An Asymmetric Money-Income Relationship in Gambia: A Test of Monetary and Real Business Cycle Hypotheses

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Abstract

This paper investigates asymmetric money-income relationship in Gambia. Critical values are simulated based on leverage bootstrapping and asymmetric causality test. The results are compared between the Granger asymptotic chi-square distribution, modified WALD test with leverage bootstrapped distribution and asymmetric causality test. The traditional Granger causality test and Toda-Yamamoto modified WALD test with leverage bootstrapped critical values reveal a neutrality of money based on rational expectation hypothesis. However, the asymmetric causality test reveals bidirectional causality between money and income. This supports both the monetary and real business cycle hypotheses for Gambia. The result shows that positive and negative cumulative real money supply shocks influence positive and negative cumulative real income in the economy and vice versa. The growth of money supply in relation to expected wage rate at the point of long term negotiation leads to an increase in inflation which lower real wages. The lower real wages results in higher output/income in the economy. Furthermore, the reaction of the Gambian financial system to money demand causes changes in the economy's money growth in both good and bad times. The policy implication of this study is that the monetary authority of Gambia can stabilize the severity of sudden shocks in the business cycle by manipulating both the real money supply and real income irrespective of good or bad times.

Keywords: Asymmetric causality, Leverage bootstrap, Toda-Yamamoto, money, income, Gambia

1. Introduction

The economy of Gambia experienced a unique output and money growth due to its heavy dependence on peanut export. One of the challenges of monetary authorities in developing countries is the issue of appropriate monetary policies in relation to money and income. The appropriate policies are hindered due to spurious inferences drawn on the direction of influence between the variables. This has been a problem of monetary authorities and macroeconomists (Hatemi-J and Irandoust, 2006). The use of monetary policy to enhance the economic growth of Gambia was hampered by the political risk of the country (Corr & Vadsaria, 2013). Besides, the income growth rate has been fluctuating due to the political risk which reflected the poor investment and unstable level of income of the economy.

The money-income relationship is widely studied in the developed and emerging economies. However, the studies are virtually lacking in the developing countries such as Gambia. Moreover, the previous studies use a restrictive assumption of equal response to both positive and negative shocks on testing causality despite the proposition of the asymmetric information hypothesis. Moreover, the previous studies do not consider the effect of structural breaks especially in the developing countries where the data generating process is characterized by structural changes. Furthermore, unlike Muhd-Zulkhibri (2007) who employ a three variables vector using Toda-Yamamoto causality test in the context of Malaysia, and Katafono (2000) who used VAR to study the relationship between monetary aggregate, output and inflation in Fiji and George *et al.*, (2018) who investigate the impact of money supply on macroeconomic variables in Nigeria using ordinary least squares technique, this study is conducted on Gambia using the leverage bootstrap asymmetric causality in addition to Toda-Yamamoto (1995) modified causality approach. This methods work better in the presence of ARCH effect and violation of the normality assumption. The method also solves the problem of nuisance parameter estimates and size distortion under small sample size (Guru Gharana, 2012). In addition, the study modeled five variables VAR to avoid estimation bias unlike previous studies which mostly employ bivariate models. The study also distinguishes between causality in good and bad times using asymmetric causality test.

The rest of the sections are organized as follows: section 2 provides literature review; Section 3 presents the theoretical framework; Section 4 deals with data and methodology; Section 5 discusses the empirical results and section 6 presents conclusions and policy implication of the findings.

2. Review of literature

Since the work of David Hume in 1752 that hypothesized a proportional linkage between prices and money, the nature of causality between money and income has been a controversial debate in the literature. Keynes concludes that income is not severely affected by changes in the supply of money. However, the monetarists see changes in income to be caused by money (Hossain, 2011). The causality among the variables has been examined by Sims (1972) using post-war US data which reveals a unidirectional causality running from money to income without feedback causal effect. However, Sims (1980) controlled for other explanatory variables than income and money. The result indicates no causality between the variables when short-term interest rate was included in the model. The former version of the argument is been supported by numerous studies in both developed and emerging economies. These studies include; Abbas and Rizavi (1991); Ahmed (2002); Ahmed, Asad and Hussain (2013); Choudhry (2002); Freeman (1992); Hossain (2011); Lee and Yang (2012); Thoma (1994); Yadav (2008).

Nevertheless, some findings reveal that the causality runs from income to money supply. These findings are reported by Al-Jarrah (1996); Palalamai, Mariappan and Devakumar (2014) and Yadav (2008). Besides the two conflicting nature of causality between income and money, the other division of the literature indicates a feedback causality between money and income. The findings are summarized in Abbas and Rizavi (1991); Auerbach and Rutner (1975); Bozoklu (2013); Choudhry (2002);

Hossain (2011); Rami (2010) Shams (2012); Tsukuda and Miyakoshi (1998) and Yadav (2008). Conversely, some studies established neutrality of the money-income relationship especially in a shorter sample periods (Auerbach and Rutner, 1975). Moreover, Abbas and Razavi (1991) found a similar result for India and Korea. Adesoye (2012) also examines cointegration and causality between output, money supply and inflation. The finding of the study reveals absence of causality between money and output in Nigeria. More so, Ahmed (2002) reports neutrality of money for India and Pakistan at least for the study period.

However, these studies suffer from non-standard asymptotic distribution, which leads to nuisance parameter estimates, rank deficiency and size distortion under the null hypothesis (Guru Gharana, 2012; Toda and Philips, 1993). Furthermore, except for Thoma (1994) the inability to distinguish between positive and negative shocks effect in the causality process also leads to different conclusions (Hatemi-J, 2012).

3. Theoretical Framework

Rigid wage models or the new Keynesian models from the perspectives of business cycle hypotheses are employed to underpin the study. The monetary-based business cycle considers changes in real output as a function of money supply growth rate (Gray, 1976; Blanchard, 1990). Taylor (1980) also presents a similar model with two periods staggered wage model. This occurs when money supply grows higher than the expected wage rate at the point of the long term negotiation which causes inflation in the economy and lower real wages. The lower real wages causes cheap labour and more output production (Fisher, 1977; Taylor, 1980). In line with this version of the theory Friedman and Schwartz (1963) also establish unidirectional link from money to real income. However, the real business cycle hypothesis argues that money growth is being caused by the real income, not vice versa. The theory in its original form associates real income with real shocks not necessarily money growth (Kydland & Prescott, 1982; Long & Plosser, 1983). Nevertheless, money growth is associated to output in the model because both money and output respond to the same shocks. This is based on the ability of the real sector to influence the financial decision of individuals which affect money demand (Hatemi-J & Irandoust, 2006). Moreover, it is postulated that changes in money supply are caused by the reaction of the financial system to money demand which leads output growth.

4. Data and Methodology

Data

This paper uses quarterly data from 1980Q1 to 2017Q4. The data on money supply (M2), real income, consumer price index, exchange rate and interest rate was collected from the International Financial Statistics (IFS). The other variables in the model aside real money supply and real income are taken as control variables.

Unit Root

Although the methodology of Toda-Yamamoto (1995) is applicable irrespective of the integration order of the variables (Hacker & Hatemi-J, 2006; Toda & Yamamoto, 1995), however, the study employs the Lee and Strazicich (2013) minimum LM with one structural break to determine the maximum order of the integration. The present unit root test is break point nuisance invariant under null and alternative hypothesis, unaffected by neither size nor location distortion. Furthermore, the test is free from spurious rejection and unaffected by the size and incorrect estimation whether the break exists or not (Lee & Strazicich, 2013).

Toda-Yamamoto Causality

This study applies asymmetric test on the modified Toda-Yamamoto (1995) methodology based on augmented VAR ($p+d_{max}$) model. This model performs better if the appropriate lag lengths are employed, no omitted important variable bias and a reasonable sample size is utilized (Zapata & Rambaldi, 1997). Following Toda and Yamamoto (1995); Shan and Sun (1998) and Zapata and Rambaldi (1997) methodology, the following VAR system is outlined:

$$\begin{bmatrix} LRY_t \\ LRM2_t \\ LCPI_t \\ LEXC_t \\ LINR_t \end{bmatrix} = B_0 + B_1 \begin{bmatrix} LRY_{t-1} \\ LRM2_{t-1} \\ LCPI_{t-1} \\ LEXC_{t-1} \\ LINR_{t-1} \end{bmatrix} + B_n \begin{bmatrix} LRY_{t-n} \\ LRM2_{t-n} \\ LCPI_{t-n} \\ LEXC_{t-n} \\ LINR_{t-n} \end{bmatrix} + \begin{bmatrix} \varepsilon_{LRY_t} \\ \varepsilon_{LRM2_t} \\ \varepsilon_{LCPI_t} \\ \varepsilon_{LEXC_t} \\ \varepsilon_{LINR_t} \end{bmatrix} \quad (1)$$

where *LRY, LRM2, LCPI, LEXC* and *LINR* represent logarithms of real income, real money supply, consumer price index, exchange rate and interest rate respectively. The symbol B_0 is a vector of constant values denoted as identity matrices whereas, $B_1 - B_n$ is a five by n vector of coefficients. To test the null hypothesis of whether real money supply causes real income or not, the following restriction is imposed $H_0 \ B_7^{(1)} = B_7^{(2)} = 0$ where $B_7^{(1)}, B_7^{(2)}$ are the coefficients of the two lag values of real money supply. Similarly, the second hypothesis that income does not Granger cause money is tested by imposing the following restrictions: $H_0 \ B_6^{(1)} = B_6^{(2)} = 0$ where $B_6^{(1)}, B_6^{(2)}$ are the coefficients of the two lags of real income. The significance of the *MWALD* statistics on the lagged values of the explanatory variables in the two hypotheses indicate the rejection of the null hypotheses of no Granger causality from real money to real income and the other way round respectively.

The correct lag length is chosen through testing the significance of the lags in Equation 1 for $p > k$ condition (Toda & Yamamoto, 1995) and minimizing the Hatemi-J (2003) information criterion described underneath.

$$HJC = ln\left(\left|\bigcap_z\right|\right) + z \times v^2 \left(\frac{\ln N + 2\ln(lnN)}{2N}\right) \quad z = 0, \ldots, p. \quad (2)$$

where *HJC* is the Hatemi-J information criterion, ln is the natural logarithm, $\left|\bigcap_z\right|$ represents the lag order z determinant of the estimated white noise variance-covariance matrix in the VAR framework, v and N denote the number of variables and observations used in the VAR model respectively. Furthermore, Equation 2 has been tested to work better especially if integration exists among the variables

(Hacker & Hatemi-J, 2006). However, when normality assumption is not fulfilled, and the ARCH effect exists, the usual asymptotic distribution theory does not work well (Hatemi-J & Irandoust, 2006; Hatemi-J, 2012). The study employs leverage distribution theory and asymmetric causality which are found to be more reliable in a finite sample study to avoid size distortion and spurious inferences.

Asymmetric causality

The asymmetric causality test is conducted following Hatemi-J (2012) methodology. The Toda-Yamamoto process is replicated while assuming positive and negative shocks. The following VAR(*p*) order is applied as shown in Equations 3 and 4 respectively.

$$x_t^+ = \xi + B_1 x_{t-1}^+ + \ldots + B_p x_{t-1}^+ + e_t^+ \quad (3)$$

$$x_t^- = \xi + B_1 x_{t-1}^- + \ldots + B_p x_{t-1}^- + e_t^- \quad (4)$$

here x_t^+ and x_t^- represent vector of positive and negative variables (real money supply, real income, consumer price index, exchange rate and interest rate) respectively. ξ is a vector of constant parameters. The symbol B is a vector of parameters to be estimated and e_t^+ and e_t^- denote the vector of both positive and negative error components for the cumulative sum and changes of positive and negative shocks respectively in the integrated and stationary variables model. The information criteria in Equation 2 is also adjusted to include the square of the number of the observations N^2 in the VAR model (Hatemi-J, 2012). The rest of the process is as presented in the previous and subsequent sections while taking into account asymmetric condition of positive and negative shocks.

We simulate the critical values of the leverage bootstrap and asymmetric causality test with GAUSS using the program procedure developed by Hacker and Hatemi-J (2010) and Hatemi-J (2012) respectively. The critical values are generated based on the underlying empirical data through bootstrap simulation. The iteration is conducted 10,000 times and *MWALD t*-statistics are estimated after every iteration to determine the upper quantile of the bootstrapped distribution of the *MWALD t*-statistics in order to generate 1%, 5% and 10% bootstrapped critical values. Lastly, the raw data rather than the bootstrapped one is utilized to calculate the *MWALD* statistics. The hypothesis of no Granger causality is rejected if the *MWALD* statistics calculated using the original data is greater than the bootstrapped critical values.

5. Empirical Results

Unit Root Result

The study investigates the maximum order of integration of the time series using LS test (Lee & Strazicich, 2013) to determine the data generating process of the variables[1]. The test establishes that the maximum order of integration for all variables in the model is found to be (1) order. This implies that the lag augmentation in estimating Toda-Yamamoto model is determined as one.

1- The result is not presented due to space limit but can be provided based on request.

Table 1 Test for ARCH effect and normality in the VAR model

Country	ARCH effect	Normality
Gambia	0.011***	0.000***

*** represents rejection of the null hypothesis at 1% significance level.

Source: *Author's Computation*

Table 1 shows that the null hypotheses of both ARCH effect and normality in the VAR model are rejected. The existence of ARCH effect and inability of the model to fulfill the normality assumption render the usual asymptotic distribution theory to be less effective (Hatemi-J & Irandoust, 2006; Hatemi-J, 2012). This leads to size distortion and nuisance parameter estimates in establishing causality (Hacker & Hatemi-J, 2006). Therefore, this study employs the more reliable leverage distribution theory and asymmetric causality test which perform better in the presence of non-normality and ARCH effect, as well as further, distinguish between positive and negative shocks in the causality analysis.

Table 2: The result of Granger, Toda-Yamamoto causality, and Bootstrap simulation

			Leverage Bootstrap		
The null hypothesis	Non-Granger causality	MWALD test statistics	1% CV	5% CV	10% CV
$LRM2 \neq> LRY$	0.247 (.624)	0.012	8.675	4.281	2.823
$LRM2^{+} \neq> LRY^{+}$		5.974*	11.509	7.378	5.459
$LRM2^{-} \neq> LRY^{-}$		8.104**	12.161	7.228	5.373
$LRY \neq> LRM2$	3.769 (.097)	2.123	7.767	3.964	2.693
$LRY^{+} \neq> LRM2^{+}$		5.934*	11.654	7.217	5.406
$LRY^{-} \neq> LRM2^{-}$		7.892**	12.778	7.431	5.393

***, ** & * represent rejection of the null hypothesis at 1%, 5% and 10% significance level. The symbol ≠> represents Granger non-causality. The figures enclose in parenthesis under column two represent the *p* values of Granger non-causality.

Source: *Authors computations using RATS and GAUSS versions 8 and 11 respectively.*

From Table 2 the Granger causality test and Toda-Yamamoto modified WALD test with leverage bootstrapped critical values reveal a neutrality of money based on rational expectation hypothesis. However, the Granger causality was developed and tested based on asymptotic critical values which lead to a spurious conclusion. Furthermore, Sims, Stock and Watson, (1990); Toda and Philips, (1993) argue that the null hypothesis of integrated Granger non-causality suffers from independence of nuisance parameter estimates.

On the other hand, Hatemi-J (2012) argues that the response to positive and negative asymmetric shocks lead to varying causal relationship. The asymmetric causality test reveals bidirectional causality between money and income. This supports both the monetary and real business cycle hypotheses for Gambia. The result shows that positive and negative cumulative real money supply shocks influence positive and negative cumulative real income in the economy and vice versa. The growth of money supply in relation to expected wage rate at the point of long term negotiation leads to an increase in inflation which lower real wages. The lower real wages results in higher output/income in the economy. Furthermore, the reaction of the Gambian financial system to money demand causes changes in the economy's money growth in both good and bad times. The results describe the significance of estimating asymmetric causality which differentiates between the nature of causality during positive and negative shocks.

6. Conclusions and policy implication

The paper establishes integration order of the series using Lagrange Multiplier Minimum test. The study further shows that presence of ARCH effect and non-normality of residuals lead to spurious inferences when asymptotic critical values are used to determine causality between variables. This is shown when the traditional Granger causality is estimated where there exists no causal relationship from either direction. The paper remedies the problem of the asymptotic Granger causality by employing leverage bootstrapping and further test if causality differs during good and bad times. The asymmetric causality based on the modified *WALD* test reveals bidirectional causality from both positive and negative cumulative real money supply shocks to real income and vice versa. The policy implication of this study is that the monetary authority of Gambia can stabilize the severity of sudden shocks in the business cycle by manipulating both the real money supply and real income irrespective of positive or negative shocks.

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