Resilience of developing countries to shocks: Case study of WAEMU countries with SUR and VAR Approaches

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ABSTRACT

This article investigates the economic resilience of West African Economic and Monetary Union (WAEMU) member states to shocks. Towards that end, an in-depth study is conducted with, first, seemingly unrelated regression (SUR) and structural vector auto-regression (SVAR) models. Second, two indexes - namely, a resistance index and a recovery index — capturing two major aspects of economic resilience in a given country, or group of countries, are constructed. Following a comprehensive analysis of results, five key elements stand out: (i) the WAEMU as a whole takes longer than the individual member countries to accommodate both domestic and external shocks; (ii) contrary to expectations, the impacts of changes in economic conditions from Europe are weak; (iii) the concept of 'engineering resilience' embodies more closely the type of resilience experienced in the WAEMU; (iv) with respect to resistance and recovery post-shock, the 'best students' appear to be Senegal, Côte d'Ivoire and Niger in the former case, while Togo and Côte d'Ivoire emerge on top in the latter, and (v) member states exhibit more dissimilarities in terms of resistance than recovery. A five-point course of action, at both macro and microeconomic levels, aimed at enhancing the degree of economic resilience in individual countries, and the Union, as well as reducing resilience gaps among countries, seem appropriate. This course, if diligently pursued, will strengthen the effectiveness of monetary policy tools at the disposal of authorities as they deal with shocks, both internal and external.

1. INTRODUCTION

Countries across the globe are increasingly interconnected and interdependent. This fact has become a binding constraint that each country must incorporate in its policy-making process. In such a context, it has become difficult, if not impossible, for a country to stay unscathed by economic events, political actions or natural phenomena in other countries.

An illustration of this new reality can be seen through two topical cases. On the one hand, there is the well-documented 2008 subprime mortgage crisis that originated in the United States. In the aftermath of the subprime market collapse, the world experienced a severe financial crisis that impacted negatively upon the real economy. This situation — which led to a decline in commodities prices as world demand faltered — put downward pressure on the revenue streams of developing countries in general, and African countries, in particular. Indeed, it has been established over recent decades that African countries are highly dependent on the proceeds from the international trade of raw materials or commodities.

On the other hand, the political crises that flared up in some countries of the West African Economic and Monetary Union (WAEMU) — for instance, Côte d'Ivoire and Mali — have not only directly affected their respective economies, but also their neighbouring trading partners and possibly the Union.

It hence appears important for each state to design and implement appropriate macroeconomic policies to address the risk of contagion from both endogenous and exogenous shocks. This cannot be achieved without a thorough knowledge of the sources of these shocks, their impacts and, to some extent, their nature.

The present analysis intends to provide policymakers and stakeholders with an increased understanding of the economic resilience of the WAEMU, as an aggregate unit, and its individual member states, to shocks. It focuses on both external shocks — from traditional partners such as the European Union, the United States; and the partners that have gained in importance in recent years, namely China — and internal shocks to the Union. Regarding the latter, it makes sense to first examine the effects of idiosyncratic shocks to a given country and then assess, to what extent if any, intra-WAEMU shocks affect a country. This study, moreover, investigates the post-shock dynamics as well as their impacts on member states' economies through time.

The variety and abundance of studies in the economic and financial literature on the topic of shocks are a testament to its continued relevance. Among many studies, there are Mehrotra *et al* (2013), du Plessis *et al* (2008) and Goldfajn *et al* (2003) who respectively focus on China, Brazil and South Africa. However, studies on the concept of economic resilience are limited, especially for African countries. In general, economic resilience can be defined as the ability of an economy to maintain its level of production close to potential output following a shock (Duval and Vogel 2008).

Besides the existing literature gap regarding resilience in WAEMU member countries, which is addressed herein, this study provides new insights into the understanding and impacts of shocks. This is the novelty and this is what adds to its relevance. As a matter of fact, most studies investigating shocks in these countries generally inquire, among others, about convergence and heterogeneity (Bah 2015). Some other authors explore shocks and

financial 'contagion' through capital markets and trade linkages (Hegerty 2013), whereas others scrutinise shocks and probable misalignments in the real effective exchange rate of the CFA franc, using the fundamental equilibrium exchange rate (FEER) approach (Abdih and Tsangarides 2010). In other instances, shocks and optimality of the WAEMU monetary union have been the main focuses (Coulibaly and Gnimassoun 2013). They shed light on the economic resilience of Union members by looking into the dynamics of their behaviours following internal and external shocks.

By furthering our understanding of sources and effects of shocks, this paper aims at contributing to the design and implementation of economic policies and programmes in order to strengthen the resilience of member states' economies and the Union as a whole. This is a key issue that has, as of late, been part of the debate owing to the good economic performances achieved by these countries since 2012. Indeed, it would be helpful throughout the development process of these countries if policymakers could find ways to maintain this trend, as well as safeguard the hard achieved recent gains against internal and external shocks.

Towards its objectives, this article is structured around six major points. The next section covers the literature review, while the third makes a holistic presentation of the WAEMU, along with an outlook. The fourth point is dedicated to the discussion of the methodology along with the description of data. The fifth section assesses the results and their implications for WAEMU member states. Finally, the sixth section offers concluding remarks and policy recommendations.

2. Literature review

Duval and Vogel (2008) have conducted a study evaluating the resilience of Organisation for Economic Cooperation and Development (OECD) member states' economies. Their work centres on the role played by structural policies in the resilience of these countries. They assume from the outset that, even under similar shocks, the levels of resilience for individual economies differ within the OECD. This assumption holds, although cyclical fluctuations between these countries may weaken over time. On that basis, they establish empirically that very strict standards on the labour market generally, tend to reduce resilience to shocks because they increase the persistence of output gaps.

In addition, they find evidence showing that some countercyclical forces may kick in and improve the resilience, by absorbing the initial impacts of shocks. Their methodology has two major steps, namely (i) the determination of output gaps from a dynamic specification based upon an AR(2) function, and (ii) the determination of impulse response functions of these output gaps. For the 20 countries considered, it appears that the role played by rigidities, through the labour and goods markets, remains ambiguous — both empirically and theoretically.

On the other hand, Fingleton *et al* (2012) spotlight the United Kingdom (UK) and canvass the resilience of 12 regions in the aftermath of labour market related shocks. In order to evaluate the resilience of these regions, the technique used by the authors proceeds from two approaches. Seemingly unrelated regressions (SUR) models and a vector error correction model (VECM) are used to scrutinise the dynamics of each region's resilience and determine whether permanent effects of shocks exist.

Overall, they find that UK regions exhibit differences in their economic resilience following a shock in the labour market. These differences are more pronounced with respect to their resistance to shocks than post-shock recovery. Intra-regional shocks to employment have permanent effects, especially in regions closer to the source of these shocks.

Briguglio *et al* (2009) make a distinction between the concepts of vulnerability and economic resilience, while providing ways to measure both. They define economic vulnerability as an economy's degree of exposure to external shocks, as a result of its openness to the rest of the world, while economic resilience describes an economy's ability to resist or recover in the wake of shocks. They develop an index to measure the degree of resilience by looking at four main aspects of an economy: macroeconomic stability, microeconomic market efficiency, good governance and social development. This index and a second one, capturing economic vulnerability, are utilised as determinants in a regression.[2] They find that per capita real GDP is positively related to economic resilience, but negatively to economic vulnerability.

Martin (2012) surveys the literature regarding the concept of resilience which, he observes, has been gaining in importance. He admits that this concept is relatively new in economic and related fields, in spite of the fact it has long held a stamp of familiarity in areas such as physics, engineering and environmental sciences. As far as economic resilience is concerned, he distinguishes three types of resilience.

First, there is what can be described as 'engineering resilience' — that is, the ability of a system to withstand shocks and return to its pre-shock level or state. It is also close to the definition found in physics. Second, there is the concept of 'ecological resilience' that is the ability or capacity of a system to reach its (elasticity) threshold beyond which it is irreversibly altered, into another form. The concept of hysteresis is closely related to this concept when it is defined as 'a situation where a disturbance [or impact] permanently affects the trajectory of the economy' (Romer 2001 p 471). Third, there is the notion of 'adaptive resilience' regarding complex adaptive systems and their ability to self-organise with — or through — all their components following an internal or external shock (Martin and Sunley 2007). As a consequence of these various forms of resilience in the literature, it is possible to identify its four main features, namely, (i) resistance, (ii) speed and extent of recovery, (iii) magnitude of structural shift, and (iv) resumption of the economic growth path before impact.

On another note, the economic resilience of 459 communities in the United Kingdom, in the wake of shocks associated with the closure of coal-mines in the 1980s, has been studied by Ormerod (2010). With a simple method of least squares regression applied to data from 1982 to 2002, he finds that UK regions did show different degrees of resilience. He also found that improvements in employment were faster in regions with the lowest concentration of jobs in the coal industry. Overall, job creation lagged in regions with the highest concentration of this industry, compared to other regions in the UK.

Navarro-Espigares *et al* (2012) explore the role of the service sector in regional economic resilience, which is defined in this study as the resistance to the loss of gross valued added (GVA) and jobs originating from the initial impact of the crisis. They look at GVA and employment series of 17 regions in Spain from 1986 to 2010. For each region, they investigate whether the relative size of the service sector in the regional economy plays an important role in determining their level of resilience, in the short and medium term, following a crisis. Using time series regression with variants of ARIMA models their results indicate, based upon the two crises that marked the study period in 1992 and 2008, that service-intensive regions have shown greater resilience. Nonetheless, no clear-cut conclusion about the patterns of behaviour of service-intensive regions over time, beyond the initial point of impact, can be drawn as a result of the 2008 crisis. Some cushioning role played by the service industry is apparent in the medium-term only for the 1992 economic crisis within the country.

Holm and Østergaard (2013) examine the regional industrial resilience of the Danish information and communication technology (ICT) sector, in the aftermath of the bursting of the 1990s technological bubble. Using data on 21 regions in Denmark, spanning 1993-2005, they introduce a methodology that follows two main steps. First, nine distinct variables are considered to analyse the regional industry's structure through basic regressions. Then, the marginal effect conditional upon the industry's structure is determined with two elaborate models involving employment growth in the ICT sector for all regions. The results reveal the existence of four general types of regions, namely the adaptively resilient, the rigidly resilient, the non-resilient, and the entrepreneurially resilient. Furthermore, this study establishes that the ICT sector in urban and agglomerated regions was more sensitive to the business cycle, compared with less urbanised regions, which exhibited higher resistance.

As previously mentioned, the concept of resilience constitutes a relatively new avenue of research in the economics literature. It is an emerging concept and as such, like in any discipline, the body of knowledge regarding this concept remains fluid, evolving and even confusing at times. To push for more clarity in the current state of understanding of this concept, Martin and Sunley (2015) have surveyed the literature extensively, to provide much needed clarifications

about regional economic resilience, its determinants, and the necessity to analyse it as a dynamic process.[3] They argue that regional economic resilience should be concerned with the long-run growth and development path of that particular region's economy along, with the employment, output, welfare and income therewith associated. Likewise, they point out that economic resilience in general encompasses four dimensions, namely vulnerability, resistance, robustness and recoverability, all of which are interconnected.

From a different but complementary angle, the notion of resilience has been investigated from a microeconomic standpoint. For instance, some scholars have looked into the role played by entrepreneurship in determining the economic resilience of a region. Williams *et al* (2013) have brought attention to the relationship between entrepreneurship and economic resilience by looking at the Thessaloniki City region in Greece. They contend that entrepreneurship, beyond its critical role played in economic reorientation and recovery, is also essential to the resilience of this region to shocks in the long-run. They accordingly recommend the implementation of institutional arrangements that will effectively promote an entrepreneurship-based regional economy as a shift away from the current paradigm wherein the public sector remains dominant in the local economy.

Lastly, Bhaskaran (2010) discusses how resilient Southeast Asian countries were in the face of the 2008-2009 financial crisis. The paper concludes that these countries, surprisingly exhibited a high degree of resilience to this shock, considering their strong exposure to the G3 (European Union, Japan and the United States). In addition, it identifies the structural reforms undertaken following the 1997-1998 Asian crisis as the primary source of that resilience, especially at the macroeconomic level and in the banking sector.

It is noteworthy that both the concepts of shocks and resilience are so intertwined that the former cannot be overlooked in any discussion regarding the latter. Contrary to economic resilience, shocks have been studied extensively. This justifies the diversity and abundance of perspectives, or angles, pertaining to this concept that are available in the literature. Indeed, from Asian countries to countries in transition, by way of Southern African and Gulf countries, studies do exist.[4]

3. Overview and outlook of the WAEMU

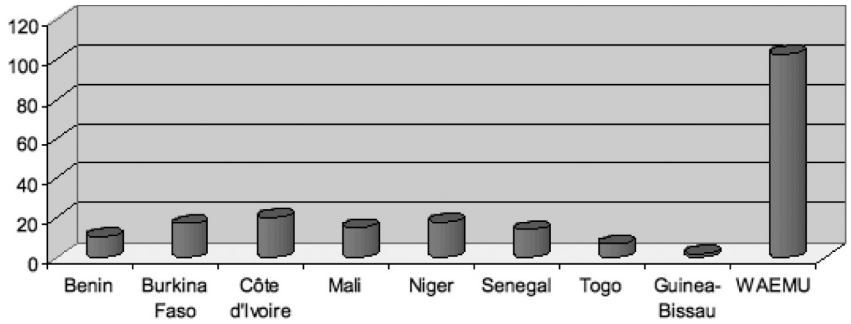
The West African Economic and Monetary Union (WAEMU) was created in 1994. It draws its origins from the treaty of the West African Monetary Union (WAMU) signed in 1962, which then had seven member countries.[5] WAMU countries shared a common monetary unit called the African Financial Community franc (FCFA, the French acronym). The WAMU — and the WAEMU — currently has eight member countries, including Guinea-Bissau, which joined the Union in 1997 and adopted the FCFA.[6]

There may be some confusion regarding the distinction between both entities — the WAMU and the WAEMU. As aforementioned, the latter, which

was carved out of the former, is meant to pursue the exclusive role of spearheading, strengthening and promoting the ambitious project of economic integration laid out through the WAMU treaty at its inception. In that perspective, there was a formal transfer of all economic integration-related matters to the WAEMU Commission on February 22, 1995.[7]

Nowadays, the WAEMU has emerged as an economic zone covering a total area of approximately 3.5 million km2, with nearly 103 million consumers (Figure 1). It likewise boasts attractive features that include a single currency, a large population, common linguistic and cultural ties, with both financial and goods markets experiencing constant mutations and increasingly deepening integration in accordance with the WAEMU founding charter. In addition, Figure 2 displays the evolution of real GDP growth in these countries over the period considered in this analysis. It highlights, for example, that real GDP in the Union has exhibited a positive trend since the early 1980s, with an average growth rate of about 2.7 per cent.

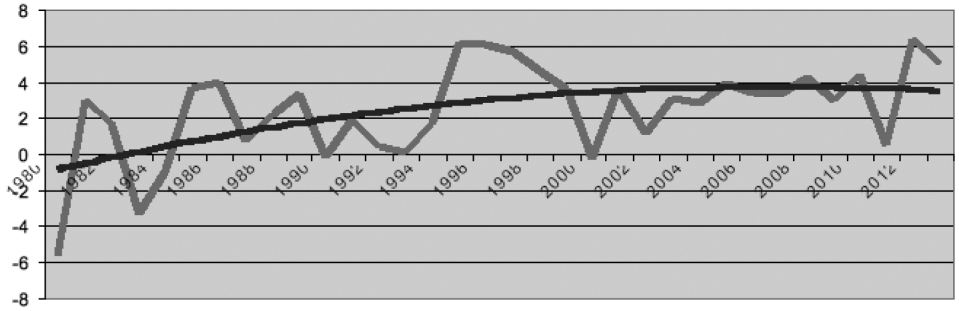
Figure 1: Population of WAEMU member countries in 2013, in million



Source: *World Development Indicators,* The World Bank Group.

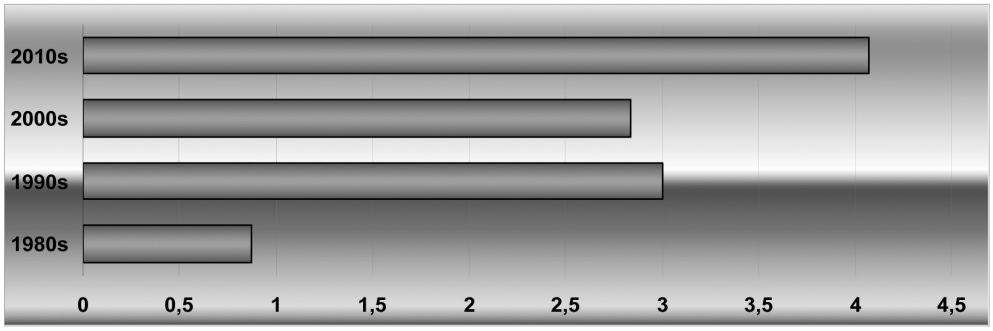
A more detailed analysis of this growth trend through the decades reveals that WAEMU member countries are on a satisfactory growth path, with economic activity accelerating across the Union in the 2010s (Figure 3).

Figure 2: Real GDP Growth of the WAEMU, 1980-2013 (in %)



Source: *World Development Indicators*, The World Bank Group.

Figure 3: Real GDP growth of the WAEMU through the decades (in %)



Source: *World Development Indicators*, The World Bank Group.

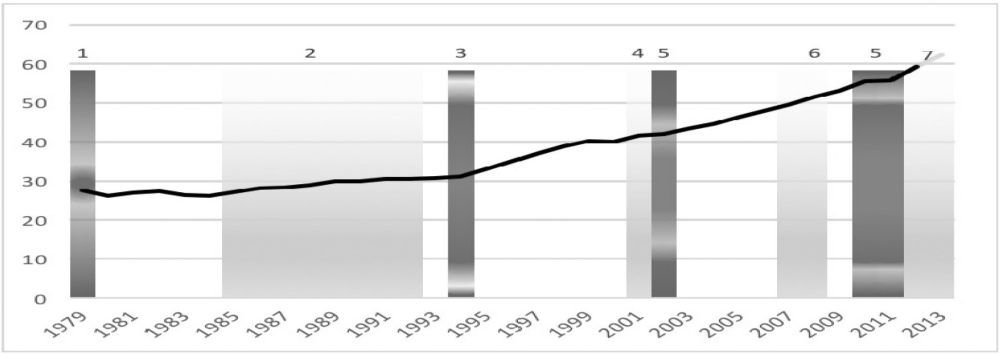
Since 1979, the WAEMU and the world have experienced many crises that have led to shocks of various magnitudes. For the Union and its members, seven major shocks are worth noting, in the context of the present study. These shocks fall into two broad categories —regional (i.e. intra-WAEMU or country specific) and international —depending on their sources. Additionally, they were chosen because of their relevance to the world economy and their potential impacts on Union member economies, which are particularly vulnerable to fluctuations or volatilities in global commodity markets. This vulnerability is a consequence of their heavy reliance on the exports of agricultural and mining products. Specifically, there are shocks related to (1) the Iranian revolution in 1979 (which resulted in a major oil shock in 1980-1981); (2) the sharp decline in commodity prices, particularly for coffee and cocoa, which severely affected the largest economy in the Union, Côte d'Ivoire, between 1985 and 1992; (3) the 1994 devaluation of the FCFA; (4) the global recession of 2001; (5) the Ivorian crises of 2002 and 2010-2011; (6) the 2007-2008 U.S. housing market crisis, and (7) the Malian crisis of 2012-2013.

Figure 4 presents a comprehensive overview of the behaviour of real output in the Union from 1979 to 2013, covering these crises. Overall, a positive trend is seen for the Union as a whole, but with slowdowns and contractions during crises. However, before proceeding further, one needs to be cognisant of the fact that this overall trend could conceal peculiarities in the responses or performances of countries when taken individually during a particular crisis. This concern deserves attention and a detailed analysis is provided in this study.

Despite the fact that WAEMU member countries have belonged to the same economic union and shared the same currency over the years, they do exhibit singular patterns that are evident. A look at the degree of convergence between these countries may help to explain these singularities. Several studies have indeed reported some heterogeneity across members. Bah (2015), for example, using a panel stationary analysis which endogenously identifies structural breaks, finds stochastic convergence in only a few WAEMU countries. A ß-con-

vergence analysis shows that countries like Niger and Senegal are still diverging from the community average, while Burkina Faso and Mali are catching up.[8]

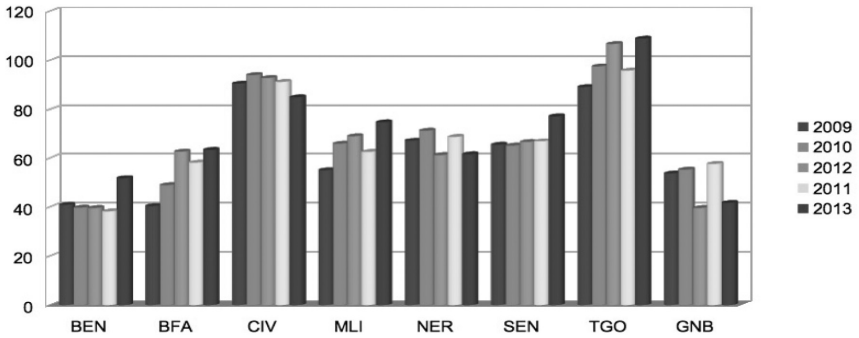
Figure 4: Shocks and real GDP growth in the WAEMU, 1979-2013, in billions of constant 2005 U.S. dollars[30]



Sources: *World Development Indicators,* The World Bank Group; *The CIA World Factbook*, CIA.

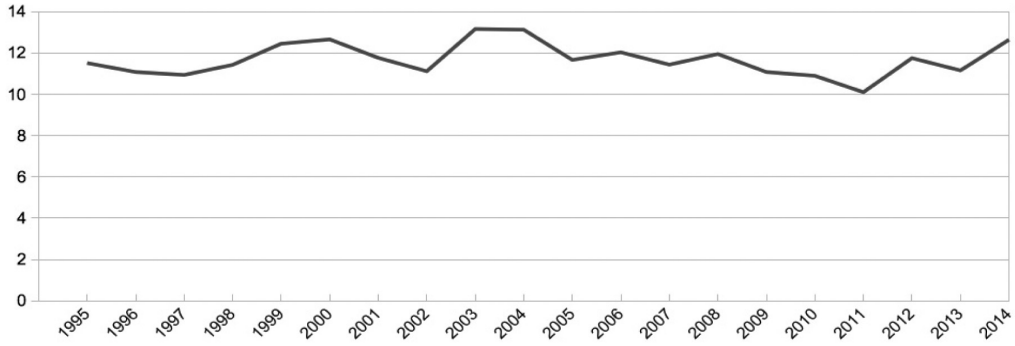
Peculiarities of member countries can also be observed through key macro variables such as trade openness, intra-regional trade, average and effective tariff rates. For instance, Figure 5 reveals that the relative importance of trade openness varies considerably across member countries. Indeed, using the five most recent years of data available, it appears that some members (Togo, Côte d 'Ivoire, Senegal, Niger and Mali) are more active in international trade, while others (Benin, Guinea Bissau and Burkina Faso) exhibit relatively low involvement in foreign trade. For the most active country in international trade, Togo, trade openness varied between 89 and 109 per cent from 2009 to 2013, while the least active country, Benin, had rates of trade openness varying between 38 and 52 per cent. Another important stylised fact about these countries is the level of intraregional trade. As a percentage of total trade, this is low, fluctuating between 10 and 13.5 per cent since 1995 (Figure 6).

Figure 5: Trade openness of WAEMU member countries, 2009-2013 (in %)



Source: UNCTAD Statistics, United Nations Conference on Trade and Development.

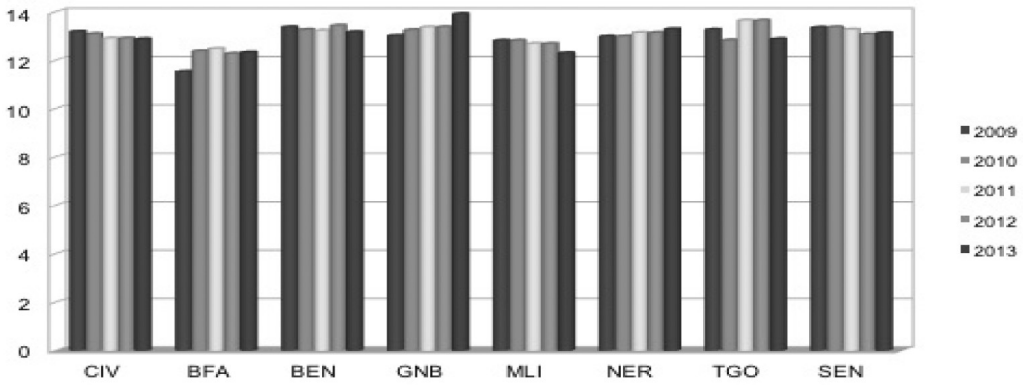
Figure 6: Intraregional trade of the WAEMU, 1995-2014 (in % of total trade)



Source: UNCTAD Statistics, United Nations Conference on Trade and Development.

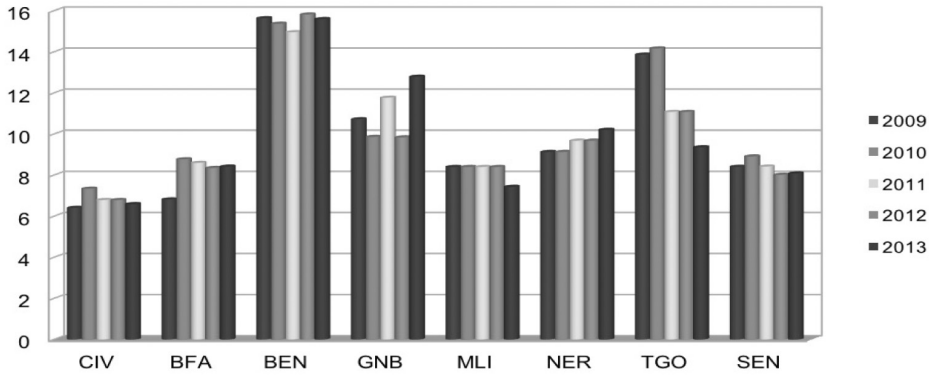
Similarly, both average and effective tariff rates show differences among member countries. These differences are more pronounced for the latter (Figures 7 and 8). The average effective tariff rate, from 2009 to 2013, is about 15.5 per cent in Benin, followed by Togo at about 12 per cent. Côte d'Ivoire has an average effective rate of about 6.8 per cent with Burkina Faso having the second lowest rate at roughly 8.2 per cent. Overall, such discrepancies could explain the peculiarities behind the noted heterogeneity of member countries through disparities in the markets for goods and services. Such disparities might in turn lead to varying degrees of economic resilience across countries.

Figure 7: Average tariff rates in WAEMU member countries, 2009-2013 (in %)



Source: *World Development Indicators*, The World Bank Group.

Figure 8: Effective tariff rates in WAEMU member countries, 2009-2013 (in %)



Source: *World Development Indicators*, The World Bank Group.

4. Methodology and description of the database

4.1 Methodology

The methodology pursues a three-pronged approach. First, a static analysis is performed through a seemingly unrelated regression (SUR) model. This analysis enables a preliminary assessment to be made of the resilience of WAEMU economies. Then, a dynamic analysis is conducted using a structural vector auto-regression (SVAR) model, to study the short, medium and long-term impacts of both internal and external shocks to individual member economies and to the Union's economy as a whole. Third, two indexes are constructed, to further our understanding of economic resilience in WAEMU countries: (i) an index of resistance and (ii) an index of recovery (post-shock).

The formal introduction of the SUR technique in the literature was made by Zellner (1962). He states that, under certain conditions, this technique produces estimators that are asymptotically at least as efficient as estimators derived through the standard least squares method. . Moreover, the robustness of the estimators increases with the degree of correlation between the error terms of individual equations. In our case, this is more, rather than less, likely with WAEMU member countries since these countries have been sharing, over decades, a wide range of cultural, political and diplomatic, as well as economic affinities, bolstered by a variety of bilateral and multilateral treaties. Furthermore, the geographical closeness, the virtuality of borders and the numerous people-to-people exchanges that have historically taken place in the region are no less important.[9]

A SUR approach is applied in this study, where a set of n small open countries is considered. For a given country *i* at time *t*,

$$Y_{it} = X_{it}\alpha_{it} + \xi_{it} \quad (1)$$

Equation (1) holds at $t = 1, 2,\ldots, T$, and for $i = 1, 2, \ldots, n$. Y and X respectively denote the regressand and regressor, while ξ designates the unobserved error term. In practice, the SUR model generalises multivariate regressions with stacked vectors of independent variables and parameters. Equation (1) can, accordingly, be expressed as:

$$\begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{pmatrix} = \begin{pmatrix} X_1 & 0 & \cdots & 0 \\ \vdots & . & . & \vdots \\ 0 & 0 & \cdots & X_n \end{pmatrix} \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \vdots \\ \alpha_p * \end{pmatrix} + \begin{pmatrix} \zeta_1 \\ \zeta_2 \\ \vdots \\ \zeta_n \end{pmatrix} \quad (2)$$

or $Y = X\alpha + \xi$, where Y, X, α and ξ are matrices defined in such a manner that Y is $(nT\text{x}1)$, X is $(nT\text{x}p^*)$, α is $p^*\text{x}1$), and ξ is $nT\text{x}1$. $p^* = \Sigma ipi$, and p represents the number of independent (and non-stochastic) variables. In addition, the following basic assumptions hold for each individual country, both across equations and time:

$$E(\xi_i | X) = 0 \quad (3)$$

$$E(\xi_t \xi_k | X) = \sigma_i I_T \quad (4)^{10}$$

where $\sigma_{tk} \neq 0$ for $t \neq k$

$$E(\xi_i \xi'_i | X) = \sigma_{ii} I_T \quad (5)$$

$$E(\xi_i \xi_j | X) = \sigma_{ij} I_T \quad (6)$$

where $\sigma_{ij} = 0$ or $\sigma_{ij} \neq 0$, for all t, i and j.

The variance-covariance matrix, Θ, is defined as:

$$E(\xi\xi') \equiv \Theta = \Pi \otimes I_T, \text{ where } \Pi = ?_{ij} \quad (7)$$

In a more elaborate form, equation (1) becomes:

$$g_{it} = a_{0i} + a_{1i}C_{1t} + a_{2i}C_{2t} + a_{3i}C_{3t} + a_{4i}C_{4t} + a_{5i}C_{5t} + a_{6i}C_{6t} + a_{7i}C_{7t} + a_{8i}P_{1t} + a_{9i}P_{2t} + a_{10i}P_{3t} + a_{11i}P_{4t} + a_{12i}P_{5t} + a_{13i}P_{6t} + \varepsilon_{it} \quad (8)$$

g represents the growth rate of production; a_0 is the autonomous growth rate; C_1, C_2, C_3, C_4, C_5, C_6 and C_7 are dummy variables capturing the seven major shocks that spanned the study period. These shocks capture specifically the 1979 Iranian Revolution (shock 1), the sharp decline in the prices of commodities, especially coffee and

cocoa, from 1985 to 1992 (shock 2), the devaluation of the CFA franc in 1994 (shock 3), the global recession of 2001 (shock 4), civil wars and unrests in Côte dIvoire in 2002 and 2011 (shock 5), the U.S. subprime mortgage crisis in 2007-2008 (shock 6), and the Malian civil war in 2012-2013 (shock 7). P_1, P_2, P_3, P_4, P_5, and P_6 denote the post-shock periods and ε is the error term.[11] From equation (2), the estimator of a is determined using the Feasible Generalised Least Squares (FGLS) technique:

$$\hat{\alpha}_{FGLS}=\left(X'\hat{\Theta}^{-1}X\right)^{-1}X'\hat{\Theta}^{-1}Y \tag{9}$$

where the '^' sign indicates that the associated variable is a matrix of estimates.[12]

The literature recommends the use of equation (9) when the estimate of the variance-covariance matrix is known, which is generally the case in practice with empirical analyses.[13]

As a reminder, the concept of economic resilience in this analysis is considered from two angles: resistance to shocks and recovery post-shock of economic systems. For the preliminary analysis of economic resilience in WAEMU member countries, four tests are conducted to answer four distinct questions using equations (8) and (9):

i. Is the impact of any given shock similar across each WAEMU member country?

ii. Regardless of the shock, are impacts similar within a given country?

iii. Is the post-shock recovery similar across each WAEMU member country for any shock?

iv. Regardless of the shock, are post-shock recoveries similar within a given country?

The answers to these questions are captured through the following restrictions applied to equation (8):

1) $a_{q1} = a_{q2} = a_{q3} = a_{q4} = \ldots = a_{q8}$, where $q = 1, 2,\ldots, 7$

2) $a_{1i} = a_{2i} = a_{3i} = a_{4i} = a_{5i} = a_{6i} = a_{7i}$, where $i = 1, 2,\ldots, 8$

3) $a_{q1} = a_{q2} = a_{q3} = a_{q4} = \ldots = a_{q8}$, where $q = 8, 9,\ldots, 13$

4) $a_{8i} = a_{9i} = a_{10i} = a_{11i} = a_{12i} = a_{13i}$, where $i = 1, 2,\ldots, 8$

The results for each of these cases give a glimpse into the economic resilience of WAEMU member states.

Subsequent to the SUR method, this analysis assesses the dynamics of the impacts of shocks, whether internal or external, to a particular member

country and the Union. To this end, a structural vector auto regression (SVAR) model is used. In the footsteps of Duval and Vogel (2008) and Fingleton *et al* (2012), this analysis investigates the two criteria of resilience presented above.[14]

Our analysis proceeds via three steps. First, one must define and identify a unique SVAR of order *r*. In the literature, the relevance of SVARs in studies related to the behaviours of micro and macro variables is notable. It is flexible and it can accommodate a variety of scenarios or frameworks pertaining to different economic structures or systems. In fact, since its introduction by Sims (1980), this approach has been used extensively in both impact and non-impact studies, within and beyond economics.[15]

With q endogenous variables, the system is written as follows:

$$\beta_0 y_t = \lambda_0 + \beta_1 y_{t-1} + \ldots + \beta_r y_{t-r} + \alpha\mu_t \quad (10)$$

where y_t is a random (qx1) vector; βz represents a (qxq) coefficient matrix, with z = 1,..., r; β_0 is a (qxq) vector that captures the instantaneous effects between variables; μ_t is the (qx1) vector of structural innovations; λ_0 is a (qx1) vector of constants; α is a (qxq) matrix of structural parameters. μ_t are independent and identically distributed (iid). Also, the distribution of μ_t is normal so that $\mu_t \sim N(0, \Phi)$, where Φ is a diagonal variance-covariance matrix of order (qxq).

Assuming that β_0^{-1} exists, the reduced form of equation is derived:

$$y_t = b_0 + b_1 y_{t-1} + \ldots + b_r y_{t-r} + e_t \quad (11)$$

where $b_0 = \beta_0^{-1} \lambda_0$(12); $b_r = \beta_0^{-1}\beta_r$ (13); $\beta_0 e_t = \alpha\mu_t$ (14). Moreover, it should be added that $E[y_{t-r}e_t] = 0$ and $E[e_t e_t'] = \Omega$, where Ω is the variance-covariance matrix of the reduced form.

It is possible to obtain μ_t from equation (14), which describes the relationship between error terms of both the SVAR and its reduced form. In the process, a number of restrictions must be imposed to allow for a unique identification scheme for μ_t. As a matter of fact, there are $2q^2$ elements to be identified, while the maximum number of identifiable parameters is $q(q+1)/2$. In other words, it is necessary to impose $2q^2 - q(q+1)/2$ additional restrictions.

In the second step, we derive each country's, and the Union's, potential outputs. For this we use the Hodrick Prescott filter (HP). This method consists of deriving a 'smoothed' trend component, h_t, of a given series y_t, by solving the following programme (Hodrick and Prescott 1980, 1997):

$$\underset{h_t}{Min} \sum_{t=1}^{T} (y_t - h_t)^2 + \lambda \sum_{t=2}^{T-1} [(h_{t+1} - h_t) - (h_t - h_{t-1})]^2 \quad (15)$$

where (y_t-h_t) represents the cyclical component of y_t. λ is a positive smoothing parameter that penalises the 'variability' in the trend component series and increases with the frequency of the series y_t.

It should be noted from the outset that statistical filtering methods in general, including the HP and Baxter-King (BK) methods, are subject to criticism because they are not model-based. To address this criticism, different approaches to determining the potential output of an economy have been developed. For example, the OECD has introduced an alternative method that is model-based and takes into account a production function that includes capital, job creation, factor productivity and wages that do not accelerate unemployment (Duval and Vogel 2008). Claus (2003) likewise proposes a model-based approach involving a SVAR, in his evaluation of potential output in New Zealand.

Beyond this critique, commonly used filtering methods display statistical weaknesses. It is well known, for instance, that the HP method creates biases due to the unsatisfactory treatment of endpoint observations in a sample.[17] The impulse response functions of endogenous variables are determined in the third step of our analysis. To enhance clarity in our work at this juncture, it is noteworthy that the endogenous variables considered are the output gaps for each country, or group of countries, of interest. Simply put, the present study strives to understand the two aspects of economic resilience through the lenses of the behaviours, or responses, of output gaps in the wake of shocks.

Similar to Fingleton *et al* (2012), this study introduces restrictions based upon macroeconomic theory, mathematical considerations and stylised facts. Some shocks are permanent, while others are temporary in a model including I(1) variables that are cointegrated and not mean-reverting. Matrices are orthogonalised in order to remove contemporaneous correlations and avoid spurious causal interpretations of impulse response functions. This procedure makes it possible to apply a specific shock to a country or group of countries, without shocking another country or group of countries.

Considering equation (14), the SVAR model of innovations can be established by considering five rather than 12 vectors — i.e., eight vectors for each WAEMU member country, one for the Union and three for the main trading partners under consideration. The five vectors represent, respectively (i) a given WAEMU member country, (ii) WAEMU as a whole (excluding the member country considered in (i)), (iii) Europe (EUR), (iv) the United States (USA), and (v) China (CHN). In proceeding this way, both internal and external shocks are captured for this particular member country, and the study can reach its overall objective which is, first and foremost, to explore the behaviours of the Union and each country within it. This approach greatly simplifies the identification process in the manner below:

$$\begin{pmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & 1 & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{pmatrix} \begin{pmatrix} e_t^{COUNTRY} \\ e_t^{WAEMU} \\ e_t^{EUR} \\ e_t^{USA} \\ e_t^{CHN} \end{pmatrix} = \begin{pmatrix} a_{11} & 0 & 0 & 0 & 0 \\ 0 & a_{22} & 0 & 0 & 0 \\ 0 & 0 & a_{33} & 0 & 0 \\ 0 & 0 & 0 & a_{44} & 0 \\ 0 & 0 & 0 & 0 & a_{55} \end{pmatrix} \begin{pmatrix} \mu_t^{COUNTRY} \\ \mu_t^{WAEMU} \\ \mu_t^{EUR} \\ \mu_t^{USA} \\ \mu_t^{CHN} \end{pmatrix} \quad (16)$$

Using equation (16), the vector of structural errors,μ_t, may be retrieved by imposing 35 restrictions.[18] α includes 20 nil coefficients and β_0 has five coefficients with the value 1 on the diagonal. To avoid the straightforward approach that consists of systematically setting another group of ten coefficients equal to zero, this study conducts a series of auxiliary regressions to determine the appropriate elasticities, which are then inserted in β_0. Elasticities that are found to be significant are retained and inserted in the matrix while a value of zero is otherwise considered. Specifically, this process is applied to the determination of coefficients b_{43}, b_{45}, b_{53} and b_{54}. The results for the auxiliary regressions are reported in Table 1 (see Appendix).

Moreover, given the relatively small economic size of WAEMU member states, taken individually or as a group, compared with their main trading partners in the current study, the following working hypothesis is considered for six restrictions: $b_{31} = b_{32} = b_{41} = b_{42} = b_{51} = b_{52} = 0$. In other words, this study argues that Europe, America nor China can contemporaneously be affected by shocks occurring in WAEMU countries or the Union. However, it should be noted that this study does not exclude the effects, if any, of these shocks over time.

Once the 35 restrictions are imposed, the impulse response functions of output gaps are determined to assess the dynamics of the resilience of WAEMU members and the Union in the face of internal and external shocks. After applying all restrictions, the complete functional form of equation (16) becomes:

$$\begin{pmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{25} \\ 0 & 0 & 1 & b_{34} & b_{35} \\ 0 & 0 & 1.44 & 1 & 0.30 \\ 0 & 0 & 4.66 & 3.23 & 1 \end{pmatrix} \begin{pmatrix} e_t^{COUNTRY} \\ e_t^{WAEMU} \\ e_t^{EUR} \\ e_t^{USA} \\ e_t^{CHN} \end{pmatrix} = \begin{pmatrix} a_{11} & 0 & 0 & 0 & 0 \\ 0 & a_{22} & 0 & 0 & 0 \\ 0 & 0 & a_{33} & 0 & 0 \\ 0 & 0 & 0 & a_{44} & 0 \\ 0 & 0 & 0 & 0 & a_{55} \end{pmatrix} \begin{pmatrix} \mu_t^{COUNTRY} \\ \mu_t^{WAEMU} \\ \mu_t^{EUR} \\ \mu_t^{USA} \\ \mu_t^{CHN} \end{pmatrix} \quad (17)$$

Using equation (17), the dynamics of economic resilience for each country and the Union are analysed through the patterns of behaviour in output

gaps following a shock. In practice, three types of shocks and their effects are scrutinised over time for each country and the Union:[19]

(i) internal shocks — occurring within;

(ii) external shocks — but originating within the WAEMU (intra-WAEMU);

(iii) external shocks — but originating beyond the WAEMU (extra-WAEMU).

Finally, the resistance and (post-shock) recovery indexes are computed. The former is computed based upon a modified version of the index introduced by Duval and Vogel (2008). It is a measure of the sensitivity of a given economy to shocks and is meant to capture the initial volatility in output gap for a country or group of countries in the aftermath of a shock. This index is the ratio of the absolute value of the most extreme points of variation in output gaps at the end of the first year, relative to the Union.[20] It is inversely related to the degree of resistance of the country and is formulated as:

$$I_i^{Res} = \left| \frac{V_i^{Max} - V_i^{Min}}{V_{WAEMU}} \right| \tag{18}$$

where, for country i, V_i^{Max} and V_i^{Min} respectively represent the maximum and minimum values of output gaps following a shock. Plus $V_{WAEMU} = V_{WAEMU}^{Max} - V_{WAEMU}^{Min}$.

The latter is constructed based on Fingleton et al (2012), but modified to accommodate the specificities of WAEMU member states. It helps assess the capacity or the speed of recovery of a country or group of countries in the aftermath of a shock. It is inversely related to the capacity of recovery of a country, or system, and is computed according to the formula:

$$I_i^{Rec} = \frac{T_i}{T_{WAEMU}} \tag{19}$$

where T_i is the post-shock recovery time for country i and T_{WAEMU} captures the average post-shock recovery time for the WAEMU as a whole.

4.2 Sources of data

This project considers annual data spanning 1979 to 2013. Two main sources were used — The World Bank's *World Development Indicators* and the *CIA World Factbook*. Summary statistics of data for each country are reported in Table 2.[21]

5. Results and implications for WAEMU member countries

5.1 Static analysis

A unit root test conducted to check for the stationarity of real GDP reveals the presence of unit roots (Table 3). As a result, the growth rate of real GDP —

which is I(0) — is considered in the estimation of equations to obtain more consistent and efficient estimates in accordance with equation (9). These estimates are summarised in Table 4 for each country.

Analysis of the results of the restriction tests (Table 5) confirms that the impacts are uniform in all 8 countries for shocks 2, 4, 5 and 6, at the five per cent significance level. This suggests that these shocks symmetrically affect WAEMU countries. On the other hand, shocks 1, 3 and 7 produced non-uniform effects on these countries, underlining their asymmetrical nature. The simultaneous presence of both symmetrical and non-symmetrical shocks could suggest the existence of structural differences between some countries in the Union. These results are of particular importance in a monetary union, because they allow authorities to have more clarity in the conduct of monetary policy (Theodoropoulos 2005, Bajo-Rubio and Diaz-Roldan 2005).

Furthermore, we must distinguish two groups of countries as far as internal reactions to shocks are concerned. Regardless of the shock, the effects are generally spread evenly in six countries, Benin, Burkina Faso, Mali, Niger, Senegal and Togo. In contrast, for two countries — Côte d'Ivoire and Guinea-Bissau — the impacts of shocks are country-specific.

As far as post-shock recoveries are concerned, the tests indicate that they are uniform for any shock in all WAEMU member countries, with the notable exception of the recovery period (P2) following the collapse of commodity prices, at the five per cent significance level. This finding is supported by the fact that the collapse in commodity prices from 1985 to 1992 was uneven across the commodities exported by these countries. As a result, some countries were able to recover faster than others. However, these results could connote that any monetary policy move implemented to jumpstart economies in the aftermath of a shock or crisis — for instance, an expansionary monetary policy — should achieve its goal and have uniform anticipated effects, all things being equal, for the entire zone.

Within five countries — Benin, Burkina Faso, Mali, Senegal and Togo — post shock recoveries remain uniform regardless of the shock, at the five per cent significance level. Yet, for Côte d'Ivoire, Guinea-Bissau and Niger, post-shock recoveries mostly depend upon the type of crisis experienced. This test carries interest for the authorities in these three countries, as their policy responses to a shock or crisis would need to be specific and targeted.

From this preliminary analysis, it is found that Union member countries differ more in terms of resistance to shocks than post-shock recovery. Nonetheless, a note of caution is warranted given the inherent limitations of SUR methods, which do not capture interactions between countries and over time. To overcome these shortcomings, and to further the understanding of economic resilience in the Union, a dynamic analysis is considered in the next section.

5.2 Dynamic analysis

All the results discussed below are reported in Figure 9 and Table 6.

• *Benin*

At the time of impact, an increase in the output gap occurs - which eventually disappears after the sixth year. The Beninese economy takes six years on the average to completely eliminate the effects of internal shocks. With respect to shocks from the rest of the WAEMU, it appears that this average time falls to five years.

In addition external, non-WAEMU, shocks are eliminated by the economy in about six years for shocks originating in Europe, the US and China. Variance decomposition functions (VDFs) also show that the bulk of fluctuations in the output gaps of Benin — 82 per cent in the short and long term — are explained by internal factors. Only nine per cent of these variations are explained by conditions or economic phenomena in other WAEMU countries. United States-based phenomena follow, accounting for about six and half per cent of fluctuations.

• *Burkina Faso*

On average, the economy of Burkina Faso fully absorbs the effects of internal shocks within four years. This is true also for intra-WAEMU shocks. Regarding non-WAEMU shocks, US-originated shocks are assimilated entirely after four years, whereas shocks from Europe and China require six years. Some effects still persist for the latter shocks, but they remain marginal throughout the period of analysis. This finding indicates that both European and Chinese shocks would have no notable and permanent effects on Burkina Faso.

The VDFs show that about 90 per cent of domestic conditions explain variations in output gaps within this country, while the WAEMU roughly accounts for five per cent.

• *Côte d'Ivoire*

For the largest economy in the Union, the impacts of internal shocks are contained within two years. This time span is shorter than all other countries in the Union except Togo. This period of containment rises to three years for intra-WAEMU shocks. The initial effects of shocks originating in Europe, the US and China, respectively, disappear within about four, five and one year(s). The effects of shocks from China are very low, even unnoticeable. Finally, VDFs show that almost all the fluctuations of Côte d'Ivoire's output gaps — 96 per cent— are generated by domestic factors. Economic conditions in the WAEMU account for barely two per cent of these fluctuations.

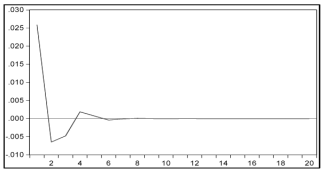
• *Guinea Bissau*

The brunt of intra-WAEMU shocks dies out within four years. US and Chinese external shocks are no longer perceptible after four years compared to five for European shocks. It is noteworthy that the effects of these shocks, however, remain very low. Similarly to other countries, VDFs in this country stress that most fluctuations — nearly 94 per cent — in output gaps are driven by internal shocks. Barely three per cent of fluctuations in output gaps, on average,

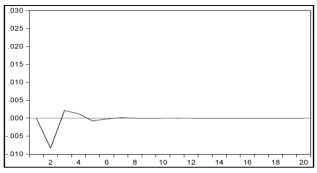
Figure 9: Impulse response functions

- Benin

Internal



Intra-WAEMU



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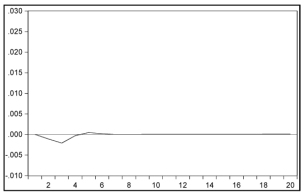

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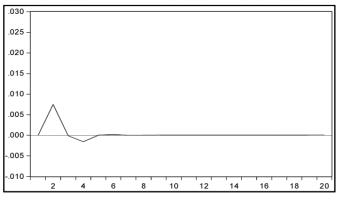

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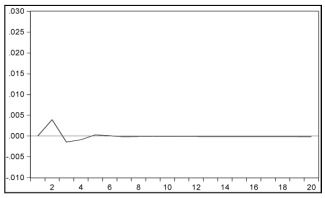

- Burkina Faso

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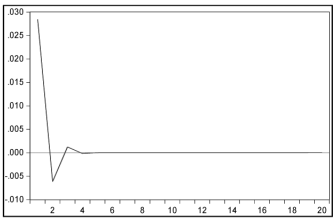

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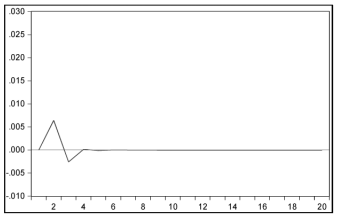

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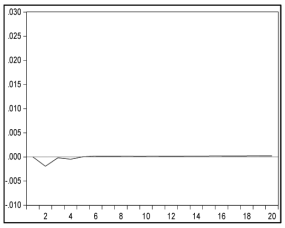

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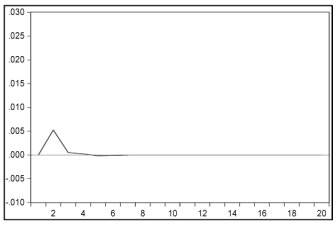

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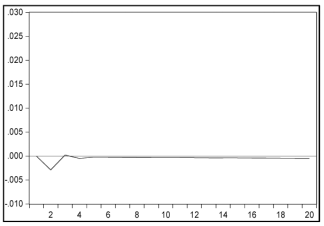

- Côte d'Ivoire

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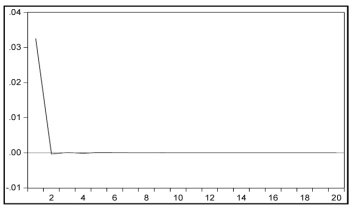

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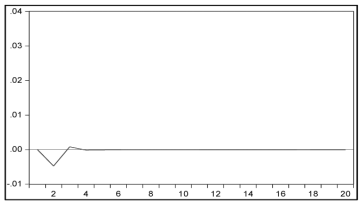

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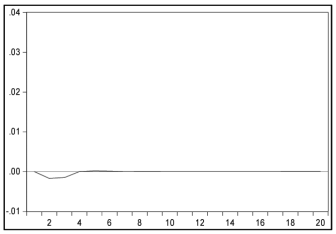

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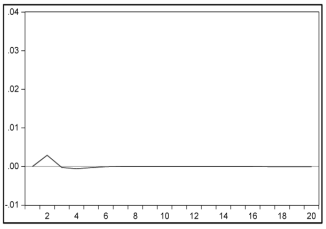

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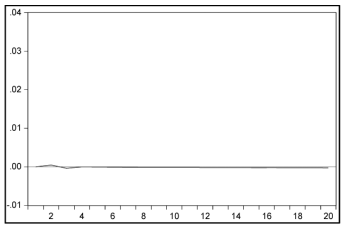

- Guinea-Bissau

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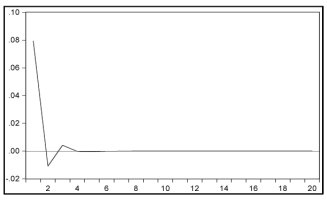

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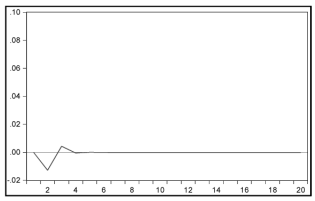

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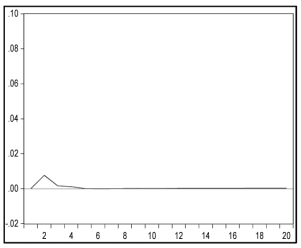

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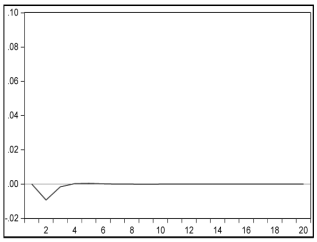

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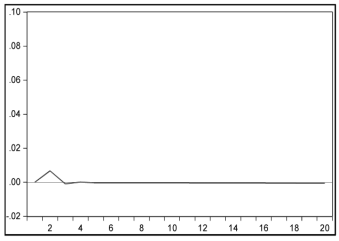

- Mali

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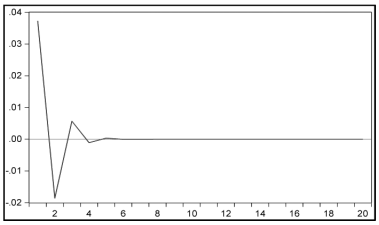

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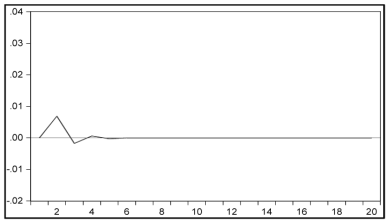

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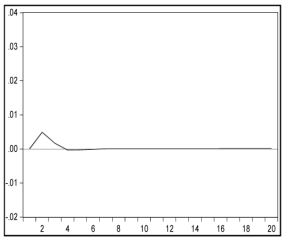

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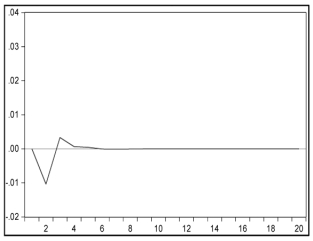

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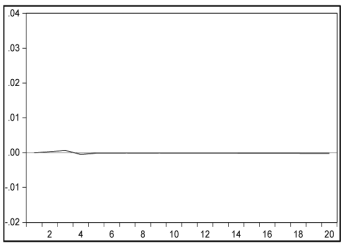

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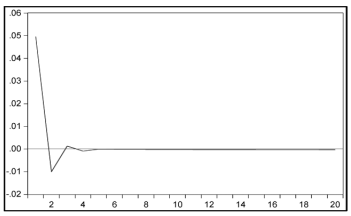

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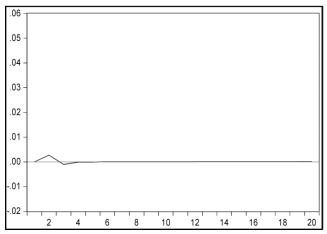

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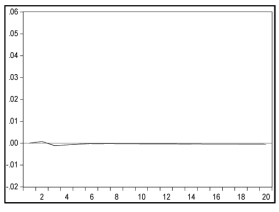

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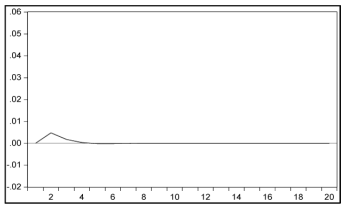

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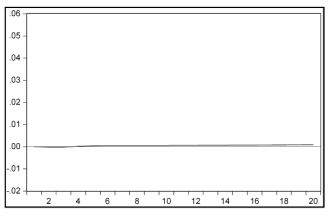
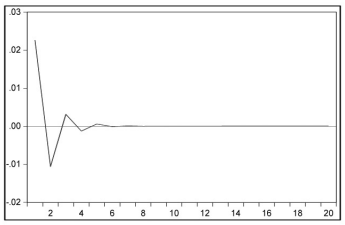
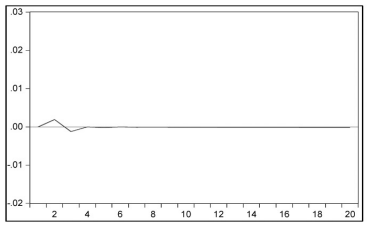


- Senegal

Internal

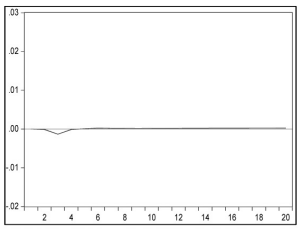


Intra-WAEMU



External

Europe



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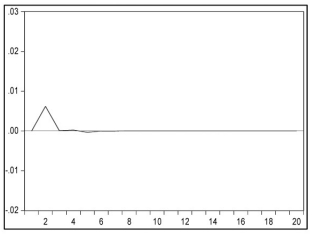
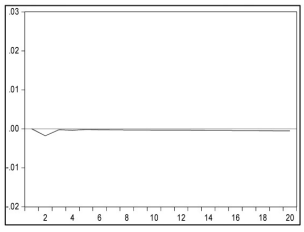
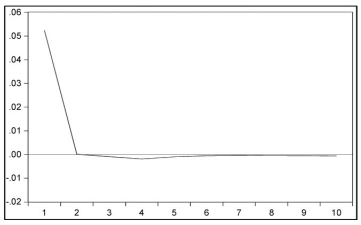


China

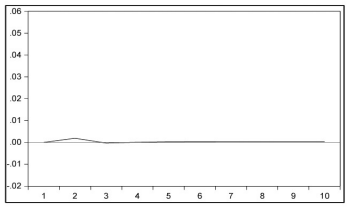


- Togo

Internal



Intra-WAEMU



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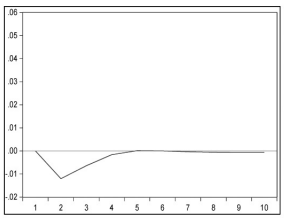
Europe



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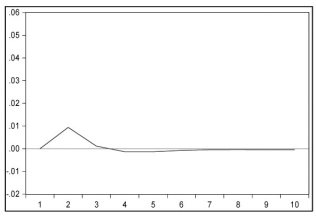

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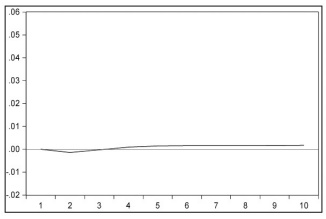
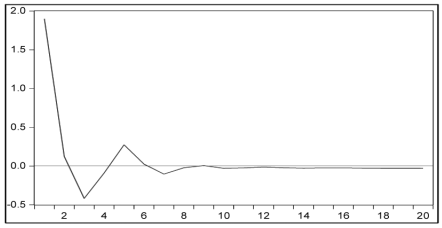


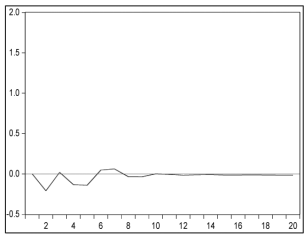
- WAEMU

Internal

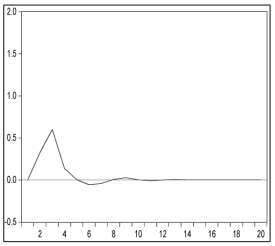


External

Europe



USA



China

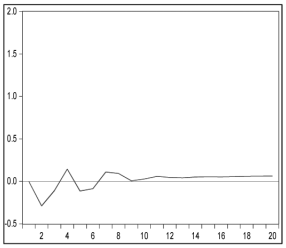
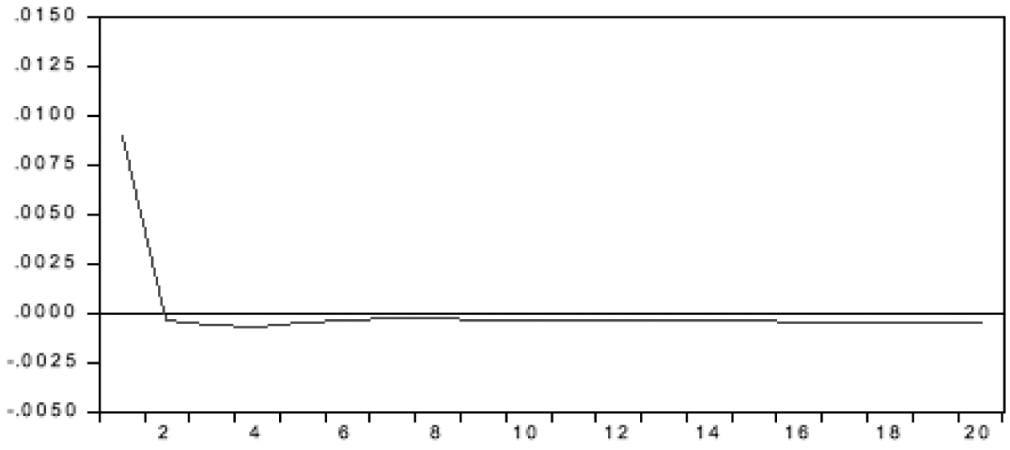


Figure 10: Impulse response function of the WAEMU to shocks from Côte d'Ivoire



are attributable to intra-WAEMU factors.

• *Mali*
Four years are necessary for the Malian economy to eliminate all the effects of domestic and intra-WAEMU shocks on its output gap. In addition, impacts of European and US shocks are curbed within four and five years, respectively, while shocks from China are almost imperceptible. According to the VDFs, about 70 per cent of the fluctuations in Mali's output gaps are caused by internal shocks. It appears that conditions in the WAEMU and Europe respectively account for 12 and eight per cent, on average, of total fluctuations in Mali's output gaps — over a time horizon of 15 years.

• *Niger*
Niger's economy requires at most three years to absorb the effects of both intra-WAEMU and internal shocks. Unlike other countries, except for Côte d'Ivoire, the economy negates these two types of shock at a faster pace. The impacts of European shocks are negligible and they vanish within two to three years. US shocks have comparatively greater impacts, but they are completely contained over four years. Chinese shocks meanwhile have no tangible effects on the economy. It must further be noted that a very high percentage of fluctuations — 98 per cent — in this country's output gaps is driven by internal shocks. This situation is unique in the WAEMU, and could suggest that Niger has very limited, if not the most limited, economic exposure to the rest of the Union in particular, and to the world in general.

• *Senegal*
It takes on average five years for the Senegalese economy to curb effectively its internal shocks. It takes, on the other hand, three years to contain fully the impacts of intra-WAEMU shocks. With external shocks, European, US and Chinese, this economy requires three, four and three years respectively to tackle their impacts. The VDFs indicate that approximately 92 per cent of fluctuations in the output gaps of Senegal are explained by internal shocks, followed by US-based shocks at an average of five per cent.

• *Togo*
The economy completes its correction of the effects of internal and intra-WAEMU shocks entirely within two years. However, the latter shocks remain negligible. European- and US-caused shocks are more impactful than Chinese. The impacts of European shocks are barely perceptible after five years, while US shocks vanish after four years. Chinese shocks are partially absorbed after three years, but they remain negligible throughout the period of analysis considered. Therefore, there exist permanent effects of European and Chinese shocks, though they remain minute. According to the VDFs, the internal situation in the country explains nearly 89 per cent of variations in output gaps.

• *WAEMU*
Intra-WAEMU shocks are totally phased out by the region's economy within eight years. Some impacts reappear in later years, but they remain marginal. As far as external shocks are concerned, those from Europe and the US dissipate after nine years, while those from China are negligible from the ninth year onwards. The VDFs show that about 83 per cent of fluctuations in the Union's output gaps can be explained by internal shocks. The US economy accounts for about ten per cent of these variations, compared to about two per cent for Europe.

• *Summary of results*
Considering these results, four key points can be highlighted. First, it appears that WAEMU countries are heavily dependent on their respective domestic economic conditions, which explain most of the fluctuations in their economies. On the other hand, intra-WAEMU shocks leave relatively small impacts on any individual member country's economy. This finding suggests that these countries are generally less dependent on, or responsive to, each other's economic conditions, making each country less vulnerable to internal developments in other member states in the medium and long terms. In the short term, the effects of intra-WAEMU shocks may be discernible, but they remain circumscribed in most instances. Further evidence of this finding is found through the typical case of Côte d'Ivoire, the largest economy, which accounts for about one-third of the Union's total output. This study has shown that the repeated and severe crises in this country have had little effect on the overall performance of the other seven members. Indeed, according to Figure 10, negative shocks from Côte d'Ivoire trigger only minor, although permanent, impacts on the other countries.

The results of this analysis give credence to the stylised fact that economic linkages among member states are limited, despite the existence of a monetary union that is more than five decades old. These limitations are apparent in a variety of studies pertaining to the WAEMU (Fe 2014 and Bah 2015, among others), evidenced by a low level of intra-regional trade, which is an excellent indicator of how economically close or intertwined a group of countries are in a particular region. Indeed, intra-regional trade has represented a mere 11.7 per cent of total Union trade, on average, since 1995 (Figure 6).

Second, WAEMU as a whole takes longer to absorb both internal and external shocks. Another point highlighted by these results is that most individual countries exhibit greater economic resilience than the Union. These could be indicative of the relative weakness of the convergence process among member states. For instance, Bah (2015) provides an illustration of this fact. It is known that structural differences across countries could explain such a weakness, which can be grounded in two main sources. First, there is the lack of a common fiscal policy, or the non-respect of common benchmarks for fiscal discipline, in member states. Second, a persistent dichotomy exists across markets for goods and services due, on the one hand, to differences among

states regarding the availability of adequate storage facilities and other transportation infrastructures to move harvests from production to distribution, or consumption, centres. Also, differences in tariff structures, especially effective tariff rates (see Figure 8), applied by each individual member might well be a factor. Indeed, it is meaningful because domestic markets for goods and services abound in consumer goods that primarily, are imported, given the small manufacturing bases in these developing countries.

Third, regarding external shocks, it is found that the European economy in particular, contrary to expectations, weakly impacts economies in the Union. This is also true for US and Chinese economic conditions.

Fourth, it appears that 'engineering resilience', as compared with 'ecological resilience' or 'adaptive resilience', most accurately characterises the type of economic resilience exhibited by WAEMU member countries (Martin 2012).

Overall, the results from the SVAR provide a wealth of information that can be used to develop two indices to push our understanding of economic resilience in WAEMU countries forward: (i) an index of resistance, and (ii) an index of recovery (post-shock).

5.3 Analysis of indexes

On the one hand, an examination of resistance indexes reveals that the countries which show the most resistance to internal shocks are Senegal and Benin. They are followed by Burkina Faso, Côte d'Ivoire and Mali in joint 3rd place. Niger is 6th, while Togo and Guinea-Bissau are respectively 7th and 8th in the Union.

For intra-WAEMU shocks, Togo boasts the best performance. It is followed by Niger and Senegal in 2nd position along with Côte d'Ivoire in 4th. Burkina Faso and Mali stand in 5th position, whereas Benin and Guinea-Bissau place 7th and 8th, respectively.

With respect to external shocks, Côte d'Ivoire takes the lead, followed by Burkina Faso, Niger and Senegal in 2nd position. Benin, Guinea-Bissau and Togo respectively rank 5th, 6th and 7th, with Mali in 8th (Figs. 11, 12 and 13).

Figure 11: Resistance indexes of WAEMU member countries (internal shocks)

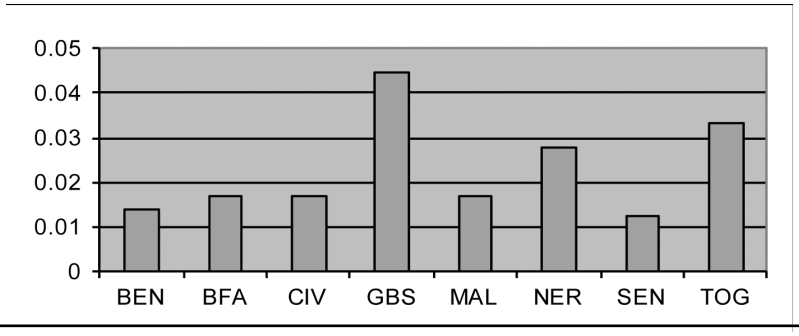


Figure 12: Resistance indexes of WAEMU member countries (intra-WAEMU shocks)

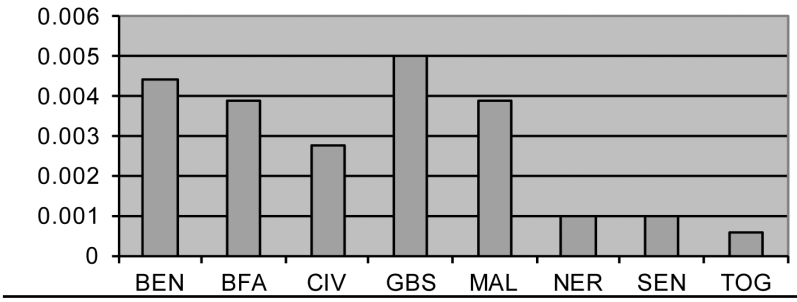
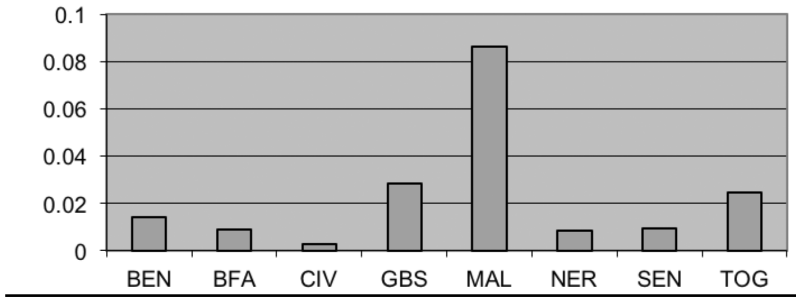


Figure 13: Resistance indexes of WAEMU member countries (external shocks)



On the other hand, recovery indexes expose that Côte d'Ivoire and Togo are the 'best students' of the Union as far as post-shock recovery is concerned after an internal shock. Niger follows in 3rd place. Mali, Burkina Faso and Guinea-Bissau enter in 4th place as Senegal and Benin emerge in 7th and 8th places, respectively. For intra-WAEMU shocks, Togo turns up on top of the list, followed by Côte d'Ivoire, Niger and Senegal in 2nd position. Burkina Faso, Guinea-Bissau and Mali hold in 5th place, while Benin wraps up the list in 8th place.

As far as non-WAEMU external shocks are concerned, Niger leads followed by Côte d'Ivoire, Mali, Senegal and Togo in 2nd position. Guinea-Bissau is in 6th position, while Benin and Burkina Faso are in 7th place (see Figs 14, 15 and 16).

Table 7 provides a summary of each state's performances in the light of the two economic resilience indexes. Interestingly, the dynamic analysis reveals that Union member countries differ more in terms of resistance than post-shock recovery: a finding initially inferred through the static analysis.[24]

Figure 14: Recovery Indexes for WAEMU Member Countries (Internal shocks)

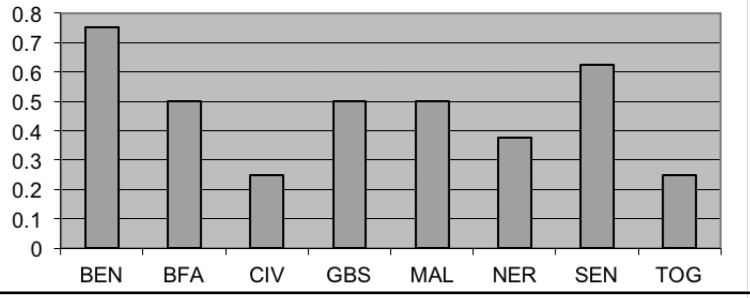


Figure 15: Recovery Indexes for WAEMU Member Countries (intra-WAEMU shocks)

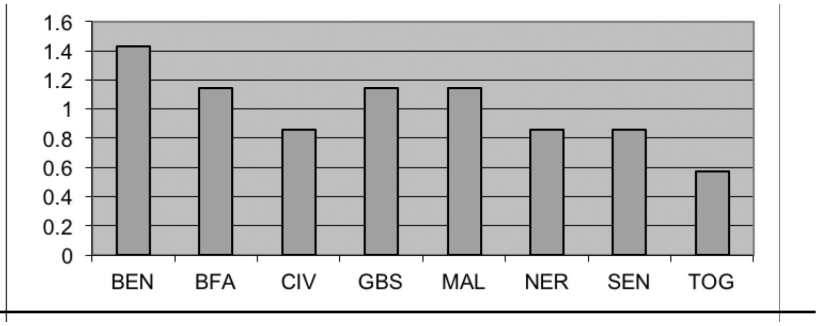
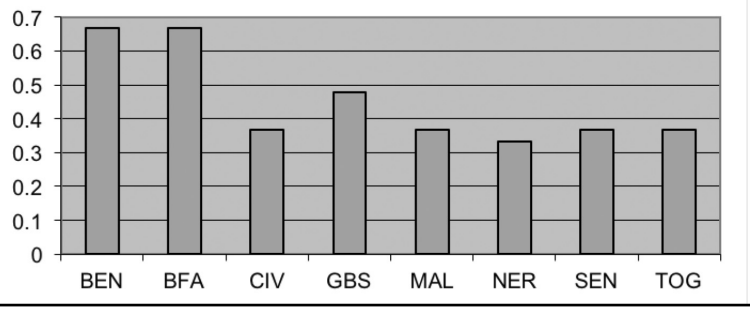


Figure 16: Recovery Indexes for WAEMU Member Countries (External shocks)



6. Conclusions and recommendations

This project has sought to examine the economic resilience of WAEMU countries in the aftermath of shocks. In this context, a comprehensive study was undertaken, on the one hand, by means of seemingly unrelated regression (SUR) and structural vector auto-regression (SVAR) models. Then, based upon the latter model's findings, two indexes — a resistance index and a recovery index — capturing two major features of the concept of economic resilience,

were constructed. Overall, the analysis has found varying degrees of resilience that show up at two levels: first, among the eight member countries of the Union, taken individually, and, second, between the Union as a whole and its members. Moreover, it has been shown that member states exhibit rather more dissimilarities in terms of resistance than post-shock recovery. These findings beg two questions: How can economic resilience in member countries and the Union be improved? How can decision-makers ensure that the level of economic resilience is uniform across countries, by reducing both structural and non-structural discrepancies? Any viable policy recommendation must address these pivotal aspects. A five-point course of action is proposed in that regard:

(i) create the conditions to accelerate the implementation and enforcement of the existing pact of convergence, stability, growth and solidarity, as it pertains to fiscal policy, in all eight member states. This will stimulate macroeconomic integration across the Union;

(ii) build, or improve, automatic stabilisers by strengthening, promoting and fostering the institution of operable social security nets, through unemployment benefits, financial assistance programmes etc. These safety-nets are known to be robust factors in boosting the resilience of a country in the aftermath of shocks, or during times of economic duress (Duval and Vogel 2008);

(iii) step up the development of both intra- and cross-state infrastructures (communication, telecommunication and energy) to mitigate the existing differences across domestic markets of goods and services. Cross-state communication and telecommunication infrastructures, in particular, remain largely underdeveloped or in poor condition despite years, even decades, spent under a single currency and an economic union. This situation acts as an important impediment and is known to sustain structural differences across these domestic markets even though there exist, in principle, a common tariff regime and a free trade agreement among member states. This also constitutes an obstacle to the expansion of intra-regional trade. The latter could serve as a powerful channel through which economic resilience would be both levelled across member states and enhanced for the Union as a whole;

(iv) boost the microeconomic efficiency of domestic markets by reducing persistent and sudden imbalances between the demand and supply of locally farmed perishable goods. This can be achieved through the expansion of storage facilities, along with modern irrigation technology to support the agricultural sector, which is still dominant in these economies. It will reduce the vulnerability of the supply chain due to weather-related shocks that are not uncommon in the region;

(v) prioritise further the development of a manufacturing base, which could initially be anchored in the transformation of agricultural and mining prod-

ucts into fully- or semi-processed goods. Public private partnerships (PPP), subsidies and/or internal funding through the issuance of national or domestic bonds, for instance, could be explored as financing options. Countries in Europe and Asia have used a combination of these measures to finance programmes deemed strategic and vital to their economic development. This move would propel economies up the value chain and reduce their high exposure to commodity price fluctuations, thereby increasing their resilience in times of economic turbulence (Aiginger 2009).[25]

Such a course, if diligently pursued, will strengthen economic resilience and make it more uniform across states and the Union. Increased uniformity in particular will ultimately enhance the effectiveness of monetary policy tools at the disposal of authorities in dealing with any type of shock, whether internal or external.

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APPENDIX

Table 1: Determination of coefficients b_{43}, b_{45}, b_{53} and b_{54} of matrix β_0

	Regressand	
Regressor	USA	CHN
EUR	1.442**	4.66*
CHN	0.303*	…
USA	…	3.234**

Table 2 - Summary statistics of real output

	BEN	*BFA*	*CIV*	*GBS*	*MAL*	*NER*
Mean	3277055854	3892825722	14929715154	531216930.4	3952540061	2953729040
Median	2935760725	3191476178	15104716696	545971135.4	3128950319	2519427238
Minimum	1560091487	1665688193	11771338853	311318674.8	2186373474	1922845667
Maximum	5926422058	8750081522	20134099589	708789572.3	7250559664	5324500182
Std Error	222323636.7	2040910052	388761123.4	18195426.16	289777615.1	147128764.1
Count	35	35	35	35	35	35

	SEN	*TOG*	*WAEMU*	*CHN*	*USA*	*EUR*
Mean	6685332059	1843982059	38066396879	1.51E+012	1.00E+013	8.49E+012
Median	5784977493	1761241862	35086462705	1.03E+012	9.70E+012	8.37E+012
Minimum	3964387195	1266988606	26058953184	2.01E+011	5.93E+012	5.90E+012
Maximum	11302627245	2873925198	62222946484	4.94E+012	1.46E+013	1.08E+013
Std Error	382273452.3	75046086.76	1834595317	2.32E+011	4.86E+011	2.87E+011
Count	35	35	35	35	35	35

Table 3: Unit root tests

ADF	*Constant*	*p-value*	*Constant and trend*	
LOG(RGDP)	-0.32	0.919	-1.486	0.833
RGDPGRW	-16.192	0	-16.171	0
PP				
	Constant	*p-value*	*Constant and trend*	
LOG(RGDP)	-0.355	0.911	-1.524	0.8199
RGDPGRW	-17.983	0	-17.974	0

Table 4[28]: SUR method coefficients

	BEN	*BFA*	*CIV*	*GBS*	*MAL*	*NER*	*SEN*	*TOG*
a_{0i}	3.607	5.67	0.451	-1.916	4.782	3.131	3.836	-3.481
a_{1i}	2.839	-2.299*	-10.233*	-22.972***	-4.355	2.603	-6.144	16.266
a_{2i}	-0.493	-1.56*	0.823**	5.575	-2.545	-1.044*	-1.462	5.159
a_{3i}	-3.664	-5.493	-4.722	-2.041	-3.085	1.437	-3.334	9.063
a_{4i}	2.641	0.915	-0.472	9.14	7.317	3.973	0.744	1.854
a_{5i}	-0.176***	1.543	0.564	3.103	-1.352	3.29	-0.062	0.6
a_{6i}	1.216*	-0.967*	1.571	10.166	-0.144	3.236	0.474*	5.734
a_{7i}	1.727*	4.007***	8.499	-5.672	-3.019	6.819	-0.857	-1.682
a_{8i}	0.336	-2.574	-1.176**	8.935	-4.753	-7.967	-1.003	1.792
a_{9i}	1.28	0.414	3.33*	10.793	-2.724	-0.606	-2.003	1.686
a_{10i}	0.798	0.724	1.753	-3.636	1.939	0.042	1.489	7.714*
a_{11i}	0.67	-0.106	-1.43*	-1.687	2.541	-0.592	-1.092*	2.95
a_{12i}	-0.133	0.275	-1.592**	1.164*	-1.7	-0.069	1.913	4.493
a_{13i}	-0.587	-1.238	0.364	3.031	0.571	-0.882	-1.535	5.884*
R-sq	0.138	0.279	0.669	0.454	0.334	0.422	0.348	0.496

*: denotes significance at the 10% level;**: denotes significance at the 5% level;
***: denotes significance at the 1% level.

Table 5 - Tests for restrictions on SUR model

Case i

Shocks	1	2	3	4	5	6	7
Test Stat.	119.845	10.6	24.209	8.177	1.245	12.108	24.568
P-value	0	0.157	0.001	0.317	0.99	0.097	0.001

Case ii

Country	*BEN*	*BFA*	*CIV*	*GBS*	*MAL*	*NER*	*SEN*	*TOG*
Test Stat.	4.409	6.226	35.368	17.561	6.075	4.607	6.032	10.487
P-value	0.622	0.399	0	0.007	0.415	0.595	0.42	0.106

Case iii

Post-shock periods	P1	P2	P3	P4	P5	P6
Test Stat.	13.42	19.155	13.137	2.597	8.505	4.35
P-value	0.062	0.008	0.069	0.92	0.29	0.739

Case iv

Country	*BEN*	*BFA*	*CIV*	*GBS*	*MAL*	*NER*	*SEN*	*TOG*
Test Stat.	1.376	3.817	19.179	11.932	6.007	11.01	4.465	4.615
P-value	0.927	0.576	0.002	0.036	0.305	0.051	0.485	0.465

Table 6 - Variance decomposition functions (in %)

*: WAEMU, excluding the country of interest

Period	*BEN*	*WAEMU**	*EUROPE*	*USA*	*CHINA*
2	83.26500	8.197812	0.139487	6.563132	1.834574
10	82.19884	8.541852	0.658774	6.519347	2.081183
15	82.19234	8.541192	0.659796	6.519182	2.087495

Period	*BFA*	*WAEMU**	*EUROPE*	*USA*	*CHINA*
2	91.25339	4.449208	0.408655	2.989118	0.899630
10	90.47333	5.123567	0.444709	2.994045	0.964346
15	90.40157	5.120243	0.459921	2.991640	1.026621

Period	*CIV*	*WAEMU**	*EUROPE*	*USA*	*CHINA*
2	96.89474	2.063435	0.256918	0.765728	0.019181
10	96.56231	2.121616	0.462840	0.809463	0.043767
15	96.54192	2.123296	0.463987	0.809325	0.061477

Period	*GBS*	*WAEMU**	*EUROPE*	*USA*	*CHINA*
2	94.78898	2.410843	0.872479	1.259349	0.668354
10	94.40750	2.677807	0.931410	1.292494	0.690790
15	94.38778	2.677889	0.935472	1.292226	0.706636

cont.....

Period	*MAL*	*WAEMU**	*EUROPE*	*USA*	*CHINA*
2	90.68374	2.469666	1.255542	5.587292	0.003764
10	89.96985	2.579922	1.374609	6.034273	0.041345
15	89.96349	2.579887	1.375802	6.033847	0.046974

Period	*NER*	*WAEMU**	*EUROPE*	*USA*	*CHINA*
2	98.79944	0.294345	0.023144	0.881365	0.001701
10	98.47924	0.334905	0.114984	1.004267	0.066601
15	98.37552	0.336957	0.147178	1.003108	0.137242

Period	*SEN*	*WAEMU**	*EUROPE*	*USA*	*CHINA*
2	93.27108	0.545539	0.002180	5.697322	0.483874
10	92.79512	0.760479	0.284642	5.588001	0.571763
15	92.66993	0.766811	0.309228	5.580459	0.673573

Period	*TOG*	*WAEMU**	*EUROPE*	*USA*	*CHINA*
2	92.00872	0.115633	4.838775	2.974735	0.062141
10	89.94868	0.149800	6.197029	3.094506	0.609981
15	89.21005	0.194130	6.226308	3.118571	1.250936

Period	*WAEMU*	…	*EUROPE*	*USA*	*CHINA*
2	93.91830	…	1.132743	2.792644	2.156316
10	83.98854	…	1.941015	10.66679	3.403655
15	83.74358	…	1.948569	10.63032	3.677533

Table 7 - Economic resilience: Summary of countries' rankings by index

	Resistance index			*Recovery index*		
	Internal	*Intra-WAEMU*	*External*	*Internal*	*Intra-WAEMU*	*External*
BEN	2	7	5	8	8	7
BFA	3	5	2	4	5	7
CIV	3	4	1	1	2	2
GBS	8	8	6	4	5	6
MAL	3	5	8	4	5	2
NER	6	2	2	3	2	1
SEN	1	2	2	7	2	2
TOG	7	1	7	1	1	2

ENDNOTES

1. Department of Economics, Eastern Illinois University, Charleston, IL, USA. Email: aadom@eiu.edu. The author is thankful for all the valuable comments received in the making of this project. All other insufficiencies solely remain his.

2. For the vulnerability index, see Briguglio (1995) and Cordina (2004).

3. Boschma (2014) also conducts a survey and provides an evolutionary perspective in understanding the concept of resilience.

4. See for instance, Kożluk and Mehrotra (2009), Erjavec *et al* (2012), *Stan du Plessis et al* (2008) and Ziaei (2013).

5. Côte d'Ivoire, Dahomey (now Benin), The Upper Volta (now Burkina Faso), Mali, Mauritania, Niger and Senegal.

6. Mali and Mauritania, two founding members, left the Union in 1962 and 1973, respectively. Togo joined in 1963, and Mali returned in 1984.

7. An eventual merger of these two treaties is expected.

8. Fe (2014) also underlines the lack of conclusive evidence in the literature establishing the existence of convergence among WAEMU member countries. Further, he finds evidence that the Union has not had any significant effects in enhancing economic development of member countries.

9. It should be noted as well that all of these countries, excepting Guinea-Bissau, shared a common experience with colonialism under the former French West Africa (AOF) administration and jurisdiction. Despite the vast array of circumstantial evidence that could possibly justify this working hypothesis, our scientific approach requires that it be probed formally. Overall, with a few exceptions, relatively high correlations are detected among error terms using the least squares method. Results are available upon request from the author.

10. I is the identity matrix, and (σ..) stands for either variance or covariance, as dictated by subscripts.

11. With eight countries in the system, $i = 1, 2,..., 8$, and t represents the year, $t = 1979 = 1$, $1980 = 2,..., 2013 = 35$.

12. It can be shown that $plim_{T\to\infty}\hat{\sigma}_{ij} = \sigma_{ij}$.

13. See Zellner (1962), Takada *et al* (1995), Moon and Perron (2006) for further discussions.

14. On the one hand, resistance of a country or group of countries is proxied by the volatility in output gap following a shock. On the other hand, post-shock recovery is captured by the time it takes in years for that country or group of countries to revert to potential output afterwards.

15. Among others, the effects of currency on production (Sims and Zha 2006), the impact of demand and supply shocks on the cycle of economic activities (Blanchard and Quah 1989), the effects of fiscal policy (Blanchard and Perotti 2002), the link

between technology and labour hours (Galí 1999).

16. This study considers $\lambda = 100$, as suggested in the literature, to accommodate annual frequency series (Backus *et al* 1992, and Eviews® 8.1 User's Guide I, p 464, equation 11.90, (2014)).

17. See Konuki (2010) for further discussion. To mitigate even further these endpoint biases, an ad hoc remedy is introduced by considering three additional years at either end of the dataset. Then, only the results covering the actual data period (1979-2013) are extracted and reported.

18. Methods for determining restrictions as developed by Blanchard and Quah (1989) and Clarida and Gali (1994) are less practical in this case.

19. For the Union as a unit, internal and intra-WAEMU shocks are the same.

20. In a couple of isolated cases, not past the second year.

21. The summary reported includes the main variable used in this study — real output at constant 2005 USD. For space and conciseness considerations, other variables, namely, the 13 dummies along with the computed potential real output, have not been reported.

22. Three precautions are taken to ensure robustness of our results: First, to control for potential biases due to country sizes, relative values of output gaps are used. Second, appropriate lags are determined using both AIC and BIC tests, suggesting one lag for all eight countries and the Union. Third, Chow (1960) tests were conducted to assess the structural integrity of our sample, especially in the 1990s because of the FCFA devaluation in 1994, the expansion of the Union with the entry of Guinea-Bissau in 1997, and the introduction in 1999 of the euro, to which the FCFA is pegged via the French Franc. No structural breaks were detected in the time series. These results are not reported in the Appendix for conciseness, but are available upon request from the author.

23. From 1995 to 2014, intra-regional trade as a fraction of the Union's total trade reached its peak in 2003, at 13.16 per cent.

24. The coefficients of variation of both the resistance and recovery indexes are respectively 1.17 and 0.50. These statistics confirm that relative dispersions, after accounting for differences in scale, are more pronounced for resistance than recovery.

25. Aiginger (2009) also provides a broader discussion into how to strengthen the resilience of an economy.

26. Normality and stability tests indicate robust coefficients.

27. H0: Presence of unit root.

28.Zellner's approach accounts for potential heterogeneity and contemporaneous correlation problems with error terms.

29. Author’s calculations using constant 2005 USD.

30.Columns mark major shocks experienced in the region over the study period.

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