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Asymmetry and Correlation of Macroeconomic Shocks: Adjustments within Heterogeneous Union

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Abstract

This article aims to identify the asymmetry and degree of correlation of supply and demand shocks within eight European Union countries over the period 2000Q1–2020Q1. We employ a structural VAR model by decomposing macroeconomic shocks into demand and supply disturbances. We define a transformation matrix from canonical shocks to structural ones with reference to the theoretical AS-AD model by imposing a long-run restriction to verify the long-run demand shock neutrality hypothesis on production. The originality of this research paper lies in the method of shock decomposition. Our results indicating the degree of asymmetry in the European countries are relatively significant. The disparities between member countries continue to grow, and recently a form of heterogeneity has appeared that includes the degree of price flexibility and rigidity. The

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European Union is experiencing a dichotomy. On the one hand, core countries are correctly aligned and maintain a significantly smaller degree of asymmetry of supply and demand shocks. On the other hand, peripheral countries are characterized by flagrant inequalities that have overwhelmed their local economies. However, the various measures adopted by the European authorities remain limited. We demonstrate that to resist the potential challenges of violent fluctuations, the European authorities must move towards fiscal reforms and carefully coordinate their economic policies.

Keywords: asymmetry of macroeconomic shocks, economic and monetary integration, structural VAR model, optimal currency area
JEL Classification: F15, F33, C19

1. Introduction

Since its construction, the European Union (EU) has been confronted with episodes of economic and financial disruptions. Its efforts to achieve deep economic and monetary integration did not prevent the Member States from abandoning the euro area and devaluing their currencies against the dollar to get out of the crisis at the time of the 1973 oil shock. The loss of the exchange rate instrument, as an effective tool for adjusting this specific type of disturbance, is caused by the entrance to the common monetary system.

Despite the signing of the Maastricht Treaty which was proposed in 1992 to correct this dilemma, the leeway to member countries in terms of exchange rates remains limited and does not solve the problem of adjusting to asymmetric shocks that can adversely affect European economies. More recently, another event has disrupted the EU which was the United Kingdom's (UK) exit from the Union in 2020, commonly referred to as Brexit. This has undoubtedly caused economic disruptions not only for the UK but also for the EU in general through disrupting the process of economic integration. On the demand side, there has been a remarkable depreciation of the UK's national currency, which has typically produced a considerable increase in consumer credit. On the supply side, there

has been a severe inflation resulting in higher production costs which in turn has increased the price level. This, in turn, adversely affects European multinational companies.

In addition, the COVID-19 pandemic represented an upset to the global economy (Baldwin & Weder di Mauro, 2020), followed by a blockage of world trade due to local confinement. This disruption, combined with demand shocks, leads to the fall not only of the European financial system but also of the world economy. All these events have much influenced the economic stability of a fragile union. Being strapped by its structural heterogeneities and being vulnerable to asymmetric shocks have worked against its good functioning. The severity of these effects on the macroeconomic equilibrium increases paralleling to the degree of asymmetry of the shocks. Consequently, they call into question the EU's ability to stabilise such economic disturbances.

In other words, stabilising these economic fluctuations and trying to emerge from crises at the lowest cost remain an enormous challenge for the member countries. Various efforts have been established by the European authorities to reduce heterogeneities between countries and to better link their economic policies to resolutely face the asymmetric shocks as a first step towards a positive and more homogeneous union.

This raises a number of questions about the shocks' asymmetry degree, their evolution over time and their effects on the macroeconomic balance; as well as the effectiveness of the various mechanisms for stabilising economic fluctuations after all the efforts made to ensure the survival of the EU.

The objective of this paper is to identify supply and demand shocks to assess their degree of asymmetry and correlation across the 8 EU member countries over the period 2000Q1-2020Q1. It also aims to better understand the dynamics of the macroeconomic equilibrium of the union's member countries in the face of disturbances. As follows, employing the theory of optimal currency area (OCA), we verify the effectiveness of the various measures taken by the European authorities to adjust the asymmetric shocks. To resolve this, we present the elements of answer in four steps.

The article is organised as follows: In the first section, we present the theoretical framework adopted in order to theoretically identify shocks and properly analyze the equilibrium dynamics in the face of supply and demand shocks. The second section is

devoted to the presentation of the empirical literature's review of the previous work on the asymmetry of economic shocks. We provide an overview on the adjustment mechanism according to the OCA theory. The third section is devoted to the presentation of our estimation method using the structural vector auto regression modelling (SVAR) to empirically identify the demand and supply shocks so as to examine their degree of asymmetry and correlation over time. The fourth section deals with the results of the estimation and the discussion. We complete this article by proposing an adjustment mechanism based on the results of our study. In the conclusion, we demonstrate our contribution of this study and we give a future research perspective.

2. Literature review

The economic literature is extremely abundant in models describing the effects of different shocks on macroeconomic equilibrium; among which we have preferred the Aggregate Supply-Aggregate Demand (AS-AD) model. This one seems appropriate to theoretically identify supply and demand shocks and analyse their effects on economic equilibrium, which is the ultimate objective of this article.

Therein section, we briefly present the AS-AD model.

2.1 Theoretical Framework

The AS-AD model implies that the long-run aggregate supply curve (LRAS) is vertical. In contrast, the short-run aggregate supply curve (SRAS) has a positive slope. This fundamental difference in shape is explained by the sticky wage theory (Keynes, 1936)[1]. Which states that if prices fall, wages adjust only in the long-run because of the long periods for which labour contracts are fixed; and so, the producing firms decrease their level of production and employment. They face lower prices while the costs are higher. Therefore, the aggregate demand curve has a negative slope in the short-run (SR) and in the long-run (LR), which justifies the hypothesis that lower prices stimulate global

[1] See the famous book by Keynes (1936) entitled "the General Theory of Employment, Interest and Money."

demand. Similarly, for high prices, real wages are lower in the SR, while in the LR wages adjust instantly.

The macroeconomic equilibrium dynamics face to demand and supply shocks according to the AS-AD model

By way of illustration, we consider the example of a negative demand shock and a positive supply shock. A negative demand shock decreases the produced quantity Y_t, and increases unemployment, which in turn decreases aggregate demand (AD). Thus, the short-run (AD) curve moves to the left (AD'). The price decreases from the full employment equilibrium price P^* to P_1 and the output decreases from Y_{PO} to Y_1. These manifestations are represented by a recessionary situation, where unemployment increases and prices fall. Thus, output Y_1 is lower than potential output Y_{PO}; the (SRAS) curve shifts downward to the new full employment equilibrium. This new equilibrium precisely corresponds to a price level P_2 that is significantly lower than P^*. (Figure 1)

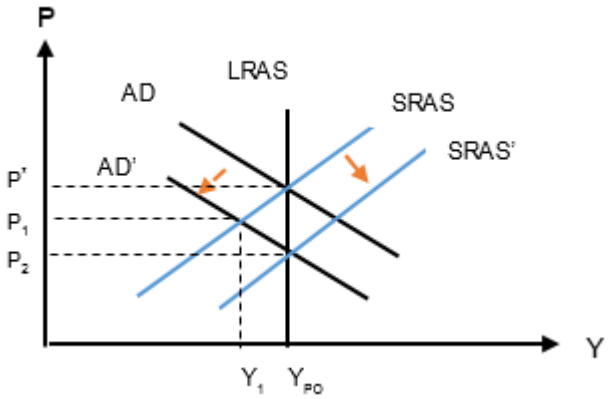

Figure 1: Adjustment of a negative demand shock

Source: Fidrmuc and Korhonen (2001)

A positive supply shock reduces inflation and increases output Y_t. In the short-run, the (SRAS) curve shifts to the right giving the new equilibrium B' which is a point of intersection between the (AD) curve and (SRAS') where prices decrease from P^* to P_1 and output Y_1 increases and becomes higher than the potential Y_{PO}. The LR adjustment is marked by the shift of the (LRAS) curve further to the right (LRAS'). The equilibrium moves

from B' to B'' is marked by the decrease of prices from P_1 to P_2 and the increase of output from Y_1 to Y_2. (Figure 2)

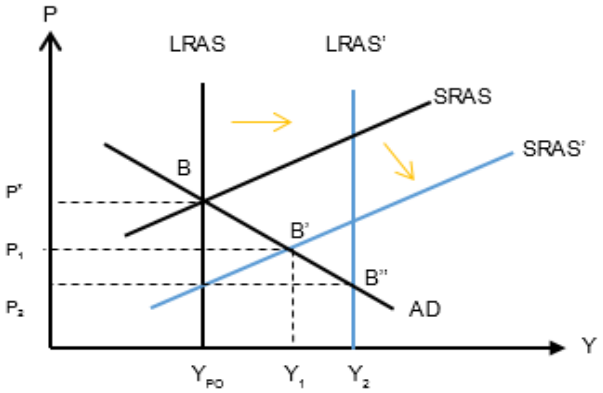

Figure 2: Adjustment of a positive supply shock

Source: Fidrmuc and Korhonen (2001)

In conclusion, the AS-AD model illustrates two essential characteristics of economic disturbances:

- Only supply shocks have a permanent effect on real GDP.
- Negative demand shocks and positive supply ones decrease prices; while positive demand shocks and negative supply ones increase prices.

2.2 Empirical Framework

The empirical literature provides for us a variety of approaches to measuring asymmetric shocks ranging from the most traditional to modern ones. Helg, Manasse, Monacelli, and Rovelli (1995) have analysed the correlations between industrial production shocks in a sample of 11 EMU countries using an integrated VAR model. Their results demonstrate the existence of country-specific shocks, local shocks, and industry-specific ones. Mélitz and Weber (1996) attempt to examine the correlation of the cumulative effects of shocks and their dynamics within the euro area. They find that there is a significant degree of symmetry between France and Germany in terms of cumulative effects and their convergence dynamics.

Other economists such as Dibooglu and Horvath (1997) decompose the shocks into nominal and real budgetary shocks. They show that the majority of member countries, especially the new ones, were affected by asymmetric shocks, hence the need for an

adjustment mechanism outside national monetary policy. Horvath and Rátfai (2004) have found that Hungary is characterised by a high correlation of aggregate supply shocks and a low correlation of demand ones. In contrast, Weimann (2003) concluded that Hungary had a significant correlation of the aggregate demand side.

Ben Arfa (2009) estimates a high interdependence of demand shocks for recent members that use the Euro as a single currency. Recent empirical works have used the SVAR model including the study of Lee and Mercurelli (2014). The latter exploited the SVAR model supplemented by dynamic correlation analysis to test the endogeneity theory for Germany, France and Italy. Their result showed that the adoption of the single currency increased the shocks symmetry's degree and accelerated the speed of convergence within these European states.

Others such as Pucar and Glavaški (2020) have addressed the subject of nominal divergence in the European Union. Their analysis shows that there is a dichotomy between core countries (Germany, France, and Belgium) and peripheral ones such as Portugal, Spain and Greece. Using a VAR model over the period 1999Q1- 2018Q4, they observed the transmission of monetary shocks (interest rates) to GDP growth. Their error decomposition results show that the interest rate channel works counter-cyclically. Such a countercyclical stabilisation mechanism is feasible for the core, which is not the case for the peripheral countries, especially Greece. They concluded that the EU was relatively fragile in the face of shocks because of the heterogeneity of its members.

We emphasise the legitimate need for a stabilisation mechanism for asymmetric shocks, which is at the heart of the controversial economic literature. In fact, the adjustment mechanism in the EU can be compared to the OCA theory initiated by Mundell (1961) which recommends certain proposals in the case of symmetric shocks. According to him, it seems effective to use the fixed exchange rate as an instrument of stabilisation. While in the case of asymmetric shocks, labour mobility and wage flexibility are recommended. Since labour movability is limited within the EU, this proposal has been opposed by some authors. (Scitovsky, 1976; Ingram, 1969, 1973) proposes an adjustment mechanism as an excellent substitute for labour mobility. Their results prove the effectiveness of capital mobility as a stabilisation mechanism. Kenen (1969) prefers a

centralisation of national budgets allowing to reduce asymmetric effects and to benefit from funds' transfers without reimbursement. This approach of Kenen (1969) has been criticised on several occasions because the most convergent countries do not want to finance the others regularly. Some economists argue that an efficient fiscal policy allows a more suitable response to symmetric and asymmetric shocks (Bensaïd & Gavrel, 1993).

3. Methodology and Data

3.1. Methodology

In line with our objective, we present our analytical process for identifying supply and demand shocks. We also analyse the dynamics of macroeconomic equilibrium in the economies of 8 EU member states to specify the most effective stabilisation mechanism. We use the SVAR model, which provides a framework for empirical analysis based on economic theory. It ideally allows us to specify the links and causal relationships between the observed variables. We focus on two variables; the industrial production (GDP) noted Y_t and the consumer price index (CPI) noted P_t. They are the macroeconomic indicators that are directly related to supply and demand shocks. We employ a structural VAR model by transposing the method of Blanchard and Quah (1989) to a system of supply and demand disturbances instead of unemployment rate adopted by these two economists. We also define a transformation matrix from canonical shocks to structural ones with reference to the theoretical AS-AD model, and we impose a long-run restriction to verify the long-run demand shock neutrality hypothesis on output. We consider a system modelled by an infinite moving average representation, $(MA(\infty))$ composed by a vector of two variables Y_t and P_t. This $MA(\infty)$ representation is obtained by inversion of a stationary Vector Autoregression (VAR) model.

3.1.1 Model Specification

Our starting point will be the standard VAR model, which will be developed to obtain an interpretable structure. We consider the following standard VAR model:

$$X_t = \phi(L) X_{t-1} + u_t \quad (1)$$

Where X_t is a vector composed of n endogenous variables with p is the number of lags

u_t : The vector of the canonical residues of the standard VAR system.

3.1.2 Reduced-form of the VAR model

We estimate the following reduced form of the VAR model:

$$X_t = \sum_{i=1}^{n} \phi_i X_{t-i} + u_t \quad (2)$$

Where: $X_t = \left[\Delta Y_t, \Delta P_t\right]'$ is a vector composed of two variables Y_t is the logarithm of the GDP and P_t is the logarithm of the CPI.

ϕ_i : Square matrix of order $n \times n$ of the coefficients.

X_{t-i} : The shifted eigenvalues of each variable.

Δ : Indicates the first variations of the variables Y_t and P_t.

u_t : The reduced form errors are white noises with null average and a variance $(var = \sigma^2)$

Note: The two variables are used in the logarithm to ensure that they respect the stationarity conditions.

$$X_t = \left(Y_t, P_t\right)' \quad (3)$$
$$Y_t = logY_t - logY_{t-1}$$
$$P_t = logP_t - logP_{t-1}$$

So the equation (2) can be rewritten in the following form:

$$\phi(L)X_t = u_t \quad (4)$$

And

$$\phi(L) = \phi_0 - \sum_{i=0}^{n} \phi_i L^i \quad (5)$$
$$\phi_0 = I$$

3.1.3 Inversion of the VAR model

To obtain the structural shocks, we need to define a pass-through matrix obtained by inverting the VAR model into a $MA(\infty)$ form. Starting with equation (4), we can estimate the $MA(\infty)$ form if the process $\phi(L)$ has its roots outside the unit circle "VAR model stationarity hypothesis." Therefore, the $MA(\infty)$ form is the following:

$$X_t = c + A(L)u_t \quad (6)$$

With $c = \phi(L)^{-1}$ and $A(L) = \phi(L)^{-1}$

$$\Leftrightarrow \quad X_t = \phi(L)^{-1} + \phi(L)^{-1} u_t \quad (7)$$

So the $MA(\infty)$ form is:

$$X_t = \sum_{i=0}^{\infty} L^i \phi_i u_t \quad (8)$$

where

u_t : The canonical residuals of the standard VAR form representation.

ϕ_i : The variance-covariance matrix of u_t .

We can then rewrite the errors of the reduced form as a linear combination of the shocks such that:

$$u_t = P\varepsilon_t \quad (9)$$

P : Matrix of passage from canonical residues u_t to structural shocks ε_t

$\varepsilon_t (\varepsilon_t^d, \varepsilon_t^s)$: Vector of structural shocks with:

ε_t^d : Demand shock

ε_t^s : Supply shock

We consider that the shocks are normalized to a unity and they are orthogonal (hypothesis of non-correlation of supply and demand shocks) $\varepsilon_t^d \perp \varepsilon_t^s$.

satisfying these conditions :

$u_t = P\varepsilon_t$

And

$E\left(\varepsilon\varepsilon'\right) = I$

This allows the matrix P to be defined in a unique way $PP' = \Sigma$. Furthermore, the knowledge of the orthogonalisation matrix P allows to write the $MA(\infty)$ form in terms of independent shocks, known as structural shocks:

$$X_t - c = A(L)P\varepsilon_t \quad (10)$$

$$X_t - c = C(L)\varepsilon_t \quad (11)$$

$$C(L) = A(L)P \quad (12)$$

Where $C(L)$: the matrix that describes the dynamic response of the observed variables contained in X_t to demand and supply shocks.

By abstracting the constant c we can rewrite equation (10) in the form:

$$X_t = A(L)P\varepsilon_t \quad (13)$$

Whose matrix form is

$$X_t = A(L)\begin{pmatrix} P_{yd} & P_{ys} \\ P_{pd} & P_{ps} \end{pmatrix}\begin{pmatrix} \varepsilon_t^d \\ \varepsilon_t^s \end{pmatrix} \quad (14)$$

$A(L)$: The matrix which represents the evolution of the impulse reaction of Y_t and P_t in the face of demand and supply shocks.

Taking into account equation (12), the matrix representation (14) can be transformed as:

$$\begin{pmatrix} \Delta Y \\ \Delta P \end{pmatrix} = \sum_{i=0}^{\infty}\begin{pmatrix} c_{11,i} & c_{12,i} \\ c_{21,i} & c_{22,i} \end{pmatrix}\begin{pmatrix} \varepsilon_t^d \\ \varepsilon_t^s \end{pmatrix} \quad (15)$$

With $c_{11,i}$ represents the element $c_{11}(1)$ in the matrix ϕ_1

Knowing that $u_t = P\varepsilon_t$, the matrix to be estimated is:

$$\varepsilon_t = P^{-1}u_t$$

3.1.4 Identification scheme

To determine the SVAR form, we need to impose $\frac{n(n+1)}{2}$ identifying restrictions. In the variance-covariance matrix, we have 3 coefficients and we just know 2 to estimate the last parameter, we need to impose an additional restriction. Based on the characteristics of the shocks from the theoretical AS-AD model, we impose a simple linear restriction that implies that the demand shock does not have permanent long-run effects on Y_t and subsequently the cumulative effects of demand shocks on the variation of Y_t are zero.

$$\sum_{i=0}^{\infty} c_{11,i} = 0 \quad \Leftrightarrow \quad c_{11}(1) = 0$$

So the matrix form (15) becomes:

$$\begin{pmatrix} Y_{1t} \\ P_{2t} \end{pmatrix} = \begin{pmatrix} 0 & c_{12}(1) \\ c_{21}(1) & c_{22}(1) \end{pmatrix}\begin{pmatrix} \varepsilon_{1t}^d \\ \varepsilon_{2t}^s \end{pmatrix} \quad (16)$$

The zero in the first row of this matrix reflects the assumption that the demand shock does not exert persistent effects on Y_t (the assumption of long-run neutrality of demand shock on output).

3.2 Sample size and data included in the SVAR model

3.2.1 Sample size

Our sample includes 8 EU countries: Germany (GER), France (FRA), Spain (SPA), Belgium (BELG), Greece (GREE), Italy (ITA), Hungary (HUNG) and the UK.

3.2.2 Data

We have chosen quarterly data over the period 2000Q1-2020Q1. (Table 1)

Table 1: Description of the data used

Series	Notation	Description
GDP (industrial production)	Y_t	GDP and CPI series are taken from the Eurostat database.
CPI (consumer price index)	P_t	

4. Results and Discussion

4.1. Results of the unit-root and cointegration tests

By properly applying the Augmented Dickey-Fuller test (ADF) on the Y_t and P_t series; the results show that, whatever the estimated model, the Y_t and P_t variables are integrated in order 1; that is to say stationary at first difference.

To verify any cointegration relationship, we applied the Johansen test between the series. We have found that there are no cointegration relations among the variables. In that case we proceed to the estimation of the SVAR model.

4.2. Determination of lags's number (p)

The application of the specification tests gives, according to the criterion AIC, (FPE, LR) = 4 Lags. However, according to the SC criterion = 0 lag. We prefer the AIC criterion to the SC criterion because in practice, it offers an optimal VAR model compared to the 0 lag.

4.3. Impulse response functions

Indeed, the impulse response functions traces the adjustment trajectory of each variable Y_t and P_t into shocks (1) and (2) over time with a horizon of 10 quarters. The analysis of these graphs allows us to confirm the potential relevance of our adopted identification scheme. It instantly shows that a demand shock leads to a marked reduction

in P_t and causes a transitory effect on Y_t, which also registers a decrease. Therefore, according to the characteristics of the shocks illustrated by the theoretical model AS-AD, economic innovation (1) is indeed a negative demand shock. Moreover, a supply shock leads to a long-run increase in Y_t and a decrease in P_t in all the studied countries. Shock (2) is clearly identified as a positive supply one. These results are consistent with the theoretical AS- AD model.

4.4. European macroeconomic equilibrium dynamics face to negative demand shock

In accordance with our theoretical predictions, the graphs of the impulse response functions show that the two variables Y_t and P_t react negatively to a negative demand shock. There is a decrease in aggregate demand in the majority of the countries studied. However, the amplitude and the time lag of the responses of Y_t and P_t to this shock differ from one country to another.

The analysis of a negative demand shock effect's dynamics on industrial production Y_t shows that Germany, France and Spain present a similar response to their output Y_t , which registers a slight drop in SR in front of this shock. This reduction is equal to -0.1 % and becomes lower than the full employment production.

At LR, the effect of this shock is attenuated and the output Y_t adjusts gradually to the equilibrium state especially in the case of France, Germany and Spain, whose production shows a relatively rapid adjustment time after 2 and 4 quarters on average. (Figure 3)

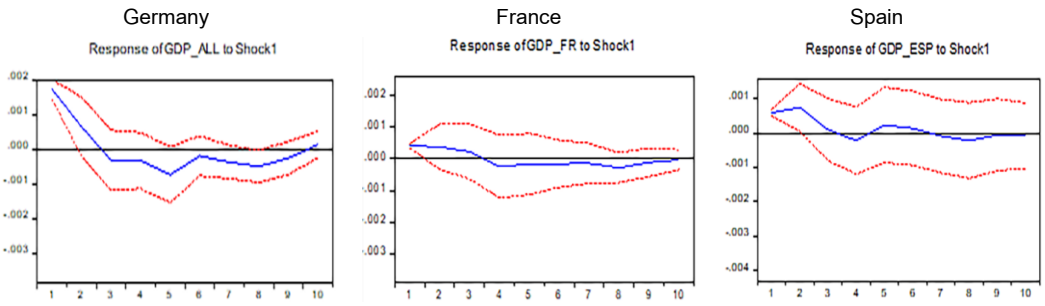

Figure 3: Germany, France and Spain's GDP responses to demand shock

However, Italy, the United Kingdom and Belgium are encountering intense fluctuations in their production due to the fact that they are going through numerous crises. Recently, the COVID-19 health crisis, which has caused a simultaneous supply and demand shock. Italy has suffered, as a consequence of the confinement measures, from a reduction in the demand for goods and services. Severe consequences on its economy have been translated by the closure of the market and a remarkable fall of its production equal to -0.2 %, which is more than double compared, to what has been observed in Belgium and the United Kingdom (Figure 4). Our results are in line with those obtained by Delatte and Guillaume (2020).

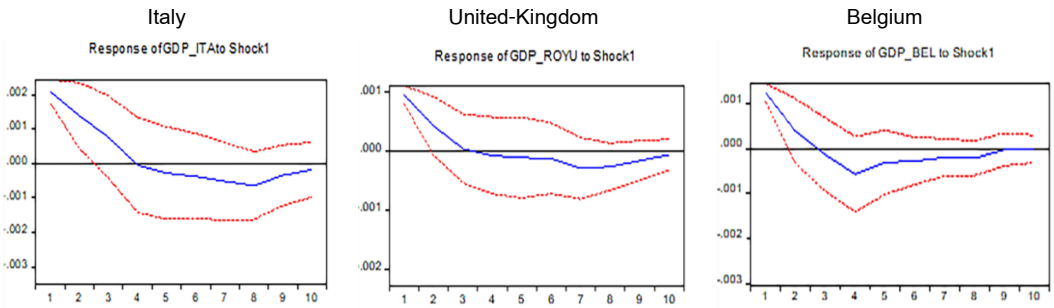

Figure 4: Italy, UK and Belgium's GDP responses to demand shock

For the other countries like Hungary and Greece, the effect of this demand shock is still relatively long. These phases of the economic slowdown and recession correspond to periods during which imbalances are corrected. Governments have intervened to prevent their local economies. This leads to the stabilisation of production; and most countries come out of economic recession from the 4th and 5th quarters onwards and show some recovery in output growth. (Figure 5)

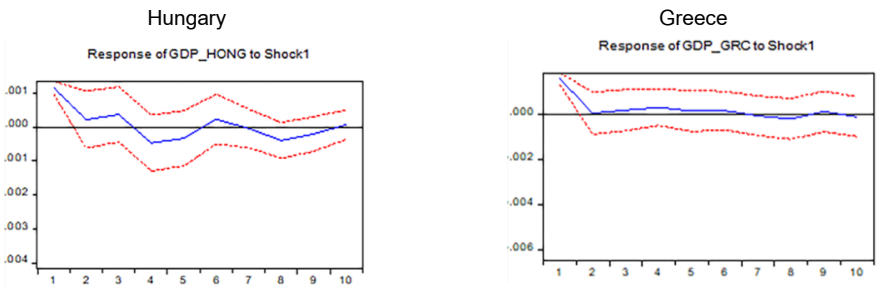

Figure 5: Hungary and Greece's GDP responses to demand shock

In SR, face to a negative demand shock, the P_t reacted negatively from the 2nd quarter for all the countries in our study sample. They become more reduced than the equilibrium price and they continue to fluctuate throughout the period to reach their stability level. Prices seem to be flexible in France, Belgium and Germany, which explains the rapid return of their production to its equilibrium level. (Figure 6)

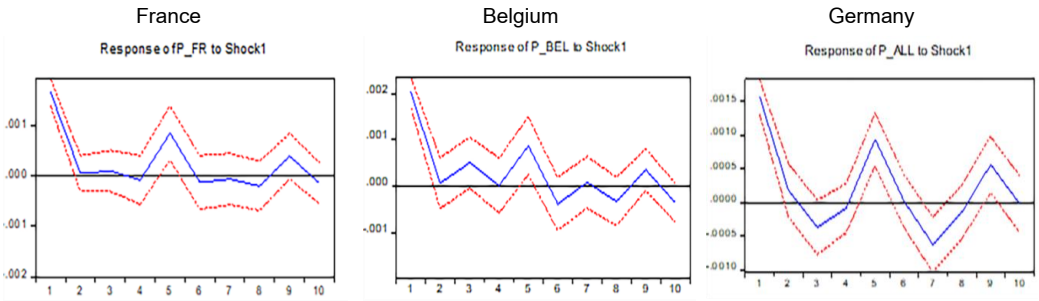

Figure 6: France, Belgium and Germany's CPI responses to demand shock

However, in Greece and Italy the prices' response is maintained relatively high for a long time; with a value more than 0.2 % compared to 0.1 % in Belgium and Germany (Figure 7). In other words, consumers adapt their habits gradually because of the prices' rigidity, which produces the persistence of shock effects on aggregate demand (Attanasio, 1999). So, we can say that these countries are characterised by price rigidity, which explains precisely why demand remains too low. According to the economic theory, in a framework where demand remains too low, unemployment appears. In the case of price rigidity, the reduction of nominal wages recommended by neoclassical economists to reduce unemployment only aggravates the situation. Indeed, a decrease in wages reduces consumption considerably which, in turn, further increases unemployment, especially in Greece. It also finds itself in a trade-off to strongly reduce their costs to keep their price competitiveness. This adjustment mechanism only worsens the situation and plunges the Greek economy into a prolonged depression and increases its unemployment rate to uncontrollable levels.

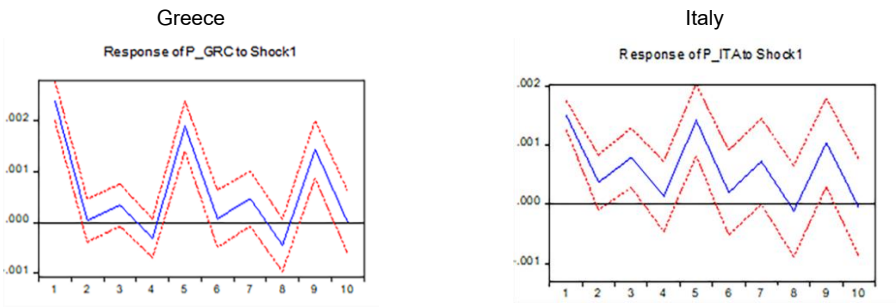

Figure 7: Greece and Italy's CPI responses to demand shock

4.5. European macroeconomic equilibrium dynamics face to positive supply shock

According to Figure 8, the reaction of Y_t confirms our theoretical predictions. A positive supply shock has increased Y_t. We notice that the LR response of Y_t for all countries is higher than its SR response. Besides, the speed of adjustment to equilibrium is relatively faster especially in the case of France, Belgium and the United Kingdom. In those countries, the economic situation becomes marked by a strong supply-side thanks to their productive capacities and their adjustment measures to the shock; except for Greece where the amplitude and the adjustment of Y_t in the face of a positive supply disturbance seem different. Eventhough production has progressively increased, it still remains negative.

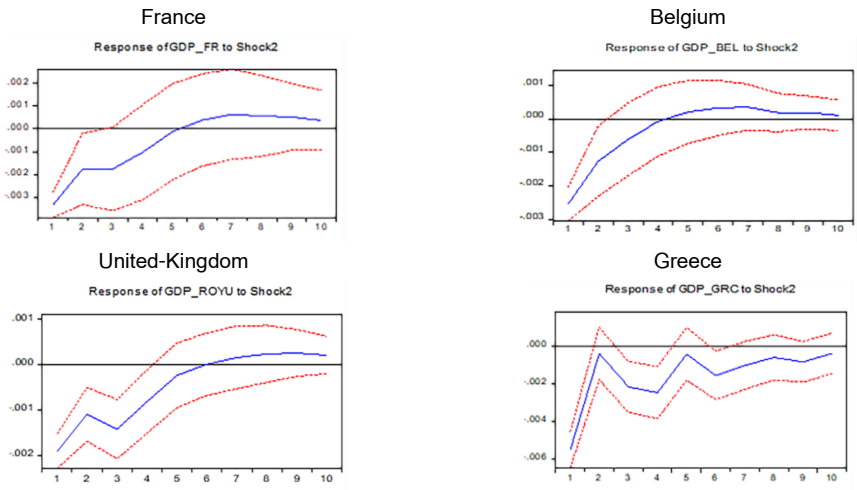

Figure 8: Summary of the GDP's response to supply shock

This delay, in the return of Y_t to equilibrium after a positive supply shock, is adequately explained by the structural heterogeneity within the EU members knowing that they differ in their production structures. Moreover, the considerable divergence in the fiscal policies adopted by these countries, the inequitable distribution of adjustment weights between the instruments and the difference in the orientation of economic policies wields a profound influence on the reaction of Y_t to the shock.

The graphs of the impulse response functions show a negative response of the P_t to a positive supply shock for the majority of countries. At SR, in the face of this innovation, the P_t falls rapidly to a more reduced level than that of the equilibrium standard in the countries studied. At LR, the positive supply shock continues to exert its effects significantly decreasing P_t and increasing Y_t further. This inevitably leads to a decline in inflationary pressures in the various countries. Except in the case of Spain, Hungary and Greece where the P_t tends to increase over time; a sign of the persistence of inflationary pressures in these countries. (Figure 9)

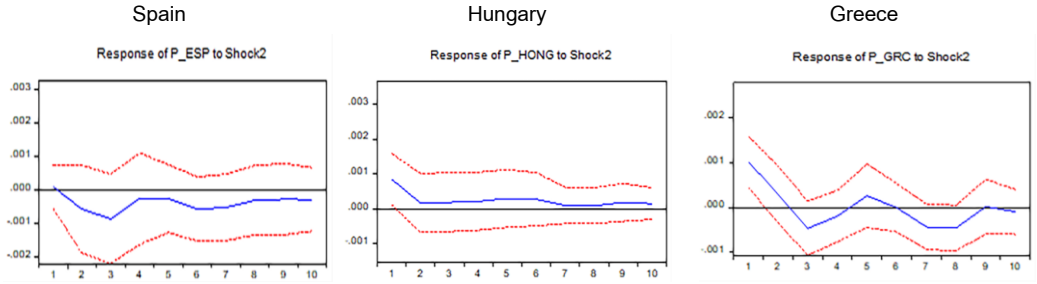

Figure 9: Spain, Hungary and Greece's CPI responses to supply shock

4.6. The error variance decomposition

The error variance decomposition allows us to determine precisely the sources of fluctuation of the endogenous variables Y_t and P_t. It allows us to measure the share of the expected variance of each variable over a 10-quarter horizon that is explained by both supply and demand shocks. Our decomposition results show that for all the countries studied, industrial production Y_t is essentially determined by the supply shock, which

dominates the demand in both SR and LR; that is 98.43% in France, 92.26% in Greece and 99.01% in Italy.

The share of demand shock in explaining the variance of Y_t is negligible compared to that of the supply one. It contributes by 1.56% in France, 7.73% in Greece and 0.98% in Italy. The considerable majority of the fluctuations in P_t is explained by the demand innovation. Instantaneously, the negative demand shock contributes powerfully to the variation of P_t by 99.84% in Spain, 93.0% in Hungary and 98.72% in Italy. Over time, the supply shock occupies a significant role in the fluctuations of P_t. It contributes by 49.30% in France and 40.56% in Belgium.

4.7. Correlation matrix of demand and supply shocks

To examine in more detail the asymmetric effects of negative demand and positive supply shocks on Y_t and P_t, we calculate the correlation coefficients. We construct supply and demand innovations series from the contribution of each one to the variation of Y_t and P_t. Next, the Pearson correlation coefficient is calculated for both types of responses of Y_t and P_t to the supply and demand shocks. The Pearson's correlation coefficient varies between -1 and 1; 0 reflects no relationship between the two variables. As shown in the following Table 2.

Table 2: Meaning of The Pearson's correlation coefficient

Correlation	Negative	Positive
Weak	r varies from -0,5 to 0	r varies from 0 to 0,5
Strong	r varies from -1 to -0,5	r varies from 0,5 to 1

Note : r : The Pearson correlation coefficient

H0 : $p = 0$: No correlation between variables

H1 : $p \neq 0$: Correlation between variables

An analysis of the supply and demand disturbances' asymmetry degree can be done by comparing the correlation coefficients of the similar type of shock. To properly assess the degree of asymmetry, we indicate that those positive correlation coefficients signify symmetry and the negative ones indicate dissymmetry of supply and demand shocks.

4.7.1. Demand shock correlation matrix

According to Table 3 demand shocks are positively correlated among the core EU countries (Germany, France, Spain, Belgium and Italy). A positive correlation of these shocks between Germany and France with a coefficient of (0.93). The same observation is amidst France and Italy (0.87) and between Italy and Spain (0.90). This means that the reactions of Y_t and P_t of the core countries to a negative demand shock are similar. This negative demand shock exerts symmetric effects on the economies of the core.

However, there is a negative correlation between the core countries and the peripheral ones like Hungary. The aggregate demand shocks among Germany and Hungary are negatively correlated with a coefficient (-0.62). Moreover, there is a negative correlation of the demand innovations between Hungary and the rest of the core states notably France (-0.76) and Italy (-0.65). We therefore conclude that there is a high degree of asymmetry in demand shocks effects between the core and peripheral countries. This means that the two variables Y_t and P_t of the peripheral do not react in the same way to a negative demand shock as those of core countries of the EU. Our results are in line with those obtained by Weimann (2002) who found that Hungary exhibits a correlation of the aggregate demand shock side with the rest of the EU member countries.

Table 3: Correlations between demand shocks series 2000Q1-2020Q1

Country	GER	FRA	ITA	HUNG	BELG	UK	SPA	GREE
GER	1	0.93**	0.83**	-0.62**	0.77**	-0.22	0.95**	0.42
FRA		1	0.87**	-0.76**	0.92**	-0.32	0.97**	0.11
ITA			1	-0.65**	0.76**	-0.53**	0.90**	0.05
HUNG				1	-0.60**	0.56**	-0.67**	0.15
BELG					1	-0.18	0.88**	-0.09
UK						1	-0.38	0.50
SPA							1	0.15
GREE								1

4.7.2. Supply shock correlation matrix

From Table 4 above we observe that the degree of supply shock symmetry becomes important between Hungary and some core countries. Indeed, the negative supply shock in Hungary is positively correlated with those in Belgium at a coefficient of (0.77) and with those in Italy at a coefficient of (0.68). These symmetries of the positive supply shocks' have effects on the responses of the Hungary and the core countries' aggregates. It informs us about the dynamics of rapprochement in the process of adjustment to shock which is the fruit of the measures adopted by the European authorities to reduce heterogeneities and disparities among its members. However, we observe a severe degree of supply shock asymmetry, which still persists despite the establishment of different mechanisms provided by the European authorities, which aim at bringing the economies of the core counties (Germany, France and Belgium) and the peripheral ones (Greece) closer together. A negative correlation of supply shock between Belgium and Greece is characterised by a negative correlation coefficient (-0.63) which is a sign of great divergence between those two countries.

Table 4: Correlations between supply shocks series 2000Q1-2020Q1

Country	GER	FRA	ITA	HUNG	BELG	UK	SPA	GREE
GER	1	0.71**	-0.31	0.17	0.09	-0.43	0.06	-0.52**
FRA		1	-0.78**	-0.23	0.03	-0.81**	0.33	-0.79**
ITA			1	0.68**	0.20	0.71**	-0.68**	0.49
HUNG				1	0.77**	0.005	-0.95**	-0.26
BELG					1	-0.50	-0.82**	-0.63**
UK						1	-0.0001	0.94**
SPA							1	0.24
GREE								1

4.8. Implication and discussion of the results

The results of our study show that there is a strong symmetry of demand and supply shocks between the core countries (France, Belgium and Germany). This local symmetry in the effects of the economic shocks is the consequence of the adjustment

measures' similarity face the demand and supply shocks. They are the results of economic policies' approximation between these countries, in particular fiscal policies. As demonstrated, these countries are characterised by price flexibility, which adequately explains the rapidity of the return to equilibrium after a negative demand disturbance. In contrast, in Greece and Italy prices appear to be rigid. It appears that the degree of price rigidity and flexibility are heterogeneous between the member countries. This is an important conclusion compared to the forms of heterogeneity detected in the previous literature. (Burriel & Galesi, 2018; Serati & Venegoni, 2019).

Moreover, being confronted with the same shock does not always imply identical responses from countries in the same region. The analysis of the results obtained by our empirical study shows that the amplitude of demand and supply shocks' asymmetry degree between core and peripheral countries is extremely high (case of Belgium and Greece). Our results are in line with those obtained by Pucar and Glavaški (2020). According to the OCA theory, in a monetary union where two member countries are affected by the same shock, the production and price responses are different. There is a crucial factor that explains such a phenomenon, the divergence of economic structures which may have to induce imbalances between the countries composing the union. In this case, the relative international competitiveness is affected among states and costs arise because the countries cannot use the exchange rate to eliminate the imbalances.

In addition, the divergence of budgetary and fiscal policies between the countries studied, as well as the monetary policy optimality's degree, which despite being unique is not homogeneous. Evidence that has been demonstrated by De Grauwe and Ji (2017). This heterogenies better explains the predominance of the supply shock in giving an idea about the marked fluctuations of Y_t and its significant contribution to the explanation of P_t. Since P_t is significantly influenced by the macroeconomic policies adopted, by the economic specificities of each country, and also by the behaviour of the economic agents which are not homogeneous; they should be considered as the essential sources of heterogeneity within the EU.

It should be noted that the greater the degree of asymmetry, the more difficult it is to maintain economic and financial stability; especially in the case of supply shocks which

may require more painful adjustments (Frenkel & Nickel, 2005). The degree of asymmetry of economic shocks is still significantly acute as our results join those obtained by Pucar and Glavaški (2020). The disparities between member countries continue to grow and appear in a recent form precisely of "heterogeneity in the prices' flexibility and rigidity's degree." It is evident that the EU is typically experiencing a dichotomy and is operating at two speeds. Core countries are correctly aligned and maintain a significantly lesser supply and demand shocks' asymmetry degree. However, peripheral countries are entering a vicious circle characterised by flagrant disparities that have overwhelmed their local economies. However, the various measures adopted by the European authorities like the official adoption of the convergence criteria remain limited.

5. Conclusion

Our empirical study of supply and demand shocks' asymmetry degree adopting the SVAR model following the method of Blanchard and Quah (1989) generates fascinating insights that overcome the essential contribution of this research paper well. It shows that the degree of asymmetry and heterogeneity in the EU is relatively high. This undoubtedly proves that the preventive measures adopted by the European authorities to reduce the structural disparities between its member countries and to mitigate the asymmetric effect of economic shocks remain limited. We conclude from our study that heterogeneity within the EU is not only in the structures of the member countries as the previous empirical works like Penot, Pollin and Seltz (2000) and Georgiadis (2015) suggest, but also in the degree of price flexibility and rigidity which are heterogeneous as well. Furthermore, we demonstrate that to resist the potential challenges of violent fluctuations of an asymmetric nature, the European authorities must move towards fiscal reforms to better harmonise and carefully coordinate their economic policies.

Finally, the observation and analysis of impulse response functions allow us to draw two major conclusions. These obtained impulse responses go in contrast with the traditional Keynesian view. Our result goes against the implications of this specific point of view which states that the response to the demand shock represents the counterpart of price rigidity and that the economy adapts slowly only to changes in aggregate demand

because of this inflexibility. It means that prices do not react rapidly to decreases in demand because of their rigidity. Starting from the responses obtained by our study, we cannot generalise these implications since at short-run, the rapid price (P_t) reaction to a demand shock are clearly the counterpart of a flexibility of prices. This strongly attests to Y_t 's short-run reaction to the same demand shock in the case of Germany, Belgium and France. Indeed, this sufficiently illustrates the relevance of the AS-AD model with price flexibility.

An additional exercise seems interesting to us. This is done by integrating the wage as a variable to study the nominal rigidity of wages; which are at the heart of the theoretical macroeconomic controversies. And to assess accurately the empirical relevance of the nominal wage inflexibility's hypothesis which according to the Keynesians allows to account for the demand shock effects.

Moreover, we cannot reject the hypothesis of long-run neutrality of demand shocks. Essentially, in the member countries of the EU like Germany, Belgium and France where the contribution of demand shocks disappears over time. However, there is a persistence of demand shocks in Greece, Hungary. This advances us to submit a fundamental question, if we accept the hypothesis of the non-neutrality of demand shocks in the long-run: In what sense does a temporary shock exert an effect in the long-run?

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