AFRICAN ECONOMIC AND SOCIAL RESEARCH INSTITUTE (AESRI)

WORKING PAPER SERIES

BANKING REGULATION AND BANK CREDIT DELIVERY IN SELECTED SUBSAHARAN AFRICAN COUNTRIES: SYMMETRIC AND ASYMMETRIC CAUSAL LINKAGES[1]

Accepted: *Heliyon*

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WP 05/2024

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[1] This working paper also appeared in the UNISA Economic Research Working Paper Series.

BANKING REGULATION AND BANK CREDIT DELIVERY IN SELECTED SUB-SAHARAN AFRICAN COUNTRIES: SYMMETRIC AND ASYMMETRIC CAUSAL LINKAGES

Retselisitsoe I. Thamae[2] & Nicholas M. Odhiambo

Abstract

This study aimed to empirically determine the symmetric and asymmetric causal relationship between banking regulation and bank credit delivery using a context of 23 sub-Saharan African countries from 1995 to 2017. The estimated symmetric and asymmetric error correction-based multivariate panel Granger-causality models allowed for both long-run and short-run causal relationships. The results generally supported the existence of long-run symmetric and asymmetric causality between banking regulatory measures, bank credit delivery and two intermittent variables, namely, economic growth and inflation. In the short run, bidirectional symmetric causality existed between banking entry barriers and bank credit delivery, as well as a one-way symmetric causal flow running from bank credit delivery to banking capital regulations. Moreover, positive shocks to bank credit delivery Granger caused negative shocks to banking entry barriers, activity restrictions or capital regulations, while negative shocks to mixing of banking and commerce restrictions Granger caused positive or negative shocks to bank credit delivery. The findings highlight that policymakers should take into consideration not only the symmetric but also the asymmetric causal effects of reforms aimed at enhancing banking regulation and such reforms should be well-targeted and well-designed for them to stimulate bank credit delivery.

Keywords: Banking regulation; bank credit delivery; symmetric and asymmetric panel causality; error correction; sub-Saharan Africa

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1. Introduction

Sub-Saharan African (SSA) countries have implemented banking regulatory reforms in the twentieth and twenty-first centuries following regional banking and global financial crises, respectively (Nyantakyi and Sy, 2015; Anginer et al., 2019; Gondwe et al., 2022). These reforms were meant to foster financial stability and enhance sustainable bank credit delivery to the private sector (Çolak and Öztekin, 2021; Asteriou et al., 2021). However, as the financial system structure evolves, resulting in the provision of more credit delivery, new financial risks emerge. Consequently, the existing banking laws and regulations need to be revised to mitigate such risks and enhance prudent credit delivery. Therefore, it is imperative to empirically determine whether banking regulation drives bank credit delivery or whether developments in bank credit delivery shape the direction of banking regulation.

According to economic literature, a bidirectional causality can exist between institutions and economic performance measures (Law et al., 2013; Ehigiamusoe and Samsurijan, 2021). This is because institutions shape the way societies interact and this affects economic performance (North, 1990; Uddin et al., 2020). But economic development is also required before laws and regulations can be properly instituted (Rosenberg and Birdzel, 1986; Cox et al., 2019). Given that banking regulation forms part of formal institutions, while bank credit delivery is an important component of financial development, banking regulation is not only expected to influence the delivery of bank credit, but the reverse causality can exist whereby developments in bank credit delivery are expected to shape the direction of banking regulation (Deli and Hasan, 2017; Fratzscher et al., 2016; Kim et al., 2014). In line with Patrick (1966), banking regulation can cause the delivery of bank credit at the early stages of financial development but, at the later stages, banking regulation can follow developments in bank credit delivery.

Nevertheless, the omission-of-variable bias can exist when modelling the causal linkage between banking regulation and bank credit delivery using the bivariate panel causality models (Odhiambo et al., 2019; Odhiambo, 2021). As a result, intermittent variables need to be included as part of this relationship, and the common ones are economic growth and inflation. As highlighted by Cottarelli et al. (2005) and Djankov et al. (2007), economic growth can influence the delivery of bank credit because economies with more income normally have larger credit markets with increased provision of financial services. Furthermore, economic growth and development are normally required before laws and regulations can be properly

instituted (Dincer and Neyapti, 2008; Cox et al., 2019). On the other hand, inflation as a proxy for macroeconomic stability can influence the supply of domestic credit by discouraging customers from seeking additional lending (Djankov et al., 2007; Adesina, 2019). Moreover, inflation can affect the direction of banking regulation since changes in banking regulation can be motivated by perceptions about trends in bank credit delivery and their likely impact on the economic environment (Kim et al., 2014; Fratzscher et al., 2016; Bruno et al., 2017; Deli and Hasan, 2017).

Despite these issues, the empirical studies mainly focused on the impact of banking regulation as one of the determinants of bank credit delivery (see Thamae and Odhiambo, 2022a, 2022b, 2022c), while the ones examining causal linkages between banking regulation and bank credit delivery are very limited and concentrated on banking capital, using only symmetric causality approaches for modelling that yielded ambiguous results (Aiyar et al., 2016; Oyebowale, 2020). Additionally, these studies did not account for the possible asymmetric causal response between banking regulation and bank credit delivery as positive and negative shocks to banking regulation (bank credit delivery) were not expected to have the same causal effect on bank credit delivery (banking regulation) (Shin et al., 2014).

This study, therefore, aims to determine the causal linkages between banking regulation and bank credit delivery in 23 SSA countries during the period 1995-2017. Specifically, the paper assesses the direction of symmetric and asymmetric causality between banking regulatory measures and bank credit delivery. It tests whether there is bidirectional causality between measures of banking regulation and credit delivery in the study countries. Unlike others, it estimated the symmetric and asymmetric error correction-based multivariate panel Granger-causality models, which allowed for the estimation of both long-run and short-run causal relationships. Furthermore, the study employed different indices of banking regulation obtained from the World Bank's Bank Regulation and Supervision surveys (BRSS), namely, banking entry barriers, mixing of banking and commerce restrictions, banking activity restrictions and banking capital regulations. To the best of the authors' knowledge, this is the first study that adopted these approaches to investigate the symmetric and asymmetric causal relationship between banking regulation and the delivery of bank credit in the SSA context.

The main findings from this study can be easily summarized. First, the estimated results from the multivariate error correction-based panel Granger-causality models generally provided evidence of long-run causality between banking regulatory measures and bank credit delivery (plus two intermittent variables, namely, economic growth and inflation). Second, in the short run, there was bidirectional symmetric causality between banking entry barriers and bank credit delivery, as well as a one-way symmetric causal flow from bank credit delivery to banking capital regulations. Additionally, positive shocks to bank credit delivery Granger caused negative shocks to banking entry barriers, activity restrictions or capital regulations, while negative shocks to mixing of banking and commerce restrictions Granger caused positive or negative shocks to bank credit delivery. These results imply that policymakers should not only consider the symmetric but also the asymmetric causal effects of reforms aimed at enhancing banking regulation and such reforms should be well-targeted and well-designed for them to stimulate the delivery of bank credit.

For the paper, Section 2 briefly reviews the literature on the causal relationship between banking regulation and bank credit delivery. Section 3 discusses data and econometric methodology, while Section 4 presents the empirical results and their discussion. Section 5 concludes the study and offers policy recommendations.

2. Literature Review

In most developing economies, banks play a major role in the allocation of credit. However, if banking regulation is poor, banks are likely to engage in more risk-taking behaviour that encourages bad lending (Barth et al., 2004; Mishkin, 2009; Djalilov and Piesse, 2019). This can lead to poor performance of banks' balance sheets and force banks to significantly cut credit delivery, thereby resulting in banking crises. To prevent this situation, sound banking regulation is required to ensure that banks can properly manage risks and efficiently channel credit to projects that yield high returns. Thus, banking regulation is expected to influence developments in the delivery of bank credit.

On the other hand, trends in bank credit delivery can shape the direction of banking regulation over time. This is because changes in banking regulation can be motivated by perceptions about trends in credit delivery and their likely impact on the general economic environment (Deli and Hasan, 2017; Fratzscher et al., 2016; Kim et al., 2014). For instance, Hahm et al. (2013)

indicate that credit growth has a predictive power of both credit and currency crises. Likewise, Barth et al. (2013) and Fratzscher et al. (2016) point out that various reforms in banking regulation have been undertaken worldwide following different systemic banking crises since the 1970s, and even after the 2007-2008 global financial crisis, to limit excessive credit growth and enhance financial stability. Therefore, banking regulation can respond to developments in bank credit delivery.

The empirical evidence on the causal relationship between banking regulation and bank credit delivery is very limited and has focused only on bank capital and its symmetric causal effect on bank credit. For example, the study by Aiyar et al. (2016) investigated the possible existence of reverse causality coming from the delivery of bank credit to banking regulation in the United Kingdom from 1998 to 2007, and established a unidirectional symmetric causal flow from banking capital to the growth of bank credit delivery. Alternatively, Oyebowale (2020) examined the existence of symmetric Granger causality between the banking capital growth and the growth rate in aggregate bank loans and advances in Nigeria over the period 1961-2016 and found no evidence of Granger causality between the two. Nonetheless, these studies neither employed different measures of banking regulation nor accounted for the possible asymmetric causal response between banking regulation and bank credit delivery. Thus, this paper fills these research gaps by analysing the relationship between banking regulation and bank credit delivery using the symmetric and asymmetric error correction-based multivariate panel Granger-causality models as well as different indices of banking regulation in the context of the SSA region.

3. Method

3.1. Data

This study employed annualized sample data from 23 SSA economies[3] spanning 1995 to 2017. Following Thamae and Odhiambo (2022b), the selected countries were chosen on the basis of data availability from a minimum of three in five World Bank's BRSS (Barth et al., 2001, 2004, 2008, 2013; Cihak et al., 2013; Anginer et al., 2019). Since the BRSS normally include questions regarding the current years as well as the preceding ones, the indices for Surveys I

[3] The names of these countries are Angola, Benin, Botswana, Burkina Faso, Burundi, Cote d'Ivoire, Eswatini, Ghana, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritius, Namibia, Niger, Nigeria, Senegal, South Africa, Tanzania, Togo and Uganda.

(completed in 1999), II (completed in 2003), III (completed in 2007), IV (completed in 2011) and V (administered in 2017 and published in 2019) were used as time series values for 1995-1999, 2000-2003, 2004-2007, 2008-2011 and 2012-2017, respectively. Banking entry barriers were proxied by the licensing and foreign ownership requirements of banks, while the mixing of banking and commerce restrictions were measured by the degree of limitations on ownership and control between banks, non-bank financial firms and non-financial firms. Banking activity restrictions were captured by the limits imposed on banks in terms of participating in securities, insurance and real estate markets, whereas banking capital regulations were proxied by the stringency of regulatory requirements regarding banking capital[4].

The data on credit delivery to the domestic private sector from banks as a fraction of gross domestic product (GDP) came from the World Bank's Financial Development and Structure and Global Financial Development, as well as from the International Monetary Fund's International Financial Statistics. Furthermore, the data on two intermittent variables, namely, the real GDP (in 2011 international dollar purchasing power parity), with its log being a proxy for economic growth, and the consumer price index, with its log representing inflation, were sourced from the International Monetary Fund's World Economic Outlook and the World Bank's World Development Indicators. Therefore, the summary of data sources and description of variables are given in Table A1 in the Appendix, while Tables A2 and A3 present the descriptive statistics and correlation matrix, respectively.

3.2. Econometric Methodology

This study employed the symmetric and asymmetric error correction-based multivariate panel Granger-causality models to investigate the direction of causality between banking regulation and the delivery of bank credit.

Symmetric Error Correction-based Multivariate Granger Causality

The symmetric causal linkages between banking regulatory measures and bank credit delivery can be determined within the following error correction-based multivariate panel Granger-causality models (see Odhiambo, 2021), namely:

[4] See Thamae and Odhiambo (2022b) for the sub-components, qualification criteria and range for these banking regulatory variables.

$$\Delta L_{i,t} = \mu_{1i} + \phi_{1i} ECT_{t-1} + \sum_{j=1}^{p} \alpha_{1ij} \Delta L_{i,t-j} + \sum_{j=1}^{q} \delta_{1ij} \Delta R_{i,t-j} + \sum_{j=1}^{r} \lambda_{1ij} \Delta Y_{i,t-j} + \sum_{j=1}^{s} \tau_{1ij} \Delta \pi_{i,t-j} + \varepsilon_{1i,t} \quad (1)$$

$$\Delta R_{i,t} = \mu_{2i} + \phi_{2i} ECT_{t-1} + \sum_{j=1}^{p} \alpha_{2ij} \Delta R_{i,t-j} + \sum_{j=1}^{q} \delta_{2ij} \Delta L_{i,t-j} + \sum_{j=1}^{r} \lambda_{2ij} \Delta Y_{i,t-j} + \sum_{j=1}^{s} \tau_{2ij} \Delta \pi_{i,t-j} + \varepsilon_{2i,t} \quad (2)$$

$$\Delta Y_{i,t} = \mu_{3i} + \phi_{3i} ECT_{t-1} + \sum_{j=1}^{p} \alpha_{3ij} \Delta Y_{i,t-j} + \sum_{j=1}^{q} \delta_{3ij} \Delta L_{i,t-j} + \sum_{j=1}^{r} \lambda_{3ij} \Delta R_{i,t-j} + \sum_{j=1}^{s} \tau_{3ij} \Delta \pi_{i,t-j} + \varepsilon_{3i,t} \quad (3)$$

$$\Delta \pi_{i,t} = \mu_{4i} + \phi_{4i} ECT_{t-1} + \sum_{j=1}^{p} \alpha_{4ij} \Delta \pi_{i,t-j} + \sum_{j=1}^{q} \delta_{4ij} \Delta L_{i,t-j} + \sum_{j=1}^{r} \lambda_{4ij} \Delta R_{i,t-j} + \sum_{j=1}^{s} \tau_{4ij} \Delta Y_{i,t-j} + \varepsilon_{4i,t} \quad (4)$$

$L_{i,t}$ is bank credit delivery for country i at period t; $R_{i,t}$ is a banking regulatory measure; $Y_{i,t}$ is economic growth; $\pi_{i,t}$ is inflation; Δ is a first difference operator; μ_i's are country-specific intercepts; ϕ_i's capture the speed of adjustment toward a long-run equilibrium; ECT_{t-1} represents the lagged error-correction term; α_{ij}'s, δ_{ij}'s, λ_{ij}'s and τ_{ij}'s are scalars representing the coefficients to be estimated; p, q, r and s are the optimal number of lags; and $\varepsilon_{i,t}$'s are country-specific independent and identically distributed error terms.

The long-run causality between banking regulation and bank credit delivery exists if the null hypothesis that each $\phi = 0$ in Equations (1) and (2) is rejected using the *t*-statistic, while the short-run causality exists if the null hypothesis that each $\delta = 0$ in those equations is rejected

using the Wald (1943) test (Odhiambo, 2017, 2021). The same applies to all other combinations in Equations (1) to (4).

Asymmetric Error Correction-based Multivariate Granger Causality

In line with Wong (2022), Bhat and Sharma (2020) and Kouton (2019), this study further assessed the asymmetric causal linkages between banking regulation and bank credit delivery as shown by the following multivariate error-correction representations that separate the effect of positive shocks from negative ones as suggested by Shin et al. (2014), namely:

$$\Delta L_{i,t}^{+} = \mu_{1i} + \phi_{1i}^{+}\xi_{i,t-1}^{+} + \sum_{j=1}^{p}\alpha_{1ij}^{+}\Delta L_{i,t-j}^{+} + \sum_{j=1}^{q}\delta_{1ij}^{+}\Delta R_{i,t-j}^{+} + \sum_{j=1}^{r}\lambda_{1ij}^{+}\Delta Y_{i,t-j}^{+} + \sum_{j=1}^{s}\tau_{1ij}^{+}\Delta\pi_{i,t-j}^{+} + \varepsilon_{1i,t} \quad (5)$$

$$\Delta L_{i,t}^{+} = \mu_{2i} + \phi_{2i}^{+}\xi_{i,t-1}^{+} + \sum_{j=1}^{p}\alpha_{2ij}^{+}\Delta L_{i,t-j}^{+} + \sum_{j=1}^{q}\delta_{2ij}^{-}\Delta R_{i,t-j}^{-} + \sum_{j=1}^{r}\lambda_{2ij}^{-}\Delta Y_{i,t-j}^{-} + \sum_{j=1}^{s}\tau_{2ij}^{-}\Delta\pi_{i,t-j}^{-} + \varepsilon_{2i,t} \quad (6)$$

$$\Delta L_{i,t}^{-} = \mu_{3i} + \phi_{3i}^{-}\xi_{i,t-1}^{-} + \sum_{j=1}^{p}\alpha_{3ij}^{-}\Delta L_{i,t-j}^{-} + \sum_{j=1}^{q}\delta_{3ij}^{-}\Delta R_{i,t-j}^{-} + \sum_{j=1}^{r}\lambda_{3ij}^{-}\Delta Y_{i,t-j}^{-} + \sum_{j=1}^{s}\tau_{3ij}^{-}\Delta\pi_{i,t-j}^{-} + \varepsilon_{3i,t} \quad (7)$$

$$\Delta L_{i,t}^{-} = \mu_{4i} + \phi_{4i}^{-}\xi_{i,t-1}^{-} + \sum_{j=1}^{p}\alpha_{4ij}^{-}\Delta L_{i,t-j}^{-} + \sum_{j=1}^{q}\delta_{4ij}^{+}\Delta R_{i,t-j}^{+} + \sum_{j=1}^{r}\lambda_{4ij}^{+}\Delta Y_{i,t-j}^{+} + \sum_{j=1}^{s}\tau_{4ij}^{+}\Delta\pi_{i,t-j}^{+} + \varepsilon_{4i,t} \quad (8)$$

$$\Delta R_{i,t}^{+} = \mu_{5i} + \phi_{5i}^{+}\xi_{i,t-1}^{+} + \sum_{j=1}^{p}\alpha_{5ij}^{+}\Delta R_{i,t-j}^{+} + \sum_{j=1}^{q}\delta_{5ij}^{+}\Delta L_{i,t-j}^{+} + \sum_{j=1}^{r}\lambda_{5ij}^{+}\Delta Y_{i,t-j}^{+} + \sum_{j=1}^{s}\tau_{5ij}^{+}\Delta\pi_{i,t-j}^{+} + \varepsilon_{5i,t} \quad (9)$$

$$\Delta R_{i,t}^{+} = \mu_{6i} + \phi_{6i}^{+}\xi_{i,t-1}^{+} + \sum_{j=1}^{p}\alpha_{6ij}^{+}\Delta R_{i,t-j}^{+} + \sum_{j=1}^{q}\delta_{6ij}^{-}\Delta L_{i,t-j}^{-} + \sum_{j=1}^{r}\lambda_{6ij}^{-}\Delta Y_{i,t-j}^{-} + \sum_{j=1}^{s}\tau_{6ij}^{-}\Delta\pi_{i,t-j}^{-} + \varepsilon_{6i,t} \quad (10)$$

$$\Delta R_{i,t}^{-} = \mu_{7i} + \phi_{7i}^{-}\xi_{i,t-1}^{-} + \sum_{j=1}^{p}\alpha_{7ij}^{-}\Delta R_{i,t-j}^{-} + \sum_{j=1}^{q}\delta_{7ij}^{-}\Delta L_{i,t-j}^{-} + \sum_{j=1}^{r}\lambda_{7ij}^{-}\Delta Y_{i,t-j}^{-} + \sum_{j=1}^{s}\tau_{7ij}^{-}\Delta\pi_{i,t-j}^{-} + \varepsilon_{7i,t} \quad (11)$$

$$\Delta R_{i,t}^{-} = \mu_{8i} + \phi_{8i}^{-}\xi_{i,t-1}^{-} + \sum_{j=1}^{p}\alpha_{8ij}^{-}\Delta R_{i,t-j}^{-} + \sum_{j=1}^{q}\delta_{8ij}^{+}\Delta L_{i,t-j}^{+} + \sum_{j=1}^{r}\lambda_{8ij}^{+}\Delta Y_{i,t-j}^{+} + \sum_{j=1}^{s}\tau_{8ij}^{+}\Delta\pi_{i,t-j}^{+} + \varepsilon_{8i,t} \quad (12)$$

$$\Delta Y_{i,t}^{+} = \mu_{9i} + \phi_{9i}^{+}\xi_{i,t-1}^{+} + \sum_{j=1}^{p}\alpha_{9ij}^{+}\Delta Y_{i,t-j}^{+} + \sum_{j=1}^{q}\delta_{9ij}^{+}\Delta L_{i,t-j}^{+} + \sum_{j=1}^{r}\lambda_{9ij}^{+}\Delta R_{i,t-j}^{+} + \sum_{j=1}^{s}\tau_{9ij}^{+}\Delta\pi_{i,t-j}^{+} + \varepsilon_{9i,t} \quad (13)$$

$$\Delta Y_{i,t}^{+} = \mu_{10i} + \phi_{10i}^{+}\xi_{i,t-1}^{+} + \sum_{j=1}^{p}\alpha_{10ij}^{+}\Delta Y_{i,t-j}^{+} + \sum_{j=1}^{q}\delta_{10ij}^{-}\Delta L_{i,t-j}^{-} + \sum_{j=1}^{r}\lambda_{10ij}^{-}\Delta R_{i,t-j}^{-} + \sum_{j=1}^{s}\tau_{10ij}^{-}\Delta\pi_{i,t-j}^{-} + \varepsilon_{10i,t} \quad (14)$$

$$\Delta Y_{i,t}^{-} = \mu_{11i} + \phi_{11i}^{-}\xi_{i,t-1}^{-} + \sum_{j=1}^{p}\alpha_{11ij}^{-}\Delta Y_{i,t-j}^{-} + \sum_{j=1}^{q}\delta_{11ij}^{-}\Delta L_{i,t-j}^{-} + \sum_{j=1}^{r}\lambda_{11ij}^{-}\Delta R_{i,t-j}^{-} + \sum_{j=1}^{s}\tau_{11ij}^{-}\Delta\pi_{i,t-j}^{-} + \varepsilon_{11i,t} \quad (15)$$

$$\Delta Y_{i,t}^{-} = \mu_{12i} + \phi_{12i}^{-}\xi_{i,t-1}^{-} + \sum_{j=1}^{p} \alpha_{12ij}^{-}\Delta Y_{i,t-j}^{-} + \sum_{j=1}^{q} \delta_{12ij}^{+}\Delta L_{i,t-j}^{+} + \sum_{j=1}^{r} \lambda_{12ij}^{+}\Delta R_{i,t-j}^{+} + \sum_{j=1}^{s} \tau_{12ij}^{+}\Delta \pi_{i,t-j}^{+} + \varepsilon_{12i,t} \quad (16)$$

$$\Delta \pi_{i,t}^{+} = \mu_{13i} + \phi_{13i}^{+}\xi_{i,t-1}^{+} + \sum_{j=1}^{p} \alpha_{13ij}^{+}\Delta \pi_{i,t-j}^{+} + \sum_{j=1}^{q} \delta_{13ij}^{+}\Delta L_{i,t-j}^{+} + \sum_{j=1}^{r} \lambda_{13ij}^{+}\Delta R_{i,t-j}^{+} + \sum_{j=1}^{s} \tau_{13ij}^{+}\Delta Y_{i,t-j}^{+} + \varepsilon_{13i,t} \quad (17)$$

$$\Delta \pi_{i,t}^{+} = \mu_{14i} + \phi_{14i}^{+}\xi_{i,t-1}^{+} + \sum_{j=1}^{p} \alpha_{14ij}^{+}\Delta \pi_{i,t-j}^{+} + \sum_{j=1}^{q} \delta_{14ij}^{-}\Delta L_{i,t-j}^{-} + \sum_{j=1}^{r} \lambda_{14ij}^{-}\Delta R_{i,t-j}^{-} + \sum_{j=1}^{s} \tau_{14ij}^{-}\Delta Y_{i,t-j}^{-} + \varepsilon_{14i,t} \quad (18)$$

$$\Delta \pi_{i,t}^{-} = \mu_{15i} + \phi_{15i}^{-}\xi_{i,t-1}^{-} + \sum_{j=1}^{p} \alpha_{15ij}^{-}\Delta \pi_{i,t-j}^{-} + \sum_{j=1}^{q} \delta_{15ij}^{-}\Delta L_{i,t-j}^{-} + \sum_{j=1}^{r} \lambda_{15ij}^{-}\Delta R_{i,t-j}^{-} + \sum_{j=1}^{s} \tau_{15ij}^{-}\Delta Y_{i,t-j}^{-} + \varepsilon_{15i,t} \quad (19)$$

$$\Delta \pi_{i,t}^{-} = \mu_{16i} + \phi_{16i}^{-}\xi_{i,t-1}^{-} + \sum_{j=1}^{p} \alpha_{16ij}^{-}\Delta \pi_{i,t-j}^{-} + \sum_{j=1}^{q} \delta_{16ij}^{+}\Delta L_{i,t-j}^{+} + \sum_{j=1}^{r} \lambda_{16ij}^{+}\Delta R_{i,t-j}^{+} + \sum_{j=1}^{s} \tau_{16ij}^{+}\Delta Y_{i,t-j}^{+} + \varepsilon_{16i,t} \quad (20)$$

where

$$V_{i,t}^{+} = \sum_{k=1}^{t} \Delta V_{ik}^{+} = \sum_{k=1}^{t} \max(\Delta V_{ik}^{+}, 0) \quad (21)$$

and V represent L, R, Y, or π; and $\xi_{i,t-1}$'s in Equations (5) and (20) are the error-correction terms capturing the long-run equilibrium. All other variables have been explained.

The asymmetric short-run causal effect, for example, running from $R_{i,t}^{+}$ to $L_{i,t}^{+}$, is captured by Equation (5), which is given by the rejection of the null hypothesis that all λ_{1ij}^{+}'s are equal to zero using the Wald (1943) test. However, the asymmetric long-run causality exists if the null hypothesis that ϕ_{1i}^{+} equals zero is rejected using the *t*-statistic. The same applies to all other combinations in Equations (5) and (20).

4. Results

4.1. Cross-Sectional Dependence

Given that the selected SSA countries could have been affected by any shocks emanating from one of the economies within the chosen sample, this study tested for such cross-sectional dependence using the Lagrange multiplier (LM) (Breusch and Pagan, 1980), scaled LM (Pesaran, 2004, 2021), bias-adjusted LM (Pesaran et al., 2008) and cross-sectional dependence (CD) (Pesaran, 2004, 2021) tests. The results for all these tests are given in Table 1. The test statistics rejected the null hypothesis of no error cross-correlations for all variables.

Table 1 Test statistics for cross-sectional dependence

Variables	Pesaran scaled LM	Breusch-Pagan scaled LM	Bias-corrected scaled LM	Pesaran CD
L	6.73***	404.03***	6.20***	5.50***
R_{EB}	60.93***	1140.83***	60.54***	18.28***
R_{BC}	99.49***	2490.87***	98.96***	8.82***
R_{AR}	82.41***	2106.70***	81.88***	20.32***
R_{CR}	127.24***	3115.16***	126.72***	37.40***
Y	3.18***	324.59***	2.66***	2.85***
π	25.02***	815.89***	24.50***	17.61***

*Notes: This table provides test statistics for cross-sectional dependence based on the errors from the 1st order augmented Dickey-Fuller [ADF(1)] regressions with a constant and a trend (the results remained generally robust in other lag orders of p = 2, 3, 4); L = bank credit delivery; R_{EB} = banking entry barriers; R_{BC} = mixing of banking and commerce restrictions; R_{AR} = banking activity restrictions; R_{CR} = banking capital regulations; Y = economic growth; π = inflation; *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

4.2. Panel Unit Root

The study used the cross-sectionally augmented Im-Pesaran-Shin (CIPS) panel unit root test, which controls for residual cross-sectional dependence and heterogeneity (Pesaran, 2007). The results of this test are provided in Table 2. The test statistics for CIPS with a constant and a

trend failed to reject the null hypothesis of unit root for all given variables in levels. However, these statistics rejected this null when the variables were in first differences. Therefore, all variables were considered to be $I(1)$.

Table 2 Test statistics for panel unit root

Variables	CIPS
With a constant	
ΔL	-3.14***
ΔR_{EB}	-3.06***
ΔR_{BC}	-4.48***
ΔR_{AR}	-4.52***
ΔR_{CR}	-4.64***
ΔY	-3.78***
$\Delta \pi$	-3.57***
L	-1.88
R_{EB}	-0.38
R_{BC}	-1.37
R_{AR}	-1.33
R_{CR}	-0.66
Y	-1.56
π	-2.11*
With a constant and a trend	
L	-1.82
R_{EB}	-1.59
R_{BC}	-1.78
R_{AR}	-2.16
R_{CR}	-2.27
Y	-1.92
π	-1.78

*Notes: This table provides test statistics for panel unit root based on the errors from the 1st order augmented Dickey-Fuller [ADF(1)] regressions with a constant and a trend (the results remained generally robust in other lag orders of p = 2, 3, 4); CIPS statistics are cross-section averages of p-th-order cross-sectionally augmented Dickey-Fuller (CADF) test statistics; Δ = first difference operator; L = bank credit delivery; R_{EB} = banking entry barriers; R_{BC} = mixing of banking and commerce restrictions; R_{AR} = banking activity restrictions; R_{CR} = banking capital regulations; Y = economic growth; π = inflation; *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

4.3. Panel Cointegration

The study used a two-stage second-generation error-based cointegration method since the structure of the panel data in this study had $N = 23$ and $T = 23$, with the latter not being significantly large (Holly et al., 2010; Banerjee and Carrion-i-Silvestre, 2017). First, the study estimated the long-run models. Second, it subjected the obtained errors to the CIPS panel unit root test to examine the presence of cointegration. Table 3 gives the test statistics for panel cointegration. The CIPS statistics significantly rejected the null hypothesis of unit root on the obtained errors in all the specified models. Thus, the study concluded that there was cointegration among variables.

Table 3 Test statistics for panel cointegration

Model	CIPS (with a constant)
$L = f(R_{EB}, Y, \pi)$	-3.71***
$R_{EB} = f(L, Y, \pi)$	-3.12***
$Y = f(L, R_{EB}, \pi)$	-3.92***
$\pi = f(L, R_{EB}, Y)$	-6.19***
$L = f(R_{BC}, Y, \pi)$	-4.20***
$R_{BC} = f(L, Y, \pi)$	-4.70***
$Y = f(L, R_{BC}, \pi)$	-4.07***
$\pi = f(L, R_{BC}, Y)$	-5.08***
$L = f(R_{AR}, Y, \pi)$	-3.69***
$R_{AR} = f(L, Y, \pi)$	-3.86***
$Y = f(L, R_{AR}, \pi)$	-4.02***
$\pi = f(L, R_{AR}, Y)$	-5.91***
$L = f(R_{CR}, Y, \pi)$	-3.72***
$R_{CR} = f(L, Y, \pi)$	-6.19***
$Y = f(L, R_{CR}, \pi)$	-4.05***
$\pi = f(L, R_{CR}, Y)$	-5.96***

*Notes: This table provides test statistics for panel cointegration based on the errors of the specified long-run models; 1st order cross-sectionally augmented Im-Pesaran-Shin [CIPS(1)] statistics, which are cross-section averages of 1st order cross-sectionally augmented Dickey-Fuller [CADF(1)] test statistics are reported (the results remained generally robust in other lag orders of p = 2, 3, 4); L = bank credit delivery; R_{EB} = banking entry barriers; R_{BC} = mixing of banking and commerce restrictions; R_{AR} = banking activity restrictions; R_{CR} = banking capital regulations; Y = economic growth; π = inflation; *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

4.4. Symmetric Granger Causality

The study first tested for the symmetric causality between banking regulatory measures and bank credit delivery within a multivariate panel Granger-causality framework. Table 4 reports the results for symmetric long- and short-run causality in the selected SSA countries. The Chi-squared statistics were employed to test for Granger causality in the short run, while the t-statistics for the coefficients of the error-correction term were used to determine the long-run causality.

The results in Table 4 indicated that bidirectional long-run symmetric causality existed between banking entry barriers (or mixing of banking and commerce restrictions, or banking capital regulations), bank credit delivery, economic growth and inflation, as well as between banking activity restrictions, bank credit delivery and economic growth in the selected SSA countries. Furthermore, there was bidirectional short-run symmetric causality between banking entry barriers and the delivery of bank credit, as well as a one-way short-run causal flow from bank credit delivery to banking capital regulations. Other results from Table 4 revealed that the selected SSA economies exhibited unidirectional short-run causality running from banking

entry barriers to economic growth. There was also bidirectional short-run causality between bank credit delivery and economic growth, under all models with banking regulatory measures.

Table 4 Results for symmetric causality

Dependent variable	Source of causation (independent variables)				
	Short run				Long run
Models with banking entry barriers					
	$\Delta(L)$	$\Delta(R_{EB})$	$\Delta(Y)$	$\Delta(\pi)$	ETC_{t-1}
$\Delta(L)$	-	3.51*	38.14***	0.02	-0.67***
$\Delta(R_{EB})$	3.79*	-	0.43	1.00	-0.74***
$\Delta(Y)$	3.67*	3.51*	-	0.53	-0.62***
$\Delta(\pi)$	1.32	0.76	0.01	-	-0.0004**
Models with mixing of banking and commerce restrictions					
	$\Delta(L)$	$\Delta(R_{BC})$	$\Delta(Y)$	$\Delta(\pi)$	ETC_{t-1}
$\Delta(L)$	-	0.94	38.20***	0.00	-0.69***
$\Delta(R_{BC})$	0.54	-	0.35	0.00	-0.86***
$\Delta(Y)$	3.48*	0.00	-	0.00	-0.65***
$\Delta(\pi)$	1.11	0.21	0.01	-	-0.0003*
Models with banking activity restrictions					
	$\Delta(L)$	$\Delta(R_{AR})$	$\Delta(Y)$	$\Delta(\pi)$	ETC_{t-1}
$\Delta(L)$	-	0.03	39.10***	0.03	-0.64***
$\Delta(R_{AR})$	1.04	-	0.03	0.00	-0.70***
$\Delta(Y)$	2.95*	2.19	-	0.11	-0.57***
$\Delta(\pi)$	1.04	0.66	0.01	-	-0.0003
Models with banking capital regulations					
	$\Delta(L)$	$\Delta(R_{CR})$	$\Delta(Y)$	$\Delta(\pi)$	ETC_{t-1}
$\Delta(L)$	-	0.68	38.22***	0.03	-0.72***
$\Delta(R_{CR})$	3.99**	-	0.28	0.01	-1.00***
$\Delta(Y)$	3.20*	0.15	-	0.03	-0.65***
$\Delta(\pi)$	1.15	0.30	0.01	-	-0.0004*

*Notes: This table provides the results for symmetric causality; Chi-squared statistics are reported for the short run; coefficients for an error-correction term (ECT) are reported for the long run; Δ is the first difference operator; L = bank credit delivery; R_{EB} = banking entry barriers; R_{BC} = mixing of banking and commerce restrictions; R_{AR} = banking activity restrictions; R_{CR} = banking capital regulations; Y = economic growth; π = inflation; *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

4.5. Asymmetric Granger Causality

The study further tested for the asymmetric causality between banking regulation and bank credit delivery within a multivariate panel Granger-causality framework. Tables 5 to 8 present the asymmetric long- and short-run causality results for models with banking entry barriers, mixing of banking and commerce restrictions, banking activity restrictions and banking capital regulations, respectively, in the selected SSA economies. Many significant coefficients of the error-correction term under different models supported the existence of long-run asymmetric causality between banking regulatory measures, bank credit delivery, economic growth and/or inflation.

In the short run, the Chi-squared statistics indicated that there were one-way causal flows from i) positive shocks to bank credit delivery to negative shocks to banking entry barriers, banking activity restrictions or banking capital regulations (Table 5, Table 7 and Table 8), and ii) negative shocks to mixing of banking and commerce restrictions to positive or negative shocks to bank credit delivery (Table 6). Other findings showed that unidirectional causality existed, running from i) negative shocks to bank credit delivery to positive shocks to economic growth (Table 5 to Table 8), ii) positive shocks to economic growth to positive shocks to bank credit delivery (Table 5 to Table 8), iii) positive shocks to economic growth to negative shocks to bank credit delivery (Table 5 to Table 8), iv) negative shocks to economic growth to negative shocks to bank credit delivery (Table 5 to Table 8), v) negative shocks to economic growth to positive shocks to bank credit delivery (Table 6 to Table 8), vi) positive shocks to banking entry barriers to negative shocks to economic growth (Table 5), vii) negative shocks to economic growth to positive or negative shocks to inflation (Table 5, Table 6 and Table 8), viii) positive shocks to economic growth to negative shocks to inflation (Table 5, Table 7 and Table 8), ix) negative shocks to inflation to positive shocks to banking entry barriers or banking activity restrictions (Table 5 and Table 7), x) negative shocks to inflation to positive shocks to economic growth (Table 6 and Table 7), and xi) negative shocks to inflation to positive shocks to economic growth (Table 8). Thus, different shocks to these variables did not have the same causal effect.

Table 5 Results for asymmetric causality (models with banking entry barriers)

Dependent variable	Source of causation (independent variables)				
	Short run				Long run
	$\Delta(L^+)$	$\Delta(R_{EB}^+)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	ETC_{t-1}
$\Delta(L^+)$	-	0.16	36.19***	0.39	-0.03*
$\Delta(R_{EB}^+)$	0.02	-	0.23	1.60	-0.001
$\Delta(Y^+)$	1.01	0.84	-	2.32	-0.04
$\Delta(\pi^+)$	0.06	0.46	0.26	-	0.23**
	$\Delta(L^+)$	$\Delta(R_{EB}^-)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(L^+)$	-	1.02	8.32***	0.06	-0.31***
	$\Delta(L^-)$	$\Delta(R_{EB}^+)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(R_{EB}^+)$	0.98	-	0.27	33.62***	-0.39***
	$\Delta(L^-)$	$\Delta(R_{EB}^-)$	$\Delta(Y^+)$	$\Delta(\pi^-)$	
$\Delta(Y^+)$	4.47**	2.58	-	2.16	-0.29***
	$\Delta(L^-)$	$\Delta(R_{EB}^-)$	$\Delta(Y^-)$	$\Delta(\pi^+)$	
$\Delta(\pi^+)$	2.06	0.31	1.40	-	0.02***
	$\Delta(L^-)$	$\Delta(R_{EB}^-)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(L^-)$	-	1.13	6.67**	0.90	-0.65***
$\Delta(R_{EB}^-)$	0.01	-	0.18	0.25	-0.46***
$\Delta(Y^-)$	0.34	1.09	-	0.08	-0.49***
$\Delta(\pi^-)$	0.45	0.06	28.46***	-	-0.79***
	$\Delta(L^-)$	$\Delta(R_{EB}^+)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	
$\Delta(L^-)$	-	0.04	21.92***	0.42	-0.71***
	$\Delta(L^+)$	$\Delta(R_{EB}^-)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	
$\Delta(R_{EB}^-)$	7.56***	-	0.03	0.03	-0.85***
	$\Delta(L^+)$	$\Delta(R_{EB}^+)$	$\Delta(Y^-)$	$\Delta(\pi^+)$	
$\Delta(Y^-)$	1.85	3.56*	-	0.01	-0.69***
	$\Delta(L^+)$	$\Delta(R_{EB}^+)$	$\Delta(Y^+)$	$\Delta(\pi^-)$	
$\Delta(\pi^-)$	0.33	1.14	4.62**	-	-0.70***

*Notes: This table provides the results for asymmetric causality (models with banking entry barriers); Chi-squared statistics are reported for the short run; coefficients for an error-correction term (ECT) are reported for the long run; Δ is the first difference operator; $+ =$ positive shock; $- =$ negative shock; $L =$ bank credit delivery; $R_{EB} =$ banking entry barriers; $Y =$ economic growth; $\pi =$ inflation; *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

Table 6 Results for asymmetric causality (models with mixing of banking and commerce restrictions)

Dependent variable	Source of causation (independent variables)				
	Short run				Long run
	$\Delta(L^+)$	$\Delta(R_{BC}^+)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	ETC_{t-1}
$\Delta(L^+)$	-	0.19	36.30***	0.82	-0.05**
$\Delta(R_{BC}^+)$	0.00	-	0.01	0.30	-0.74***
$\Delta(Y^+)$	1.18	2.08	-	1.96	-0.10**
$\Delta(\pi^+)$	0.16	1.68	0.00	-	-0.35***
	$\Delta(L^+)$	$\Delta(R_{BC}^-)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(L^+)$	-	2.90*	8.80***	0.02	-0.01
	$\Delta(L^-)$	$\Delta(R_{BC}^+)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(R_{BC}^+)$	0.10	-	0.25	0.82	-0.53***
	$\Delta(L^-)$	$\Delta(R_{BC}^-)$	$\Delta(Y^+)$	$\Delta(\pi^-)$	
$\Delta(Y^+)$	4.38**	0.52	-	3.05*	-0.01
	$\Delta(L^-)$	$\Delta(R_{BC}^-)$	$\Delta(Y^-)$	$\Delta(\pi^+)$	
$\Delta(\pi^+)$	1.62	1.54	1.25	-	0.01
	$\Delta(L^-)$	$\Delta(R_{BC}^-)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(L^-)$	-	5.22**	7.51***	1.15	-0.72***
$\Delta(R_{BC}^-)$	0.00	-	0.03	0.86	-0.43***
$\Delta(Y^-)$	0.12	0.01	-	0.05	-0.52***
$\Delta(\pi^-)$	0.42	0.19	31.86***	-	-0.89***
	$\Delta(L^-)$	$\Delta(R_{BC}^+)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	
$\Delta(L^-)$	-	0.65	25.81***	0.54	-0.51***
	$\Delta(L^+)$	$\Delta(R_{BC}^-)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	
$\Delta(R_{BC}^-)$	1.54	-	0.18	0.48	-0.01
	$\Delta(L^+)$	$\Delta(R_{BC}^+)$	$\Delta(Y^-)$	$\Delta(\pi^+)$	
$\Delta(Y^-)$	0.72	0.00	-	0.00	-0.70***
	$\Delta(L^+)$	$\Delta(R_{BC}^+)$	$\Delta(Y^+)$	$\Delta(\pi^-)$	
$\Delta(\pi^-)$	0.05	0.30	1.48	-	-1.05***

*Notes: This table provides the results for asymmetric causality (models with mixing of banking and commerce restrictions); Chi-squared statistics are reported for the short run; coefficients for an error-correction term (ECT) are reported for the long run; Δ is the first difference operator; $+$ = positive shock; $-$ = negative shock; L = bank credit delivery; R_{BC} = mixing of banking and commerce restrictions; Y = economic growth; π = inflation; *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

Table 7 Results for asymmetric causality (models with banking activity restrictions)

Dependent variable	Source of causation (independent variables)				
	Short run				Long run
	$\Delta(L^+)$	$\Delta(R_{AR}^+)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	ETC_{t-1}
$\Delta(L^+)$	-	0.00	3.35*	1.94	-1.83***
$\Delta(R_{AR}^+)$	0.57	-	0.65	0.31	-0.03
$\Delta(Y^+)$	1.87	0.89	-	0.43	-0.52***
$\Delta(\pi^+)$	0.10	0.18	0.88	-	-0.08***
	$\Delta(L^+)$	$\Delta(R_{AR}^-)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(L^+)$	-	0.06	8.40***	0.09	-0.29***
	$\Delta(L^-)$	$\Delta(R_{AR}^+)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(R_{AR}^+)$	0.00	-	0.16	2.84*	-0.34***
	$\Delta(L^-)$	$\Delta(R_{AR}^-)$	$\Delta(Y^+)$	$\Delta(\pi^-)$	
$\Delta(Y^+)$	5.42**	6.41**	-	3.50*	-0.01
	$\Delta(L^-)$	$\Delta(R_{AR}^-)$	$\Delta(Y^-)$	$\Delta(\pi^+)$	
$\Delta(\pi^+)$	0.57	0.44	2.04	-	0.05***
	$\Delta(L^-)$	$\Delta(R_{AR}^-)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(L^-)$	-	0.02	7.51***	0.76	-0.70***
$\Delta(R_{AR}^-)$	1.03	-	2.53	0.89	-0.02
$\Delta(Y^-)$	0.14	0.00	-	0.00	-0.49***
$\Delta(\pi^-)$	0.56	0.03	28.08***	-	-0.80***
	$\Delta(L^-)$	$\Delta(R_{AR}^+)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	
$\Delta(L^-)$	-	0.01	20.68***	0.40	-0.67***
	$\Delta(L^+)$	$\Delta(R_{AR}^-)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	
$\Delta(R_{AR}^-)$	2.81*	-	1.18	0.26	0.002
	$\Delta(L^+)$	$\Delta(R_{AR}^+)$	$\Delta(Y^-)$	$\Delta(\pi^+)$	
$\Delta(Y^-)$	1.48	0.18*	-	0.03	-0.68***
	$\Delta(L^+)$	$\Delta(R_{AR}^+)$	$\Delta(Y^+)$	$\Delta(\pi^-)$	
$\Delta(\pi^-)$	0.43	0.37	4.91**	-	-0.70***

*Notes: This table provides the results for asymmetric causality (models with banking activity restrictions); Chi-squared statistics are reported for the short run; coefficients for an error-correction term (ECT) are reported for the long run; Δ is the first difference operator; $+ =$ positive shock; $- =$ negative shock; $L =$ bank credit delivery; $R_{AR} =$ banking activity restrictions; $Y =$ economic growth; $\pi =$ inflation; *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

Table 8 Results for asymmetric causality (models with banking capital regulations)

Dependent variable	Source of causation (independent variables)				
	Short run				Long run
	$\Delta(L^+)$	$\Delta(R_{CR}^+)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	ETC_{t-1}
$\Delta(L^+)$	-	0.11	10.60***	0.04	-0.44***
$\Delta(R_{CR}^+)$	0.24	-	0.00	0.24	-0.0002
$\Delta(Y^+)$	1.55	2.43	-	2.41	-0.007
$\Delta(\pi^+)$	0.02	0.76	0.94	-	-1.10***
	$\Delta(L^+)$	$\Delta(R_{CR}^-)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(L^+)$	-	0.14	9.19***	0.02	-0.02
	$\Delta(L^-)$	$\Delta(R_{CR}^+)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(R_{CR}^+)$	1.28	-	0.46	0.00	0.03
	$\Delta(L^-)$	$\Delta(R_{CR}^-)$	$\Delta(Y^+)$	$\Delta(\pi^-)$	
$\Delta(Y^+)$	4.61**	0.02	-	2.90*	0.0004
	$\Delta(L^-)$	$\Delta(R_{CR}^-)$	$\Delta(Y^-)$	$\Delta(\pi^+)$	
$\Delta(\pi^+)$	1.15	0.57	1.43	-	0.02*
	$\Delta(L^-)$	$\Delta(R_{CR}^-)$	$\Delta(Y^-)$	$\Delta(\pi^-)$	
$\Delta(L^-)$	-	2.03	6.06**	0.82	-0.37***
$\Delta(R_{CR}^-)$	0.64	-	0.03	1.07	-0.04
$\Delta(Y^-)$	0.22	0.16	-	0.01	-0.45***
$\Delta(\pi^-)$	0.29	0.54	31.81***	-	-0.68***
	$\Delta(L^-)$	$\Delta(R_{CR}^+)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	
$\Delta(L^-)$	-	0.15	29.29***	0.17	-0.52***
	$\Delta(L^+)$	$\Delta(R_{CR}^-)$	$\Delta(Y^+)$	$\Delta(\pi^+)$	
$\Delta(R_{CR}^-)$	3.20*	-	0.07	0.24	0.002
	$\Delta(L^+)$	$\Delta(R_{CR}^+)$	$\Delta(Y^-)$	$\Delta(\pi^+)$	
$\Delta(Y^-)$	2.35	2.12	-	0.03	-0.73***
	$\Delta(L^+)$	$\Delta(R_{CR}^+)$	$\Delta(Y^+)$	$\Delta(\pi^-)$	
$\Delta(\pi^-)$	0.01	0.01	11.10***	-	-0.78***

*Notes: This table provides the results for asymmetric causality (models with banking capital regulations); Chi-squared statistics are reported for the short run; coefficients for an error-correction term (ECT) are reported for the long run; Δ is the first difference operator; $+ =$ positive shock; $- =$ negative shock; $L =$ bank credit delivery; $R_{CR} =$ banking capital regulations; $Y =$ economic growth; $\pi =$ inflation; *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.*

5. Discussions

The results showed that there was bidirectional long-run symmetric causality between banking regulatory measures, bank credit delivery, economic growth and/or inflation in the selected SSA countries. There was also bidirectional short-run symmetric causality between banking entry barriers and the delivery of bank credit, as well as a one-way short-run causal flow from bank credit delivery to banking capital regulations. These findings support the hypothesis that causal relationship exists between institutions and economic performance measures (Law et al., 2013; North, 1990; Rosenberg and Birdzel, 1986). Thus, in line with Patrick (1966), banking regulation causes the delivery of bank credit, possibly at the early stages of financial development, while, at the later stages, banking regulation follows developments in bank credit delivery.

The estimated results further revealed that the selected SSA countries experienced bidirectional short-run symmetric causality between bank credit delivery and economic growth. This confirms that while the delivery of bank credit promotes financial development and growth, economic growth also influences bank credit delivery since economies with more income normally have larger credit markets with increased provision of financial services (Cottarelli et al., 2005; Djankov et al., 2007).

On top of the long-run asymmetric causality between banking regulatory measures, bank credit delivery, economic growth and/or inflation, one-way short-run causal flows existed running from positive shocks to bank credit delivery to negative shocks to banking entry barriers, banking activity restrictions or banking capital regulations. These findings support the notion that past developments in bank credit delivery, especially positive ones, influenced the current stringency of banking regulatory measures (Deli and Hasan, 2017; Fratzscher et al., 2016; Kim et al., 2014). Finally, the other results highlighted that shocks to bank credit delivery also responded to previous reforms in banking regulation, particularly shocks to the restrictions on the mixing of banking and commerce.

6. Conclusions

Reforms in banking regulation are meant to foster financial stability and enhance sustainable bank credit delivery to the private sector. While the evolving structure of the financial system can lead to increased delivery of credit, it can also pose new financial risks that require the

existing banking laws and regulations to be revised. Therefore, this study examined the symmetric and asymmetric causal relationship between banking regulation and bank credit delivery in 23 SSA countries during the period 1995-2017 using the error correction-based multivariate panel Granger-causality models. The symmetric causality results indicated that there was bidirectional long-run causal relationship between banking regulatory measures, bank credit delivery, economic growth and/or inflation in the selected SSA economies. Furthermore, bidirectional short-run symmetric causality existed between banking entry barriers and the delivery of bank credit, as well as a one-way short-run causal flow running from the delivery of bank credit to banking capital regulations. These findings support the hypothesis that causal association exists between institutions and economic performance measures (Law et al., 2013; North, 1990; Rosenberg and Birdzel, 1986).

In the case of asymmetric causality, the results generally confirmed the existence of long-run causality between shocks to banking regulatory measures, bank credit delivery, economic growth and/or inflation. In the short run, there was evidence of one-way causal flows from positive shocks to bank credit delivery to negative shocks to banking entry barriers, banking activity restrictions or banking capital regulations, and from negative shocks to mixing of banking and commerce restrictions to positive or negative shocks to bank credit delivery. The first finding is in accordance with the notion that past developments in bank credit delivery, especially positive ones, influence the current stringency of banking regulatory measures (Deli and Hasan, 2017; Fratzscher et al., 2016; Kim et al., 2014). However, the last finding showed that the delivery of bank credit also responded to previous reforms in bank regulation, particularly shocks to the restrictions on the mixing of banking and commerce.

In terms of policy implications, the findings suggested that policymakers needed to take into consideration not just the short-term but also the long-term causal effects of reforms aimed at enhancing bank regulation or bank credit since their past developments have a bearing on their current long-run paths. Furthermore, regulators should be aware that positive and negative shocks to bank regulatory measures have different causal effects. As a result, bank regulatory reforms should be well-targeted and well-designed for them to stimulate bank credit. Lastly, policymakers should promote economic growth as it is necessary to stimulate the delivery of bank credit and promote banking development.

Nevertheless, the encountered data availability constraints limited the study to focus on a panel of selected SSA economies. As more data become available in the future, it would be important to undertake single-country analyses to determine whether the tested hypothesis in this study would still hold. Moreover, the econometric approach used in this study was only appropriate for analysing the existence of first-round effects in the nexus between banking regulation and bank credit delivery. In future, it would be of interest for other studies to account for second-round effects when assessing the relationship between banking regulation and credit delivery to see if the observed causal effects would be reduced or exacerbated.

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Appendix

Table A1 Data sources and description of variables

Variable Names	Data Sources	Description
Bank credit delivery	World Bank's Financial Development and Structure; World Bank's Global Financial Development; International Monetary Fund's International Financial Statistics	The delivery of credit to the domestic private sector by banks as a fraction of GDP
Banking entry barriers	World Bank's Bank Regulation and Supervision Surveys	Licensing and foreign ownership requirements of banks (index normalized to one)
Mixing of banking and commerce restrictions	World Bank's Bank Regulation and Supervision Surveys	The degree of limitations on ownership and control between banks, non-bank financial firms and non-financial firms (index normalized to one)
Banking activity restrictions	World Bank's Bank Regulation and Supervision Surveys	Limits imposed on banks in terms of participating in securities, insurance and real estate markets (index normalized to one)
Banking capital regulations	World Bank's Bank Regulation and Supervision Surveys	The stringency of regulatory requirements regarding banking capital (index normalized to one)
Economic growth	International Monetary Fund's World Economic Outlook; World Bank's World Development Indicators	Log of real GDP (in purchasing power parity using the 2011 international dollar)
Inflation	International Monetary Fund's World Economic Outlook / World Bank's World Development Indicators	Log of consumer price index

Source: Adapted from Thamae and Odhiambo (2022b).

Table A2 Descriptive statistics

Variables	Observations	Mean	Standard deviation	Minimum	Maximum
L	529	0.20	0.18	0.01	1.03
R_{EB}	529	0.56	0.08	0.38	0.75
R_{BC}	529	0.63	0.11	0.33	0.92
R_{AR}	529	0.66	0.12	0.42	1.00
R_{CR}	529	0.66	0.16	0.30	1.00
Y	529	24.00	1.40	21.14	27.66
π	529	4.33	1.03	-6.91	6.06

Notes: This table provides descriptive statistics; $L =$ bank credit delivery; $R_{EB} =$ banking entry barriers; $R_{BC} =$ mixing of banking and commerce restrictions; $R_{AR} =$ banking activity restrictions; $R_{CR} =$ banking capital regulations; $Y =$ economic growth; $\pi =$ inflation.

Table A3 Correlation matrix

Variables	L	R_{EB}	R_{BC}	R_{AR}	R_{CR}	Y	π
L	1.00						
R_{EB}	-0.30**	1.00					
R_{BC}	-0.03	-0.18**	1.00				
R_{AR}	-0.08	0.03	0.01	1.00			
R_{CR}	0.06	0.20**	0.03	0.13**	1.00		
Y	0.25**	0.24**	-0.21**	-0.15**	0.16**	1.00	
π	0.11**	0.09**	0.30**	-0.30**	0.08	0.07	1.00

*Notes: This table provides the correlation matrix; L = bank credit delivery; R_{EB} = banking entry barriers; R_{BC} = mixing of banking and commerce restrictions; R_{AR} = banking activity restrictions; R_{CR} = banking capital regulations; Y = economic growth; π = inflation; ** represents 5% significance level or stronger.*