

EXTERNAL SHOCKS AND MONETARY POLICY EFFECTIVENESS: A REVIEW OF EXTANT METHODOLOGIES

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This study reviews the extant methodologies in research focusing on the nexus between external shocks and monetary policy effectiveness. It is premised on the argument that the adopted methodology to examine the empirical validity and plausibility of estimated models is fundamental in monetary policy effectiveness in the light of external shocks. Hence, the choice of the methodological approach translates the effectiveness of corresponding monetary policy rules and institutions. It is established in the review that the extant literature converges on a set of methodological underpinnings that are relevant in assessing the effects of external shocks on monetary policy effectiveness. Such convergence is documented in this study by assessing country-specific and panel-oriented studies focusing on non-WAEMU (West African Economic and Monetary Union) countries, especially in terms of information criteria motivating the choice of extant methodologies.

Keywords: Methodology; External Shocks; Monetary Policy

JEL Classification: C10; C50; F15; F36; F42; O55

1. INTRODUCTION

The last three decades have been characterized by a growing interest in quantitative research techniques in many economic fields including models of general equilibrium in the business cycle (Christiano et al., 1999, 2005; Cooley and Hansen, 2021). This tendency articulates the relevance of debates in monetary policy, especially as it pertains to the robustness of corresponding methodologies in view of monetary policy effectiveness. Accordingly, while it is obvious that statistical methods are important in assessing the responsiveness of monetary policy to external shocks, understanding how the literature has evolved in the corresponding methods is worthwhile in order to provide both scholars and policy makers with perspectives on the convergence in empirical approaches as well as divergences that have been apparent. In view of the fact that each estimation technique is associated with specific information criteria for its adoption,

each estimation approach is also linked to specific policy implications that are associated with such methodologies.

The premise of this study is also motivated by a scholarly gap in the literature. To the best of knowledge, the closest research to the inquiry is Christiano et al. (1999) which more than two decades ago provided insights into what scholars had learned from decades of monetary policy shocks. The present study improves this strand of literature from two main angles: on the one hand, the study by Christiano et al. (1999) is more than two decades old and hence, the methods have evolved over time and by extension, it is important to provide scholars and policy makers with more contemporary insights. On the other hand, the underlying study largely focuses on monetary policy pertaining to developed economies. Given that most developing countries prior to 1999 were not equipped with instruments of monetary policy effectiveness, it is also relevant to take stock of how the literature has evolved in developing countries. This study fills this gap by focusing on a specific region of African countries or non-UEMOA countries. To put this argument in perspective, Weeks (2010), Asongu (2014) and Sedegah and Odhiambo (2021) have argued that a standard approach to the effectiveness of monetary policy is not appropriate in most countries in sub-Saharan Africa due to the absence of mainstream monetary policy instruments for such effectiveness. The authors have posited that two principal mechanisms by which monetary policy is implemented have been lacking in countries in the sub-region, namely: (i) instruments by which the borrowing rates are affected by the private sector through the adjustment of interest rates at which central banks lend to commercial banks and (ii) the effectiveness of influencing private credit by means of open market operations. It follows from the underlying substantiation that the relevance of Christiano et al. (1999), is not only non-contemporary, but particularly has limited implications for African countries.

Beyond the limited geographical relevance and non-contemporary feature of Christiano et al. (1999), there is also a statistical element that argues in favor of a contemporary review of corresponding methodologies with specific emphasis on less developed countries. The application of VAR models require data with rich time series properties and given that such data were not reliably apparent more than two decades ago for African countries, the statistical premise on which monetary policy was conducted is also likely to be less reliable. As has been argued in the literature (Jerven, 2015), data on Africa was less reliable two decades ago and according to Giannakouros and Chen (2018), updated data is fundamental for better scholarly and policy communication in social science.

The rest of the study is structured as follows. Section 2 presents the VAR methodology while Section 3 discusses the extant empirical literature with respect to non-WAEMU -centric studies. Section 4 concludes.

2. THE VAR METHODOLOGY

Consistent with contemporary literature (Oladunni, 2020), VAR models have been established to elucidate dependencies and provide forecast among variables. The author documents that VAR models have been employed in most contemporary and non-contemporary studies on the importance of monetary policy in the macroeconomic framework (Christiano et al., 1999; Canova, 2011; Cooley and Hansen, 2021). The narrative maintains that VAR models enable macroeconomic data to adjust robustly in order to capture dynamic incidences of both responses and shocks within a specific framework of variables. Generally, a specification of VAR type calls for each variable to be clarified as a driver of its previous observations or lagged value as well as previous observations of other variables within the system. Other relevant outputs underpinning VAR estimations include; historical decompositions, variance error decomposition and impulse response functions. In the underlying literature, a VAR (p) process is of the following form in Equation (1):

$$y_t = Ay_{t-1} + e_t, \quad t = 1, \dots, T, \quad (1)$$

where y_t is $(n \times 1)$ endogenous variables' in the model; A_i reflects $(n \times n)$ coefficient matrices for, $i = 1, \dots, p$; and e_t denotes $(n \times 1)$ vector of a white noise process that is unobservable with and $E(e_t) = 0$, constant and covariance matrix that is positive-definite of the form $E(e_t e_t^l) = cov(e_t) = \Omega_e$. The underlying errors denoted e_t , while characterized by zero auto-correlation, could also be characterized by cross-equation correlations. It is worthwhile to emphasize that such a possibility of correlation across equations could diminish how plausible valid economic intuitions could be extracted from VAR models that are of reduced form.

It is also imperative to clarify that in spite of the popularity that VAR models command, they are exclusively statistical and hence, for economic inferences of meaningful nature to be derived from the corresponding VAR estimates, economic structures that are plausible are traditionally imposed on the VAR system that is unrestricted. Hence, from a practical perspective, identifying the given VAR structure related to the reduced VAR form is necessary in order to take into account some underpinnings of economic theory that are worthwhile to motivate policy analysis (Oladunni, 2020; Wolf, 2020).

2.1. Reduced Form VAR from Structural VAR

Within a framework of a VAR that is unrestricted, exclusively variables that are predetermined are specified in Equation (2) on the right-hand side (RHS) while contemporaneous interactions among variables are allowed within the framework of structural VAR (Oladunni, 2020; Wolf, 2020). Generally, a structural VAR model that is stationary of order 1 can be expressed as the following matrix in Equation (2):

$$\beta_0 y_t = \beta_i y_{t-i} + \varepsilon_t, \quad t = 1, \dots, T. \quad (2)$$

The contemporaneous effect matrix is β_0 which provides a summary on the interactions of instantaneous nature among variables while β_i denotes $(n \times n)$ a matrix of coefficients dynamics of the model. While the first characteristic provides a distinction between the unrestricted and the structural VAR beyond the effect matrix β_0 , the second reflects a substitution of the residual or errors that are in reduced form with e_t by an $(n \times 1)$ vector of shocks that are structural or zero mean processes of white noise ε_t . The corresponding property guarantees that e_t are not serially correlated and mutually independent such that, the co-covariance matrix Ω_e normalizes to I. Orthogonalization is necessary to ensure that ε_t shocks are both structurally true and distinct from the residuals of reduced form e_t . The process of orthogonalization enables that shocks of structural nature are uncorrelated mutually. The related matrix of co-variance represents an identity matrix showing that shocks of structural nature are not correlated.

Given the above, an economic interpretation can be provided to ε_t . In an original model, the relevance of structural VAR (SVAR) is mostly in pinning-down and identifying shocks in the process of examining the impact of structural innovations on outcome variables. Accordingly, the SVAR model is employed to connect unobserved innovations from structural reforms to residuals that are observable in the classical VAR. It therefore enables a connection between theory and data. With the help of complementary instruments (i.e. impulse response functions, historical variance decompositions and forecast error variance decomposition), the SVAR method is useful in identifying shocks as well as establishing the propagation of underlying shocks. Most often, the structural model representation is premised on underpinnings which build on prior beliefs and economic theory. It has been observed in the literature that errors of reduced form (e_t) are often weighted mean values from structural shocks (ε_t) (Kilian, 2013). Moreover, all reduced form model parameters can be estimated using the ordinary least squares (OLS) technique on an equation by equation basis. This also applies to the computation of the co-covariance matrix Ω_e .

It is worthwhile to note that the model in Equation (2) is unidentified. For identification to be achieved, the corresponding inverse of β_0 (i.e. contemporaneous effect matrix) is used to multiply that equation (i.e. β_0^{-1}), as presented below in Equation (3).

$$\beta_0^{-1}\beta_0 y_t = \beta_0^{-1}y_{t-i} + \beta_0^{-1}\varepsilon_t. \quad (3)$$

This underlying generates Equation (4):

$$y_t = \beta_0^{-1}\beta_i y_{t-i} + \beta_0^{-1}\varepsilon_t. \quad (4)$$

The reduced form expression of VAR in Equation (1) is equivalent to Equation (4) where

$$A_i = \beta_0^{-1} \beta_i, \quad i = 1, \dots, p,$$

$$e_t = \beta_0^{-1} \varepsilon_t,$$

$$\text{and } \text{Cov}(e_t) = \Omega_e.$$

The variance of the errors that are in reduced form e_t can be presented as follows in Equation (5):

$$E(e_t e_t^l) = \beta_0^{-1} E(\varepsilon_t \varepsilon_t^l) \beta_0^{-1^l} = \Omega_e. \quad (5)$$

The underlying can also be written in Equation (6) as:

$$\Omega_e = \beta_0^{-1} \Omega_e \beta_0^{-1^l} = \beta_0^{-1} I \beta_0^{-1^l} = \beta_0^{-1} \beta_0^{-1^l}. \quad (6)$$

Equation (6) can be employed to obtain elements of the unknown parameter in β_0^{-1} .

In addressing $\Omega_e = \beta_0^{-1} \Omega_e \beta_0^{-1^l}$, there is a concern of the a certain number of parameters that are unknown in the VAR that is structural, more than the parameters that are known from the equation of reduced form. The disclosed condition for addressing β_0^{-1} is that the corresponding parameters that are unknown in β_0^{-1} are supposed to be above the corresponding number of equations in the system. If this rule is violated, an issue of under-identification emerges which can be addressed by involving additional identifying restrictions; this according to Kilian (2013) can be realized via proportionality restrictions, exclusion restrictions or other restrictions of equality.

A procedure that is popular consists of arriving at the targeted restrictions by equating some elements of β_0^{-1} to zero, which is also considered as exclusion restrictions. Accordingly, as posited by Lütkepohl (2013), not all variables are allowed to impact other variables contemporaneously. According to Kilian (2013), should the number of free parameters underpinning Ω_e be disclosed as $N(N+1)/2$, the minimum number of parameters that are restricted in β_0^{-1} would results in a unique identification of the type $N(N+1)/2$. The parameters that are of reduced form are contingent on data properties and hence, measures towards providing structural parameters of data property would engender indeterminacy if, an identifying restriction that is appropriate is established (Bjornland and Thorsrud, 2015).

2.2. Zero Restrictions in the Short-run

Zero restrictions in the short-run are premised on the Cholesky decomposition that supposes the existence of a structure that is recursive. In order to identify shocks, while zero(s) are assigned to all spaces in the upper part of the triangular matrix, one(s) are assigned to the corresponding elements in the main diagonal. The β_0^{-1} matrix is thus orthogonalized and via Ω_e can be equated to the matrix of error co-variance. The

technique of Cholesky decomposition is employed to implement restrictions in the short-run which reveal shocks of structural nature by providing an order of the variables in the system in such a way as to enable variables that are most exogenous to be first apparent. The procedure of ordering is essential in constraining how specific variables respond in the period immediately following a shock or an innovation. Within this remit, ε_t structural shocks can be employed to restore the lower triangular matrix which enables the exact identification of all parameters.

According to Popescu (2014), in spite of the usefulness of the underlying, the procedure that is recursive is flawed in the light of the underlying shock identification of the Cholesky orthogonalisation which is rigid. Moreover, as argued by Kilian (2013), orthogonalizing reduced-form residuals via the procedure of Cholesky decomposition is worthwhile on the condition that economic justifications motivating the recursive procedure are apparent; without which, a simple mechanical resolution will be produced in the absence of a theoretical content. Some examples of fundamental studies which have popularized the applications scheme relevant to recursive identification in the estimation of channels of monetary policy transmission include Christiano et al. (1999), Bernanke and Blinder (1992) and Sims (1980).

2.3. Zero Restrictions in the Long-run

Zero restrictions in the long run is an alternative to the narrative in the preceding section such that, if restrictions of the long term are used to constraint the VAR system, the corresponding impulse responses are tailored to mirror values that are in accordance with economic rationale. Within this framework, the response that is accumulated for a specific variable in relation to a shock is designed for zero to be added to the entire analytical period. A case in point is Blanchard and Quah (1989) who within the remit of bi-variate unemployment rate and output growth VAR model, suppose that in the long-run, the incidence on output growth from demand shock is zero. While restrictions in the long term have been relevant to authors favoring research underpinned by economic theory, measurement errors and small sample biases nonetheless affect the robustness of such estimations (Peersman, 2005). Accordingly, as argued by Faust and Leeper (1997), it is difficult to accurately predict impulse responses functions when horizons are long and by extension, infinite in the presence of data constraints. Alternatively, in the presence of a non-recursive scheme of identification, the corresponding Cholesky decomposition is not as rigid and it is possible to impose restrictions without more liberty in accordance with theoretical propositions. In this vein, more flexibility is apparent to provide a worthwhile economic theory to the estimation and this also represents an opportunity to provide more exploration of inter-dependencies that are apparent among variables. It is nonetheless worthwhile to note that this approach has also been criticized owing to disparities in the identification of restrictions.

2.4. Restrictions in Sign

As documented in the literature (Oladunni, 2020), the premise of restrictions in signs procedure as an alternative way for identification in structural VAR is largely to the credit works from authors such as Uhlig (2005), Canova and De Nicrolo (2002) and Faust (1998). Accordingly, by restricting the shape and/or sign of structural responses, these authors are able to achieve identification. Contrary to the SVAR procedure, it is not required for zero restrictions to be imposed on an impact matrix that is contemporaneous. The system is tailored to identify a number of impulse responses that are consistent with theory-oriented sign expectations. Contrary to the non-recursive and recursive methods used in the identification of VAR that are usually object of criticism owing to concerns surrounding the validity of corresponding restrictions, the theoretical focus of SVAR is strong since anticipations that are *a priori*, are for the most part, obtained from outputs of robust dynamic stochastic general equilibrium (DSGE) model(s).

As documented in Jaaskela and Smith (2011), it is worthwhile to highlight that restrictions are imposed on the sign related to the impulse responses in order to constraint its direction for a specific period in response to specified innovations of different nature. Moreover, it is posited by Fry and Pagan (2011) that restrictions in sign identification are specifically relevant in scenarios where variables are determined simultaneously owing to causality that is bi-directional and hence, other identifying restriction procedures cannot be easily employed. Accordingly, theoretical DSGE models validate identification restrictions with sign restrictions. Moreover, situations of puzzles (e.g. price puzzle, liquidity puzzle, inter *alia*) in scholarship, make room for the suspicion that in the extant literature, shocks may not have been effectively identified as really exogenous. Hence, tackling the puzzles require that proper signs on impulse responses should be imposed (Kim, 2013). In models that are restricted using signs, the identification process requires that each shock is linked to a specific sign tendency. There is a growing stream of macroeconomic literature on the employment of sign restrictions in VAR estimations (Canova and De Nicrolo, 2002; Canova, 2011; Dedola and Neri, 2007; Scholl and Uhlig, 2008; Mountford and Uhlig, 2009; Pappa, 2009; Kilian and Murphy, 2012; Baumeister and Peersman, 2013; Fujita, 2018).

A fundamental shortcoming of SVAR that is restricted in sign is that there is no implication in unique identification given that specific sign restrictions that are imposed could be addressed by a plethora of impulse responses. According to Fry and Pagan (2011), when a specific restriction is compatible with a set of impulse responses, finding an exact identification is almost an impossible task. This is consistent with the position of Kilian (2013) in that, with sign restriction the impulse response functions of structural nature are not associated with a specific point estimate and by extension, VAR models that are sign identified are equally identified in set. It is the consequence of sign restriction features which are perceived as inequality restrictions. Hence, there is an apparent issue of identifying the particular impulse response function which captures underlying information efficiently (Lanne and Luoto, 2021).

2.5. GMM in Reduced Form and Structural Form

Consistent with Lanne and Luoto (2021), a plethora of approaches have been suggested in order to enable the statistical identification in SVAR models in the theoretical and empirical literature. Accordingly, a strand of the corresponding literature leverages on the fact that some errors that are non-Gaussian may be apparent as structural breaks in the corresponding covariance matrix and conditional heteroscedasticity (Kilian and Lutkepohl, 2017). In the light of the non-Gaussian nature, related SVAR model parameters are identified statistically and seldom are an economic interpretation provided with the identification. According to Lanne and Luoto (2021), alternative identification frameworks that are contrasting become apparent in testing and identifying models. Accordingly, economic limitations that are not rejected can also be appropriately employed in empirical analysis. Identification of statistical nature could also be merged with economic data, especially as it pertains to impacts and signs of shocks related to an economic model that is implied, in view of easing economic interpretation (Lanne and Luoto, 2016).

Building on the existing literature, Lanne and Luoto (2021) have proposed a GMM approach based on the SVAR technique, with moment conditions that are revealing of when a model is characterized by non-Gaussian error terms. The proposition is broadly consistent with the procedure of estimation found in independent component analysis using fourth moments. The authors argue that the literature is limited to data that are distributed identically and independently. Furthermore, such processes are largely apparent in estimators as opposed to being perceived as algorithms, with their statistical properties largely remaining unknown. According to the authors, the closest to the proposed GMM estimators in the empirical literature are the maximum likelihood (ML) estimators proposed by Lanne, Meitz, and Saikkonen (2017) which have been extended to pseudo ML (PML) estimators by Gouriéroux, Monfort and Renne (2017). The proposed GMM estimator is linked to the estimator of Herwartz (2015).

According to Lanne and Luoto (2021), there is a plethora of advantages when compared with previous studies. The most notable of these being that they depart from previous studies (Herwartz, 2015; Lanne et al., 2017; Gouriéroux et al., 2017) which assume that structural errors are mutually independent. As has been argued by Kilian and Lutkepohl (2017), such an assumption of independence could be problematic and misleading given that linear transformations are not necessarily linked to independent errors in a VAR model that is of reduced form. Hence, following Bekaert, Engstrom and Ermolov (2017), Lanne and Luoto (2021) do not impose the underlying independence.

Boer and Lütkepohl (2020) have also contributed to the extant literature by proxying VAR models and making a proposal on an easy-to-construct variable. According to the authors, it is fundamental to construct a valid instrument that is relevant for assessing the initial shock responses in an analysis based on VAR proxy. For the VAR estimates to be precised, a proxy should be robust, especially as it relates to the proxy correlating adequately with the structural shock and at the same time not correlated with the

remaining shocks. Given that such a proxy variable cannot easily be found in real life, Boer and Lütkepohl (2020) propose the construction of a proxy for which ± 1 is assigned to special events linked to the occurrence of shocks. Hence, when constructing a proxy, knowledge of the direction and timing of the corresponding shocks is relevant.

Boer and Lütkepohl (2020) have contributed to the literature by employing a simulation to show that adopting the underlying sign-proxy approach leads to estimates and effects that are comparatively efficient as more traditional sophisticated approaches. According to the estimates, a reasonable precise estimator can be apparent even for errors of occasional nature that are apparent when signs are being assigned to shocks. Furthermore, it is pointed-out that moment conditions that are implied by the variable of proxy could be accompanied by moment conditions owing to possible variations from events that are special.

The underlying study maintains that moment conditions that are combined can be employed in GMM estimation for the shock effects. Whereas the attendant GMM estimator cannot enhance the precision of the estimation in some simulations, merit could be apparent if the GMM target can be reduced with reliability that is judged as sufficient. Regardless of the scenario, the sign-proxy can be substantially more robust in precision compared to the estimators that are motivated by volatile variations that are prompted by special events.

Boer and Lütkepohl (2020) provide the rewards of employing the sign-proxy by assessing the effect of shocks in monetary policy on interest rates in the long run when zero policy interest rates are apparent. The authors demonstrate that confidence intervals from bootstrap related to impulse responses from a combination estimator or estimator that is sign-proxy, are from the perspective of volatility variations predominantly less compared to competitors. Moreover, the sign-proxy can result in estimates that are more specific compared to a proxy estimator that is conventional. Hence, a sign-proxy estimator is a relevant selection in analyses of empirical structural VAR given that only restricted information that is outside the VAR model is valuable.

Consistent with Boer and Lütkepohl (2020), a fundamental challenge within the framework of proxy vector autoregressive analysis is how a suitable instrument can be constructed in order to identify a relevant shock. Building on this concern, the authors propose a proxy that can be simply constructed when authors are knowledgeable of the sign and dating of specific shocks. It is established by the authors that the suggested proxy can engender estimates of impulse response related to the impact effects associated with the shock of interest. Moreover, such relevant shocks can compare with methods based on conventional and more sophisticated proxy in terms of efficiency. There is another corollary stream of literature on the proper specification of GMM by means of properly disclosing and discussing identification and exclusion restrictions underpinning the choice of the outcome variables, the independent variables of interests and strictly exogenous variables (Asongu and Odhiambo, 2022).

In order to properly specify GMM equations, a strand of contemporary literature is arguing for the need to properly discuss identification and exclusion restrictions in order

to avoid the process of estimation appearing like an opaque empirical exercise. Following the relevant contemporary literature (Meniago and Asongu, 2018; Tchamyou, 2019), the procedure through which the highlighted categories of variable are clarified is known as identification. Such an identification process imposes exclusions restrictions that can be valid or invalid, contingent on the outcome of the test used to assess the corresponding validity of the exclusion restrictions.

Building on the argument of Roodman (2009), that because it is not easy to find strictly exogenous variables, years can be assumed to exhibit strict exogeneity, a strand of contemporary studies in the discussion of identification and exclusion restrictions associated with GMM specifications, have assumed years to be strictly exogenous (Tchamyou and Asongu, 2017; Odhiambo, 2020), not least, because as argued by Roodman (2009), upon first difference, it is not feasible for years to be endogenous. The remaining variables (i.e. independent variables of interest, moderating variables and control variables) are assumed by the attendant literature to be endogenous explaining or predetermined. As such, the hypothesis related to exclusion restriction consists to examining whether the assumption of exclusion restriction underpinning the identification process holds or not.

The corresponding test used to assess this hypothesis for exclusion restrictions is the Difference in Hansen Test (DHT) whose null hypothesis is the premise that the identified strictly exogenous variables exhibit strict exogeneity by explaining the identified outcome variable (s) exclusively through the exogenous mechanisms of the predetermined or endogenous explaining variables. It is worthwhile to emphasize that this procedure by which the strictly exogenous variables are validated is broadly consistent with the procedure adopted in less contemporary instrumental variables regressions in which the Hansen and/or Sargan test(s) of overidentifying restrictions should not be validated in order for the hypothesis of exclusion restriction to hold. As argued by Amavilah, Asongu and Andrés (2017), in an instrumental variable estimation approach, when the null hypothesis of the Hansen and/or Sargan test is rejected, it implies that identified instruments or strictly exogenous variables elicit the outcome variable beyond the disclosed channels on the predetermined variables. A solution to this concern usually consists of including more predetermined variables in the specification while keeping in mind that such inclusion should engender instrument proliferation that can render the estimated models less robust.

3. METHODOLOGIES FROM NON-WAEMU COUNTRIES LITERATURE

It is important to discuss the summary of findings on the methodologies employed in the extant literature highlighted in Table 1. In the same chronological order as highlighted, Abradu-Otoo, Amoah and Bawumia (2003), use multivariate modeling approaches to assess the dynamics nexus between non-systemic and systemic shocks on macroeconomic factors in Ghana with the fundamental purpose of understanding how

decisions of monetary actions and policy influence output and inflation. The authors employ a structural vector error correction (SVECM), leveraging on insights from estimated cointegrating nexuses. As information criteria for the selection of models, they have used, (i) the Augmented Dickey Fuller (ADF) and Philips-Perron (PP); (ii) optimal lag selection; (iii) cointegration and (iv) vector error correction (VEC) multivariate tests. The findings reveal strong feedback of instruments of monetary policy influencing output and inflation in the economy of the country in the long term. Moreover, the exchange rate mechanism is the principal channel via which the effectiveness of monetary policy is ascertained.

Adam and Goderis (2008) use a stylized short term open economy model with currency substitution as the principal information criterion for the assessment of monetary policy and oil price surges in Nigeria. The authors note that the protracted history of mismanagement at the fiscal level has compromised the capacity of the Central Bank of the country to implement a monetary policy that is coherent. The authors maintain that in the absence of a well-functioning fiscal stance that is predictable and disciplined, the Central Bank cannot implement credible policies towards inflation targeting or engage in intermediate targets focusing on the exchange rate and money supply. Within this scenario, it is not apparent that monetary policy can aptly be premised on expectations in terms of inflation. In spite of these non-contemporary concerns, over the past 20 years, changes have been apparent in the landscape. The authors maintain that, with more stringent political commitment, improved fiscal management has been made possible by a number of factors such as the Fiscal Responsibility Bill, the success in consolidating the financial sector towards the end of 2005 and foreign exchange markets being unified at the beginning of 2006. Owing to these reforms, monetary policy can play a crucial role in management of the country by means of macroeconomic policies because of the increasing independence of the Central Bank of the country.

Olusegun (2008) assess the effects of shocks in oil price on the performance of some macroeconomic indicators in Nigeria employing a Vector Autoregression (VAR) approach. The empirical framework is based on 7 macroeconomic factors such as consumer price index, real gross domestic product, real oil revenue, real government recurrent expenditure, real money supply, real oil price and real government capital expenditure. The study is based on data for the period 1970 to 2005 and uses the following information criteria for the selection of models: (i) ADF and PP stationarity tests and (ii) Johansen cointegration tests. About four principal cointegrating vectors are identified using the Johansen cointegration test. Moreover, forecast error variance decomposition that are predicted using the VAR model shows that shocks in oil prices substantially contributed towards the output and oil variability. Conversely, the findings also show that a shock in oil price fails to have a considerable impact on the supply of money, government expenditure and level of prices. The study also shows that apart from an idiosyncratic shock, the variability of prices is substantially traceable to shocks in money supply and output. This result therefore confirms the perspective that shocks in

oil prices do not necessarily engender inflationary pressures and hence, by implication, fiscal policy can be more effectively leveraged upon to stabilize the economy in the aftermath of a shock in oil prices.

Ogunkola and Tarawalie (2008) have focused on Sierra Leone while assessing monetary policy transmission mechanism. The authors use quarterly data from 1990 to 2006 within an empirical framework of vector error correction (VEC). According to their findings, as predicted, domestic prices and outcomes are influenced by instruments of monetary policy, as apparent from the mechanism of bank lending. The information criteria employed for model selection are stationarity and cointegration tests.

Chuku (2009) within the framework of Nigeria is motivated by the fact that when monetary policy innovations are identified correctly, appropriate policy-making follows. A controlled experiment is performed by the author using a structural vector autoregression (SVAR) framework in order to trace the impacts of shocks in monetary policy on prices and output in the country. It is assumed by the authors that unanticipated variations cannot be observed within a similar period. This assumption puts a recursive restriction on the SVAR disturbances as the authors conduct an experiment by means of three different instruments of policy, (i.e., the real effective exchange rate (REER), Minimum Rediscount Rate (MRR) and broad money (M2)). The information criteria employed for model selection are traditional stationarity tests (ADF and PP tests) and other tests (e.g., Ng-Perron (NP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests) that tackle the concerns of low size and power distortions in the underlying traditional tests. It is established that innovations in monetary policy performed from an anchor that is quantity-based (i.e., M2) leads to an adjustment speed that is fast, accompanied by mild incidences on prices and output. The authors also find innovations anchors that are price-based such as MRR and REER lead to fleeting and neutral impacts on output. It is concluded by the authors that when the quantity of money (i.e., M2) is manipulated, it becomes the most significant instrument in the implementation of monetary policy. Therefore, it is recommended by the author that more emphasis should be placed by the central bank on the employment of the nominal anchor that is quantity instead of one which is based on price.

Ogun and Akinlo (2010) have used a SVAR technique to assess the effectiveness of the bank credit mechanism in the transmission of monetary policy. The paper adopts deregulatory indicators and uses secondary data for the period 1986 to 2006. The information criteria used for model selection are traditional stationarity (ADF and PP) tests as well as the Johansen and 'Johansen and Juselius' cointegration tests. It is found by the study that bank deposits, 'total loans and advances' and security holdings slowly respond to shocks in monetary policy during the period of stimulation. It is also established that shocks in monetary policy did not contribute substantially to errors in forecast and bank credit mechanism is not effective in the collapse.

In Nigeria, Umar and Abdulkakeem (2010) use a VAR model to assess the effect of variations in prices on four principal macroeconomic indicators, to find that oil prices lead to a substantial effect on unemployment, money supply and real GDP. The

information criteria employed for model selection are traditional stationarity (ADF & PP) tests. However, the effect of the consumer price index or the fourth variables is insignificant. A corresponding implication is that three fundamental macroeconomic factors are substantially explained by variables that are exogenous and considerably volatile. Therefore, the examined economy is vulnerable to shocks from the outside. It follows that economic diversification is essential in order to hedge against the ramifications of outside shocks because macroeconomic management would not be easy owing a volatile macroeconomic performance.

Kovanen (2011) build on exchange rate pass through modeling information criteria from the existing literature to assess interest rate pass through in the Ghanaian economy. Using bank-oriented and time series data, the author provides insights into linkages among retail market interest, wholesale market and policy rates. The analysis illustrates that reactions to variations in policy interest rate are slow in the wholesale market. Moreover, protracted variation from the prime rate of the interbank interest rate shows concerns that the central bank of the country is having when it comes to anticipating short term interest rate in the money market. Accordingly, wholesale market adjustment asymmetries are linked to monetary policy showing weak liquidity management and policy credibility. From the retail perspective, pass-through lending and deposit rates are incomplete and protracted.

Adenekan and Ahoritor (2013) have reviewed the framework for the implementation of monetary policy in Nigeria using a VAR methodology and data for the period 2000 to 2009. They are concerned with how the rest of the economy is affected by actions from monetary policy. The main criteria that is used for model selection is the optimal lag criteria for lag selection. Results of the study reveal that from a basic model, integrating broad money, robustness and strength are more apparent compared to exchange and interest rates as well as the credit mechanisms which are shown to be weak. There is also evidence to show that authorities governing monetary policy are more concerned about the stability of prices than they are about economic growth. This is notably because anticipations with respect of monetary aggregates are closely monitored and the linkage between broad money and price is more robust consistently, compared to the other indicators found in the model. Transmission channels that are not strong in credit as well as in exchange and interest rates reveal a financial system that is shallow and weak. It is possible to mitigate this constraint by consolidating and entrenching the financial system.

Focusing on the Gambia, the main information criteria Touray (2013) uses for model selection are the traditional stationarity (ADF and PP) tests on the one hand and on the other, the lag selection criteria used for the choice of optimal lags in model specification. The main purpose of the study is to assess empirically (i.e. using the VAR technique) how monetary policy operates in the Gambia. Much emphasis is placed on how monetary policy is robust in maintaining the stability of prices as well as confirming the tendency of exchange rate and banking lending mechanisms in the light of theoretical expectations. Going by the objective of the central bank of the country which is to

ensure the stability of prices, a monetary policy contraction that is not anticipated is followed by a brief decrease in prices. With respect to mechanisms, that of the exchange rate is robust as it initially is more effective than the bank lending mechanism, especially with respect to speed and size. However, such effectiveness weakens in time with the domination of the bank lending mechanism. It is however, important to note that issues related to the effect of fiscal policy on monetary objective seem apparent with respect to the country. Hence, more robust tailoring of monetary and fiscal policy is essential in order to facilitate how monetary policy objectives are achieved.

In Ghana, Houssa, Mohimont and Otrók (2015) investigate the incidence of domestic and global shocks in influencing macroeconomic variations. In more perspective, they examine the effect of exogenous shocks which entail, credit supply, commodity price and productivity shocks. The authors identify such shocks building on a combination of recursive and sign restrictions using Bayesian VAR (BVAR) models. Two main information criteria are employed for model selection: (i) sign and zero restrictions in structural identification and (ii) the use of two prior types in the BVAR model. Shocks in the country are established to occur via three main mechanisms: credit, trade and prices of commodities.

In Ghana, Sakyi, Mensah and Obeng (2017) examine both the short and long term transmission rates related to the prime of interest rates in the aftermath of when an inflation targeting policy was implemented in the country. The study uses data for the period 2002 to 2016. Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) are employed as estimation techniques. Two fundamental information criteria are used for the choice of estimation techniques: the ADF, PP and Zandrews unit root tests for stationarity and the Johansen and Hansen parameter instability cointegration tests. The long term findings reveal over pass-through to the 91-day Treasury bill rate and an incomplete pass-through with respect to the prime rate to the deposit and lending rates of commercial banks. Moreover, short-term adjustment reveals a comparatively slow transmission of the prime rate compared to the respective interest rates.

Quaidoo (2018) has examined the effectiveness of monetary policy in the potential West African Monetary Zone (WAMZ). The author has used two main information criteria in the selection of the models adopted for the empirical strategy. They include traditional stationarity (ADF & PP) tests and the lag selection criteria for optimal lag selection. The author finds that monetary policy transmission channels are dissimilar across the many countries that constitute the potential WAMZ. The author also posits that whereas the effectiveness of the interest rate channel is not established in the WAMZ member state countries, in Ghana and the Gambia, the lending channel is effective. Furthermore, the author shows that the exchange rate channel is feasible in Nigeria. Given the observed heterogeneity in monetary policy effectiveness, potential member states are recommended to boost their domestic financial markets in order to enhance financial intermediation, with the ultimate objective of reaching price stability through the relevant monetary policy channels.

Table 1. Summary of Studies on the Response of Monetary Policy to External Shocks

Author(s)	Research	Methods	Sample	Justification for Model Selection
Abradu-Otoo, Amoah and Bawumia (2003)	Monetary policy transmission in Ghana	Structural VECM	Ghana	-Stationarity tests (ADF & PP tests) -Lag order selection criteria -Cointegration tests (Johansen) -VEC multivariate tests (Autocorrelation, Serial correlation, Normality and Heteroscedasticity tests)
Adam and Goderis (2008)	Monetary policy and oil price surges in Nigeria	Process tracing, Standard deviations	Nigeria	-Stylized short-run open economy model with currency substitution
Olusegun (2008)	Oil price shocks and the Nigerian economy	VAR models	Nigeria with annual data between the periods 1970-2005.	-Stationarity tests (ADF & PP tests) -Cointegration tests (Johansen)
Ogunkola and Tarawalie (2008)	Monetary policy transmission	VECM	Sierra Leone	-Stationarity tests -Cointegration tests
Chuku (2009)	Measuring the effects of monetary policy innovations in Nigeria	Structural VAR	Nigeria	-Traditional stationarity tests (ADF & PP tests) -Other tests to address issues of low power and size distortions in traditional tests (NP & KPSS tests)
Ogun and Akinlo (2010)	Effectiveness of the bank credit channel in monetary policy	Structural VAR	Nigeria	-Traditional Stationarity tests (ADF & PP tests) - Johansen & 'Johansen and Juselius' cointegration tests
Umar and Abdulhakeem (2010)	Oil price shocks and the Nigeria Economy	VAR models	Nigeria	-Traditional Stationarity tests (ADF & PP tests)
Kovanen (2011)	The interest rate channel of monetary policy transmission	VAR Models	Ghana	-Exchange rate pass through model based on existing literature
Adenekan and Ahoror (2013)	Monetary policy transmission	VAR models	Nigeria	-Lag length selection (i.e. optimal lag selection criteria)
Touray (2013)	Effectiveness of monetary policy transmission channels in the Gambia	VAR models	The Gambia	-Traditional Stationarity tests (ADF & PP tests) - Lag length selection (i.e. optimal lag selection criteria)
Houssa, Mohimont and Orok (2015)	Sources of Business Cycles in a Low Income Country	Bayesian VAR (BVAR) model	Ghana	-Zero and sign restrictions are used for structural identification. -Employment of two prior types in the BVAR model.

Table 1. Summary of Studies on the Response of Monetary Policy to External Shocks (cont')

Author(s)	Research	Methods	Sample	Justification for Model Selection
Sakyi, Mensah and Obeng (2017)	Inflation targeting and interest rate transmission	FMOLS and DOLS	Ghana	-ADF, PP, and Zandrews unit root tests for stationarity - The Johansen and Hansen parameter instability cointegration tests
Quaidoo (2018)	Monetary policy effectiveness in the WAMZ	VAR models	WAMZ countries	-Traditional Stationarity tests (ADF & PP tests) - Lag length selection (i.e. optimal lag selection criteria)
Egwaikhide and Eregha (2018)	The role of globalization in monetary policy effectiveness	GMM	WAMZ	-Traditional Stationarity tests (ADF & PP tests)
Shobande, Shodipe and Asongu (2019)	Global shocks alert and monetary policy responses	DSGE	Ghana	Motivated by the existing literature on the problem statement
Lavally and Nyambe (2019)	Effectiveness of monetary policy transmission mechanisms	VAR	Sierra Leone	- Augmented Dickey Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski Phillips Schmidt and Shin (KPSS) tests. - Johansen co-integration test
Tule, Ajilore and Ujunwa (2019)	Monetary policy contagion in the West African Monetary Zone (WAMZ)	VAR	WAMZ countries	- Zivot-Andrews Unit Root with a Structural Break - Gregory-Hansen (G-H) Cointegration Test
Kamara and Zuo (2020)	Effectiveness of monetary policy transmission in Liberia	VAR	Liberia	-The Augmented Dickey Fuller (ADF) and Dickey Fuller Generalized Least Squares (DF-GLS) stationarity tests -Lag selection criteria -Johansen co-integration test
Akosah, Alagidede and Schaling (2020)	Estimation of monetary policy reaction function	GMM	Ghana	- Augmented Dickey Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski Phillips Schmidt and Shin (KPSS) tests. -Bai-Perron Multiple Break Test.
Bangura, Ngombu, Pessima and Kargbo (2021)	Effectiveness of the bank lending channel	GMM	Sierra Leone	Motivated by the existing literature on the problem statement

Note: VAR: Vector autoregression. DSGE: Dynamic Stochastic General Equilibrium. VECM: Vector Error Correction Model. DOLS: Dynamic Ordinary Least Squares. FMOLS: Fully Modified Ordinary Least Squares. GMM: Generalized Method of Moments. ADF: Augmented Dickey Fuller Test. PP: Phillips-Perron Test. ECT: Error Correction Term. NP: Ng-Perron (NP) test. KPSS: Kwiatkowski, Phillips, Schmidt and Shin test.

Source: An extension of Sedegah and Odhiambo (2021).

In another study on the WAMZ, using the traditional stationarity (ADF & PP) tests as information criteria, Egwaikhide and Eregha (2018) have studied the incidence of global characteristics on the reaction of monetary policy using data for the period 1980 to 2015. Employing the generalized method of moments (GMM), the authors find strong evidence to support the perspective that global output gap and inflation have affected decisions surrounding monetary policies in the central banks making-up the potential zone. Hence, it is recommended that global factors should be taken into account and given the much relevant weights when forecasting monetary policy rules and domestic inflation.

Focusing on Ghana, Shobande, Shodipe and Asongu (2019) have assessed the incidence of global predictors on national monetary policy with the help of the New Keynesian DSGE (Dynamic Stochastic General Equilibrium) framework. The information criteria used to choose to empirical strategy are informed by the existing literature. The authors develop and calibrate automatically the chosen DSGE model by employing the Bayesian estimator to provide a model that is robust to subjective choices. From the simulation findings, it is apparent that global factors largely explain the central banks' incapacity to estimate the conduct of financial and macroeconomic variables.

Lavally and Nyambe (2019), focus on Sierra Leone using data from 1980 to 2012. The VAR empirical approach the study uses is based on two main criteria of information, notably: the ADF, PP and KPSS unit root tests on the one hand and on the other, the Johansen cointegration test. The purpose of the study is to understand how economic activities can be oriented by means of effective monetary policy transmission channels (e.g. the interest rate, exchange rate and credit mechanisms). From the findings, it is apparent that: (i) cointegration is present; (ii) gross capital formation granger cause exchange rate and real interest rate. (iii) Impulse response findings further show that with increase in interest rate, output is positively related to monetary shocks whereas with regard to exchange rate and private domestic credit, it is revealed that even in the long run, shock effects should not necessarily be transitory in order to arrive at steady state convergence.

Tule, Ajilore and Ujunwa (2019) have recently focused on Nigeria and three countries in the potential WAMZ. The study focuses on data for the period 1980 to 2016 and two information criteria are used notably: (i) the Zivot–Andrews Unit Root with a Structural Break and (ii) the Gregory–Hansen (G–H) Cointegration tests. The authors aim to examine if shocks from monetary policy that come from Nigeria are a relevant source of macroeconomic variations in the WAMZ countries. In the study, the Global vector autoregressive technique that employs connected weights in analytical computation is employed. Projections from a generalized impulse response function show that an unanticipated monetary policy shock in Nigeria leads to depreciation in the exchange rate between the USA and Nigeria; boosts economic growth; reduces inflation and increases money stock in the short term for Nigeria. In Ghana, the monetary policy shocks of Nigeria similarly lead to depreciation in exchange rate and reduce economic growth with a substantial short term inflationary effect. As for the Gambia, the

unexpected shock from Nigeria consolidates the USA-Gambia exchange rate as well as reduces inflationary pressures and growth. In Sierra Leone, there is also a currency appreciation as in the Gambia, coupled with growing inflation and economic expansion. There is increase in money supply for consistency with the supply of money. These findings validate the hypothesis on the existence of substantial geopolitical nexuses in the WAMZ region via which the transmission of macroeconomic fluctuations is apparent. Concerning policy implications, it is recommended that in the region, monetary authorities should tackle concerns about how economies can be stabilized in relation to monetary policy responses to shocks coming from Nigeria.

Kamara and Zuo (2020) focus on Liberia and analyze how effective monetary policy transmission is. The authors examine how monetary policy affects real per capita and inflation by employing three principal monetary mechanisms (i.e. exchange rate, money supply and bank lending). The VECM and VAR techniques are employed for the period 2006 to 2019. Three main information criteria are employed for the selection of models, notably: (i) the ADF and the Dickey Fuller Generalized Least Squares (DF-GLS) stationarity tests; (ii) the lag selection criteria used for the choice of optimal lags in model specification and (iii) Johansen cointegration test. The findings show that of the three adopted channels, the exchange rate channel is the most relevant in the impact of domestic price and is also not a predictor of potential per capita output. The results reveal monetary policy consolidation from an exchange rate targeting framework. Furthermore, combined effect of banking channels and monetary policy are relevant in influencing output through monetary impulses of transmission. As policy recommendations, the authors recommend that consolidation in the coordination between fiscal and monetary authorities should be considered in view of ensuring macroeconomic stability that facilitates inclusive growth, job creation and low inflation.

Akosah, Alagidede and Schaling (2020) have estimated the monetary policy reaction function for Ghana in order to understand the policy conduct of the Bank of Ghana (BoG). The study employs the GMM estimation strategy with emphasis on wavelet multiscale analysis. The following information criteria are employed for the choice of the estimation strategy, the: (i) ADF, PP and KPSS stationarity tests and (ii) the Bai-Perron Multiple Break test. The multitude of tendencies from the empirical results shows that diverse and relevant policy actions are essential for the central bank of the country to achieve its objective of price stability.

Bangura et al. (2021) employ the GMM empirical strategy in Sierra Leone to assess evidence of the bank lending mechanism in monetary policy. The choice of the estimation strategy is motivated by information criteria from the extant GMM literature. The data is for the period 2014 to 2018. Accordingly, the objective of the study is to empirically assess how bank lending behavior is affected by changes in monetary policy. Moreover, the study also assesses the degree by which bank-oriented features of liquidity, capital and size influence how monetary policy is effective. The findings show that monetary policy rate negatively and substantially influences the supply of loans from banks. The finding supports evidence of the bank lending mechanism for the

transmission of monetary policy. Among other findings and policy implications, a main recommendation from the study is that when investigating monetary policy, apart from the monetary policy rate, it is relevant for central banks to oversee characteristics of individual banks especially as it relates to micro-dynamics from the perspective of size in order to boost the impact of monetary policy efficacy on the country's real sector.

4. CONCLUSION

This paper has reviewed the extant methodological literature on the studies assessing the linkage between external shocks and monetary policy effectiveness. The objective has been to improve the extant literature by taking stock of empirical approaches that have been employed over the past two decades to provide scholarly insights and policy recommendations on the investigated relationship. The relevance of the methodological literature review particularly builds on the premise that the adopted empirical approach in examining the plausibility and validity of estimated models is essential for the robust analyses and corresponding accurate implications for monetary policy effectiveness in response to external shocks. As argued in the study, the methodological choice contributes toward tailoring how monetary policy institutions and rules are applied in response to external shocks. It is established in the review that the extant literature converges on a set of methodological underpinnings that are relevant in assessing the effects of external shocks on monetary policy effectiveness. Such convergence is documented in this study by assessing country-specific and panel-oriented studies focusing on non-WAEMU (West African Economic and Monetary Union) countries, especially in terms of information criteria motivating the choice of extant methodologies.

The study has put a structure to the extant literature on the problem statement in order to clearly provide scholars with evidence of how empirical approaches converge both in terms of information criteria and adopted empirical strategies. Hence, from the study, it is apparent that substantial consensus exists on both the information criteria motivating the choice of empirical strategies as well as the adopted empirical approaches. Future studies aiming to further existing scholarship on this subject should not lose sight of the focus of this study on exclusively non-WAEMU countries which are predominantly developing countries with less developed financial systems and monetary policy instruments. Hence, future studies should focus on other developing regions as well as developed countries.

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