15. BÖLÜM / CHAPTER 15

THE COMMODITY PRICES SHOCKS ON ECONOMIC ACTIVITY IN THE PRESENCE OF A TRADING RELATIONSHIP: A GLOBAL VAR ANALYSIS

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ABSTRACT

This article uses the global vector autoregression (GVAR) approach to investigate commodity price shocks and monetary shocks. The study's focus is on commodity price shocks that affect both the total price level and variables related to monetary policy, such as short-term interest rates. In this paper, we address this issue using a framework comprising of 26 country/region-specific models, estimated over the period 1979Q2-2016Q4, with the Euro area considered as a single economy. We contribute to the energy-macroeconomics literature by using exogenous variations in energy and non-fuel commodity prices events over time and its effects on different regions to causally identify the effects of energy and non-fuel commodity prices shocks (directly and total) on key macro-economic variables such as growth, inflation, and significant macroeconomic variables. It is seen that there are significant heterogeneities in the reactions of different countries against energy prices shocks. Australia, New Zealand, Switzerland, and the United Kingdom face a short-term drop-in economic activity in response to the UK oil price shock, while it has a growth-enhancing effect for other countries (including Turkey, the United States and the Euro zone). The results show that commodity price shocks such as oil and metal have a huge impact on the real economy, with metal prices having a greater quantitative impact on output compared to oil prices. Given these findings, macro-economic policies should take into account the changes and effects of energy and non-fuel commodity prices.

Keywords: Oil and non-fuel commodity prices shocks, Global macro-econometric modelling, International business cycle

1. Introduction

Developments in commodity prices, particularly oil, are important to policymakers. A careful understanding of the commodity prices-economy relationship will help to design policies effectively. Commodity prices, which had been at unprecedented levels throughout 2008, fell abruptly in the wake of the financial crisis and the global economic downturn. By contrast, from early 2009, they first stabilised and then went on an upward path characterised by relatively high volatility. While commodity prices, particularly the price of oil, are an important component of the Consumer Price Index (CPI), their evolution and the driving forces behind them are clearly critical in the conduct of monetary policy, see Svensson (2005).

How do commodity price shocks affect real output, inflation, real effective exchange rates, interest rates and stock prices in different countries, including major oil exporters? The goal of analysing commodity prices is not only on the individual economies of the country, but also on the global economy and its individual effects on the economies of different countries. There is a wide range of literature on the impact of energy prices, particularly oil, on macroeconomic variables in which individual countries are addressed; see Kilian (2008) for a survey. By examining the issue on a global scale, however, there are fewer findings about the impact of oil and other commodity prices on macro-economic variables.

Our focus on movements in commodity prices is related to increasing concerns about impacts on both the global economic system and on the macroeconomics of countries with various economic structures. While uncertainties in energy and non-fuel prices could create severe inflation, they could trigger social unrest in countries dependent on commodity imports, particularly energy. It has been suggested that energy and non-fuel price shocks may even have played a role in severe economic dislocations, suggesting a causal link from higher energy prices to recessions, higher unemployment, and possibly inflation, see Aguiar-Conraria and Wen (2007). Considering economic interlinkages and spillovers that exist between different regions, we investigate the macroeconomic transmission of energy price shocks, both nationally and internationally; we employ a dynamic multi-country framework (including time series, panel data, and factor analysis techniques).

To this end, in this study we contribute to the literature evaluating the macroeconomic effects of energy and non-fuel price shocks in various dimensions. The effects of common factors that have been observed or not observed are considered by the modelling generated in the study. In this way, the relationship between energy and economy is defined from specific local properties (using both time series and cross–sectional dimensions). We introduce and

evaluate the global vector autoregressive model, an innovative econometric methodology. The GVAR approach is particularly attractive for analysis of the energy market worldwide for two reasons. First, it is specifically designed to model the interactions that exist between countries. This is a crucial feature given the characteristics of the world energy market, as well as the global dimension of the energy price crisis, which cannot be confined to one country. Second, GVAR allows us to model the dynamics of energy prices as the result of impacts from applying country-specific and foreign-specific variables. The rest of this paper is organised as follows. Section 2 presents a short review of literature focusing on the subject. Section 3 summarises the GVAR methodology by defining our modelling approach. Section 4 investigates the interactions of commodity prices with macroeconomic variables in our multi-country framework. Section 5 includes the result with some policy recommendations.

2. Literature

There is no widely accepted belief as to whether energy prices, especially crude oil prices, are endogenous or not. The concept of endogeneity expresses both the fact that energy prices affect a country's economy and the fact that there is reverse causation from components in the country's economy. The situation is like that of a global economy in the same way that it works in a country's economy. Clearly, global macroeconomic factors such as global real economic activity and interest rates influence both energy supply and energy demand; see Robert B. Barsky and Lutz Kilian (2002, 2004).

Much of the work in the literature focuses solely on oil prices, and often the impact of oil prices on the economy is explored. The effects of oil shocks on real output and real equity prices for the global economy are studied in several studies. Recently, some studies have attempted to extend the work on searching for effects of commodity prices by considering the global economy in terms of their impacts on real output and real equity prices. For instance, Hamilton (2009) examines similarities and differences between the run-up of oil prices in 2007-08 and earlier oil price shocks, looking at what caused the price increase and what effects it had on the economy. He uses econometric methods and finds evidence of oil price shocks having significant effects on overall consumption spending for the U.S.

Cashin et al. (2014) consider a Global VAR model of 38 countries/regions for the period 1979Q2-2011Q2. They apply the sign restrictions on the impulse responses of the model and find the economic consequences of a supply-driven oil-price shock as very different from those of an oil-demand shock driven by global economic activity and vary for oil importing countries compared to energy exporters. Mohaddes and Raissi (2016) consider the global

macroeconomic consequences of falling oil prices due to the oil revolution in the USA using a global VAR model. They find there are considerable heterogeneities in the responses of different countries to a US supply-driven oil price shock, with real GDP increasing in both advanced and emerging market oil-importing economies, output declining in commodity exporters, inflation falling in most countries, and equity prices rising worldwide for the period 1979Q2–2011Q2. In general, the literature states that the initial effects of oil price changes differ for countries. It shows that oil importers are taking advantage of the fall in oil prices and that oil exporters are losing out from the fall in price.

The purpose of this article is to contribute to the literature on world-scale economic activities using a global-scale model of other commodity prices, including oil. Understanding and evaluating this relationship is crucial because commodity prices are the forecasting model for the economy, allowing policymakers to determine whether commodity prices are overvalued. To accomplish this goal, we use the Global VAR model approach developed by Dees, et al., (2007). This approach provides the opportunity for global inference to consider the interaction between individual economies.

3. Modelling the commodity-macroeconomics relationship at the global level

The rest of the article uses the GVAR methodology to analyse the international macroeconomic transmission of shocks in energy prices. Within this framework, not only temporal but also cross-sectional dimensions of the data are considered; interrelationships that may exist between different countries and regions; effect of non-observable and observable common factors[1]. This is crucial as the impact of shocks in energy prices cannot be limited to a single country but will involve multiple regions instead. Depending on the degree of openness and trade structure of the countries, this effect may increase or decrease.

The models estimated as vector autoregression that contain individual characteristics of several countries' economies are combined to form the GVAR model. Foreign-specific and global variables related to each country's international export models are included in linking individual models to each other. For the individual country model, weak exogeneity properties are a test for both specific foreign and global variables. The small economy hypothesis applies to each country, and therefore it is understood that energy prices are determined in the world market. Before defining the data and model specification, we provide a brief description of the GVAR approach used.

1 For a global unobserved common factor model, Dees et al (2007) derives GVAR as an approximation, and states that this method is highly effective when it comes to international collaborations of common factor dependencies and business cycles.

3.1. The Global VAR (GVAR) methodology

Indexed by $i = 0,1,\ldots,N$, there are $N + 1$ countries in the global economy. The United States is considered the reference country and labelled with 0. Besides this, other countries are modeled as small open economies, except for the United States. The GVAR approach is a four-step analysis. In the first step, $t = 1,2,...,T.$, a *VAR* model with exogenous variables (*VARX**) containing both domestic and foreign variables is established for each of the $N + 1$ countries. A set of individual *VARX** models forms the GVAR framework. A *VARX** (p_i,q_i) model incorporates $k_i \times 1$ vector of domestic variables for country i in period t, $\boldsymbol{x}_{it}$, and $k_i^* \times 1$ vector of domestic variables for country i in period t, $\boldsymbol{x}_{it}^*$[2]. The *VARX** (p_i,q_i) model is given below:

$$\boldsymbol{\phi}i\ (L, p_i\ )\ \boldsymbol{x_{it}} = \boldsymbol{a_{i0}} + a_{i1}\ t + \boldsymbol{\Lambda_i}\ (L, q i\ )\ \boldsymbol{x_{it}^*} + \mathbf{u_{it}} \tag{3.1}$$

where $\boldsymbol{a_{i0}}$ and $\boldsymbol{a_{i1}}$ are $k_i \times 1$ vectors of fixed intercepts and coefficients on the deterministic time trends, respectively. Finally, country-specific shocks are $\boldsymbol{u_{it}}$, is a $k_i \times 1$ error vectors, which are assumed to be serially uncorrelated with zero mean and has a non-singular covariance matrix, $\boldsymbol{\Sigma_{ii}}$, time invariant covariance matrix, namely $\boldsymbol{u_{it}} \sim IID(0, \boldsymbol{\Sigma_{ii}})$. In addition, matrix lag polynomials of coefficients are $\boldsymbol{\phi_i}\ (L,p_i) = I - \sum_{i=1}^{p_i} \boldsymbol{\phi_i} L^i$ and $\boldsymbol{\Lambda i}\ (L, q_i\ ) = I - \sum_{i=1}^{q_i} \boldsymbol{\Lambda_i}\ L^i$, belonging to domestic and foreign variables, respectively. The coefficients, p_i and q_i, can be selected on a country-by-country basis, so $\boldsymbol{\phi_i}\ (L,p_i\ )$ and $\boldsymbol{\Lambda_i}\ (L,q_i\ )$ are allowed to differ across countries.

The GVAR methodology is extended by Chudik and Pesaran (2013) to a situation where common variables are added to conditional country models (as observed global factors or dominant variables). In this case, Eq.(3.1) is augmented by the vector of dominant variables, $\boldsymbol{\omega_t}$, and its lag values:

$$\boldsymbol{\phi_i}\ (L, p_i)\ \boldsymbol{x_{it}} = \boldsymbol{a_{i0}} + \boldsymbol{a_{i1}}\ \boldsymbol{t} + \boldsymbol{\Lambda i}\ (L, q_i\ )\ \boldsymbol{x_{it}^*} + \boldsymbol{Y_i}\ (L, s_i)\ \boldsymbol{\omega_t} + \boldsymbol{u_{it}} \tag{3.2}$$

where $\mathbf{Y_i}\ (L, s_i) = \sum_{i=0}^{s_i} \mathbf{Y_i}\ L^i$ is the matrix lag polynomial of the coefficients of the dominant units.

In the second step, the country-specific foreign variables are obtained from cross-sectional averages of domestic variables using binary trade data as weights,w_{ij}:

$$\boldsymbol{x_{it}^*} = \sum_{j=0}^{N} w_{ij}\ \boldsymbol{x_{jt}} \tag{3.3}$$

where $j = 0,1,\ldots, N$, $w_{ii} = 0$, and $\sum_{j=0}^{N} w_{ij} = 1$[3]. In practice it is often taken on a three-year average in trading weights[4]:

2 For detailed theoretical framework of these models, see Pesaran et al. (2004) and Dees et al. (2007).

3 In the presence of unobserved common shocks in the GVAR model, country-specific foreign variables act as proxies for these potential factors. This is confirmed by the Monte Carlo experiments in Kapetanios and Pesaran (2007), where the estimators that make use of cross-section averages out-perform other estimators based on principal components.

4 Baxter and Kouparitsas (2005) displays the use of binary trading weights to be the most important determinant of national business cycle co-movements.

$$w_{ij} = \frac{T_{ij,2012}+T_{ij,2013}+T_{ij,2014}}{T_{i,2012}+T_{i,2013}+T_{i,2014}}, \tag{3.4}$$

$T_{ij,t}$ is calculated as the average of exports and imports of country i with j and the bilateral trade of country i with country j for a given year. For all countries included in the data set: t = 2012, 2013 and 2014, $T_{it} = \sum_{j=0}^{N} T_{ijt}$ (total trade of country i). $\boldsymbol{\omega_t}$, $m_{\omega} \times 1$, is considered weakly exogenous for the purpose of estimation and testing. In estimating the marginal model for dominant variables, feedback effects from $\boldsymbol{x_{it}}$ can be used. To allow feedback effects to dominant variables, cross-sectional averages of the variables contained in the GVAR model are utilised:

$$\boldsymbol{\omega_t} = \sum_{l=1}^{p_{\omega}} \boldsymbol{\phi_{\omega l}}\, \boldsymbol{\omega_{t-l}} + \sum_{l=1}^{p_{\omega}} \boldsymbol{\Lambda_{\omega l}}\, \boldsymbol{x^{*}_{i,t-l}} + \boldsymbol{\eta_{it}} \tag{3.5}$$

In this equation, the contemporaneous values of the star variables are not included and $\boldsymbol{\omega_t}$ is "causal".

In the third step, all variables are transferred endogenously to the system, although estimation is done on a country-by-country basis. Conditional (Eq. (3.1)) and marginal models (Eq. (3.2)) are solved by taking place together within a complete GVAR model. Let $\boldsymbol{y_t} = (\boldsymbol{\omega_t'}, \boldsymbol{x_t'})$ be the vector of all observable variables in the dimension of $(k + m_{\omega}) \times 1$:

$$\boldsymbol{G_{y,0}}\, \boldsymbol{y_t} = \sum_{l=1}^{p} \boldsymbol{G_{y,l}}\, \boldsymbol{y_{t-l}} + \boldsymbol{\varepsilon_{yt}}, \tag{3.6}$$

where $\boldsymbol{\varepsilon_{yt}} = (\boldsymbol{u_t'}, \boldsymbol{\eta_t'})'$,

$$\boldsymbol{G_{y,0}} = \begin{pmatrix} \boldsymbol{I_{m_{\omega}}} & \boldsymbol{0_{m_{\omega} \times k}} \\ \boldsymbol{D_0} & \boldsymbol{G_0} \end{pmatrix}, \boldsymbol{G_{y,l}} = \begin{pmatrix} \boldsymbol{\Phi_{\omega l}} & \boldsymbol{\Lambda_{\omega l}} \widetilde{\boldsymbol{W}}_{\omega} \\ \boldsymbol{D_l} & \boldsymbol{G_l} \end{pmatrix}, for\ l = 1,2, \dots, p,$$

$\boldsymbol{D_l} = (\boldsymbol{D'_{1l}}, \boldsymbol{D'_{2l}}, \dots, \boldsymbol{D'_{Nl}})$^' for =1,2,…,$p$, $p = max_i \{p_i, q_i, s_i, p_{\omega}, q_{\omega}\}$.. Pesaran (2015) displays that matrix $\boldsymbol{G_{y,0}}$ is invertible if and only if $\boldsymbol{G_0}$ is invertible. In the fourth step, multiplying both sides of (3.5) by $\boldsymbol{G^{-1}_{y,0}}$,

$$\boldsymbol{y_t} = \sum_{l=1}^{p} \mathbf{F_l}\, \boldsymbol{y_{t-l}} + \boldsymbol{G^{-1}_{y,0}}\, \boldsymbol{\varepsilon_{yt}}, \tag{3.7}$$

where $\boldsymbol{F_l} = \boldsymbol{G^{-1}_{y,0}} \boldsymbol{G_{y,l}}$ for l = 1,2,…, p..

a. Model Specification

By combining global quarterly econometric models developed in Mohaddes and Pesaran (2016) and Dees et al (2007), we use them to investigate the transfer of commodity prices in the global economy, particularly in oil prices. Since commodity prices, especially oil, are modelled separately from country-specific vector autoregressive models, a commodity-oil price equation that considers global demand conditions is in line with our goals. The Model covers 33 countries, where 8 of the 11 countries that joined the euro on 1 January 1999 were grouped together, and the remaining 25 countries are modelled separately (see Table 1). This framework was first advanced by Pesaran et al. (2004). Thus, 26 countries / regions are examined:

Table 1
Countries and regions in the GVAR model

USA	Sweden	Euro area	Brazil
China	Switzerland	Germany	Mexico
Japan	Norway	France	Argentina
UK	Thailand	Italy	Chile
Canada	Philippines	Spain	Peru
Australia	Malaysia	Netherlands	India
New Zealand	Singapore	Belgium	South Africa
Korea		Austria	Turkey
Indonesia		Finland	Saudi Arabia

Through this approach, both the direct exposure of countries to shocks and their indirect effects through secondary and tertiary channels are considered and analysis of the international macroeconomic transfer of the effects of country-specific shocks is provided. As mentioned in Section 3, we combine 8 European countries in our sample. Purchasing power parity GDP weights are used for the European bloc based on the years 2012-2014. Thus, as can be seen from Table 1, the model addresses 33 countries (with models specific to 26 countries/ regions), covering 90% of the world GDP. The model examines the period 1979(2)-2016(4). Variables found in the current version of GVAR are as evaluated by Dees et al., (2007). More specifically, the following variables are taken in the study:

Table 2
Variables and Descriptions[5]

y_{it}	real output
π_{it}	the rate of inflation
$(e_{it} - p_{it})$	the real exchange rate
q_{it}	real equity prices
ρ_{it}^{s}	short term interest rate
ρ_{it}^{L}	long term interest rate
p_t^0	oil price
p_t^{mat}	raw material price
p_t^{metal}	metal price

Table III summarises domestic and foreign variables in country-specific models.

Table 3
Domestic and foreign variables included in the country-specific models

Variables	**All countries excluding US**		**US**	
	Endogenous	**Foreign**	**Endogenous**	**Foreign**
Real output	y_{it}	y_{it}^{*}	$y_{US,t}$	y_{it}^{*}
Inflation	π_{it}	π_{it}^{*}	$\pi_{US,t}$	π_{it}^{*}
Real exchange rate	$(e_{it} - p_{it})$	-	-	$(e_{it} - p_i)$
Real equity price	q_{it}	q_{it}^{*}	$q_{US,t}$	q_{it}^{*}
Short-term interest rate	ρ_{it}^{s}	ρ_{it}^{s*}	$\rho_{US,t}^{s}$	ρ_{it}^{s*}
Long-term interest rate	ρ_{it}^{L}a	ρ_{it}^{L*}	$\rho_{US,t}^{L}$	ρ_{it}^{L*}
Oil price	-	p_t^0	-	p_t^0
Raw Material price	-	p_t^{mat}	-	p_t^{mat}
Metal price	-	p_t^{metal}	-	p_t^{metal}

Note: Time series data is generated for the eurozone using average purchasing power parity GDP weights calculated over the period 2012-2014: Germany, France, Italy, Spain, The Netherlands, Belgium, Austria and Finland.

5 Detailed information about the variables is included in Appendix A.

Table 4
Lag orders of the country-specific VARX (p_i,q_i) models together with the number of cointegrating relations*

	VARX* **order**		**Cointegrating relations (r_i)**
Country	p	q	r
ARGENTINA	4	4	4
AUSTRALIA	3	1	4
BRAZIL	4	4	2
CANADA	4	4	4
CHINA	4	4	3
CHILE	4	1	3
EURO	4	4	4
INDIA	4	4	4
INDONESIA	3	1	2
JAPAN	2	2	3
KOREA	4	4	5
MALAYSIA	3	1	3
MEXICO	4	4	3
NORWAY	2	1	3
NEW ZEALAND	4	3	4
PERU	4	4	3
PHILIPPINES	4	1	3
SOUTH AFRICA	2	1	2
SAUDI ARABIA	3	1	2
SINGAPORE	3	1	1
SWEDEN	3	4	4
SWITZERLAND	4	4	3
THAILAND	4	4	2
TURKEY	2	2	2
UNITED KINGDOM	4	4	4
USA	3	3	2

Note: p_i and q_i denote the lag order for the domestic and foreign variables respectively and are selected by the Akaike Information Criterion (AIC). The number of cointegrating relations (r_i) are selected using the maximal eigenvalue test statistics based on the 95% simulated critical values computed by stochastic simulations and 1000 replications for all countries.

Table V. Trade weights averages over 2012-2014

Country	ARGENTINA	AUSTRALIA	BRAZIL	CANADA	CHINA	CHILE	EURO	INDIA	INDONESIA	JAPAN	KOREA	MALAYSIA	MEXICO	NORWAY	NEW ZEALAND	PERU	PHILIPPINES	SOUTH AFRICA	SAUDI ARABIA	SINGAPORE	SWEDEN	SWITZERLAND	THAILAND	TURKEY	UNITED KINGDOM	USA
ARGENTINA	0.00	0.00	0.09	0.00	0.01	0.04	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AUSTRALIA	0.01	0.00	0.00	0.00	0.05	0.01	0.01	0.03	0.03	0.06	0.04	0.04	0.00	0.00	0.20	0.00	0.02	0.02	0.01	0.04	0.01	0.01	0.04	0.01	0.01	0.01
BRAZIL	0.30	0.00	0.00	0.01	0.05	0.07	0.03	0.02	0.01	0.01	0.02	0.01	0.01	0.03	0.00	0.06	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
CANADA	0.02	0.01	0.02	0.00	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0.05	0.01	0.02	0.01	0.00	0.01	0.01	0.01	0.01	0.02	0.20
CHINA	0.14	0.31	0.22	0.08	0.00	0.25	0.16	0.15	0.16	0.26	0.29	0.18	0.10	0.05	0.21	0.25	0.15	0.19	0.17	0.16	0.06	0.06	0.18	0.13	0.08	0.18
CHILE	0.04	0.00	0.02	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
EURO	0.16	0.09	0.21	0.06	0.16	0.14	0.00	0.16	0.08	0.09	0.08	0.10	0.07	0.45	0.10	0.14	0.11	0.26	0.13	0.10	0.14	0.52	0.08	0.46	0.50	0.14
INDIA	0.02	0.03	0.05	0.01	0.03	0.02	0.03	0.00	0.05	0.01	0.02	0.04	0.01	0.00	0.01	0.02	0.01	0.06	0.10	0.04	0.01	0.04	0.02	0.05	0.02	0.02
INDONESIA	0.02	0.03	0.01	0.00	0.03	0.00	0.01	0.04	0.00	0.05	0.04	0.05	0.00	0.00	0.02	0.00	0.04	0.01	0.01	0.11	0.00	0.00	0.05	0.01	0.00	0.01
JAPAN	0.02	0.15	0.04	0.03	0.12	0.08	0.04	0.04	0.15	0.00	0.12	0.12	0.05	0.02	0.08	0.05	0.18	0.07	0.14	0.07	0.02	0.02	0.18	0.02	0.02	0.07
KOREA	0.02	0.07	0.04	0.01	0.11	0.05	0.02	0.04	0.08	0.08	0.00	0.05	0.02	0.03	0.05	0.04	0.08	0.03	0.11	0.07	0.01	0.01	0.04	0.03	0.01	0.05
MALAYSIA	0.01	0.04	0.01	0.00	0.04	0.00	0.01	0.03	0.07	0.04	0.02	0.00	0.01	0.00	0.04	0.00	0.04	0.01	0.01	0.16	0.00	0.00	0.07	0.01	0.01	0.01
MEXICO	0.03	0.01	0.03	0.04	0.02	0.03	0.02	0.01	0.00	0.01	0.02	0.01	0.00	0.00	0.01	0.03	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.16
NORWAY	0.00	0.00	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.01	0.04	0.00
NEW ZEALAND	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
PERU	0.01	0.00	0.01	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
PHILIPPINES	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.02	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.02	0.00	0.00	0.01
SOUTH AFRICA	0.01	0.01	0.01	0.00	0.02	0.00	0.01	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.00
SAUDI ARABIA	0.01	0.01	0.02	0.00	0.03	0.00	0.02	0.10	0.03	0.05	0.05	0.06	0.01	0.00	0.00	0.02	0.00	0.03	0.06	0.00	0.03	0.01	0.01	0.03	0.01	0.02
SINGAPORE	0.00	0.05	0.01	0.00	0.03	0.00	0.02	0.04	0.14	0.02	0.04	0.16	0.00	0.01	0.04	0.00	0.09	0.02	0.04	0.00	0.00	0.02	0.05	0.00	0.01	0.02
SWEDEN	0.00	0.01	0.01	0.00	0.01	0.01	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.02	0.02	0.00
SWITZERLAND	0.01	0.01	0.01	0.01	0.02	0.01	0.09	0.06	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.03	0.01	0.02	0.01	0.01	0.01	0.00	0.03	0.04	0.06	0.02
THAILAND	0.01	0.04	0.01	0.00	0.03	0.01	0.01	0.02	0.05	0.05	0.02	0.07	0.01	0.00	0.03	0.01	0.06	0.02	0.03	0.04	0.01	0.01	0.00	0.01	0.01	0.01
TURKEY	0.01	0.00	0.01	0.00	0.01	0.00	0.04	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.02	0.00	0.00	0.02	0.01
UNITED KINGDOM	0.01	0.03	0.02	0.03	0.03	0.01	0.18	0.03	0.01	0.02	0.02	0.01	0.01	0.21	0.03	0.01	0.01	0.05	0.01	0.02	0.09	0.11	0.02	0.07	0.00	0.03
USA	0.12	0.09	0.17	0.68	0.20	0.20	0.16	0.14	0.08	0.18	0.14	0.10	0.68	0.06	0.11	0.23	0.15	0.10	0.14	0.11	0.06	0.10	0.11	0.09	0.12	0.00

4. Empirical Findings Based on The Multi-Country Model

For the 33 countries included in our sample (see Table 1) the GVAR website is used: https://sites.google.com/site/gvarmodelling, see Smith and Galesi (2014)). Oil price data and data on non-fuel commodity prices are taken from the GVAR website. Estimating the 26 country-specific $VARX^*$ (p_i,q_i) model addresses quarterly observations during the 1979Q2-2016Q4 period[6]. Domestic and foreign variables need to be determined before the estimation of p_i and q_i lag orders. On account of this, the Akaike information criterion (AIC) is applied to the underlying unrestricted $VARX^*$ models. Maximum lag orders are determined as $p_{max} = q_{max}$=4. See Table IV for selected $VARX^*$ orders. Afterwards, we continue to determine the number of long-term relationships. Employing Johansen's maximal eigenvalue and trace statistics as developed in Pesaran et al. (2000) for models with weakly exogenous I(1) regressors, unrestricted intercepts and restricted trend coefficients, cointegration tests with the null hypothesis of no cointegration, one cointegrating relation, and so on are performed. The maximum number of cointegrating relations (r_i) based on eigenvalue test statistics is selected using stochastic simulations and 95% simulated critical values calculated with 1000 replications.

Next, we consider persistence profiles for the effects of system-wide shocks on fully defined cointegrating vectors developed by Lee and Pesaran (1993) and Pesaran and Shin (1996). The rate at which persistence profiles (PPs) converge to zero provides information on the speed at which equilibrium correction occurs in response to shocks. The effect of persistence profiles (PPS) is normalised to take the unity value and information is received about the rate at which equilibrium correction takes place in response to shocks with the bending rate to zero. At first the PP values may be excessive shooting or even exceeding unity, but if the vector under consideration is indeed cointegrated it should eventually decrease to zero. However, the findings are not met with this, and PP values are quickly damped. The number of cointegrating relationships is reported in Table IV. In the name of brevity, we present country-specific estimates and test results in Appendix B, including evidence of the weak exogeneity assumption of foreign variables.

In general, defining shocks in the economy is not seen as a straightforward task. However, in our application, it is clear that the energy price shock, a positive unit shock (equal to one standard error) to oil price anomalies. Below we examine the direct and indirect effects of shocks in the energy and goods market on the economies of the country and in the global

6 All results are obtained through GVAR Toolbox 2.0. For all technical details, see Smith and Galesi (2014).

context. We are also exploring the time profile of these effects for inflation and real output growth across countries in addition to commodity prices.

Consider first the GIRFs for a one standard error positive shock negative shock to oil prices. This shock is equivalent to an increase of around 12–15% in oil prices per quarter. The oil price shock is accompanied by an increase in Euro area real GDP of around 0.2% on impact, by 0.5% on average over the first year and by 0.7% on average over the second year (see Figure 1). The transmission of the shock to the US real GDP takes place rather quickly and the effects of the shock are generally statistically significant. A similar situation is seen for Turkey.

In terms of financial variables, it is not surprising that the rise in oil prices negatively affects stock prices and exerts an upward pressure on long-term interest rates. It points out that the increase in long-term interest rates indicates that the bond markets tend to react more to inflation expectations rather than growth expectations. Stock prices in Turkey fall at about 4% and the impact on the stock market in the first two years is felt more.

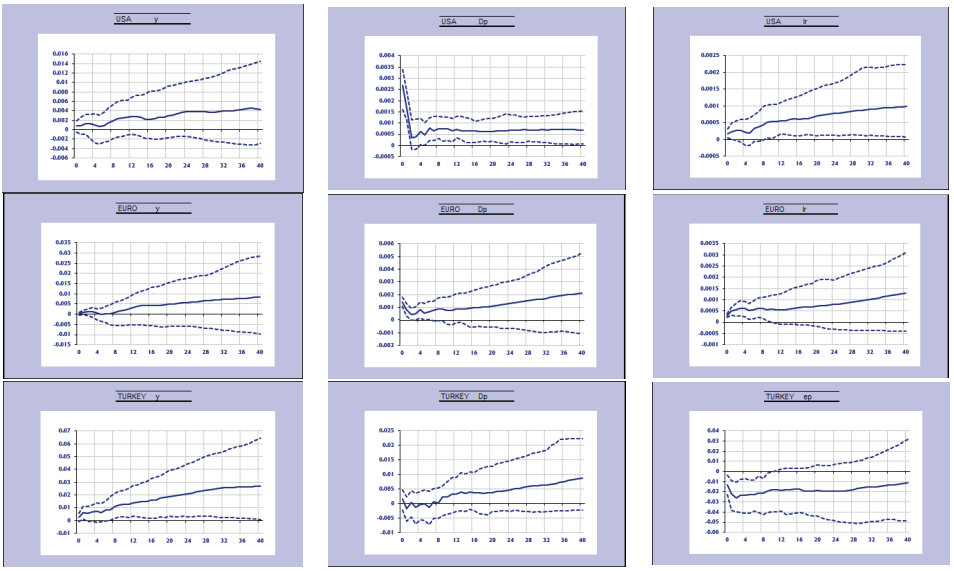


Figure 1. The impact of an oil price shock on selected countries' economies (in percentage points).
Notes: Figures are median impulse responses to a one standard deviation increase in oil price, together with the 5%–95% (blue short-dashed) bootstrapped error bounds. The impact is in percentage points and the horizon is quarterly.

5. Concluding Remarks

This paper has contributed to the commodity–Macroeconomics literature, using the model in which commercial goods are externally determined to causally describe the effects of commodity price shocks on growth, inflation, energy and non-fuel commodity prices. Using the global VAR (GVAR) model that allows simultaneous interaction of variables between countries, this article evaluates the effects of commodity price shocks on real economic activities. Our findings show that oil price shocks and two other commodity price shocks have a similar effect on real output, inflation, short- and long-term interest rates and real exchange rate.

The results may have some important policy implications and aspects for future research. First, we see that commodity price shocks have different effects on country economies. Therefore, as is common in other trade relations, policy coordination (such as in the European Union) may not be useful in dealing with global shocks. Second, our results show that GDP has a positive response to the positive commodity price shock. This contradicts previous findings for similar data sets using standard methodologies. This underlines the need to consider cross-country influences in trading blocs to inform policy.

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Appendix A.

The main data source of the GVAR model covering the 1979Q2-2016q4 period and oil prices and quarterly observations of all-country macro variables are taken from Smith and Galesi (2014). The data can be downloaded from: https://sites.google.com/site/gvarmodelling.

GDP_{it}: nominal gross domestic product of country i during period t; in domestic currency,

CPI_{it}: consumer price index in country i at time t; equal to 1:0 in a base year (say 1995),

EQ_{it}: nominal equity price index,

E_{it}: exchange rate of country i at time t in terms of U.S. dollars

R^{S}_{it}: nominal rate of interest per annum, in percent., short-term.

R^{L}_{it}: nominal rate of interest per annum, in percent., long-term.

The necessary transformations in these variables and the series used in the study are obtained:

Variables	Description
$y_{it} = ln(\frac{GDP_{it}}{CPI_{it}})$	real output
$p_{it} = ln(CPI_{it})$	The rate of inflation $\pi_{it} = p_{it} - p_{i,t-1}$
$q_{it} = ln(\frac{EQ_{it}}{CPI_{it}})$	
$e_{it} = lnE_{it}$	
$\rho^{S}_{it} = 0.25 \times ln(1 + \frac{R^{S}_{it}}{100})$	
$\rho^{L}_{it} = 0.25 \times ln(1 + \frac{R^{L}_{it}}{100})$	

Appendix B.

The basis of the GVAR modelling approach is the estimation of individual VARX* (p_i, q_i) models, the assumption that the country-specific foreign and common variables are weak exogenous, and that the parameters of the models are stable over time.

B.1. Unit root tests

We perform Augmented Dickey-Fuller (ADF) and the weighted symmetric ADF tests on the level and first differences of all the variables. This analysis results in a large number of unit root tests (approximately 2000), which generally support the treatment of variables in our model as I (1) as a first-order approach. For abbreviation, these test results are not reported here, but are available from the authors upon request.

B.2. Weak Exogeneity Tests

Weak exogeneity of country-specific foreign variables and global variables related to the long-term parameters of the conditional model are crucial in the construction and implementation of the GVAR model. Practically, this assumption is tested following the procedure in Johansen (1992) and Harbo et al. (1998). For brevity, these test results are not reported here, but are available from the authors upon request.