

1 **The Effectiveness Of Transmission Mechanisms Of**
2 **Monetary Policy In Sierra Leone**

3
4 **ABSTRACT**

5 Studies on the effectiveness on the effectiveness of transmission mechanisms of monetary
6 policy are crucial for an economy. It is essential to understand how effective are the channels
7 of monetary transmission in directing economic activities in Sierra Leone. In this case,
8 particular focus is on the interest rate, exchange rate, and credit channels. The analytical
9 methods used are unit root tests, cointegration, Granger causality test, impulse responses and
10 variance decomposition. Central to this investigation is the use of the Vector Autoregression
11 (VAR) approach to estimate time series annual data from 1980 to 2012. The cointegration
12 test result revealed that cointegration exists. The Granger causality test showed that gross
13 capital formation Granger causes exchange rate and real interest rate. The impulse response
14 function showed that output responded positively to monetary shocks, as interest rate
15 increased. For exchange rate and private domestic credit, output showed that even in the long
16 run, the effects of the shocks might not be transitory in order to converge towards a steady
17 state. The variance decomposition indicated that fluctuations in gross domestic product per
18 capita (GDPPC) were attributed to itself. While the total contribution of real interest rate
19 (RIR) and exchange rate (ER) was relatively insignificant. The error forecast of RIR was
20 attributed by itself with an insignificant contribution of GDPPC and none by ER and private
21 domestic credit (PDC). Fluctuations in forecasting ER were greatly attributed to itself and
22 trivial contributions by the other variables. As the trend fell, there was a slight increase in the

23 contribution of the other variables. The results provided evidence of ineffective channels in
24 the Sierra Leone economy.

25

26 Keywords: Impulse response function, variance decomposition, reparametrization; and
27 private domestic credit.

28

29 **1. INTRODUCTION**

30 Successful implementation of any monetary policy regime requires an accurate and informed
31 assessment of how fast the effects of policy changes propagate to other parts of the economy
32 and how large these effects are. In order to attain such, it requires a thorough understanding
33 of the mechanism through which monetary policy actions and other forms of shocks affect
34 economic activity. Specifically, such an understanding should provide an informed
35 assessment of the channels through which monetary policy affects prices and economic
36 activity. Most Central Banks that have been successful at controlling inflation and
37 stabilizing output within their domestic economies have done so largely through an
38 understanding of these mechanisms [1].

39

40 A useful way to understand monetary policy is to focus patently on central bank policy
41 actions and the transmission mechanisms through which those actions work their effect. The
42 central bank's policy rule embodies its response to deviations in macroeconomic variables in
43 order to achieve its ultimate policy objectives. Monetary transmission mechanism refers to
44 the process through which changes in monetary policy instruments (such as monetary
45 aggregates or short-term policy interest rates) affect the rest of the economy and, in

46 particular, output and inflation. Monetary policy impulses transmit through various channels,
47 affecting different variables and different markets, and at various speeds and intensities [2].

48

49 Monetary policy affects output and prices through its influence on key financial variables
50 such as interest rates, exchange rates, asset prices, credit and monetary aggregates. At the
51 same time, changes in the structure of the economy tend to alter the effects of a given
52 monetary policy measure. This requires central banks to continuously reinterpret monetary
53 transmission channels [3].

54

55 Since the inception of the Bank of Sierra Leone (BSL) in 1964, monetary policy has solely
56 been conducted by the central bank using market-based instruments. The major objectives
57 have been the attainment of price stability, curbing of inflationary shocks and rebuilding
58 foreign reserves which are geared towards the creation of suitable macroeconomic
59 environment. These objectives are complemented by maintaining a higher reserve-
60 requirement ratio and using interest rates more effectively. The BSL Act 2011 mandated the
61 central bank to formulate, adopt and execute monetary policy. The Monetary Policy
62 Technical Committee (MPTC) within the central bank was given the task to execute such
63 functions under the auspices of the Bank Governor. The main objective set by the committee
64 was the maintenance of low inflation, high sustainable economic growth and price stability.

65

66 Before 1992, the Central monetary authority was using a combination of direct and indirect
67 monetary policy instruments such as reserve requirements, special deposits requirements,
68 selective credit control and moral suasion to achieve its objectives. This meant that growth of

69 money and credit were therefore sought to be limited by the Central Bank through direct
70 constraint on the growth of commercial banks' balance sheets. It indicated that interest rates
71 on government securities were determined by the monetary authorities. In relation to reserve
72 requirements, commercial banks were urged to hold a minimum of 40 percent of their total
73 deposits liabilities as reserve asset with the BSL. Moral suasion was considered as a vibrant
74 monetary policy instrument at that time because the Central Bank's Governor was able to
75 convince the Managing Directors (MDs) of commercial banks to cooperate with the
76 objectives and policies of the central bank [4].

77

78 It is important to identify the most effective channel(s) in Sierra Leone to determine the set of
79 policy instruments, the timing of policy changes, and restrictions that the central bank is
80 faced in making decisions. The effectiveness of a channel depends whether the central bank
81 would achieve its objectives that are geared towards macroeconomic stability. For interest
82 rate channel to work effectively and efficiently, changes in the short-term policy rate should
83 feed into the bank and other market rates in the economy. The critical issue is the pass-
84 through, that is, the degree and the speed with which the variations in monetary policy stance
85 are passed on to the interest rate spectrum of the economy. Arbitrage between long-term
86 bonds on the one hand, and equities and real assets, on the other, affects stock market values
87 and real estate prices, which in turn affect household wealth and consumer spending,
88 constituting the asset channel. Arbitrage between assets denominated in domestic and foreign
89 currencies affects the real exchange rate, which alters the composition of both consumption
90 and investment spending between domestic and foreign goods. This constitutes the exchange
91 rate channel. Finally, credit market frictions imply that some borrowers have access to
92 external funds only through bank credit, while others must pay a premium over the risk-free
93 rate that depends on their net worth (the external finance premium). The credit channel

94 captures the dual effects that changes in the supply of banking system reserves exert on
95 aggregate demand through changes in the terms on which bank customers have access to
96 loans (the bank lending channel) as well as through changes in the external finance premium
97 [5].

98 In most countries, particularly in developing economies, the major objective of monetary
99 authorities is to create a suitable macroeconomic environment. The monetary transmission
100 mechanisms that are effective depend on whether the monetary policies meet the set goals of
101 the authorities (6). According to (7), there are a number of channels through which monetary
102 policy impacts real economic variables. Among them, the interest rate, exchange rate, and
103 bank lending channels which are pertinent to Sierra Leone given the structure of its economy
104 and the underdeveloped state of its financial sector.

105

106 Over the years, Sierra Leone has been faced with numerous difficulties in the conduct of
107 monetary policy to achieve macroeconomic stability. (8) investigated the monetary
108 transmission mechanism in Sierra Leone using a Vector Error Correction Model for the
109 period 1990 to 2006 and found that the credit channel (bank lending channel) is the main
110 medium through which the effect of monetary policies are transmitted into the domestic
111 economy. Unlike the study by (8) which only focused on the civil war period (1991 to 2001)
112 and used three groups of variables. The first group comprised of real GDP and domestic
113 prices; the second domestic short term interest rate, real effective exchange rate, and private
114 sector credit; and the last an index of world fuel prices and US Federal Fund rate. In contrast
115 to their series, this study will use the following variables such as real interest rate, exchange
116 rate, gross capital formation, consumer price index, private domestic credit and gross

117 domestic product per capita which give a clearer financial and monetary policy stance of a
118 country like Sierra Leone as compared to those used by previous study.

119

120 **2. LITERATURE REVIEW**

121 **2.1 Theoretical Literature**

122 A vast number of theories have explained certain links to the main channels of monetary
123 transmission mechanisms. With the interest rate channel, the traditional Keynesian IS-LM
124 view of monetary transmission mechanism can be characterized by showing the impact of an
125 expansionary monetary policy. An increase in money supply (M) leads to a fall in real
126 interest rate (R_i) which in turn reduces the cost of capital, causing a rise in investment (I)
127 spending thereby leading to an increase in aggregate demand and a rise in output (Y). Below
128 is the schematic indicating the effect of expansionary monetary policy.

129

$$130 \quad M \uparrow \rightarrow R_i \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow \quad (1)$$

131

132 With nominal interest rates at a floor of zero, an expansionary monetary policy that is
133 increase money supply (M) can increase the expected price (P^e) and follow by expected
134 inflation (π^e) and hence reducing the real interest rate (R_i) even when the nominal interest
135 rate is at zero. This would increase investment (I) spending follow by output (Y). The
136 schematic is shown below.

$$137 \quad M \uparrow \rightarrow P^e \uparrow \rightarrow \pi^e \uparrow \rightarrow R_i \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow \quad (2)$$

138 This channel shows that monetary policy can still be effective even when nominal interest
139 rates have already been driven down to zero by monetary authorities.

140

141 The exchange rate channel plays a crucial role in how monetary policy affects the domestic
142 economy. This channel includes interest rate effects in the sense that when domestic real
143 interest rates (R_i) fall, domestic dollar deposits become less attractive relative to deposit
144 denomination in foreign currencies, leading to a fall in the value of dollar deposits relative to
145 other currency deposits which means a depreciation of the dollar (E). As a result of the low
146 value of the domestic currency, this makes domestic goods cheaper than foreign goods,
147 thereby causing a rise in net exports (NX) and in aggregate output (Y) [9, 10]. The
148 schematic of the expansionary policy is illustrated below as follows:

$$149 \quad M \uparrow \rightarrow R_i \downarrow \rightarrow E \downarrow \rightarrow NX \uparrow \rightarrow Y \uparrow \quad (3)$$

150

151 The Keynesians such as Modigliani saw asset price effects as being critical to the monetary
152 transmission mechanism. These are two key assets apart from bonds that receive substantial
153 attention in the literature on transmission mechanism namely foreign exchange and equities.
154 With regards to the equity price, there are two channels that are important to the monetary
155 transmission mechanisms, namely: the Tobin' q theory of investment and wealth effects on
156 consumption. Tobin propounded the Tobin's q theory and explained that is a mechanism by
157 means of which monetary policy affects the economy through its effects on the valuation of
158 equities. An expansionary monetary policy makes bonds less attractive relative to equities
159 leading to an increase in the price of equities (P_e). This will lead to an increase in q (defined
160 as the market value of firms divided by the replacement cost of capital) and hence higher

161 investment (I) spending and an increase in output(Y) [11, 12]. The schematic is shown
162 below:

$$163 \quad M \uparrow \rightarrow P_e \uparrow \rightarrow q \uparrow \rightarrow I \uparrow \rightarrow Y \uparrow \quad (4)$$

164 The wealth effect was advocated by Modigliani in his life cycle model that consumption
165 spending is determined by the life time resources of consumers which are composed of
166 human capital, real capital and financial wealth. With the wealth effect, an expansionary
167 monetary policy can lead to a rise in stock prices(P_e), leading to an increase in wealth(W);
168 consumption(C); and hence, output(Y). The schematic of monetary policy expansion is
169 depicted below.

$$170 \quad M \uparrow \rightarrow P_e \uparrow \rightarrow W \uparrow \rightarrow C \uparrow \rightarrow Y \uparrow \quad (5)$$

171 Credit channel of monetary transmission mechanism constitutes two sub-channels: the bank
172 lending channel and the balance sheet. Commercial banks play a crucial role in most financial
173 systems by solving the problem of asymmetric information in the financial markets. With the
174 bank lending channel, an expansionary monetary policy increases bank reserves and bank
175 deposits (B_d) leading to a rise in the quantity of bank loans (B_L) to borrowers. As a result,
176 investment (I) expenditure rises and hence, an increase in output (Y) [13,14,15].
177 Schematically, the expansionary policy effect is illustrated as:

$$178 \quad M \uparrow \rightarrow B_d \uparrow \rightarrow B_L \uparrow \rightarrow I \uparrow \rightarrow Y \uparrow \quad (6)$$

179 The balance sheet channel came about as a result of information asymmetry problems in the
180 credit markets. Monetary policy can affect the balance sheet of firms. Expansionary monetary
181 policy that is increase in the stock of money (M) may cause a rise in equity prices (P_e) which

182 increase the net worth of firms leading (L) to higher investment (I) spending and a rise in
183 aggregate demand (AD) due to the a fall in adverse selection (AS) and moral hazard (MH)
184 problems [13]. The schematic illustration is shown as:

$$185 \quad M \uparrow \rightarrow P_e \uparrow \rightarrow AS \downarrow \& MH \downarrow \rightarrow L \uparrow \rightarrow I \uparrow \rightarrow AD \uparrow \quad (7)$$

186 The controversy regarding the channels has not only taken place from a theoretical point of
187 view but they have also influenced empirical studies as well.

188

189 **2.2 Empirical Literature**

190 Various studies have investigated the transmission mechanisms of monetary policy using
191 different macroeconomic variables and employing series of estimation techniques to identify
192 the channel(s) of monetary policy transmission of countries. Some of their findings have been
193 proven to be useful by monetary authorities and policy makers of certain nations in
194 maintaining economic stability. In a study in the U.S. [16] on the credit channel which used
195 federal funds rate, unemployment rate, logarithm of Consumer Price Index (CPI), deposits,
196 loans and securities. Their result revealed that both the conventional money demand and the
197 credit mechanisms operate and after two years, the entire long run impact of the decline in
198 deposits is reflected in loans. They inferred that their findings supported the operation of a
199 credit channel.

200

201 In another study in Jamaica [17] which assessed the channels through which monetary policy
202 is transmitted in Jamaica since economic liberalization. The authors used a Vector
203 Autoregression (VAR) model to analyse the process whereby monetary policy impulses are

204 transmitted by both the money channel and credit channel via a method of portfolio
205 substitution. The results pointed out to the possible use of a monetary conditions index (MCI)
206 as an intermediate target for monetary policy. In addition, the impact of monetary policy was
207 found to be immediate and pervasive. Finally, the findings showed that monetary policy
208 impulses were transmitted by both the money channel and credit channel through a process of
209 portfolio substitution.

210

211 Also, a study in Pakistan [18] used Vector Autoregression (VAR) to examine the monetary
212 transmission mechanism. The study estimated four models which represented four channels.
213 The results indicated that monetary tightening led to a fall in domestic demand particularly
214 investment demand financed by bank lending which translated into gradual reduction in price
215 pressures that eventually reduced the overall price level with a significant lag. In addition to
216 the traditional interest rate channel, the results showed a transmission mechanism in which
217 banks play an important role. The authors also found an active asset price channel and the
218 exchange rate channel was less significant.

219

220 Furthermore, [19] analysed the monetary policy transmission mechanisms to the real
221 economy in Nigeria by examining the process by which the interest rate policy of the Central
222 Bank of Nigeria affected the structure of interest rates, credit, aggregate demand and output
223 production and hence, changes in inflation rate. The study adopted Vector Autoregression
224 with dynamic logarithmic form and the ordinary least squares (OLS) methods. The study
225 found that the credit channel in the financial market for credit supply and accessibility to the
226 private sector provided the effect of a linchpin in the process by which monetary policy

227 transmitted to the real economy. The interest rate and exchange rate channels during the
228 period 1981 to 2008 appeared to have had a weak effect on the real economy.

229

230 From the various empirical studies and findings reached, it is cleared that most of the
231 channels of monetary transmission mechanisms that have existed in economies had a
232 significant impact on output.

233

234 **3. MATERIALS AND METHODS**

235 **3.1 Model Specification and Econometric Framework**

236 To investigate the effectiveness of transmission mechanisms of monetary policy, the VAR
237 model will take the form described below.

238 The preliminary model is presented as: Let X_t be the vector of variables to be analyzed.

239 These variables are: real interest rate (rir), exchange rate (er), private domestic credit ($pdcc$)

240 and GDP per capita ($gdppc$). Given an $N \times 1$ vector of variables $X_t = (rir, er, pdcc, gdppc)$ in

241 this case, at date t . The VAR model of order p (Gaussian errors), and the dynamics of X_t are

242 presumed to be governed by a p^{th} order Gaussian Vector Autoregression. Then, the VAR(p)

243 can be written as

$$244 \quad X_t = a + b_1 X_{t-1} + b_2 X_{t-2} + \dots + b_p X_{t-p} + \varepsilon_t \quad (8)$$

245 Where X_t is an $(n \times 1)$ vector of variables defined as above, $a = n \times 1$ vector of constants or

246 drift terms in this case, $b_i = n \times n$ matrices of time invariant, $i = 1, \dots, p$ (lag operator) and

247 $\varepsilon = n \times 1$ vector of independent and identically distributed (i.i.d) errors with a positive

248 covariance matrix. The VAR (p) defined in Equation (8) is covariance stationary iff all values
 249 of Z ,

$$250 \quad \left| I_n - b_1 Z - b_2 Z^2 - \dots - b_p Z^p \right| = 0 \quad (9)$$

251 lie outside the unit circle. The determinant comprises an identity I , matrix of time invariant b
 252, and Z the coefficient of b . In order to make a distinction between stationarity by linear
 253 combinations and by differencing, a reparametrization is required. Thus, the system defined
 254 in Equation (8) in error-correction form becomes,

$$255 \quad \Delta X_t = a + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-p} + \Pi X_{t-p} + \varepsilon_t \quad (10)$$

256 Where $\Pi = -\left(I - \sum_{i=1}^{p-1} b_i \right)$ and $\Gamma_i = -(b_{i+1} + \dots + b_i)$, $i = 1, \dots, p-1$. The only difference
 257 between Equation (10) and a standard VAR in differences is the error-correction term ΠX_{t-p} .
 258 The system represented in Equation (10) also contains information on both the short and long
 259 run adjustments to changes in X_t , via the estimates of Γ_i and Π respectively. The non-
 260 stationary component (Π) can also be factorized to test the null hypothesis r of reduced rank
 261 or equivalently, the number of cointegrating relationships, that is,

$$262 \quad H_0 : \Pi = \alpha \beta', \quad \text{rank}(\Pi) = r < n \quad (11)$$

263 Where β is the matrix of co-integrating vectors and α the adjustment coefficients.

264 Since X_t is a vector of non-stationary I(1) (at first difference) variables, all the terms in
 265 Equation (10) which involves ΔX_{t-i} are stationary or I(0) (at levels), and ΠX_{t-p} must also be
 266 stationary for

267 $\varepsilon_t \square I(0)$ to be stationary. More usually, Π has reduced rank, i.e., there are $r \leq (n-1)$ co-
268 integration vectors present.

269

270 The above model although very attractive cannot completely and fully describe the dynamics
271 of the involved VAR(p) model. Based on economic theory, a VAR with exogenous variables
272 could better capture that dynamics. This VAR model with exogenous variables is described
273 as,

$$274 \quad X_t = A(L)X_{t-p} + B(L)Y_{t-q} + u_t \quad (12)$$

275 where X_t is the vector of endogenous variables, Y_t is the vector of exogenous variables, u_t is
276 the vector of serially uncorrelated disturbances that has a zero mean and a time invariant
277 covariance matrix, A and B are denoted as coefficient matrices, and L denotes the lag
278 operators. The vector of exogenous has two components, consumer price index (*cpi*) and
279 gross capital formation (*gcf*) as a proxy for investment. All the inferences described for the
280 VAR(p) remain valid in this last case.

281

282 From the variables above, the real interest rate represents the role of the interest rate channel,
283 exchange rate the exchange rate channel, private domestic credit to identify the credit channel
284 and GDP per capita for output, consumer price index to control for changes in external
285 inflation as result trade among countries and gross capital formation to capture investment
286 since investment is predominantly undertaken by foreigners. These channels are reflective of
287 the financial development of our nation in which the stock market is still weak to consider the
288 asset price channel.

289 In order to conduct the Vector Autoregression (VAR) analysis, the following techniques are
290 considered necessary: Test for unit root and determine the order of integration for the
291 variables by employing the following test techniques: Augmented Dickey Fuller (ADF),
292 Philips and Peron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). Testing for
293 cointegration, and if there is cointegration relationship among the variables can be re-
294 parameterised which will have both short and long-run effects. The Johansen cointegration
295 can be adopted. Granger-causality; that is if there is cointegration there should be Granger-
296 causality in at least one direction. Impulse response and variance decomposition.

297

298 **3.2 Data and Sources**

299 The study makes use of secondary time series data collected for the period of the study (1980
300 to 2012) from the Central Bank of Sierra Leone and World Bank Data Base. The data on real
301 interest rate, exchange rate, private domestic credit, GDP per capita, and gross capital
302 formation were collected from the World Bank Data Bases. The data on consumer price
303 index were collected from the Central Bank of Sierra Leone.

304

305 **4. RESULTS AND DISCUSSION**

306 **4.1 Unit Root Tests**

307 This study employs the Augmented Dickey Fuller (ADF), Phillips-Perron (PP), and
308 Kwiatkowski Phillips Schmidt and Shin (KPSS) tests to test the time series whether or not
309 they are stationary and determine their order of integration. Table 1 shows the results of the
310 Unit Root Test in levels and first difference. The ADF and PP test results reveal that only the
311 RIR that is stationary at level $I(0)$ while the KPSS shows that all the series are stationary at
312 level $I(0)$. In addition, the three tests show that the following series: GCF, ER, PDC, and

313 GDPPC are stationary at first difference I(1). Whereas, the ADF and PP reveal that the RIR is
314 stationary at I(1) and the KPSS shows that the CPI is stationary at I(1).

315

316 4.2 Cointegration Tests

317 To conduct a co-integration test, the use of the Johansen co-integration test is applied.
318 According to (20, 21) for co-integration procedure, the VAR model order has to be
319 determined. In this study, the Akaike Information Criterion (AIC), Hannan-Quinn Criterion
320 (HQC), and Schwarz' Bayesian Information Criterion (BIC) have been used to get the
321 appropriate lag length. The maximum likelihood procedures developed in [20, 21] were used
322 for estimating cointegration relationships. In Table 2, the results from the co-integration tests
323 are presented. About the cointegration test results (Table 2), given the small sample,
324 Johansen [22], suggests to use the Bartlett corrections of the rank test statistic that improves
325 the finite sample properties and corrects for the under-rejection of the trace test statistic in
326 small samples. Moreover, the ML estimate results of the VECM estimation are not reported.
327 In equation (13) the authors report the cointegration relationship, then, conditional on r
328 (cointegration rank) a test for weak exogeneity should be applied to indicate which (or if
329 some) variable is weakly exogenous, or does not respond to the deviations from the long-run
330 equilibrium, so that If the test fails to reject the null hypothesis, the variable is weakly
331 exogenous and it should be excluded from the cointegrated equation (i.e. $\alpha_i = 0$). This test is
332 not only an econometric exercise but the results could be important for the conduct of the
333 monetary policy. A summary of diagnostic tests on the residuals is also missing. Given the
334 long period of political and economic instability in Sierra Leone (due to civil war), it would
335 be advisable to carry out some kind of recursive test that shows the stability of the
336 cointegration vector, e.g. the max test of beta constancy and test of 'Known Beta' [23], or the
337 CUSUM, CUSUMSQ tests.

338 The eigenvalues from the minimization of the product of the concentrated likelihood are
339 reported in descending order, along with the maximum eigenvalue statistic and the
340 cumulative form of that statistic, known as the trace statistic. Tests for the number of co-
341 integration relationships in the data consist of the maximum eigenvalue and trace statistics,
342 where λ_{\max} tests for at most r co-integration vectors against an alternative of exactly $r+1$ co-
343 integration relationships, while trace tests for at most r cointegrating vectors against an
344 alternative of at least $r+1$ vectors. The trace and maximum eigenvalue tests provide the
345 basis for rejecting the null hypothesis that there are zero co-integrating vectors. The two tests
346 suggest that there is a long-run relationship among the variables (real interest rate, exchange

347 rate, private domestic credit, GDP per capita, gross capital formation, and consumer price
348 index). In order to make the result interpretable, there is a need to normalize it based on
349 economic theory. It appears that normalizing with GDPPC is a reasonable procedure and the
350 outcome is:

351

$$352 \quad GDPPC - 0.000501 ER + 0.00143 RIR - 0.17 PDC = 0 \quad (13)$$

353 With everything being equal, a depreciation of the domestic currency where by imports
354 become expensive and exports cheaper, the output of a nation is anticipated to improve. Also,
355 a fall in the real interest rate (interest earned after adjusting for inflation) is expected to lead
356 to an increase in the national output of a country. Finally, as the quantity of bank loans to
357 borrowers increases the output is expected to improve since investors can access the required
358 fund for investment. Thus, one error correction term is constructed and included in the
359 maximum likelihood estimate of the Vector Error Correction model (VECM). The detailed
360 results of the estimated equation are reported in Table 2.

361

362 **4.3 Causality Tests**

363 After an examination of co-integration among the six variables in the previous section,
364 certain unresolved questions emerged regarding Granger-causation. These questions are: (i)
365 Does any Granger causality among the variables of the channels and the others? (ii) What is
366 the direction of the causality, if any? (iii) What are the economic implications of possible
367 Granger causality between the variables? In this section, an investigation of the short-run as
368 well as long dynamic interactions among the six variables (with a special emphasis on the
369 variables depicting the channels and the other variables) are summarized in Table 3. The
370 table represents the F-statistics (significance levels only) constructed under the null
371 hypothesis of non-causality. For the variable on the right hand side, rejection of the null

372 hypothesis implies that these variables Granger-cause the dependent variables. At the 10 %
373 level of significance, the results show that consumer price index Granger-causes exchange
374 rate and GDP per capita. This finding is in accordance with economic theory which implies
375 that if all things being equal, a change in consumer price index has an effect on exchange rate
376 and hence GDP per capita. It highlights pertinent issues regarding the exchange rate channel.
377 CPI which represents external inflation as a result of trading activities among member states
378 may have an impact on the exchange rate of Sierra Leone and thereby affect the exchange
379 rate channel. Furthermore, it may also have a spill-over effect on the output of the economy
380 [24].

381

382 On the other hand, the results from the same Table 3 indicates that gross capital formation
383 which is a proxy for investment (predominantly owned and undertaken by foreigners)
384 Granger causes exchange rate at 1% level of significance and it also Granger causes real
385 interest rate at 10% significance level. This finding is again in accordance with economic
386 theory wherein issues relating to the inflows and outflows of remittances may be raised.
387 Assuming that all things equal, an increase or decrease in foreign investment has an effect on
388 the exchange rate of an economy and hence real interest rate. This may affect both the
389 exchange rate and interest rate channels of monetary policy in country.

390

391 **4.4 Dynamic Simulation**

392 The simulations are adopted to compute the impulse response functions (IRF) and variance
393 decompositions (VDC). The IRF of GDPPC to innovations in the real interest rate, exchange
394 rate, and private domestic credit are presented in Figure 1. The impulse response functions
395 reflect responses of GDPPC (output) to one standard deviation shock to policy variables. The
396 GDPPC responds positively to monetary shocks, as real interest rate (RIR) increases, GDPPC

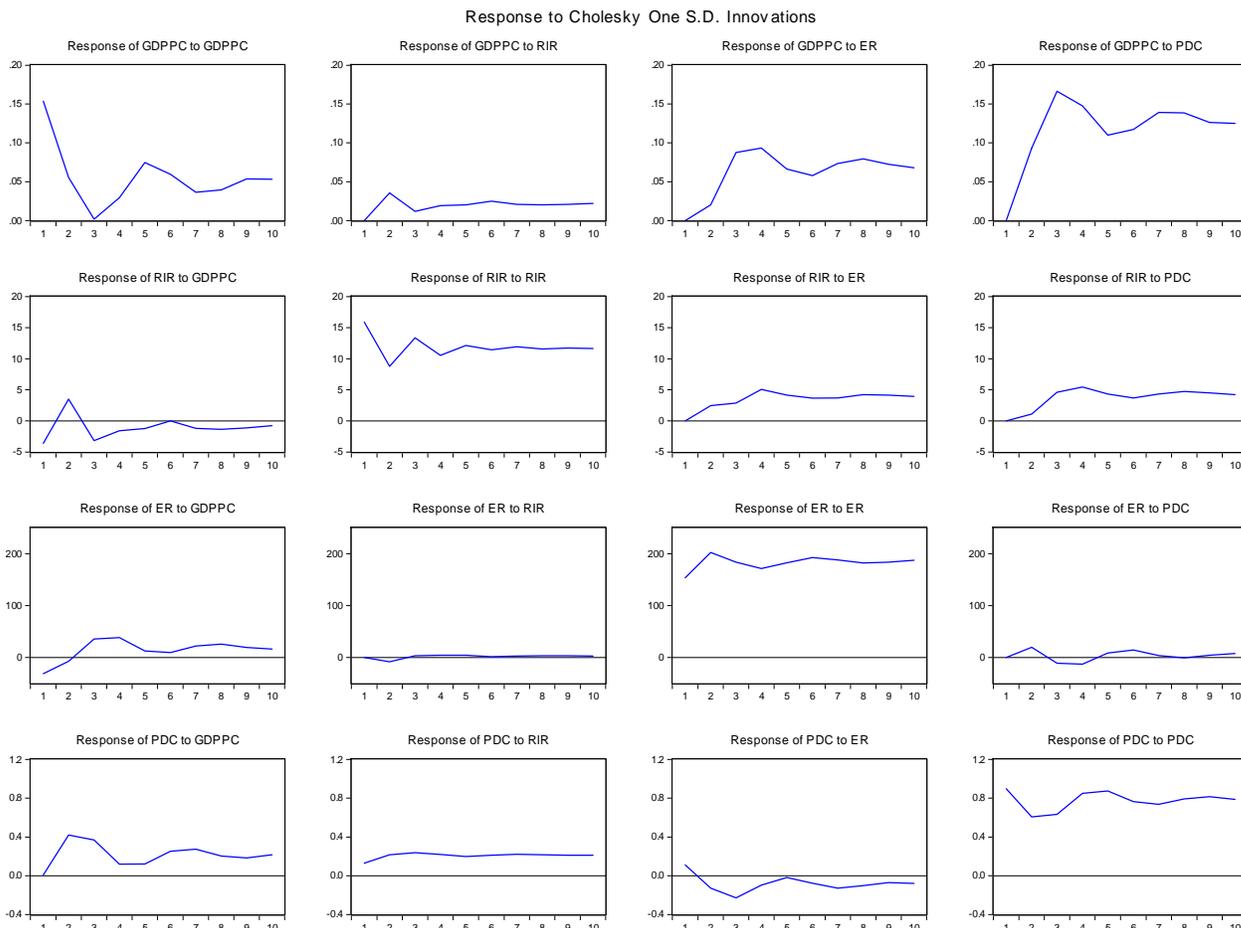
397 increases for a short period and then declined. But in the long run, it becomes constant which
398 is not in line with economic theory (it is expected to have a constant inverse relationship with
399 real interest rate). This may be attributed to the period when the economy was disrupted by
400 civil unrest or political turmoil. The impulse response function of GDPPC to exchange rate
401 (ER) and private domestic credit (PDC) shows that even in the long run, the effects of the
402 shocks might not be transitory in order to converge towards a steady state. In this regard, the
403 channels of monetary policy are proving to be ineffective in transmitting effects to output.

404

405 Table 4 indicates the variance decomposition results of the model. The asterisk is used to
406 point out that an estimate is at least twice its standard error and hence statistically significant.
407 To allow the system dynamic to function well, a 10-period horizon is employed. The results
408 of three different time periods are reported to transmit a notion of the system dynamics. The
409 results from Table 4 show that fluctuations in forecasting GDPPC in the first year period are
410 explained by itself. Over the following period, the fluctuations dwindle drastically with a
411 significant contribution of 61.6% by PDC, while RIR and ER contribute 1.8% and 18.4%
412 respectively. The error forecast of RIR in the first period is greatly dominated by itself with
413 an insignificant contribution of GDPPC and none by ER and PDC. The error forecast trend of
414 RIR continues with an insignificant contribution of the same variables. Fluctuations in
415 forecasting ER in the first period were greatly attributed to itself but in the successive period,
416 the forecasting trend of ER increases with a trivial contribution by the GDPPC, RIR, and
417 PDC. Finally, the error forecast of PDC in the first period is greatly dominated by itself. As
418 the trend falls, there is a slight increase in the contribution of GDPPC, RIR, and ER. It is
419 evident that from the three channels (interest rate, exchange rate, and credit) are ineffective in
420 transmitting significant shocks to output.

421

422 **Figure 1. Impulse responses of GDPPC, ER, RIR and PDC**



423

424

425 **Table 1. Unit Root Tests**

Variables	<u>ADF level</u>		<u>PP level</u>		<u>KPSS level</u>		<u>ADF 1st Diff</u>		<u>PP 1st Diff</u>		<u>KPSS 1st Diff</u>	
	τ_{μ}	τ_t	τ_{μ}	τ_t	τ_{μ}	τ_t	τ_{μ}	τ_t	τ_{μ}	τ_t	τ_{μ}	τ_t
GCF	-1.665	-1.921	-1.665	-1.846	0.254	0.194 ^b	-5.727 ^a	-6.107 ^a	-5.758 ^a	-7.780 ^a	0.319	0.272 ^a
ER	2.379	-2.222	4.609	-2.312	0.738 ^b	0.196 ^b	-3.822 ^a	-5.717 ^a	-3.428 ^b	-4.223 ^b	0.574 ^b	0.435 ^a
RIR	-1.448	-4.339 ^a	-3.487 ^b	-4.273 ^a	0.359 ^c	0.091	-5.948 ^a	-2.862	-9.290 ^a	-9.549 ^a	0.141	0.113
CPI	2.775	3.309	6.983	2.636	0.714 ^b	0.193 ^b	-0.958	-2.476	-0.729	-2.513	0.599 ^b	0.142 ^c
PDC	-1.655	-1.620	-1.758	-1.620	0.184	0.184 ^b	-5.516 ^a	-6.159 ^a	-5.524 ^a	-6.530 ^a	0.364 ^c	0.070

GDPPC -1.665 -1.921 -1.665 -1.846 0.338 0.192^b -4.776^a -5.694^a -4.784^a -12.929^a 0.417^c 0.500^a

426 **Note:** τ_{μ} Series with a constant, τ_t Constant and a Trend, ADF denotes the Augmented Dickey
 427 Fuller, PP - the Philips-Perron and KPSS - Kwiatkowski Phillips Schmidt and Shin Significance at
 428 1%, 5%, and 10% are denoted by a, b, and c respectively. Mackinnon (1996) one-sided p-values or
 429 critical values are used for rejection of hypothesis of a unit root.
 430

431 Table 2. Tests for Cointegration

Null	Alternative	Test Statistic	95% Critical Value
(1) Maximum Eigen Value Test			
$r = 0$	$r = 1$	55.429*	47.856
$r \leq 1$	$r = 2$	24.088	29.797
$r \leq 2$	$r = 3$	6.201	15.494
$r \leq 3$	$r = 4$	1.946	3.841
(2) Trace Test			
$r = 0$	$r \geq 1$	31.341*	27.584
$r \leq 1$	$r \geq 2$	17.886	21.131
$r \leq 2$	$r \geq 3$	4.254	14.264
$r \leq 3$	$r \geq 4$	1.946	3.841

432 Note: * denotes rejection of the null hypothesis. Critical values are taken from MacKinnon-
 433 Haug-Michelis (1999) p value.

434

435 Table 3. Causality Results

Model	Δer	$\Delta gdppc$	Δpdc	Δir	Δcpi	Δgcf	$\varepsilon_{it} (\psi_{t-1})$
Dependent							
Variables	F- Statistics (significance levels)						t- statistics
Δer	-	1.565	0.203	0.685	2.806 ^c	7.292 ^a	0.028

Δgdp_{pc}	1.565	-	0.051	0.389	3.021 ^c	0.047	-3.489 ^a
Δpdc	0.203	0.051	-	0.955	0.115	0.003	0.356
Δrir	0.685	0.389	0.955	-	0.616	3.691 ^c	-0.686

436 *Note:* All variables are in first differences except the error-correction term obtained from the Johansen order of
437 co-integration tests reported in Table 4.4. a, b and c indicate significance at the 1%, 5% and 10% levels
438 respectively.
439

440 Table 4. Point estimates (standard deviations) of variance decomposition for the VECM
441 model

Dependent Variables	Relative variation in period	Explained by innovations in			
		GDPPC	RIR	ER	PDC
GDPPC	1	100 [*]	0	0	0
	5	26.11 [*]	1.72 [*]	16.70 [*]	55.45 [*]
	10	18.07 [*]	1.82 [*]	18.42 [*]	61.67 [*]
RIR	1	4.90	95.09 [*]	0	0
	5	4.23	82.09 [*]	6.08	7.58
	10	2.50	80.82	7.50	9.16
ER	1	3.98	0.00018	96.01	0
	5	2.36	0.07	97.10	0.45
	10	1.69	0.04	97.95	0.30
PDC	1	0.007	1.96 [*]	1.46	96.56 [*]
	5	9.19 [*]	5.56 [*]	2.45	82.78 [*]
	10	8.23 [*]	5.98 [*]	1.85	83.91 [*]

442

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444

445 **CONCLUSION**

446 In order to determine the effectiveness of transmission mechanisms of monetary policy in
447 Sierra Leone, the study focused on three channels namely interest rate, exchange rate, and
448 credit channels that may be applicable to most developing countries where stock exchange
449 markets are not fully established or not operating. The study made use of the following
450 variables: real interest rate (RIR), exchange rate (ER), private domestic credit (PDC),
451 consumer price index (CPI), gross capital formation (GCF), and gross domestic product per
452 capita (GDPPC). An unrestrictive Vector autoregressive (VAR) model was adopted but a
453 Vector Error Correction Model (VECM) was used because the variables were found to be
454 cointegrated with the series spanning from 1980 to 2012. The study used the Granger
455 Causality test and it revealed that consumer price index Granger-causes exchange rate and
456 GDP per capita. Thus, the objectives of monetary policy should be in consonance with that of fiscal
457 policy in order to achieve macroeconomic stability consistent with sustainable real GDP growth and
458 low inflation. Also, gross capital formation Granger causes exchange rate and real interest rate.
459 In general, the results show that all the channels of monetary policy were ineffective since
460 real interest rate, exchange rate, and private domestic credit as monetary policy tool were
461 unable to transmit significant shocks to output. As a matter of policy consideration, the
462 following should be considered: First, even though the results show that the channels are
463 ineffective, but the Private domestic credit (PDC) which represents the credit channel is able
464 to transmit the highest shocks to output as compared to the interest rate and exchange rate
465 channels despite its transmission being insignificant. Second, monetary authorities should put
466 a mechanism in place to enhance this channel which stands out to be effective in the long run.
467 This can be done through banking supervision by the central bank or monetary authorities
468 and coupled with increased competition among commercial banks. Third, the development of

469 the financial sector will be essential to augmenting the effectiveness of the transmission
470 channels. The country will experience rapid economic transformation which will foster
471 sustainable economic growth if these policies are implemented.

472

473 **Disclaimer:**

474

475 This paper is based on preliminary dataset. Readers are requested to consider this paper as
476 preliminary research article. Authors are aware that a bigger sample size is required to get a
477 scientifically established interpretation. Readers are requested to use the conclusion of this
478 paper judiciously as sample size is smaller. Authors also recommend bigger sample size for
479 similar future studies.

480

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