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A GLOBAL VAR ANALYSIS

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In 2009 all ECB publications feature a motif taken from the €200 banknote.

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Abstract

Amid the recent commodity price gyrations, policy makers have become increasingly concerned in assessing to what extent oil and food price shocks transmit to the inflationary outlook and the real economy. In this paper, we try to tackle this issue by means of a Global Vector Autoregressive (GVAR) model. We first examine the short-run inflationary effects of oil and food price shocks on a given set of countries. Secondly, we assess the importance of inflation linkages among countries, by dis-entangling the geographical sources of inflationary pressures for each region.

Generalized impulse response functions reveal that the direct inflationary effects of oil price shocks affect mostly developed countries while less sizeable effects are observed for emerging economies. Food price increases also have significative inflationary direct effects, but especially for emerging economies. Moreover, significant second-round effects are observed in some countries. Generalized forecast error variance decompositions indicate that considerable linkages through which inflationary pressures spill over exist among regions. In addition, a considerable part of the observed headline inflation rises is attributable to foreign sources for the vast majority of the regions.

Keywords: oil shock, commodity prices, inflation, second-round effects, Global VAR.

JEL Classification : C32, E31

Non-technical summary

The increasing economic integration is at the present juncture raising a number of important issues concerning its potential implications. In particular, the majority of the world economies are experiencing a considerable degree of vulnerability to external shocks. Even though the sources of these shocks are heterogeneous, their effects are timely reflected on the macroeconomic performance of affected countries. These macroeconomic effects could be generalized to the world economy, for example when a supply shock in a local market implies large gyrations on international commodity prices, or they could spread 'by contagion' through various transmission channels.

Monetary authorities are devoting special attention to the inflationary effects of external shocks. In this paper we tackle the issue of international inflationary spillovers by estimating a Global VAR model, in which the variables endogenous to each country are: core inflation, headline inflation, industrial production, nominal short-term interest rate and nominal effective exchange rate. The global variables, i.e. variables common to each country, are oil and food prices.

We first examine the effects of shocks to food and oil prices on a set of macroeconomic variables for both developed and emerging economies. The main questions we tackle in this exercise are:

- Do the two shocks have different inflationary impacts?
- Is there a significant pass-through of external shocks to core inflation?
- To what extent are inflationary effects persistent?

Results reveal that first-round inflationary effects of an oil price shock mostly affect developed regions, while smaller effects are observed for emerging countries. For the vast majority of developed regions, there are no significant second-round effects of oil shocks on core inflation, while a positive relationship between food price shocks and core inflation is observed for the US and Baltic countries. This result is consistent with the finding that the reaction function of monetary authorities is the main driver of second-round effects of oil price shocks. Oil and food price shocks have a different impact on core inflation across countries, implying that monetary authorities react differently depending on the nature of the shock.

Secondly, we evaluate the international linkages among countries and regions by allocating the forecast error variance for a region to its respective sources. The issues to be addressed are:

- Which are the main transmission channels of inflationary shocks across countries?
- Which foreign regions are mostly affected by inflationary developments in other regions?
- How much of the inflationary innovations in a given region are accounted for by both domestic and foreign innovations?

Results suggest that there exist considerable geographical linkages across regions, through which inflationary pressures are transmitted. As expected, these linkages are region-specific and asymmetric. Furthermore, a considerable part of headline inflation changes in the vast majority of the considered regions is attributed to foreign sources.

As a caveat, It is important to keep in mind that our results are based on a non-structural model. To get a more thorough economic understanding of the linkages, structural identification of shocks will have to be performed.

1 Introduction

The increasing economic integration is at the present juncture raising a number of important issues concerning its potential implications. In particular, the majority of the world economies are observing a considerable degree of vulnerability to external shocks originating from sources that are often outside the economic sphere. For example, a geographically localized natural catastrophic event could destroy the agricultural output giving rise to a large increase in global food prices. Nonetheless, even though the sources of these shocks are heterogeneous, their effects are timely reflected on the macroeconomic performance of affected countries. These macroeconomic effects could be generalized to the world economy, for example when a supply shock in a local market implies large gyrations on international commodity prices, or they could spread 'by contagion' through transmission channels that are not easy to identify.

Monetary authorities are devoting special attention to the inflationary effects of external shocks. In this paper we tackle the issue of international inflationary spillovers by estimating a Global Vector Autoregressive (Global VAR) model, as introduced by Pesaran, Schuermann and Weiner (2004) and further developed in Dées, di Mauro, Pesaran, Smith (2007). Each of the countries under scrutiny is modeled as a Vector Autoregressive model augmented by weakly exogenous I(1) variables (e.g. VARX*), in which the endogenous variables are: core inflation, headline inflation, industrial production, nominal short-term interest rate and nominal effective exchange rate. The global variables, i.e. variables common to each model, are oil and food prices.

As a first exercise, we examine the effects of two exogenous shocks to food and oil prices on a set of macroeconomic variables of both developed and emerging economies by employing the generalized impulse response functions (GIRFs), as developed by Koop, Pesaran and Potter (1996) and Pesaran and Shin (1998). This technique is particularly suitable for multi-country models such as the GVAR model since it yields outcomes that are invariant to country- and variable-ordering. The main questions we tackle in this exercise are:

– Do the two shocks have different inflationary impacts?

– Is there a significant pass-through of external shocks to core inflation?

– To what extent are inflationary effects persistent?

We analyze inflationary effects of external shocks by evaluating the responses of headline and core inflation. Indeed, inflationary effects of these exogenous shocks could be disentangled in two components: a first-round effect hitting headline inflation, as oil and food prices are included in the consumer price index; and a second-round effect passing from headline through core inflation. GIRFs outcomes reveal that first-round inflationary effects of an oil price shock mostly affect developed regions, while smaller effects are observed for emerging countries. For the vast majority of developed regions, there are no significant second-round effects of oil shocks on core inflation, while a positive relationship between food price shocks and core inflation is observed for the US and Baltic countries. This result is consistent with Hooker (2002), which suggests that the reaction function of monetary authorities is the main driver of second-round effects of oil price shocks.

However, oil and food price shocks have a different impact on core inflation across countries, implying that monetary authorities react differently depending on the nature of the shock.

We then evaluate the international linkages among countries and regions by simulating an increase in headline inflation in each region and then, by means of the generalized forecast error variance decompositions (GFEVDs), by decomposing the forecast error variances of each simulated shock, in order to allocate the forecast error variance for a region into its respective source regions. The issues to be addressed in the following exercise are:

– Which are the main transmission channels of inflationary shocks across countries?

– Which foreign regions are mostly affected by inflationary developments in other regions?

– How much of the inflationary innovations in a given region are accounted for by both domestic and foreign innovations?

The GFEVDs reveal some interesting results: first, there exist considerable geographical linkages among regions, through which inflationary pressures are transmitted. As expected, these linkages are region-specific and asymmetric; and second, a considerable part of headline inflation changes in the vast majority of the considered regions is attributed to foreign sources.

The rest of the paper is organized as follows. Section 2 introduces the relationship between external shocks and monetary policy. Section 3 describes the GVAR model employed in our work, the data and the estimation issues. Section 4 presents the results from the dynamic analysis of the GVAR model. Section 5 concludes.

2 External shocks and monetary policy

A typical external shock is an increase in oil prices. Given that crude oil is exchanged in a world-integrated market, most of the countries are in fact unable to individually influence its price. In the short-run, oil price shocks affect macroeconomic performance through various channels, namely through their effects on real income, production costs and uncertainty. In addition, if oil price changes are perceived as persistent, the affected economies would experience a significant structural modification of demand and supply of oil-based products. The main macroeconomic channels through which rising oil prices affect a given economy are presented:

– The *terms-of-trade effect* consists in a redistribution of real income from oil importing countries to oil exporting countries, since the terms of trade of the former decrease while those of the latter increase. The aggregate demand of the oil-consumer countries is expected to decline while the opposite is expected in the case of oil-producing countries.

– *Higher costs of production*. Since oil is a production factor, a price increase will raise the costs of production, while in the medium-long term there could be a substitution of oil with cheaper energy inputs.

– *Inflationary effect*. Since oil-based products are an important component of the Consumer Price Index, the first-round effect of higher oil prices is a sudden increase of the headline inflation. The degree of pass-through into domestic prices depends on the domestic response to the shock.

– *Financial effect*. Since financial markets react quickly to changes in core macroeconomic variables, also equity prices, bond ratings and exchange rates would be influenced from a rise in oil prices.

– *Psychological effect*. Given the uncertainty about how long will oil prices remain high, oil consumers could postpone their purchases of oil related products (e.g. cars), or reduce their oil consumption.

In general it is difficult to quantify the net effect of an oil price hike, given the various channels through which oil price shocks affect the economy. The pass-through of oil price changes into the domestic rate of inflation can be disentangled into 3 channels: (*i*) the *direct* or *first-round effect*, which refers to the rise in prices of energy products; (*ii*) the *indirect effect*, which refers to the pass-through of higher energy-related costs of production to prices of other goods and services such as freight and transportation; and (*iii*) the *second-round effect*, which refers to a situation where, due to an increase in the costs of living, workers demand a wage increase in order to maintain their real income.[1] While the effects of the first two channels are likely to be short in the medium term, the second-round effect is likely to be more prolonged and may result in a wage-price spiral, causing inflation to accelerate.

Historically, after the oil price shocks of the 1970s, monetary authorities often adopted expansionary monetary policies, which eventually aggravated the effects on inflation (Bruno and Sachs, 1985). Nowadays, most of the monetary authorities commit themselves to rapidly counter inflationary pressures: monetary policy credibility is a fundamental determinant of the extent of second-round effects. A credible inflation-countering strategy would create a stable environment of low inflation, anchoring the inflation expectations and thus influencing the price-setting behavior. Indeed, there is scant evidence that the recent sharp rise in energy prices has had significant second-round effects in industrialized countries.

Even though the vast majority of the empirical literature on oil prices is concerned with their real effects, there also exists a strand of literature that focuses on the relationship between oil price changes and the rate of inflation. The work of Hooker (2002) is one of the main studies on the relationship between oil price changes and inflation. He uses a model including the rate of change of oil prices, the unemployment gap and lagged inflation. Using a sample that spanned from 1962 to 2000, he found a structural break in the relationship between oil prices and inflation near the year 1980. By analyzing separately the two subsamples 1962-1980 and 1980-2000, he concludes that in the first subsample oil prices had a significant effect on inflation, while in the second subsample this effect has decreased. Trehan (2005) suggests that this could be due to a different monetary policy response since the lesson of the 1970s.

[1] There is no consensus among monetary authorities about the definition of first- and second-round effects: the ECB and several other central banks consider the indirect effect as part of the first-round effect, while the Federal Reserve subsumes it under the second-round effect.

By focusing on the relationship between oil price shocks and core inflation in the US, Clarida, Galì, and Gertler (2000) show that nowadays the Federal Reserve counters inflationary pressures more aggressively than during the 1970s; this implies that inflation expectations are better anchored than during the 1970s. Therefore, given an oil price increase, inflation expectations would respond less than during the 1970s, hence monetary authorities would not need to undertake tightening measures as during the 1980s.

3 The GVAR Model

To address the issues raised above, we make use of the recently developed Global Vector Autoregressive modelling approach. The GVAR model is presented in Pesaran, Schuermann and Weiner (2004, hereafter PSW), and further developed in Dées, di Mauro, Pesaran and Smith (2007, hereafter DdPS); it consists of a macroeconometric framework which allows the analysis of interactions among the economies under scrutiny.

Generally, the GVAR model is composed of a number of economies modeled individually as a VAR. Each country model is linked to the others by including foreign-specific variables related to the international trade pattern of the given country. In addition, global variables representing international factors are included in each of the country models.

The original feature of the GVAR modeling approach lies in its estimation procedure. Each country model is individually estimated by assuming weak exogeneity for both foreign-specific and global variables: this accounts to assume the small open economy hypothesis for each country. If the weak exogeneity assumption is empirically validated through appropriate tests further described, then it allows for the individual estimation of each country model, thus eschewing the (unfeasible) full-system estimation of the whole GVAR.

The estimation is undertaken by taking into account the integration properties of the series; as a consequence it is possible to find cointegrating relationships among domestic and foreign variables. Even if the GVAR model is atheoretical in spirit, it can incorporate economic-based structural restrictions.[2]

After having estimated the country-models, their corresponding estimates are connected through link matrices and then stacked together in order to build the GVAR model. To analyze results, it is possible to employ the Generalized Impulse Response Functions (GIRFs) and the Generalized Forecast Error Variance Decompositions (GFEVDs), developed in Koop, Pesaran and Potter (1996) and in Pesaran and Shin (1998).

The GVAR model we estimate here covers 33 countries, both developed and emerging economies (cf. Table 1). [3] We consider $N+1$ countries in the global economy, indexed by $i = 0, 1, 2, \ldots N$.

[2]For example, by means of the recently developed *Long Structural Modeling Approach* in Garratt, Lee, Pesaran and Shin (2000, 2003, 2006), it is possible to build a GVAR model that incorporates long-run relationships derived from macroeconomic theory, such as stock-flow and accounting identities, arbitrage conditions and long-run solvency requirements. Another example is found in Dées, Holly, Pesaran and Smith (2007), in which a GVAR model integrates a number of long-run structural relationships derived from arbitrage in financial and goods markets. Then these long run relations, namely the Fisher relationship, the Uncovered Interest Rate Parity and the Purchasing Power Parity, are tested for each country under study.

[3]The 12 euro area countries are modeled as a single region, while the remaining countries are estimated individually.

Table 1: Countries and Regions in the GVAR Model

USA	**Other developed European countries**	**South Eastern European countries**
	Denmark	Bulgaria
United Kingdom	Norway	Romania
	Sweden	
euro area	Switzerland	**Emerging European countries**
Austria		Russia
Belgium	**Baltic countries**	Turkey
Finland	Estonia	Ukraine
France	Latvia	
Germany	Lithuania	**Developing Asian countries**
Greece		China
Ireland	**Central Eastern European countries**	India
Italy	Czech Republic	
Netherlands	Hungary	**Middle Eastern countries**
Portugal	Poland	Saudi Arabia
Slovenia	Slovak Republic	
Spain		

Each country i is represented as a vector autoregressive model augmented by weakly exogenous I(1) variables, specifically a VARX*(p_i, q_i) model, in which country-specific (domestic) variables are related to foreign-specific and global variables, plus a deterministic time trend:

$$\mathbf{\Phi}_i(L,p_i)\mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \mathbf{\Lambda}_i(L,q_i)\mathbf{x}^*_{it} + \mathbf{\Psi}_i(L,q_i)\mathbf{d}_t + \mathbf{u}_{it}, \tag{1}$$

for $i = 0, 1, \ldots, N$ and $t = 1, \ldots, T$, where $\mathbf{x}_{it}$ is a set of country-specific (domestic) variables and $\mathbf{\Phi}_i(L,p_i) = I - \sum_{i=1}^{p_i} \mathbf{\Phi}_i L^i$ is the matrix lag polynomial of the associated coefficients; $\mathbf{a}_{i0}$ is a $k_i \times 1$ vector of fixed intercepts and $\mathbf{a}_{i1}$ is a $k_i \times 1$ vector of coefficients of the deterministic time trend; $\mathbf{x}^*_{it}$ is a set of foreign-specific variables and $\mathbf{\Lambda}_i(L,q_i) = \sum_{i=0}^{q_i} \mathbf{\Lambda}_i L^i$ is the matrix lag polynomial of related coefficients; $\mathbf{d}_t$ is a set of global variables and $\mathbf{\Psi}_i(L,q_i) = \sum_{i=0}^{q_i} \mathbf{\Psi}_i L^i$ is the matrix lag polynomial of associated coefficients; $\mathbf{u}_{it}$ is a $k_i \times 1$ vector of idiosyncratic, serially uncorrelated, country-specific shocks with

$$\mathbf{u}_{it} \sim iid(0, \mathbf{\Sigma}_{ii}) \tag{2}$$

for $i = 0, 1, \ldots, N$, and $t = 1, 2, \ldots, T$, where $\mathbf{\Sigma}_{ii}$ is nonsingular.

The lag orders, p_i and q_i, are respectively associated to the domestic variables and to both the foreign-specific and the global variables, and they can vary across countries. For each country i, they are chosen by minimizing the Akaike information criterion, where the maximum lag order which they can assume is set equal to 2.[4]

Therefore, the GVAR model is composed of 22 VARX* models representing 21 countries and one region. All the steps of the work, specifically the data analysis, the GVAR model estimation, construction and dynamical analysis were implemented in MATLAB.

[4]We chose the maximum lag order equal to 2 due to data limitations (available observations are 108) as higher lag orders would necessarily require a larger observational sample. Moreover, for each country VARX* model we put the additional condition that $p_i \geq q_i$ in order to assign a relatively more articulated dynamics to domestic variables.

The set $\mathbf{x}_{it}$ of country-specific variables includes: the core inflation (π_{it}^c), calculated as the annualized monthly CPI 'ex food and energy' inflation; the headline inflation (π_{it}^h), i.e. annualized monthly CPI inflation; the industrial production index (y_{it}) deflated by the producer price index; the nominal effective exchange rate (e_{it}) and the nominal short-term interest rate (i_{it}).

The set $\mathbf{x}_{it}^*$ contains the foreign-specific variables, which represent the influence of the rest of the world on a given economy, being calculated as weighted averages of the corresponding variables of other countries, with weights based on bilateral trade flows.

The set $\mathbf{d}_t$ contains the global variables, namely variables which are common to each country-VARX* model. Two global variables are considered: the price of food (p^f) and the price of oil (p^o); although these variables are common, they affect each economy in a specific way. Global variables are included in the US model as endogenous variables and in other country models as weakly exogenous. The choice of modelling differently the US is a tentative solution to take into account of their relative importance. Imposing the small open economy assumption to the US does not easily reconcile with empirical evidence, we therefore thought appropriate to consider global variables as endogenous for this economy.[5]

The idiosyncratic shocks $\mathbf{u}_{it}$ are correlated across regions: more specifically,

$$E(\mathbf{u}_{it}\mathbf{u'}_{jt'}) = \begin{cases} \mathbf{\Sigma}_{ij} & \text{for } t = t' \\ \mathbf{0} & \text{for } t \neq t' \end{cases} \tag{3}$$

Therefore, by construction, the GVAR model allows for interdependence through three channels: (i) the contemporaneous interrelation of domestic variables, $\mathbf{x}_{it}$, with foreign-specific variables, $\mathbf{x}_{it}^*$, and with their lagged values; (ii) the dependence of domestic variables, $\mathbf{x}_{it}$ on global variables, $\mathbf{d}_t$, and their related lagged values; (iii) the contemporaneous dependence of shocks in country i on the shocks in country j, as described by the cross-country covariances, $\mathbf{\Sigma}_{ij}$, where $\mathbf{\Sigma}_{ij} = Cov(\mathbf{u}_{it}, \mathbf{u}_{jt}) = E(\mathbf{u}_{it}\mathbf{u}'_{jt})$, for $i \neq j$.

Each country-VARX* model is individually estimated using monthly data over the period January 1999 - December 2007, treating the foreign-specific and global variables as weakly exogenous I(1). After having estimated all the country-models, their corresponding estimates are related through link matrices and then stacked together in order to build the GVAR model. In particular, consider a generic country i model in (1) with p_i and q_i equal to 2:[6]

$$\mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \mathbf{\Phi}_{i1}\mathbf{x}_{i,t-1} + \mathbf{\Phi}_{i2}\mathbf{x}_{i,t-2} + \mathbf{\Lambda}_{i0}\mathbf{x}_{it}^* + \mathbf{\Lambda}_{i1}\mathbf{x}_{i,t-1}^* + \mathbf{\Lambda}_{i2}\mathbf{x}_{i,t-2}^* + \mathbf{u}_{it}. \tag{4}$$

First, for each country we group both the domestic and foreign variables as

$$\mathbf{z}_{it} = \begin{pmatrix} \mathbf{x}_{it} \\ \mathbf{x}_{it}^* \end{pmatrix}, \tag{5}$$

[5]In PSW the global variable, namely the oil price, is exogenous with respect to the whole set of country models, while in DdPS the oil price is included as endogenous in the US VARX* model.

[6]We omit the set of global variables (food and oil prices): since these are endogenous for the US model, while are weakly exogenous for the remaining models, global variables are implicitly included in the set of foreign-specific variables of all countries but the US.

therefore, each country-VARX* model (4) becomes:

$$\mathbf{A}_i \mathbf{z}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1} t + \mathbf{B}_{i1} \mathbf{z}_{i,t-1} + \mathbf{B}_{i2} \mathbf{z}_{i,t-2} + \mathbf{u}_{it}, \tag{6}$$

where

$$\mathbf{A}_i = (\mathbf{I}_{k_i}, -\mathbf{\Lambda}_{i0}), \quad \mathbf{B}_{i1} = (\mathbf{\Phi_{i1}}, \mathbf{\Lambda}_{i1}), \quad \mathbf{B}_{i2} = (\mathbf{\Phi}_{i2}, \mathbf{\Lambda}_{i2}). \tag{7}$$

Second, by collecting all of the domestic (endogenous) variables together we create the *global* vector, $\mathbf{x}_t$, with dimensions $k \times 1$, where $k = \sum_{i=0}^{N} k_i$:

$$\mathbf{x}_t = \begin{pmatrix} \mathbf{x}_{0t} \\ \mathbf{x}_{1t} \\ \vdots \\ \mathbf{x}_{Nt}. \end{pmatrix} \tag{8}$$

After these two steps, we obtain the following identity:

$$\mathbf{z}_{it} = \mathbf{W}_i \mathbf{x}_t, \quad \forall i = 0, 1, \ldots, N, \tag{9}$$

where $\mathbf{W}_i$ is a matrix with dimensions $(k_i + k_i^*) \times k$, constructed based on the trade weights. The $\mathbf{W}_i$ matrix allows each country model to be written in terms of the *global*, $\mathbf{x}_t$, thus it is the fundamental device through which the economies are related in the GVAR model.

Then, given that p_i and q_i vary among each country i and having restricted them to be lower or equal to 2, we derive $\mathbf{A}_i(L, p)$ from $\mathbf{A}_i(L, p_i, q_i)$ by augmenting the $p - p_i$ or $p - q_i$ additional terms in powers of L by zeros, with p being by construction equal to 2. Moreover, we use the identity (9) in each country-VARX* model (6), obtaining

$$\mathbf{A}_i \mathbf{W}_i \mathbf{z}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1} t + \mathbf{B}_{i1} \mathbf{W}_i \mathbf{z}_{i,t-1} + \mathbf{B}_{i2} \mathbf{W}_i \mathbf{z}_{i,t-2} + \mathbf{u}_{it}, \tag{10}$$

for $i = 0, 1, \ldots, N$, and $\mathbf{A}_i \mathbf{W}_i$ has dimensions $k_i \times k$.

Finally, by stacking each country-specific model in (10), we obtain the Global VAR(2) model for all the endogenous variables in the system, $\mathbf{x}_t$,

$$\mathbf{G} \mathbf{x}_t = \mathbf{a}_0 + \mathbf{a}_1 t + \mathbf{H}_1 \mathbf{x}_{t-1} + \mathbf{H}_2 \mathbf{x}_{t-2} + \mathbf{u}_t, \tag{11}$$

where

$$\mathbf{G} = \begin{pmatrix} \mathbf{A}_0 \mathbf{W}_0 \\ \mathbf{A}_1 \mathbf{W}_1 \\ \vdots \\ \mathbf{A}_N \mathbf{W}_N \end{pmatrix}, \quad \mathbf{H}_1 = \begin{pmatrix} \mathbf{B}_{01} \mathbf{W}_0 \\ \mathbf{B}_{11} \mathbf{W}_1 \\ \vdots \\ \mathbf{B}_{N1} \mathbf{W}_N \end{pmatrix}, \quad \mathbf{H}_2 = \begin{pmatrix} \mathbf{B}_{02} \mathbf{W}_0 \\ \mathbf{B}_{12} \mathbf{W}_1 \\ \vdots \\ \mathbf{B}_{N2} \mathbf{W}_N \end{pmatrix},$$

$$\mathbf{a}_0 = \begin{pmatrix} \mathbf{a}_{00} \\ \mathbf{a}_{10} \\ \vdots \\ \mathbf{a}_{N0} \end{pmatrix}, \quad \mathbf{a}_1 = \begin{pmatrix} \mathbf{a}_{01} \\ \mathbf{a}_{11} \\ \vdots \\ \mathbf{a}_{N1} \end{pmatrix}, \quad \mathbf{u}_t = \begin{pmatrix} \mathbf{u}_{0t} \\ \mathbf{u}_{1t} \\ \vdots \\ \mathbf{u}_{Nt} \end{pmatrix}.$$

The $\mathbf{G}$ matrix has dimensions $k \times k$ and if it is nonsingular (e.g. of full rank) then we can invert it. By inverting the $\mathbf{G}$ matrix we obtain the Global VAR in its reduced form:

$$\mathbf{x}_t = \mathbf{b}_0 + \mathbf{b}_1 t + \mathbf{F}_1 \mathbf{x}_{t-1} + \mathbf{F}_2 \mathbf{x}_{t-2} + \mathbf{v}_t. \tag{12}$$

where

$$\mathbf{F}_1 = \mathbf{G}^{-1}\mathbf{H}_1, \quad \mathbf{F}_2 = \mathbf{G}^{-1}\mathbf{H}_2, \quad \mathbf{b}_0 = \mathbf{G}^{-1}\mathbf{a}_0, \quad \mathbf{b}_1 = \mathbf{G}^{-1}\mathbf{a}_1, \quad \mathbf{v}_t = \mathbf{G}^{-1}\mathbf{u}_t.$$

3.1 The Data

In our application we employ data for 33 countries, at monthly frequency, for the period spanning from January 1999 to December 2007. The sample chosen features more recent observations with respect to PSW (e.g. quarterly data ranging in 1979(2)-1999(4)) and DdPS (quarterly data, 1979(2)-2003(4)). Admittedly, our sample covers only a limited span of years which may affect the robustness of results. However, we made this choice in order to have a sufficiently large set of variables for all countries under scrutiny.

As anticipated, the GVAR model includes five country-specific variables for each country-VARX* model: core inflation (π^c_{it}), headline inflation (π^h_{it}), industrial production (y_{it}), short-term interest rate (i_{it}), and nominal effective exchange rate (e_{it}).[7] However, some country-VARX* models do not include the whole set of country-specific variables: π^c is not included in China, India and Saudi Arabia's models, due to lack of available data. For the same reason, the model of Saudi Arabia does not include y_{it}. Therefore, the number of country-specific variables, k_i, varies across countries.

Since euro area countries are aggregated in a single regional VARX* model, the euro area regional series are constructed as weighted averages of the country-specific variables π^c_{it},π^h_{it},y_{it},i_{it},e_{it} for the following countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Spain.[8] The weights are based on the GDP shares of each country in the euro area region. Specifically, weights are constructed by averaging over the period 1999-2007 the Purchasing Power Parity's adjusted GDP series (PPP-GDP) for each given country. Then they are divided by the total PPP-GDP of the euro area region in order to sum up to one.

The foreign-specific variables are constructed using trade-based weights. The choice of weights based on trade is undertaken with the rationale that exogenous shocks, specifically adverse oil and food price shocks, could pass-through on inflation in all countries via the trade channel. Specifically,

[7] Including wages and some proxies for price mark-ups, as well price expectations, would enable a more precise disentanglement of inflationary effects between first- and second-round effects. However, we have not used them due to lack of homogeneous data.

[8] Cyprus, Luxembourg and Malta are left out as their weight is extremely limited and including them would have just added additional estimation variability.

weights are fixed over time, and computed as averages of exports and imports' cross-country data for the period 1999-2007.[9]

Given that the number of endogenous variables is not constant across countries, foreign-specific variables are constructed attaching zero-weights to countries in which the corresponding domestic variables are absent, and subsequently rescaling the weights so to sum up to one. Moreover, the foreign-specific nominal effective exchange rate variables are not included in the country specific models, since they are typically strongly correlated with their domestic-specific counterparts.[10] Therefore, following the recommendations in PSW, in our application the set of foreign-specific variables for the generic i^{th} country is given by $\mathbf{x}_{it}^{*} = (\pi_{it}^{c*'}, \pi_{it}^{h*'}, y_{it}^{*'}, i_{it}^{*'})'$. Food and oil indices, respectively p^f and p^o, are common variables to each of all country-VARX* models, and are from the IFS Database of the IMF.

Finally, although the country-VARX* models are estimated at a country level, we analyze regional responses to both global and region-specific shocks, by aggregating GIRFs and GFEVDs using the averages of country PPP-GDPs over the period 1999-2007.

3.2 Estimation of Country-Specific Models

Having tested that the majority of our series are $I(1)$, the cointegrating VARX* country models are estimated; more specifically, each cointegrating VARX* model is estimated subject to the reduced rank restriction (Johansen, 1992 and 1995). Therefore, the cointegration rank is derived by employing both the *trace* and *maximum eigenvalue* statistics. Trace statistics have been chosen for the rank selection, given that they yield better small sample power results compared to the maximum eigenvalue statistics. The asymptotic distribution of the trace and maximum eigenvalue statistics depend on whether the intercept and/or the coefficients on the deterministic trend are restricted or unrestricted.[11] In the current application, the reduced rank regressions are used in the case of unrestricted intercepts and restricted trends (e.g. case IV in Pesaran, Shin and Smith, 2000). In particular, rank tests are conducted at the 95% significance level. Rank tests statistics are reported in Tables 8 and 9, while ranks for each country VARX* model are reported in Table 2.

The reduced rank procedure does not indicate exactly which cointegrating relationships are found (i.e. which of the variables are linked together), nor does it identify them. In order to exactly identify the cointegrating matrix, r contemporaneous restrictions on each cointegrating vector are imposed. These are implemented by normalizing each cointegrating vector, thus following a purely

[9] In DdPS time-varying weights are computed basing on three-years wide rolling windows, in order to take into account eventual changes in countries trade structure. However, given the relatively short sample used in the current application (nine years), it might not be necessary to use time-varying weights in the present context. Further, having in mind the key role of trade in transmitting inflationary pressures we also estimated our GVAR model using imports-based weights: no significant changes are observed in the results, so the choice of using imports/exports-based weights is made following the atheoretical nature of our model.

[10] This is also discussed in PSW, in which the authors demonstrate that a strong correlation among domestic and foreign-specific nominal exchange rates is specifically observed for those countries that peg their currency to another one (generally to the US Dollar).

[11] The related critical values, suited for cointegrating VAR models with exogenous I(1) variables, are calculated from MacKinnon, Haug and Michelis (1999).

Table 2: VARX* Order and Number of Cointegrating Relationships in the Country-Specific Models

Country	p_i	q_i	# Cointegrating Relations	Country	p_i	q_i	# Cointegrating Relations
Bulgaria	1	1	3	Poland	2	2	4
China	2	1	1	Romania	2	1	3
Czech Republic	2	2	3	Russia	1	1	3
Denmark	2	1	4	Saudi Arabia	2	2	1
Estonia	2	1	3	Slovak Republic	1	1	3
euro area	2	2	3	Sweden	1	1	3
Hungary	1	1	4	Switzerland	2	2	4
India	2	1	1	Turkey	2	1	2
Latvia	2	1	3	Ukraine	2	2	3
Lithuania	1	1	3	United Kingdom	2	1	1
Norway	2	1	3	United States	2	1	2

Note: Rank orders are derived using Johansen's trace statistics, at the 95% critical value level.

atheoretical approach, as we do in our work. Subsequently, in cases where cointegration is found, each country VARX* model is estimated under its vector error correction (VECMX*) form.[12]

3.3 Impact Elasticities

The estimation of the cointegrating VARX* models gives the opportunity to examine the feedback of foreign-specific variables on their domestic counterparts, as derived by the coefficients estimates related to contemporaneous foreign variables in differences, which are generally viewed as *impact elasticities*. *Impact elasticities* measure the contemporaneous variation of a domestic variable due to a 1 percent change in its corresponding foreign-specific counterpart, and they are particularly useful in the GVAR framework in order to identify general co-movements among variables across different countries. Table 3 shows the impact elasticities with the corresponding t-ratios, computed based on the White's heteroscedasticity-consistent variance estimator.

Looking at core inflation, the majority of the estimates is not statistically significant; this finding implies the absence of a generalized co-movement in core inflation across the countries, suggesting that when countries suffer from domestic-generated inflationary pressures, their dynamics is generally independent from the internal developments of foreign countries.

With respect to the headline inflation, a number of estimates are positive and significant. Some estimated values lie between 0 and 1, in particular, the lowest value is found for euro area (0.17), while the highest one is associated to Estonia (0.97). Impact elasticities greater than one are found for Lithuania (1.19) and Denmark (1.03), thus revealing an overreaction of the headline inflation relative to these countries with respect to an increase in headline inflation of their main trading

[12]In order to eschew to problems arising from the presence of heteroskedasticity in the regressions, all tests have been performed using White heteroskedasticity-corrected standard errors.

partners. This marked difference between the former and the latter results suggests the importance of energy and food prices in driving co-movements of inflation across countries. It appears also that low elasticities are associated to large countries, while the opposite holds for small countries. This is compatible with the general finding that the transmission channel of inflation works mostly unidirectionally, from large to small countries.

Looking at industrial production coefficients, the vast majority of them is statistically significant. It is striking to observe that most of the coefficients are greater than 1, especially for small emerging countries: it is therefore expected that foreign output increases (mainly coming from developed countries) are markedly larger in absolute value than the domestic output of small emerging countries, so that production in the latter economies strongly overreacts to foreign output increases.

Table 3: Contemporaneous Effects of Starred Variables on their Country-Specific Counterparts

Country	π^c	π^h	y	i	Country	π^c	π^h	y	i
Bulgaria	-0.47	1.03	3.04	0.02	Poland	-0.16	0.56	3.44	-0.02
	[-1.39]	[1.35]	[5.48]	[0.36]		[-0.55]	[1.88]	[10.84]	[-0.09]
China	—	0.31	0.03	0.01	Romania	0.29	0.67	1.94	0.32
	—	[0.80]	[0.03]	[0.52]		[0.53]	[1.09]	[4.24]	[0.87]
Czech Republic	0.07	0.49	5.64	0.04	Russia	-0.53	0.51	1.46	0.63
	[0.13]	[1.09]	[9.30]	[0.58]		[-0.72]	[1.73]	[3.31]	[3.53]
Denmark	-0.22	1.03	2.37	0.32	Saudi Arabia	—	-0.44	—	0.15
	[-0.99]	[5.50]	[4.86]	[2.32]		—	[-1.63]	—	[1.48]
Estonia	-0.37	0.97	2.92	-0.11	Slovak Republic	-0.25	1.09	2.21	0.04
	[-2.05]	[3.01]	[7.06]	[-0.74]		[-0.41]	[1.02]	[14.66]	[0.51]
euro area	-0.06	0.17	0.04	0.02	Sweden	-0.10	0.83	0.22	0.12
	[-0.70]	[2.67]	[0.76]	[1.18]		[-0.31]	[4.90]	[1.61]	[1.77]
Hungary	0.99	0.36	5.07	0.06	Switzerland	0.26	0.76	0.15	-0.04
	[2.23]	[0.68]	[9.90]	[0.61]		[1.03]	[4.13]	[0.75]	[-0.75]
India	—	-0.24	1.41	0.08	Turkey	-0.46	1.48	3.33	0.57
	—	[-0.79]	[2.40]	[1.64]		[-0.61]	[1.79]	[4.04]	[0.17]
Latvia	0.02	0.83	1.87	0.66	Ukraine	0.08	-0.11	1.47	0.79
	[0.07]	[3.12]	[6.89]	[3.02]		[2.19]	[-0.78]	[7.12]	[1.17]
Lithuania	-0.21	1.19	1.75	0.35	United Kingdom	-1.03	0.40	0.32	0.02
	[-0.83]	[3.50]	[5.17]	[2.19]		[-0.90]	[0.45]	[1.94]	[0.05]
Norway	0.43	0.18	0.78	0.13	United States	-0.11	0.22	0.00	0.01
	[3.52]	[0.64]	[1.47]	[0.81]		[-1.04]	[1.39]	[-0.04]	[0.12]

Note: White's heteroscedastic robust t-statistics are given in square brackets.

3.4 Testing Weak Exogeneity of Foreign-Specific and Global Variables

After having estimated each country VARX* model, it is necessary to verify the hypothesis of weak exogeneity for both the foreign-specific and global variables. To this end, we employ weak exogeneity tests as proposed by Johansen (1992) and Harbo *et al.* (1998).

For each country-specific model, the joint significance of the estimated error correction terms for the foreign-specific and global variables is tested. In particular, grouping foreign-specific and global variables in $\tilde{\mathbf{x}}^*_{it}$, for each l^{th} element of $\tilde{\mathbf{x}}^*_{it}$, the following regression is performed:

$$\Delta\tilde{x}^*_{it,l} = \mu_{il} + \sum_{j=1}^{r_i}\gamma_{ij,l}ECM^j_{i,t-1} + \sum_{k=1}^{p_i}\phi_{ik,l}\Delta\mathbf{x}_{i,t-k} + \sum_{m=1}^{q_i}\theta_{im,l}\Delta\tilde{\mathbf{x}}^*_{i,t-m} + \varepsilon_{it,l} \qquad (13)$$

where $ECM^j_{i,t-1}$ is the estimated error correction terms, with $j = 1,\ldots,r_i$, and r_i is the number of cointegrating relations (e.g. the rank) found for the i^{th} country model; $\Delta\mathbf{x}_{i,t-k}$ is the set of domestic variables in differences, with $k = 1,\ldots,p_i$, where p_i is the lag order of the domestic component of each i^{th} country model; $\Delta\tilde{\mathbf{x}}^*_{i,t-m}$ is the set of foreign-specific and global variables in differences, with $m = 1,\ldots,q_i$, where q_i is the lag order of the foreign (weakly exogenous) component of each i^{th} country model. The test consists in verifying by means of an F test the joint hypothesis that $\gamma_{ij,l} = 0$ for each $j = 1,\ldots,r_i$. Results (Table 4) suggest that most of the weak exogeneity assumptions cannot be rejected. Only 8 out of 130 exogeneity tests indicate a rejection; results could hence be seen as positive.[13]

Table 4: F Statistics for Testing the Weak Exogeneity of the Country-specific Foreign Variables and Global Variables

Country		95% F-stat Critical Values	π^{c*}	π^{h*}	y^*	i^*	p^f	p^o
Bulgaria	F(3,89)	2.71	0.77	0.45	0.08	0.49	1.27	0.49
China	F(1,88)	3.95	1.21	0.00	0.06	1.08	1.03	0.01
Czech Republic	F(3,78)	2.72	0.49	0.20	0.29	1.55	1.29	0.68
Denmark	F(4,83)	2.48	0.83	0.64	3.01*	1.55	0.90	0.92
Estonia	F(3,84)	2.71	1.18	1.17	0.50	1.02	0.18	0.56
euro area	F(3,78)	2.72	0.67	0.16	1.59	1.13	1.31	0.95
Hungary	F(4,88)	2.48	1.06	0.29	2.59*	0.29	0.87	0.60
India	F(1,88)	3.95	0.21	1.39	0.73	0.77	0.22	1.88
Latvia	F(3,84)	2.71	0.33	0.73	0.56	0.78	1.16	2.54
Lithuania	F(3,89)	2.71	0.22	2.02	0.36	0.59	2.37	2.10
Norway	F(3,84)	2.71	0.60	0.34	1.11	0.36	2.22	0.10
Poland	F(4,77)	2.49	0.34	1.26	1.08	0.27	1.19	0.92
Romania	F(3,84)	2.71	0.59	2.51	0.38	2.79*	0.25	1.09
Russia	F(3,89)	2.71	0.38	0.66	0.82	2.19	0.21	1.77
Saudi Arabia	F(1,84)	3.95	3.37	0.78	0.08	0.24	9.21*	0.06
Slovak Republic	F(3,89)	2.71	0.47	0.19	0.21	2.36	1.78	2.95*
Sweden	F(3,89)	2.71	0.69	0.15	2.79*	0.15	0.58	0.58
Switzerland	F(4,77)	2.49	0.94	1.75	1.61	3.38*	0.84	1.73
Turkey	F(2,85)	3.10	1.56	1.52	0.90	1.48	1.51	0.52
Ukraine	F(3,78)	2.72	0.76	0.90	0.05	0.18	0.25	0.45
United Kingdom	F(1,86)	3.95	0.21	0.35	0.45	4.04*	0.59	0.50
United States	F(2,83)	3.11	0.08	0.41	0.37	1.22	—	—

Note: * denotes statistical significance at the 5%.

[13] In addition, the weak exogeneity assumption is rejected for relatively small countries. Therefore, it appears not to be unrealistic to impose the weak exogeneity assumption also for those countries. For robustness check we also carried out another battery of regressions by setting $q_i = 2$ in (13): results confirm and strengthen our findings, as the weak exogeneity rejection ratio passes from 8/130 to 6/130.

4 Generalized Impulse Response Analysis

We investigate the dynamic properties of our GVAR by means of the Generalized Impulse Response Functions (GIRFs), proposed in Koop, Pesaran and Potter (1996) and further developed in Pesaran and Shin (1998). In the Global VAR framework, the GIRFs are more appealing compared to the traditional Sims' (1980) Orthogonalized Impulse Response Functions, as they are invariant to the ordering of the variables and of the countries. Given that in such a multi-country setting there is not a clear economical *a priori* knowledge which can establish a reasonable ordering of the countries, it is preferable to employ the GIRFs. Moreover, even if the GIRFs assess the effects of observable-specific rather than identified shock, the typical (and atheoretical) Global VAR analysis is based on the investigation of the geographical transmission of country-specific or global shocks, thus this limitation is not considerably perceived.[14]

4.1 Generalized Impulse Response Functions

A positive standard error unit shock is simulated on, respectively, oil and food prices.[15] The aim of the following simulation is to determine the extent to which each region responds to a common external shock. In addition, it is of interest to compare the different macroeconomic effects deriving from external shocks of different natures, such as from oil and food prices hikes. The issues to be addressed in the following exercise are:

– Do these two shocks have different inflationary impacts?

– Is there a significant pass-through of external shocks to the core inflation?

– To what extent are the inflationary effects persistent?

Each GIRF shows the dynamic response of each domestic variable of each of region to standard error unit shocks to oil or food prices up to a limit of 24 periods (e.g. 2 years). Confidence intervals are at the 90% significance level, and they are calculated using the sieve bootstrap method with 1000 replications.[16] We anticipate that the vast majority of responses are not significant, and this is mainly due to three causes:

1. we present the impulse responses aggregated at a regional level for condensed results: the aggregation of country-specific GIRFs can lead to non-significant regional outcomes;

2. the estimation of the GVAR model at monthly frequency implies the presence of higher volatility in our estimates;

3. the country-specific parameter estimates are derived from unrestricted estimations: in the context of a short-run analysis we have chosen not to impose economic-based restrictions in

[14] Yet, it could be a limit in the setting of monetary policy analysis.

[15] Setting the shock equal to one standard error is common practice in the empirical literature. Given that the GVAR is a linear model, resizing the shock is straightforward.

[16] See Kreiss (1992), Bühlmann (1997) and Bickel and Bühlmann (1999) for a complete presentation of the sieve bootstrap technique.

the cointegrating space of each country VECMX* model, which are likely to be rejected by the appropriate tests.

It is important to keep in mind that dynamic properties of the GVAR model, as well as the degree of persistence of GIRFs, can be preliminary assessed by inspecting the eigenvalues of the dynamic system. Since the GVAR includes 108 endogenous variables and its maximum lag order is equal to 2, its companion VAR(1) form has 216 eigenvalues. Their moduli are all less than or equal to unity, hence the GVAR model is dynamically stable; consequently, GIRFs settle down relatively quickly. Also, 60 eigenvalues fall on the unit circle (corresponding to the unit roots of the model).[17] Given that the model features the presence of unit roots, simulated shocks will affect permanently the levels of most of the variables under consideration. Of the remaining 156 eigenvalues falling inside the unit circle, 118 of them are complex, implying that GIRFs will display cyclical behavior. And finally, the three largest eigenvalues among those which are in moduli less than unity are 0.8648215, 0.8092224 and 0.800062, therefore we expect to observe convergence towards a steady-state equilibrium.

4.1.1 Shock to Oil Prices

A positive standard error unit shock to nominal oil prices corresponds to an increase of about 6 percent of the oil price index in one month (cf. Figure 1). The food price response does not significantly vary, remaining close to the zero line.[18]

The impulse responses associated to the regional headline inflations provide the (non-structural) assessment of direct inflationary effects due to the oil price hikes. Results indicate a significant historical correlation between oil price shocks and inflationary pressures for the developed regions under study, while non-significant effects are observed for the less developed economies. US headline inflation response (Figure 1) is on impact equal to 1.1%, then it rapidly dies out, becoming statistically non-significant after three months. Euro area headline inflation (Figure 1) increases for a 0.6% at the time of the shock, then its magnitude declines and reaches the baseline after two months. The observed effects on euro area are nearly half of the effects size for the United States: this could suggest that euro area, while still strongly dependent on crude oil, has experienced, since the beginning of the 80's of the previous century, a steady substitution of oil towards cheaper energy sources, while the same does not hold for the United States. Further, higher energy taxes in euro area rather than in the United States potentially explain this discrepancy, dampening the effect of oil price hikes.

The other developed European countries' response averages 0.9% on impact, then rapidly dies out in 2 months (cf. Figures 3-12 in the Appendix). The headline inflation in the United Kingdom surprisingly decelerates (although the response is not statistically significant), and the same behavior is observed for the Middle Eastern countries: the consideration that both the economies are oil

[17] This is consistent with the theorem in PSW, which implies that the number of unit roots in the global model should be at least equal to the difference between the number of endogenous variables (108) and the sum of cointegrating relationships across all country models (48).

[18] As we expected to observe a significant positive dynamic correlation between oil and food prices, this counter-intuitive finding could be due to endogeneizing the global variables in the GVAR model, so that the effect on food price of a oil price shock is dampened by all the variables' contributions in the system.

producers could be a tentative explanation of these counterintuitive results. Further, the negative response of headline inflation features also the developing Asian countries, but also in this case it is not statistically significant: the reason is possibly related to the administered energy prices applied in these economies.

The effects on core inflation are not statistically significant for the US (Figure 1). This is consistent with the findings in Hooker (2002). No second-round effects are found also for the euro area: given that both the FED and the ECB are particularly concerned by the nominal consequences of oil shocks, the following results suggest that also in this case the monetary policy framework contributes to anchoring inflation expectations at low levels.

US industrial production (Figure 1) falls on impact by 0.25%, then after two years it averages -0.37%; smaller effects are observed in euro area, where the associated GIRF decreases on impact by 0.1%, then it stabilizes to -0.2%. A generalized decrease of production is observed for the rest of the regions, however noting that impulse responses are rarely significant.

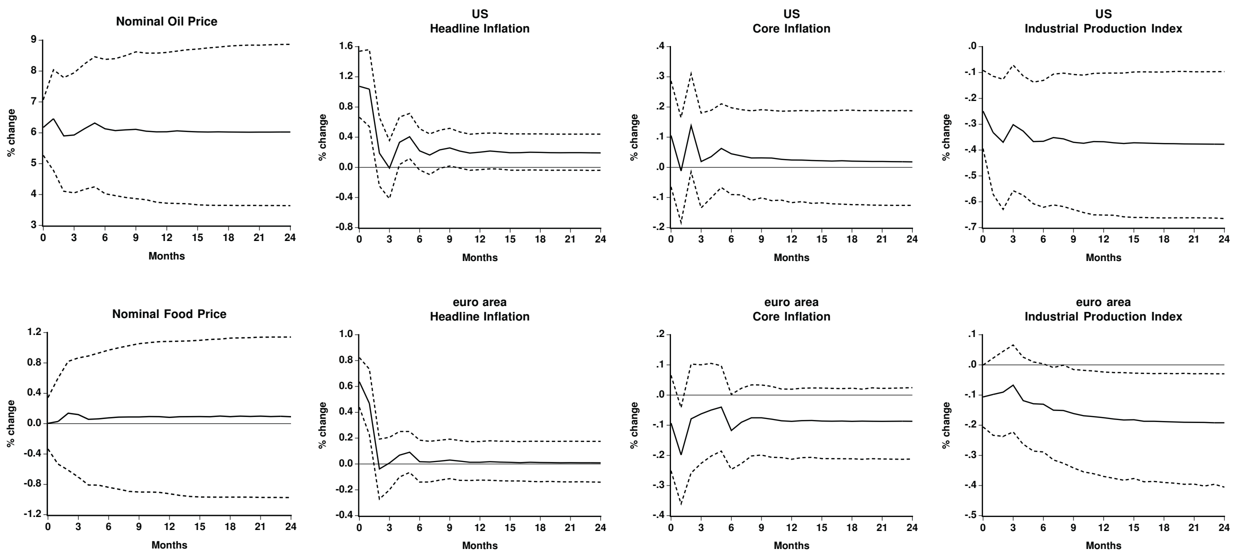

Figure 1: Generalized impulse responses of a positive unit (1 s.e.) shock to oil prices

4.1.2 Shock to Food Prices

A positive standard error unit shock to nominal food prices corresponds to an increase of about 1.8% in one month of the food price index (cf. Figure 2). The simulated food price increase is accompanied by a contemporaneous oil price increase, even though oil price response is not statistically significant.

A significant increase in headline inflation is found for Baltic countries, in which inflationary effects are persistent over time: the initial effect averages 0.5%, and then stabilizes after two years to 0.6% above the pre-shock level. The short-run inflationary effects for the remaining regions are mainly non-significant, even though they are in absolute terms bigger for emerging countries. The effect of a food price shock partially reflects the weight that the food price component has in each region-specific consumer price basket. As expected, since food is a relevant component of the CPI especially in emerging economies, a food price shock mainly affects these regions.

US core inflation is significantly and positively affected by the food price shock (Figure 2): while on impact its GIRF is not significant (and equal to 0.1% increase), it becomes statistically significant after 5 months from the shock, then it increases stabilizing to 0.15% above the pre-shock level. The fact that a food price shock does not affect US headline inflation but core inflation suggests that increases in food commodities typically pass-through into the domestic CPI with a substantial delay. Stronger effects are observed for the Baltic countries, where core inflation initially rises by 0.3%, then it averages 0.4% increase after two years.

The effects on the industrial production indices across regions are clearly different from the oil price shock case: here the signs of the responses are generally positive, even though most of them are not statistically significant. For example, the euro area GIRF (Figure 2) does not react on impact, while it increases after one month by nearly 0.25%. Then it gradually dies out, approaching the zero line after two years from the shock. A similar dynamic behavior is observed for Baltic, Central Eastern European, South Eastern European and emerging European countries, with related GIRFs reaching their peak after one month and then steadily declining over time. The fact that GIRFs have positive sign is consistent with our expectations: food commodities, differently from the crude oil, are not —in a strict sense— broadband production factors, thus a raise in their price does not in general lead to a decrease in output. Further, synchronized responses suggest a considerable degree of co-movements of industrial production indices across these countries.

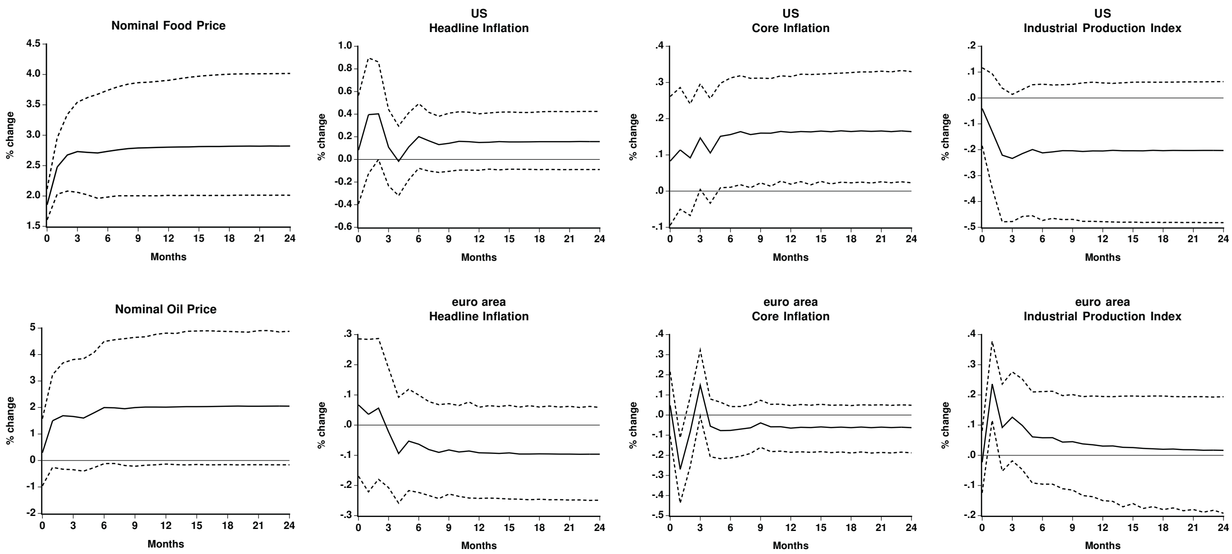

Figure 2: Generalized impulse responses of a positive unit (1 s.e.) shock to food prices

4.2 Generalized Forecast Error Variance Decompositions

In order to examine inflation linkages across regions, we simulate, for each region in the GVAR model, a positive standard error unit shock to the domestic headline rate of inflation in each region[19] and, by means of the Generalized Forecast Error Variance Decompositions (GFEVDs) we investigate cross-region inter-linkages. The GFEVDs contain information about the proportion of the movements in the headline inflation of a given region due to domestic versus foreign-originated shocks. More specifically, we allocate the forecast error variance for a region into its respective source regions. The quantities obtained, even though they could not be considered proportions due to the contemporaneous correlations among innovations, measure the importance of the innovation to a given region's variable to the rest of the regions' variables. However, following Wang (2000) we rescale the GFEVDs such that the associated percentages add up to 100.[20] Therefore, the GFEVDs identify the relative importance of each variable for each region in explaining the geographical propagation of inflation; as such they provide insights on the transmission channels through which region-specific shocks spill over.

The issues to be addressed in the following exercise are:

– Which are the main transmission channels of international transmission of inflationary shocks?

– Which foreign regions are mostly involved in the inflationary innovation in a given region?

– How much of the inflationary innovations in a given region are accounted for by both domestic- and foreign-originated innovations?

We focus our comments on results for the United States and the euro area, displayed in Tables 12 and 13. For both the regions the headline inflation is itself the domestic variable that mostly explains the forecast error variance of the historical shock. While the relative importance of headline inflation decreases steadily over time for both the economies, the contribution of core inflation remains stable for the euro area while it tends to gain importance over longer horizons for the United States. This result implies that a component of the headline inflation increase feeds into the core inflation, thus becoming more persistent over time. The relative contribution of the US nominal short-term interest rate is negligible: it is on impact equal to 0.2%, then it increases to 0.4% after two years; in contrast, due to a shock to the euro area headline inflation, the nominal short-term interest rate explains 3.5% of the shock on impact, then its contribution decreases over time, reaching 0.8% after one year. While it is not possible from these results to infer anything about the reaction functions of the different monetary authorities we can nonetheless observe that the interest rate gives a different contribution in the 2 regions, by looking at its share in the explanation of the shock and its development over time.

On impact, the US nominal effective exchange rate's contribution is not relevant, it slightly increases over time, passing from 0.1% on impact to 1.4% after two years. In the case of the euro area, the contribution of the exchange rate averages 1.2% on impact; as for the United States, it increases reaching 11.8% after two years. Thus, the relative importance of exchange rate innovations

[19]Simulating a positive standard error unit shock to the headline inflation of a specific region amounts to shock each headline inflation equation of countries belonging to the selected region, weighting the country-specific shocks using the PPP-GDP weights, such that the sum of the country-specific shocks adds up to one (standard error). Then, the regional aggregation of GFEVDs using the PPP-GDP weights for all the regions in the GVAR model is straightforward.

[20]The rationale is that if the forecast covariance matrix converges to a finite value as the forecast horizon tends to infinity, the bias derived from rescaling the GFEVDs decreases over time.

tends to increase over time, while the opposite is observed for the shocks associated with the headline inflation, both from domestic and foreign sources. This is in line with the finding of Eun and Jeong (1999) that inflation innovations tend to pass-through to the domestic price levels faster than exchange rate innovations. This result also suggests that exchange rate innovations may be perceived as less permanent, whereas the opposite may hold for headline inflation innovations. In fact, as the authors suggest, firms do not timely change their prices following fluctuations of exchange rates, but prefer to adjust their mark-ups, following a *pricing-to-market* strategy. This phenomenon implies that, in the short run, the exchange rate pass-through is incomplete.

The oil price explains 7.4% of the forecast error variance of the simulated shock to the US headline inflation on impact, 2.1% after one year and 1.9% after two years. Surprisingly, the food price does not contribute, at all horizons, to the explanation of the simulated shock. Moreover, oil and food prices do not considerably explain the shock to euro area headline inflation. This result is mainly due to the fact that oil and food price contributions feed into the headline inflation counterparts of all the regions, so that the global variables implicitly contribute through headline inflation innovations.

Looking at the regional contributions, the foreign regions that mostly contribute on impact to the explanation of the simulated US headline inflation increase are the euro area (12.3%), the other developed European countries (6.6%) and the Central Eastern European countries (4.1%). The regional contributions vary over time, and after two years the euro area is still the foreign region that mostly explains the shock (8.8%). In the case of the euro area, on impact the most relevant foreign regions are, in decreasing order, the United States (14.7%), the other developed European countries (8.8%) and the Baltic countries (6.4%). After two years, these are still the United States (16.2%), followed by the other developed European countries (8.2%) and the developing Asian countries (7.0%). It is interesting to observe that regional contributions do not strictly follow an international trade pattern. We also remark that the regional contributions are not symmetric, in the sense that, as expected, the geographical transmission channel is mainly unidirectional, from the larger to the smaller country. The explanation of these asymmetric linkages is still an open issue: further research, possibly using alternative econometric approaches, are required in order to improve our knowledge on the geographical transmission of inflationary pressures.

Finally, from the forecast error variance of each historical shock it is possible to disentangle the components due to both domestic and foreign innovations. On impact, for both regions the inflationary shocks are mainly explained by domestic sources (57.4% and 53.6%, respectively, for the United States and the euro area). For the US, the contribution related to foreign innovations decreases over time, while the opposite holds for the euro area. Structural differences between the two economies (e.g. different degrees of trade openness) are potential candidates to explain this divergence, but apart from these, our GVAR is able to reveal the topical role of the exchange rate: in the euro area the importance of headline inflation decreases over time, while the opposite is observed for the effective exchange rate counterpart. As explained before, this phenomenon could imply an incomplete exchange rate pass-through in the short-run.

5 Concluding Remarks

In this paper we have applied the Global Vector Autoregressive (GVAR) methodology to study short-run inflationary effects of common external shocks as well as the international transmission of inflation for a set of 33 countries. Impulse response analysis reveals that oil and food price shocks have different inflationary effects. During the period 1999-2007, the inflationary effects of an oil price shock mostly affected developed regions, while food price increases hit particularly emerging economies. No significant relationship between oil shocks and core inflation for the United States and the euro area is observed. This result suggests that the presence of significant second-round effects on inflation depends on the country-specific reaction function of the monetary authorities.

The GFEVDs reveal some interesting results: first, there exist considerable geographical linkages among regions through which inflationary pressures are transmitted; second, a considerable part of headline inflation changes in the vast majority of the considered regions is attributed to foreign sources.

It is important to keep in mind that these results are based on a non-structural model. To get a more thorough economic understanding of the linkages, structural identification of shocks will have to be performed. This could be done for example using the new approach proposed by Chudik and Fidora (2009), and we leave this for future research.

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Table 5: Trade Weights Based on Direction of Trade Statistics

	Bulg	Chin	Czec	Denm	Esto	EA	Hung	Indi	Latv	Lith	Norw	Pola	Roma	Russ	Saud	Slvk	Swed	Swit	Turk	Ukra	UK	US
Bulgaria	0.0000	0.0010	0.0026	0.0010	0.0005	0.0060	0.0033	0.0007	0.0011	0.0014	0.0002	0.0025	0.0180	0.0093	0.0003	0.0028	0.0011	0.0012	0.0174	0.0156	0.0009	0.0008
China	0.0269	0.0000	0.0159	0.0262	0.0213	0.0757	0.0284	0.1567	0.0180	0.0154	0.0176	0.0202	0.0357	0.1000	0.1333	0.0102	0.0266	0.0216	0.0390	0.0553	0.0326	0.2172
Czech Republic	0.0156	0.0067	0.0000	0.0079	0.0080	0.0433	0.0333	0.0044	0.0115	0.0150	0.0052	0.0483	0.0174	0.0196	0.0009	0.1757	0.0093	0.0082	0.0068	0.0209	0.0083	0.0042
Denmark	0.0060	0.0076	0.0079	0.0000	0.0277	0.0367	0.0067	0.0073	0.0371	0.0359	0.0654	0.0195	0.0035	0.0083	0.0040	0.0057	0.0995	0.0072	0.0085	0.0058	0.0180	0.0091
Estonia	0.0004	0.0007	0.0009	0.0034	0.0000	0.0035	0.0018	0.0002	0.0791	0.0383	0.0022	0.0025	0.0002	0.0071	0.0001	0.0005	0.0091	0.0004	0.0008	0.0055	0.0007	0.0005
euro area	0.5537	0.2821	0.6551	0.5437	0.4143	0.0000	0.6498	0.3260	0.2903	0.3571	0.4649	0.6245	0.6109	0.4331	0.3393	0.5382	0.5078	0.6698	0.5240	0.2612	0.6281	0.4656
Hungary	0.0210	0.0080	0.0264	0.0059	0.0086	0.0356	0.0000	0.0021	0.0062	0.0080	0.0015	0.0248	0.0589	0.0233	0.0016	0.0529	0.0086	0.0057	0.0088	0.0285	0.0064	0.0040
India	0.0029	0.0273	0.0021	0.0047	0.0010	0.0162	0.0016	0.0000	0.0017	0.0017	0.0030	0.0022	0.0054	0.0114	0.0365	0.0010	0.0060	0.0169	0.0089	0.0139	0.0126	0.0288
Latvia	0.0007	0.0003	0.0012	0.0036	0.0623	0.0021	0.0009	0.0002	0.0000	0.0700	0.0015	0.0040	0.0001	0.0046	0.0000	0.0011	0.0040	0.0006	0.0004	0.0039	0.0010	0.0003
Lithuania	0.0016	0.0007	0.0021	0.0066	0.0523	0.0038	0.0015	0.0004	0.1186	0.0000	0.0022	0.0104	0.0005	0.0180	0.0002	0.0012	0.0044	0.0013	0.0019	0.0091	0.0015	0.0008
Norway	0.0015	0.0071	0.0073	0.0564	0.0204	0.0316	0.0029	0.0041	0.0189	0.0160	0.0000	0.0107	0.0048	0.0078	0.0010	0.0024	0.0735	0.0042	0.0061	0.0041	0.0388	0.0120
Poland	0.0175	0.0079	0.0563	0.0249	0.0259	0.0501	0.0369	0.0045	0.0510	0.0910	0.0190	0.0000	0.0229	0.0473	0.0016	0.0534	0.0247	0.0065	0.0148	0.0692	0.0113	0.0045
Romania	0.0444	0.0026	0.0078	0.0015	0.0007	0.0165	0.0243	0.0033	0.0008	0.0015	0.0020	0.0084	0.0000	0.0120	0.0014	0.0089	0.0025	0.0020	0.0269	0.0158	0.0034	0.0019
Russia	0.0851	0.0368	0.0325	0.0119	0.1284	0.0531	0.0492	0.0342	0.1260	0.1811	0.0086	0.0657	0.0447	0.0000	0.0023	0.0652	0.0184	0.0385	0.0914	0.3499	0.0142	0.0173
Saudi Arabia	0.0016	0.0223	0.0008	0.0028	0.0007	0.0159	0.0017	0.0337	0.0002	0.0008	0.0009	0.0010	0.0026	0.0011	0.0000	0.0004	0.0046	0.0054	0.0186	0.0069	0.0074	0.0371
Slovak Republic	0.0065	0.0015	0.0782	0.0028	0.0016	0.0160	0.0297	0.0009	0.0053	0.0040	0.0009	0.0204	0.0101	0.0173	0.0002	0.0000	0.0029	0.0024	0.0034	0.0154	0.0022	0.0014
Sweden	0.0081	0.0112	0.0136	0.1399	0.1109	0.0539	0.0133	0.0138	0.0673	0.0442	0.1521	0.0315	0.0083	0.0184	0.0115	0.0080	0.0000	0.0114	0.0155	0.0087	0.0279	0.0211
Switzerland	0.0126	0.0096	0.0141	0.0141	0.0046	0.0823	0.0126	0.0153	0.0086	0.0053	0.0066	0.0106	0.0099	0.0132	0.0129	0.0096	0.0136	0.0000	0.0204	0.0052	0.0190	0.0281
Turkey	0.0959	0.0113	0.0065	0.0078	0.0057	0.0316	0.0104	0.0133	0.0043	0.0122	0.0049	0.0099	0.0607	0.0542	0.0267	0.0068	0.0093	0.0158	0.0000	0.0592	0.0139	0.0119
Ukraine	0.0376	0.0051	0.0072	0.0021	0.0163	0.0068	0.0142	0.0082	0.0238	0.0239	0.0012	0.0188	0.0142	0.0780	0.0034	0.0136	0.0023	0.0022	0.0225	0.0000	0.0013	0.0022
United Kingdom	0.0277	0.0477	0.0385	0.0778	0.0526	0.2187	0.0387	0.0960	0.0894	0.0406	0.1686	0.0427	0.0428	0.0408	0.0595	0.0216	0.0851	0.0683	0.0811	0.0138	0.0000	0.1311
United States	0.0326	0.5026	0.0230	0.0549	0.0360	0.2005	0.0388	0.2749	0.0409	0.0369	0.0716	0.0213	0.0283	0.0751	0.3633	0.0208	0.0867	0.1106	0.0829	0.0320	0.1507	0.0000

Note: Trade weights are computed as averages of shares of exports and imports over the period 1999-2007. They are displayed in column by country/region. Each column, but not row, sums to 1.
Source: Direction of Trade Statistics, IMF.

Table 6: Augmented Dickey-Fuller Unit Root Test Statistics for Domestic and Foreign Variables

Variables	Bulg	Chin	Czec	Denm	Esto	EA	Hung	Indi	Latv	Lith	Norw
π^c	-1.84	—	-3.45	-3.44	-0.42	-2.39	-5.20	—	-3.67	-5.09	-1.94
$\Delta\pi^c$	-4.63	—	-3.97	-6.49	-3.03	-3.50	-9.80	—	-8.10	-6.89	-7.30
$\Delta^2\pi^c$	-4.60	—	-7.07	-7.11	-7.00	-5.55	-6.78	—	-5.02	-6.10	-9.35
π^h	-3.71	-0.40	-4.64	-4.02	-0.79	-6.88	-4.05	-2.52	0.43	-0.38	-6.71
$\Delta\pi^h$	-6.94	-5.23	-7.54	-6.66	-3.40	-4.02	-9.84	-8.17	-4.51	-4.59	-7.50
$\Delta^2\pi^h$	-6.09	-5.76	-8.22	-5.97	-7.99	-8.71	-8.76	-7.79	-4.08	-4.07	-7.11
i	-1.98	0.88	-1.74	-2.32	-0.49	-1.56	-2.31	-1.66	-2.05	-1.83	-1.40
Δi	-8.02	-4.54	-2.85	-2.54	0.52	-2.50	-5.66	-2.30	-3.55	-3.17	-1.59
$\Delta^2 i$	-6.99	-6.56	-6.36	-4.51	-2.55	-4.09	-9.26	-3.66	-5.71	-6.57	-3.79
e	-2.12	-1.62	-2.37	-2.96	-2.78	-3.11	-2.63	-2.47	-2.88	-2.97	-2.51
Δe	-7.86	-6.60	-7.18	-7.18	-4.87	-2.98	-8.05	-6.67	-2.38	-2.21	-7.36
$\Delta^2 e$	-4.24	-4.84	-7.77	-7.47	-6.83	-6.89	-9.00	-7.99	-7.23	-6.88	-8.64
y	-1.54	-1.63	-2.04	-3.72	1.51	-3.14	-1.21	-1.03	0.70	-0.72	-1.65
Δy	-2.23	-3.79	-3.42	-4.84	-2.68	-3.98	-4.51	-2.17	-1.57	-3.56	-9.27
$\Delta^2 y$	-6.85	-11.33	-6.74	-7.88	-7.45	-4.55	-10.62	-7.55	-7.07	-6.70	-6.65
π^{c*}	-4.17	-3.72	-2.18	-1.97	-4.88	-3.77	-2.43	-4.08	-3.04	-4.35	-2.91
$\Delta\pi^{c*}$	-2.73	-5.91	-3.25	-4.64	-3.40	-8.84	-2.54	-3.91	-4.17	-9.74	-4.10
$\Delta^2\pi^{c*}$	-5.14	-6.61	-6.34	-5.45	-6.55	-5.32	-6.13	-6.33	-6.31	-6.63	-6.45
π^{h*}	-2.00	-2.41	-2.22	-6.00	-3.59	-2.06	-1.74	-1.95	-3.14	-1.59	-2.01
$\Delta\pi^{h*}$	-6.28	-3.41	-7.76	-2.96	-2.79	-2.71	-2.74	-2.30	-9.89	-2.55	-2.68
$\Delta^2\pi^{h*}$	-5.51	-5.18	-6.04	-5.81	-5.42	-6.66	-5.81	-4.77	-7.33	-7.42	-7.09
i^*	-1.62	-2.03	-1.82	-1.35	-1.76	-1.66	-1.46	-2.04	-2.20	-1.74	-1.62
Δi^*	-5.23	-2.30	-2.41	-3.09	-1.74	-4.67	-5.42	-2.21	-1.59	-2.11	-2.68
$\Delta^2 i^*$	-13.35	-7.04	-5.84	-11.01	-6.12	-6.08	-5.14	-5.53	-6.74	-6.00	-3.66
y^*	-2.50	-2.70	-2.44	-2.42	-1.84	-3.05	-2.78	-2.90	-1.50	-2.30	-3.30
Δy^*	-2.11	-9.42	-2.42	-3.05	-2.40	-2.64	-2.87	-8.75	-2.86	-1.72	-3.32
$\Delta^2 y^*$	-7.15	-7.84	-6.35	-8.79	-6.86	-5.29	-5.04	-7.09	-6.44	-9.72	-3.07
p^f	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45
Δp^f	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36
$\Delta^2 p^f$	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22
p^o	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32
Δp^o	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33
$\Delta^2 p^o$	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20

Variables	Pola	Roma	Russ	Saud	Slov	Swed	Swit	Turk	Ukra	UK	US
π^c	-2.54	-2.63	-3.88	—	-3.70	-2.87	-5.28	-4.40	-2.99	-3.98	-4.09
$\Delta\pi^c$	-3.00	-7.77	-8.16	—	-3.60	-4.73	-5.57	-3.95	-3.40	-9.15	-7.95
$\Delta^2\pi^c$	-4.83	-6.97	-6.14	—	-5.88	-7.10	-6.32	-5.20	-7.56	-5.34	-6.12
π^h	-3.34	-2.55	-3.72	2.27	-3.60	-6.55	-8.72	-2.34	-3.71	-2.47	-2.98
$\Delta\pi^h$	-2.98	-3.64	-4.83	-1.07	-3.15	-7.41	-6.72	-4.17	-15.69	-3.92	-4.22
$\Delta^2\pi^h$	-4.51	-6.13	-7.30	-7.78	-10.21	-7.08	-6.12	-5.95	-6.47	-6.45	-5.03
i	-1.96	-1.87	-2.48	-2.49	-1.39	-2.15	-2.73	-2.34	-2.78	-1.71	-2.53
Δi	-2.29	-6.04	-5.32	-2.13	-6.61	-3.87	-3.60	-5.72	-3.33	-2.90	-2.85
$\Delta^2 i$	-3.89	-3.87	-6.30	-5.59	-4.24	-5.25	-4.87	-13.55	-7.38	-4.67	-10.09
e	-1.87	-1.24	-3.36	-1.97	-2.17	-1.87	-1.46	-1.14	-3.13	-2.82	-1.63
Δe	-7.44	-2.11	-2.88	-6.73	-6.09	-7.77	-7.41	-3.07	-4.51	-7.65	-7.39
$\Delta^2 e$	-6.36	-7.90	-4.67	-7.24	-7.32	-9.84	-6.89	-4.35	-4.16	-7.52	-4.57
y	-1.33	-2.55	-3.37	—	-0.70	-2.43	-0.94	-2.16	-1.16	-2.97	-2.94
Δy	-2.20	-2.81	-2.40	—	-2.44	-3.70	-4.76	-3.19	-1.58	-3.27	-4.21
$\Delta^2 y$	-8.69	-6.22	-5.60	—	-7.35	-4.07	-6.28	-10.06	-8.98	-6.79	-5.94
π^{c*}	-4.57	-1.87	-1.89	-1.78	-3.42	-2.25	-2.49	-5.49	-3.27	-2.30	-2.80
$\Delta\pi^{c*}$	-2.63	-2.66	-3.41	-3.89	-8.77	-4.28	-4.11	-3.77	-8.34	-2.27	-4.39
$\Delta^2\pi^{c*}$	-5.46	-5.89	-4.66	-6.30	-6.08	-5.26	-5.65	-5.33	-6.61	-6.12	-5.35
π^{h*}	-1.67	-1.94	-2.04	-2.14	-1.76	-3.89	-1.97	-2.01	-1.76	-2.25	-1.01
$\Delta\pi^{h*}$	-2.81	-3.08	-4.26	-3.52	-2.36	-2.48	-2.87	-1.97	-2.74	-3.65	-7.22
$\Delta^2\pi^{h*}$	-5.82	-6.38	-5.94	-5.22	-5.41	-7.36	-7.57	-7.68	-8.80	-5.96	-4.90
i^*	-1.39	-1.68	-1.10	-1.59	-1.81	-1.32	-1.25	-1.75	-1.81	-1.44	-1.22
Δi^*	-2.14	-4.96	-3.76	-3.73	-1.94	-3.20	-4.09	-7.35	-6.41	-3.24	-3.97
$\Delta^2 i^*$	-4.92	-13.51	-5.74	-12.61	-6.97	-5.57	-6.63	-8.09	-6.17	-12.02	-4.88
y^*	-2.52	-2.42	-1.79	-2.84	-1.90	-2.21	-2.63	-3.13	-3.01	-2.59	-1.92
Δy^*	-2.86	-2.33	-2.76	-8.30	-2.51	-6.49	-11.36	-2.44	-2.08	-5.42	-2.78
$\Delta^2 y^*$	-5.56	-6.40	-5.93	-7.00	-7.11	-9.52	-8.56	-5.43	-8.03	-8.01	-7.93
p^f	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45
Δp^f	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36	-3.36
$\Delta^2 p^f$	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22	-6.22
p^o	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32
Δp^o	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33	-8.33
$\Delta^2 p^o$	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20	-3.20

Note: The ADF statistics are based on univariate AR(p) models in the levels with p chosen according to the AIC, with a maximum lag order of 12. The sample period is 1999(3)-2007(12). The regressions for all the level variables include an intercept and a linear trend with the exception of the headline rate of inflation and of the nominal short-term interest rate variables, whose underlying regressions include only an intercept. The 95% critical value of the ADF statistics for regressions with trend is -3.17, and for regressions without trend -2.59.

Table 7: Weighted Symmetric ADF Unit Root Test Statistics for Domestic and Foreign Variables

Variables	Bulg	Chin	Czec	Denm	Esto	EA	Hung	Indi	Latv	Lith	Norw
π^c	-2.27	—	-2.81	-3.57	-1.11	-2.13	-5.12	—	-2.89	-4.84	-2.23
$\Delta\pi^c$	-5.12	—	-4.32	-6.81	-3.37	-3.63	-9.99	—	-8.08	-7.08	-7.14
$\Delta^2\pi^c$	-4.11	—	-7.07	-4.98	-7.41	-5.94	-6.71	—	-5.27	-5.23	-4.70
π^h	-3.96	-0.80	-4.79	-3.84	-1.18	-7.03	-3.93	-2.80	-0.08	-0.89	-6.82
$\Delta\pi^h$	-7.12	-4.82	-7.88	-7.02	-3.79	-4.25	-10.08	-6.84	-4.99	-5.01	-7.87
$\Delta^2\pi^h$	-5.28	-1.62	-7.66	-2.51	-8.61	-5.13	-9.08	-7.98	-4.01	-4.29	-7.56
i	-2.23	0.10	0.16	-2.58	-1.54	-1.62	-0.67	-1.89	-2.44	-0.72	-1.42
Δi	-8.34	-3.44	-2.94	-2.87	-0.45	-2.83	-5.82	-2.69	-3.62	-3.18	-1.86
$\Delta^2 i$	-7.58	-6.73	-6.31	-4.69	-2.05	-3.62	-9.50	-3.06	-5.86	-5.63	-4.10
e	-2.33	-1.83	-2.60	-1.29	-1.78	-1.92	-2.68	-2.72	-0.03	-0.85	-2.72
Δe	-8.05	-6.77	-7.28	-7.24	-4.86	-2.96	-8.19	-6.85	-1.73	-2.35	-7.45
$\Delta^2 e$	-4.56	-5.24	-7.86	-7.91	-7.24	-7.25	-9.11	-8.15	-7.39	-7.28	-8.89
y	-1.37	-1.15	-1.52	-3.17	-0.35	-2.38	-1.76	-0.38	-0.74	-1.61	-1.50
Δy	-1.99	-3.41	-2.96	-4.52	-2.29	-4.04	-4.24	-2.16	-1.91	-2.86	-9.44
$\Delta^2 y$	-7.19	-12.28	-3.54	-7.35	-6.60	-4.31	-8.21	-2.85	-6.61	-6.32	-7.09
π^{c*}	-3.23	-2.59	-1.64	-1.95	-1.98	-3.04	-1.47	-2.73	-2.66	-3.13	-2.89
$\Delta\pi^{c*}$	-2.94	-5.69	-3.29	-3.79	-2.71	-9.04	-2.40	-2.55	-3.60	-9.86	-2.92
$\Delta^2\pi^{c*}$	-5.00	-6.59	-6.84	-5.68	-6.45	-5.48	-6.68	-6.49	-6.04	-6.88	-6.44
π^{h*}	-0.35	-2.64	-2.01	-6.18	-3.65	-2.27	-1.58	-2.28	-3.27	-1.59	-2.33
$\Delta\pi^{h*}$	-6.61	-3.73	-7.83	-3.20	-3.06	-2.71	-3.08	-2.44	-10.13	-2.62	-2.50
$\Delta^2\pi^{h*}$	-4.84	-2.50	-4.02	-4.16	-4.35	-7.05	-4.05	-5.06	-7.09	-6.76	-6.28
i^*	-0.28	-1.41	-0.68	-1.59	-1.17	-0.46	-0.46	-1.17	-0.69	-0.54	-1.49
Δi^*	-4.66	-2.60	-2.66	-2.60	-1.89	-4.04	-2.90	-2.36	-1.82	-2.26	-2.89
$\Delta^2 i^*$	-13.31	-5.83	-4.96	-11.01	-6.16	-6.13	-4.87	-5.33	-6.42	-6.14	-3.43
y^*	-2.70	-2.96	-2.78	-2.59	-2.30	-3.28	-3.00	-3.12	-1.95	-2.27	-3.40
Δy^*	-2.38	-9.51	-2.67	-3.37	-2.50	-2.93	-3.18	-8.82	-2.68	-1.95	-3.58
$\Delta^2 y^*$	-7.62	-7.97	-6.98	-8.95	-7.47	-5.63	-5.56	-7.51	-6.67	-10.50	-3.29
p^f	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38
Δp^f	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67
$\Delta^2 p^f$	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68
p^o	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93
Δp^o	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15
$\Delta^2 p^o$	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23

Variables	Pola	Roma	Russ	Saud	Slov	Swed	Swit	Turk	Ukra	UK	US
π^c	-1.58	-2.33	-3.04	—	-3.55	-2.67	-5.50	-4.57	-3.08	-3.96	-4.31
$\Delta\pi^c$	-3.09	-7.97	-8.40	—	-3.90	-5.05	-5.97	-4.37	-3.76	-9.37	-8.25
$\Delta^2\pi^c$	-4.95	-7.39	-6.56	—	-6.35	-7.45	-4.41	-5.22	-8.17	-5.50	-4.83
π^h	-2.21	1.17	-1.40	1.29	-1.48	-6.57	-8.85	-2.29	-3.53	-2.80	-3.29
$\Delta\pi^h$	-2.71	-1.95	-3.76	-0.55	-3.20	-7.54	-7.09	-4.64	-15.97	-3.67	-4.55
$\Delta^2\pi^h$	-4.57	-2.07	-7.70	-8.09	-9.23	-4.17	-6.22	-6.27	-6.86	-6.53	-2.52
i	-1.88	1.16	-1.01	-1.40	-0.42	-2.19	-2.83	-2.21	0.91	-1.55	-2.53
Δi	-2.38	-1.52	-5.60	-2.47	-6.78	-3.84	-3.74	-6.02	-2.50	-3.24	-3.05
$\Delta^2 i$	-4.17	-2.69	-6.63	-4.58	-4.26	-4.14	-4.04	-13.85	-6.57	-4.29	-10.25
e	-2.13	0.04	-3.03	-1.45	-1.72	-1.77	-1.72	-0.50	-3.43	-3.01	-1.02
Δe	-7.57	-2.04	-3.15	-6.87	-5.59	-7.97	-7.48	-3.35	-2.53	-7.85	-7.58
$\Delta^2 e$	-6.84	-7.59	-4.42	-7.39	-7.18	-10.11	-7.29	-4.68	-4.35	-7.41	-4.74
y	-0.63	-0.67	-2.16	—	-1.48	-2.57	-1.30	-2.46	-1.83	-0.86	-3.19
Δy	-2.38	-0.68	-1.64	—	-2.44	-4.13	-4.87	-3.56	-1.82	-1.97	-4.75
$\Delta^2 y$	-8.85	-4.98	-5.22	—	-5.87	-3.65	-6.54	-10.01	-9.17	-7.06	-6.20
π^{c*}	-1.13	-1.96	-2.44	-2.14	-1.42	-2.04	-1.72	-1.59	-1.80	-2.43	-2.62
$\Delta\pi^{c*}$	-2.39	-2.73	-3.70	-3.26	-9.00	-3.42	-3.03	-2.88	-8.53	-2.57	-3.04
$\Delta^2\pi^{c*}$	-5.83	-5.78	-4.53	-6.55	-6.54	-4.59	-5.98	-5.51	-7.09	-6.27	-5.06
π^{h*}	-1.85	-1.52	-1.63	-2.37	-1.71	-4.08	-2.26	-2.22	-0.65	-2.22	-1.37
$\Delta\pi^{h*}$	-3.15	-3.38	-4.36	-3.27	-2.82	-2.65	-3.15	-2.27	-2.40	-3.95	-7.31
$\Delta^2\pi^{h*}$	-3.86	-4.53	-5.59	-4.52	-3.37	-6.19	-5.61	-7.28	-9.25	-3.33	-4.25
i^*	-0.86	-1.39	-0.11	-1.60	-0.73	-1.48	-1.37	-0.46	-0.31	-1.61	-1.28
Δi^*	-2.17	-4.93	-2.75	-3.84	-1.88	-2.65	-3.55	-5.38	-5.90	-2.99	-3.30
$\Delta^2 i^*$	-5.12	-13.74	-5.88	-12.87	-6.49	-4.40	-5.88	-7.11	-6.61	-12.18	-4.55
y^*	-2.87	-2.76	-2.23	-3.11	-2.01	-1.95	-2.74	-3.16	-2.09	-2.61	-2.33
Δy^*	-3.17	-2.60	-3.05	-8.45	-2.65	-6.71	-11.39	-2.74	-1.59	-5.68	-2.89
$\Delta^2 y^*$	-6.13	-6.92	-6.45	-7.35	-6.31	-9.80	-8.76	-5.72	-8.44	-8.21	-8.40
p^f	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38
Δp^f	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67	-3.67
$\Delta^2 p^f$	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68	-6.68
p^o	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93	-1.93
Δp^o	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15	-8.15
$\Delta^2 p^o$	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23	-2.23

Note: The WS statistics are based on univariate AR(p) models in the levels with p chosen according to the AIC, with a maximum lag order of 12. The sample period is 1999(3)-2007(12). The regressions for all the level variables include an intercept and a linear trend with the exception of the headline rate of inflation and of the nominal short-term interest rate variables, whose underlying regressions include only an intercept. The 95% critical value of the WS statistics for regressions with trend is -3.24, and for regressions without trend -2.55.

Table 8: Cointegration Rank Statistics

Country	Eigenvalues	Trace				Maximum Eigenvalue			
		H0	H1	Statistics	95% Critical values	H0	H1	Statistics	95% Critical values
Bulgaria	0.63	r=0	r>1	260.70	156.40	r=0	r=1	104.10	57.13
	0.49	r<1	r≥2	156.60	119.00	r<1	r=2	70.43	50.64
	0.33	r≤2	r≥3	86.20	85.44	r≤2	r=3	42.65	43.94
	0.28	r≤3	r≥4	43.55	55.50	r≤3	r=4	35.11	36.84
	0.08	r≤4	r≥5	8.44	28.81	r≤4	r=5	8.44	28.81
China	0.50	r=0	r>1	157.70	119.00	r=0	r=1	73.25	50.64
	0.32	r<1	r≥2	84.44	85.44	r<1	r=2	39.79	43.94
	0.25	r≤2	r≥3	44.65	55.50	r≤2	r=3	29.67	36.84
	0.13	r≤3	r≥4	14.98	28.81	r≤3	r=4	14.98	28.81
Czech Republic	0.54	r=0	r>1	257.30	156.40	r=0	r=1	81.48	57.13
	0.50	r<1	r≥2	175.80	119.00	r<1	r=2	72.91	50.64
	0.40	r≤2	r≥3	102.90	85.44	r≤2	r=3	53.34	43.94
	0.25	r≤3	r≥4	49.56	55.50	r≤3	r=4	30.08	36.84
	0.17	r≤4	r≥5	19.47	28.81	r≤4	r=5	19.47	28.81
Denmark	0.59	r=0	r>1	312.80	156.40	r=0	r=1	93.76	57.13
	0.56	r<1	r≥2	219.10	119.00	r<1	r=2	86.14	50.64
	0.49	r≤2	r≥3	132.90	85.44	r≤2	r=3	70.57	43.94
	0.31	r≤3	r≥4	62.36	55.50	r≤3	r=4	38.90	36.84
	0.20	r≤4	r≥5	23.46	28.81	r≤4	r=5	23.46	28.81
Estonia	0.58	r=0	r>1	264.90	156.40	r=0	r=1	90.58	57.13
	0.47	r<1	r≥2	174.30	119.00	r<1	r=2	67.09	50.64
	0.42	r≤2	r≥3	107.20	85.44	r≤2	r=3	56.95	43.94
	0.23	r≤3	r≥4	50.22	55.50	r≤3	r=4	28.02	36.84
	0.19	r≤4	r≥5	22.21	28.81	r≤4	r=5	22.21	28.81
euro area	0.59	r=0	r>1	270.00	156.40	r=0	r=1	92.91	57.13
	0.47	r<1	r≥2	177.10	119.00	r<1	r=2	65.85	50.64
	0.43	r≤2	r≥3	111.30	85.44	r≤2	r=3	59.79	43.94
	0.25	r≤3	r≥4	51.48	55.50	r≤3	r=4	29.51	36.84
	0.19	r≤4	r≥5	21.96	28.81	r≤4	r=5	21.96	28.81
Hungary	0.60	r=0	r>1	284.10	156.40	r=0	r=1	96.59	57.13
	0.50	r<1	r≥2	187.60	119.00	r<1	r=2	73.30	50.64
	0.41	r≤2	r≥3	114.30	85.44	r≤2	r=3	55.87	43.94
	0.32	r≤3	r≥4	58.38	55.50	r≤3	r=4	40.48	36.84
	0.16	r≤4	r≥5	17.91	28.81	r≤4	r=5	17.91	28.81
India	0.49	r=0	r>1	147.60	119.00	r=0	r=1	71.17	50.64
	0.29	r<1	r≥2	76.44	85.44	r<1	r=2	35.61	43.94
	0.21	r≤2	r≥3	40.83	55.50	r≤2	r=3	24.88	36.84
	0.14	r≤3	r≥4	15.95	28.81	r≤3	r=4	15.95	28.81
Latvia	0.55	r=0	r>1	239.10	156.40	r=0	r=1	83.25	57.13
	0.46	r<1	r≥2	155.80	119.00	r<1	r=2	64.21	50.64
	0.37	r≤2	r≥3	91.61	85.44	r≤2	r=3	48.45	43.94
	0.21	r≤3	r≥4	43.16	55.50	r≤3	r=4	24.87	36.84
	0.16	r≤4	r≥5	18.29	28.81	r≤4	r=5	18.29	28.81
Lithuania	0.69	r=0	r>1	314.20	156.40	r=0	r=1	121.80	57.13
	0.63	r<1	r≥2	192.40	119.00	r<1	r=2	103.30	50.64
	0.34	r≤2	r≥3	89.05	85.44	r≤2	r=3	43.54	43.94
	0.27	r≤3	r≥4	45.51	55.50	r≤3	r=4	32.90	36.84
	0.11	r≤4	r≥5	12.61	28.81	r≤4	r=5	12.61	28.81
Norway	0.59	r=0	r>1	246.50	156.40	r=0	r=1	94.29	57.13
	0.44	r<1	r≥2	152.20	119.00	r<1	r=2	59.98	50.64
	0.36	r≤2	r≥3	92.22	85.44	r≤2	r=3	46.87	43.94
	0.23	r≤3	r≥4	45.34	55.50	r≤3	r=4	27.45	36.84
	0.16	r≤4	r≥5	17.89	28.81	r≤4	r=5	17.89	28.81

Note: The null hypothesis (H0) indicates r cointegration vectors against the alternative hypothesis (H1) of (at most) $r+1$ cointegration vectors for the maximum eigenvalue (trace) test. r is choosen as the first non significant statistics, undertaking sequentially the test starting from $r=0$.

Table 9: (Continued) Cointegration Rank Statistics

Country	Eigenvalues	Trace				Maximum Eigenvalue			
		H0	H1	Statistics	95% Critical values	H0	H1	Statistics	95% Critical values
Poland	0.57	r=0	r>1	252.10	156.40	r=0	r=1	88.23	57.13
	0.44	r<1	r≥2	163.90	119.00	r<1	r=2	60.90	50.64
	0.33	r≤2	r≥3	103.00	85.44	r≤2	r=3	42.74	43.94
	0.31	r≤3	r≥4	60.26	55.50	r≤3	r=4	38.32	36.84
	0.19	r≤4	r≥5	21.94	28.81	r≤4	r=5	21.94	28.81
Romania	0.62	r=0	r>1	252.30	156.40	r=0	r=1	101.30	57.13
	0.41	r<1	r≥2	151.00	119.00	r<1	r=2	54.96	50.64
	0.33	r≤2	r≥3	96.02	85.44	r≤2	r=3	42.11	43.94
	0.26	r≤3	r≥4	53.90	55.50	r≤3	r=4	31.82	36.84
	0.19	r≤4	r≥5	22.09	28.81	r≤4	r=5	22.09	28.81
Russia	0.50	r=0	r>1	235.50	156.40	r=0	r=1	72.98	57.13
	0.47	r<1	r≥2	162.50	119.00	r<1	r=2	67.48	50.64
	0.33	r≤2	r≥3	95.00	85.44	r≤2	r=3	42.04	43.94
	0.30	r≤3	r≥4	52.97	55.50	r≤3	r=4	37.56	36.84
	0.14	r≤4	r≥5	15.40	28.81	r≤4	r=5	15.40	28.81
Saudi Arabia	0.37	r=0	r>1	101.20	85.44	r=0	r=1	47.83	43.94
	0.28	r<1	r≥2	53.33	55.50	r<1	r=2	34.99	36.84
	0.16	r≤2	r≥3	18.34	28.81	r≤2	r=3	18.34	28.81
Slovak Republic	0.57	r=0	r>1	264.40	156.40	r=0	r=1	88.72	57.13
	0.54	r<1	r≥2	175.70	119.00	r<1	r=2	80.55	50.64
	0.40	r≤2	r≥3	95.12	85.44	r≤2	r=3	53.13	43.94
	0.22	r≤3	r≥4	41.99	55.50	r≤3	r=4	26.30	36.84
	0.14	r≤4	r≥5	15.70	28.81	r≤4	r=5	15.70	28.81
Sweden	0.70	r=0	r>1	338.50	156.40	r=0	r=1	124.90	57.13
	0.63	r<1	r≥2	213.60	119.00	r<1	r=2	103.70	50.64
	0.43	r≤2	r≥3	109.90	85.44	r≤2	r=3	58.42	43.94
	0.34	r≤3	r≥4	51.49	55.50	r≤3	r=4	43.08	36.84
	0.08	r≤4	r≥5	8.42	28.81	r≤4	r=5	8.42	28.81
Switzerland	0.58	r=0	r>1	279.70	156.40	r=0	r=1	91.26	57.13
	0.51	r<1	r≥2	188.50	119.00	r<1	r=2	75.34	50.64
	0.40	r≤2	r≥3	113.10	85.44	r≤2	r=3	54.01	43.94
	0.37	r≤3	r≥4	59.11	55.50	r≤3	r=4	47.91	36.84
	0.10	r≤4	r≥5	11.21	28.81	r≤4	r=5	11.21	28.81
Turkey	0.52	r=0	r>1	210.90	156.40	r=0	r=1	77.27	57.13
	0.41	r<1	r≥2	133.60	119.00	r<1	r=2	55.05	50.64
	0.31	r≤2	r≥3	78.58	85.44	r≤2	r=3	38.30	43.94
	0.23	r≤3	r≥4	40.29	55.50	r≤3	r=4	26.93	36.84
	0.12	r≤4	r≥5	13.36	28.81	r≤4	r=5	13.36	28.81
Ukraine	0.59	r=0	r>1	257.90	156.40	r=0	r=1	93.35	57.13
	0.49	r<1	r≥2	164.60	119.00	r<1	r=2	70.69	50.64
	0.41	r≤2	r≥3	93.87	85.44	r≤2	r=3	54.53	43.94
	0.21	r≤3	r≥4	39.34	55.50	r≤3	r=4	25.02	36.84
	0.13	r≤4	r≥5	14.31	28.81	r≤4	r=5	14.31	28.81
United Kingdom	0.41	r=0	r>1	157.60	156.40	r=0	r=1	56.05	57.13
	0.32	r<1	r≥2	101.60	119.00	r<1	r=2	39.90	50.64
	0.23	r≤2	r≥3	61.66	85.44	r≤2	r=3	27.31	43.94
	0.21	r≤3	r≥4	34.35	55.50	r≤3	r=4	24.74	36.84
	0.09	r≤4	r≥5	9.60	28.81	r≤4	r=5	9.60	28.81
United States	0.60	r=0	r>1	290.00	212.40	r=0	r=1	97.50	63.61
	0.51	r<1	r≥2	192.50	171.30	r<1	r=2	74.19	57.38
	0.34	r≤2	r≥3	118.40	134.20	r≤2	r=3	43.30	51.10
	0.24	r≤3	r≥4	75.06	101.00	r≤3	r=4	29.34	44.71
	0.19	r≤4	r≥5	45.72	71.56	r≤4	r=5	21.49	38.15
	0.12	r≤5	r≥6	24.23	45.90	r≤5	r=6	13.27	31.28
	0.10	r≤6	r≥7	10.96	23.63	r≤6	r=7	10.96	23.63

Note: The null hypothesis (H0) indicates r cointegration vectors against the alternative hypothesis (H1) of (at most) $r+1$ cointegration vectors for the maximum eigenvalue (trace) test. r is choosen as the first non significant statistics, undertaking sequentially the test starting from $r=0$.

Table 10: Average Pair-Wise Cross-Section Correlations of all Variables and Associated Model's Residuals

Country	Core Inflation				Headline Inflation			
	Levels	1st diff.	VAR Resids	VARX* Resids	Levels	1st diff.	VAR Resids	VARX* Resids
Bulg	0.06	0.03	0.01	0.02	0.10	0.02	0.08	0.02
Chin	—	—	—	—	0.09	0.05	0.06	0.01
Czec	0.06	0.03	0.01	0.00	0.20	0.08	0.13	0.01
Denm	0.03	0.01	-0.01	0.00	0.22	0.15	0.20	0.01
Esto	0.03	0.00	-0.02	0.01	0.23	0.12	0.11	-0.01
EA	0.04	-0.02	0.01	0.04	0.27	0.20	0.23	0.04
Hung	0.04	0.03	0.04	0.03	0.12	0.05	0.06	0.00
Indi	—	—	—	—	-0.06	-0.07	-0.04	0.00
Latv	-0.06	0.00	0.01	0.02	0.15	0.08	0.10	0.01
Lith	0.00	-0.01	0.00	0.01	0.16	0.08	0.10	0.03
Norw	0.07	0.04	0.02	0.02	0.14	0.07	0.08	-0.04
Pola	0.02	0.00	0.00	0.01	0.21	0.11	0.12	0.00
Roma	0.05	0.01	0.01	0.03	0.01	-0.03	-0.05	-0.02
Russ	0.01	-0.05	-0.02	-0.01	0.09	0.07	0.08	-0.07
Saud	—	—	—	—	0.03	-0.04	-0.04	0.01
Slvk	0.01	0.03	0.04	0.06	0.09	0.05	0.08	0.00
Swed	0.05	-0.03	0.01	0.02	0.20	0.14	0.18	0.00
Swit	0.02	0.00	0.01	0.01	0.21	0.13	0.16	0.00
Turk	0.06	-0.03	-0.03	-0.01	0.06	0.06	0.07	0.04
Ukra	0.01	0.02	0.01	-0.01	0.11	0.10	0.03	0.01
UK	-0.04	-0.01	-0.01	0.04	0.12	0.09	0.06	-0.03
US	0.04	0.00	0.00	0.03	0.20	0.16	0.15	0.03

Note: VAR residuals are based on cointegrating VAR models with domestic variables only and food and oil prices. VARX* residuals refer to the country models with country-specific foreign variables.

Table 11: (Continued). Average Pair-Wise Cross-Section Correlations of all Variables and Associated Model's Residuals

Country	Short-Term Interest Rate				Industrial Production Index				Effective Exchange Rate			
	Levels	1st diff.	VAR Resids	VARX* Resids	Levels	1st diff.	VAR Resids	VARX* Resids	Levels	1st diff.	VAR Resids	VARX* Resids
Bulg	0.33	0.07	0.07	0.06	0.08	0.26	0.22	0.02	0.09	0.01	0.00	0.02
Chin	0.36	0.05	-0.02	-0.02	-0.01	-0.02	-0.05	-0.08	-0.04	0.02	0.00	0.01
Czec	0.61	0.13	0.02	0.04	0.08	0.32	0.27	0.02	0.11	0.04	0.03	0.04
Denm	0.59	0.19	0.10	0.07	0.03	0.16	0.10	-0.02	0.07	0.00	-0.01	0.00
Esto	0.58	0.06	0.08	0.08	0.06	0.33	0.26	0.04	0.08	-0.02	-0.03	-0.03
EA	0.58	0.26	0.15	0.10	-0.05	0.16	0.12	-0.12	0.07	-0.13	-0.14	-0.15
Hung	0.34	0.03	0.02	0.03	0.11	0.33	0.28	0.05	0.10	0.09	0.08	0.08
Indi	0.56	0.25	0.15	0.11	-0.01	0.17	0.05	-0.02	-0.14	0.02	0.02	0.03
Latv	0.33	0.02	0.03	0.01	0.07	0.33	0.27	0.01	-0.14	0.01	0.04	0.03
Lith	0.48	0.05	0.05	0.00	0.07	0.26	0.21	-0.02	0.07	0.02	0.05	0.04
Norw	0.55	0.13	0.03	0.03	-0.05	0.05	0.02	0.00	0.11	0.04	0.03	0.04
Pola	0.54	0.02	-0.01	-0.02	0.07	0.38	0.30	0.01	0.07	0.07	0.06	0.05
Roma	0.44	-0.01	-0.04	-0.04	-0.08	0.07	0.07	-0.01	-0.15	0.07	0.10	0.11
Russ	0.41	0.02	0.03	-0.04	-0.06	0.20	0.19	-0.04	-0.03	0.02	0.02	0.02
Saud	0.47	0.15	0.10	0.06	—	—	—	—	-0.14	0.01	0.01	0.02
Slvk	0.47	0.03	0.04	0.04	0.13	0.32	0.25	0.01	0.10	0.06	0.06	0.06
Swed	0.43	0.13	0.07	0.04	0.07	0.03	0.02	-0.04	-0.04	0.02	0.03	0.03
Swit	0.53	0.08	0.00	0.01	-0.06	-0.05	0.02	0.00	0.06	0.04	0.02	0.05
Turk	0.41	0.03	0.01	-0.03	0.12	0.24	0.19	-0.03	-0.18	-0.03	-0.02	-0.04
Ukra	0.36	0.04	0.06	0.04	0.07	0.26	0.21	-0.02	-0.10	0.02	0.00	0.02
UK	0.41	-0.04	0.00	-0.02	-0.07	0.12	0.04	-0.03	0.03	0.00	0.00	-0.01
US	0.46	0.12	0.02	0.03	-0.07	-0.03	-0.02	-0.03	-0.14	0.00	-0.01	-0.01

Note: VAR residuals are based on cointegrating VAR models with domestic variables only and food and oil prices. VARX* residuals refer to the country models with country-specific foreign variables.

Table 12: Generalized Forecast Error Variance Decompositions: a Positive Standard Error Unit Shock to United States Headline Inflation

Months		0	1	2	4	8	12	24
Domestic Variables								
US	π^c	0.7	2.0	2.2	2.5	3.5	4.0	4.8
	π^h	37.1	35.1	34.0	34.4	34.2	33.9	32.7
	i	0.1	0.1	0.1	0.3	0.3	0.3	0.4
	e	0.1	0.1	0.9	1.6	1.4	1.4	1.4
	y	19.5	24.0	24.4	24.3	25.5	26.2	27.8
	US Vars	57.4	61.3	61.6	63.1	65.0	65.9	67.1
Foreign Variables								
Global variables	p^f	0.0	0.0	0.0	0.1	0.1	0.1	0.2
	p^o	7.4	4.8	3.3	2.6	2.1	1.9	1.7
	GLB Vars	7.4	4.8	3.4	2.6	2.2	2.1	1.9
euro area	π^c	0.2	0.2	0.2	0.4	0.6	0.8	1.1
	π^h	10.6	8.8	9.5	9.0	8.0	7.2	5.7
	i	0.2	0.5	0.3	0.1	0.0	0.0	0.0
	e	0.1	0.2	0.2	0.2	0.3	0.4	0.4
	y	1.1	1.1	1.0	1.0	1.2	1.3	1.6
	EA Vars	12.3	10.8	11.2	10.7	10.1	9.7	8.8
United Kingdom	π^c	0.2	0.2	0.1	0.1	0.1	0.1	0.0
	π^h	0.6	0.6	0.8	0.7	0.8	0.8	0.9
	i	0.1	0.1	0.1	0.1	0.1	0.1	0.0
	e	0.3	0.1	0.1	0.1	0.1	0.0	0.0
	y	1.8	2.1	2.0	2.0	2.1	2.2	2.3
	UK Vars	3.0	3.1	3.1	3.1	3.1	3.2	3.4
Other developed European countries	π^c	0.2	0.5	0.7	0.9	0.9	1.0	1.0
	π^h	4.4	4.1	4.4	4.1	3.6	3.2	2.5
	i	0.9	0.7	0.6	0.4	0.2	0.1	0.1
	e	0.4	0.4	0.3	0.3	0.2	0.2	0.2
	y	0.7	0.6	0.6	0.7	0.7	0.7	0.7
	OTH Vars	6.6	6.3	6.6	6.2	5.6	5.2	4.5
Baltic countries	π^c	0.9	1.2	1.4	1.4	1.3	1.2	1.2
	π^h	1.7	1.4	1.6	1.6	1.5	1.4	1.2
	i	0.4	0.4	0.4	0.5	0.6	0.6	0.8
	e	0.2	0.3	0.2	0.2	0.2	0.2	0.2
	y	0.2	0.1	0.1	0.2	0.2	0.2	0.3
	BALT Vars	3.4	3.4	3.7	3.9	3.7	3.7	3.6
Central Eastern European countries	π^c	1.3	1.1	1.2	1.1	0.9	0.8	0.7
	π^h	2.0	2.0	2.1	1.9	1.5	1.3	0.9
	i	0.5	0.4	0.3	0.3	0.4	0.4	0.5
	e	0.2	0.4	0.4	0.4	0.4	0.6	0.8
	y	0.1	0.1	0.1	0.3	0.3	0.3	0.4
	CEE Vars	4.1	4.0	4.1	3.9	3.6	3.4	3.3
South Eastern European countries	π^c	0.3	0.3	0.3	0.3	0.2	0.2	0.2
	π^h	0.1	0.4	0.5	0.6	0.6	0.5	0.5
	i	0.9	0.7	0.5	0.4	0.4	0.4	0.4
	e	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	y	0.0	0.1	0.2	0.4	0.6	0.7	0.9
	SEE Vars	1.3	1.5	1.6	1.7	1.8	1.8	2.0
Emerging European countries	π^c	0.2	0.2	0.1	0.2	0.3	0.3	0.4
	π^h	0.3	0.3	0.4	0.5	0.6	0.6	0.6
	i	0.0	0.1	0.1	0.2	0.2	0.1	0.1
	e	0.1	0.1	0.2	0.1	0.1	0.1	0.1
	y	0.1	0.1	0.1	0.2	0.2	0.2	0.3
	EM Vars	0.7	0.7	1.0	1.2	1.3	1.4	1.5
Developing Asian countries	π^h	0.1	0.1	0.4	0.4	0.6	0.8	1.3
	i	0.2	0.2	0.2	0.2	0.2	0.2	0.1
	e	0.4	0.3	0.4	0.5	0.5	0.5	0.5
	y	0.3	0.3	0.2	0.2	0.1	0.1	0.1
	DEV Vars	0.9	0.9	1.2	1.2	1.4	1.6	2.1
Middle Eastern countries	i	2.6	2.6	2.3	2.2	2.0	1.9	1.8
	e	0.0	0.2	0.1	0.1	0.1	0.1	0.1
	y	0.3	0.4	0.2	0.1	0.1	0.1	0.1
	MID Vars	2.9	3.1	2.7	2.4	2.2	2.1	1.9
	Non-US Vars	42.6	38.7	38.4	36.9	35.0	34.1	32.9
Total								
		100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 13: Generalized Forecast Error Variance Decompositions: a Positive Standard Error Unit Shock to euro area Headline Inflation

Months		0	1	2	4	8	12	24
Domestic Variables								
euro area	π^c	9.3	8.5	7.1	7.0	7.6	8.1	8.9
	π^h	34.7	28.4	26.2	25.2	23.5	22.1	18.7
	i	3.5	3.8	2.7	1.5	0.9	0.8	0.7
	e	1.2	5.1	6.7	8.1	9.6	10.4	11.8
	y	4.8	4.2	4.0	3.5	3.1	2.8	2.2
	EA Vars	53.6	50.0	46.7	45.5	44.8	44.1	42.3
Foreign Variables								
Global variables	p^f	0.1	0.1	0.1	0.2	0.2	0.2	0.2
	p^o	0.4	0.2	0.2	0.2	0.1	0.1	0.1
	GLB Vars	0.5	0.3	0.3	0.3	0.3	0.3	0.3
US	π^c	1.2	1.2	1.2	1.1	0.9	0.8	0.5
	π^h	7.6	6.8	7.4	7.8	8.2	8.4	8.4
	i	0.8	1.0	0.8	0.7	0.7	0.8	0.9
	e	0.0	0.1	0.4	0.5	0.5	0.5	0.5
	y	3.1	4.1	3.9	3.8	3.9	4.1	4.4
	US Vars	12.7	13.3	13.6	13.9	14.2	14.4	14.7
United Kingdom	π^c	0.0	0.2	0.2	0.2	0.3	0.3	0.3
	π^h	1.7	1.4	1.5	1.4	1.5	1.5	1.6
	i	0.3	0.5	0.4	0.3	0.3	0.3	0.2
	e	0.8	1.6	2.3	2.6	3.0	3.2	3.7
	y	0.3	0.5	0.4	0.3	0.3	0.2	0.2
	UK Vars	3.2	4.2	4.7	5.0	5.3	5.5	6.1
Other developed European countries	π^c	0.5	0.9	1.3	1.3	1.3	1.3	1.3
	π^h	4.2	3.8	3.7	3.5	3.3	3.1	2.7
	i	2.6	2.6	2.5	2.4	2.5	2.5	2.6
	e	0.6	0.6	0.8	0.9	0.9	0.9	1.0
	y	0.9	0.9	1.0	1.0	0.8	0.7	0.6
	OTH Vars	8.8	8.7	9.2	9.0	8.8	8.6	8.2
Baltic countries	π^c	0.1	0.2	0.3	0.3	0.4	0.4	0.6
	π^h	4.3	3.9	4.0	3.8	3.5	3.2	2.6
	i	0.5	0.4	0.4	0.6	0.9	1.1	1.5
	e	1.1	1.5	1.4	1.3	1.3	1.3	1.4
	y	0.4	0.5	0.5	0.5	0.4	0.4	0.3
	BALT Vars	6.4	6.5	6.6	6.6	6.5	6.5	6.5
Central Eastern European countries	π^c	0.3	0.4	0.8	1.1	0.9	0.9	0.7
	π^h	2.0	2.0	2.1	1.9	1.6	1.4	1.1
	i	0.4	0.3	0.4	0.5	0.3	0.3	0.4
	e	0.1	0.2	0.2	0.3	0.4	0.4	0.4
	y	0.2	0.2	0.4	0.4	0.5	0.6	0.8
	CEE Vars	3.0	3.2	3.9	4.2	3.7	3.6	3.4
South Eastern European countries	π^c	1.0	1.0	1.1	1.1	1.2	1.2	1.3
	π^h	0.7	0.7	0.7	0.7	0.7	0.7	0.6
	i	0.6	0.6	0.6	0.7	1.0	1.3	1.8
	e	0.5	0.7	0.9	1.1	1.2	1.3	1.5
	y	0.4	0.4	0.4	0.3	0.3	0.2	0.2
	SEE Vars	3.2	3.5	3.6	3.9	4.4	4.8	5.4
Emerging European countries	π^c	1.4	1.2	1.2	1.0	0.8	0.7	0.5
	π^h	0.8	1.0	1.1	1.0	0.9	0.9	0.8
	i	0.0	0.0	0.1	0.1	0.2	0.3	0.4
	e	0.4	0.4	0.3	0.3	0.2	0.2	0.2
	y	0.5	0.5	0.5	0.7	0.9	1.0	1.2
	EM Vars	3.2	3.1	3.1	3.1	3.0	3.0	3.1
Developing Asian countries	π^h	2.0	2.1	2.2	2.3	2.4	2.5	2.5
	i	1.0	1.3	1.4	1.5	1.6	1.7	1.9
	e	0.8	1.3	1.4	1.6	1.7	1.8	2.0
	y	0.4	0.4	0.5	0.5	0.5	0.5	0.6
	DEV Vars	4.3	5.1	5.5	5.9	6.2	6.5	7.0
Middle Eastern countries	i	0.3	0.6	0.5	0.4	0.4	0.3	0.2
	e	0.2	0.5	0.5	0.4	0.6	0.7	0.8
	y	0.7	1.1	1.5	1.7	1.7	1.7	1.9
	MID Vars	1.2	2.2	2.5	2.6	2.7	2.8	3.0
	Non-EA Vars	46.4	50.0	53.3	54.5	55.2	55.9	57.7
Total								
		100.0	100.0	100.0	100.0	100.0	100.0	100.0

Figure 3: Generalized Impulse Responses of United States

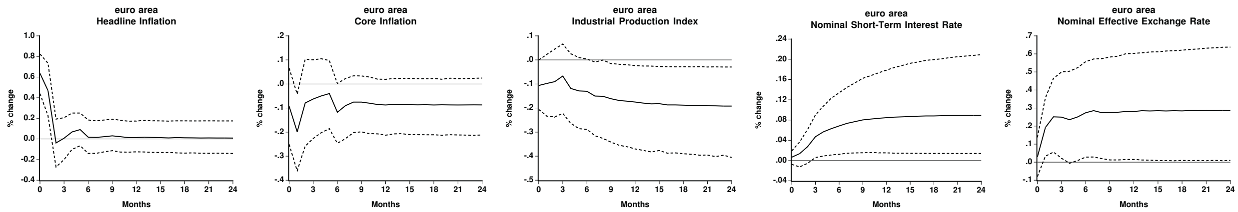
A) A Positive Unit (1 s.e.) Shock to Oil Price

B) A Positive Unit (1 s.e.) Shock to Food Price

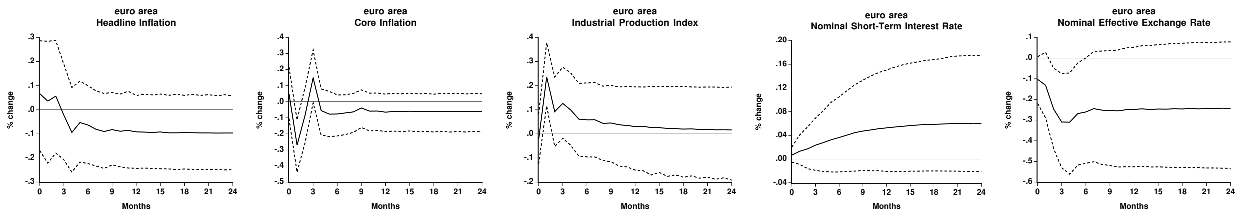
Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

Figure 4: Generalized Impulse Responses of euro area

A) A Positive Unit (1 s.e.) Shock to Oil Price



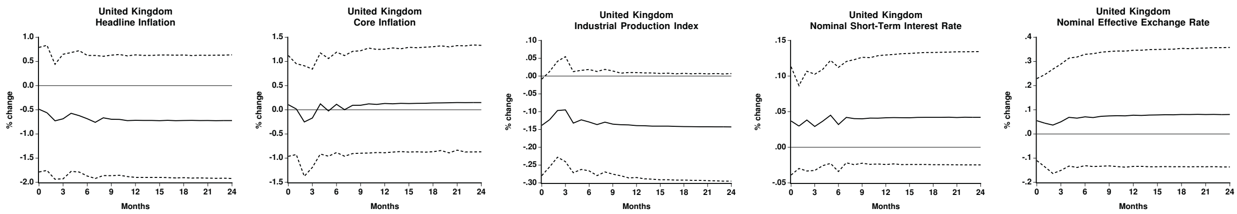
B) A Positive Unit (1 s.e.) Shock to Food Price



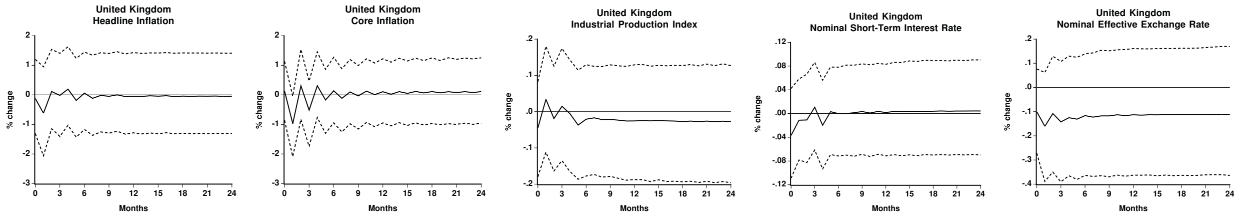
Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

Figure 5: Generalized Impulse Responses of United Kingdom

A) A Positive Unit (1 s.e.) Shock to Oil Price



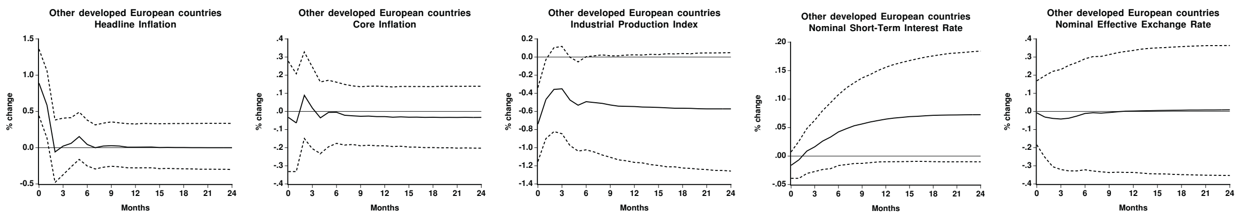
B) A Positive Unit (1 s.e.) Shock to Food Price



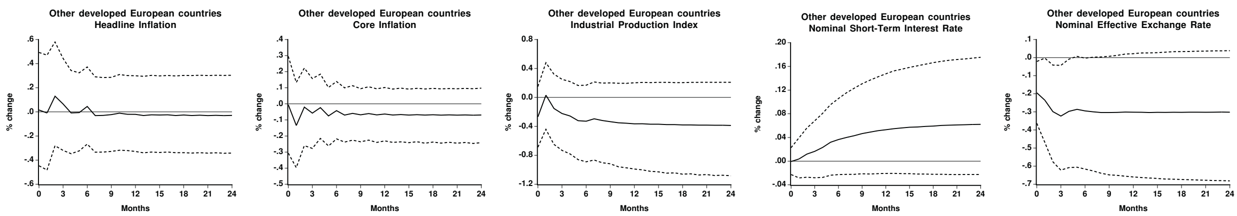
Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

Figure 6: Generalized Impulse Responses of Other Developed European Countries

A) A Positive Unit (1 s.e.) Shock to Oil Price



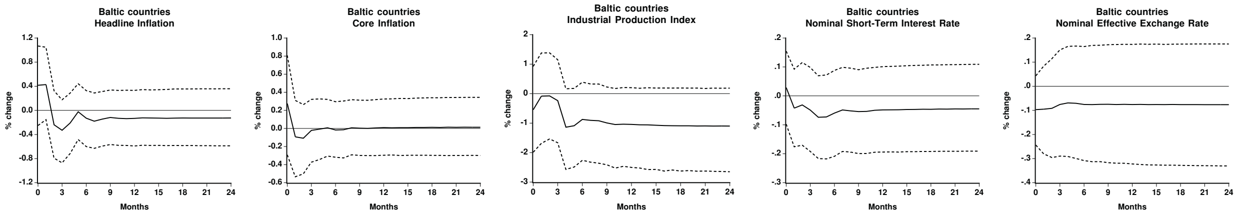
B) A Positive Unit (1 s.e.) Shock to Food Price



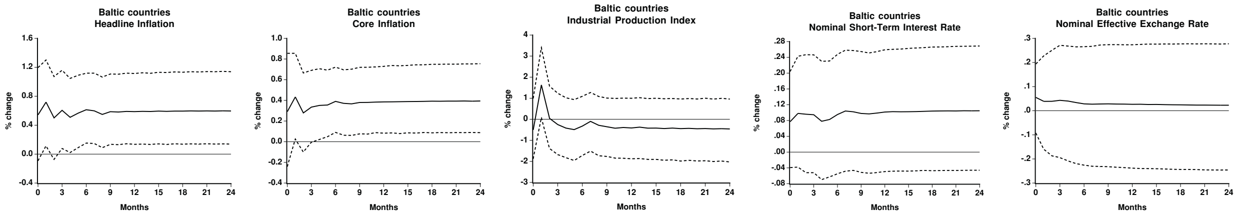
Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

Figure 7: Generalized Impulse Responses of Baltic Countries

A) A Positive Unit (1 s.e.) Shock to Oil Price



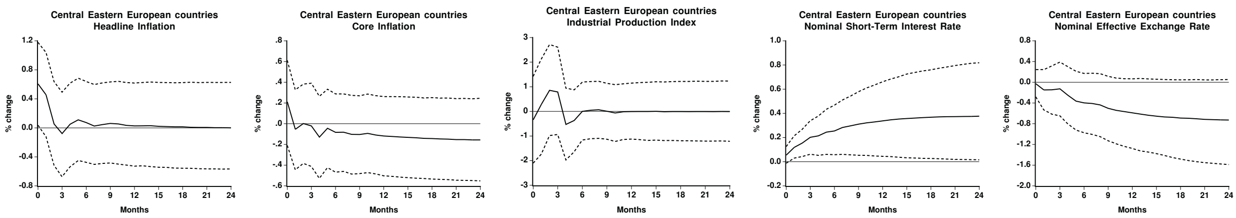
B) A Positive Unit (1 s.e.) Shock to Food Price



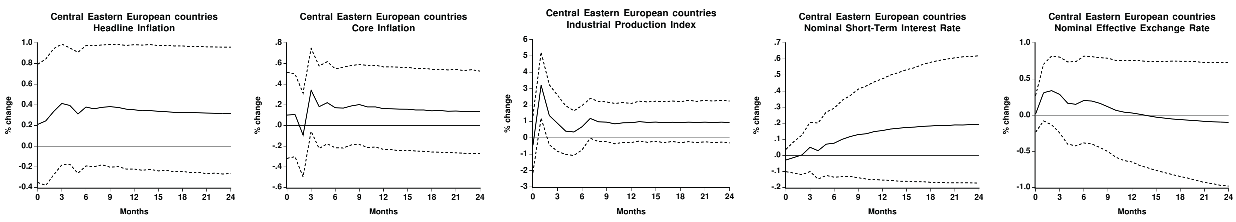
Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

Figure 8: Generalized Impulse Responses of Central Eastern European Countries

A) A Positive Unit (1 s.e.) Shock to Oil Price



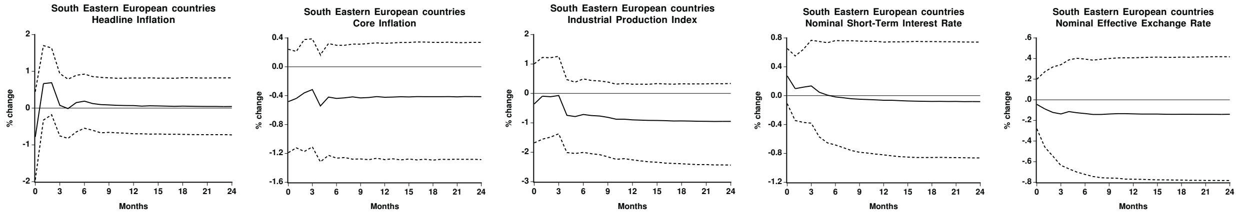
B) A Positive Unit (1 s.e.) Shock to Food Price



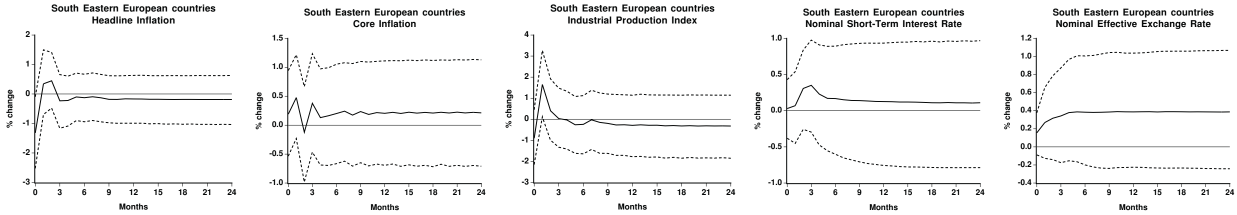
Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

Figure 9: Generalized Impulse Responses of South Eastern European Countries

A) A Positive Unit (1 s.e.) Shock to Oil Price



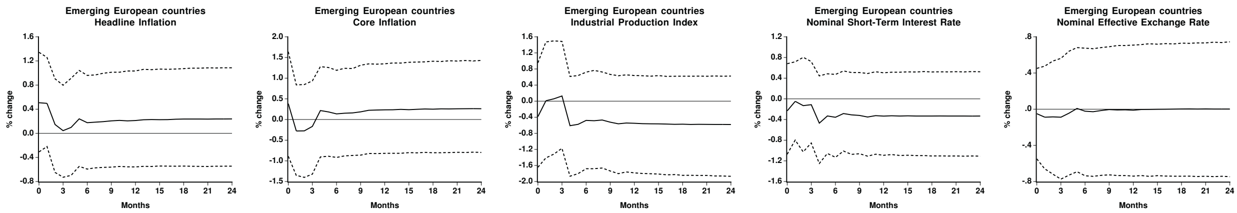
B) A Positive Unit (1 s.e.) Shock to Food Price



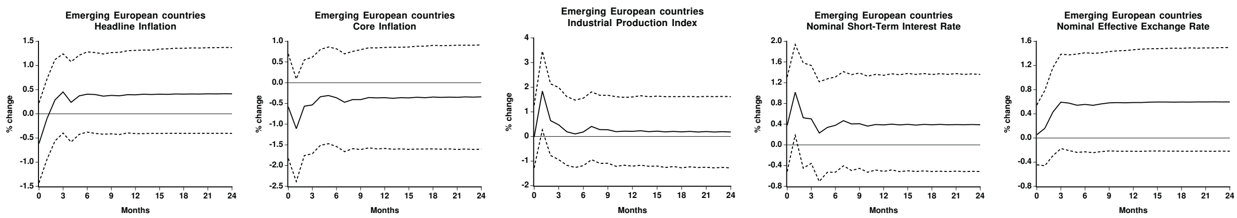
Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

Figure 10: Generalized Impulse Responses of Emerging European Countries

A) A Positive Unit (1 s.e.) Shock to Oil Price



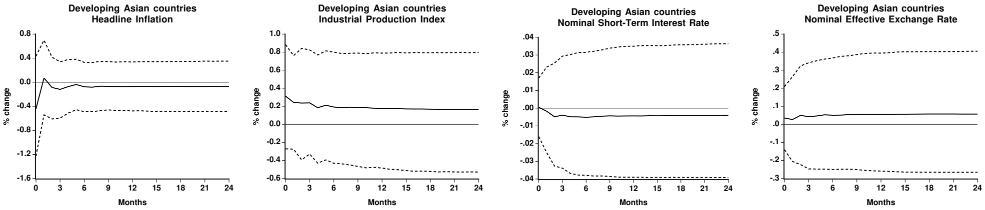
B) A Positive Unit (1 s.e.) Shock to Food Price



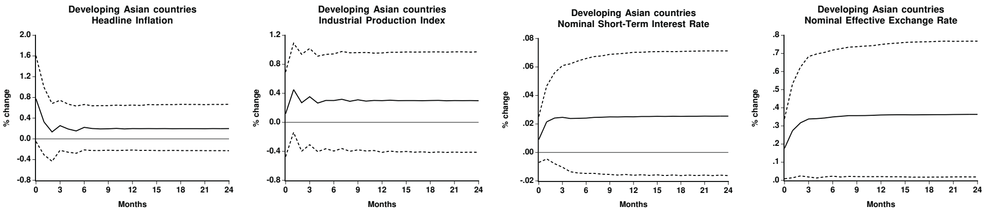
Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

Figure 11: Generalized Impulse Responses of Developing Asian Countries

A) A Positive Unit (1 s.e.) Shock to Oil Price



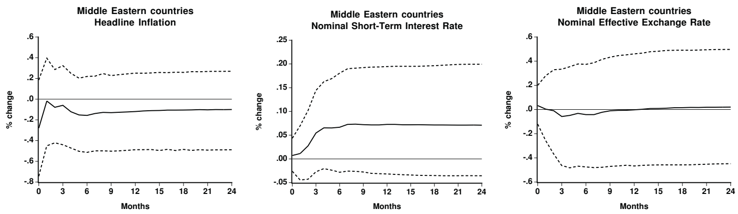
B) A Positive Unit (1 s.e.) Shock to Food Price



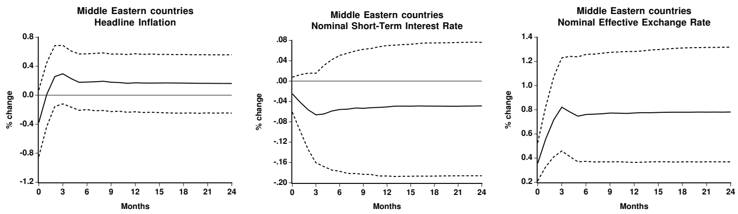
Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

Figure 12: Generalized Impulse Responses of Middle Eastern Countries

A) A Positive Unit (1 s.e.) Shock to Oil Price



B) A Positive Unit (1 s.e.) Shock to Food Price



Note: Bootstrap Mean Estimates and 90 percent Bootstrap Error Bounds, with 1000 replications.

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