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Assessing the optimality of euro adoption in Romania through shock correlations

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Abstract. The present paper is concerned with the prospect of euro adoption in Romania. The study starts from the relevant literature of the Optimum Currency Areas and identifies the most widely acknowledged meta property and methodological model for this purpose: the SVAR Blanchard and Quah decomposition for identifying the supply and demand shocks. Employing the indicated model and the most recent data, we are able extract and analyse the underlying shocks that hit 34 European economic entities in the period 1995-2019, while also taking into account two crucial structural changes for the Romanian economy – central bank independence and EU accession. After performing the pairwise correlations between Romania and the rest of the economic entities for both the supply and demand disturbances, we map them on a bidimensional graph. We discover that while there is relevant integration and connectedness that ensures relatively high correlations between supply shocks, the politically-motivated monetary and fiscal policy disturbances that created ample and hectic demand side movements, are a factor of great concern for the prospect of single currency adoption in this Eastern European country. The findings support the view that there is room for the conduct of macro policies to become more supportive to the process of euro adoption and that the respect of convergence criteria would help in this respect. To our knowledge, this is the first study performing pairwise shock correlations between Romania and many other European economic entities, while also isolating the effect of post 2005 structural changes.

Keywords. optimum currency areas; SVAR; Blanchard and Quah decomposition; Romania; euro adoption; shock correlation

JEL Codes. E31; E32; E37.

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1. Introduction

The main objective of this study is to provide an evidence-backed answer to whether, at this point in time, Romania is prepared to adopt the European single currency. The empirical evaluation of this very complex issue is done using the most widely accepted methodology in the optimum currency areas (OCA) literature: the SVAR Blanchard and Quah decomposition for the underlying demand and supply shocks (Blanchard & Quah, 1989). By correlating these shocks that hit the Romanian economy and the ones that hit some other European economic entities (both national economies and EU/EA economic aggregates) in the past 25 years (1995-2019), a clear conclusion on the matter at hand can be inferred.

[1] **Disclaimer**. The information and views set out in this article are those of the author and do not necessarily reflect the opinion of the European Commission. The present study has been conducted before the author joined the European Commission.

The relevance of this paper stems from the fact that it is the first study of this kind involving Romania taking into account the effect of two irreversible and structural changes that took place after 2005 (central bank independence and EU accession). As such, this study comes to reassess the situation after three decades of economic and political transition, after 14 years of central bank independence, and after 12 years of EU integration efforts.

Furthermore, the recent advances from neighbor countries on euro adoption, might also push the issue on the agenda of the executive from Bucharest. Given that the regional political and macroeconomic landscape has changed, a reassessment of the optimality of euro adoption is clearly demanded.

The literature on the optimum currency areas (OCAs) in Europe has developed a great deal since the seminal paper of Mundell (1961) and comprises both theoretical and empirical studies which shaped academic and the policy-oriented discussion on the creation and functioning of the single currency area we know today. At the same time and in parallel, the European single currency project advanced passing through various phases (European Monetary System, ECU, euro and cash euro, etc.) since the Werner Report and the end of Bretton-Woods system in the 70's. Nowadays, the euro area encompasses the economies of 19 European countries (with other micro and small states using the euro as their *de facto* currency on the basis of agreements on monetary relations or due to the *euroization* of their economies), and close to 350 million citizens as daily users.

On the basis of EU legislation, all EU countries without the euro (except Denmark, which opted out) are required to adopt the single currency after having fulfilled the Maastricht convergence criteria[2]. Nevertheless, five countries (Czech Republic, Hungary, Poland, Romania and Sweden) preferred not relinquishing their monetary sovereignty at all, while other two (Bulgaria and Croatia) only recently expressed their intention to join the euro antechamber (i.e. ERM II)[3].

The most recent Eurobarometers show very mixed feelings; while there are some euro-optimist member states, significantly low or decreasing popular support for the euro adoption and Economic and Monetary Union are registered in several of these countries, with governments and central banks hesitant on advancements on the issue.

These facts pose a conundrum for both academic and policy-making spheres with respect to the optimal size and the right composition of the euro area. This study, although touching upon all EU member states, focuses on the Romanian case in the effort of making an empirical and measurable assessment of euro adoption optimality in this Eastern European country.

The rest of the paper is structured as follows. In the second section, an in-depth literature review centered on OCAs is provided with subsections centered on its theoretical foundations, its properties and the most relevant empirical studies. The subsequent section details the economic and econometric model of choice, while also indicating the data source and the statistical tool. The fourth part consists of results and their interpretation, while the last one is reserved for conclusions and policy recommendations.

[2] Art. 140 (1) TFEU

[3] "Commission welcomes Bulgaria and Croatia's entry into the Exchange Rate Mechanism II". European Commission. Brussels. Press release. 12 July 2020.

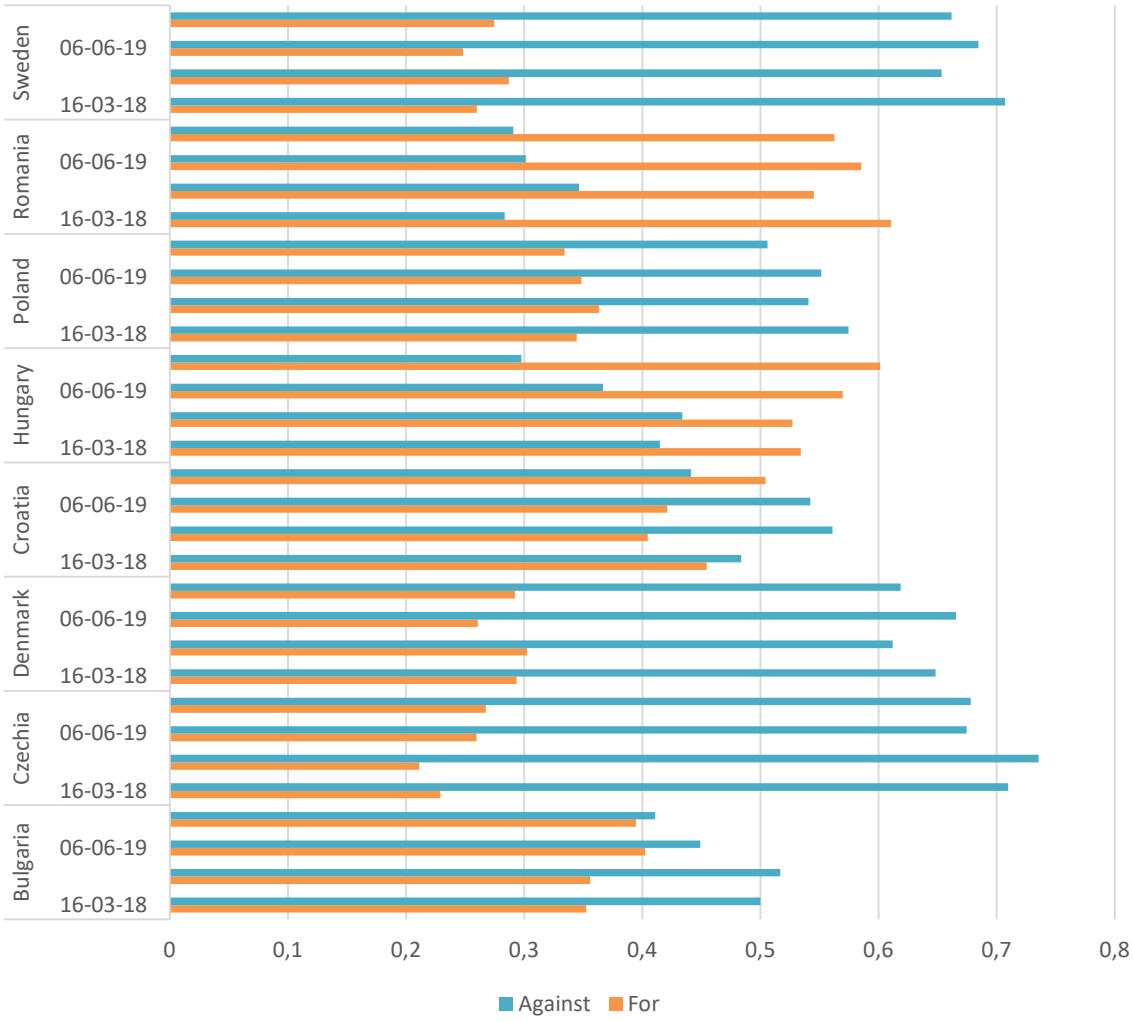

Figure 1. Sentiments regarding the EMU in selected EU non-euro area countries. Source: Eurostat. Question: "*What is your opinion on each of the following statements? Please tell me for each statement, whether you are for it or against it. A European economic and monetary union with one single currency, the euro."* DK/NAs ("don't know/no answer") not included.

2. Literature review

2.1. The foundations of the OCAs

One of the most relevant costs associated with adopting the euro is the relinquishment of the sovereign monetary policy instrument, which has been extensively used in the past, especially during the decade of the 90s by the Romania government in concert with a non-independent National Bank of Romania (Bodea & Sánchez-Santos, 2020). Against the background of the hardships imposed by transition, monetary policy helped the executive in achieving both commercial policy (devaluation to buttress exports) and fiscal policy objectives (inflation to reduce public debt denominated in domestic currency and raise seigniorage and other indirect taxes).

Nevertheless, the full range of costs, as well as benefits of joining a monetary union, is not limited only to achieving commercial and fiscal policy objectives, the issue being at the core of

the literature of optimum currency areas (OCAs).

The theory of OCAs, pioneered by Robert Mundell (1961) and McKinnon (1963), established the prerequisites for monetary integration: price and wage flexibility, mobility of factors of production, financial markets integration, economic openness, production and consumption diversification, inflation correlation and fiscal and political integration; achieving fiscal integration is only possible if there is enough political drive (Issing, 2004).

Further studies focused on the cost-benefit analysis with a special focus on the need for real exchange rate adjustments in the absence of the fine-tuning option provided by the sovereign monetary policy (Corden, 1972). Moreover, the inability to steer the economy along the unemployment-inflation curve (i.e., the Philips curve) coupled with some unrealistic assumptions of the OCA theory might entail very high costs for a fixed exchange rate regime (Ishiyama, 1975), especially in the context of asymmetric shocks (Mongelli, 2002).

The advent of the monetarist critique of the short-term Phillips curve (i.e. wage bargaining takes into account expected, not current inflation) debilitated the argument for a sovereign monetary policy (McCallum, 1989; Artis, 1991) and subsequent debates centered around the negative effects of higher inflation (association with higher unemployment levels and lower income per capita) (Emerson, 1992) and on the credibility of the sovereigns. Countries with historical higher inflation might suffer from credibility issues when pursuing inflation reduction policies since there is always the risk of reversing them. One way of gaining credibility is by "tying its hands" (also referred to as an "Ulysses pact"), i.e. entering a monetary union with another low-inflation anchor country (Giavazzi & Giovannini, 1989; Mongelli, 2002).

2.2. OCAs meta property – shock correlations

The studies cited above, although setting up the theoretical framework for the debate, lacked nevertheless the empirical dimension. The already advanced state of the debate, coupled with a renewed interest for OCAs kindled by the integration push from the Delors Commission, and with methodological advancements, mainly in time series analysis, set the scene for the "empirical studies phase" in the literature of OCAs (Mongelli, 2002). Price and wage flexibility, labor, factor, and financial markets integration, as well as the degree of economic openness and of political integration were all empirically assessed for a series of countries/regions (for a detailed literature review please refer to Mongelli, 2002). A vein of the literature concentrated on a "catch-all" or *meta* OCA property: the similarity of shocks; the present study falls in this category.

The reason for which the similarity of shocks is envisaged as some sort of catch-all property for an OCA is that in the presence of high correlation between the shocks affecting different economies, the need to have specific and divergent fiscal and monetary responses across the currency union drops, thus rendering the sovereignty in these areas less useful.

A major impediment in assessing the correlation between the shocks was with respect to the source of them; some of the shocks might not be totally exogenous in the case of countries with sovereign monetary policy, since the said policy might act as a source of asymmetric shocks

(albeit temporary). In order to solve this issue, Bayoumi and Eichengreen (1993) implemented a methodology first developed by Blanchard and Quah (1989) in order to discriminate between permanent and temporary shocks (as the ones generated by a sovereign monetary policy). It consists of extracting from the time series of prices and output data the demand and supply shocks by first estimating a structural vector autoregressive model (SVAR) and then discerning between temporary (demand-side driven) and permanent (supply-side driven) shocks. A correlation between the series of demand and supply shocks is then computed for all the prospective countries of a monetary union, on the one side, and the average of the union (or an anchor country), on the other side, thus obtaining a quantifiable indication of the optimality of single currency adoption in each country (de Grauwe, 2018).

2.3. Empirical studies on shock correlations

The firsts to discriminate between the supply and demand shocks on the basis of the effect they have on output and unemployment were Blanchard and Quah (1989), establishing that the former have a permanent effect on the GNP after two years, reaching a plateau after five, while the latter will determine a hump-shaped mirror image on both GNP and unemployment.

Bayoumi and Eichengreen (1993) borrowed from the previously-cited study the methodological apparatus and used it in the framework of OCAs literature. Employing data spanning from 1960 to 1988 for output and inflation for 12 European Community (EC) member states, among others, they established that the underlying shocks are considerably more idiosyncratic across these countries, than across the US, which corroborated with the lower factor mobility, lead the authors to infer the increased difficulty of operating a monetary union in EC. Nevertheless, at the same time a cluster of countries concentrated around West Germany was identified as the core of the future EMU on the basis of increased shock synchronization. Their findings were confirmed by Bayoumi and Eichengreen (1996) and Demertzis et al. (2000).

The finding that in Europe there is more symmetry on the demand side, mainly manipulated by the policy intervention, made Demertzis et al. (2000) conclude that the Economic and Monetary Union, while not naturally an OCA, is held together by policies targeted at synchronization.

Unsurprisingly, shock similarity between regions within the same country was found to be higher than the one between countries in Europe, as the cases of US or Germany prove (Bayoumi & Eichengreen, 1993; Funke, 2000), but however, account for a big part of the variability across the Euro Area, with peripheral countries having important regions in the core and *vice versa* (Forni & Reichlin, 1997).

Studies assessing the shock similarity between Central and Eastern European countries (CEECs) and their Western counterparts, are scanter than the ones solely concerned on Western Europe and are mostly concentrated in the period of early 2000, when the post-communist bloc was still struggling with economic transition and was in the process of EU accession.

Frenkel and Nickel (2002), building on previous research (Frenkel et al., 1999) with observations spanning from 1993 to 2001, found the highest correlations of demand shocks with

EMU as a whole to be with Hungary and Poland, while on the supply side, the best candidates for euro adoption were Hungary and Slovenia. However, due to the lack of appropriate quarterly GDP data, Romania was not included in the sample.

The first study to include Romania produced clear-cut evidence against euro adoption, as the correlation values with the euro area were virtually 0 (Fidrmuc & Korhonen, 2003) and brought again into attention that among the CEECs, Hungary was by far the most aligned with the shocks in the single currency zone.

The literature focused on this *meta* OCA property lost momentum after the empirical researches conducted in late 90s and early 2000s. Campos and Macchiarelli made a relatively recent reassessment of the shock similarity situation in the Euro Area (reaching the conclusion that the core-periphery gap narrowed since the initial studies), but without including the CEECs (Campos & Macchiarelli, 2016).

The fact that these empirical researches are concentrated in early 2000 is due to two main reasons (Frenkel & Nickel, 2002): data availability (the lack of relevant or reliable data for the decade of the 90s determined small sample sizes, affecting the estimation results and burdening the previous attempts), and political and economic uncertainty (when and by how much was the EU/EMU to expand in Central and Eastern Europe?). As such, the results obtained by these studies might not currently hold, as important structural changes might have taken place; CEECs had already known considerable periods of integration with their Western counterparts since then.

The most recent attempts to reassess the Romanian situation (we are aware of) are detailed in the following paragraphs. In a 2013 paper which briefly touched upon the shock similarity aspect in the context of a wider CEECs sample and confirmed the initial intuition in the literature: the EU integration period structurally modified the economies of the new member states and synchronized their shocks (Bobeica & Manu, 2013). Noteworthy is the fact that while the correlation of supply-side shocks reached 0.5, the demand-side one stayed close to 0, suggesting that in the transition period in Romania, the problem might have lied with behavior in consumption, which the authors link with the policy induced temporary disturbances such as the allowance of credit boom in the pre-2008 period and the cut in public sector wages in 2010 (highly pro-cyclical policies) (Bobeica & Manu, 2013).

Empirical studies conducted in the last two years seems to point towards mixed and inconclusive results. Deskar-Škrbić et al. (2020) assessing the three candidate countries from the third wave of expansion (Bulgaria, Croatia, Romania) found evidence that they are all fit for adopting the counter-cyclical ECB monetary policy, notwithstanding their different past exchange rate regimes. On the other hand, Grimm et al. (2021) rejected the notion that these countries share a common cyclical response pattern with the EA aggregate (with the exception of Sweden), at best, their business cycles exhibiting very weak codependence (given the spillovers from the EA). In the same line, Arčabić & Škrinjarić (2021), argue that due to the large spillovers, especially since 2007-2016 period of Great Recession, national stabilization policies proved ineffective, and a greater degree of international policy coordination is recommended.

One common shortcoming of these above-mentioned empirical studies is that they do not take

into account two extremely important structural changes suffered by the Romanian economy that are particularly relevant for the shock correlation aspect. (1) In 2005 the National Bank of Romania was granted a new statute, considerably more independent from political mixtures (Bodea & Sánchez-Santos, 2020) and changed its mandate from monetary base targeting to inflation targeting (Deskar-Škrbić et al., 2020). (2) In 2007, Romania's EU accession happens, granting a more integrated approach towards the fiscal and monetary policy. As such, in order to control for these changes, we propose a competing model taking into account strictly the post-2005-time series of our variables of interest, being able to isolate the latest irreversible developments without "the noise" of the 90s and early 2000s period.

Noting the inclusiveness of the empirical researches on the similarity of shocks between Romania and the euro area, as well as the lack of any study to account strictly for the effect of the past decade of EU integration policies in Romania, the present paper comes to fill these gaps in the literature and reassess the situation at 30 years since the start of the economic and political transition, at more than 14 years since central bank independence, and at more than 12 years since EU accession. Of high importance is also the evaluation of the overall effect of policy induced short term disturbances (identified in the literature as the main driver for the demand side correlation); if for the immediately *ante-* and *post-*2008 financial crisis period, the economic policy has been highly pro-cyclical and resulted in null correlations with the overall euro area trends, where does it stand now?

3. Methodology, data, and tools

3.1. The AD-AS model

The methodological framework starts from the basic aggregate demand and aggregate supply model (AD-AS). The AD curve is downward slopping since demand is inversely related to the level of prices (lower prices boost demand). On the other side, short-run AS curve is upward sloping indicating the direct relationship between price level and firm output and the wage stickiness (implying that higher prices mean lower real salaries). At the same time, long-run AS curve is perfectly inelastic to changes in price level and real wages adjust to changes in prices in the long-run (Bayoumi & Eichengreen, 1993).

An expansionary aggregate demand shock will shift both output and prices levels upwards in the short-run, but in the long run, the real output will come back to its previous level, while the prices will raise to a level permanently higher. On the other side, an aggregate long-run supply-side shock (such as a technology improvement) will result in the short-run in lower prices and higher output, since it will shift downwards the short-run AS curve. In the long run, the new AS curve will become increasingly inelastic, shifting the long-run AS to the right and permanently increasing the output, while putting downward pressure on prices (Bayoumi & Eichengreen, 1993). The exercise within the AD-AS model proves that demand shocks will have a short-living effect on real output, while the supply shocks will have a permanent one.

3.2. The SVAR model for demand vs. supply shocks discrimination

The methodology firstly proposed by Blanchard and Quah (1989) and later employed and extended by Bayoumi and Eichengreen (1993), is the procedure for decomposing permanent and temporary shocks. The model starts from the infinite moving average representation of the bivariate vector autoregressive system featuring GDP and inflation data as:

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + A_3\varepsilon_{t-3} + \cdots = \sum_{i=0}^{\infty} L^i A_i \varepsilon_t \quad [1]$$

where X_t is the bivariate vector $[\Delta y_t, \Delta p_t]$, (stationary output and prices first-differenced time series), L^i is the lag operator, and the matrix A represents the impulse response functions of the shocks to X.

As such, expression (1) can be written in matrix form as:

$$\begin{bmatrix}\Delta y_t \\ \Delta p_t\end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix}a_{11i} & a_{12i} \\ a_{21i} & a_{22i}\end{bmatrix} \begin{bmatrix}\varepsilon_{dt} \\ \varepsilon_{st}\end{bmatrix} \quad [2]$$

where $\begin{bmatrix}\varepsilon_{dt} \\ \varepsilon_{st}\end{bmatrix}$ is the vector of output and price disturbances and a_{11i} represents the element a_{11} for the country i^{th} in matrix A_i and so on.

In order to allow for the temporary effect of inflation on output (i.e. demand shocks have no permanent effect on GDP), one must impose the restriction that element a_{11i} of matrix A_i is equal to 0. Besides this restriction, there are three others to allow for the identification of all four elements of matrix A_i: the orthogonality (independence) of the demand and supply shocks and two restrictions regarding the normalization of the disturbances terms (Fidrmuc & Korhonen, 2003; Campos & Macchiarelli, 2016).

Another way to look at this is by starting from the structural VAR expression of the system (i.e. allowing for contemporaneous relations between both endogenous variables). Assuming a bivariate SVAR(1) – with one lag, the expression is as follows.

$$AX_t = \beta_0 + \beta_1 X_{t-1} + u_t \quad [3]$$

which in linear forms is

$$\begin{aligned} y_t + a_{12}p_t &= b_{10} + b_{11}y_{t-1} + b_{12}p_{t-1} + u_{yt} \\ a_{21}y_t + p_t &= b_{20} + b_{21}y_{t-1} + b_{22}p_{t-1} + u_{pt} \end{aligned} \quad [4]$$

and in matrix form is

$$\begin{bmatrix}1 & a_{12} \\ a_{21} & 1\end{bmatrix} \begin{bmatrix}y_t \\ p_t\end{bmatrix} = \begin{bmatrix}b_{10} \\ b_{20}\end{bmatrix} + \begin{bmatrix}b_{11} & b_{12} \\ b_{21} & b_{22}\end{bmatrix} \begin{bmatrix}y_{t-1} \\ p_{t-1}\end{bmatrix} + \begin{bmatrix}u_{yt} \\ u_{pt}\end{bmatrix} \quad [5]$$

In order to solve for this system of equations, one must premultiply the whole expression in equation (3) with the inverse of the matrix A, which will result in the so-called reduced-form VAR, with the following expression:

$$A^{-1}AX_t = A^{-1}\beta_0 + A^{-1}\beta_1 X_{t-1} + A^{-1}u_t \quad [6]$$

and by substituting $A^{-1}\beta_0$ with G_0, $A^{-1}\beta_1$ with G_1 and $A^{-1}u_t$ with e_t we get

$$X_t = G_0 + G_1 X_{t-1} + e_t \quad [7]$$

The identification issue persists also in this case, since there are more unknowns than parameters to be estimated, so the most straightforward way is to proceed in the same manner and impose the restrictions already mentioned above; following Fidrmuc and Korhonen (2003) and Campos and Macchiarelli (2016), we impose four restrictions: two restrictions are just normalizations defining the variance of the supply and demand shocks (u_{yt} and u_{pt}, respectively), the third one is the assumption of orthogonality of the same two shocks, and the last one is that the term $a_{12} = 0$ in matrix A, i.e. in the above-discussed case, allow for contemporaneous effect of output to prices, but not *viceversa*.

This will result in equation [4] to change to

$$\begin{aligned} y_t &= b_{10} + b_{11}y_{t-1} + b_{12}p_{t-1} + u_{yt} \\ -a_{21}y_t + p_t &= b_{20} + b_{21}y_{t-1} + b_{22}p_{t-1} + u_{pt} \end{aligned} \quad [8]$$

Noteworthy is the fact that by imposing this restriction, the inverse of matrix A, i.e. matrix A^{-1}, will also change such that

$$A^{-1} = \begin{bmatrix} 1 & 0 \\ -a_{21} & 1 \end{bmatrix} \quad [9]$$

and equation [7] in its matrix form will become

$$\begin{bmatrix} y_t \\ p_t \end{bmatrix} = \begin{bmatrix} g_{10} \\ g_{20} \end{bmatrix} + \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ p_{t-1} \end{bmatrix} + \begin{bmatrix} e_{yt} \\ e_{pt} \end{bmatrix} \quad [10]$$

which will be equivalent to

$$\begin{bmatrix} y_t \\ p_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ -a_{21}b_{10} + b_{20} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ -a_{21}b_{11} + b_{21} & -a_{21}b_{12} + b_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ p_{t-1} \end{bmatrix} + \begin{bmatrix} u_{yt} \\ -a_{21}u_{yt} + u_{pt} \end{bmatrix} \quad [11]$$

Note again how in this case also the errors (shocks) relate to one another, in the sense that an output shock will not be affected by price fluctuations, but the price level will be negatively affected by output increases, as the economic intuition dictates.

After the demand and supply shocks are recuperated from the system, we perform correlations between all the countries in the EU (with some exceptions due to missing data) and we map them on a bi-dimensional graph to have the overall picture regarding shock similarity (as in Fidrmuc & Korhonen, 2003; Bobeica & Manu, 2013; Campos & Macchiarelli, 2016).

In this regard, noteworthy is the common shortcoming of the previous papers of using uninterrupted time series. Arguably, this strategy is employed to obtain a larger sample, but the downside is quite serious – the ample shocks from 90s and early 2000s is camouflaged in the series. This pose the problem of having a past noise that is no longer relevant for the present outlook since irreversible changes (such as NBR independence and EU accession) took place. The only paper we are aware of using broken down time series (Deskar-Škrbić et al., 2020) made an debatable choice in this regard in our opinion. The choice of 2009 as the break point is not a good reference since it's a common shock to all and is losing sight of 16 quarters of important reforms in Romania.

3.3. Data, data treatment, and statistical tool

We employ quarterly country-specific time series from Eurostat for two variables: real GDP (in 2015 euro) and price index, both calendar and seasonally adjusted. To ensure the validity of using an SVAR, we performed two different test: (1) a Johansen cointegration tests for the variables in levels and (2) a stationarity test (Augmented Dickey Fuller test). The results of these tests for Romania and EU15 specific variables (presented only for these two economic entities given the space constrains) are detailed in the Statistical Annex section. The results of the Johansen test recommend the use of an SVAR model, as opposed to a vector error correction model (VECM). Noticing the non-stationarity of the output in levels, we took its natural logarithm and performed a first-order difference (inflation already is stationary as presented in Table 2 and Table 3) – a procedure also used in many other similar paper (Campos & Macchiarelli, 2016; Deskar-Škrbić et al., 2020; Fidrmuc & Korhonen, 2003).

The time span of both time-series variables is 1995q1-2019q4 including (with the exception of Czech Republic and Netherlands which start from 1996q1) and our sample covers 34 entities: EU28 countries (without Slovakia and Malta due to lack of relevant data), Switzerland, Norway, and Eurostat-aggregated data for EU28, EU27, EU15, EA12, EA19 and EA (changing composition). However, in order to take into account the very important issue of structural changes in the economy (discussed above), we employ the overall sample and another subsample (1995q1 – 2019q4 and the subsample 2005q1 – 2019q4).

Data treatment and the econometric analysis were performed in R and the specific Blanchard and Quah decomposition was achieved by executing the *BQ{vars}* function developed by Pfaff (2021). The lag selection was done following Campos and Macchiarelli (2016), i.e. of order 2.

4. Results, discussions, and implications

Although Eurostat data included observations for the period previous to the adoption of the euro, for all EA19 member states, for the sake of historical accuracy and due to continuous change in composition of the latter, the main comparison counterpart for Romania is set to be EU15.

We start from raw data representation. The graphs of quarterly (quarter-to-quarter change) output and inflation variation in Romania and EU15 are shown below in Figure 2. The variation in both variables is noticeably much higher for Romania, in accordance with two facts. In the first place, the period of economic transition brought pronounced ups and downs and the catching-up process has led to relatively higher output increases. The second fact is related to the crucial role played by the National Bank of Romania (NBR); the period up to 2005, i.e. until the independence of NBR, prompted politically-determined massive inflation rates. Once the independence status was adopted, these rates were brought to moderate levels; however, the lack of a clearly-stated inflation target still allowed for relatively higher inflationary and deflationary periods, even after 2005 (Bodea & Sánchez-Santos, 2020).

The correlations between inflation and output movements tell two different stories. The heat map of correlations for output variation shows similar growth patterns, since the correlation scores do not go below 0, and even the very small positive correlation coefficients are rare (Figure 3). The most obvious outliers in this case are surprisingly (membership to the Eurozone should have pushed in the direction of business cycle synchronization) two euro area countries: Greece and Italy on the lower side of the spectrum, and two other non-Eurozone countries at the other: Poland and Switzerland (the latter not even being an EU member state).

Contrary to the image depicted in Figure 3, Figure 4 shows considerable misalignments in terms of inflationary trends, to the point that it would be more accurately to talk about clusters, instead of core vs. outliers. The price disturbances seem to be most aligned in two areas: Eastern Europe, UK, Norway and Sweden, on the one side, and in the area of what the literature identifies as the “core of the Eurozone”: Germany, France, Netherlands, Belgium (to a smaller degree) and surprisingly Spain (country that has consistently been identified as being at the periphery).

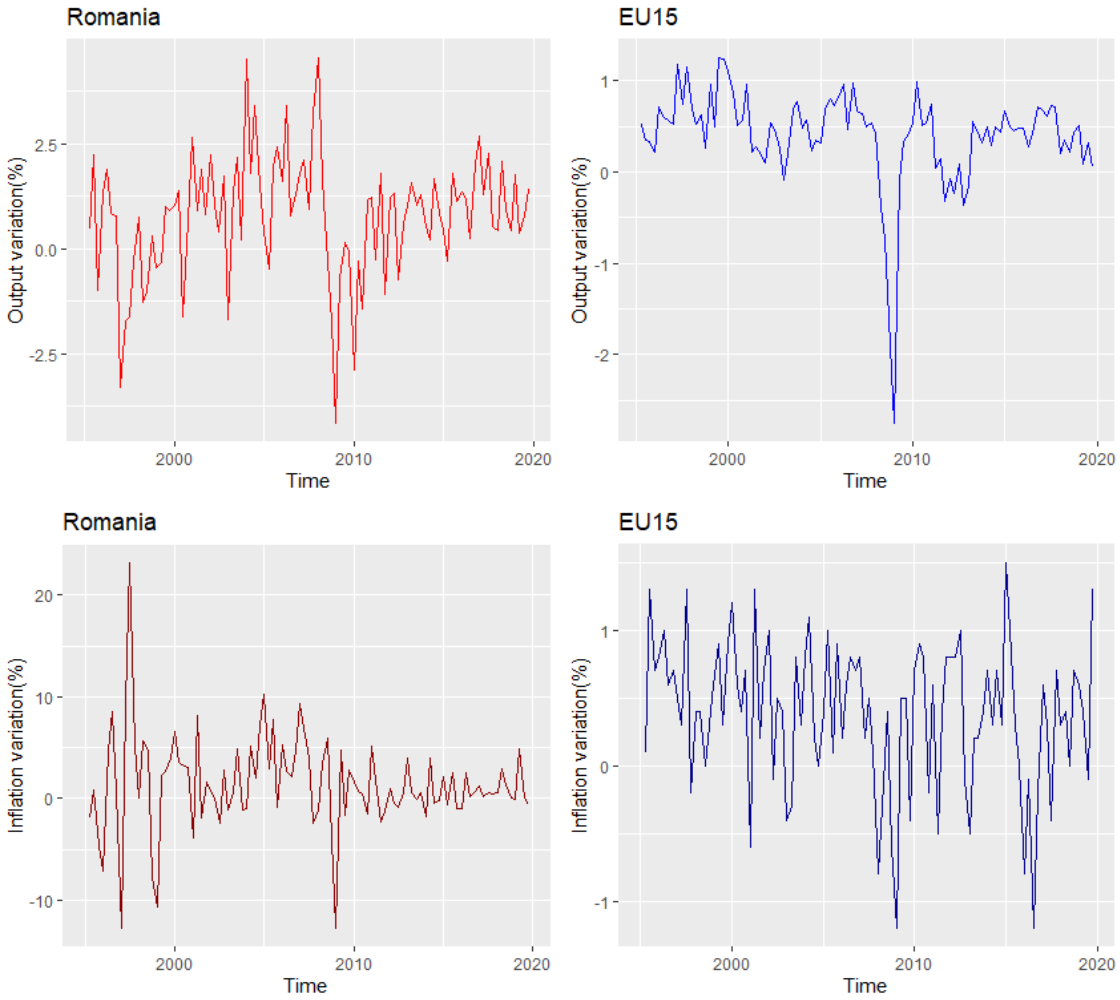

Figure 2. Quarterly output and inflation variation in Romania and EU15 1995q1-2019q4 including. Source: own elaboration with data from Eurostat.

Pairwise country correlations in terms of output variation, place Romania among the most well integrated countries in Europe, with high scores across the board, the smallest coefficients being recorded in relation with three peripheral countries: Greece, Italy and Portugal (although the same three countries registered the smallest scores with the rest of the entities in our sample). However, when it comes to inflation dynamics, the similarities with the rest of the countries seem inexistent, the highest (although weak) correlation coefficients being with other Eastern European countries: Croatia, Poland, Bulgaria and Latvia. Such fact can be explained by their similar contemporaneous economic history and transition effects.

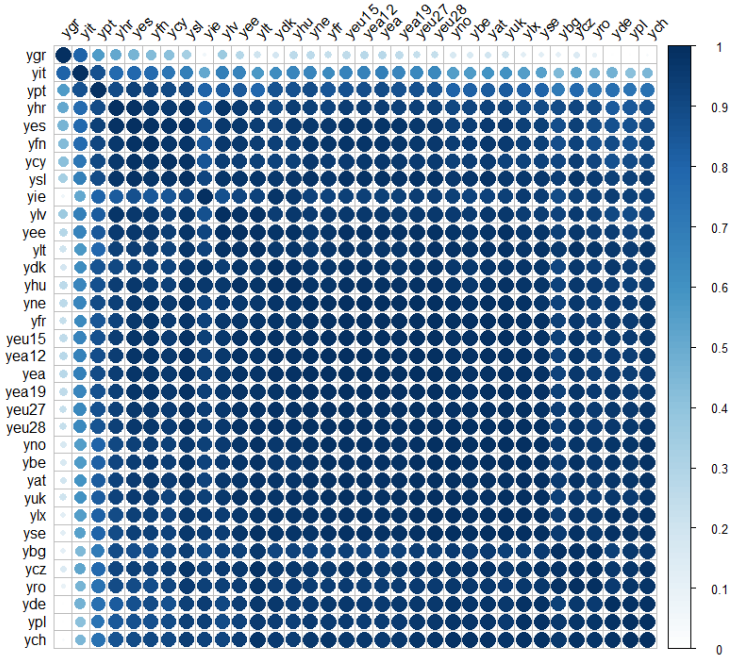

Figure 3. Heat map matrix of Pearson correlation coefficients between output growth rates for all the entities in the sample. Source: own elaboration with data from Eurostat. Note: the labels denominate the output (y) plus the two-letter country codes (e.g. at – Austria).

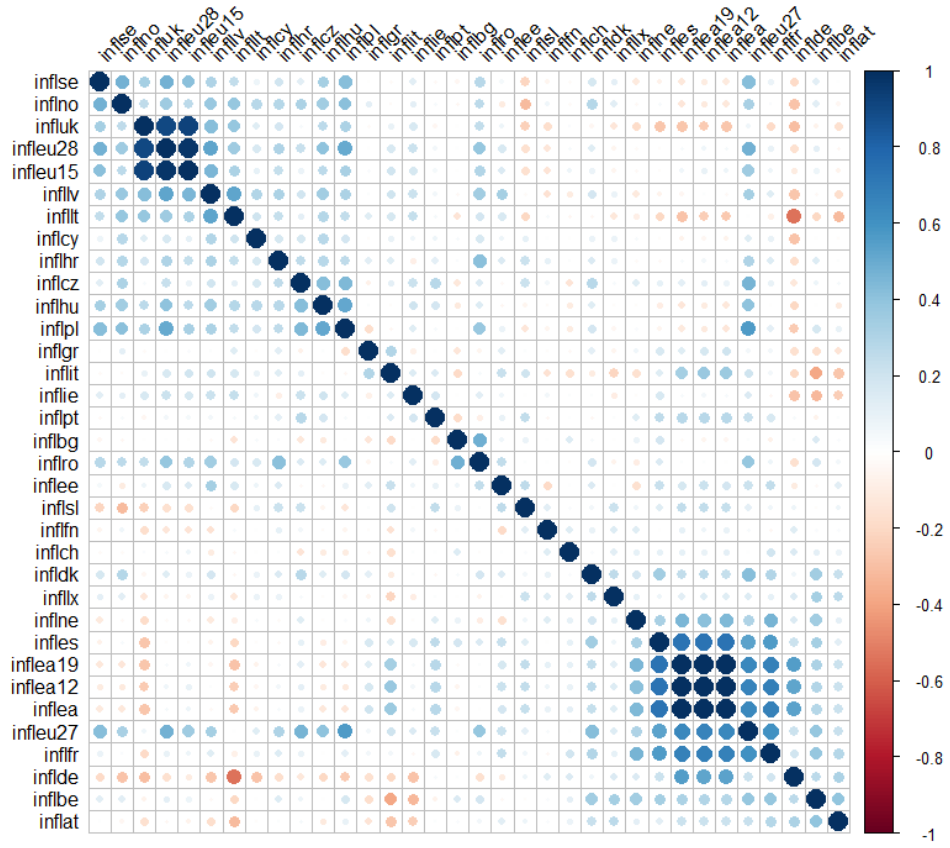

Figure 4. Heat map matrix of Pearson correlation coefficients between inflation rates for all the entities in the sample. Source: own elaboration with data from Eurostat. Note: the labels denominate the inflation (infl) plus the two-letter country codes (e.g. at – Austria).

In a second step of the analysis, we perform the typical Blanchard and Quah SVAR modelling detailed in Section 3.2 - *The SVAR model for demand vs. supply shocks discrimination.* We recover the responses of the output and inflation from the supply and demand shocks and map them on cumulative impulse response function (IRF) graphs for both Romania and EU15.

Such mapping, depicted in Figure 5, conveys two very similar, albeit at different magnitudes, responses. In line with the economic theory and expectative, positive supply shocks will have a permanent effect on output only, while price levels will suffer from a deflationary trend that will dissipate after 4 to 6 quarters. At the same time, demand shocks have very little effect on output for both Romanian and EU15 aggregate economy, but the response in price level is more apparent; initial negative demand shocks tend to cause deflationary periods for 1 to 4 quarters in Romania and for 1 to 6 quarters in EU15, after which the price levels will return to their baseline levels. Noteworthy is the very high magnitude of responses in the case of Romania; with the exception of the output response to demand impulse, the rest of responses seem to have a much higher degree of variation than in the case of the EU15 counterpart. The cause of this behaviour might be related to the higher magnitude of the shocks suffered by the transition economies and it might indicate that the Romanian economy is much more responsive to economic stimuli.

Finally, the bi-dimensional mapping of the countries according to their correlations with Romania on supply and demand shocks series (Figure 6), indicates large overall exogenous shock correlations with the other two newest members, Bulgaria and Croatia, and with the two aggregated entities of EU27 and EU28. Besides these, and fortunately for the proponents of euro adoption in Romania, on the supply side shocks are more correlated with some of the main countries at the core of the euro area: Germany, France and Netherlands and with the euro area (EA, EA12 and EA19), signalling the strong ties and similarities between structural production systems. At the opposite end of the spectrum, stand three non-euro area economies (Norway, Denmark and surprisingly Poland) and Luxembourg (a very service-intensive economy).

On the demand side, correlations are strong with three Eastern European economies (Bulgaria, Croatia and Poland) and with the EU27 and EU28 aggregates, while the ones with the Big Five euro economies (Germany, France, Italy, Spain and Netherlands) are placed around the $\rho = \pm 0.1$ band. Given the large weight of these five countries, this is an indication of possible adjustment problems to the euro area monetary policy for the Romanian economy; a euro area-wide monetary policy, with inflation and interest rates largely influenced by developments in these member states, might not fit the Romanian macroeconomic needs. Overall, the least similarity is observed with a cluster of countries consisting of the peripheral euro-area member states (Greece, Portugal, Spain, Italy, Ireland), Switzerland and Luxembourg.

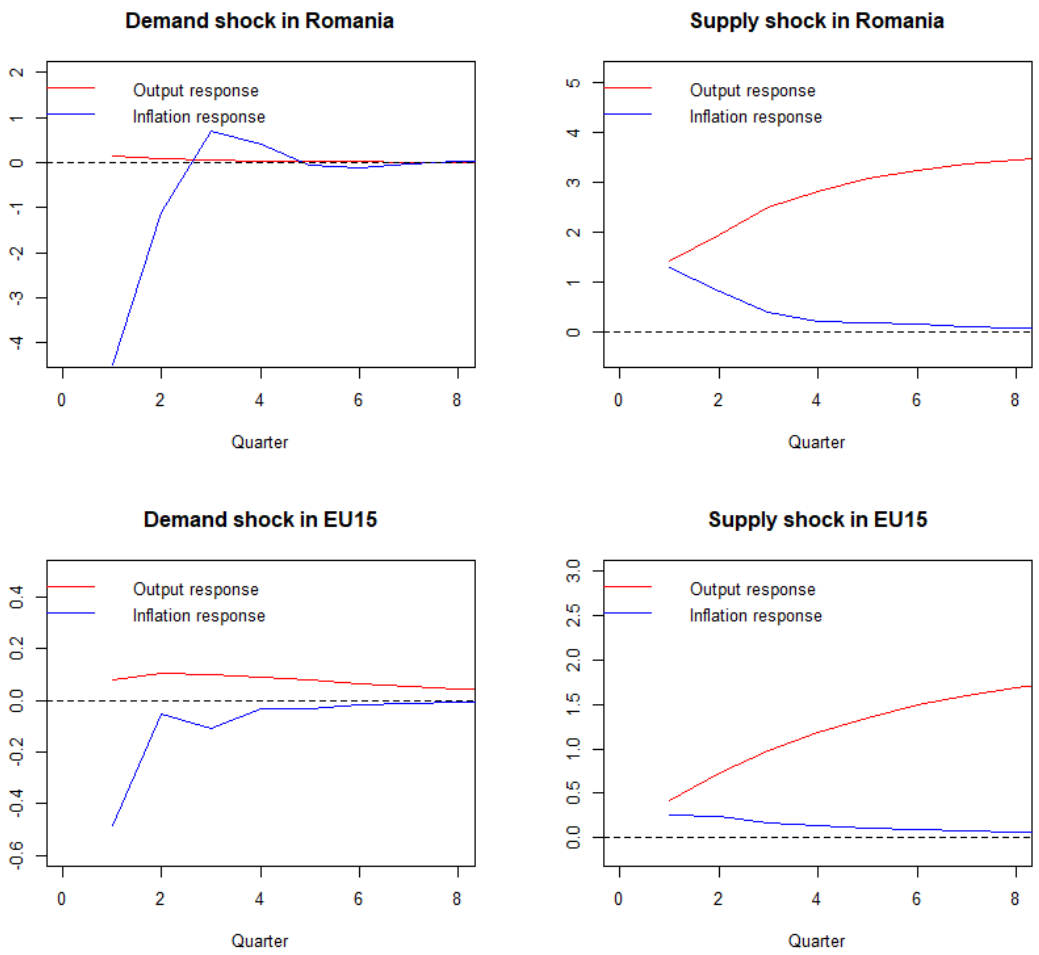

Figure 5. Mapping of the cumulative effects of positive supply and negative demand shocks on output and inflation rates for Romania and EU15. Source: own elaboration.

As previously indicated in the literature (Bobeica & Manu, 2013), Romanian structural production system is relatively well integrated with the European one and with the ones of some core countries. Nevertheless, the politically-driven demand shocks make Romania an unfit candidate for euro adoption, as shown by the very low correlation coefficients across the board.

High-inflationary periods caused by a politically influenced central bank in the 90s, booms and busts in the economy prompted by increases and cuts in salaries in the decade of 2000s, and budget deficits in the late 2010s (which caused inquiries from the Commission within the Stability and Growth Pact framework), brought hectic and ample movements in the demand behaviour of the Romanian economy, moving it further away from the prospect of euro adoption in good conditions.

Nonetheless, one should not forget that such demand shocks have a temporary nature; a more disciplined and more investment-oriented fiscal behaviour, with a long-term sustainable perspective, especially with respect to the public debt (which is increasingly accelerating in recent years), could help in the alignment of the Romanian economy with the rest of euro area's core countries.

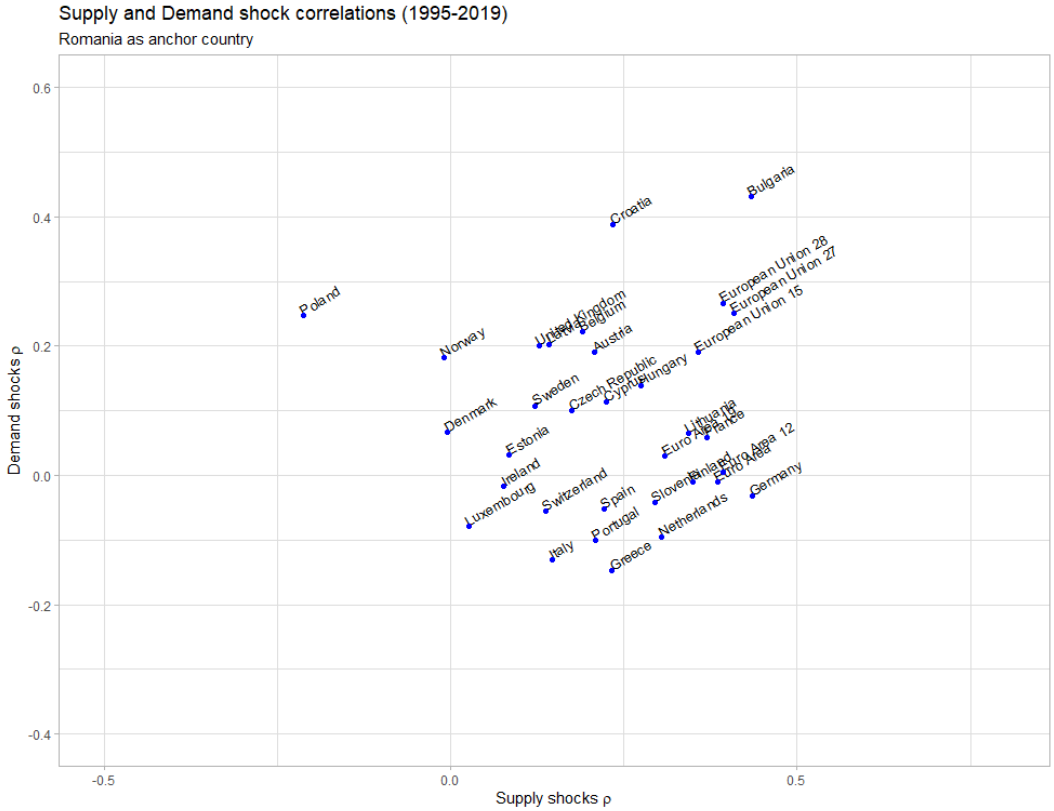

Figure 6. Bidimensional mapping of the correlation coefficients (ρ) between supply and demand shocks series recuperated from the BQ model using the whole sample (1995-2019) – Romania as anchor country. Source: own elaboration.

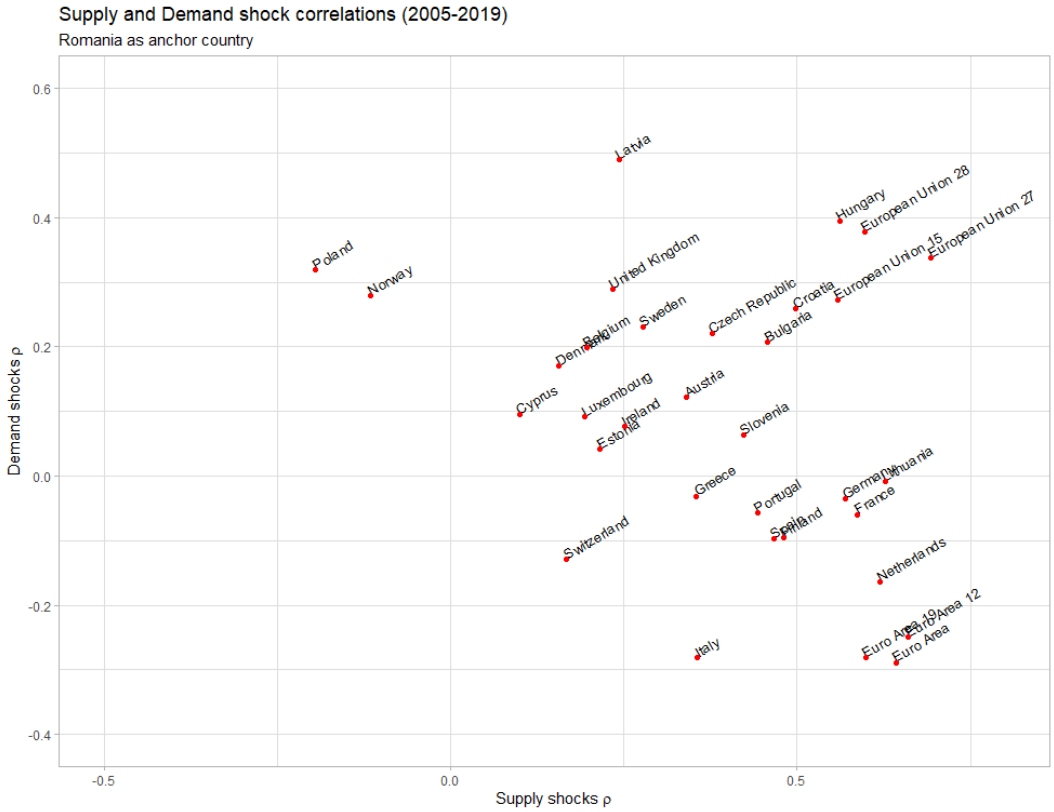

Figure 7. Bidimensional mapping of the correlation coefficients (ρ) between supply and demand shocks series recuperated from the BQ model using the sample after the breaking point (2005-2019) – Romania as anchor country. Source: own elaboration.

This point is proven by the results obtained after running the same model only for the subsample starting from 2005, i.e. after the implementation of the two structural changes (NBR independence and EU accession). Considering the distribution of the countries on the same bi-dimensional space from Figure 7, one can notice how both on the supply and demand side, the correlations increase; on the supply side, strong coefficients (above 0.5) were registered with EU and EA aggregates, Germany, France, Netherlands (core countries), while on the demand side, the highest scores were in relation with other non-euro area economies (Latvia, Poland, Hungary, United Kingdom, Norway). Again, the fact that the coefficients were all but one lower than 0.5, points that lax fiscal policy and the sovereign monetary policy proved a factor of divergence in terms of demand shocks similarity.

5. Conclusions and recommendations

Arguably, this study, like any other focused on the *meta* property of shock similarity based on time series analysis, has the flaw of being backward looking and unable to predict/asses the full impact of a change in a monetary regime as the one implied by the entry into ERM II or the adoption of the single currency, which could bring more integration. Nevertheless, it has the merit of accurately capturing the effect of 12 years of European integration, of 14 years of central bank independence, and of roughly 3 decades of transitionary efforts on the alignment of Romanian economy with other European economies.

The preliminary analysis of raw data for output and inflation rates indicated much higher variations than the EU average and strong alignments in terms of the former, while for the latter the highest correlations (albeit weak in absolute terms) were registered with Eastern European peers. These facts are indications of a still ongoing catching-up process, a relatively well connected and integrated economy, and an inflationary-prone monetary policy.

The assessment and mapping of the similarities between the underlying demand and supply shocks suggest that on the supply side such shocks are correlated to a certain degree with some relevant core countries, results that are in line with findings in the previous studies and which might make a strong case for the euro-adoption proponents. Furthermore, the increase in correlation coefficients observed in the model using just the post-2005 subsample, is an indication that the Romanian economy heads into the right direction.

Nevertheless, the values are still low compared with the ones obtained by the biggest euro area countries in their pairwise correlations, which suggests that more efforts could be made in order to increase the similarity of the economic structure and the connectedness; in this respect the recovery endeavours aimed at investments made in the post-pandemic period could represent a good opportunity to steer the economic structure in this direction.

The results obtained on the demand side are more unsatisfactory for a quick and optimal euro adoption; low correlation coefficients were observed all across the board, with the exception of just two small-sized Eastern European economies. These feeble results could be linked to the politically-motivated inflationary disturbances in the 90s and to the expansionary fiscal shocks

consistently administered to the economy during the sample period. The post-2005 results confirm the above findings, although correlation coefficients appears somewhat higher. Nevertheless, one should not lose sight of the fact that such demand shocks have a temporary nature and that a more disciplined and more prudential fiscal behaviour, compatible with the convergence criteria for euro adoption, would help mitigating the negative impact of demand shocks to the co-movement of the Romanian economy with the euro area.

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Statistical annex

Table 1. Results of the Johansen cointegration test for Romania and EU15 specific variables (in levels). Note: only the case of these two economic entities has been included due to space constraints.

Values of teststatistic and critical values of test (Romania, maximum eigenvalue statistic):	**Values of teststatistic and critical values of test (EU15, maximum eigenvalue statistic):**
test 10pct 5pct 1pct	test 10pct 5pct 1pct
r <= 1 | 11.41 7.52 9.24 12.97	r <= 1 | 8.60 7.52 9.24 12.97
r = 0 | 55.23 13.75 15.67 20.20	r = 0 | 36.23 13.75 15.67 20.20

Table 2. Results of the Augmented Dickey-Fuller test for first-order difference (FOD) GDP and inflation for Romania and EU15 (1995-2019 sample). Note: only the case of these two economic entities has been included due to space constraints.

Augmented Dickey-Fuller Test FOD GDP Romania	**Augmented Dickey-Fuller Test Inflation RO**	**Augmented Dickey-Fuller Test FOD GDP EU15**	**Augmented Dickey-Fuller Test Inflation EU15**
Type 1: no drift no trend	Type 1: no drift no trend	Type 1: no drift no trend	Type 1: no drift no trend
lag ADF p.value	lag ADF p.value	lag ADF p.value	lag ADF p.value
[1,] 0 -5.76 0.01	[1,] 0 -7.69 0.01	[1,] 0 -3.45 0.01	[1,] 0 -5.96 0.01
[2,] 1 -3.88 0.01	[2,] 1 -7.25 0.01	[2,] 1 -3.04 0.01	[2,] 1 -3.94 0.01
Type 2: with drift no trend	Type 2: with drift no trend	Type 2: with drift no trend	Type 2: with drift no trend
lag ADF p.value	lag ADF p.value	lag ADF p.value	lag ADF p.value
[1,] 0 -6.87 0.01	[1,] 0 -8.27 0.01	[1,] 0 -4.40 0.01	[1,] 0 -8.21 0.01
[2,] 1 -4.72 0.01	[2,] 1 -8.19 0.01	[2,] 1 -4.01 0.01	[2,] 1 -5.69 0.01
Type 3: with drift and trend	Type 3: with drift and trend	Type 3: with drift and trend	Type 3: with drift and trend
lag ADF p.value	lag ADF p.value	lag ADF p.value	lag ADF p.value
[1,] 0 -6.93 0.01	[1,] 0 -8.31 0.01	[1,] 0 -4.52 0.01	[1,] 0 -8.49 0.01
[2,] 1 -4.82 0.01	[2,] 1 -8.28 0.01	[2,] 1 -4.16 0.01	[2,] 1 -5.84 0.01

Table 3. Results of the Augmented Dickey-Fuller test for first-order difference (FOD) GDP and inflation for Romania and EU15 (2005-2019 sample). Note: only the case of these two economic entities has been included due to space constraints.

Augmented Dickey-Fuller Test FOD GDP Romania	**Augmented Dickey-Fuller Test Inflation RO**	**Augmented Dickey-Fuller Test FOD GDP EU15**	**Augmented Dickey-Fuller Test Inflation EU15**
Type 1: no drift no trend	Type 1: no drift no trend	Type 1: no drift no trend	Type 1: no drift no trend
lag ADF p.value	lag ADF p.value	lag ADF p.value	lag ADF p.value
[1,] 0 -3.90 0.01	[1,] 0 -6.69 0.01	[1,] 0 -3.03 0.01	[1,] 0 -4.72 0.01
[2,] 1 -2.84 0.01	[2,] 1 -4.58 0.01	[2,] 1 -3.04 0.01	[2,] 1 -3.50 0.01
Type 2: with drift no trend	Type 2: with drift no trend	Type 2: with drift no trend	Type 2: with drift no trend
lag ADF p.value	lag ADF p.value	lag ADF p.value	lag ADF p.value
[1,] 0 -4.91 0.01	[1,] 0 -7.23 0.01	[1,] 0 -3.31 0.0213	[1,] 0 -5.69 0.01
[2,] 1 -3.61 0.01	[2,] 1 -5.09 0.01	[2,] 1 -3.34 0.0198	[2,] 1 -4.33 0.01
Type 3: with drift and trend	Type 3: with drift and trend	Type 3: with drift and trend	Type 3: with drift and trend
lag ADF p.value	lag ADF p.value	lag ADF p.value	lag ADF p.value
[1,] 0 -4.86 0.0100	[1,] 0 -7.40 0.01	[1,] 0 -3.29 0.0814	[1,] 0 -5.63 0.01
[2,] 1 -3.58 0.0426	[2,] 1 -5.29 0.01	[2,] 1 -3.34 0.0732	[2,] 1 -4.25 0.01