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The impact of external shocks on economic growth: An empirical study based on the SVAR models

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Abstract. *The paper contains a series of complex analyses on the study of typologies of economic crises and can bring a significant contribution to the literature in determining the effects of external factors on economic growth, taking into account the distinct characteristics of the periods of decline. The work includes Hodrick-Prescott filtering techniques for characterizing business cycles in three Central and Eastern European countries and the Structural Vector Autoregression (SVAR) technique is used to analyze the impact of external shocks on economic growth over two distinct time-horizons. External shocks such as external debt, external interest rate, external output, producer price index and real interest rate were taken into account. For each economy analyzed, the impact of the two types of economic crisis was observed, namely financial crisis and health crisis, and two time-horizons were defined for each complete economic cycle. Over these two time-horizons, the impact of external shocks on economic growth has been assessed. There has been a general decrease in the effects of shocks in the second time-horizon, in which the most severe values of economic growth are associated with the health crisis, compared to the time-horizon associated with the financial crisis. It has also been observed that, in the case of both Hungary and Romania, the responses of economic growth to external shocks are faster compared to the Czech economy. Moreover, external production is the factor that explains most of the variance in the economic growth rate in the first time-horizon, while in the second, one of the most influential indicators is the external production price index, which has been severely affected by the slowdown in the global production process.*

Keywords: external shocks, economic growth, economic crisis, health crisis, financial crisis, SVAR.

Introduction

One of the most discussed topics is how to ensure the sustainability of economic growth, especially in the management process of the economic crises. The global economic crisis from 2008-2010 has had major and long-lasting negative economic impacts worldwide. On the other hand, the COVID-19 pandemic has had severe economic effects, and more than two years after its inception, the public health crisis continues to be the main source of uncertainty about the future evolution of economic activity. The disruption of international economic activity, due to the mobility restrictions adopted to combat the spread of the SARS-CoV2 virus, have also played an important role in the evolution of economic growth.

Thus, economic policy-makers have taken various measures over time to combat the negative effects of economic crises and to accelerate economic growth. However, the complexity and diversity of the determinants led to a slow recovery process, as the targeted measures adopted could not ensure a favorable development of the economy as a whole.

Therefore, contrary to the adopted measures, the slow nature of the economic recovery process has led to economic losses that persisted long after the end of the economic crisis. This can be mainly due to external factors such as indebtedness, due to the pressures on international economic relations and the trade channel instability caused by the slowdown in international economic activity. Based on this, external factors can be of great importance in the evolution of economic growth and numerous papers in the literature have studied different econometric methods

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for analyzing their impact on economic growth. These include models such as Vector autoregressive (VAR), Structural Vector autoregressive (SVAR), Vector Error Correction models (VECM), Autoregressive distributed lag model (ARDL) and Granger causality.

This paper proposes the use of SVAR models for the study of external factors on economic growth, as these types of models can be used to interpret the effects of external factor shocks, taking into account the structure of the analyzed economy. From this perspective, the study focuses on the analysis of several countries in Central and Eastern Europe, to highlight the different structures of economies and their main weaknesses in managing the two types of economic crisis.

Literature review

Understanding the properties of business cycles is important because recessions and expansions play a significant role in determining the disposable income of households or living standards. When we talk about economic recessions, the first thing that comes to mind is the negative impact on the evolution of the economy, most of the time, analyzed from the perspective of the Gross Domestic Product growth rate.

The recession is usually defined as the record of at least two consecutive quarters of real GDP decline. However, economic policy-makers are usually guided by the analysis of a broader set of indicators, through complex methods of dating the business cycle. In order to identify the periods of economic contraction, one of the best-known methods of dating business cycles is the BBQ algorithm, used by the National Bureau of Economic Research (NBER). Also, the application of filtering techniques such as Hodrick-Prescott, Wavelet, Band-Pass or Kalman can provide important information about the evolution of business cycles. Applying filtering techniques helps to divide real variables into cyclical components and trends. While the trend captures the direction of the economy in the long run, the deviations of the variable from the trend describe the evolution of business cycles. It is well known that not all negative deviations from the Gross Domestic Product trend define periods of economic recession, however, the worst economic crises have resulted in severe negative deviations from the trend. Perron and Wada (2009) find that filters such as Hodrick-Prescott, as well as other methods, identify different cycles, but similar to those in NBER chronology.

On the other hand, one of the most discussed topics about identifying and managing economic crises is determining their causes and effects on economic activity as a whole, but also individually, at the level of sectors of activity. A recent example is the public health crisis, which has mainly affected the production and service sectors, due to the mobility restrictions imposed to combat the spread of the SARS-CoV2 virus. Unlike the financial crisis, caused by the collapse of the real estate sector, where there was a gradual spread of its effects throughout economic activity, the health crisis generated a sudden and very severe economic downturn, followed by signs of fast recovery as a result of specific measures targeting vulnerable sectors.

In this context, the management of the economic crisis is paramount and a comparative analysis of the two types of economic crisis is appropriate and can provide important information on the possibility of adopting economic measures, to directly support the economy as a whole or to support only the vulnerable sectors. Moreover, in addition to the evolution of internal indicators and the stimulation of economic activity through targeted measures, external factors play an important role, the external debt being an important source of financing that can put additional pressure on the affected economy. Also, the producer price index and real exchange rates are important factors that can affect the evolution of the trade balance, with a direct impact on ensuring sustainable economic growth.

Thus, there is a vast literature that studies the impact of various internal and external factors on economic growth over time, but this paper focuses on the analysis of the influence of external factors on economic growth from the perspective of the two periods of economic decline. Wang et al. (2021) studies the relationship between external debt and macroeconomic fragility and finds that an increase in total or external long-term debt is constantly predicting slowdowns in short and medium-term growth. Adefabi and Rasaki (2018) study the magnitude of the impact of external shocks on economic growth in Nigeria and find that the external interest rate and external debt are among the most important factors impacting economic growth. Sosa (2008) points out that the shocks of economic growth in the USA are the main factors that determine the economic fluctuations in Mexico. Similarly, Blecker (2008) finds that the shocks to net financial flows, oil prices, the US growth rate and the real exchange rate depreciation explain most of the fluctuations in Mexico. For instance, Carranza et al. (2003) find that exchange rate volatility has a negative impact on the level of investment and implicitly on economic growth. Kamin and Rodgers (2000) show that exchange rate depreciation leads to high inflation and economic contraction in Mexico.

Therefore, in addition to the well-known internal causes of the economic crises debated over time in the literature, the analysis of the impact of external factors can provide signals about possible weaknesses in economies. From this perspective, the paper presents a detailed analysis of the impact of external shocks on the economic growth of several economies in Central and Eastern Europe, to capture different structures of economies and their main weaknesses in managing the two types of economic crisis.

Methodology

The empirical study involves a series of complex analyzes on the analysis of the typologies of economic crises, as well as the determination of the effects of external factors on their management process. Burns and Mitchell (1946) argue that economic cycles are a type of fluctuation that occurs in the aggregate economic activity of nations, and that one cycle consists of simultaneous expansions of several sectors of the economy, similarly followed by widespread contractions.

In this sense, one of the most used indicators that capture the evolution of the entire economy, in order to characterize business cycles, is the real Gross Domestic Product. The latter can be divided into trend and cyclical components. While the trend component provides information about the long-term evolution of the economy, the trend deviation of the variable captures the evolution of the business cycle.

The paper focuses on several economies in Central and Eastern Europe, namely the Czech Republic, Hungary and Romania, and to ensure a good understanding of the evolution of the economic cycles of the countries studied, it is proposed to apply a series of filtering techniques to separate cyclic and trend components. One of the most widely used filtering techniques is the filter developed by Hodrick and Prescott (1980), which is guided by two important features. On the one hand, it is assumed that the trend and the cycle are not correlated, and on the other hand, it is assumed that the change in time of the trend is allowed only if its changes are not severe. Under these conditions, the trend component $\left(y_t{}^x\right)$ can be identified and estimated using the following formula:

$$\left\{\sum_{t=0}^{x} (y_t - y_t{}^x)^2 + \lambda \sum_{t=0}^{T} \left(\left(y_{t+1}^x - y_t{}^x\right) - \left(y_t{}^x - y_{y-1}^x\right)\right)^2\right\},$$

where λ is the parameter that controls the degree of smoothing of the trend, and the residue $y_t - y_t{}^x$ represents the "component of the economic cycle". Ravn and Uhlig (1997) study the optimal value of λ and provide a visual comparison of the transfer functions of the HP filter. Thus, for a value of 1600, a perfect fit is obtained in the analysis of data with quarterly frequency, unlike the other analyzed adjustments, this being strongly supported also by Hodrick and Prescott (1997). Thus, the study of cyclical components provides important information about the main extreme events that have taken place over time in the analyzed economies, to substantiate the starting point of the analysis of the impact of external factors on economic growth.

In the second stage of the empirical study, it is proposed to use SVAR models, as these types of models can be used to interpret the effects of structural shocks on economic growth, taking into account the structure of the economies analyzed.

The purpose of the SVAR models' application is to determine the dynamic responses of economic growth to independent shocks of external factors, by separating two different time-horizons, which capture separately the characteristics of the observed recession periods. The SVAR approach is a good alternative to the theoretical VAR model, as the structure of the economy plays an important role in the economic recovery process.

We apply the following SVAR model (Adefabi and Rasaki, 2018; Yildrim, 2016; Mackowiak, 2007):

$$\sum_{p=0}^{n} [C_{11}(s)\ C_{12}(s)\ C_{21}(s)\ C_{22}(s)\ ]\left[y_t^d\ y_t^f\ \right] = \left[\varepsilon_t^d\ \varepsilon_t^f\ \right],$$

where C_{ij}represents the matrix of coefficients, $y_t = \left[y_t^d, y_t^f\ \right]^t$ is a vector of variables representing the evolutions of the analyzed economies, as well as exogenous factors, and $\varepsilon_t = \left[\varepsilon_t^d, \varepsilon_t^f\ \right]^t$ is the vector of structural shocks with domestic (ε_t^d) and external (ε_t^f) origin. The vector of internal variables is represented by the series of economic growth, and the vector of external variables contains evolutions regarding the price of external producers, the real exchange rate, the external interest rate, as well as the external production and the external debt.

Therefore, the estimation of SVAR models, on each of the two time-horizons, provides important information on the dynamic responses of economic growth to structural shocks of external factors, but also results on the percentage of variance explained by the evolution of each external factor. Moreover, the empirical results can provide important guidance on possible measures that can be taken to ensure economic growth during periods of decline, taking into account its sensitivity to external factors. Software packages such as Matlab and Eviews are used to analyze the data used and estimate the models presented.

Results and discussions

The data used are seasonally adjusted and were extracted from Eurostat database in quarterly frequency, from January 2005 to September 2021. Three Central and Eastern European countries were analyzed, namely the Czech Republic, Hungary and Romania. For the purpose of the research, real Gross Domestic Product indicators were used to determine the evolution of economic growth and five external factors were analyzed: the producer price index from EU27 (PPI), the real exchange rate, the external interest rate (3 months - EURIBOR), the external debt of the analyzed economies, as well as the Gross Domestic Product of the European Union, as a proxy of the external output.

Economic cycle overview

As described above, economic growth that describes the evolution of the economy can be broken down into cyclical and trend components. Thus, for the observation of the extreme events that took place at the level of the analyzed economies, HP cyclical components of the real Gross Domestic Product for each of the three countries is presented in Figure 1.

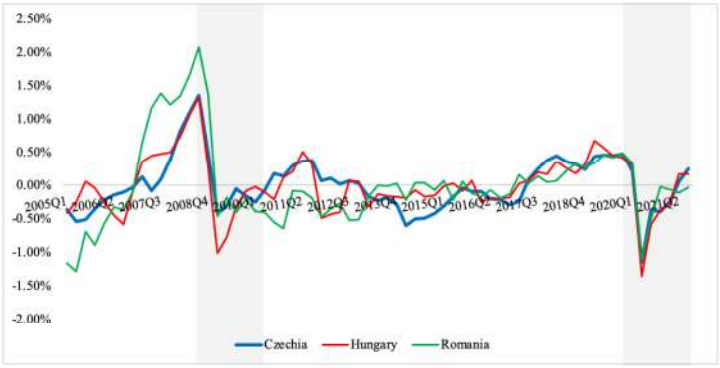


Figure 1. The HP Cyclical components of the real GDP

Source: Authors' own research.

Figure 1 shows the evolution of the three economies. As can be seen, there are two extreme events that have taken place over time, represented by the two economic recessions, namely the financial crisis from 2008 - 2010 and the health crisis in the recent period. Thus, two distinct behaviors can be distinguished in terms of the evolution of cyclic components. While the financial crisis is characterized by a long period of negative growth rates, The health crisis has an unprecedented severity, driven by mobility restrictions adopted to combat the spread of the SARS-CoV2 virus, followed by signs of a fast recovery. Therefore, two approximately equal time-horizons were defined, which capture the two extreme events: January 2005 - December 2013 and January 2014 - September 2021.

The SVAR models

The economic policy measures adopted in the recession management process have been addressed in different directions, taking into account the economic context at that time. While, during the financial crisis, measures were taken to support the entire economy, affected by the collapse of the real estate sector, during the health crisis, the measures targeted the economic sectors most affected by the economic downturn.

However, the range of uncertainties regarding the future evolution of economic activity is large. In addition to the evolution of internal indicators and the stimulation of economic activity through targeted measures, external factors play an important role, the external debt being an important source of financing that can put additional pressure on the affected economy. Also, the producer price index and real exchange rates are important factors that can affect the evolution of the trade balance, with a direct impact on ensuring sustainable economic growth.

In this sense, the estimation of SVAR models by determining the impulse response functions and the proportion of the variance of the endogenous variable, explained by the evolution of external factors, provides a complete view of the sensitivities of the economy during the two economic crises. In the following, the results of the estimates, for each of the three economies, will

be presented and a comparison will be made of the responses of economic growth to structural shocks and the percentage of variance explained by the evolution of external factors.

Impulse response functions

Figure 2 illustrates the responses of economic growth in the Czech Republic to different structural shocks on each of the two time-horizons. The figure shows a positive response of the Czech economic growth to a shock in the economic growth of the European Union, both in the first time-horizon and in the recent period. This suggests that a positive external demand shock will have a positive impact on economic growth in the Czech Republic, in line with the results of Adefabi and Rasaki (2018) and Sousa (2008).

However, there is a general decrease in the effects of shocks in the second time-horizon. It supports the artificial nature of the economic downturn imposed by restrictions on economic activity, as opposed to a financial crisis, in which most external indicators have a severe direct impact on economic growth. The same effect is observed in the case of the external interest rate (3M-EURIBOR) and the external debt, where the positive shocks on the two indicators materialize through short-term economic growth.

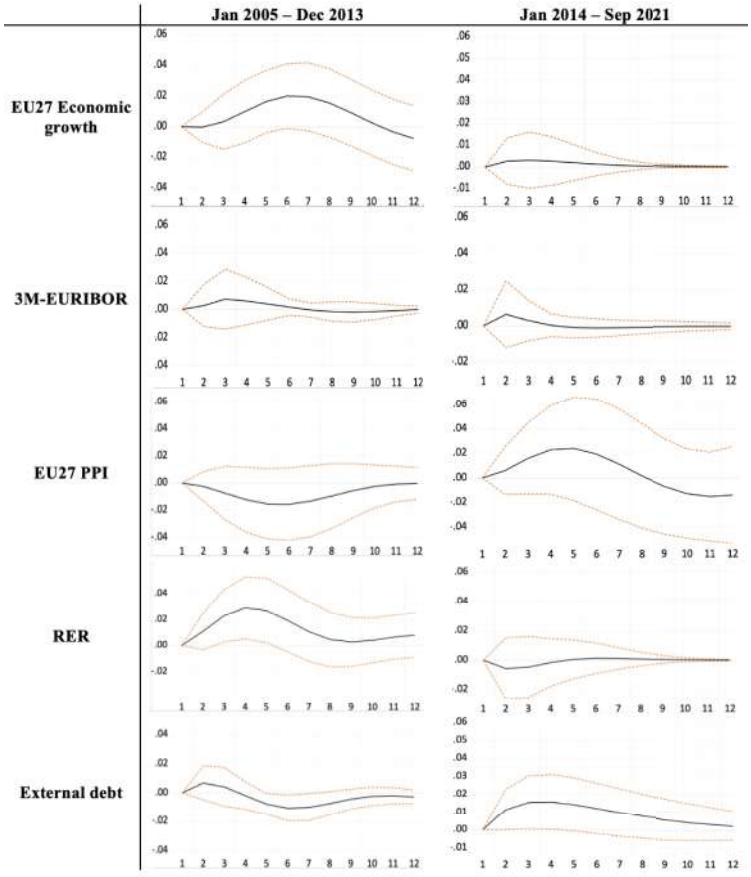


Figure 2. Response of Economic growth to external shocks – Czech Republic

Source: Authors' own research.

Thus, the measures taken by the European Central Bank to reduce 3M-EURIBOR during the financial crisis to support lending activity, coupled with a decrease in the growth rate, lead to a

direct relationship between the two indicators. At the same time, in terms of external debt, it leads to an increase in the growth rate in the first 4 quarters, followed by a decrease after 4 quarters. This implies that low levels of external debt correspond to high values of economic growth and vice versa, in line with the results obtained by Adefabi and Rasaki (2018) and di Giovanni and Shambaugh (2007).

With regard to producer price index and the real exchange rate, there are different directions for economic growth responses over the two time-horizons. While in the first time-horizon, a positive shock to the producer price index, representing a negative shock of supply in the foreign market, leads to an economic decline. In the recent period, the impact on the economic growth is positive, due to maintaining a steady price growth rate until mid-2021. Similarly, the opposite effect is observed in the case of the real exchange rate shock. While on the first time-horizon, a depreciation of the real exchange rate leads to economic growth due to an increase in the exports demand, in the recent period, the depreciation of the exchange rate has a low negative impact due to the increase in payment costs of the external debt.

At the same time, Figure 3 illustrates the responses of economic growth in Hungary to different structural shocks on each of the two time-horizons.

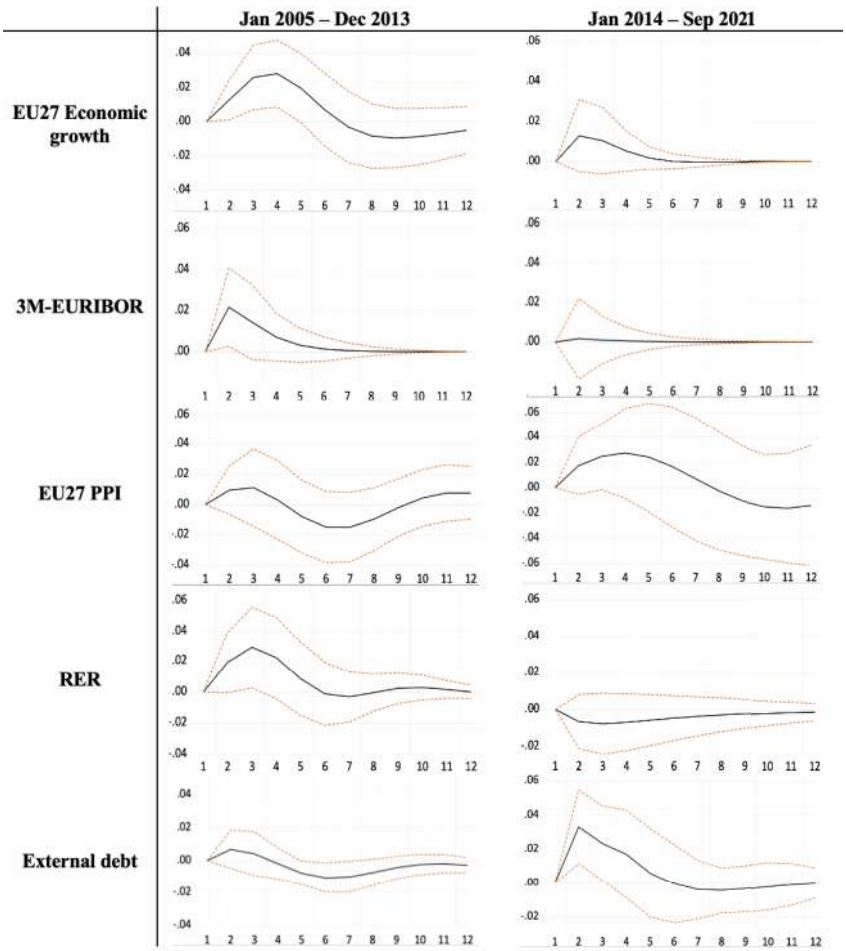


Figure 3. Response of Economic growth to external shocks – Hungary

Source: Authors' own research.

The figure shows the same decrease in the impact of external shocks on economic growth in the second time-horizon, thus highlighting the non-financial cause of the public health crisis. Unlike the Czech economy, Hungary's economic growth offers faster responses to external shocks on both time-horizons. This may support a spread of the effects of more effective policy measures, which is also supported by the analysis of the cyclical component, which captures the longer-term effects of the recession on the Czech economy. Delaying the Czech economy's growth responses to the external shock may also be an important advantage, which can ensure better economic stability in the case of negative shocks.

Figure 4 illustrates the responses of economic growth in Romania to different structural shocks, on each of the two time-horizons. The figure shows the same effect observed in the case of the other two economies, namely the reduction of the impact of external shocks on economic growth between the two time-horizons. Also, in the case of both Hungary and Romania, faster growth responses to external shocks can be seen. Moreover, the Romanian economy indicates an insensitivity to the shocks of the interest rate and the external debt in the second time-horizon, due to the constant trend of the two indicators in the analyzed period.

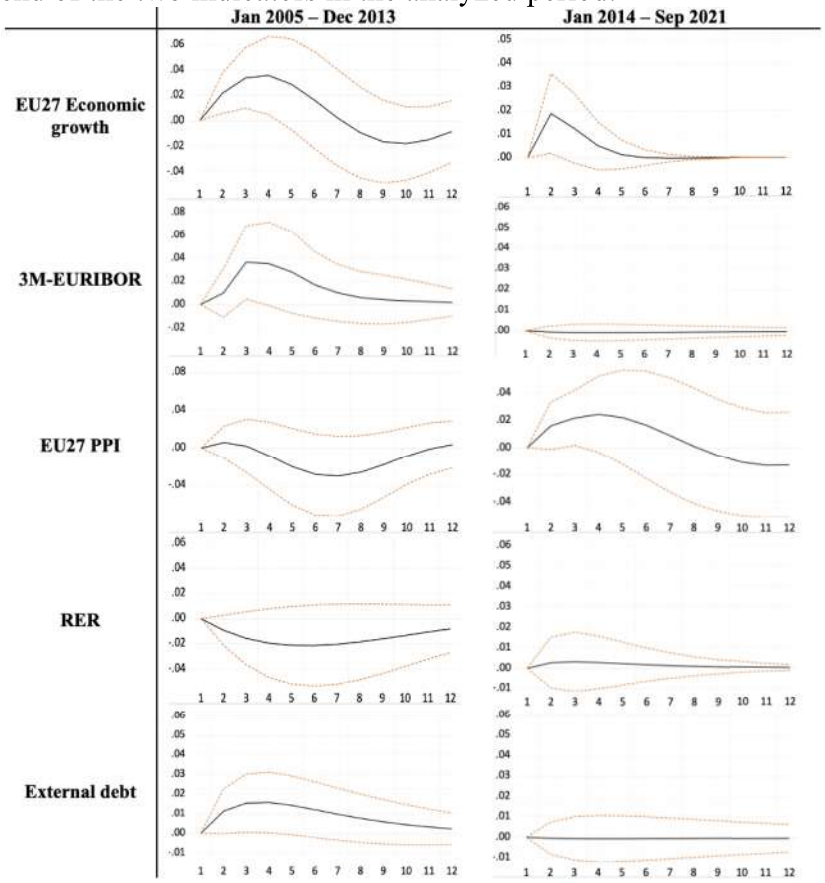


Figure 4. Response of Economic growth to external shocks – Romania

Source: Authors' own research.

Therefore, in the case of the Romanian economy, the negative effects of the health crisis observed in the evolution of economic growth are not correlated with a negative change in external debt or external interest rate. However, their effect on economic growth cannot be completely ruled out, as uncertainties caused by mutations in the viral genome can lead to an economic overheating.

Thus, there may be delayed effects of the economic recession in the financial sector, caused by rising inflation and the need for additional financing.

In this regard, the study provides important information on the possibility of targeting certain vulnerable sectors in the event of a public health crisis, but also of adopting economic policy measures to support the economy as a whole in the case of a financial crisis, taking into account the significant impact of external factors.

Variance decomposition

As mentioned in previous sections, the SVAR models' estimation provides both information on the impact of certain structural shocks on endogenous variables through the impulse response functions, and also the information on the percentage of variance in economic growth explained by the evolution of external factors. In order to provide a complete picture of the results obtained for each of the three countries, the following are presented the main results regarding the proportion of the variance of the endogenous variable, explained by the evolution of the five external factors.

Table 1 shows the contribution of external factors to the evolution of economic growth in the three economies analyzed. It can be seen that external production is the factor that explains the largest variance of the economic growth rate, in the case of the first time-horizon (TH 1). In the recent period (TH 2), one of the most influential indicators is the external producer price index, which has been severely affected by the slowdown in global production processes.

Table 1. The variance decomposition of economic growth

Economy	Horizon	EU27 Economic growth		3M-EURIBOR		EU27 PPI		RER		External debt	
		TH 1	*TH 2*	*TH 1*	*TH 2*	*TH 1*	*TH 2*	*TH 1*	*TH 2*	*TH 1*	*TH 2*
Czechia	4	2.25%	0.59%	1.32%	1.09%	3.29%	17.25%	25.75%	1.25%	1.91%	17.29%
	8	20.42%	0.74%	1.48%	1.18%	12.83%	32.22%	37.20%	1.33%	8.25%	27.31%
	12	21.03%	0.74%	1.52%	1.21%	13.02%	37.96%	37.09%	1.33%	8.79%	28.40%
Hungary	4	29.12%	6.82%	10.24%	0.09%	3.75%	28.87%	23.91%	3.43%	1.14%	37.99%
	8	32.88%	6.88%	10.35%	0.09%	11.20%	36.93%	24.01%	5.00%	8.37%	37.95%
	12	35.23%	6.88%	10.35%	0.09%	12.71%	42.10%	24.10%	5.23%	8.01%	38.09%
Romania	4	23.93%	17.79%	17.14%	0.06%	0.91%	34.92%	5.57%	0.84%	4.68%	0.04%
	8	24.88%	17.83%	21.07%	0.14%	16.29%	43.69%	13.73%	1.17%	5.43%	0.09%
	12	28.26%	17.83%	21.14%	0.17%	17.60%	47.44%	16.59%	1.20%	5.59%	0.12%

Source: Authors' own research.

Similar to the results presented above on impulse response functions, Table 1 identified a decrease in the percentage of the variance explained in the second time-horizon, due to the uncorrelation of the economic evolution across all sectors of activity. Thus, taking into account the current state of the economy, the opportunity to adopt targeted measures on the most affected economic sectors is observed, also taking into account the sensitivity of the economy as a whole to external factors, such as external economic growth, producer price index, external production and external debt.

Conclusion

The paper contains a series of complex analyses on the study of typologies of economic crises and makes a significant contribution in the literature in determining the effects of external factors on economic growth, taking into account the distinct characteristics of the periods of decline.

The Hodrick-Prescott filter application to the GDP series of the three countries indicates two periods of concentration of severe negative deviations from the trend. The two periods are associated with the two economic crises, namely the financial crisis and the health crisis. While the post-financial crisis period is characterized by a gradual economic recovery, the recent period is showing signs of a fast recovery, due to targeted measures aimed at vulnerable sectors, but also the partial cancellation of mobility restrictions adopted to combat the spread of Coronavirus.

At the same time, the results of the SVAR model estimation provide a comparison between the three economies analyzed, in terms of the magnitude and duration of the growth response to external shocks. Thus, there is a general decrease in the effects of shocks in the second time-horizon, in which the most severe values of economic growth are associated with the health crisis, compared to the time-horizon associated with the financial crisis. It has also been observed that, in the case of both Hungary and Romania, the responses of economic growth to external shocks are faster compared to the Czech economy. Moreover, external production is the factor that explains most of the variance in the economic growth rate in the first time-horizon, while in the second, one of the most influential indicators is the external production price index, which has been severely affected by the slowdown in the global production process.

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