The Impact of Money Supply Volatility on the Fisher Effect –A Botswana Empirical Perspective

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2015

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To the extent that these authors have been able to determine, existing literature on the Fisher Effect has only attempted to vary methodological approaches to test for the existence and validity of the Fisher hypothesis. It is the objective of this paper to expand on the literature by determining the degree of influence of money supply changes on the validity and existence of the Fisher Effect. The study examines interest rates and money supply quantities in Botswana from 1989 to 2013 and uses the Johansen Cointegration test to determine the strength of the relationships. The results indicate that there is no long run relationship between money supply, inflation, as well as the Fisher Effect. Subsequently, the study recommends potential areas of research which should be explored to verify further money supply volatility effects on the Fisher Effect.

INTRODUCTION

The positive relationship between nominal interest rates and inflation was coined by Fisher in 1930. Fisher (1930) indicated that nominal interest rates and inflation moved together whereas the real interest rates remained constant in this transaction. The Fisher Effect has been important in all economies, be they developed or developing. This hypothesis has formed the basis of inflation targeting because nominal interest rates provide general anticipated levels of inflation and real interest rates, a point that has made studies on the phenomenon increasingly critical. It has been proved that the Fisher hypothesis is a phenomenon that may exist in the long run (Granville & Mallicks, 2004; Evan & Lewis, 1995; Crowder & Hoffman, 1996; Atkins & Coe, 2002 and Tsong & Lee, 2013). Some authors have found evidence of a full Fisher Effect, as evidenced by Bassil (2010) and Westerlund (2008), whereas others have found evidence for a partial Fisher Effect (Atkins & Chan, 2004). Ito (2009) found evidence for only the short run Fisher Effect. An overview of these studies shows that much attention has been channeled to the examination of the degree and existence of the Fisher Effect, while overlooking the money supply effects on the Fisher Effect. It is the objective of this paper to fill this gap. Firstly, this paper intends to explore the impact of money supply changes on the Fisher Effect. The second objective is to test for the existence of a relationship between money supply and inflation. Soderlind (2001) and Williamson (2008) have indicated an inverse relationship between monetary policy, money supply and the Fisher Effect. While the results of these studies provide substantive evidence of the tested relationships, however, they lack the long term cause-effect examination of the relationship between the Fisher Effect and money supply. It is the objective of this paper to address this anomaly by using the econometrics approach.

The previous section was an introduction. The next section is literature overview and a synthesis of the different perspectives on the Fisher Effect. This will be followed by research hypothesis propositions, data properties and a discussion on research methodology. Finally, the test results are presented with findings, practical implications of the study, and potential areas for future research.

LITERATURE OVERVIEW

The Fisher Effect posits that nominal interest rates will rise with inflation, with the real interest rates being stationary in the transaction (Fisher, 1930). Empirical evidence of the Fisher Effect from the literature has not been consistent, a matter that could be attributable to several factors including methodology, data coverage range and the non-stationarity of the real interest rates. The literature coverage on the subject matter has a dual perspective: evidence of the Fisher Effect in multiple countries; and the money supply, inflation and Fisher Effect relationships. Studies on the Fisher Effect have produced different and contradictory results.

Asemota & Bala (2009) found no evidence of the long run Fisher Effect. The study used the Augmented Dickey Fuller test and the Zivot-Andrews (1992) unit root tests to validate the order of integration of macroeconomic variables among the times series. Asemota & Bala (2009) substantiated the absence of a statistically significant relationship by using the Kalman Filter test to examine statistical algorithms. Coppock & Poitras (2000) used the Ordinary Least Squares (OLS) approach and bounded influence estimation and got results that rejected the full Fisher Effect. Other studies have also rejected the Fisher Effect (Koustas & Serletis, 1999; Romer, 1986; and Hatemi-J, 2008). Equally, evidence of the existence of the Fisher Effect is substantial (Granville & Mallicks, 2004; Evan & Lewis, 1995; Crowder & Hoffman, 1996; and Tsong & Lee, 2013).

Evidence for the presence of the Fisher Effect in the long run was provided by Barsky (1987). The Barsky (1987) study aimed at explaining the variations in the existence of the Fisher Effect by examining data from 1950 to 1979 using the corrected squared correlation coefficient and the results showed that nominal interest rates were essential predictors of the real interest rates. Evidence of the Fisher Effect was further provided by Fahmy & Kandil (2003) in which the aim was to examine the reality of the Fisher Effect using data from 1980 to 1990. The study used the VAR Cointegration techniques to test the long run co-movement between nominal interest rates and inflation.

Million (2004) provided a different approach to the Fisher Effect examination by using Threshold Autoregressive (TAR) tests and cointegration. The study found that a long run Fisher Effect appears to be strong when interest rates and inflation followed stochastic trends. For the partial Fisher Effect, Koustas & Lamarche (2010) adopted the Self Exciting Threshold Autoregressive (SETAR) models to obtain unit roots and found that nominal interest rates and inflation can drift apart leading to the dismissal of the Fisher Effect. While most studies have largely focused on a single-country Fisher Effect test, Toyoshima & Hamori (2011) tested and found the presence of the full Fisher Effect in the United States, United Kingdom, and Japan using panel cointegration.

In summary, prior Fisher Effect studies provide an indication of varying levels of the existence of the Fisher parity. It is observed that the literature concentrates on exhausting the Fisher Effect existence, from one country to another, while placing less effort on factors which may inhibit the Fisherian link. This study intends to find if money supply changes affect the Fisher Effect in consequence. In terms of the association between money supply and inflation, there has been laudable evidence to suggest a positive relationship (Lucas, 1980; Dwyer & Hafer, 1999a 1988b,; McCandless & Weber, 1995; Rolnick & Weber, 1997). A study by Dwyer & Fisher (2009) found a positive relationship between money supply and inflation. This study used regression analysis and correlation statistics. The discrepancy with this technique is that it does not depict the long run examination between money supply and inflation. This glitch extends to other previous studies such as Williamson (2008) and Lucas (1980). In consequence, this study complements previous studies by using cointegration tests which will provide long run relationship assessment of the variables.

In conclusion, the literature points to two perspectives to the research on the Fisher Effect: the money supply and inflation perspectives. The proposed study intends to explore if the relationship between money supply and inflation is bound to affect the validity of the Fisher Effect in the context of the Botswana economy. Sordelind (2001) flagged that shifts in the monetary policy negatively affect the Fisher Effect; while Williamson (2008) pointed out that an increase in money supply negatively affects the Fisher Effect. There have been a limited number of studies pertaining to money supply changes on the Fisher Effect. This study brings together money supply, inflation and the Fisher Effect to determine the relations between these variables.

RESEARCH HYPOTHESES

Drawing from the literature overview, there is substantial evidence for the existence of the Fisher Effect (Granville & Mallicks, 2004; Evan & Lewis, 1995; Crowder & Hoffman, 1996; Tsong & Lee, 2013). Ironically, there is an equally formidable amount of evidence that rejects the Fisher hypothesis (Koustas & Serletis, 1999; Romer, 1986; Hatemi-J, 2008). Effectively, there is some degree of lack of consensus on the existence of the Fisher Effect. There is another stream of literature that suggests and empirically projects a positive relationship between money supply and inflation (Lucas, 1980; Dwyer & Hafer, 1999a; 1988b; McCandless & Weber, 1995; Rolnick & Weber, 1997). Intuitively, therefore, money supply sways the Fisher Effect (Williamson, 2008). Drawing from the social sciences notion that the socio-economic variables are intertwined and hence interrelated, it can be reasonably expected that factors impacting the Fisher Effect, inflation, money supply and interest rates, are interdependent. From this premise, it is hypothesised that:

H_1: There is a positive relationship between money supply and inflation.

H_2: Money supply is positively related with nominal interest rates.

DATA TESTS AND RESULTS

This study uses records from 1989 to 2013 on Botswana's economic status. The primary source of data is the Bank of Botswana publications (Botswana Financial Statistics, Bank of Botswana Research Department) accessed through the Botswana National Archives and Records Services (BNARS)**.** Prime interest rates were used to examine the volatility of the interest rates. The use of prime interest rates was informed by their availability from the BNARS over the material period (1989 to 2013). While the interest rate figures for the Bank of Botswana Certificates (central bank short-term bonds) (BoBC) was the preferred option, these figures were not available in the early central bank publications. Inflation, nominal and real interest rates were sourced from the Botswana Financial Statistics records, which are the official national statistics on key financial indicators. The only modification made was in the calculation of money supply. Money supply is defined as the sum of coins and paper money in circulation. Accordingly, the quantities of the coins were added with the corresponding paper money in circulation for each year. Previous studies have defined money supply as currency in circulation plus demand deposits for instance Vogel (1974) and Lucas (1980). The main reason for the combination of quantities of coins and paper money in circulation stems from McCandless & Weber (1995) who have indicated that a broader definition of money supply tends to correlate higher with inflation. It was crucial to avoid a restricted money supply definition for this study. Comparatively, the broad money supply definition also allowed a closer examination of liquidity effects.

Table 1 presents descriptive statistics for the key indicator variables used in the study. The mean values for coins and notes are 2980 million and 8620 million, respectively, for the period 1989-2013. It is observed that in the period 1995-2013, a large proportion of money supply was attributed to paper money in circulation, while the coins were showing low increase in quantity. Also observed is that inflation showed greater volatility over the same time period, with the highest record being 16.5% and a minimum value of 4.1%.

TABLE 1
DESCRIPTIVE STATISTICS

Descriptive Statistic	Coins[4]	Notes[5]	Money Supply[1]	Inflation	Nominal Interest rates[2]	Real interest rates[2]
Mean	2,980	8,620	11,600	9.40	13.40	4.18
Median	748	6,650	9,430	9	15	4.47
Maximum	16,300	22,400	23,500	16.5	17	9
Minimum	178	1,420	3,190	4.1	0	-3
Standard Dev.	4,710	6,680	6,220	2.91	3.85	3.29
Sum	74,500	216,000	290,000	233.90	335	104.46
Observations[3]	25	25	25	25	25	25

[1] *money supply in millions, as the sum of coins and notes in circulation*
[2] *prime interest rates*
[3] *as from 1989 to 2013*
[4] *coins in millions*
[5] *notes in millions*

Table 2 is a presentation of the distribution properties of the data set. Data distribution indicated positive skewness (skewness coefficients) for coins (S_k = 1.69), paper money (S_k = 0.84), money supply (S_k = 0.48) and inflation (S_k = 0.40). Nominal interest rates and real interest rates both registered negative skeweness.

TABLE 2
DISTRIBUTION PROPERTIES OF THE DATA SET

Descriptive Statistic	Coins	Notes	Money Supply[1]	Inflation	Nominal Interest rates[2]	Real interest rates[2]
Skewness	1.69	0.84	0.48	0.40	-1.88	-0.64
Kurtosis	4.42	2.40	2.02	2.82	6.90	2.82
Jacrque-Bera	14	3.31	1.93	0.72	30.37	1.73
Probability	0	0.19	0.38	0.70	0	0.42

[1] *money supply as the sum of coins and notes in circulation*
[2] *prime interest rates*

METHODOLOGY

The Fisher equation holds that:

$$i_t = r_t + \pi_t^e \quad (1)$$

Where:
i_t= *nominal interest rates*
r_t= *real interest rates*
π_t^e= *inflation*

Money Supply will be defined as:

$$M_s = C_n|\eta_t| + M_n|\eta_t| \quad (2)$$

Where:

M_s= *money supply*

$C_n|\eta_t|$= *coins in circulation conditional upon monetary policy effects at the time "t"*

$M_n|\eta_t|$ = *paper money in circulation conditional upon monetary policy effects at the time "t"*

Since the anticipation is that money supply rises with inflation:

$$M_s \uparrow = \pi_t^e \uparrow \quad (3)$$

$$i_t = r_t + \pi_t^e \uparrow \quad (4)$$

$$\therefore i_t \neq r_t + \pi_t^e \uparrow \quad (5)$$

An increase in inflation is anticipated to invalidate the equivalence of the Fisher equation.

Cointegration Measures: The Johansen Cointegration Test

The first hypothesis projected a positive relationship between money supply and inflation. The second hypothesis proposed that money supply is positively related with nominal interest rates. The Johansen Cointegration test was used to examine the statistical drifts between money supply, nominal interest rates, and inflation. The Johansen cointegration test was selected on the grounds that it has high statistical power than the Dickey Fuller test (Lee & Tse, 1996). Whereas Asemota & Bala (2009) have used the Dickey Fuller test in their study, it has been indicated that a high order augmentation is needed to account for errors which may result during the application of the test (Breitung, 2002). The advantage of the Johansen cointegration test is that it computes long run relationship tests (Fahmy & Kandil, 2003).
The cointegration test followed the model:

$$y_t - A_1 y_{t-1} + \cdots A_p y_{p-1} + Bx_t + \varepsilon_t \quad (6)$$

The model reduced to:

$$\Delta y_t = \prod y_{t-1} + \sum_{i-1}^{p-1} \Gamma_i \Delta y_{t-1} + Bx_t + \varepsilon_t \quad (7)$$

The coefficient matrix was defined as:

$$\prod = \sum_{i-1}^{p} A_i - I \quad (8)$$

And;

$$\Gamma_i = -\sum_{j-i+1}^{p} A_j \quad (9)$$

To determine the number of cointegrating vectors, both the trace test and the maximum eigenvalue tests were applied. The trace test was computed as:

$$LR_{tr}(r|k) = -T \sum_{i=r+1}^{k} \log(1 - \lambda_i) \quad (10)$$

The computation of the maximum eigenvalue test followed the order:

$$LR_{max}(r|r+1) = -T\,log(1-\lambda_{r+1}) \quad (11)$$

$$= -T\sum_{i=r+1}^{k}\log(1-\lambda_i) - \left(LR_{tr}(r+1|k)\right) \quad (12)$$

$$= LR_{tr}(r|k) - LR_{tr}(r+1|k) \quad (13)$$

Hypothesis Test Results

Hypothesis 1 postulated a positive relationship between money supply and inflation. The trace test specified ρ-values of 0.81 and 0.53 which were greater than the critical level of 0.05, thus indicative of no cointegrating vectors between the variables. To this end, the trace test did not support the hypothesis. The maximum eigenvalue test was further carried to support the accuracy and reliability of the trace test. The maximum eigenvalue test reported ρ-values of 0.80 and 0.53 at a critical level of 0.05, and thus the hypothesis was still not supported. In sum, the trace test and the maximum eigenvalue test indicated no cointegration between money supply and inflation. Tables 3 and 4 show the results of the cointegration test results between money supply and inflation.

TABLE 3
TRACE TEST[3]

Hypothesized No. of Coint. Vectors	Eigenvalue	Trace Test	Critical Value[1]	ρ-values[2]
0	0.18	4.95	15.50	0.81
1	0.02	0.39	3.84	0.53

TABLE 4
MAXIMUM EIGENVALUE TEST[3]

Hypothesized No. of Coint. Vectors	Eigenvalue	Max-Eigen Statistic	Critical Value[1]	ρ-values[2]
0	0.18	4.55	14.30	0.80
1	0.02	0.39	3.84	0.53

[1]*critical level of 0.05*
[2]*based on the MacKinnon-Haug-Michelis (1999) ρ-values*
[3]*as computed by EViews 7*

Hypothesis 2 postulated a positive relationship between money supply and nominal interest rates. The trace test specified ρ-values of 0.21 and 0.53 which were both greater than the critical level of 0.05, thereby suggestive of no cointegrating vectors between the two variables. In this respect, the hypothesis was not supported by the trace test. The maximum eigenvalue test reported ρ-values of 0.16 and 0.64. With both ρ-values being greater than the critical level of 0.05, the hypothesis remained unsupported. In summary, the trace test and the maximum

eigenvalue tests indicated no cointegration between money supply and the nominal interest rates. Tables 5 and 6 show the results of the cointegration test between money supply and nominal interest rates.

TABLE 5
TRACE TEST[3]

Hypothesized No. of Coint. Vectors	Eigenvalue	Trace Test	Critical Value[1]	ρ-values[2]
0	0.38	11.06	15.50	0.21
1	0	0.27	3.84	0.64

TABLE 6
MAXIM-EIGENVALUE TEST[3]

Hypothesized No. of Coint. Vectors	Eigenvalue	Max-Eigen Statistic	Critical Value[1]	ρ-values[2]
0	0.38	10.85	14.30	0.16
1	0	0.22	3.84	0.64

[1] *critical level of 0.05*
[2] *based on the MacKinnon-Haug-Michelis (1999) ρ-values*
[3] *as computed by EViews 7*

DISCUSSION

Previous studies have indicated extensive evidence of the existence and non-existence of the Fisher Effect using varying methodological approaches and in different contexts. It was the objective of this paper to draw parallels with the Botswana situation. Hypothesis 1 postulated a positive relationship between money supply and inflation. The results of the test rejected the hypothesis. The hypothesis test results were suggestive that there is no long run association between money supply and inflation. However, contrasting results have been attained in many studies (for example: Lucas, 1980; Dwyer & Hafer, 1999a, 1988b; McCandless & Weber, 1995; Rolnick & Weber, 1997). While the lack of a statistically significant relationship between the two variables remains theoretically plausible from the standpoint of the extant literature, the role and impact of other variables cannot be ruled out. Dwyer & Hafer (1988b), for example, stressed that the relationship between money supply and inflation may hold in short run circumstances therefore a long run relationship test is attached with a probability of no positive association. Another substantiating reason that Dwyer & Hafer (1999a) highlighted is that there is no absolute correspondence between money supply and inflation. For these reasons, it not inconceivable to find no association between inflation and money supply when examining data in a long-run framework.

Hypothesis 2 postulated a positive relationship between money supply and the nominal interest rates. The results of the tests indicated that the two variables do not trend together in the long run. Some previous studies have disputed this outcome, albeit, from different perspectives. Lucas (1980) applied the two-sided moving average filters to test if a given change in the quantity of money induces a change in the nominal interest rates. In this case, the positive relationship between money supply and nominal interest rates however, appeared to hold after several data smoothing operations. The relationship was not

unequivocal and self-evident. Whereas Williamson (2008) indicated that money supply and the Fisher Effect are negatively related, the money supply distribution models were not based on a long run affiliation test. The lack of a statistically significant association between the two variables is not unreasonable drawing from the findings of previous Fisher Effect studies (Koustas & Serletis, 1999; Romer, 1986; Hatemi-J, 2008).

CONCLUSIONS AND PRACTICAL IMPLICATIONS

This study explored the association of money supply and the Fisher Effect. Though numerous studies have attempted to find the existence of the Fisher Effect (Granville & Mallicks, 2004; Tsong & Lee, 2013), many studies unheeded money supply effects on the Fisher Effect. Further, previous studies focused on varying the methodological approaches such as panel cointegration, quantile cointegration analysis, structural breaks and stationarity tests which disregarded other influential variables that affect the validity and existence of the Fisher Effect. This paper endeavored to bring these critical issues to the fore. From the financial economics point of view, the results of this study are not commensurate with the quantity theory of money supply and inflation. Firstly, the hypothesis tests results have indicated that money supply and the nominal interest rates do not trend together in the long run. The study further deviates from earlier claims that money supply and inflation were positively related. It can be drawn from the study that since there is no relationship between money supply and inflation, it follows subsequently that nominal interest rates, signifying the Fisher Effect, should also be indifferent to money supply changes.

This study has not considered the degree of influence of inflation targeting on the money supply and inflation framework. It is proposed that auxiliary research should be carried out in this area. As earlier indicated, the existence of the Fisher Effect has been verified abundantly, it is now vital to address factors which impinge on the validity and applicability of the Fisher Effect.

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