International confidence spillovers and business cycles in small open economies *

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Abstract

This paper draws from two observations in the literature. First, that shocks to entrepreneur or household confidence matter for economic outcomes. Second, that it is hard to explain the extent of cyclical comovement between economies taking into account their trade links. We check empirically to what extent confidence fluctuations matter for business cycles and in particular for their comovement between economies. We focus on a large (euro area) and a small, nearby (Poland) economy. Our results show that confidence fluctuations account for the majority of business cycle fluctuations in both countries. Regarding spillovers, confidence seems important, though not overwhelming - euro area confidence accounts for 15-20% of cyclical fluctuations in Poland.

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*The views expressed herein are ours and not necessarily those of Narodowy Bank Polski or the Warsaw School of Economics.

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1 Introduction

Cyclical economic fluctuations can originate in (possibly nonfundamental) shifts in expectations about economic activity. This idea goes back at least to Pigou (1927) and Keynes (1936), who postulated that waves of optimism or pesimism might influence current economic conditions. For many years mainstream macroeconomic models have largely ignored the role of such factors as drivers of business cycles. More recent literature, both empirical and theoretical, attempts to formalize and quantify the impact of fluctuations in moods. As will be shown below, most studies document a highly significant role of such factors.

An important, related and highly relevant question is, whether confidence does also spill over borders and affect cyclical fluctuations abroad. The importance and relevance of this question stems from two observations. First, that economic fluctuations between countries are highly correlated, so that obviously business cycles spill over borders. Second, that the literature (with special emphasis on structural macroeconomic models) has a clear problem with explaining where such high correlation comes from. Neither the international real business cycle model (Backus et al., 1992) nor new Keynesian models (Justiniano and Preston, 2010) can explain the high correlation of business cycles, unless productivity shocks are assumed to be correlated. Trade seems by far not sufficient to explain comovement, adding financial factors helps somewhat (Olivero, 2010), but international correlations still remain a puzzle. This paper investigates the role of confidence in driving the international comovement of economies.

As mentioned, the literature on the role of confidence in driving cyclical fluctuations is abundant. Let us start with defining the main concepts. Contemporaneous papers (at least a substantial share) distingiush two types of confidence shocks (see eg. Barsky and Sims 2012).

The first relates to new information about future technology that is orthogonal to current technology. In the literature such shocks are usually called "technology news shocks", and we will stick to this conventions throughout the paper. One can think for instance of innovations that have already been invented (and are known to agents), but due to implementation lags have not yet been implemented and thus do not increase productivity yet. These shocks have a supply-side flavor - ultimately they are supposed to increase productivity and, as a result, are expected to have a permanent impact on output. The related literature originates from the papers of Beaudry and Portier (2006), who empirically document the existence of a shock (derived from stock price data) that causes a boom in investment and consumption and signifficantly precedes the growth of productivity. Beaudry and Portier (2004) include this type of shock (a signal about future technology) into an RBC model. Schmitt-Grohe and Uribe (2012) generalize the concept to a wider range of shocks. They estimate a DSGE model with several news shocks and confirm a very important role of anticipated shocks in driving main business cycle variables. Kamber et al. (2017) estimate VAR models for four developed, small, open economies and documents that technology news shocks explain a substantial part od output fluctuations (between 6% in New Zealand and 40% in the UK). Further contributions to the empirical stream in the literature include i.a. Barsky and Sims (2011), who estimate a new Keynesian type of model that allows for technology news shocks and show that their contribution to explaining the variance of consumption and investment, while negligible in the short run, increases to 50% in the long run. On the theoretical front Jaimovich and Rebelo (2009) discuss the conditions under which new shocks can generate comovement of main macrovariables characteristic for business cycle fluctuations. Their main conclusion is that wealth effects must be weak, since otherwise positive news shocks reduce current labor supply and, hence current output. Eusepi and Preston (2011) develop a model that departs from the rational expectations assumption towards learning, in which self-fulfiling expectations arise in response to technology shocks.

The second type of confidence shocks relates to nonfundamental shifts in demand (consumption, investment), due to expectations about future prospects of the economy. It bears similarities Keynes' notion of "animal spirits" that influence entrepreneurs' willingness to undertake investment activity and, hence, drive cyclical fluctuations. Following part of the literature we will refer to such shocks as "sentiment shocks".[1] These shocks are purely demand-driven, and, as such are expected to have only a temporary impact on economic activity. Again, both empirical and theoretical studies exist that deal with these shocks. Angeletos and La'O (2013) provide a model in which limited communication between agents provides an environment in which shocks to believes (sentiments) have real effects that resemble boom-bust phenomena. Angeletos et al. (2014) derive a main business cycle factor from US data and show that its properties differ from shocks known in the structural literature. In particular, the factor moves output, hours worked, consumption and investments in the same direction, without affecting technology. Then, the paper constructs and estimates a DSGE model with a shock to agent's believes about other agents' perception of business conditions. This shock is interpreted as a sentiment shock and has properties similar to the empirically derived factor and is shown to explain 40-50% of the variance of output, consumption and investment. Milani (2017) estimates a DSGE model with learning and shows that sentiment fluctuations are responsible for over fourty percent of business fluctuations in the United States. On the other hand, according to the Barsky and Sims (2011) estimation, sentiment shocks have a negligible impact on output and consumption for both short and long horizons (technology news is what counts).

[1] Some papers call this type of shock "confidence shock". We call it "sentiment", while leaving the term "confidence" to encompass both sentiment and news innovations.

Two papers (to our knowledge) dealt explicitly with the role of confidence in explaining international business cycle correlations. Beaudry et al. (2011) extend the model of Beaudry and Portier (2004) to a two-country setting. They show that technology news shocks can drive cross-country synchronization of cycles even in a flexible price economy. Levchenko and Pandalai-Nayar (2015) take an empirical approach to assess the spillover of confidence shocks between the US and Canada. They identify both technology news and sentiment shocks and show that the Canadian business cycle is driven to a large extent by US confidence.

Our paper deals directly with the last issue: whether and to what extent does confidence affect the international transmission of business cycles. We estimate SVAR model based on data from Poland and the euro area (a small open economy and its large neighbour). Our estimation strategy builds on Levchenko and Pandalai-Nayar (2015), but adds several important modifications. In particular, we extend the model by introducing a second sentiment shock, which affects the forward looking variables in the small open economy but remains orthogonal to the sentiment shock stemming from the large economy. We call this shock domestic sentiment as opposite to the foreign sentiment shock.

The contribution of our paper to the literature is twofold. First, we check whether the earlier findings for US-Canada spillovers are universal, in that they also hold for a large-small economy pair in a different part of the world. Second, we include domestic confidence variables and shocks, which allows to divide the contribution of sentiments into a foreign and domestic component.

Our main findings are as follows. First, we confirm the important role of confidence in driving the business cycle and generating international spillovers. Depending on the horizon confidence shocks account for 60-80% of forecast error variance decomposition of GDP in the euro area and 30-80% in Poland. Spillovers from the euro area to Poland do matter as well: foreign confidence shocks determine 15-20% of GDP fluctuations in Poland, however, with a 30-70% share domestic sentiments still seem to outweigh foreign shocks. Historical shock decompositions show periods where confidence shocks were particularly important. In the euro area sentiment shocks played a significant role in generating the slowdowns during the financial and sovereign default crises. Both events contributed to the slowdowns in Poland as well.

The rest of the paper is organized as follows. Section 2 discusses the data and the estimation strategy, Section 3 the results and Section 4 concludes.

2 Model and data

2.1 Model

We investigate the international spillovers of technology and sentiment shocks using a structural vector autoregression (SVAR) framework. We follow the approach proposed initially by Uhlig and developed by Barsky and Sims (2011) and Levchenko and Pandalai-Nayar (2015) and we identify the structural shocks by imposing the so called medium-run restictions on the impact matrix.

Our basic VAR model is going to include two groups of variables: the core variables, which are selected macroeconomic variables for the large economy (euro area): total factor productivity (TFP), real GDP, hours worked and GDP forecasts and the non-core variables, which refer to the small open economy (Poland) - real GDP and GDP forecasts - in this order.

We identify four structural shocks in the model - three of them are the shocks stemming from the euro area, which also affect Poland as the economy tightly integrated with the euro area. The fourth shock is specific for the Polish economy.

The method we apply relies on the sequential identification of the subsequent shocks. We extract the respective shocks conditional on the values of the previous shocks. In the first step we extract two technology shocks in the euro area in the spirit of Barsky and Sims (2011). The first shock is called surprise technology shock and corresponds to the reduced form innovation to the TFP equation in the VAR model with the TFP variable ordered first. The second one is a news shock about future TFP. We follow Barsky and Sims (2011) and identify the shock, which has no contemporaneous impact on TFP but explains the maximum of the forecasts error variance of the TFP series after accounting for the impact of the surprise technology shock. It reflects the assumption that TFP in the euro area is affected by these two shocks only:

$$TFP_t = \lambda_1 \epsilon_t^{sur} + \lambda_2 \epsilon_{t-k}^{news} \tag{1}$$

where TFP_t is the TFP for the euro area while ϵ_t^{sur} and ϵ_t^{news} in (1) are the surprise and news technology shocks respectively.

In the next step we identify the sentiment shock in the euro area (large economy) as proposed by Levchenko and Pandalai-Nayar (2015). The identification of the sentiment shock relies on the assumption that the expectations about future economic activity are driven by observed (surprise) and anticipated (news) technology shocks but also by the sentiment of the agents. The positive and negative waves of sentiment, not directly related to productivity (technology) changes may lead to boom and bust cycles in the economy.

Therefore expectations about the future state of the euro area can be expressed as:

$$GDP_t^{F,EA} = \lambda_1^{F,EA}\epsilon_t^{sur} + \lambda_2^{F,EA}\epsilon_{t-k}^{news} + \lambda_3^{F,EA}\epsilon_t^{sentEA} + \zeta_t^{EA} \tag{2}$$

where ϵ_t^{sentEA} is the sentiment shock in the euro area while ζ_t^{EA} is another shock (or combination of structural shocks) affecting the expectations of future economic activity in the euro area $GDP_t^{F,EA}$ not related to technology and sentiment. We follow Levchenko and Pandalai-Nayar (2015) and identify the sentiment shock as the shock which maximizes the forecasts error variance of the selected expectational variable in the VAR model (GDP forecasts) after accounting for surprise and news technology shocks. Such an approach does not exclude that some other shocks (reflected in (2) as ζ_t^{EA}) may also affect the agents' expectations about future economic activity but their role is assumed to be less influential as compared with the sentiment shock.

We extend the model by extracting another sentiment shock specific for the small open economy and not related to the sentiment changes in the large economy. We believe that in spite of tight integration of the Polish economy with the euro area there are some idiosyncratic factors, which may affect the agents' sentiment in Poland apart from the sentiment waves in the euro area. Therefore we assume that the expectations about future economic activity in Poland are driven by the technology shocks in the euro area and by two orthogonal sentiment shocks: in the euro area and in Poland:

$$GDP_t^{F,PL} = \lambda_1^{F,PL}\epsilon_t^{sur} + \lambda_2^{F,PL}\epsilon_{t-k}^{news} + \lambda_3^{F,PL}\epsilon_t^{sentEA} + \lambda_4^{F,PL}\epsilon_t^{sentPL} + \zeta_t^{PL} \tag{3}$$

where ϵ_t^{sentPL} is the sentiment shock in the Polish economy assumed to be orthogonal to the sentiment shock to the euro area while ζ_t^{PL} is the combination of remaining structural shocks - not identified in the previous steps, which may also affect the expectations about the future state of the Polish economy. $GDP_t^{F,PL}$ stands for the expectations about future economic activity in Poland - in our case the Polish GDP forecast. We identify the sentiment shock to the Polish economy as the shock which maximizes the forecast error variance of Polish GDP forecast after accounting for the three shocks identified in the euro area. It is worth to note that we will not identify technology shocks affecting the Polish economy other than the technology shocks being transmitted from the euro area. We believe that due to large discrepancy in the scale and stage of development of the these two economies as well as due to the tight integration of Poland into the global value chains technology transfers from the euro area are more important drivers of TFP in Poland than technology shocks specific for Poland. However we do not exclude that some other shocks may affect the GDP forecasts for Poland. In equation (3) these shocks are represented by ζ_t^{PL}.

We start our identification procedure with the reduced form VAR(p) model:

$$A(L)Y_t = u_t \tag{4}$$

where Y_t is the $k \times 1$ vector of observable variables in levels and u_t is a vector of reduced form disturbances.

The moving average representation of VAR(p) model (4) is:

$$Y_t = B(L)u_t. \tag{5}$$

We assume that the reduced form disturbances u_t are the linear combinations of the structural shocks ϵ_t with the impact matrix C_0, which can be written as:

$$u_t = C_0\epsilon_t \tag{6}$$

Therefore the structural representation of the VAR(p) model is:

$$Y_t = C(L)\epsilon_t \tag{7}$$

where $C(L) = B(L) \cdot C_0$. We assume that the structural shocks ϵ_t are orthogonal to each other and have unit variance, which implies that:

$$C_0C_0' = \Sigma \tag{8}$$

where Σ is a covariance matrix of reduced form innovations u_t.

It is obvious that there is an infinite number of matrices satisfying condition (8). For example the Cholesky decomposition of Σ provides the lower triangular matrix which fulfills condition (8). We denote $\tilde{C}_0$ the matrix such that $\tilde{C}_0\tilde{C}_0' = \Sigma$.

The matrix $\tilde{C}_0$ resulting from Cholesky decomposition will be a starting point for the structural decomposition with medium run restrictions.

As a next step we specify matrix D, which satisfies the restriction $DD' = I$ and which defines the impact matrix C_0 as $C_0 = \tilde{C}_0D$.

The subsequent columns of matrix D correspond to the identified structural shocks. The identification of the respective columns of matrix D is based on the assumption that the structural shocks ϵ_t explain the maximum variance of the forecast error of the particular variables in the VAR(p) model. Below we present the subsequent steps of our decomposition.

The h-steps ahead forecasts error from the VAR(p) model can be derived as:

$$Y_{t+h} - \hat{Y}_t(h) = \sum_{i=0}^{h} B_iu_{t+h-i} = \sum_{i=0}^{h} B_iC_0\epsilon_{t+h-i} = \sum_{i=0}^{h} B_i\tilde{C}_0D\epsilon_{t+h-i}, \tag{9}$$

where $\hat{Y}_t(h)$ is the h-steps ahead forecasts of Y_t while B_i is the respective coefficient matrix in the moving average representation of VAR(p).

Accordingly the h-step ahead forecast error of variable k in vector Y_t is:

$$Y_{k,t+h} - \hat{Y}_{k,t}(h) = \sum_{i=0}^{h} B_{k,i}\tilde{C}_0 D\epsilon_{t+h-i}, \tag{10}$$

where $B_{k,i}$ is the k-th row of matrix B_i. Then the forecast error variance of variable k at horizon h is:

$$\varOmega_k(h) = \sum_{i=0}^{h} B_{k,i}\varSigma B'_{k,i} \tag{11}$$

Let $\varOmega_{i,k}(h)$ denote the contribution of the structural shock j to the forecast error variance of variable k at horizon h:

$$\varOmega_{i,k}(h) = \frac{\sum_{i=0}^{h} B_{k,i}\tilde{C}_0 d_j d'_j \tilde{C}'_0 B'_{k,i}}{\sum_{i=0}^{h} B_{k,i}\varSigma B'_{k,i}}. \tag{12}$$

Without loss of generality let us assume that the first two structural shocks are the surprise and news technology shocks. The third structural shock is the euro area sentiment shock while the fourth shock is the sentiment shock specific for Poland. The baseline of the identification proposed by Barsky and Sims (2011) and adopted in our paper is the assumption expressed by (1) that only two technology shocks influence the TFP for the euro area (being ordered first). This assumption implies:

$$\varOmega_{1,1}(h) + \varOmega_{1,2}(h) = 1 \ \forall h. \tag{13}$$

The surprise technology shock is the reduced form innovation in the TFP equation in VAR(p) model (4) with TFP ordered first while the news technology shock is the shock, which maximizes the forecast error variance of TFP over H^{news} horizon after accounting for the impact of the surprise technology shock.

The maximization problem can be written as follows (see Barsky and Sims, 2011):

$$d_2 = \operatorname{argmax} \sum_{h=0}^{H^{news}} \varOmega_{1,2}(h) = \operatorname{argmax} \sum_{h=0}^{H^{news}} \left(\frac{\sum_{i=0}^{h} B_{1,i}\tilde{C}_0 d_2 d'_2 \tilde{C}'_0 B'_{1,i}}{\sum_{i=0}^{h} B_{1,i}\varSigma B'_{1,i}} \right). \tag{14}$$

s.t.

$$\tilde{C}_0(1,i) = 0 \ \forall i \neq 1$$

$$d_2(1) = 0$$

$$D'D = I$$

where d_2 is the second column of D matrix, which specifies the second structural shocks interpreted here as the news technology shock. Therefore $\tilde{C}_0 d_2$ is the impact vector of this shock. The first two restrictions guarantee that the news shock does not have a contemporaneous effect on the TFP. The third constrain ensures that vector d_2 is a column of an orthonormal matrix.

Uhlig shows that the maximization problem defined by (16) is equvalent to finding the eigenvector (which is a non-zero portion of d_2) associated with the largest eigenvalue of the lower $(k-1) \times (k-1)$ submatrix of matrix Λ^{news}, which is a weighted sum of the matrices $\left(B_{1,i}\tilde{C}_0\right)' \left(B_{1,i}\tilde{C}_0\right)$over H^{news}:

$$\Lambda^{news} = \sum_{i=0}^{H^{news}} \left(H^{news} + 1 - \max\left(1, i\right)\right) \left(B_{1,i}\tilde{C}_0\right)' \left(B_{1,i}\tilde{C}_0\right). \tag{15}$$

In the next step we identify the euro area sentiment shock, assumed to maximize the remaining forecast error variance of the euro area GDP forecast over H^{sent} horizons after accounting for the contribution of surprise and news technology shocks. The forecast horizon set for the identification of the sentiment shock is expected to be shorter than the horizon chosen to identify the technology shocks while the impact of the sentiment shock on the GDP is rather short term. As already mentioned we assume that the euro area GDP forecast is ordered fourth in the VAR(p) model while the sentiment shock is the third structural shock. It is worth to note that the identification of the sentiment shock does not alter two technology shocks specified in the previous step. Thus the contribution of these shocks to the forecast error variance of GDP forecast is fixed for all horizons.

To identify the sentiment shock we derive a respective vector d_3 by solving the following equation:

$$d_3 = \text{argmax} \sum_{h=0}^{H^{sent}} \Omega_{4,3}(h) = \text{argmax} \sum_{h=0}^{H^{news}} \left(\frac{\sum_{i=0}^{h} B_{4,i}\tilde{C}_0 d_3 d_3' \tilde{C}_0' B_{4,i}'}{\sum_{i=0}^{h} B_{4,i} \Sigma B_{4,i}'} \right) \tag{16}$$

s.t.

$$\tilde{C}_0(1, i) = 0 \ \forall i \neq 1$$

$$D\,(:,\,2) = \hat{d}_2$$

$$D'D = I.$$

The vector d_3 defining the euro area sentiment shock is thus the third column of orthonormal impact matrix D. We solve the equation (16) under the constraints that the second column of matrix D is fixed and equal to the impact vector corresponding to the news shock $\hat{d}_2$ identified in the previous step. Numerically we find vector d_3 by proceeding the following steps:

1. We form a matrix $D^{news} = \begin{bmatrix} 1 & 0 \\ 0 & \tilde{D}^{news} \end{bmatrix}$, where the subsequent columns of matrix $\tilde{D}^{news}$ are the eigenvectors associated with the eigenvalues (set in the descending order) beeing the solution of the problem (16).

2. We derive the matrix Λ^{sentEA}, as:

$$\Lambda^{sentEA} = \sum_{i=0}^{H^{sent}} \left(H^{sent} + 1 - \max\left(1, i\right)\right) \left(B_{4,i}\tilde{C}_0 D^{news}\right)' \left(B_{4,i}\tilde{C}_0 D^{news}\right). \qquad (17)$$

3. We calculate the eigenvectors corresponding to the eigenvalues of the lower $(k-2) \times (k-2)$ submatrix of matrix Λ^{sentEA}. These eigenvectors are set to be the subsequent coulmns of $(k-2) \times (k-2)$ matrix $\tilde{D}^{sentEA}$.

4. We derive a $k \times k$ matrix $D^{sentEA} = D^{news} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & \tilde{D}^{sentEA} \end{bmatrix}$.

5. The vector d_3 which corresponds to the euro area sentiment shock is the third column of D^{sentEA} matrix.

This method based on principal component analysis performed in the spirit of Barsky and Sims (2011) is equivalent to the approach used by Levchenko and Pandalai-Nayar (2015), who identify the sentiment shock by imposing directly the restrictions on the parameters of initial VAR(p) model.

Finally, we identify the fourth shock interpreted as related to domestic (Polish) sentiment. We are able to extract this shock thanks to the presence of a forward looking variable for Poland (GDP forecast) in the VAR system. We assume that the domestic sentiment shock is the shock which maximizes the forecast error variance of Poland's GDP forecast over H^{sent}

horizons after accounting for two technology shocks (surprise and news) and the sentiment shock being transmitted from the euro area to Poland. As we already mentioned without a loss of generality we assume that the domestic sentiment shock is the fourth shock and the GDP forecast for Poland variable is ordered sixth (last in a six variable VAR model).

We derive d_4 the fourth column of matrix D, which defines the domestic sentiment shock by solving the following equation:

$$d_4 = \operatorname{argmax} \sum_{h=0}^{H^{sent}} \Omega_{6,4}(h) = \operatorname{argmax} \sum_{h=0}^{H^{news}} \left(\frac{\sum_{i=0}^{h} B_{6,i} \tilde{C}_0 d_4 d_4' \tilde{C}_0' B_{6,i}'}{\sum_{i=0}^{h} B_{6,i} \Sigma B_{6,i}'} \right). \tag{18}$$

s.t.

$$\tilde{C}_0(1,i) = 0 \ \forall i \neq 1$$

$$D\,(:,\,2) = \hat{d}_2$$

$$D\,(:,\,3) = \hat{d}_3$$

$$D'D = I.$$

We identify the domestic sentiment shock under the assumption that all three shocks extracted in the previous steps and related to the euro area are fixed. In other words the identifcation of country specific sentiment shock for Poland is conditional on the identification the structural shocks for the euro area.

We estimate the vector d_4 analogously to the derivation of vector d_3 using principal component analysis as follows:

1. We derive the matrix Λ^{sentPL}, according to the formula:

$$\Lambda^{sentPL} = \sum_{i=0}^{H^{sent}} \left(H^{sent} + 1 - \max(1,i)\right) \left(B_{6,i} \tilde{C}_0 D^{sentEA}\right)' \left(B_{6,i} \tilde{C}_0 D^{sentEA}\right). \tag{19}$$

2. We compute the eigenvalues of the lower $(k-3) \times (k-3)$ submatrix of matrix Λ^{sentPL} and the corresponding eigenvectors. These eigenvectors are set to be the subsequent columns of $(k-3) \times (k-3)$ matrix $\tilde{D}^{sentPL}$.

3. We define a $k \times k$ matrix $D^{sentPL} = D^{sentEA} \cdot \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & \tilde{D}^{sentPL} \end{bmatrix}$.
4. The vector d_4, which defines domestic sentiment shock is the fourth column of D^{sentPL} matrix. The impact vector of the domestic sentiment shock is thus $\tilde{C}_0 d_4$.

The procedure we follow ensures that all columns of matrix D, which we identify here belong to the space of the possible orthogonalisation of the VAR model (4).

Having estimated the model and identified the structural shocks using the restrictions described above we will investigate the role of the respective shocks in driving the business cycles in Poland and the euro area as well analyze the transmission of shocks from large to small open economy. We are going to draw the final conclusions on the role of respective shocks by investigating the forecasts error variance decomposition of GDP in Poland and the euro area as well as by evaluating the respective impulse response functions. We also conduct historical decomposition of GDP development with respect to the extracted shocks.

2.2 Data

As already mentioned we estimate the model for the euro area (EA) and Poland (PL). Poland is strongly integrated with the euro area (which buys almost 60% of its exports). At the same time it is relatively small - at current prices Polish GDP amounts to less than 5% of the euro area. They are close in geographic and political terms (both are part of the European Union). Moreover, existing research documents a high level of business cycle correlation. Summing up, Poland and the euro area look like ideal candidates to look for a significant role of confidence spillovers between a large and small economy. Moreover, GDP per capita and productivity in Poland were in our sample much lower than in the euro area. For instance GDP per capita measured at purchasing power standards increased from 42% of the EA level in 2000 to 67% in 2016. This means that in the period under consideration Poland can be treated as an importer of technology rather than innovator, validating our decission to identify technology shocks only in the euro area.

The estimated model consists of six variables: total factor productivity (EA), real GDP (EA and PL), hours worked (EA) and GDP forecast of professional forecasters (EA and PL). As explained in Section 2.1 the last variable is supposed to allow identification of sentiment shock. For the euro area we use GDP forecasts from the Survey of Professional Forecasters (SPF) ranging two quarters ahead. For Poland the survey has been conducted by Reuters. Unfortunately the two-quarter ahead forecast has a lot of gaps, so that we were forced to use the one-quarter ahead data. The model is estimated with quarterly data from 4Q2000 until 3Q2016.

3 Sentiment spillovers

We start with specifying our basic model, which is the Vector Error Correction Model (VECM) including six macroeconomic variables in levels. First four variables refer to the euro area while the two latter are selected macroeconomic indicators for the Polish economy. As we pointed out is Section 2.2 our variables of interest are as follows: total factor productivity (TFP), real GDP, hours worked and GDP forecast for the euro area and real GDP and GDP forecast for Poland – in this order. We set the maximum lag order in the VECM equal to 3 as indicated by Akaike information criterion. The Johansen's trace test suggests four cointegrating vectors spanning the cointegrating space. Accordingly we impose the restrictions on the cointegrating vectors to identify the whole cointegrating space. We identify the first cointegrating vector as a one-factor production function for the euro area. We propose that the variable representing GDP for the euro area is a function of the euro area TFP with a unit elasticity and the variable expressing the number of hours worked. The estimated long run elasticity of GDP with respect to hours worked amounts to roughly 0.63. The second cointegrating relation links the GDP forecast for the euro area with the current GDP data. The estimate of the respective parameter in the cointegrating vector is above one, which means that the agents revise the forecasts more than proportional to the current data release. The third cointegrating vector reflects the analogous relationship between GDP forecast and current GDP for Poland. The long run elasticity of GDP forecast with respect to current GDP is very close to one, which may evidence for less sensitive reaction of the forecasts to the current data than in the euro area. The last cointegrating vector constitutes a long term transmission channel from the euro area economy to Poland. According to our specification the GDP for Poland depends in the long run on the TFP for the euro area. Surprisingly the presence of the euro area GDP variable in this cointegrating relation does not find any support from the empirical data. This result can be interpreted in such a way that in the long run the GDP in Poland may be affected to larger extent via the supply channel (TFP) than via the demand one (euro area GDP). The whole set of restrictions imposed on the cointegrating space has been not rejected by likelihood test for the binding restrictions. The p-value for the respective chi-square test statistic amounts to 0.45. The detailed estimation results for the VECM are presented in Table 1.

Next we use the residuals from the reduced form VECM model to specify the structural shocks with a desired economic interpretation. For this we impose the so called medium term restrictions on the impact matrix and identify the shocks sequentially using the method described in Section 2. We identify four structural shocks: three shocks stemming from the euro area – surprise and news technology shocks as well as euro area sentiment shock and a sentiment shock for Poland, as a shock being orthogonal to sentiment shock in the euro area. We check the features of the identified shocks by investigating the impulse response functions of the selected variables in the VECM model to the respective shocks. The impulse responses are plotted on Figures 1-5.

Figure 1 presents the reaction of the euro area TFP variable to the surprise and news technology shocks. Two technology shocks have a rather persistent effect on the euro area total factor productivity. The TFP rises on impact in response to the positive surprise and news shocks and then stabilizes after ca. 8 years. The maximum reaction of the TFP to the surprise shock is almost twice as large as to the news shock. The effects of both shocks are statistically significant. The 90 percent confidence intervals include only positive values.

The responses of the euro area GDP to surprise and news technology shocks are also long lasting (Figure 2). These shocks have a positive and permanent effect on the level of GDP. The impact of the shocks on the GDP is the strongest after 5 to 7 quarters and since then it starts weakening. The reaction of the GDP to the surprise shock is statistically significant for all horizons. As far as the reaction to the news shock is concerned the whole 90 percent confidence interval is above zero only in the short horizon while for the longer horizon the lower band of the confidence interval lies slightly below zero.

The euro area sentiment shock has a permanent (and positive) effect on the level of euro area GDP as well. The maximum effect of the shock realizes after ca. 5 quarters and is larger than the impact of the technology shocks of the same magnitude (Figure 2). The response of the euro area GDP to the sentiment shock is significant for all horizons.

The patterns of the impulse responses of the euro area GDP forecast to the euro area structural shocks are very similar to the responses of euro area GDP to the same shocks. The positive effects of all three shocks are long lasting and for most horizons statistically significant with the peaks occurring after ca. 7 quarters (Figure 3).

According to our expectations the surprise and news technology shocks stemming from the euro area contribute also to Poland's GDP variability. Both shocks have a rather permanent effect on Poland's GDP however the response to the news shocks starts to be statistically significant only after several quarters (Figure 4). On the other hand the response to surprise shocks is very quick. Moreover the maximum impact of the surprise shock to GDP is stronger than the impact of the news shocks.

The reaction of Poland's GDP to domestic demand shock is stronger than to the foreign (euro area) demand shock. The maximum effect of the domestic demand shock is quicker and occurs after ca. 4 quarters. The response to the foreign demand shocks is more muted with a peak occurring after 6 quarters. The effect of foreign demand shock for Poland's GDP dies out after 8 quarters while the impact of the domestic demand shock is slightly more persistent. It diminishes after 10 quarters.

The shape of the impulse response functions for Poland's GDP forecast is quite similar to the reaction of GDP variable (5). It differs only by the magnitude of the maximal reaction, which for the news technology shock as well as for both demand shocks is stronger for the GDP forecast than for the observed GDP. It means that the news about technology and changes in agents' sentiment transmit stronger to the forecast than to the real data.

In the further step we discuss the forecast error variance decomposition of the selected variables for euro area and Poland with respect to the contribution of the subsequent shocks. According to our expectations the forecasts error variance of TFP variable for the euro area is affected mostly by technology shocks (Table 2). The contribution of the surprise technology shock to the variance of the forecast error amounts to 92% in the short horizon (2 quarters) and decreases to 79% in the long horizon (10 years). On the contrary the contribution of the news technology shock to the TFP forecasts error variance is growing with the lengthening of the forecast horizon: from 7% for the 2 quarters ahead forecast to 21% for the 10 years ahead forecast.

The forecast error variance of the euro area GDP is accounted in the short term for mostly by the euro area demand shock (Table 3). Its contribution amounts to 63% of the overall variance for 2 quarters ahead forecast error. The contribution of the surprise and news shocks equals to 17% and 18% respectively. In the longer horizon the share of the demand shocks in the forecast error variance decreases to 36% while the contribution of the surprise and news shocks grows to 30% and 21% respectively. This result stays in line with the common understanding that in the shorter horizon the variability of GDP is driven mostly by demand shocks while in the longer horizons technology/supply shocks dominates over the demand ones.

A rather similar picture stems from the forecasts error variance decomposition of the euro area GDP forecast (Table 4). The only but small difference points to a slightly higher contribution of the news shocks in explaining the GDP forecast variability in the short horizon as compared with the variability of observed/realized GDP.

The forecast error variance decomposition of the Poland's GDP variable gives some us some conclusions about the international transmission of the shocks (Table 5). Our results point out that in the short horizon the transmission is of foreign shocks affecting GDP relatively weak but its strength increases significantly in the longer horizon.

We find that in the short horizon the contribution of the domestic sentiment shock clearly outperforms the impact of the foreign shocks. The contribution of the domestic sentiment shock amounts to 67% for the 2 quarters ahead forecast while the contribution of the foreign (euro area) technology and sentiment shocks amounts jointly to 16% of the variance only.

The euro area sentiment shock accounts for 8% of the forecast error variance of Poland's GDP while the news shock stemming from the euro area have a share of 6% in the GDP variance.

This picture looks however different for the longer horizon (10 years). The joint contribution of the euro area shocks increases to 84% of the Poland's GDP forecast error variance with the surprise technology shock dominating over the other foreign shocks with its share of 66% in the whole variance. The contribution of the news shock being transmitted from the euro area to Poland is growing from 6% in the short horizon to 18% in the longer one.

On the contrary the role of the domestic sentiment shock is diminishing together with the lengthening of the forecast horizon with its contribution equal to 10% for 10 years horizon. What is quite surprising that despite of the fact that Poland is usually perceived as a small open economy the role of the euro area sentiment shock in explaining the variability of Poland's GDP is relatively small. Its contribution ranges from 8% in the short horizon to 3% in the longer one. This findings may result from the weakening of the business cycles synchronization between Poland and euro area during global financial crisis. Polish economy was less affected by the crisis and GDP growth in Poland was relatively high during last decade what was not the fact in euro area.

The results of the forecast error variance decomposition of the Poland's GDP forecast variable are very similar to the findings stemming from the decomposition of the realized GDP but only in the longer term with the surprise and news technology shocks playing the prominent role in explaining GDP forecast variability (Table 6). In the short term a substantially higher contribution can be attributed to foreign sentiment shock, which accounts to 30% of the variance of Poland's GDP forecast. On the contrary the contribution of the domestic sentiment shocks is smaller and equal to 25% only. Also the contribution of the news shock is significantly larger than for the realized GDP and amounts to 14%. This result leads us to the conclusion that the foreign news and sentiment shocks affect to larger extent the forecasts of GDP in Poland rather than its real values.

Finally we investigate the historical decomposition of euro area and Poland's GDP with respect to technology and sentiment shocks. In the analyzed period (2001-2016) the euro area GDP growth was driven mostly by the euro area sentiment shock as well as surprise technology shock (Figure 6). The contribution of the sentiment shock to GDP growth was positive until the end of 2002 and turned out to be negative since the beginning of 2003 up to 2005 coinciding with strongly negative values of consumer confidence indicator for euro area in that period. The sentiment shock was supportive for the economic growth in the period spanning from 2006 to mid-2008 on the wave of recovery in the euro area. The consumer confidence indicators recorded that time high scores. The onset of the global financial crisis is identified by the model as an occurrence of the large and persistent negative sentiment shock.

This shock has negative contribution to GDP since the mid-2008 up to the end of 2010. In the next quarters it remains in general neutral for the economic growth. Since mid-2012 it has a positive but short lasting impact on the euro area GDP growth, which was related to the temporary improvement of consumer and business confidence as well as financial markets indicators. This improvement coincides with Mario Draghi speech "whatever it takes" and the announcement in September 2012 the OMT program preserving the euro area against the collapse, limiting the growth in sovereign bonds yields for euro area peripheral countries. The euro area sentiment shock had then a negative contribution to growth in years 2014-2015. In the mid-2014 the consumer confidence and business indicators deteriorated reflecting the lower than expected GDP growth in the euro area, high level of unemployment and weak credit expansion. Also the uncertainty related to the results of referendum in Greece might have been reflected in the negative contribution of sentiment shock to euro area GDP growth.

The news technology shock has a less pronounced impact on the euro area economic growth in the analyzed period than the sentiment shock. The contribution of this shock to euro area GDP is mainly positive up to 2007 what may be associated with the ongoing globalization process that time. In 2007 the contribution of this shock started to be negative as the news about onset of sub-prime crises might have affected the investments plans of the corporate sector. The most significant and negative impact of the news shock on the euro area GDP was identified in years 2012-2014 which may be associated with a weak investment demand in the euro area often described as a "secular stagnation" and the reverse of the globalization process.

Turning to the surprise shock we may conclude from the decomposition presented on Figure 6 that this shock had a positive contribution to the euro area GDP growth in the years 2005-2008 and a negative one since the onset of the sovereign debt crises. It coincides with the fact that in general the forecasts for the euro area GDP growth during the recovery phase preceding the onset of the crises underestimated the real GDP developments while during the crises they were usually to optimistic.

The decomposition of Poland's GDP (see Figure 7) accounts aside from euro area technology and sentiment shocks also for the contribution of the domestic sentiment shock for Poland. The prominent role of this shock in explaining Poland's GDP variability is straightforward in particular in the period before the onset of the sovereign debt crisis. In years 2003-2006 the domestic sentiment shock co-moves with the changes in consumer and business confidence associated with the accession of Poland to the European Union, which occurred in May 2004. In the period preceding the accession the confidence indicators in Poland were in the upward trend following the rising wave of optimism among the Polish consumers and producers who expected that opening of the EU market for the new member states will result in acceleration of economic growth. Moreover the concerns about possible price increase after joining EU might have also resulted in the shift of the demand from the next years to the pre-accession period. In the period just after the accession the economic activity in Poland deteriorated significantly what was the evidence the acceleration of the economic growth in the pre-accession period was not sustainable and resulted mostly from the shift of the future demand. According to our decomposition in the post accession period up to mid-2006 the domestic sentiment shock contributed negatively to GDP growth in Poland. Afterwards the impact of the sentiment shock on the GDP turned out to be positive and this shock was the main driver of economic growth in Poland until the onset of the global financial crisis. The deceleration of the economic growth in Poland in the first phase of the crisis in 2009 and 2010 resulted mostly from the contribution of the negative euro area sentiment shock. This influence was counterbalanced to some extent by the positive domestic sentiment shock which may be attributed to substantial tax reliefs and exchange rate depreciation in 2009 as well as acceleration in EU funds absorption in 2011-2012. The contribution of positive domestic sentiment shock outperformed the negative impact of foreign sentiment shock in years 2010-2012 what resulted in acceleration of GDP growth in Poland in that time. For the rest of our sample the domestic sentiment shock had mainly negative but only minor contribution the GDP growth.

The role of the foreign (euro area) sentiment shock in explaining Poland's GDP variability was significantly less prominent than the influence of the domestic sentiment shock. The euro area sentiment shock contributed negatively to Poland's growth mainly in year 2004 reflecting the slowdown in the euro area, next in the beginning of the sovereign debt crisis in 2009-2010 and finally in years 2014-2015. On the contrary the foreign shock was supportive for the growth in the period preceding the global financial crisis (2006-2007) and during the short expansions in euro area in years 2011-2013.

The news technology shock stemming from the euro area to Poland stimulated economic growth in Poland in the period 2002-2007 when the Polish economy intensified its participation in global value chains along enticing the massive inflow of FDIs to Poland. The negative contribution of the news shock was the strongest in 2012-2014 during the secular stagnation period. The last structural shock spilling over from the euro area to Poland – the surprise technology shock supported growth in Poland in years 2005-2008 and subtracted from growth since 2011 to the end of our sample.

4 Conclusions

How important are confidence fluctuations for business cycles? And how important are they for spillovers of cyclical fluctuations between economies? These questions seem fundamental to understand the nature of business cycle fluctuations. They relate to the old idea of Pigou

(1927) and Keynes (1936) that fluctuations in moods have a potential to drive business cycles. This view has recently gained substantial attention in the litarature and most existing research point to a very important role of confidence fluctuations. In this area we offer rather new data than new ideas. Furthermore, we belive that moods can also travel accross borders, thus strenghtening the international correlation of business cycles. This idea has so far been almost untested in the literature and we believe to have a genuine contribution in this area.

This paper offers an empirical approach to answering the two above questions. We estimate a VAR model for the euro area and Poland (a large and a small, neigbouring economy) and carefully identify shocks related to confidence fluctuations. We distinguish two types of confidence shocks. The first type relates to the supply side of the economy and can be interpreted as expectation of future improvemenets in technology (it is called technology news). The second type has a demand flavor and can be interpreted as fluctuations in moods about future economic performance, unrelated to technological advance (we call it sentiment).

Regarding the first question, we confirm what was already stated for other countries. Confidence shocks play an important role both in the euro area and in Poland. In particular the account for 60-80% of forecast error variance decomposition of GDP in the euro area and 30-80% in Poland (depending on the forecast horizon). They also have a clear and interpretable historical contribution to GDP fluctuations, for instance sentiment shocks played an important role, lowering GDP during the financial crisis of 2008-09 and the sovereign debt crisis of 2014-15.

Regarding confidence spillovers, our findings do confirm their significant, though not overwhelming role. Foreign confidence shocks determine 15-20% of GDP fluctuations in Poland, however, with a 30-70% share domestic sentiments still seem to outweigh foreign shocks.

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Tables and Figures

Table 1: Estimation results for VECM.

Dependent variable	GDP_t^{EA}	$GDPF_t^{EA}$	$GDPF_t^{PL}$	GDP_t^{PL}
TFP_t	1	-	-	9.388 (0.961)
GDP_t^{EA}	-	1.065 (0.019)	-	-
$HOURS_t^{EA}$	0.629 (0.079)	-	-	-
$GDPF_t^{EA}$	-	-	-	-
GDP_t^{PL}	-	-	-	-
$GDPF_t^{PL}$	-	-	0.993 (0.014)	-
LR test for binding restritions: chi2(4) = 3.655 (0.45)				

Table 2: Forecast error variance decomposition of euro area TFP

TFP				
quarters	Surprise technology	News technology	EA sentiment	PL sentiment
1	0.963	0.033	0.001	0.000
2	0.922	0.073	0.001	0.002
4	0.884	0.113	0.001	0.001
8	0.846	0.149	0.002	0.001
20	0.804	0.194	0.001	0.001
40	0.785	0.214	0.000	0.001

Table 3: Forecast error variance decomposition of euro area GDP

EA GDP				
quarters	Surprise technology	News technology	EA sentiment	PL sentiment
1	0.155	0.134	0.667	0.041
2	0.170	0.176	0.629	0.023
4	0.230	0.183	0.570	0.014
8	0.275	0.175	0.486	0.043
20	0.268	0.185	0.411	0.097
40	0.302	0.205	0.364	0.094

Table 4: Forecast error variance decomposition of euro area GDP forecast

GDP forecast				
quarters	Surprise technology	News technology	EA sentiment	PL sentiment
1	0.104	0.207	0.338	0.140
2	0.165	0.193	0.547	0.043
4	0.226	0.189	0.542	0.026
8	0.296	0.182	0.446	0.034
20	0.281	0.189	0.393	0.097
40	0.310	0.208	0.353	0.093

Table 5: Forecast error variance decomposition of Poland's GDP

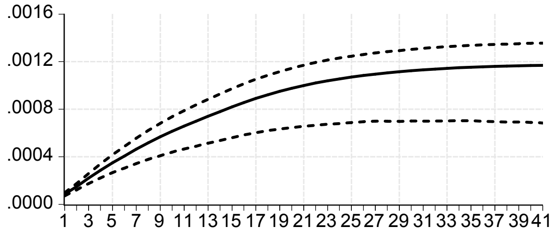
Real GDP				
quarters	Surprise technology	News technology	EA sentiment	PL sentiment
1	0.016	0.057	0.096	0.657
2	0.027	0.056	0.079	0.674
4	0.093	0.058	0.074	0.614
8	0.224	0.075	0.081	0.472
20	0.433	0.117	0.068	0.287
40	0.657	0.180	0.025	0.102

Table 6: Forecast error variance decomposition of Poland's GDP forecast

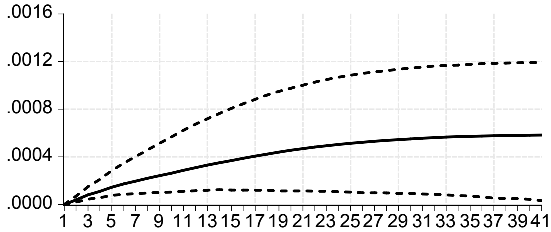
GDP forecast				
quarters	Surprise technology	News technology	EA sentiment	PL sentiment
1	0.011	0.022	0.078	0.463
2	0.015	0.139	0.302	0.251
4	0.070	0.125	0.267	0.414
8	0.249	0.109	0.168	0.361
20	0.416	0.135	0.126	0.244
40	0.631	0.182	0.052	0.101

Figure 1: The impulse responses of euro area TFP to technology shocks.

a) Response of euro area TFP to surprise technology shock



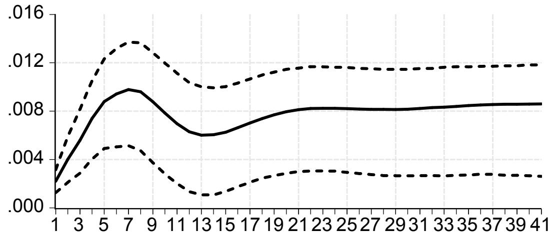
b) Response of euro area TFP to news technology shock



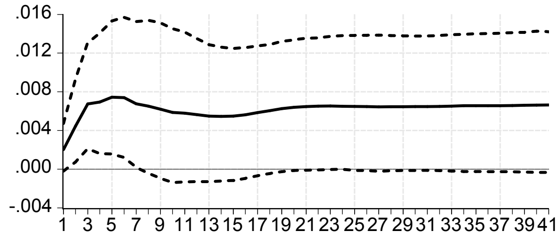
Note: Dotted lines represent the 90 percent bootstrap confidence bands calculated with 10 000 replications, using the approach proposed by Hall (1992).

Figure 2: The impulse responses of euro area GDP to shocks.

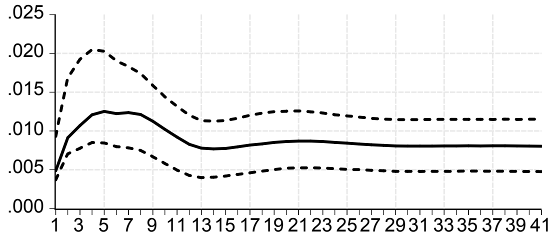
a) Response of euro area GDP to surprise technology shock



b) Response of euro area GDP to news technology shock



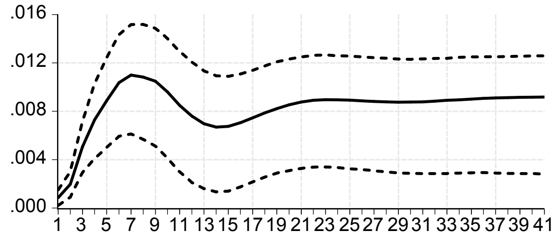
c) Response of euro area GDP to sentiment shock



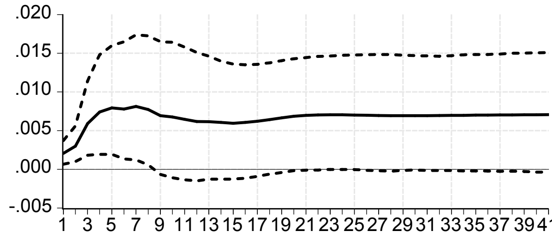
Note: Dotted lines represent the 90 percent bootstrap confidence bands calculated with 10 000 replications, using the approach proposed by Hall (1992).

Figure 3: The impulse responses for euro area GDP forecast to shocks.

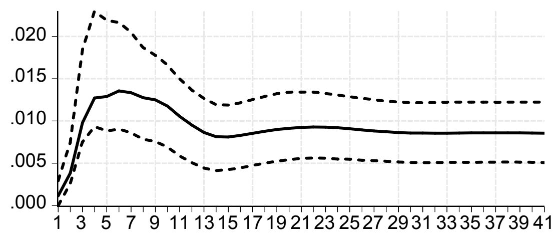
a) Response of euro area GDP forecast to surprise techn. shock



b) Response of euro area GDP forecast to news techn. shock



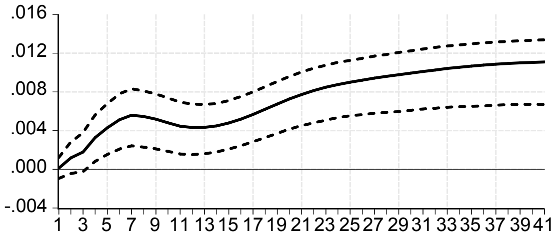
c) Response of euro area GDP forecast to sentiment shock



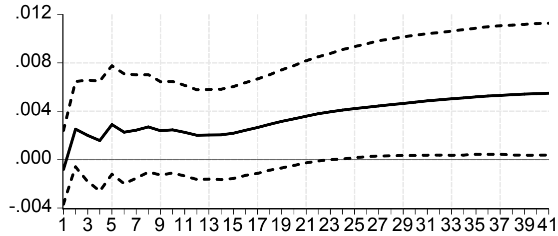
Note: Dotted lines represent the 90 percent bootstrap confidence bands calculated with 10 000 replications, using the approach proposed by Hall (1992).

Figure 4: Impulse responses for Poland's GDP to shocks.

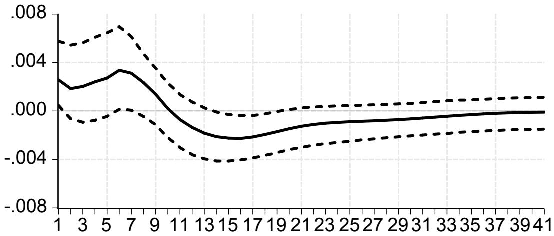
a) Response of Poland's GDP to surprise technology shock



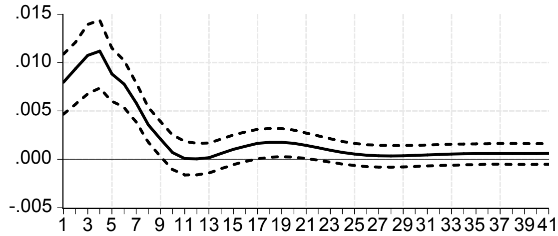
b) Response of Poland's GDP to news technology shock



c) Response of Poland's GDP to euro area sentiment shock

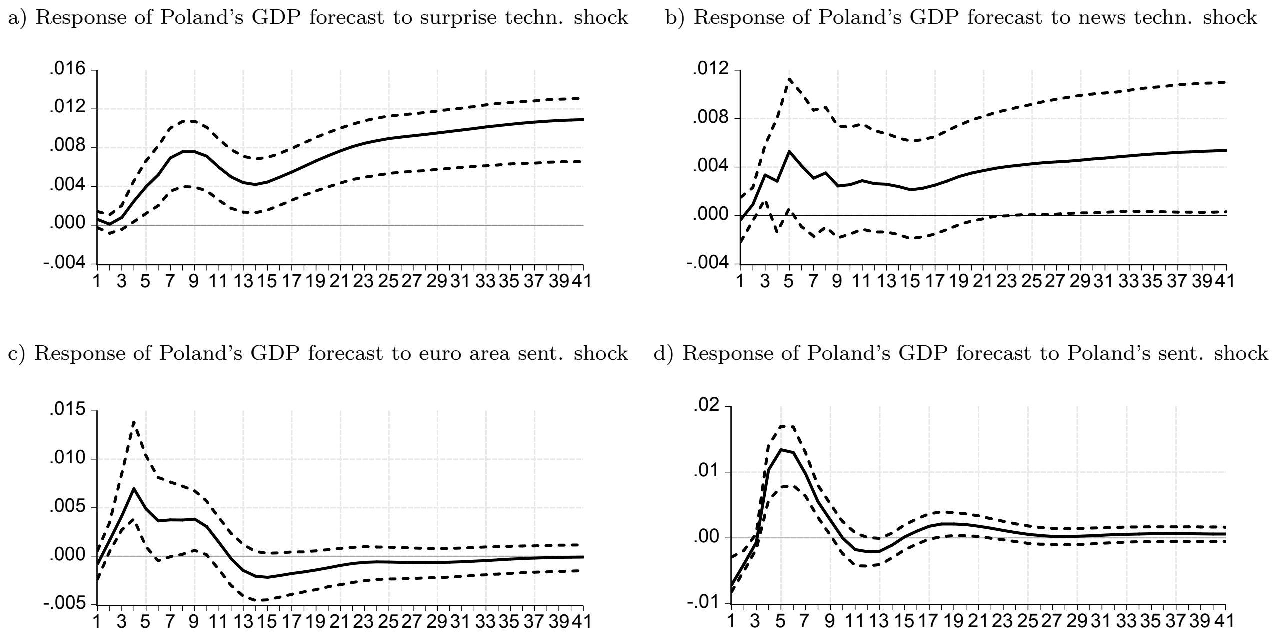


d) Response of Poland's GDP to Poland's sentiment shock



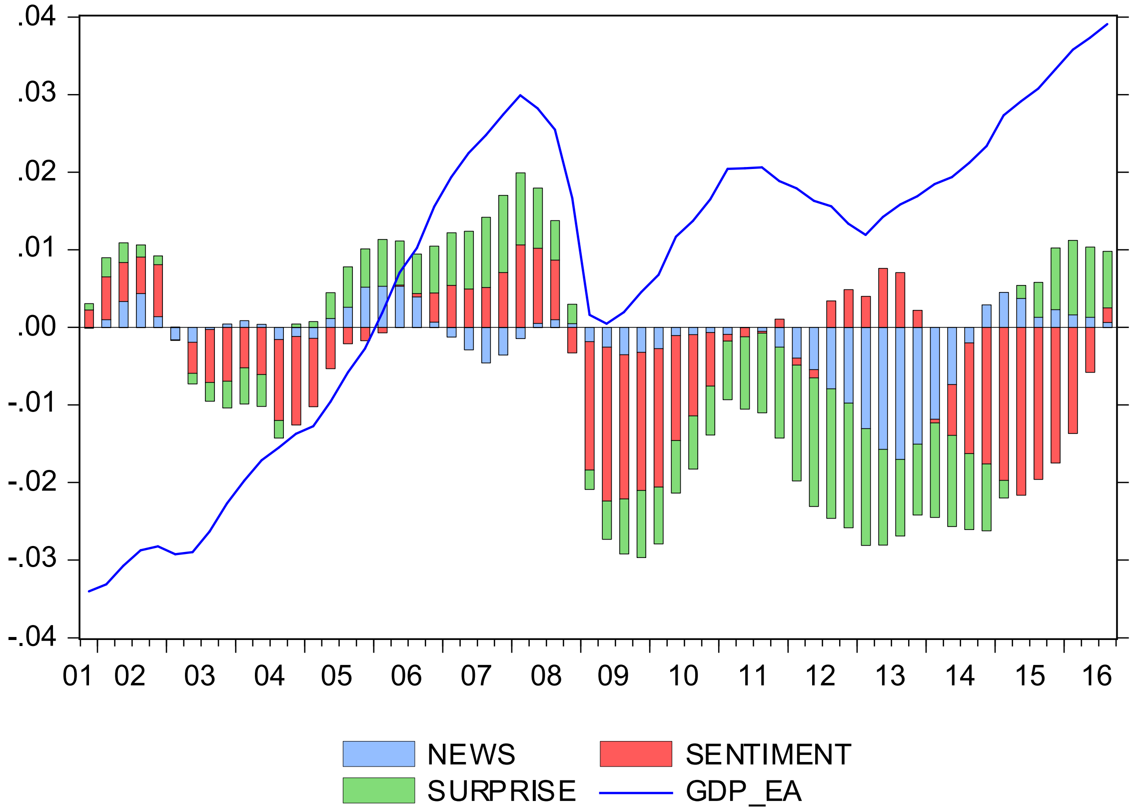
Note: Dotted lines represent the 90 percent bootstrap confidence bands calculated with 10 000 replications, using the approach proposed by Hall (1992).

Figure 5: Impulse responses for Poland's GDP forecast to shocks.



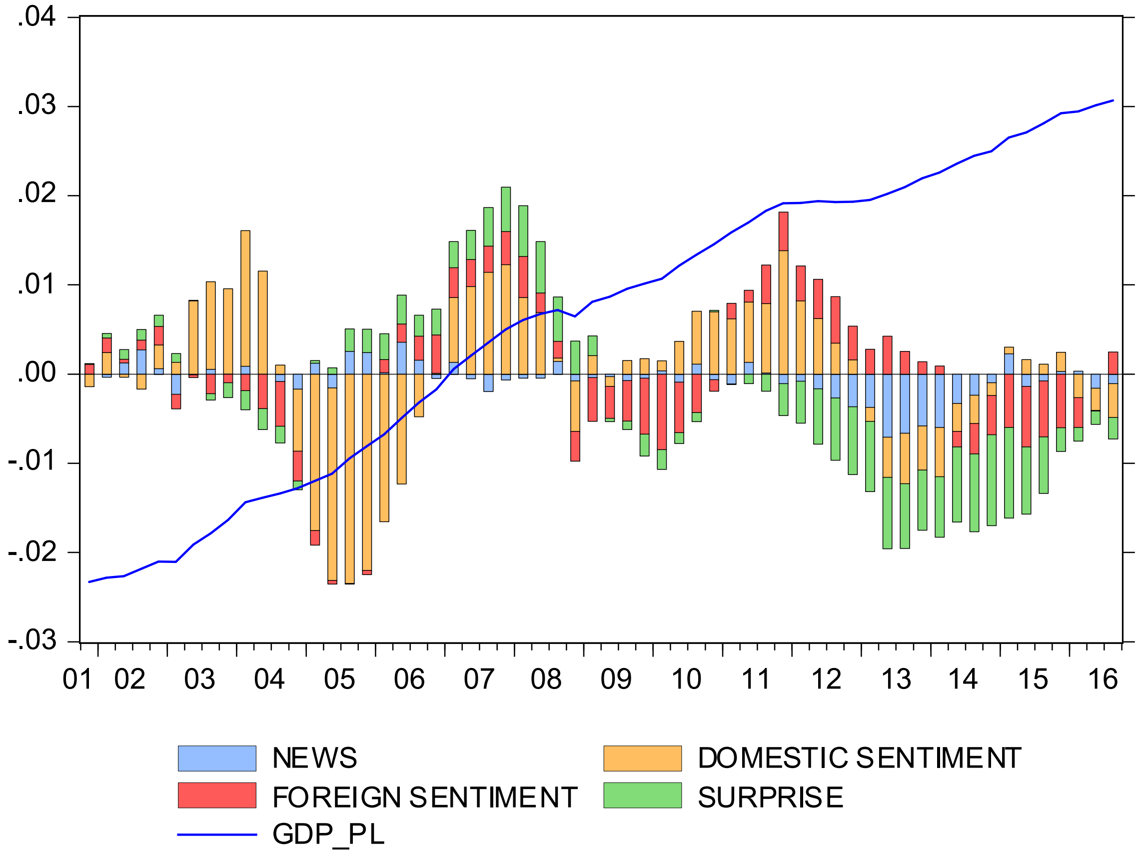
Note: Dotted lines represent the 90 percent bootstrap confidence bands calculated with 10 000 replications, using the approach proposed by Hall (1992).

Figure 6: Historical decomposition of euro area GDP.



Note: The plots represent a historical decomposition of euro area GDP with respect to structural shocks.

Figure 7: Historical decomposition of Poland's GDP.



Note: The plots represent a historical decomposition of Poland's GDP with respect to structural shocks.