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*Knut Are Aastveit, Francesco Furlanetto, Francesco Ravazzolo, Norges Bank Research**

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On the importance of foreign factors for the Norwegian economy*

Knut Are Aastveit† Francesco Furlanetto‡ Francesco Ravazzolo§

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1 Introduction

Commodity-exporting countries have seen a large improvement in their terms of trade in the last 20 years. In figure 1 we see this pattern for Canada, New Zealand, Australia and Norway. In Norway the terms of trade appreciation has been particularly large and its macroeconomic consequences can be potentially massive. The terms of trade, defined as the ratio between the price of exports over the price of imports, is a variable that is largely determined outside Norway in the international markets. However, although the terms of trade can be considered as exogenous to Norway (at least in the short run), it is important to recognize that they are determined endogenously in the rest of the world by a variety of shocks. In keeping with the terminology used by Kilian (2009) for oil shocks, not all terms of trade shocks are alike: terms of trade can respond to any kind of shocks originating in the world economy and transmitted to Norway through a

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†Address: Norges Bank, Bankplassen 2, PB 1179 Sentrum, 0107 Oslo, Norway. E-mail: Knut-Are.Aastveit@norges-bank.no. Telephone number: +47 22316121.

‡Address: Norges Bank, Bankplassen 2, PB 1179 Sentrum, 0107 Oslo, Norway. E-mail: francesco.furlanetto@norges-bank.no. Telephone number: +47 22316128.

§Address: Norges Bank and BI Norwegian Business School, Bankplassen 2, PB 1179 Sentrum, 0107 Oslo, Norway. E-mail: francesco.ravazzolo@norges-bank.no. Telephone number: +47 22316172

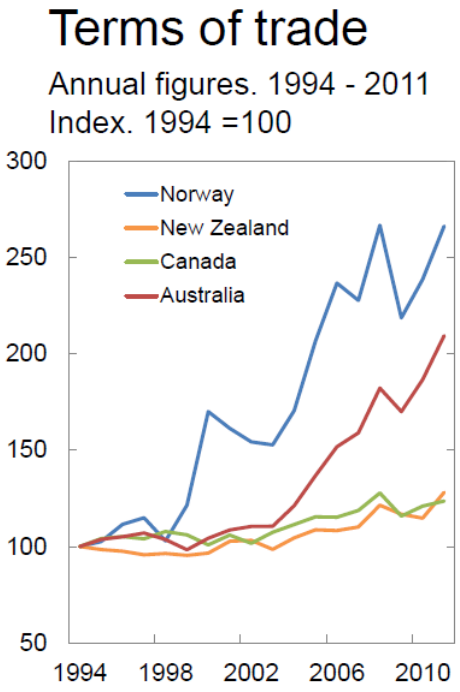


Figure 1: Terms of trade evolution over the period 1994-2010 in selected commodity producing countries.

variety of channels in the goods and financial markets. Therefore, it seems important to understand what kind of foreign shocks are driving the terms of trade appreciation, what are the consequences of these disturbances on the domestic variables and where these shocks are originating in the rest of the world (regional shocks or global shocks).

The objective of this note is to describe two recent studies that both quantify the importance of foreign factors for the Norwegian economy by using time series econometric models. Furlanetto, Ravazzolo and Sarferaz (2013) use a Vector Autoregression (VAR) while Aastveit, Bjørnland and Thorsrud (2011) use a Factor Augmented Vector Autoregression (FAVAR) to identify the foreign factors and their geographical origin. Both studies find that foreign disturbances are extremely important for the Norwegian economy: in fact, they explain more than 50 percent in the fluctuations of Norwegian macroeconomic variables. Notably, the studies reach similar conclusions using different methodologies. The VAR study uses few data series and focuses on the identification of specific disturbances. The FAVAR model exploits a large dataset and focuses on the geographical origin of the foreign disturbances.

The two studies are part of a recent literature that aims to quantify the importance of foreign factors for small open economies. Both studies build on previous literature that has a special focus on the Canadian economy and its proximity to the United States. Studies using a VAR subject to the exclusion restriction of no spillover from Canada to the United States, like Cushman and Zha (1997) and Justiniano and Preston (2010), find that United States disturbances account for a substantial fraction of fluctuations in Canadian output (almost 50 percent at medium horizons and around 75 percent at long horizons). Justiniano and Preston (2006) and Kose, Otrok and Whiteman (2003) find similar results using factor models which can be estimated using a large number of time series. Importantly, however, in these studies the foreign disturbances do not have a structural interpretation. More recently, the literature has considered a much larger set of small open economies and has made substantial progresses on the identification of specific foreign disturbances. The two studies reviewed in this note belong to this recent literature and identify a series of foreign shocks in several small open economies. In this note we focus on the results for Norway.

The first study on the importance of foreign factors for the Norwegian economy is a VAR estimated by Furlanetto, Ravazzolo and Sarferaz (2013). Their VAR includes three drivers of the terms of trade (a world demand shock, a world supply shock and a shock to the price of Norwegian exports) that are identified through sign restrictions imposed only on impact. Moreover, they identify also two domestic shocks, thereby extending the set-up proposed by Peersman and Van Robays (2012) to study different kinds of oil shocks on oil importing countries. A similar methodology is used also in Jaaskela and Smith (2011) and Karagedikli and Price (2013) in studies of terms of trade shocks in Australia and New Zealand. However, either of these papers, nor Peersman and Van Robays (2012), identify domestic shocks.

Aastveit, Bjørnland and Thorsrud (2011) explicitly introduce regional and global factors into a factor augmented VAR (FAVAR) model, thereby combining the new open economy FAVAR model proposed by Mumtaz and Surico (2009) with the recent findings of regional importance in the business cycle synchronization literature (see e.g. Stock and Watson

(2004) and Mumtaz, Simonelli and Surico (2011)). Aastveit, Bjørnland and Thorsrud (2011) identify global and regional price and activity shocks and study how they affect the Norwegian economy.

This note is organized as follows. Section 2 presents the VAR model by Furlanetto, Ravazzolo and Sarferaz (2013). Section 3 describes the FAVAR model by Aastveit, Bjørnland and Thorsrud (2011). Finally, Section 4 concludes.

2 A VAR model with foreign shocks

Furlanetto, Ravazzolo and Sarferaz (2013) evaluate the importance of foreign shocks for the Norwegian economy in a VAR estimated over the period 1985Q1-2012Q3. VAR models provide a flexible set-up to analyze the interactions between endogenous macroeconomic variables. In fact, macroeconomic shocks can be identified by imposing few restrictions on the data. In that sense, the empirical evidence provided by VAR models is often used as a validation tool for complex theoretical models that impose more structure on the data. A VAR can be summarized as a vector of macroeconomic variables that is regressed on a constant and on lagged values of the variables themselves. In our model the vector of endogenous variables is composed by GDP Mainland, CPI inflation, price of exports, price of imports and world output. We include five lags in the estimation procedure.

The residuals from the regression (reduced form residuals) can be transformed into interpretable economic shocks (structural residuals) by imposing some restrictions on the contemporaneous relationship between the endogenous macroeconomic variables. In our model we impose a minimum set of restrictions on the sign of the impact response of the endogenous variables to the identified shocks. Three foreign shocks are identified in the baseline version of the model: an aggregate demand shock in the rest of the world, an aggregate supply shock in the rest of the world and a shock to the price of Norwegian exports (largely reflecting fluctuations in the oil price that are unrelated to aggregate

demand). In addition to the foreign shocks, two domestic shocks are included in the model: a domestic demand shock and a domestic supply shock.

The following table summarizes the restrictions that are imposed in the estimation:

Table 1: Imposed sign restrictions

Variable \ shock	Supply	Demand	Price of exports	World supply	World demand
GDP Mainland	+	+	NA	NA	NA
CPI Inflation	-	+	NA	NA	NA
Price of Exports	0	0	+	+	+
Price of Imports	0	0	NA	-	+
World GDP	0	0	-	+	+

where NA means that the response of the variable is left unrestricted. Importantly, restrictions have been imposed only on impact. Notice that the series for export prices and import prices are converted into a basket of foreign currencies. Once abstracting from fluctuations in the exchange rate, import and export prices (and world output) are considered as exogenous to Norway by appealing to the small open economy assumption. As Norway is a small player in world markets (including the oil market), the exogeneity assumption seems relatively innocuous. While the restrictions on the domestic shocks are self-explaining, the restrictions imposed on foreign shocks deserve more attention.

The shock to the price of Norwegian exports can be largely interpreted as an oil shock: it has a positive impact on the price of exports and a negative impact on output in the rest of the world. It reflects fluctuations in oil prices that are specific to the oil market and that are not associated with variations in world demand. It might be driven by, for instance, political instability or natural disasters in commodity-exporter countries, unexpected changes in precautionary demand for oil or speculative trading. The world supply shock largely reflects the emergence of China as a dominant player in the international trade, leading to an increase in the supply of goods in the world economy. Higher supply of goods in the rest of the world translates in higher demand for raw materials that, in turn, leads to a higher demand for Norwegian exports (oil in particular). Therefore, the price for Norwegian exports increases. Finally, the increase in supply of goods puts a downward pressure on the price of Norwegian imports. The third foreign shock is a

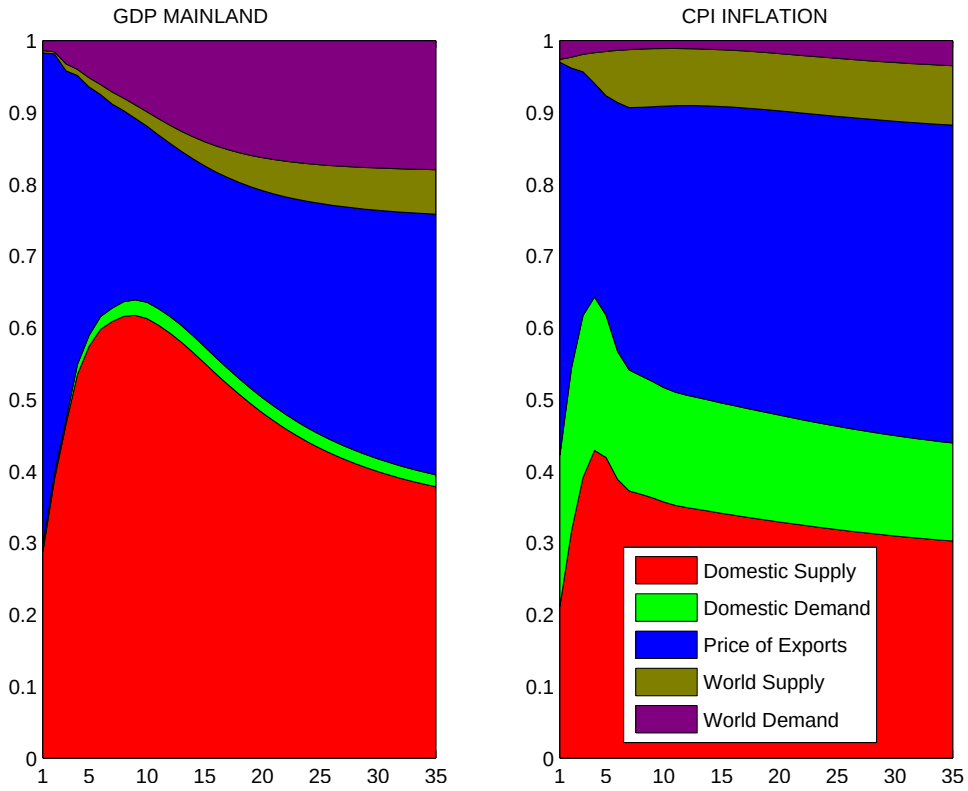


Figure 2: Variance decomposition of GDP Mainland and CPI Inflation at different horizons (from 1 to 35 quarters.

classic demand shock abroad that increases quantities (world GDP) and prices in the rest of the world (import prices, due to higher demand, and export prices, due to higher demand for energy).

Importantly, the terms of trade is considered as a variable that is exogenous to Norway, but determined endogenously in the rest of the world with all three foreign shocks contributing to fluctuations in the terms of trade.

The variance decomposition plotted in figure 2 describes the relative importance of the five identified shocks at different horizons (from zero to 35 quarters). The variance decomposition is a useful tool to quantify the relative importance of exogenous shocks in the fluctuations of endogenous variables, like GDP Mainland and CPI inflation. Two facts emerge clearly from the estimation. First, the three foreign shocks are extremely important for the Norwegian economy explaining jointly around 50 per cent of fluctuations in GDP Mainland and CPI inflation. Second, the domestic supply shock and the shock to the price of Norwegian exports are the dominant shocks in our sample and explain

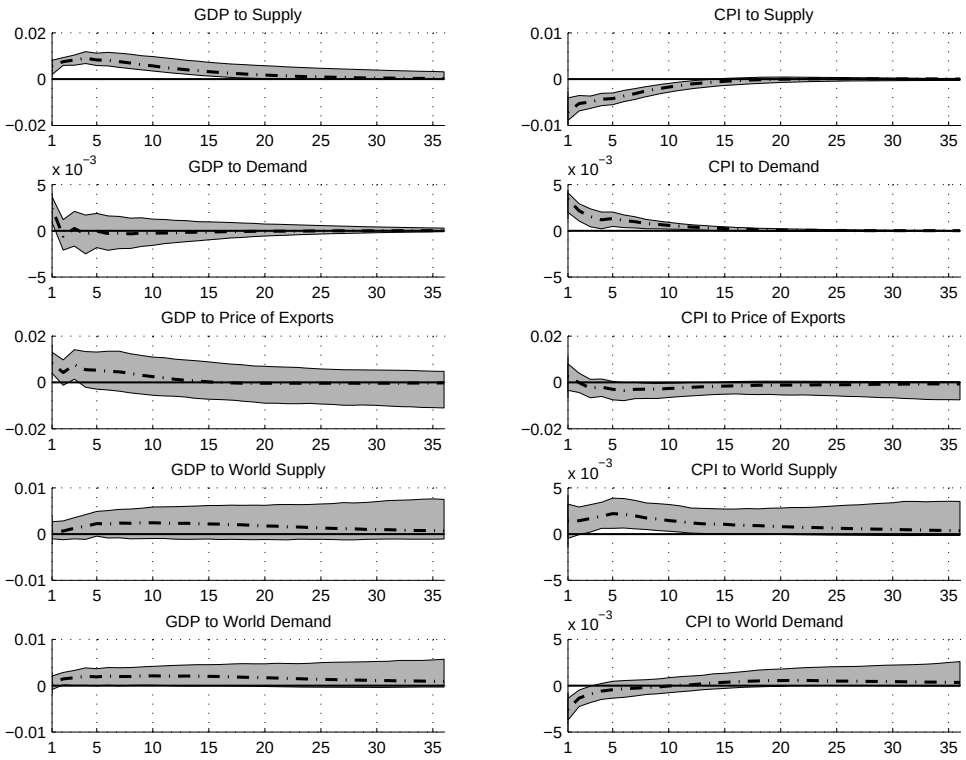


Figure 3: Impulse responses of GDP Mainland and CPI Inflation to the five shocks identified in the VAR.

jointly around 80% of fluctuations in GDP Mainland and CPI inflation.

In figure 3 we plot impulse responses of GDP Mainland and CPI inflation to the five identified shocks. Shaded areas identify the confidence interval at the 16 percent significance level. The domestic supply shock (unlike the domestic demand shock) is very well identified. The responses of GDP and CPI inflation to a supply shock are statistically significant for around 15 quarters when we imposed a positive response only on impact. This implies that the dynamics are driven by the data and not by the identifying assumption. The high degree of sectoral reallocation and the large increase in immigration may help explaining such an important role for supply factors in the Norwegian economy. This is not surprising, given that GDP Mainland and different measures of price inflation have been negatively correlated in Norway over our sample period.

By assumption all three foreign shocks imply an increase in the price of Norwegian exports on impact. Interestingly, all three shocks also lead to an improvement of the terms of trade (not plotted) which shows how an improvement in the terms of trade can be

consistent with many different disturbances coming from abroad. Quantitatively, the most important shock for the domestic variables is the shock to the price of Norwegian exports that can be interpreted essentially as an oil shock. A positive shock to the price of exports has a persistent positive effect on GDP Mainland whereas it has a positive effect on CPI inflation only on impact. The other two foreign shocks are quantitatively less important but they are not negligible: at medium horizon they explain jointly 20 percent of output fluctuations and 10 percent of inflation fluctuations. The world demand shocks raises Mainland GDP and lowers CPI inflation on the impact of the shock, in keeping with the unconditional correlation. Since import prices (measured in foreign currency) increase in response to the shock, the negative response of CPI inflation may be driven by an appreciation of the exchange rate. A world supply shock increases both GDP Mainland and CPI inflation, but the quantitative importance of this shock is rather limited.

Notice that the importance of foreign disturbances can be even larger than what our analysis suggests. Immigration flows are likely to be captured by the domestic supply shock but they could themselves be considered as a foreign factor that affects the domestic economy. Therefore, it is likely that the model might underestimate the importance of the foreign factors. Finally, the importance of the shock to the price of exports shows how the Norwegian economy is affected by shocks that are specific to the oil market (see also Bjørnland, 2000 and 2009). This feature differentiates the Norwegian economy from Australia and New Zealand where, according to Jaaskela and Smith (2011) and Karagedikli and Price (2013), shocks to the price of exports play a less important role. Moreover, in these countries foreign shocks seem to matter much less than in Norway, though this result might rely heavily on the fact that domestic shocks are not identified in Jaaskela and Smith (2011) and Karagedikli and Price (2013).

Finally, it is important to emphasize that the results described above are only the first step of a broader research agenda on business cycles in commodity-exporting small open economies. In the future we plan to analyze the effects of domestic and foreign shocks on the exchange rate to study the possible role of the Norwegian krone as a commodity currency (cf. Chen and Rogoff, 2003). We also plan to use different measures of economic

activity to measure the effects of shocks on different sectors to identify possible Dutch disease effects (cf. Charnavoki and Dolado, 2013). The role of immigration and sectoral reallocation in the Norwegian economy can be discussed by identifying the so-called matching efficiency shocks (cf. Furlanetto and Groshenny, 2012). Other shocks, both domestic and foreign, can potentially be included in the analysis (like monetary and financial shocks), although a larger number of identified shocks poses some computational challenges. Furthermore, it will be interesting to compare the results for Norway to other commodity-exporting countries: in that sense we are extending the analysis to Australia, Canada, Chile and New Zealand.

3 A FAVAR model with foreign shocks

Aastveit, Bjørnland and Thorsrud (2011) study the importance of foreign shocks to four small open economies (Canada, New Zealand, Norway and the U.K.).[1] While Kose, Otrok and Whiteman (2003) showed that a common global factor could account for a large fraction of business cycle fluctuations in many countries, more recent findings in the business cycle synchronization literature (see e.g. Stock and Watson (2004) and Mumtaz, Simonelli and Surico (2011) find that regional factors play a prominent role in explaining the evolution of the business cycle in different countries and regions. Motivated by this, Aastveit, Bjørnland and Thorsrud (2011) introduce global and regional factors into a FAVAR model and identify four foreign shocks; a global activity shock, a global price shock, a regional activity shock and a regional price shock. The FAVAR approach was first introduced by Bernanke, Boivin and Eliasz (2005) to study the effect of U.S. monetary policy shocks on the U.S macroeconomy, and later extended by Mumtaz and Surico (2009) to study how international shocks affect the U.K. macroeconomy.

Standard VAR models are restricted to only include a limited number of variables before running into problems with scarce degrees of freedom. This problem is often referred to as the "curse of dimensionality´´. The objective of factor models is to summarize the

[1] In this note, we will focus on the analysis of the Norwegian economy.

information contained in large data sets, while at the same time reducing their dimension, in other words, to reduce the parameter space. The idea of the FAVAR approach, is to augment a standard VAR model with additional information, comprised into a few common factors, and estimated from a large data set. The main advantages with the approach, is that it will be more robust to the omitted variable/information bias while also providing impulse responses to a wide range of variables based on few identified structural shocks.

In general, a FAVAR model consists of a VAR part and a factor model part. Once the unobserved factors are estimated (in the factor model part), they can be used as observable variables in a standard VAR. In the following, we will explain the model-setup in Aastveit, Bjørnland and Thorsrud (2011), and refer to the paper for more technical details.[2]

First, we estimate unobserved global, regional and domestic factors. This is essentially done using principal components block by block. That is, a global activity factor is estimated as the first principal component from a data set that includes GDP and industrial production series for a wide range of countries. A regional activity factor is then estimated as the first principal component from a set of euro area GDP and industrial production series. The regional activity (price) factor is restricted to be uncorrelated with the global activity (price) factor. Likewise, a global and regional price factor is estimated. In addition three domestic factors are estimated as the 3 first principal components of large data set containing 94 Norwegian macroeconomic variables. The 3 domestic factors are restricted to be uncorrelated with the global and regional factors.

In the second step, the estimated factors are used as observable variables in a standard VAR framework. The VAR is then estimated and four structural foreign shocks are identified using a block recursive (Cholesky identification) ordering of the variables, see Aastveit, Bjørnland and Thorsrud (2011) for details. In the model setup, global factors are ordered above the regional factors, and the domestic factors are ordered last. This

[2]The model we explain in this note, is an updated version of the model in Aastveit, Bjørnland and Thorsrud (2011).

implies that both global and regional factors cannot be affected on impact by the domestic shocks. In contrast, domestic factors are allowed to react immediately to both global and regional shocks. Furthermore, activity factors are ordered above price factors within each block. This is a common assumption in structural VAR analysis and implies that the activity factor in each block can only react to the identified price shock with a lag. However, price factors are allowed to react to activity shocks on impact.

The main motivation for distinguishing between global and regional shocks is to examine *if* and *how* common world and region specific shocks affect the domestic economies. In the business cycle literature, important papers such as, e.g., Frankel and Rose (1998) argue that trade is the most important channel transmitting foreign shocks (thereby making the countries that trade together more synchronized). An alternative view advocated by Imbs (2004), among others, is that business cycle resemblance does not require substantial trade between countries. Instead, common shocks across the world to, e.g., consumer sentiment, industries, or financial markets are what drive business cycles. This view of the business cycle awards a central role to expectations; consumers and firms continuously receive information about the future. Based on this information, they then decide on spending, which affects output and hence business cycle synchronization in the short run, see, e.g., Blanchard, L'Huillier and Lorenzoni (2013).

As mentioned above, one advantage with using a FAVAR model is that impulse responses and variance decomposition to all 94 domestic macroeconomic variables following the different global and regional shocks can be analyzed. This ensures a broad understanding of the potential heterogenous effects of the different foreign shocks. In the following, we start by presenting the results of the variance decomposition.

There is a large contribution from the foreign factors to the Norwegian economy. Taking the world and the regional factors together, on average about 50 percent of the variation in the 94 Norwegian macroeconomic variables are explained by the foreign factors on impact, increasing to about 60 percent after two years. Of these, shocks that are common to the world explain the largest proportion of the variance in the domestic variables (30 percent

on impact and 40 percent after two years). However, regional factors are also non-trivial, explaining approximately 20 percent of the variance in the domestic variables on impact and after two year.

Variance decompositions for a selection of variables (GDP, consumption, investment, export, import, consumer confidence, inflation, interest rate, stock prices, house prices, the exchange rate and terms of trade) are graphed in figure 4. The figure shows that common shocks to the world are particularly important for explaining the variance in CPI, investment, trade (export and import), terms of trade and asset prices, both on impact and over time. The regional shocks explain more of the variance in variables such as consumer confidence, imports, asset prices (house and stock prices) and the exchange rate. Note that regional shocks explain about 40 percent of the changes in house prices. This may indicate that regional shocks not only impact the economy through trade, but also through consumer sentiment.

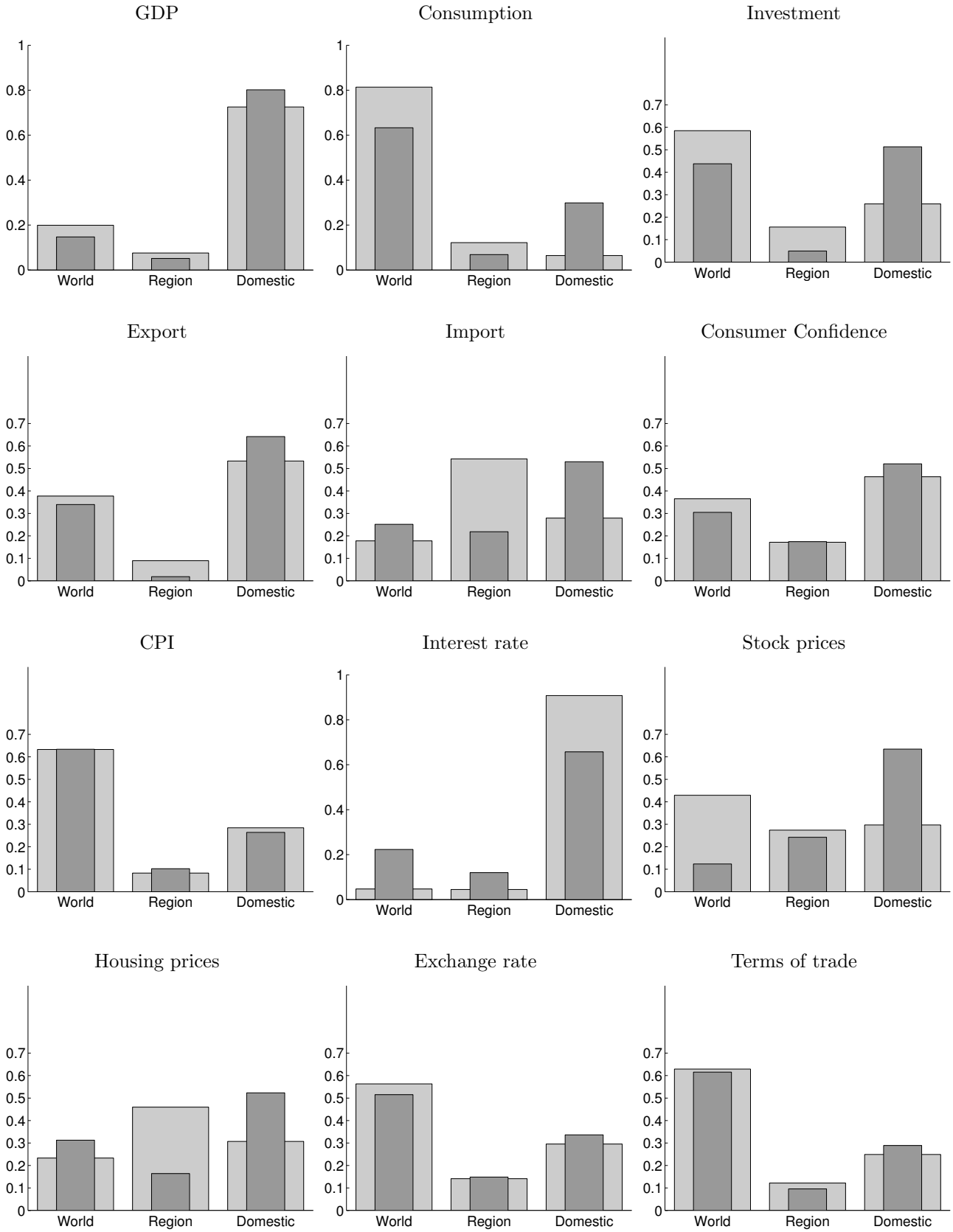
Figures 5-7 show impulse responses for the same 12 variables for three of the foreign shocks. We now go through the shocks one by one.

World activity shock. A positive shock to the world activity factor gradually increases GDP and inflation. As discussed above, an important channel through which the world activity shock affects these countries is trade. The shock has a positive effect on both exports and imports, although the effect is not statistically significant.

The world activity shock also has significant positive effects on consumer confidence, investment and stock prices. This suggests that expectations about the future are an important channel for the international drivers of business cycles. The effect on the exchange rate, however, is not significant, which is consistent with this being a shock common to the world.

All in all, a positive shock to world activity has the characteristics of a positive aggregate demand shock, increasing activity, wealth and prices.

Figure 4: **Variance decomposition**



Note: The bars display the variance decomposition for each variable and shock for horizons 1 and 8 quarters. The widest bars correspond to the shorter horizon.

World price shock. A world price shock (that increases world inflation) reduces the components of output substantially, while inflation picks up briefly in all countries. As a consequence, exports, imports, employment and asset prices gradually fall. Therefore, it seems that a world price shock can be interpreted as an adverse aggregate supply shock.

Terms of trade, however, increase temporarily due to higher export prices. The exchange rate also appreciates significantly. This could be because Norway is a net oil and gas exporter. If the adverse supply shock has the characteristics of an adverse oil price shock that increases oil prices, the response for Norway may be exchange rate appreciation. Consistent with this interpretation, investment also picks up substantially, as the demand for investment activities increases with higher energy prices.

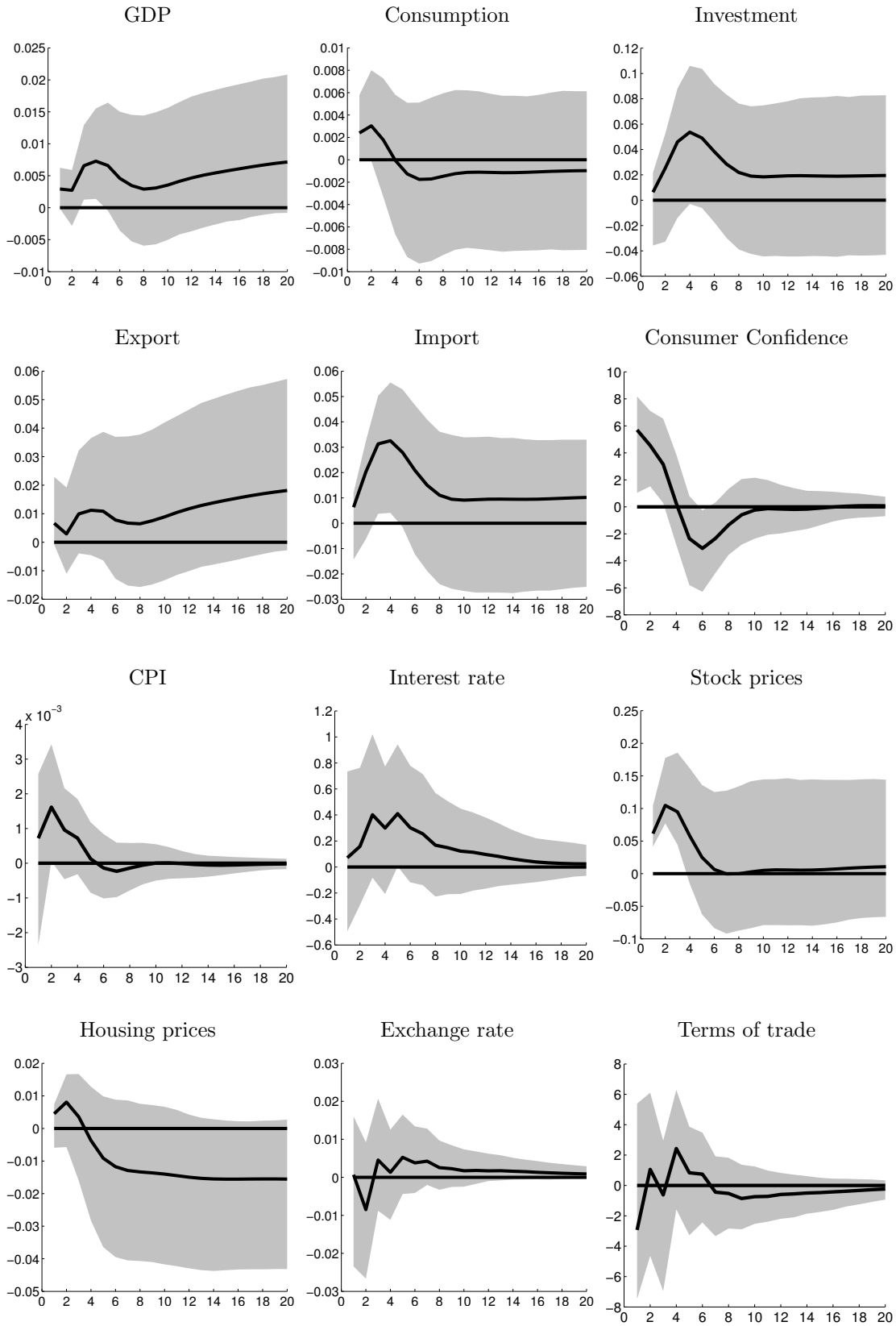
A world price shock has the characteristics of an aggregate supply shock, decreasing activity and wealth while increasing prices.

Regional activity shock. The regional activity shock is far more important than the regional price shock. It shares many characteristics with a world activity shock, increasing the components of output and inflation. The regional activity shock does not have significant effects on exports, investment or GDP. In fact, stock prices actually fall following a shock to European activity. Instead, consumer confidence, consumption and housing prices are directly affected.

That exports respond very little to the European activity shocks in Norway may seem at odds with the fact that the European Union as a whole is the most important trading partner for Norway. Two points should be noted here. First, Norway's exports of goods to the EU is concentrated in primary products, of which a large share is the supply of energy, which is not particularly price or income elastic. Second, the share of traditional goods exports (excluding energy) is rather small, making the economy less influenced by trade overall.

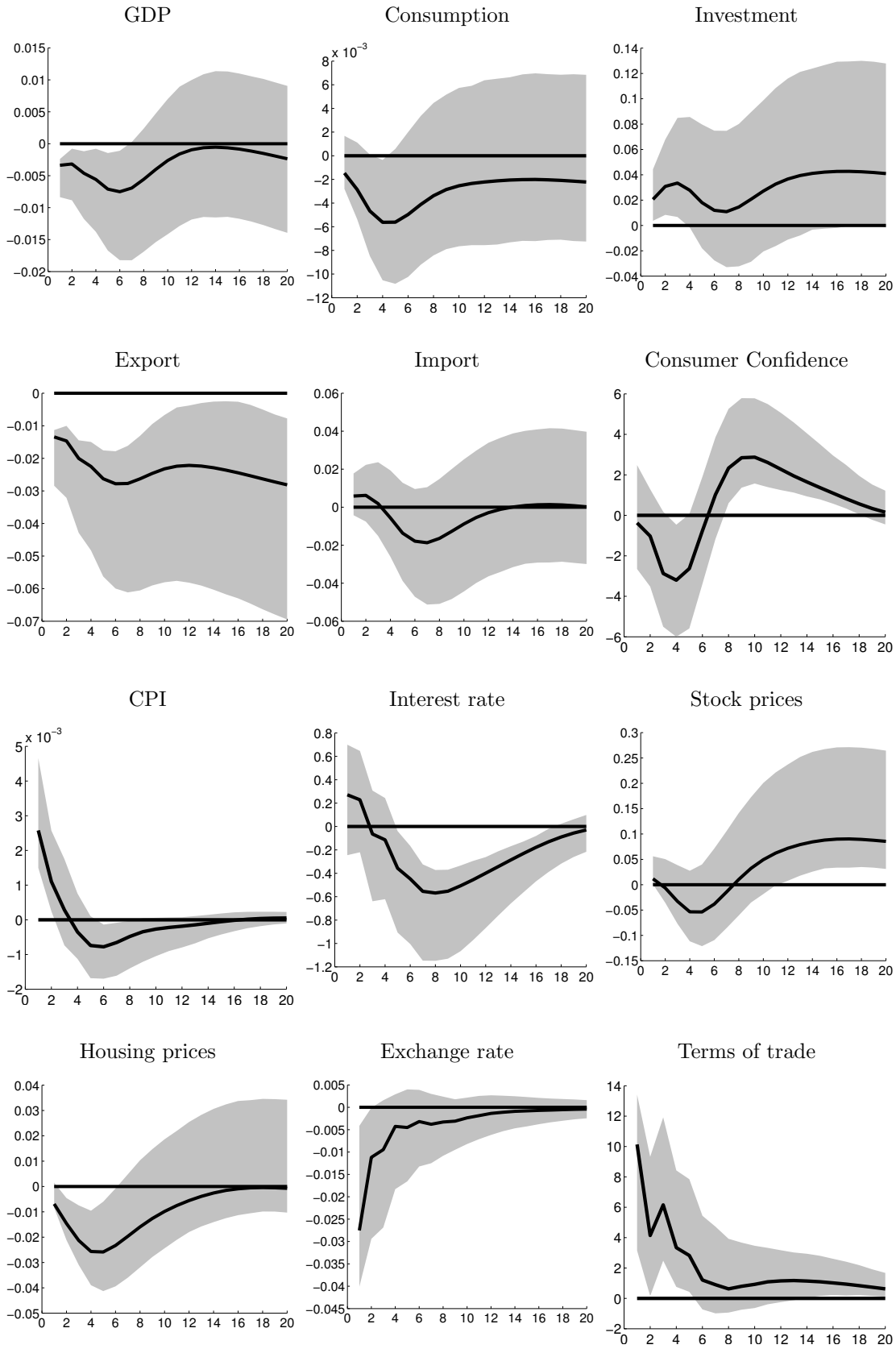
In sum, Aastveit, Bjørnland and Thorsrud (2011) find that the world activity shock has the characteristics of a positive aggregate demand shock, stimulating trade, activity, employment, wealth and prices. A world price shock, however, reduces the components

Figure 5: **Impulse responses - Global activity shock**



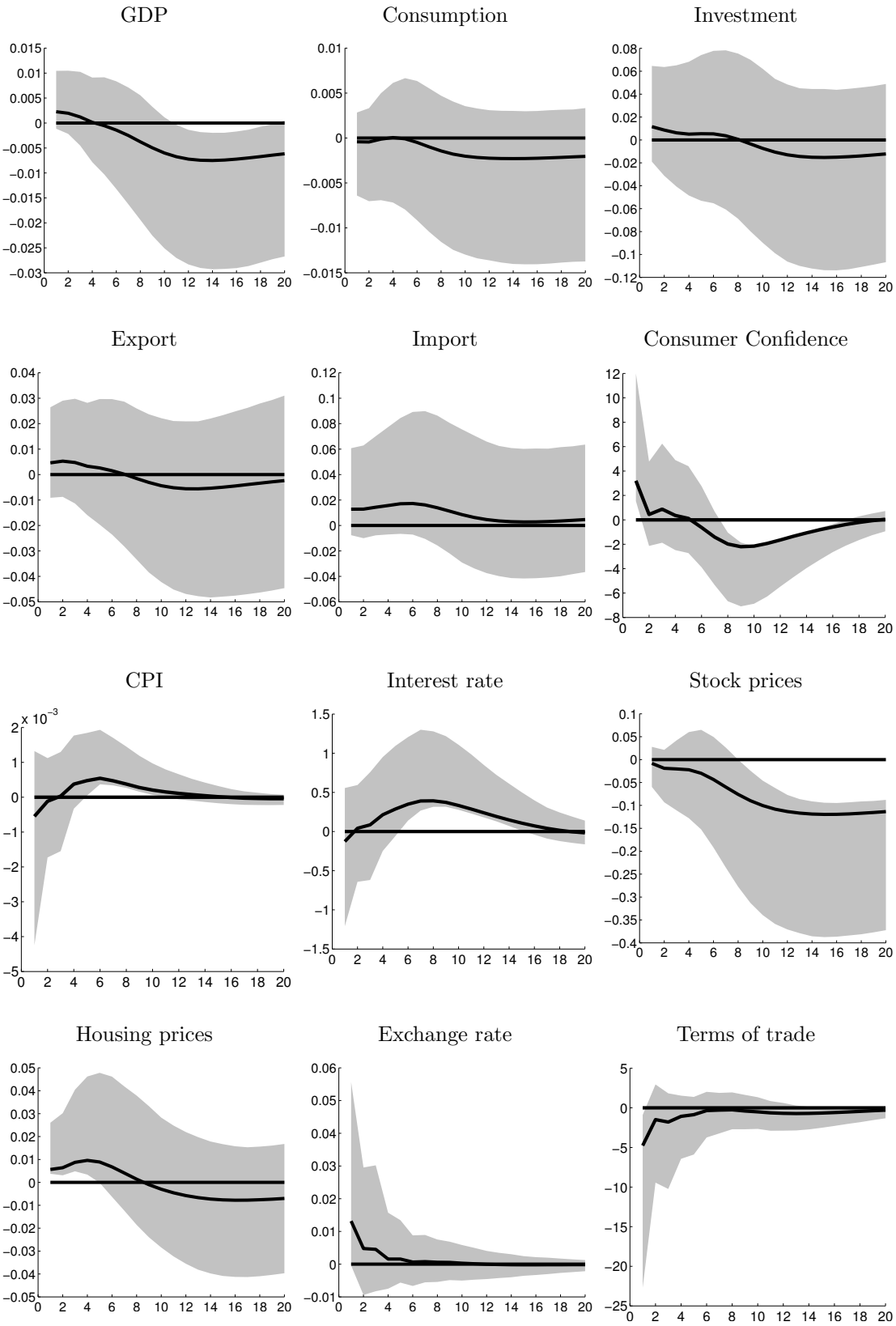
Note: Impulse responses of a one unit increase in global activity. The following abbreviations are used: GDP = Gross domestic product, Cons = Consumption, Invest = Investment, Exp = Export, Imp = Import, Conf = Consumer confidence, CPI = Consumer price index, Int = Interest rate, SP = Share prices, HP = House prices, Exch = Exchange rate, ToT = Terms of trade. All responses are in log levels except, CPI inflation. 90 percent error bands.

Figure 6: **Impulse responses - Global price shock**



Note: Impulse responses of a one unit increase in global prices. The following abbreviations are used: GDP = Gross domestic product, Cons = Consumption, Invest = Investment, Exp = Export, Imp = Import, Conf = Consumer confidence, CPI = Consumer price index, Int = Interest rate, SP = Share prices, HP = House prices, Exch = Exchange rate, ToT = Terms of trade. All responses are in log levels except, CPI inflation. 90 percent error bands.

Figure 7: **Impulse responses - Regional activity shock**



Note: Impulse responses of a one unit increase in regional activity. The following abbreviations are used: GDP = Gross domestic product, Cons = Consumption, Invest = Investment, Exp = Export, Imp = Import, Conf = Consumer confidence, CPI = Consumer price index, Int = Interest rate, SP = Share prices, HP = House prices, Exch = Exchange rate, ToT = Terms of trade. All responses are in log levels except, CPI inflation. 90 percent error bands.

of output substantially while inflation picks up briefly. Thus, a world price shock can be interpreted as an adverse aggregate supply shock. The effects of a regional activity shock in Norway is also substantial, but the positive impact on trade is somewhat weaker than for the global shocks. Instead, consumer confidence is positively affected.

The results of a strong transmission of both global and regional shocks to small open economies are in sharp contrast to evidence from recently developed small open economy DSGE models that incorporate foreign factors, as shown in Justiniano and Preston (2010). One concern in some of these models is that they assume that the shocks are not correlated across countries. For instance, the model-implied cross-correlations between Canada and US are essentially zero in Justiniano and Preston (2010).

4 Concluding remarks

The importance of foreign factors for the Norwegian economy emerges from the two studies discussed in this note. Both studies conclude that foreign disturbances account for around 50 percent of the fluctuations in Norwegian macroeconomic variables. Both studies relate the massive appreciation of the terms of trade over the last 20 years to the presence of important foreign shocks. Importantly, both papers show that many factors (at the regional and at the world level) drive the terms of trade with different effects on the domestic variables. An interesting avenue for future research is to better understand exchange rate dynamics in Norway. In fact, the massive appreciation in the Norwegian terms of trade has had only a limited effect on the exchange rate. In other countries, and in Australia in particular, the exchange rate has seen a much larger appreciation. Understanding the link between terms of trade and exchange rates in different economies is an important area of future research.

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