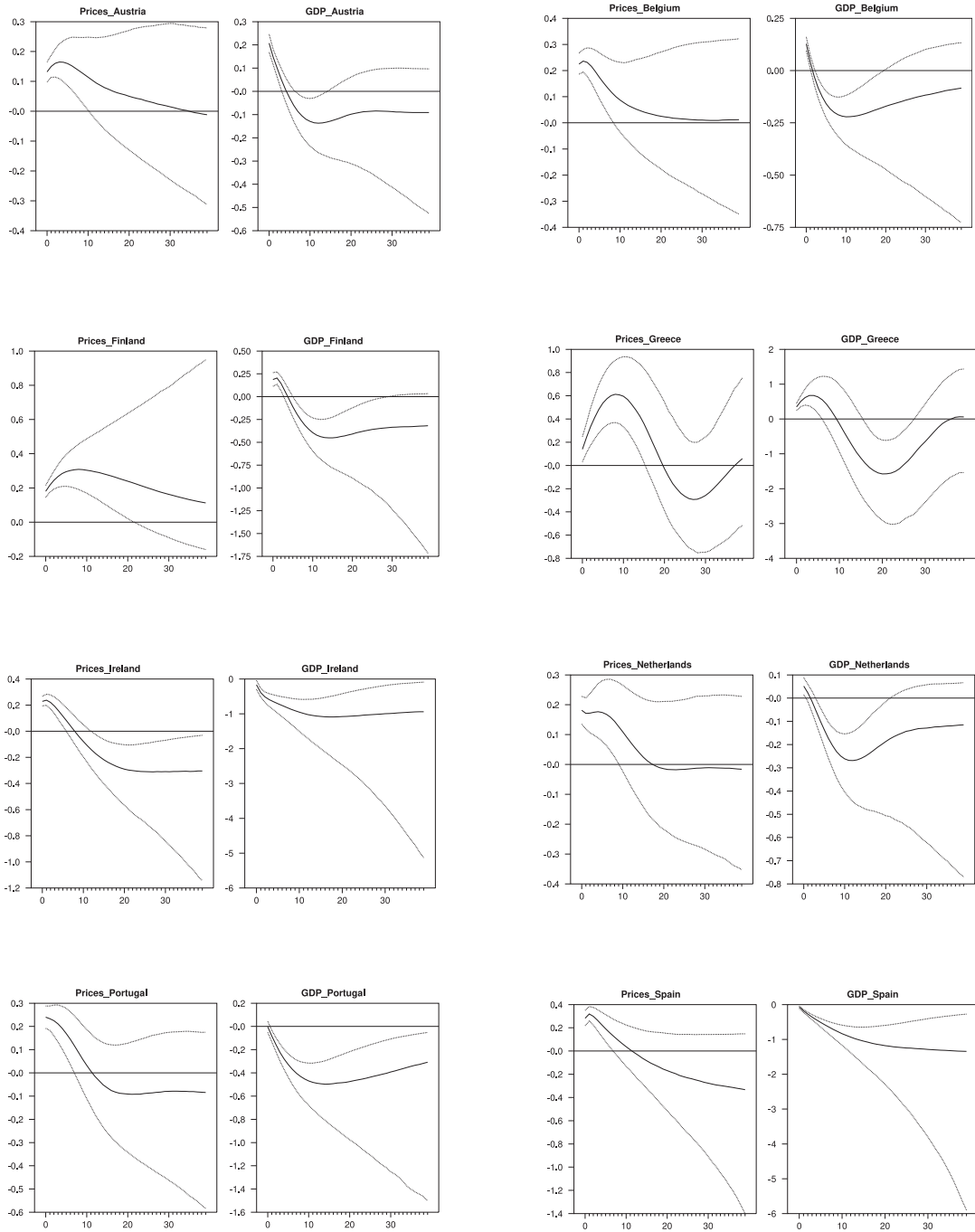
Figure 2. Impulse responses to a common, oil price shock. Responses of prices and GDP for the national economies. Solid line: median estimate; dashed lines: 68th percent confidence interval.
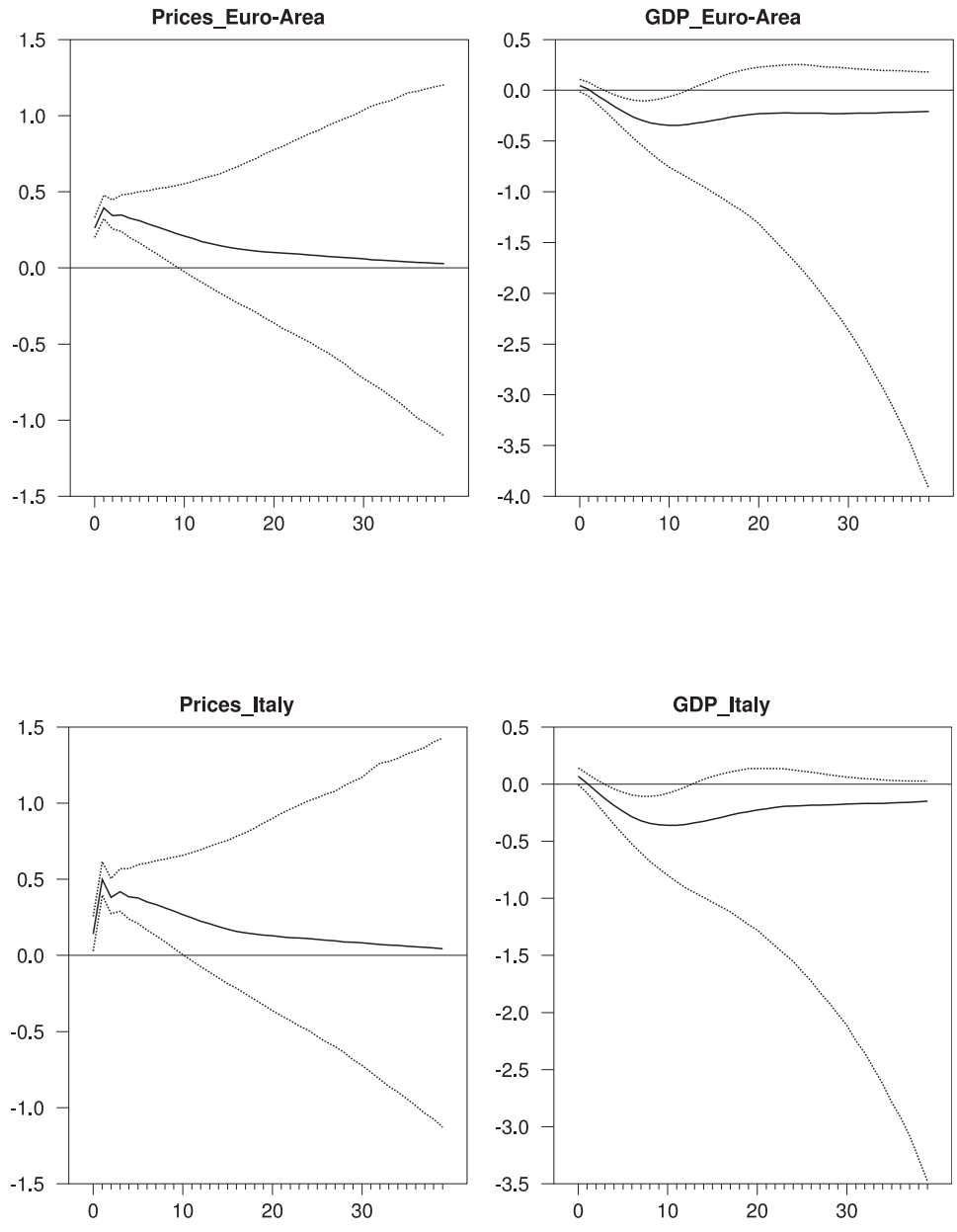
Figure 3. Responses of prices and aggregate output to an oil price shock. Results for the Euro area and Italy in the case of a full VAR with oil shock identified by sign restriction. Solid line: median estimate; dashed lines: 68th percent confidence interval.

Data Appendix

Oil Brent price: Data are collected from the US Energy Information Administration (EIA) database, quarterly frequency with aggregation based on the average. Original data are measured in dollars per barrel. We express the Oil Brent price in Euro by correcting for the US-Euro exchange rate. The effective global oil price measure which enters the VAR model is the real Brent oil price obtained by deflating the Brent Oil price (in Euro) with the GDP deflator. In turn, the GDP deflator is obtained from the OECD database.

Harmonized Consumer Price Index: Data come from the OECD database. The reference year is 2010 and the frequency is quarterly.

Real GDP: This variable is obtained by deflating the nominal GDP with the GDP deflator. Both variables come from the OECD database and are measured every quarter, with the first being the Gross Domestic Product obtained from the expenditure approach, expressed in current prices, national currency, quarterly levels and seasonally adjusted. The deflator is again obtained from the expenditure approach, 2010 as reference year and seasonally adjusted.

Interest rate differential: This variable is constructed as the difference between the European overnight interest rate (Eonia) and the Federal Funds Rate. The first one is found in the ECB dataset while the second in the FED database. Both are measured in quarters through the average of daily values.

Exchange rate: The exchange rate data comes from the FED database. It is expressed as US dollar in exchange for Euro. The monthly values have been aggregated to quarters through simple average.

Global real economic activity index: This index is developed in Kilian (2009); its download can be made from the website of Lutz Kilian: http://www-personal.umich.edu/ lkilian/paperlinks.html.