The Research Bulletin

July 2017

Research and Financial Stability Department
Bank of Botswana Volume 30 No. 1

The Research Bulletin

July 2017

Research and Financial Stability Department
Bank of Botswana

Volume 30 No. 1

The Research Bulletin, July 2017, Volume 30, No 1

Published by
The Research and Financial Stability Department, Bank of Botswana
P/Bag 154, Gaborone, Botswana.

ISSN 1027–5932

This publication is also available at the Bank of Botswana
website: www.bankofbotswana.bw

Typeset and designed by
Lentswe La Lesedi (Pty) Ltd
Tel: +267-3903994, e–mail: publisher@lightbooksbotswana.co.bw
www.lightbooksbotswana.co.bw

Printed and bound by
Printing and Publishing Company Botswana (Pty) Ltd

The purpose of The Research Bulletin is to provide a forum where research relevant to the Botswana economy can be disseminated. Although produced by the Bank of Botswana, the Bank claims no copyright on the content of the papers. If the material is used elsewhere, an appropriate acknowledgement is expected.

Comments: The Bank would welcome any comments/suggestions on papers published on the bulletin. Such communication should be addressed to:

The Director
Research and Financial Stability Department
Bank of Botswana
Private Bag 154
Gaborone

Or, e-mail to: jamesl@bob.bw

Additional copies of the Research Bulletin are available from The Librarian of the Bank at the above address. A list of the Bank's other publications, and their prices, are given below.

Bank of Botswana Publications

	Domestic	SADC Members	Rest of the World
1. Research Bulletin (per copy)	P11.00	US$10.00	US$15.00
2. Annual Report (per copy)	P22.00	US$15.00	US$20.00
3. Botswana Financial Statistics (annual: 12 issues)	Free	US$30.00	US$50.00
4. Aspects of the Botswana Economy: Selected Papers	P82.50	US$29.00	US$42.00

Please note that all domestic prices cover surface mail postage and are inclusive of VAT. Other prices include airmail postage and are free of VAT. Cheques, drafts, etc., should be drawn in favour of Bank of Botswana and forwarded to the Librarian, Bank of Botswana, Private Bag 154,Gaborone, Botswana.

Bank of New York, New York (SWIFT code: IRVTUS3N)
Account Number: 8900331348
ABA Number: 021000018
Account Name: Bank of Botswana

Please always indicate the purpose of payment for easy reference.

All customers are urged to use the Bank's website http//:www.bob.bw, from which most of the publications listed above can be downloaded, free of charge.

Contents

Implications of the Term Structure of Interest Rates (Yield Curve) on Expected Inflation in Botswana

Lerato V. James and Princess Puskas[1]

Abstract

This paper empirically examines the link between the term structure of nominal interest rates and the future path of inflation in Botswana by analysing data from January 2008 to June 2015. Specifically, the paper employs the simple ordinary least squares (OLS) regression method to determine the predictive power of the term structure of nominal interest rates on inflation. This is achieved by estimating an inflation forecasting equation where the inflation spread is regressed on the interest rate spread (term structure of interest rates). It is found that the term structure of nominal interest rates for maturities less than six months contains no information about the future path of inflation whereas the term structure of nominal interest rates for longer maturities such as six to twelve months has information content about the future path of inflation in line with the theory of Irving Fisher (1930). This finding is relevant; as noted by Mishkin F. et.al, (1995), the term structure of interest rates represents a simple measure which is considered complementary information that can be used to help guide monetary policy.

1. Introduction

The term structure of interest rates[2] is important in the formulation and implementation of monetary policy because it often contains expectations about future changes in inflation as posited in the theory of Irving Fisher (1930).[3] It follows then, that the term structure of interest rates ought to be studied to determine its predictive power which can be used to enhance accuracy of the inflation forecast. The adoption of forward-looking monetary policy frameworks by many central banks in pursuit of the price stability objective has considerably amplified the need for understanding the role that the term structure of interest rates can play in macroeconomic forecasting and monetary policy implementation. Mishkin F. et.al, (1995) noted that the term structure of interest rates is a simple measure that should be viewed as complementary information,[4] which can be used to help guide monetary policy. It has been found, that a comprehensive and careful analysis of financial indicators can guide conduct of monetary policy in both the less developed and developed financial markets (Mwega, 2014).

The usefulness of the term structure of interest rates as a guide for policymaking also stems from the ability to gauge the stance of monetary policy in terms of whether it is restrictive (tight) or accommodative (loose). These alternative monetary policy postures are deduced from the slope and shape of the term structure (yield curve). The yield curve may either be upward sloping, in which case, long-term interest rates are higher than short-term interest rates or downward sloping, where long-term interest rates are lower than their short-term rates. Where short-term and long-term interest rates are equal, the term structure (yield curve) assumes a flat shape.

Both direction and steepness of the slope of the yield curve are important in the analysis of future inflation (expectations). A steeper slope signifies a larger disparity or spread between interest rates over any particular period. Generally, a positively sloped and relatively steeper yield curve implies accommodative monetary policy, indicative of expectations of future increase in inflation. Conversely, a restrictive monetary policy stance (downward-sloping yield curve) usually arises from an increase in short-term nominal interest rates relative to long-term interest rates and, thus, represents a bias towards falling inflation (expectations), going forward. In addition to changes in interest rates, there are other factors at work in the determination of the yield curve such as the risk premium and agency ratings.

The remainder of this paper is organised as follows: Section 2 deals with theories of the term struc-

---

1 Principal Economist and Economist, respectively, in the Modelling and Forecasting Unit of the Research and Financial Stability Department. The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of Botswana.

2 The term structure is the relationship between yields and term to maturity (i.e., interest rate spread). The term structure of interest rates is also known as a yield curve, hence the two can be used interchangeably.

3 The theory presumes that the nominal interest rate consists of two components: the expected inflation rate and the real rate of interest. The real rate of interest is defined as the return on the investment to savers after accounting for the expected inflation, and is measured as the nominal interest rate minus the expected inflation rate. If the real rate of interest is constant over time, then the nominal rate of interest must adjust to changes in the expected rate of inflation.

4 The word "information" is being used in this paper in a restrictively narrow sense. Information in the term structure about the path of future inflation refers only to the ability of the term structure to predict the change in inflation. None of the evidence in this paper rules out predictive power for other forecasting equations or models that make use of more complicated interactions of interest rates at maturities of six months or less or that use additional economic variables in combination with the term structure.

ture of interest rates. Section 3 reviews empirical literature. Section 4 is dedicated to data and methodology description. Model estimation and results are outlined in Section 5, while Section 6 concludes.

2. THEORIES OF THE TERM STRUCTURE OF INTEREST RATES[5]

There are several theories that explain the implications of the shape and slope of the yield curve. Three stylised facts are relevant in this regard. First, interest rates for different maturities tend to move together over time. Second, yields on short-term bonds are more volatile than yields on long-term bonds. Third, long-term yields tend to be higher than their short term counterparts hence, yield curves are usually upward-sloping. The *Expectations Theory* explains the first two prepositions very well, while the *Segmented Market Theory* can explain the third preposition but not the first two. The *Liquidity Preference Theory*, which combines both the Expectations Theory and the Segmented Market Theory, can explain all the three prepositions.

(a) Expectations Theory

The Expectations Theory assumes that the implied forward rates are an unbiased estimate of future spot rates. This means that at any one time, the debt contracts of different maturities are perfect substitutes implying that investors are indifferent between investing in long term securities and rolling over an investment at the short term rates. This also implies that all investors are risk neutral because they remain indifferent to inflation and interest rates risks. Furthermore, according to this theory, an upward-sloping yield curve indicates that investors expect future spot rates to be higher than current spot rates, and the yield curve is downward sloping when investors expect future spot rates to be lower than current spot rates. That is, an upward-sloping yield curve is indicative of a rise in inflation in the future and vice versa. Meanwhile, a flat yield curve indicates expectation of stable or little change in inflation.

(b) Market Segmentation Theory[6]

The Market Segmentation Theory is also known as Institutional Hedging or Habitat Theory. It categorises maturities into two habitats or segments; one long, the other short. Each segment or habitat is assumed to have a schedule of supply (lenders) and demand (borrowers) for loanable funds. The point of intersection for these schedules determines the prevailing interest rate for that sector. The market segmentation model posits that the spread between long and short-term interest rates depends on the relative supply and demand for these instruments (long and short-term bonds) by investors in their preferred habitats. Long-term bonds have associated inflation and interest rate risks and, thus completely different short-term bonds. In essence, bonds of different maturities are not substitutes and the expected return from a bond of one maturity has no effect on the demand for a bond of a different maturity. Shorter maturity bonds have lower inflation and interest rate risks, implying that the yield on longer-term bonds will generally be higher, which explains why the yield curve is usually upward sloping.

However, since markets for different-maturity bonds are completely segmented, the theory cannot explain why the short-term yields should be more volatile than the longer-term yields and there is also no reason why the short-term and long-term yields should move together. In addition, institutional restrictions which include government regulation, company policy, goals and objectives, fiscal and operational considerations on the asset side and hedging pressures on the liability side lead to very little substitutability between bonds of different maturities. For example, commercial banks generally supply loans in the short-term segment of the market whereas life insurance companies and pension funds supply the long-term segment in anticipation of a steady stream of income over the long term. The latter's goals and objectives differ from those of the former.

(c) Liquidity Preference Theory

Mainly owing to the fact that investors are often risk averse, the Liquidity Preference Theory holds that lenders anticipate the potential need to quit an investment earlier than expected. Therefore, investors tend to prefer to lend on a short-term basis since the price unpredictability of a short-term investment is lower than that of a long-term investment; lending long-term only when induced to do so by, for example, borrowers willing to pay more than what they would otherwise pay. Conversely, borrowers prefer long-term bonds because they eliminate the risk of having to refinance at higher interest rates in future periods. Therefore, borrowers often opt to pay a premium[7] to attract long-term financing in order to avoid the usually high fixed costs of frequent refinancing. Uncertainty about inflation creates uncertainty about a bond's real return, making the bond a risky investment. The further into the future, the greater the uncertainty about the level of inflation, which implies that a bond's inflation risk increases with duration. This theory postulates that an upward sloping yield curve would be expected to occur more often than a downward sloping yield curve.

5 A detailed account of the different theories of the term structure of interest rates can be seen in the article; "A Theory of the Term Structure of Interest Rates" by John C. Cox, Jonathan E. Ingersoll, JR., and Stephen A. Ross.

6 The Market Segmentation Theory has been previously applied to Botswana to explain why the return on long-term bonds (which are in short supply) has generally been low. Flyvholm, K. (2004), Bank of Botswana Research Bulletin, October 2004.

7 But that premium may be indicative of latent high loan losses and, therefore, cannot guarantee success.

3. Empirical Literature

There exist a number of studies on the relationship between the yield curve and future changes in inflation. The predictive ability of the yield curve has been acknowledged in many developed countries as a useful indicator in forecasting of inflation. However, the same cannot be said about developing countries where there is a paucity of similar studies, and data, as well as absence of relevant market structures. A sample of relevant studies include Mwega (2014), which uses a simple OLS regression method to analyse the relationship between the yield curve and future changes in inflation in Kenya. The study concluded that the slope of the yield curve contained some information on changes in inflation over periods less than six months in Kenya. Specifically, the spread between the 182-days and 91-days Treasury Bill Rates (TBRs) provided significant information about future changes in inflation in Kenya, while the spread between the longer-term interest rates did not have such predictive information. Using the 364-days TBRs and the 91-days TBRs, the paper found non-significant results with only ten observations involved. The paper, therefore, provided a case for investigating further the relationship between the yield curve and expected inflation utilising a wider spectrum of government securities when a longer historical data became available.

Oyedele (2014) sought to establish the relationship between the term structure of interest rates (yield curve) and future inflation and economic activity in Nigeria, using quarterly data spanning 1986 to 2008. The study employed the Dynamic Ordinary Least Square technique on the spread between the 14-year federal government bond and 3-month Treasury bill rates, as well as inflation. The term structure of interest rates was found to have a significant and positive long-run relationship with inflation.

Earlier on, Kotlan (1999) used OLS regression analysis to examine the information content of the term structure of interest rates regarding future inflation developments in the Czech Republic using headline and net inflation[8] as well as interbank interest rates for the period April 1992 to July 1999. The study revealed that the short end of the term structure (one and three and three and six months) contains virtually no information on the future development in inflation. Conversely, longer spreads (six and twelve and nine and twelve months) contained some information regarding future inflation.

The empirical tests of the second hypothesis[9] brought about even more positive results. The assumption that the yield curve contained significant information about the stance of monetary policy was confirmed. Furthermore, the results suggested that the yield curve contained significant information about future inflation beyond 18 months. However, the study cautioned that, although the 18 months lead equations provided certain information on the development of future inflation, a great amount of caution was to be exercised when interpreting those predictions since the Czech capital market then, lacked both sufficient liquidity and stability to enable market prices to act as reliable inflation indicators.

Also using the OLS regression method, Mishkin (1990) examined the impact of the term structure of interest rates on future inflation using the United States (US) Treasury Bills data for the period February 1964 to December 1986. The results indicated that for maturities of six months or less, the term structure had no information about the future path of inflation. In contrast, maturities of nine to twelve months appeared to contain information about the future path of inflation. Fama (1990) confirmed Mishkin's findings. The study used regression analysis to forecast changes in the one year spot rate, inflation rate and the real rate of return using the spread in the yield curve on a five-year bond over the one-year spot rate and concluded that the term structure helped forecast future inflation at longer maturities (over a year) in the US.

In an earlier study, Fama (1975), using one to six months US Treasury Bills data, concluded that during the 1953 to 1971 period, there were definite relationships between nominal interest rates and subsequent rates of inflation. Moreover, in the same period, the TBRs market seemed to be efficient in the sense that the nominal interest rates summarised all the information about future inflation rates over the historical period. Furthermore, the substantial variation in nominal bill rates during the same period seemed to be entirely due to the variance in expected inflation.

4. Data and Methodology Description

(a) Data Description

This paper estimates an inflation forecasting equation in which a change in inflation between two distinct periods is regressed on the nominal interest rate spread or the yield curve using data for the period January 2008 to June 2015. The year 2008 is critical since it coincides with the time that the Bank adopted the current forward-looking monetary policy framework. Prior to 2008, the Bank implemented an annual objective range to be achieved over the next year. However, post 2008; the Bank introduced a forward-looking monetary policy strategy (forecast-based), with a 3-6 percent inflation objective range to be achieved in the medium term (2-3 years). This was chosen with respect to the need for the continuous review of the inflation outlook as well as the pursuit of the objective of price stability.

First, inflation is computed for various periods from the monthly consumer price index (CPI). Changes are then derived from these inflation rates.

8 Net inflation calculated as the growth in prices in the unregulated part of the consumer basket adjusted for changes in indirect taxes and subsidies.

9 The second hypothesis is that the yield curve approximated by the spread between long and short rates is a good indicator of the stance of monetary policy.

For example, inflation rates for the following periods are calculated: one month (π), three-months (π^3), six-months (π^6) and twelve-months (π^{12}). A January 2008 observation for a one month's inflation rate is calculated from the December 2007 and January 2008 CPI, a March 2008 observation for a three-months' inflation rate is computed from the December 2007 and March 2008 CPI, a June 2008 observation for a six-months' inflation rate is obtained from the December 2007 and June 2008 CPI and a December 2008 observation for a twelve-months' inflation rate is calculated from the December 2007 and December 2008 CPI. Changes in inflation are then computed between one and three-month's inflation ($\pi^3 - \pi$) for the short-term and, six and twelve-month's inflation ($\pi^{12} - \pi^6$) for the longer-term spread (Mishkin, 1990).

Secondly, the interest rate spreads or the term structure, are calculated from the following nominal interest rates: the 31 day or 1 month (i), 3-month BoBCs (i^3)[10], as well as the six (i^6) and twelve-months (i^{12}) fixed deposit rates. As in the case of the inflation spread, the short-term interest rate spread was calculated as the difference between the one month and 3-month BoBCs ($i^3 - i$), while the longer-term spread was calculated as the difference between the six and twelve-months' fixed deposit rates ($i^{12} - i^6$) (Mishkin, 1990). While the latter used bond yield spreads, deposit rate spreads were used in this study owing to insufficient data on bond yields. Furthermore, this study used deposit rates instead of lending rates following other previous studies[11] that observed that deposit rates are relatively more responsive to monetary policy changes. According to Das (2015), the pass-through of monetary policy to deposit and lending rates has generally been found to be relatively slow in developing countries, with the deposit rate being more responsive to monetary policy changes than is the case with the lending rate. However, the estimated speed of adjustment coefficients indicate that the deposit rate adjusts downwards when the target rate falls, but does not adjust upwards after a monetary policy tightening.

(b) Methodology

Similar to comparator Studies, a simple OLS regression method is employed to evaluate the predictive power of the term structure of interest rates in Botswana inflation. The paper seeks to contribute towards the limited developing country literature on the term structure-inflation nexus. The ability of the yield curve or the term structure of interest rates to predict changes in inflation begins with the standard Fisher equation as espoused in Mishkin (1990), which formulates the link between expected inflation, nominal interest rates and real interest rates as follows:

$$E_t\pi_t^m = i_t^m - rr_t^m \qquad (1)$$

Where $E_t\pi_t^m$ denotes expectations at time t of inflation at time t to t+m, i_t^m is the m-period nominal interest rate at time t to t+m and rr_t^m is the m-period (ex-ante) real interest rate at time t, i.e., the ex-ante real return on an m-period deposit rate from time t to t+m.

The realised inflation over the next m periods can be written as the expected inflation rate plus the forecast error:

$$\pi_t^m = E_t\pi_t^m + \varepsilon_t^m \qquad (2)$$

where ε_t^m is the inflation forecast error ($\pi_t^m - E_t\pi_t^m$). Substituting in for $E_t\pi_t^m$ from equation (1), we obtain,

$$\pi_t^m = i_t^m - rr_t^m + \varepsilon_t^m \qquad (3)$$

Future changes in inflation can then be modelled as follows:

$$\pi_t^m - \pi_t^n = i_t^m - i_t^n - rr_t^m - rr_t^n + \varepsilon_t^m - \varepsilon_t^n \qquad (4)$$

Equation (4) above can, therefore, be re-written in the form of an inflation-change forecasting equation as:

$$(\pi_t^m - \pi_t^n) = \alpha_{m,n} + \beta_{m,n}(i_t^m - i_t^n) + \eta_t^{m,n} \qquad (5)$$

where
$\alpha_{m,n} = r^n - r^m$,
$\eta_t^{m,n} = \varepsilon_t^m - \varepsilon_t^n - (u_t^m - u_t^n)$,
$u_t^m = rr_t^m - r^m$ and
$u_t^n = rr_t^n - r^n$

From equation (5), as in Fama (1975), we assume that, if expectations are rational and the slope of the real term structure ($rr_t^m - rr_t^n$) remains constant over time, then the OLS estimates of the inflation-change forecasting equation (5) produces a reliable estimate of $\beta_{m,n}$ that is unity. If the slope of the real term structure is not constant and the slope of the nominal term structure is correlated with the slope of the real term structure, then the error term in equation (5) will be correlated with the slope of the nominal term structure and the OLS estimate of the mean slope of the real term structure, $r^n - r^m$, will not be a reliable estimator. However, if the slope of the real term structure is not constant, statistical significance of the coefficient of the nominal term structure implies the presence of information about future inflation.

Tests of the statistical significance of the $\beta_{m,n}$ coefficient and whether it differs from unity reveals how much information there is in the slope of the term structure about the future path of inflation. The null hypothesis of $\beta_{m,n} = 0$ is statistically rejected if the t-statistic is less than 2, reflecting that the nominal interest rates contain some information about the level of future inflation. The coefficients can be either positive or negative reflecting the slope of the yield curve.

10 BoBCs are the primary means through which the Bank conducts open market operations to support monetary policy by absorbing excess liquidity in the economy. They are of two types of maturities when issued; 14 days and 91 days.

11 However, there is no Botswana-specific research on this issue.

5. Model Estimation and Results

(a) Model Estimation

The process of estimating the model (Equation 5) starts with subjecting the constituent variables to the Phillips-Perron stationarity test. All the variables, being the inflation and interest rate spreads were found to be stationary at levels as reported in (Table 1). The variables, therefore, satisfy the OLS estimation requirement that variables have to be stationary in order to avoid spurious regressions.

TABLE 1: UNIT ROOT TESTS

Variables	Phillips-Perron	Stationarity
$\pi^3 - \pi$	*-4.73 (0.00)*	*Yes*
$\pi^{12} - \pi^6$	*-3.57 (0.04)*	*Yes*
$i^3 - i$	*-6.32 (0.00)*	*Yes*
$i^{12} - i^6$	*-4.65 (0.00)*	*Yes*

Note: Values in parentheses are probabilities. The null hypothesis for the Phillips-Perron test is that the series is non-stationary. The null hypothesis is rejected when the probability is lower than 0.05 or 5 percent. Conversely, the null hypothesis is not rejected when the probability is greater than 5 percent.

(b) Diagnostic Tests

After estimation, the model was, in turn, subjected to diagnostic tests for normality, serial correlation, heteroscedasticity and stability to ensure that underlying assumptions of the OLS estimation hold. The diagnostic results (Table 2) indicate that the errors of the estimated equation are normally distributed and that the parameters are stable as indicated by the Jacque-Bera test. However, serial correlation was detected in both spreads, while heteroskedasticity was only detected in the long-term spread as indicated by the Durbin-Watson and Breuch Pagan-Godfrey tests, respectively. The Newly-West Heteroskedasticity and Autocorrelation Consistent (HAC) estimator was, therefore, employed to correct for serial correlation in both spreads and heteroskedasticity in the long-term spread.

TABLE 2: DIAGNOSTIC TESTS

Diagnostic Test	Test statistic	Probability	Conclusion
Normality	(3,1) JB= 5.59	*0.06*	*Passed*
	(12,6) JB= 4.21	*0.12*	*Passed*
Stability	(3,1) JB= 1.75	*0.19*	*Passed*
	(12,6) JB= 0.49	*0.47*	*Passed*

Note: The null hypothesis for normality is that the model residuals are normally distributed; while that of stability is that the coefficients of the model are stable. In both cases, the null hypothesis is not rejected if the probability is greater than 0.05 or 5 percent.

(c) Results

The results of the estimated inflation-change forecasting equation, which regresses the change in inflation between two periods ($\pi^m - \pi^n$) on the term structure or yield curve ($i^m - i^n$), are summarised in Table 3. The results indicate that the term structure contains no information about the path of future inflation in the shortest end of the term structure (maturities of six months and less) since we fail to reject the null hypothesis (the t-statistic is less than 2). This means that future developments in inflation cannot be inferred from the shorter segment of the yield curve for the period under study. This is similar to the outcome in a study by Mishkin (1990), where maturities of six months or less provided no information about the future path of inflation in the United States of America.

In the case of the longer-term spread, the $\beta_{m,n}$ coefficient is statistically different from zero, implying that the yield curve for maturities of six months or more contain some information on the path of expected inflation. Therefore, an upward-sloping yield curve or term structure, other things being equal, would imply rising inflation in the future and vice versa. The information content of the longer maturity term structure as opposed to the shorter maturity term structure can be viewed as consistent with the lags inherent in the transmission mechanism of monetary policy. A deviation of forecast inflation from the objective or target usually prompts monetary policy to react in the current or short term in order to bring future inflation back to target. This is because in the short term, inflation outcomes are already determined by past developments or shocks and, therefore, cannot respond to current policy action to any significant degree (Bank of Botswana Monetary Policy Statement, 2008).

TABLE 3: ESTIMATES OF THE INFLATION CHANGE EQUATION

m,n (months)	$\alpha_{m,n}$	$\beta_{m,n}$	t-statistic of $\beta_{m,n} = 0$
$\pi^3 - \pi$	0.65	0.18	1.81
	(0.21)	(0.10)	
$\pi^{12} - \pi^6$	5.63	-3.29	2.00
	(0.74)	(1.64)	

Note: Values in parenthesis are standard errors.

6. Conclusion

This paper provides a perspective on the information content of the yield curve with respect to anticipated path of inflation in Botswana in both the short and longer-term horizons. It concludes that for maturities of six months or less, the yield curve contains no information about the future path of inflation. Conversely, evidence from the estimated model indicates that there is some information in the longer maturity segment of the yield curve about the future path of inflation. Therefore, at longer maturities, the yield curve can be used to enhance assessment of future inflationary pressures in Botswana and, thus, help predict inflation. Thus, the yield curve represents a simple measure that should be viewed as a complementary predictor which, along with other information, can be used to help guide monetary policy. However, these results should be interpreted with caution, given the country's rudimentary stage

of financial markets development and the not so well defined transmission channels in the domestic financial markets. Moreover, the time-varying risk premium and the impact of some policy decisions have the potential to distort the yield curve and its relationship with changes in future inflation.

References

Bank of Botswana (2008-2014). Botswana Financial Statistics. Gaborone: Bank of Botswana

Bank of Botswana (2008). Monetary Policy Statement. Gaborone: Bank of Botswana

Das, S. (2015): "Monetary Policy in India: Transmission to Bank Interest Rates," IMF Working Paper 15/129 (Washington: International Monetary Fund).

Fama, E.F. (1975). "Short-Term Interest Rates as Predictors of Inflation," American Economic Review, American Economic Association, Vol. 65(3), pp. 269-82, June.

Fama, E.F. (1990). "Term Structure Forecasts of Interest Rates, Inflation, and Real Returns," Journal of Monetary Economics, 25, pp. 59-76.

Fisher, I. (1930). *The Theory of Interest, as Determined by Impatience to Spend Income and Opportunity to Invest it,* New York: Macmillan, 1930.

Flyvholm, K. (2004). "The Government Bond Market in Botswana," Bank of Botswana Research Bulletin, October 2004, Volume 22, No 1, pp. 17-25.

John C. Cox, Jonathan E. Ingersoll, JR. and Stephen A. Ross (1985): "A Theory of the Term Structure of Interest Rates," Econometrica, Vol.53, No.2, pp. 385-407.

Kotlan, N. (1999) "The Term Structure of Interest Rates and Future Inflation," Eastern European Economics, Vol. 37, No.5, pp. 36-51, September-October 1999.

Mishkin, F. (1990) "What Does the Term Structure Tell Us about Future Inflation?" Journal of Monetary Economics, Vol 25, pp. 77-95.

Mishkin, F. and Estrella, A. (1995) "The Term Structure of Interest Rates and its Role in Monetary Policy for the European Central Bank" National Bureau of Economic Research (NBER) Working Paper Series, pp. 1-55.

Mwega, F. (2013, June): "A Note on Term Structure and Inflationary Expectations in Kenya". Paper presented at the Central Bank of Kenya (CBK) Technical Retreat, Naivasha, Kenya. Retrieved from https://www.centralbank.go.ke/images/docs/Research/Discussion Papers/termstructureinflationaryexpectationskenya.pdf

Mylonas, P. and Schich, S. (1999) "The Use of Financial Market Indicators by Monetary Authorities," OECD Economics Department Working Paper, No. 223.

Oyedele, O. (2014) "The Relationship between the Term Structure of Interest Rates and Nigeria Economic Growth and Inflation Rate," International Journal of Innovation and Scientific Research, Vol. 11 No. 2, pp. 295-303, November. 2014.

Robertson, D. (1992) "Term Structure Forecasts of Inflation." The Economic Journal, Vol. 102, Issue: 414, pp. 1083-1093, September.

Can Money Overhang Help Predict Inflation in Botswana?

Thato Mokoti[1]

Abstract

This paper empirically evaluates whether money overhang helps to improve the forecasting accuracy of inflation in Botswana by analysing quarterly data over the period 2006Q2-2014Q4. The study estimates a standard money demand equation, constructs a money indicator called money overhang and investigates its predictive ability for inflation via standard econometric models of autoregressive integrated moving average (ARIMA) and vector autoregressive (VAR) nature. The results indicate that money overhang does not seem to improve the accuracy of inflation forecasts in Botswana. In other words, the information content of money overhang for inflation forecasting in Botswana is limited. Therefore, money overhang cannot be considered one of the variables with significant and useful supplementary information for prediction of inflation in Botswana.

1. Introduction

A popular view of the determinants of inflation movements is based on the traditional quantity theory of money. According to this view, inflation is predominantly a monetary phenomenon and, therefore, money growth should supposedly cause changes in inflation.[2] However, the role of money in the conduct of monetary policy has been greatly disputed over the years. Some studies have concluded that money does not carry any additional information and, thus, from a monetary policy perspective, money has little relevance for price developments. For example, modern macroeconomics, especially models based on the New Keynesian framework, suggests that central banks should set interest rates without focusing on monetary aggregates. This implies that monetary aggregates have inconsequential role to play in monetary policy deliberations for some economies.

However, not all economists and policymakers agree with the notion of de-emphasising money as a determinant of inflation. Notably, the European Central Bank (ECB) continues to assign a prominent role to money in its monetary policy framework, through its "two-pillar strategy" that comprises "economic analysis" and "monetary analysis". The two pillars are complementary with regard to analysing risks to price stability and ensuring that no relevant information is lost in the assessment of risks. While the economic analysis is concerned with price developments determined through the interplay of supply and demand in the real economy, the monetary analysis is concerned with the long-run link between money and prices.

Nevertheless, from a policy perspective, the important question is not whether money matters, but the extent to which it matters. Money may be found to be significant in many inflation forecast equations, but an important issue would be whether inflation forecasts become more accurate with money, as compared to other standard models that exclude money variables. If indeed inflation forecasts become more accurate, then there is a strong argument for monitoring monetary developments.

Therefore, the primary objective of this paper is to contribute to the empirical literature by evaluating whether money helps to improve forecasting accuracy of inflation in Botswana by analysing data between 2006 and 2014. The study constructs a standard money indicator called "money overhang" and investigates its predictive ability for inflation via standard econometric models of autoregressive integrated moving average (ARIMA) and vector autoregressive (VAR) nature. Money overhang signals money-market disequilibria, either inflationary or disinflationary pressures. Money overhang is preferred in this study since derived measures of this indicator are believed to provide more accurate forecasts of inflation than simple measures such as money growth. Meanwhile, although money overhang has become popular in economic literature for its wide use as an indicator of inflationary pressures over the medium-term horizon, the author is not aware of any empirical work carried out in respect of Botswana. Hence, in-sample forecasts for inflation based on ARIMA and VAR are generated up to a horizon of three years[3] with and without the money overhang indicator. Forecast errors from the models are then used to evaluate whether money helps to improve the forecasting precision of inflation in Botswana. It should be noted that, for a model to be considered good enough, it should be able to replicate history, hence the use of in-sample forecasts.

Section 2 of this paper reviews the relevant empirical literature. Section 3 specifies the methodology, while Section 4 covers data description. Section 5 presents the results of the study and Section 6 concludes.

2. Empirical Literature

There is a large body of literature that has estimated money demand functions and tested their stability.

1 Senior Economist, Modelling and Forecasting Unit, Research and Financial Stability Department. The views expressed in this paper are those of the author and do not necessarily reflect those of the Bank of Botswana.

2 Notably, Milton Friedman said "inflation is everywhere and anywhere a monetary phenomenon".

3 This is a period that is largely considered to be consistent with the monetary policy framework in Botswana.

However, empirical work on the information content of money for inflation forecasting has been limited mainly to developed countries. Horvath et al. (2010) investigated the predictive ability of money for inflation in the Czech Republic, Hungary, Poland and Slovakia using data for the period 1998Q3-2008Q3. The study examined the performance of three other commonly used monetary indicators (monetary overhang, nominal gap and real money gap) for inflation forecasting vis-à-vis some benchmark models such as the random walk and simple autoregressive models. The study constructed money overhang as the deviation of money from its equilibrium inferred from money demand, which was estimated within some vector error correction model (VECM). The study used data on the money stock (M2), consumer price index (CPI), real gross domestic product (GDP), interest rate and exchange rate in estimating the money demand equation. The results suggested that the performance of the examined forecasting models containing money was quite heterogeneous and, in general, not better in comparison with the random walk and autoregressive benchmark models. Meanwhile, the study failed to evaluate the predictability of money at different frequencies.

Hossfeld (2010) analysed the US money demand stability and the indicator properties of derived money overhang measures of various monetary aggregates (M1, M2, M2 minus short-term deposits and MZM[4]) for predicting inflation over a sample from 1987Q1-2008Q2. The study used cointegrated VAR models for the estimation of money demand and derivation of money overhang. The variables used include various measures of monetary aggregates along with real GDP, interest rates (3-month Treasury bill rate and the own rate of M2) and inflation. The results from the exercise suggested that by recursively re-estimating the cointegrated VAR model in each period, and by imposing sensible short-run and long-run restrictions, money overhang significantly improved forecasts of inflation over the 3-year horizon, similar to the univariate model (MA(1)), which has a good predictive capability for this forecast horizon. Thus, the study concluded that money overhang measures can be considered useful supplementary information variables for predicting long-run changes in the US inflation. A criticism of the study is that it used a closed economy version of money demand which may not be relevant for the US economy.

Wesche et al. (2007) investigated the relationship between money growth and inflation in Japan using data for the period 1970Q1-2005Q4. The study used a band spectrum regression to analyse the information content of money growth for inflation at both lower and higher frequencies. The variables used in the estimation include M2 plus deposits at all depository institutions, real GDP, interest rate (call rate) and CPI. The study found that inflation was related to money growth at lower frequencies. Granger causality test results also indicated causality from money growth to inflation. Thus, the study concluded money growth does contain information useful for predicting future inflation. However, the approach used in the analysis failed to control for changes in velocity arising from financial innovation and also adopted the closed economy version of money demand which may not be relevant for the Japanese economy.

Gottschalk et al. (2000) evaluated the information content of money for the forecast of inflation, output, investment and consumption in the Euro zone using data covering the period 1980Q1- 1992Q2. With respect to the forecast of inflation, the analysis was conducted within the context of bivariate VAR models containing money[5] as an indicator variable and inflation. To provide a benchmark for the assessment of the forecast performance of the indicator variable, univariate models for inflation based on ARIMA were estimated. The results indicated that none of the money based indicators managed to outperform the benchmark models. Thus, on balance, the study concluded that the information content of money for the forecast of inflation appeared rather limited. However, unlike other studies which relied on estimating the money demand function in deriving money indicators, this study assessed the information content of money by simply relying on Granger-causality tests between money and inflation.

For a developing country, Whyte (2011) investigated the role of monetary indicators for predicting inflation in Jamaica using data from 1997Q1-2011Q1. The study used the autoregressive distributed lag (ARDL) approach for estimating the money demand equation and derivation of excess money. The variables used in the estimation include M3, real GDP, CPI, interest rate (180-day Treasury bill rate) and real financial wealth. Meanwhile, the study also estimated two ARDL models, one based on money growth (M3) and the other one excluding a monetary aggregate in order to assess the true contribution of monetary aggregates in inflation forecasting. The study found that, compared to money growth, excess money does not perform better in inflation prediction. However, excess money outperformed the model without a monetary aggregate. Therefore, the study concluded that monetary indicators are useful in inflation prediction, especially if the forecasting equations are based on money supply growth. However, just like Hossfeld (2010), this study opted for the closed economy version of money demand which may not be relevant for Jamaica.

There is no study that has investigated the inflation predictive power of money in Botswana. However, the closest work in Botswana is on estimation of the demand for money. The notable studies are Kganetsano (2001), Mosweu (2003) and Tsheole (2006). Kganetsano (2001) estimated a money demand equation for M1 and M2 using a single equation error correction model for the period 1978-1997. Mosweu (2003) analysed the demand for money (M1) for the period 1975-2001 using VECM, while Tsheole (2006)

4 MZM refers to money at zero maturity.

5 The study used the growth of M1 and M3.

estimated the money demand function (M2) using VECM for the period 1978-2005. Although all the three studies used different sample periods, various specifications for money demand equation and somewhat different methodologies, they all found a stable money demand function for Botswana.

3. METHODOLOGY

In determining whether money helps to improve the forecasting accuracy of inflation in Botswana, this paper follows the methodology by Horvath et al. (2010) with some modifications. Given the relatively short sample period, the estimation of a money demand function using VECM is avoided in order to conserve degrees of freedom. First, the study constructs a standard money indicator called money overhang by estimating a long-run money demand equation. Second, the predictive ability for inflation of money overhang is investigated via standard benchmark econometric models of ARIMA and VAR.[6] That is, in-sample forecasts for inflation based on ARIMA and VAR are generated up to a horizon of three years with and without money overhang. Then, forecast errors from the models are used to evaluate whether money helps to improve the forecasting precision of inflation in Botswana.

To construct money overhang, a long-run money demand function is first estimated. Imposing price homogeneity condition transforms the model of nominal money demand into real money demand equation. The long-run real money demand equation widely used in the literature is, thus, specified as follows:

$$lm2_t = c_1 + lcpi_t + c_2 ly_t + c_3 is_t + \varepsilon_t \quad (1)$$

where $lm2_t$, $lcpi_t$, ly_t and is_t denote the money stock, price level, real income and nominal interest rate, respectively. c_1, c_2 and c_3 are parameters, and ε_t is the error term.

This is the conventional specification where the determinants are real output as a variable capturing the transaction motive of holding money balances and the interest rate to model the opportunity costs. Meanwhile, although some variables such as exchange rate could have been added in the case of Botswana, such variables were found not to be statistically significant, and, therefore, were omitted in the specification.

The difference between the actual money supply and the calculated money demand is the money overhang. In other words, the residuals[7] from Equation (1) measure the money-market disequilibrium (money overhang). However, to conclude that there is money overhang, three conditions have to be satisfied. First, the residuals have to be stationary (existence of cointegration based on the Engle-Granger procedure). Second, residuals need to be positively correlated with inflation and, third, causation should run from money to inflation and not vice versa. Satisfying the three conditions, if the residuals are positive, it means that money stock is greater than the required money stock, implying inflationary pressures going forward and the need for policy tightening. Negative residuals imply the economy has less money than the required money stock, implying disinflationary pressures and the need for policy easing.

To ensure the robustness of the estimates of the approach used above, the money demand equation is re-estimated by an additional cointegration regression of the fully modified ordinary least squares (FMOLS). That is, a comparison is made between fully modified estimates and estimates of the money demand in Equation (1) by testing the null hypothesis that the estimates of c_2 and c_3 hold in Equation (1). To do so, a t-statistic is derived as the difference between the coefficient from the FMOLS approach and the first approach, divided by the standard error from the FMOLS approach. This t-statistic is then used given the degrees of freedom to generate the p-value. The null hypothesis is rejected if the p-value is less than 0.05.

As indicated earlier, the inflation predictive ability of money overhang is investigated via standard benchmark econometric models in the following steps. First, in-sample forecasts up to a horizon of three years are produced based on the two models represented by Equation (2) for ARIMA and (3) for VAR. Second, residuals (money overhang) from Equation (1) are added as an explanatory variable to Equation (2) and (3) and in-sample forecasts are generated up to a horizon of three years. Lastly, forecast errors from the two models, with and without money overhang, are evaluated to determine whether money helps to improve the forecasting precision of inflation in Botswana.

$$dlcpi_t = \propto + \rho_1 dlcpi_{t-1} + \theta_1 \varepsilon_{t-2} + \theta_2 \varepsilon_{t-3} + \varepsilon_t \quad (2)$$

$$lcpi_t = \beta + \sum_{j=1}^{2} \varphi_j \, lcpi_{t-j} + \sum_{j=1}^{2} \omega_j \, lssar_{t-j} + \sum_{j=1}^{2} \emptyset_j \, ion_{t-j} + dumoil + u_t \quad (3)$$

In Equation (2), $dlcpi_t$ is the first difference of the log of cpi, $dlcpi_{t-1}$ is the autoregressive part of this variable, and ε_{t-2} and ε_{t-3} represent the moving average part of the model. α, ρ_1, θ_1 and θ_2 are parameters, while ε_t is the error term. For Equation (3), $lcpi_t$ is log of cpi, $lssar_t$ is log of exchange rate, ion_t is the interest rate, $dumoil$ is a dummy variable, and parameters are captured by β, ψ_j, ω_j and ϕ_j, while u_t is the error term.

4. DATA DESCRIPTION

The study uses quarterly data series for the period 2006Q2 – 2014Q4. The choice of the sample is moti-

6 It is worth noting that as inflation becomes more stable in a country, more information is already incorporated into the lagged values of inflation itself. Hence, the use of simple autoregressive models in this study.

7 Residuals should be interpreted as changes in money stock that cannot be explained using the conventional determinants of money demand in Equation 1.

vated mainly by lack of a longer time series data for some variables, as well as the approach used in the study.[8] The variables used for determining whether there is money overhang are M2 ($lm2_t$) to represent money stock, total real GDP (ly_t) and real non-mining GDP (lyn_t) to denote real income, consumer price index ($lcpi_t$) and nominal interest rate (is_t). All series, apart from the nominal interest rate, have been converted into logarithms. M2 is defined as currency in circulation plus transferable and time deposits. The nominal interest rate is calculated as the spread[9] between the long-term government bond yield and the 88-day deposit rate. The variables used for forecasting inflation are $lcpi_t$, rand/Pula exchange rate level ($lssar_t$), Bank Rate (ion_t) and money overhang indicator (MO). There is also a dummy variable (*dumoil*) which picks up the effect of the global rise in oil prices as well as surging food prices during the second quarter of 2008.

In analysing the impact of monetary policy on domestic demand, it is appreciated in this analysis that some demand conditions such as the demand for diamonds cannot be influenced by monetary policy changes in Botswana; but depends on the trading and marketing arrangement between Debswana and De Beers, as well as world demand for rough diamonds. For this reason, the analysis of the effects of monetary policy in Botswana need to take into account the two components: that which is determined by factors outside the influence of Botswana's monetary authorities and the other, which is amenable to monetary policy. This study, therefore, tests for the existence of money overhang for both the whole economy and, alternatively, for the non-mining output part of the economy. The GDP and CPI data are sourced from Statistics Botswana, while all the remaining data are sourced from Bank of Botswana.

5. RESULTS

Standard unit root tests confirm the results[10] found in the other money demand studies. The null hypothesis of non-stationarity of M2, real GDP, CPI and interest rate cannot be rejected for both functions.[11] Table 1 shows results from the estimated long-run money demand equation (M2). All the estimates are statistically significant and have the correct signs as postulated by theory. Meanwhile, the lower than unitary income elasticity of demand for money suggests that money demand has been rising at a lower rate than changes in total transactions in the economy.[12] Conversely, the interest elasticity of money demand is quite high, possibly driven by time deposits which account for more than 70 percent of M2 for the period under investigation.

TABLE 1: MONEY DEMAND ESTIMATES IN BOTSWANA

	GDP	is
Total GDP (lyt)	0.18*	-7.66*
	(2.51)	(-5.03)
Non-Mining GDP (lyn)	0.13*	-6.98*
	(2.48)	(-4.21)

*Note: * denotes significance at the 5 percent level, while t-statistics are in brackets.*

The results from the two functions further indicate the existence of money overhang in Botswana. First, the residuals are stationary (existence of cointegration based on the Engle-Granger procedure). Second, the residuals are positively correlated with inflation and, third, causation runs from money to inflation and not vice versa. Table 2 presents the results for unit root and causality tests for each of the functions.

TABLE 2: RESIDUAL TESTS FOR EXISTENCE OF MONEY OVERHANG

Unit Root Test (ADF)	t-Statistic	Critical Value
Resm1	*-4.45*	*-2.95*
Resm2	*-4.27*	*-2.95*
Granger Causality Test	**F-Statistic**	**Probability**
Resm1 does not Granger cause inflation	*3.61*	*0.04*
Inflation does not Granger cause Resm1	*1.90*	*0.17*

Note: Resm1 are the residuals/money overhang from the money demand function estimated using total GDP while Resm2 are those from the non-mining GDP function.

Since the stability of the money demand equation is often cited as a precondition for good forecasting power, several diagnostic tests, among them the stability test, were conducted. For both functions, the null hypotheses of no serial correlation, homoscedasticity, normality and stability are not rejected (see Figures 1 and 2 in the Appendix).

To further cement the robustness of the estimates of the money demand equation used in this study, the equation was re-estimated through an additional

8 For example, although the long-term government bond (BW003) was initially issued in April 2003, plausible results from the money demand function were only obtained when using data that start from the second quarter of 2006.

9 According to Coenen and Vega (1999), the spread between long and short-term rates is sometimes used in the literature. The spread also contains information about the stance of monetary policy and it has predictive power on future inflation.

10 Some tests results are not presented here. However, the information is available on request.

11 Functions here refer to the money demand equation based on total GDP and the one based on non-mining GDP.

12 Intuitively, total GDP should not give rise to much money demand in the economy compared to non-mining GDP since most of the mineral revenue goes to Government and deposited at Bank of Botswana (not counted as part of M2), while another large portion of the mineral output is repatriated as dividends to the foreign shareholder(s). Therefore, the results should be interpreted with caution given the quality of data (particularly GDP, which is often subject to substantive revisions) and the omission of other variables such as exchange rate in the specification of the money demand equation.

cointegration regression of the FMOLS. That is, a comparison was made between fully modified estimates and estimates of the money demand in Equation (1). The null hypothesis that the estimates of c_2 and c_2 hold in Equation (1) cannot be rejected as indicated in Table 3. Therefore, the estimates from Equation (1) are valid and the residuals indicate the existence of money overhang in Botswana.

TABLE 3: ROBUSTNESS CHECKS WHETHER ESTIMATES OF MONEY DEMAND EQUATION HOLDS BASED ON FMOLS ESTIMATES

	t-Statistic	Probability
Total GDP (lyt)	-0.45	0.65
is	-0.46	0.65
Non-Mining GDP (lyn)	-0.38	0.70
is	-0.47	0.64

Meanwhile, as indicated earlier, the inflation predictive ability of money overhang was investigated via standard benchmark econometric models of ARIMA and VAR.[13] First, in-sample forecasts up to a horizon of three years were produced based on the two models represented by Equations (2) and (3). Second, residuals (money overhang) from Equation (1) were added as an explanatory variable on Equation (2) and (3) and in-sample forecasts generated up to a horizon of three years. Lastly, forecast errors from the two models, with and without money overhang, were evaluated to determine whether money helps to improve the forecasting precision of inflation in Botswana. The results in Table 4 indicate that despite the estimated money demand equation being stable (probably due to the fact that shifts in the velocity of money in Botswana have tended to be small for the period under investigation, fluctuating between 0.4 and 0.7 for total GDP, and 0.4 and 0.5 for non-mining GDP), money generally does not improve the accuracy of inflation forecasts in Botswana.[14]

6. CONCLUSION

This paper set out to evaluate whether money overhang helps to improve the forecasting accuracy of inflation in Botswana by estimating a standard money demand equation, constructing a money indicator called money overhang and investigating its inflation predictive ability. To do this, the paper estimated standard ARIMA and VAR econometric models. The results indicate that despite the estimated money demand equation being stable, money overhang does not seem to improve the accuracy of inflation forecasts in Botswana. In other words, the information content of money overhang for inflation forecasting in Botswana is limited. Therefore, money overhang need not be considered one of the variables with significant and useful supplementary information for prediction of inflation in Botswana. Hence, there seems to be some justification for the Bank of Botswana not to target monetary aggregates, but rather focus on inflation forecast as the intermediate target.

TABLE 4: IN-SAMPLE FORECAST ERRORS FOR MODELS WITH AND WITHOUT MONEY OVERHANG

	ARIMA			VAR		
	Without	MON	MOT	Without	MON	MOT
RMSE	0.7653	0.7587	1.0629	0.3693	0.4328	0.4410
MAE	0.6122	0.6291	0.8690	0.1749	0.2034	0.2053
MAPE	0.3648	0.3746	0.5134	0.1027	0.1215	0.1223
THEIL	0.0023	0.0023	0.0057	0.0013	0.0015	0.0016

Note: RMSE, MAE, MAPE and THEIL are Root Mean Squared Error, Mean Absolute Error, Mean Absolute Percent Error and Theil Inequality Coefficient, respectively. All these four measures indicate the predictive power of the model. The more accurate the forecasts, the lower the value of the measure. MON is model with money overhang derived using an equation based on non-mining GDP, while MOT is the model with money overhang from total GDP.

REFERENCES

Brand, C. and Cassola, N. (2000). "A Money Demand System for Euro Area M3". Working Paper No. 39. European Central Bank.

Carstensen, K., Hagen, J., Hossfeld, O. and Neaves, A.L. (2006). "Money Demand and Money Overhang in the Four Largest EMU Countries". Kiel Institute for the World Economy.

Coenen, G. and Vega, J.L. (1999). "The Demand for M3 in the Euro Area". Working Paper Series 6. European Central Bank.

Gottschalk, J., Rico, F.M. and Zandweghe, W.V. (2000). "Money as an Indicator in the Euro Zone". Kiel Working Paper No. 984. Kiel Institute of World Economics.

Horvath, R., Komarek, L. and Rozsypal, F. (2010). Does Money Help Predict Inflation? An Empirical Assessment for Central Europe. Czech National Bank.

Hossfeld, O. (2010). "US Money Demand, Monetary Overhang and Inflation Prediction". Working Paper No. 4. International Network for Economic Research.

13 For more information on these models, see James et al. (2009) on Bank of Botswana's Short-Term Inflation Forecasting Models. However, the two models passed all diagnostic tests they were subjected to.

14 The main reason for money not often being, if not typically, regarded as an unreliable indicator of inflation is due to shifts in velocity, which tend to arise as a consequence of financial innovation and deregulation, as well as changes in interest rates. However, shifts in velocity in Botswana have rather been small. Therefore, the potential explanation is that, as inflation becomes more stable for Botswana, more information is already incorporated into the lagged values of inflation and, thus, it is harder to beat simple autoregressive forecasts.

James, L.V., Mokoti, T.P., and Molalapata, I. (2009). "Bank of Botswana's Short-Term Inflation Forecasting Model." The Research Bulletin. Vol 23 (1). Bank of Botswana.

Kganetsano, T.A. (2001). "Demand for Money in Botswana: Cointegration and Error Correction Approach". The Research Bulletin. Vol 19 (1). Bank of Botswana.

Kool, C., Reget, E.D., and Veen, T.V. (2014). "Money Overhang and Financial Imbalances in the Euro Area". Utrecht University.

Moinuddin. (2010). "Monetary Overhang in Pakistan". State Bank of Pakistan Research Bulletin 6(2).

Mosweu, W. (2003). "An Approach to Estimating the Demand for Narrow Money in Botswana". The Research Bulletin Vol 21 (2). Bank of Botswana.

Schreiber, S. (2013). "(When) Does Money Growth Help to Predict Euro-area Inflation at Low Frequencies?". Free University Berlin.

Tsheole, T. (2006). "The Demand for Broad Money (M2) in Botswana". Rhodes University.

Wesche, K., Gerlach, S. and Sekine, T. (2007). "Monetary Factors and Inflation in Japan". Working Paper No. 13. Swiss National Bank.

Whyte, S. (2011). "Modelling the Inflation Rate in Jamaica: The Role of Monetary Indicators". Research Paper No.8. Bank of Jamaica.

Woodford, M. (2007). "How Important is Money in the Conduct of Monetary Policy". National Bureau of Economic Research.

APPENDIX

FIGURE 1: DIAGNOSTIC TESTS FOR MONEY DEMAND FUNCTION BASED ON TOTAL GDP

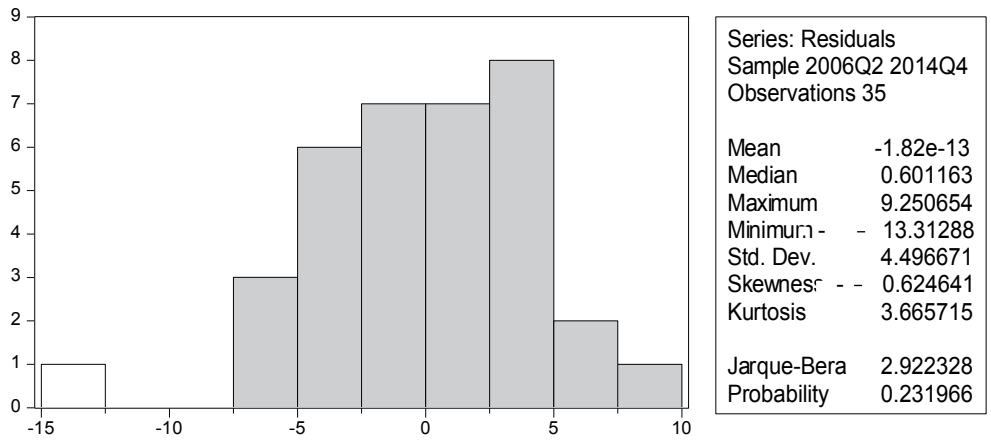
1. Breusch-Godfrey Serial Correlation LM Test

F-statistic	2.276648	Prob. F(3,29)	0.1007
*Obs*R-squared*	6.671738	Prob. Chi-Square(3)	0.0831

2. Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.051791	Prob. F(3,31)	0.3836
Obs*R-squared	3.233401	Prob. Chi-Square(3)	0.3570
Scaled explained SS	3.602526	Prob. Chi-Square(3)	0.3077

3. Normality Test



4. Stability Test

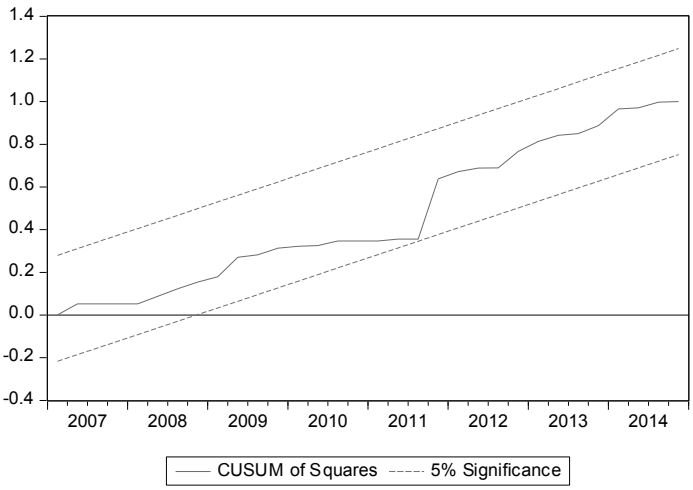


FIGURE 2: DIAGNOSTIC TESTS FOR MONEY DEMAND FUNCTION BASED ON TOTAL NON-MINING GDP

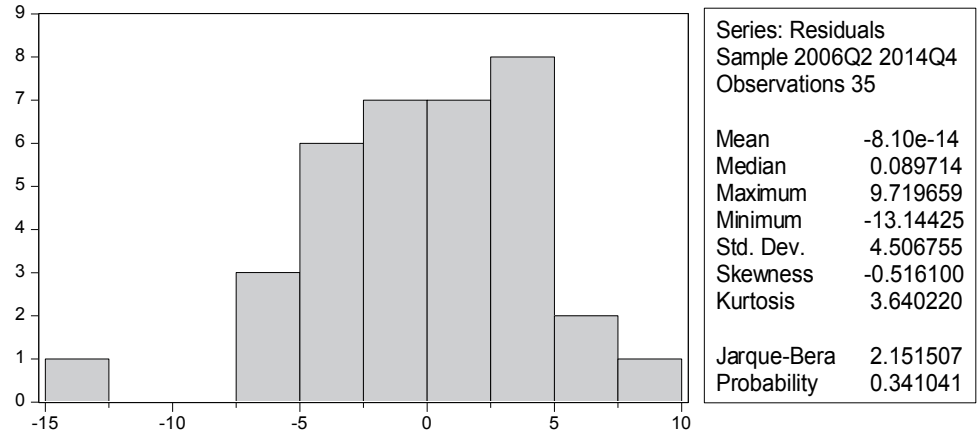
1. Breusch-Godfrey Serial Correlation LM Test

F-statistic	2.751822	Prob. F(3,29)	0.0606
*Obs*R-squared*	7.755675	Prob. Chi-Square(3)	0.0513

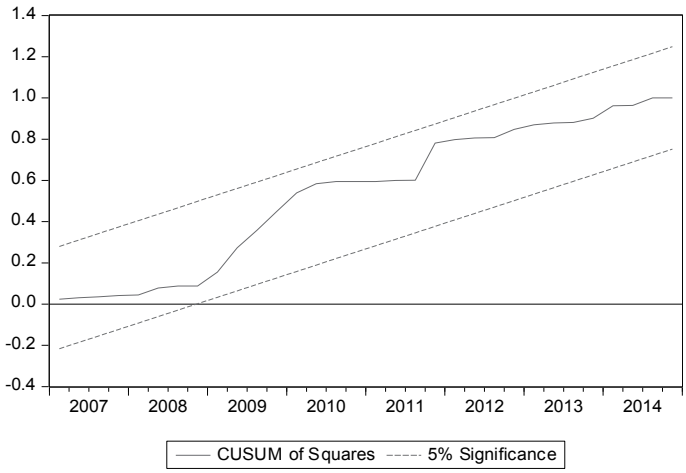
2. Heteroskedasticity Test: ARCH

F-statistic	0.052911	Prob. F(1,32)	0.8195
*Obs*R-squared*	0.056125	Prob. Chi-Square(1)	0.8127

3. Normality Test



4. Stability Test



The Short-Run Dynamics of Inflation: Estimating the Hybrid New Phillips Curve for Botswana

Lizzy K. Sediakgotla[1]

Abstract

This paper investigates inflation dynamics in Botswana by way of the hybrid new Keynesian Phillips curve using quarterly data for the period 2005:1-2015:1 using the Generalised Method of Moments (GMM) approach. The paper finds that the hybrid Phillips curve exists for Botswana. There is evidence of some inflation persistence in the inflation process as demonstrated by a significant backward-looking coefficient. The forward-looking coefficient is also statistically significant, indicating that inflation expectations are an important component of the inflationary process in Botswana. As such, a commitment to anchor inflation expectations at low levels could help stabilise inflation at those levels. Furthermore, the paper concludes that the non-mining output gap has a positive influence on inflation. The findings imply that, in pursuit of price stability, monetary policy actions can potentially reduce or boost aggregate demand. This therefore suggests that harmonised activism by the monetary authorities could be effective in meeting policy objectives. The paper further concludes that the exchange rate plays an important role in the determination of inflation. Overall, the results suggest that there is merit in a forward-looking monetary policy strategy that models aggregate demand.

1. Introduction

The attainment of price stability largely hinges on a clear understanding of inflation dynamics and appropriate conduct of monetary policy. Without a good interpretation of inflation dynamics, the conduct of monetary policy is bound to be misjudged or misinterpreted. As such, inflation dynamics remains one of the fiercely debated topics in macroeconomic literature. Pertinent to this debate is what should be the appropriate conduct of monetary policy to maintain price stability. By virtue of the relationship between inflation and monetary policy, the latter also continues to attract significant attention in this debate. In this regard, empirical modeling of inflation dynamics typically involves estimation of what is commonly known as the Phillips curve (and its variations).

The Phillips curve suggests that aggregate demand has some influence on the general level of prices. Thus, when the economy operates above potential, inflation pressures increase. Conversely, below-potential production generates disinflationary pressures. Assumptions about the existence of this relationship have necessitated closer observation of output developments in order to ascertain their influence on inflation; hence the inclusion of the output gap[2] measure in the modeling of inflation dynamics. The output gap is not only a good measure of economic performance, but it also provides hints about the position of the business cycle. Therefore, it continues to play a central role in macroeconomic modeling.

Maintenance of price stability is key to macroeconomic stability and is a principal monetary policy objective in Botswana. Therefore, in line with the approach by central banks globally, it is germane to model inflation dynamics in Botswana so as to guide monetary policy. Moreover, over the years, the approach to monetary policy analysis has become model entrenched, even though a pragmatic approach that takes into account other relevant information is recommended. In fact, most inflation targeting countries, as well as aspiring inflation targeters, navigate their way around monetary policy through models, which provide some discipline to the process. The underlying purpose of monetary policy models is not only to quantify and summarise economic developments in a logical and systematic manner, but also to project into the future information that can better guide monetary policy decisions. Moreover, parallel to the increasing need to stabilise inflation, there has been increased commitment to forward-looking monetary policy. Communication, accountability and transparency have also enhanced the discipline around the conduct of monetary policy.

Botswana's monetary policy underwent an important transformation in 2008,[3] when a forward-looking monetary policy framework was adopted. The transformation demonstrated the Bank of Botswana's

1 Senior Economist, Modeling and Forecasting Unit, Research and Financial Stability Department. The views expressed in this paper are those of the author and do not necessarily represent those of the Bank of Botswana.

2 The output gap is defined as the difference between actual output and potential output. It is an approximation of the position of the economy in the business cycle; a negative output gap reflects that the economy is operating below potential and a positive output gap indicates that the economy is operating above potential. Thus, a negative output gap relates to capacity underutilisation and vice versa, while a gap of zero indicates that the economy is operating at full capacity. However, although unobservable (it is estimated through filtering techniques and these are diverse and some are able to capture the structure of the economy, e.g. Kalman filtration method), it is believed to be a good approximation of aggregate demand.

3 See Monetary Policy Statement (2008).

commitment to defining and achieving price stability. Accordingly, the objective range for inflation was set at 3-6 percent, achievable in the medium term. Consistent with the forward-looking framework, the Bank, prior to that, had commenced work on econometric modeling of inflation dynamics based on the monetary policy transmission channels (James et al., 2011). The subsequent adoption of the Forecasting and Policy Analysis System (FPAS) accentuated the need for accountability and transparency.[4] Importantly, the attainment of price stability is pursued in such a manner as not to unduly harm growth and employment.

Modelling inflation dynamics involves investigation of the existence of a short-run trade-off between inflation and output, and also establishing the combined influence of backward and forward-looking behaviour on inflation, which is modelled through the Hybrid New Keynesian Phillips Curve (HNKPC). Thus, the study is confined to the HNKPC, which takes into account the Lucas Critique[5] and is also accommodative of policy analysis. The HNKPC determines the importance of the output gap, backward-looking and forward-looking behaviour in inflation dynamics and it is a backbone to the new generation of models used by most central banks for the analysis of monetary policy.

The validity of the Phillips curve and its postulation remains largely unexplored in Botswana. Therefore, this study aims at bridging the knowledge gap in this area. The results of the study are expected to enhance knowledge on the interrelationship between aggregate demand and inflation, as well as the importance of this relationship to the Bank's monetary policy framework.

The remainder of the paper is organised as follows; Section 2 covers the literature review. The methodology is presented in Section 3 and the results follow in Section 4. Section 5 concludes the paper.

7. LITERATURE REVIEW ON THE PHILLIPS CURVE

Fundamental to the Phillips curve theory is the inverse relationship between inflation and unemployment. There is established consensus that a short-run trade-off between unemployment and inflation exists. The original (traditional) Phillips curve was based on an empirical analysis of the relationship between the level of unemployment and nominal wages in the United Kingdom (Phillips, 1958) and was exclusively backward-looking. A direct interpretation of this relationship is that a decrease in unemployment inevitably leads to an increase in inflation. This can also be interpreted to mean that, above potential economic activity creates inflationary pressures and that the reverse is true. However, the traditional Phillips curve was less robust and failed the Lucas Critique, and therefore inappropriate for forward-looking policy analysis. This resulted in the various forms of and improvements to the Phillips curve to capture rational expectations and a purely forward-looking behaviour in what is called the New Keynesian Phillips Curve (NKPC). The NKPC is purely forward looking, implying that the inflation process does not have inertia (persistence).

The NKPC has come under criticism because of its inability to fully explain inflation developments in some countries. In addition to sticky prices, some monetary shocks affect inflation with a lag. Thus, without accounting for inflation inertia, the NKPC remains limited in its explanation of inflation dynamics. In response, there has been a modification to Calvo (1983) price setting,[6] to include backward-looking behaviour, resulting in a hybrid version of the Phillips curve (Gali and Gertler, 1999). Based on the USA data for the period 1960:1-1997:4 using the Generalised Method of Moments (GMM) estimation approach, Gali and Gertler (1999) established that the NKPC was a good approximation of inflation dynamics. However, given on arguments that price rigidities exist, an empirical conclusion for the significance of adaptive and rational expectations could not be refuted. Hence, it was established that the hybrid version fit the data well, with a strong forward-looking behaviour of inflation. Gali *et al*. (2005) reaffirm the robustness of the hybrid version under different methodologies (closed form estimation and non-linear instrumental variables).

The hybrid Phillips curve thus contains both backward-looking (adaptive expectations) and forward-looking (rational expectations) behaviour; and it is considered to accommodate robust policy analysis. Some studies have extended this model to include imported prices (open economy) and being comprehensive in terms of determinants of inflation, the model is often adapted for use in inflation forecasting. Meanwhile, traditional empirical literature on

4 The Bank made a commitment (Monetary Policy Statement, 2008) to disclose, going forward, the projected rate of inflation in the short-term and medium-term and, the policy rule (whereupon it was disclosed that monetary policy would react to the medium term inflation forecast rather than the observed or short-term inflation forecast). Consequently, implications of disclosure are that there would have to be an account for all deviations outside the disclosed inflation trajectory/forecast.

5 The Lucas critique postulates that decisions made solely based on past information are inaccurate because every policy change affects the circumstances in which different situations occur. Thus, economic agents' decisions will change concurrently with the change in policy.

6 The basis for this modification is that only a certain fraction of firms are able to adjust prices based on future marginal costs (often indicated as real unit labour costs, thus reflecting cost-push influence from the economy) and the remaining fraction of firms adjust prices based on past inflation plus an adjustment for expected inflation or rule-of-thumb (Rummel, 2012; Gali and Gertler, 1999, Gali et al., 2005). Microfoundations of the Phillips curve indicate that prices are set in an environment of monopolistically competitive firms and the price setting behavior borrows from the Calvo (1983) type price setting, which assumes staggered price setting (Gali and Gertler, 1999).

the Phillips curve highlights the output gap measure as a relevant indicator of real economic activity as opposed to marginal costs (real unit labour cost). The output gap captures economy wide aggregate demand and it has an advantage of gauging the position of the economy in the business cycle.

Table 1 provides a summary of selected studies on the Phillips curve in a number of countries. Based on the studies under discussion in Table 1, it is evident that the Phillips curve cannot be assumed to be present in every economy. Ogbokor (2005) discovered that the short-run trade-off between inflation and unemployment does not exist in Namibia. Based on data from 1991-2005, results of an empirical analysis using linear and logarithm regressions suggested that there is stagflation; that is, both unemployment and inflation increase continually at the same time. This has implications for the conduct of monetary policy; by inference, this implies that it would be impossible to reduce inflation by generating high unemployment.

Meanwhile, for Ghana, for the period 1970-2012, Solomon (2014) found no evidence of the relationship between inflation and unemployment in the traditional and adaptive expectations-augmented Philips curve. The NKPC, however, showed mixed results of negative and positive relationships between inflation and output. The models were fitted on an ordinary least squares (OLS) regression and the measure of cost-push influence from the economy was the output gap. The author attributes the inconsistencies in the results to economic shocks, such as high crude oil prices, devaluation of the Ghanaian currency and inconsistent economic policies.

Maturu *et al*. (2006) established that the HNKPC fits Kenyan data for the period 1997- 2005, and that forward-looking behaviour is dominant and important for the inflation process in Kenya. Backward-looking expectations and wage stickiness were identified as sources of inertia. The study used the output gap and overhead labour costs to proxy marginal costs.

In South Africa, the trade-off between inflation and unemployment has been found to be generally weak since the 1970s (a significant but mild relationship was observed in the 1960s). Burger and Marinkov (2006) found little evidence of the output effect on data spanning 1976-2002 using the Gordon triangular model. The Gordon triangular model controls for inertia effects, output level effects and rates of change in output effects. du Plessis and Burger (2006) also tested the validity of the NKPC for South Africa for the period spanning 1975q1-2003q4, based on GMM estimation, but evidence of the short-run trade-off could only be found in the latter sample period 1985q1-2003q4. However, the results suffered a problem of weak instruments. The results were inconsistent and thus inconclusive for the HNKPC. The sensitivity of the model to different specifications (restricted and unrestricted parameters, instrument size and sample choice) gave rise to the inconsistency in the results.

Cespedes *et al*. (2005) established that, for the period 1990q1-2004q4, estimation utilising the GMM methodology supports the presence of the hybrid Phillips curve in Chile. Core inflation was used while various measures of marginal costs were considered including: labour share, overhead labour costs and a production function with constant elasticity of factor substitution. All the model specifications based on the different measures of marginal costs yielded satisfactory results. The backward-looking coefficient was

TABLE 1: STUDIES ON THE PHILLIPS CURVE

Author and Date	Period and Country	Method	Measure of Inflation and Aggregate Demand	Evidence of the Phillips Curve
Solomon, S. (2014)	1970-2012 Ghana	OLS	Inflation and output gap	Non-existent traditional Phillips curve and mixed results for NKPC
Rummel, O. (2012)	1996:2-2009:3 India	GMM	GDP deflator and output gap	Strong backward looking component of HNKPC
Maturu et al. (2006)	1997-2005 (Monthly) Kenya	GMM	Inflation, output gap and overhead labour costs	Evidence of NKPC and HNKPC with strong forward looking component
du Plessis and Burger (2006)	1975:1-2003:4 South Africa	GMM	CPI, output gap, unit labour costs and labour income share	Evidence of the NKPC for shorter and later sample but inconclusive results for the HKNPC
Burger and Marinkov (2006)	1976:1-2002:2 South Africa	Gordon triangular model	CPI (inflation gap) and output gap	Little evidence of output effects
Ogbokor, C.A. (2005)	1991-2005 Namibia	Linear and logarithm regression	Inflation and unemployment	Stagflation
Cespedes et al (2005)	1990:1-2004:4 Chile	GMM	Core inflation, labour share, output gap and overhead labour costs	Evidence of HNKPC with strong forward-looking behaviour
Gali and Gertler (1999)	1960:1-1997:4 United States	GMM	GDP deflator, labour income share and output gap	Evidence of NKPC and HNKPC with strong forward looking component

estimated at about 0.40, indicating the dominance of forward-looking behaviour. The results further indicate that the inflationary process became more forward looking in the years following the adoption of inflation targeting.

Rummel (2012) and Patra and Kapur (2010) using the GDP deflator and output gap as measures of inflation and marginal costs, respectively, observed that the hybrid Phillips curve fits the Indian data well and that there is a strong backward-looking behaviour. The period of study is 1996:2-2009:3 for both studies. The output gap variable (at four lags) is statistically significant in both studies.

Overall, the varying results suggest that, although a powerful tool for analysing inflation dynamics, the Phillips curve estimation could be sensitive to the choice of proxy variables for inflation and aggregate demand. Mohanty and Klau (2001) argue that the Phillips curve may not be picked up in the data for some countries because feedback from the demand side is blurred by transitory factors. They posit that this might be the case for emerging market economies, since the main drivers of inflation in these countries are administered prices and supply shocks.

8. METHODOLOGY

(a) Data

Estimation of the HNKPC model is based on quarterly data from the first quarter of 2005 to the first quarter of 2015. Data coverage was limited by the non-availability of some variables in earlier periods, i.e., the spread between the Government long-term bond and the 88-day notice interest rate (long term-short term interest rate spread henceforth).

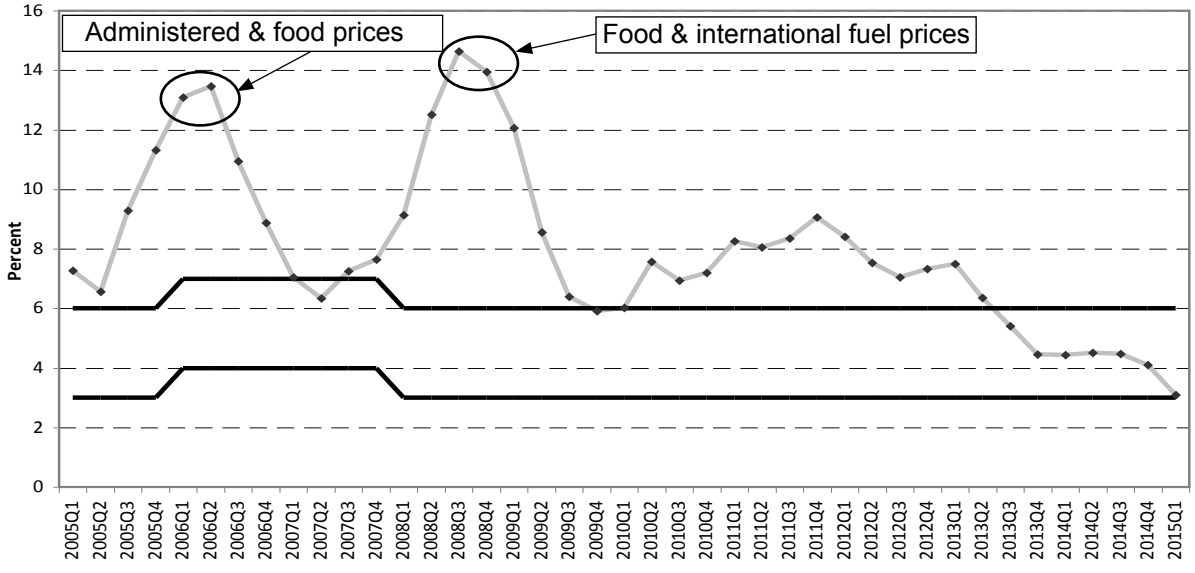
Variables used in the study are year-on-year headline inflation; non-mining output gap (seasonally adjusted); nominal effective exchange rate (NEER) gap; m2; long term-short term interest rate spread and a dummy for 2008q3. The dummy accounts for the spike in inflation, which was driven by the substantial increase in international food and oil prices. Meanwhile, due to non-availability of time series data on expected inflation (some countries use business/private sector surveys where long spanning time series data is available), actual inflation is used, as in Rummel (2012). Real non-mining output is used instead of total GDP because the dominance of mining in total output may distort the results, given the non-responsiveness of mining prices to monetary policy actions. The long term-short term interest rate spread contains information about the stance of monetary policy and it has predictive power on future inflation (Rummel, 2012).

Stationarity tests based on the Augmented Dickey Fuller test indicate that all variables except inflation are integrated of order 1. Inflation is stationary at the levels, i.e., I (0). Meanwhile, the non-mining output and the NEER gaps were calculated using the Hodrick-Prescott (HP) filter.

From Chart 1, it is clear that Botswana inflation was volatile in the period between 2005 and 2009. The peak in inflation in the second quarter of 2006 was attributed to increase in administered prices (re-introduction of government school fees in secondary schools) and food prices. The other peak during the third quarter of 2008 was due to rising food and international oil prices, which coincides with a point during the global economic recession.

From 2010, inflation became relatively stable and by the second quarter of 2013 it fell within the medium-term objective range of 3-6 percent[7] and subsequently to around the lower end of the objective

CHART 1: BOTSWANA HEADLINE INFLATION: FIRST QUARTER 2005 – FIRST QUARTER 2015



Source: Bank of Botswana

7 Between 2006 and 2007, the objective range had been set at 4–7 percent

range, driven mainly by falling oil prices. A stronger Pula against the rand has also contributed to the moderation in inflation. The lower and stable inflation in recent years potentially provides the basis for anchoring inflation expectations at low rates and, thus, contribute to stabilisation of inflation at low rates going forward. The period under study coincides with the adoption of a forward-looking monetary policy strategy in Botswana, which features a structured process of modeling and forecasting of inflation dynamics, as well as improvements in communication.

(b) The Model

This paper uses the GMM approach to estimate the HNKPC. The hybrid model used and the choice of method of estimation are based on Rummel (2012) because it is relatively simple and easy to interpret. Estimation of the model in GMM requires that a set of instruments and orthogonality conditions have to be met. As such, GMM estimates are obtained by writing the moment conditions as orthogonality between an expression including the parameters to be estimated and a set of instruments. The advantage of GMM is its ability to correct for unknown forms of autocorrelation and heteroskedasticity.

The hybrid NKPC (equation 1) postulates that inflation (π_t) is a function of past inflation (π_{t-1}), expected inflation (π_{t+1}) and a measure of aggregate real marginal cost (mc_t). γ_b and γ_f are backward- and forward-looking coefficients, respectively. The quantum of these coefficients matter for monetary policy. Dominance of backward-looking behaviour of inflation signifies inflation persistence and it also implies that current policy affects inflation with a lag. On the other hand, the dominance of forward-looking behaviour means that inflation is expectations driven, thus policy action is also forward looking. Meanwhile, the significance of the marginal costs coefficient implies that, in addressing inflation, monetary policy action can potentially reduce or boost aggregate demand.

$$\pi_t = \gamma_b \pi_{t-1} + \gamma_f E_t(\pi_{t+1}) + \lambda mc_t + e_t \qquad (1)$$

where

$$\lambda > 0, 0 < \gamma_b < 1, 0 < \gamma_f < 1, \gamma_b + \gamma_f = 1$$

The HNKPC in equation 1 is adopted for this study, with a slight modification to capture imported inflation through the exchange rate. Due to the absence of reliable data for marginal costs in Botswana, the output gap is used. A measure of inflation used in the study is year-on-year headline inflation.

The inclusion of explanatory variables has been found to improve the explanatory power of the model and to deliver the correct signs for the estimated coefficients (Rummel, 2012). As such, a dummy has been included to capture the substantial push in inflation in the third quarter of 2008. Other studies have added as part of their explanatory variables, international oil prices and supply shocks (Rummel, 2012; Gali and Gertler, 1999). These were considered for this study but excluded because they were insignificant. Thus, the model to estimate is as follows;

$$\begin{aligned} \inf l_t &= c(1) + c(2) * \inf l_{t-1} + c(3) * \inf l_{t+1} + \\ & c(4) * ny\_gap_{t-2} - c(5) * NEER\_Gap_t + \\ & C(6) * dum2008q3 + \varepsilon_t \end{aligned} \qquad (2)$$

Equation 2 models inflation as a function of past inflation, expected inflation, non-mining output gap and the exchange rate gap. Expected signs of the coefficients are: c(2), c(3), c(4), c(6)>0. Due to the manner in which the Pula exchange rate is quoted (Dollars per Pula), the exchange rate coefficient is expected to be negative. Accordingly, an appreciation of the domestic currency is disinflationary, while a depreciation is inflationary. The same argument is true with regard to the exchange rate gap. A positive exchange rate gap is non-inflationary and a negative gap is inflationary.

$$\begin{aligned} \varepsilon_t = \inf l_t - c(1) - c(2) * \inf l_{t-1} - c(3) * \inf l_{t+1} \\ - c(4) * ny\_gap_{t-2} + c(5) * NEER\_Gap_t - \\ c(6) * dum2008q3 \end{aligned} \qquad (3)$$

Equation 2 is re-written as a function of residuals so as to derive orthogonality conditions,

In order to obtain GMM estimates, the moment conditions are written in orthogonality condition between the residual of a regression equation, e_t, and a set of instrumental variables, Z_t. Therefore, using equation 3, the orthogonality conditions are $E_t[Z_t' \varepsilon_t] = 0$, where; Z is a set of instruments. The equivalent moment conditions are given as:

$$\begin{aligned} E[(\inf l_t - c(1) - c(2) * \inf l_{t-1} - c(3) * \inf l_{t+1} - \\ c(4) * ny\_gap_{t-2} + c(5) * NEER\_Gap_t - \\ c(6) * dum2008q3) Z_t] = 0 \end{aligned} \qquad (4)$$

Instrumental variables (Z_t) used include four lags of each of the following variables: inflation, non-mining output gap, nominal effective exchange rate gap, m2 and the long term-short term interest rate spread. Instrumental variables can be any other variable that has an influence on inflation. As such, m2 and the long term-short term interest rate spread enter the model as instruments only. A constant is included as an instrument so as to restrict the model errors in equation 2 to have a zero mean.

(c) Shortcomings

The goal of the methodology is to keep it parsimonious and easy to understand. Nonetheless, there are some points that are worth noting. First, due to unavailability of data on marginal costs, the estimation is based on the output gap, and the two measures are likely to give different results. Second, the study acknowledges that filtration methods other than the HP filter are also likely to produce different results.

9. RESULTS

The results (Table 2) of the traditional and the NKPC models are presented only for information (nonetheless, a short-run trade-off between inflation and output is estimated to exist for both models) and the core analysis of this research is confined to the results of the hybrid version. Apart from establishing whether a short-run trade-off between inflation and output exits, the paper also establishes the combined influence of backward and forward-looking behaviour, which is better captured by the HNKPC. As pointed out before, the HNKPC contains rich information about adaptive and rational expectations and it is robust for policy analysis.

The hybrid Phillips curve specification has statistically significant coefficients on both the backward-looking and forward-looking components. The backward-looking component is estimated at 0.54, indicating some level of inflation persistence. The significance of the forward-looking coefficient suggests that the inflation process in Botswana is also to some extent influenced by forward-looking behaviour. The Chi-squared test result validates that the two values (backward and forward coefficients) are equal to one (Table 2). The coefficient of the non-mining output gap at two lags is also statistically significant and the relationship is positive, confirming the existence of the short-run trade-off between inflation and aggregate demand. This implies that monetary policy is able to affect inflation through aggregate demand and monetary policy actions can potentially reduce or boost aggregate demand.

The coefficient of the NEER gap is also significant and carries a correct sign. The pass-through is robust, suggesting the strength of the exchange rate channel. On the basis of this result, it can be inferred that better inflation management can be achieved if the exchange rate is managed in line with price stability

TABLE 2: RESULTS OF THE PHILLIPS CURVE

Variable	Dependent variable: Inflation			
	Sample Period: 2005:1 – 2015:1			Sample Period: 2007:1 - 2015:1
	Traditional	NKPC	Hybrid	Hybrid 2
Constant	0.42	0.55	-0.01	0.02
	(6.44)	(6.90)	(-0.22)	(0.38)
Inflation (-1)	0.71		0.54	0.52
	(17.43)		(32.97)	(23.46)
Inflation (+1)		0.69	0.46	0.47
		(15.67)	(17.70)	(18.40)
Non-Mining Output Gap (-2)	1.50	1.72	1.10	0.88
	(3.87)	(2.93)	(3.48)	(2.86)
NEER Gap			-6.82	-5.88
			(-3.55)	(-2.42)
NEER	-23.33	-17.16		
	(-4.82)	(-4.37)		
Dum2008q3	0.86	0.50	0.27	0.21
	(3.93)	(-2.95)	(3.67)	(5.17)
S.E. of Regression	0.18	0.15	0.08	0.07
R - bar squared	0.75	0.80	0.95	0.94
Q - statistic	0.79	0.03	0.13	0.17
J - test	8.17	7.58	8.36	8.04
Significance level of J-test	0.94	0.96	0.91	0.92
Jarque-Bera (Probability)	0.28	0.81	0.61	0.28
Chi-Squared (1) Significance level			0.81	0.65
Sacrifice ratio	0.19		0.42	0.55

Notes: Figures in parentheses are t-statistics. The J-test and its significance level is a test of the over-identifying restrictions. The null hypothesis is that the over identifying restrictions are satisfied. The Q-statistic is the significance level of the Ljung-Box Q-statistic for residual autocorrelation for 4 lags. If there is no autocorrelations and partial autocorrelations, the Q-statistics should not be significant. Normality test for residuals indicates that if the residuals are normally distributed, the Jarque-Bera statistic should not be significant. The Chi-Square statistic and its associated significance level tests the null hypothesis that the sum of the coefficients on lagged and expected inflation is equal to one. The sacrifice ratio is defined as ((1- coefficient on lagged inflation)/coefficient on output gap) (Rummel, 2012).

goals.[8] The real effective exchange rate and its gap were included in all the models; however, their coefficients had wrong signs; hence the use of the NEER.

The results in Table 2 can be used to address an issue of potential interest to the policy- maker. That is, what is the cost of disinflation on output or what is the sacrifice ratio? The sacrifice ratio is defined as the trade-off between inflation and growth. The closer to zero the sacrifice ratio, the smaller the cost of disinflation. A sacrifice ratio was calculated outside the model (see notes under Table 2 for the formula) and it was found to be 0.42. This suggests that a monetary policy induced disinflation of one percentage point is associated with output loss of about 0.42 percent. The results may not be consistent with Mokoti (2011) who found a sacrifice ratio of 0.57. The variation in results could be due to the differing methodology and time period of study.

An evaluation of the results of diagnostic tests to check the robustness of the hybrid model indicates that the residuals are normally distributed and they are not serially correlated. The J-test of over-identifying restrictions is not rejected thus indicating that the model is correctly specified. The test for weak instruments indicates that the model instruments are weak as shown by the smaller value of the Cragg-Donald F-Statistic than the Stock-Yogo critical values (Table 3). Furthermore, for purposes of checking the stability of the model, the same model was fitted in a different sample period (2007q1-2015q1). The sample trim is by default from the estimation procedure given that all periods from the second quarter of 2007 were insufficient for the model to run. The results for the truncated sample (hybrid2, Table 2) are similar to the estimates for the full period (correct signs and significant coefficients), confirming the stability of the estimated model.

10. Conclusion

Using GMM methodology for quarterly time series data from 2005:1-2015:1, the study finds evidence of the hybrid Phillips curve in Botswana. The findings imply that there is a short-run trade-off between real economic activity and inflation. Therefore, there is a need to factor in output developments in monetary policy actions. Intuitively, the estimated sacrifice ratio suggests that disinflation by one percentage point leads to a 0.42 percent loss in output. The backward-looking component is estimated at 0.54. This suggests that there is some inflation persistence in the inflation process. Forward-looking behaviour is also significant and, therefore, important to inflation dynamics. Implications for these findings for monetary policy are that, it is important to anchor inflation expectations at low levels so as to help stabilise inflation. Thus, it can be argued that the HNKPC provides an empirical basis for the current monetary policy framework in Botswana.

8 There are also arguments for the harmonisation of monetary and fiscal policies so as to better gauge shocks to inflation.

TABLE 3: WEAK INSTRUMENT DIAGNOSTICS

Model	Results					
Hybrid	*Cragg-Donald F-Statistic Stock-*				*0.4989*	
	Yogo critical values	*5%*	*10%*	*20%*	*30%*	*19.29 10.52 5.94 4.32*
Hybrid2	*Cragg-Donald F-Statistic Stock-*				*0.5665*	
	Yogo critical values	*5%*	*10%*	*20%*	*30%*	*19.29 10.52 5.94 4.32*

It is worth acknowledging that administered prices and commodity prices, particularly food and oil prices, have been and may continue to be important drivers of inflation in Botswana. Such factors, which are outside the scope of monetary policy, tend to blur the impact of monetary policy and can strengthen doubts about the role of demand side of the economy on inflation developments. At the same time, uncertainty in price developments of commodity prices often introduces complications in the conduct of monetary policy. Even then, models help instil discipline in the analytical process and minimise unsubstantiated assumptions in policy formulation. In summary, a good approach to monetary policy should be premised on a good understanding of inflation dynamics (modelled and non-modelled) and a consistent decision making process.

11. References

Burger, P. and M. Marinkov (2006). 'The South African Phillips curve: how applicable is the Gordon model?' South African Journal of Economics 74(2): 172-189.

Calvo, G. (1983). 'Staggered prices in a utility maximizing framework', Journal of Monetary Economics, 12, pp. 383-398.

Cespedes, L.F., Ochoa, M. and C. Soto (2005). 'The New Keynesian Phillips Curve in an Emerging Market Economy: The case of Chile", Working Paper No. 355, Central Bank of Chile.

du Plessis, S. and R. Burger (2006). A New Keynesian Phillips Curve for South Africa, Presented at the South African Reserve Bank 2006 Conference.

James, L., Kganetsano, A. and B. Powder (2011). 'Macroeconomic Models at the Bank of Botswana', The Research Bulletin. Bank of Botswana, Volume 25 Number 1.

Gali, J. and M. Gertler (1999). 'Inflation Dynamics: A structural economic analysis', Journal of Monetary Economics, Volume 44, 195-222.

Gali, J., Gertler, M. and J. D. Lopez-Salido (2005). 'Robustness of the Estimates of the Hybrid New Keynesian Phillips Curve', Journal of Monetary Economics, 52, pp. 1107-1118.

Maturu B., Kisinguh, K. and I. Maana (2006). A New Keynesian Phillips Curve for Kenya, Presented at the African Econometric Society 2007 Conference, 4-6 July 2007.

Mohanty, M. S. and M. Klau (2001). 'What Determines Inflation in Emerging Market Economies?' BIS Number No 8.

Mokoti, T. (2011). 'Estimating the Sacrifice Ratio: Evidence from the Botswana Data', The Research Bulletin. Bank of Botswana, Volume 25 Number 1.

Phillips, A.W. (1958). 'The relation between unemployment and the rate of change of money wages in the United Kingdom', Economica, 25: 283-299.

Ogbokor, C. A. (2005). 'The Applicability of the Short-run

Phillips Curve to Namibia', Journal of Social Sciences 1(4).

Rummel, O. (2012). 'Money Transmission Channels, Liquidity Conditions and Determinants of Inflation: Estimating the New Keynesian Phillips Curve in a Monetary Model (Without Money) for India', Centre of Central Bank Studies, Bank of England.

Solomon, S. (2014). 'The Expectations-Augmented Phillips Curve: Evidence from Ghana', International Journal of Economics, Commerce and Management, Volume II, Issue 11.

Investment Implications of the RMBs Inclusion into the SDR Basket: A Botswana Perspective

Pako Thupayagale and Otsile Moduka[1]

Abstract

This paper examines the effect that the inclusion of the renminbi (RMB) within the Special Drawing Right (SDR) basket will have on the USD/SDR exchange rate in terms of risk and return profile. The results show that the inclusion of the RMB would generate better returns and risk reduction through diversification from a portfolio management perspective. The paper further shows that China's low correlations with the fixed income and equity markets of the current SDR member countries provides important diversification benefits particularly in the context of foreign exchange reserves management. Overall, these findings suggest that the incorporation of the RMB into the SDR will enhance the attractiveness of SDR-based benchmarks and provide asset allocators greater opportunities to construct well-diversified portfolios. The results are, however, essentially demonstrative as considerations of controls, governance and market bottlenecks are important in assessing safety and liquidity objectives in the investment of foreign exchange reserves, which supersede the return objective.

1. Introduction

The Special Drawing Right (SDR) has been an important part of Botswana's economic and financial policies. This is most clearly reflected in exchange rate policy framework (where since 1980 the pula has been partially pegged to a basket of currencies comprising the SDR); and, monetary policy (where inflation in the SDR countries is a major consideration in setting Botswana's inflation objective); and, foreign exchange reserves management (where foreign currency benchmark allocations reflect the configuration of the SDR). This study will focus on the investment policy aspects of the extension of the SDR. Accordingly, the risks and rewards of RMB inclusion into the SDR will be highlighted in order to stimulate debate within Botswana and elsewhere regarding the relative merits of investing in China in the context of an overall reserves management programme.[2]

On November 30, 2015, the IMF Executive Board approved the inclusion of the renminbi (RMB) into the special drawing right (SDR) basket as a fifth currency, along with the US dollar, euro, Japanese yen and British pound. The new SDR took effect from October 1, 2016. This decision underscored the increasing role and importance of China in international trade and finance. Table 1 presents the updated composition and weights of the SDR.

TABLE 1: PREVIOUS AND NEW SDR CURRENCY WEIGHTS

Currency	Previous SDR Basket	New SDR Basket
USD	*41.9*	*41.7*
EUR	*37.4*	*30.9*
GBP	*11.3*	*8.1*
JPY	*9.4*	*8.3*
RMB	*-*	*10.9*

Against this background, this analysis considers the following related strands: Section 2 provides background to the SDR. Section 3 reviews the criteria for inclusion into the SDR and shows the degree to which the RMB meets the SDR selection requirements. Section 4 simulates the behaviour of the updated SDR/USD exchange rate. Section 5 provides a comparative analysis of China's fixed income and equity markets relative to those of the current SDR members. Section 6 demonstrates the extent to which the incorporation of RMB-denominated assets improves overall risk adjusted returns of various asset portfolios. Section 7 examines the likely impact of RMB inclusion on Botswana's reserve management policies, while Section 8 concludes.

2. Background to the SDR

The SDR is neither a currency in the traditional sense of the term nor is it a claim on the International Monetary Fund (IMF). Instead, the SDR is a potential claim on the currencies of IMF member countries for which they may be exchanged. This may be effected through either a voluntary exchange between members or through the IMF's intermediation. Thus, the SDR is the unit of account for the International Monetary Fund and a select number of multilateral lenders. Additionally, it is a reserve asset that mostly exists in accounting form, which transforms into actual flows when IMF member countries exchange their SDRs for any of the liquid or 'freely usable' currencies that comprise the SDR.

1 Deputy Director and former Senior Dealer, respectively, in the Financial Markets Department, Bank of Botswana. The views expressed in the paper are those of the authors and do not necessarily reflect those of the Bank of Botswana.

2 RMB is used in the sense of the onshore Chinese yuan (CNY).

(a) Creation of the SDR

In 1969, the IMF created the Special Drawing Right or SDRs to help supplement its official reserves, namely gold and the US dollar. This decision was taken in the context of rising concern that the US dollar would be devalued against gold; and, as such, there would be an impending shortage of international reserves assets. The value of the SDR was initially defined as 0.888671 grams of gold, which was equal to one US dollar. Ultimately, however, the Bretton Woods fixed exchange rate system collapsed and no major currency was convertible to gold, hence, the SDR link to gold was also discontinued. In 1974, the SDR was redefined as a currency basket comprising sixteen countries whose shares of world trade were at least one percent.[3] In 1980, the Executive Board of the IMF resolved to reduce the number of currencies comprising of the SDR to only five, namely; the US dollar (USD), Japanese yen (JPY), British pound (GBP), Deutschemark and the French franc. This currency distribution remained until 1999 when the Deutschemark and the French franc were replaced by the euro (EUR). Therefore, before the inclusion of the RMB, there was only four currencies constituting the SDR.

(b) Use of the SDR

The SDR is an international reserve asset created by the IMF for all its members to safeguard the stability of the international financial system and supplement their official reserves. Countries can exchange their SDRs for (the liquid) currencies comprising the SDR in the event of a financial and/or economic crisis. The SDR also serves as a unit of account and derives its value from a basket that currently comprises the US dollar, the euro, the British pound, the Japanese yen and the renminbi. The basket was historically reviewed on an ad-hoc basis, although, in recent times it has been reviewed every five years. To date, a total of SDR204 billion (less than three percent of global reserves) have been allocated to the 188 IMF members.

3. ANALYSIS OF CRITERIA FOR INCLUSION INTO THE SDR

There are two main criteria for currency inclusion. The first – the 'Gateway' criterion – is an assessment based on the country's export share in the world. The second – the 'Freely Usable' criterion – is assessed on the basis of whether a currency is 'widely used' to make payments in global transactions, and 'widely traded' in major exchange markets. Ultimately, though, the SDR valuation decision is made by the IMF Executive Board through a vote. Table 1 provides a summary of the main issues relating to inclusion in the SDR.

3 This arrangement was inherently unstable, as it necessitated continual changes to the SDR basket. For example, at one stage the Saudi Arabian riyal and the Iranian rial were included in the SDR, while the Danish krone and the South African rand were removed.

TABLE 2: INCLUSION CRITERIA FOR THE SDR

Definition	An IMF member currency used for investment and financing
Previous Composition	*US dollar, euro, pound sterling and Japanese yen with weights of 41.9 percent, 37.4 percent, 11.3 percent and 9.4 percent, respectively (effective and expiration dates are January 1, 2011 and September 30, 2016, respectively).*
Main Criteria for Inclusion	*Quantitative 'Gateway' Criterion: world's main exporters of goods and services.*
	Qualitative 'Freely Usable' Criterion: Widely used and widely traded.
Ancillary Criteria for Inclusion	*Reflect relative importance in the world's trading and financial systems and enhance the attractiveness of the SDR as a reserve asset.*
	Meet operational requirements (existence of representative foreign exchange and interest rates and hedging instruments).
Review Process	*The SDR valuation decision is made by the IMF Executive Board through a vote. In particular, the method of valuation is determined by a 70 percent majority of the total voting power, provided that an 85 percent majority is required for (i) a change in the principle of valuation, or (ii) a fundamental change in the application of the principle in effect. In practice, all decisions that have changed the SDR valuation method have been adopted with a 70 percent majority of the total voting power.*
Review Period	*On an ad hoc basis (not necessarily every 5 years, although, in recent years that has typically been the case).*

Source: International Monetary Fund (IMF).

(a) Global Export Share

The 'Gateway' criterion is assessed based on the share of global exports of goods and services, and income credits a country represents. China is the third largest exporter and accounts for more than the combined weight of both Japan and the UK in global trade. The export criterion, therefore, argues in favour of RMB inclusion into the SDR. Indeed, in its 2010 review, the IMF adjudged that China met the requirements of the 'Gateway' criterion.

(b) Freely Usable

This measure comprises two principles, each of which has to be met independently: (i) widely used to make payments in international transactions; and (ii) widely traded in principal exchange markets. Key indicators include the magnitude to which a currency is represented in official reserves, international banking liabilities and global debt securities, as well as the volume of use in foreign-exchange markets.

TABLE 3: GLOBAL EXPORT SHARE

Rank	Country/Region	Export Share (5-year average in percent)
1	*Eurozone*	18.2
2	*US*	13.6
3	*China*	11.0
4	*Japan*	5.0
5	*UK*	4.9

Source: Credit Agricole-Corporate and Investment Bank

(c) Widely Used to Make Payments in International Transactions

Tables 4 to 6, show the current rankings of the RMB in the context of the four main free usability criteria, namely, the share in: foreign exchange market turnover (RMB is ranked ninth globally), international debt securities (ranked eighth globally), allocated global foreign exchange reserves (ranked seventh globally) and international bank liabilities (ranked fourth globally). The RMB is behind all the current SDR members, except JPY in the category of share in international bank liabilities. The share of RMB in FX reserves is not categorically clear given data limitations. Market participants, for their part, are mostly concerned with the limited supply of RMB-denominated international debt securities, as it constrains the ability of RMB holders to invest their funds.

TABLE 4: SHARE IN GLOBAL FOREIGN EXCHANGE RESERVES

Rank	Currency	Share in Allocated Global FX Reserves (percent)
1	*US dollar*	*64.9*
2	*Euro*	*21.0*
3	*Japanese Yen*	*4.2*
4	*British pound*	*4.0*
5	*Australian dollar*	*1.9*
6	*Canadian dollar*	*1.9*
7	*Renminbi*	*1.1*
8	*Swiss franc*	*0.3*

Source: International Monetary Fund (IMF).

TABLE 4: INTERNATIONAL BANK LIABILITIES

Rank	Currency	International Bank Liabilities (USD trillions)
1	*US dollar*	14.4
2	*Euro*	7.8
3	*British pound*	1.4
4	*Renminbi*	1.3
5	*Japanese yen*	0.7
6	*Swiss franc*	0.5

Source: Peoples Bank of China (PBoC).

TABLE 5: SHARE IN INTERNATIONAL DEBT SECURITIES

Rank	Currency	Share of International Debt Securities (percent)
1	*US dollar*	43.1
2	*Euro*	38.5
3	*British pound*	9.6
4	*Japanese yen*	2.0
5	*Swiss franc*	1.4
6	*Australian dollar*	1.3
7	*Canadian dollar*	0.9
8	*Renminbi*	0.6

Source: Credit Agricole-Corporate and Investment Bank.

(d) Widely Traded in Principal Exchange Markets

TABLE 6: SHARE IN GLOBAL FX TRADING

Rank	Currency	Share in Global FX Trading (percent)
1	*US dollar*	87.0
2	*Euro*	33.4
3	*Japanese yen*	23.0
4	*British pound*	11.8
5	*Australian dollar*	8.6
6	*Swiss franc*	5.2
7	*Canadian dollar*	4.6
8	*New Zealand dollar*	3.3
9	*Renminbi*	2.2
10	*Swedish krona*	2.0

Source: International Monetary Fund and own calculations.
Note: As a computational detail, currency pairs are summed to 200 percent.

In terms of the more supplementary measures, such as the RMB's use in trade finance and narrow bid-offer spread, the RMB warranted inclusion into the SDR. Moreover, ongoing and future reforms in China suggest that progress towards attaining free usability will quickly be achieved. According to the Peoples Bank of China (PBoC), the RMB is used by almost 60 central banks and Sovereign Wealth Funds for their global investments. With the acceleration of RMB internationalisation, almost 40 countries have signed bilateral currency swap agreements with China. Overall, preceding data shows that China has made significant progress in liberalising its currency; however, the extent of free usability of the RMB is considerably less than that of the existing SDR member currencies. This, in turn, suggests that the IMF adopted a more flexible and forward-looking interpretation of 'free-usability' in its decision to include the RMB in the SDR basket. Furthermore, it is important to note that the Executive Board of the IMF has discretion to consider other factors that it deems relevant in its decision making process. These discretionary aspects are aimed at reflecting the changes in the global economy and promoting a stable international monetary system.

TABLE 7: SUMMARY OF RMB PERFORMANCE VERSUS FREE USABILITY CRITERIA

Main Free Usability Metrics	Assessment
Share in FX market turnover	*Not in favour of inclusion*
Share in international debt securities	*Not in favour of inclusion*
Share in composition of FX reserves	*Inconclusive*
Share in international bank liabilities	*In favour of inclusion*
Selected Supplementary Free Usability Metrics	
Narrow bid-offer spreads	*In favour of inclusion*
Share in gross issuance of international debt securities	*Inconclusive*
Share in trade finance	*In favour of inclusion*

Source: BNP Paribas, HSBC and Credit Agricole-Corporate Bank.
Notes:
1. *The RMB has the narrowest bid-ask spreads (0.001 percent) among the major economies, which supports inclusion.*
2. *Issuance of international debt securities, while expanding rapidly, remains comparatively small, although in the longer term it is expected to be significant.*
3. *China accounts for the third largest of trade finance (4 percent) after the US dollar (86 percent) and euro (7 percent).*

(e) Other Key Requirements for SDR Accession

In addition to the export and free usability rules which govern inclusion into the SDR, the IMF also stipulates that candidate currencies must: (i) reflect their relative importance in the world's trading and financial systems, and enhance the attractiveness of the SDR as a reserve asset; and (ii) satisfy operational feasibility, that is, the existence of a representative exchange rate; the existence of a reference interest rate and the accessibility of instruments for reserve management purposes; and the ability to hedge risks. In terms of the requirements of operational feasibility, these can easily and quickly be satisfied through the acceleration and expansion of ongoing financial market liberalisation by the Chinese authorities.

(f) Voting Power at the IMF

Table 8 shows the distribution of voting power at the IMF. To date, all decisions that have changed the SDR valuation method have been adopted with a 70 percent majority of the total voting power. Therefore, broad consensus is necessary to update the composition of the SDR basket.

(g) The IMF Agrees to Include the RMB in SDR

On November 30, 2015 the IMF decided to add the RMB to the SDR basket in October 2016. This decision was predicated on the actual and prospective reforms China would have made to advance free usability of the RMB. The IMF staff had recommended to the IMF Board that the RMB should have a weight of 14-16 percent in the SDR. However, the Board announced that the RMB will have a weight of 10.92 percent in the SDR, which is larger than the proportions

TABLE 8: VOTING POWER AT THE IMF

Rank	Country	Total Votes	Total Votes (percent)
1	*US*	*831 407*	*16.53*
2	*Japan*	*309 670*	*6.16*
3	*China*	*306 294*	*6.09*
4	*Germany*	*267 809*	*5.32*
5	*France*	*203 016*	*4.04*
5	*UK*	*203 016*	*4.04*
:	*:*	*:*	*:*
33	*South Africa*	*31 977*	*0.64*
34	*Nigeria*	*26 010*	*0.52*
:	*:*	*:*	*:*
:	*:*	*:*	*:*
120	*Botswana*	*3 437*	*0.07*
121	*Namibia*	*3 376*	*0.07*
:		*:*	*:*
137	*Mauritius*	*2 887*	*0.06*
:	*:*	*:*	*:*
188	*Tuvalu*	*1 490*	*0.03*

Source: International Monetary Fund (2017)

of two existing SDR member countries, the Japanese yen and British pound. The final weight of the RMB was, therefore, lower than indicated by the IMF's own methodology given the RMBs growing, albeit, comparatively narrower degree of free usability vis-à-vis the existing SDR currencies. The IMF has also noted that the decision to include the RMB into the SDR was also supported by three main pillars: first, the pace and level of integration of China's economy into the global economy; second, recognition of the progress China has made in initiating and implementing comprehensive financial market reforms; and, third, China's ongoing role in strengthening the international financial system and promoting the resilience of the global economy. Fundamentally, therefore, the decision to include RMB in the SDR, means the IMF has formally concluded that the currency meets eligibility criteria i.e. widely used in global trade and freely usable.

4. SIMULATING THE BEHAVIOUR OF THE SDR WITH THE RMB INCLUDED IN THE BASKET

The criteria used to allocate the weights to the SDR constituents is based on each currency's share among all SDR currencies in terms of exports of goods and services and in terms of holdings of foreign exchange reserves. At the last review conducted in 2010, the share of exports was assigned a 67 percent weight, while foreign exchange reserves accounted for 33 percent. For the 2015 review, the IMF adopted a new formula for determining the currency weights in the SDR basket, which specifies an equally weighted ratio of the currency's share of exports and share of foreign exchange reserves. Applying this methodology indicated that the RMB should be allocated a weight of 11.3 percent. However, it is important to note that

the Executive Board of the IMF also has discretion to consider other factors that it deems relevant in its decision making process. These discretionary aspects are aimed at reflecting the changes in the global economy and promoting a stable international monetary system. Table 9 below illustrates a purely technical allocation to the SDR, which does not consider the objective judgements or broader interests of the IMF's Executive Board.

TABLE 9: DETERMINING THE CURRENCY WEIGHTS WITHIN THE SDR (IN PERCENT)

2015 Review	USD	EUR	GBP	JPY	RMB
Exports of goods and services	*25.8*	*34.5*	*9.3*	*9.5*	*20.9*
FX reserves composition	*67.9*	*22.0*	*4.1*	*4.4*	*1.6*
Weighted Average	*46.9*	*28.3*	*6.7*	*7.0*	*11.3*

Source: Credit Agricole-Corporate and Investment Bank
Notes:
1. *The weighted average percent reflects the prospective weight in the SDR*
2. *USD, EUR, GBP, JPY and RMB, denote the US dollar, euro, British pound, Japanese yen and renminbi, respectively.*

The IMF staff estimated that the RMB weight would likely be in the range of 14 to 16 percent, but the IMF assigned the RMB a proportion of 10.92 percent. This study examines the assigned weight of the RMB in the SDR basket along with a hypothetical scenario whereby the SDR comprised an RMB allocation of 15 percent. This is intended to provide a reference in capturing the extent to which variations in the RMB weight in the SDR impact the overall return and volatility characteristics of the SDR, particularly since an RMB weight of 15 percent was the mid-point provided by IMF staff in their analysis during the IMF Review process.

TABLE 10: POSSIBLE COMPOSITIONS OF THE SDR WITH VARYING RMB WEIGHTS (IN PERCENT)

Currency	Current Weights	RMB at 10.92 percent	RMB at 15 percent
USD	*41.9*	*41.7*	*42*
EUR	*37.4*	*30.7*	*29*
GBP	*11.3*	*8.1*	*7*
JPY	*9.4*	*8.3*	*7*
RMB		*10.9*	*15*

Simulation of SDR with various RMB weights

According to the IMF rule O-1, the value of the SDR is calculated as the sum of the values of the designated amounts of the constituent SDR members' currencies.[4] The amount designated to each currency is consistent with the allocated weight within the SDR. Additionally, Rule O-2(a) indicates that the value of the USD in terms of the SDR is defined as the reciprocal of the sum of the USD equivalents of the amounts of the currencies in the SDR basket. Applying this valuation procedure allows the simulation of the SDR considering various RMB weights. Therefore, in simulating the time series for the US dollar value of the SDR components, plausible assumptions were made so as to accommodate the inclusion of the RMB. This simulation is based on what would have transpired over the period 2011 to 2015 had the RMB been included in the SDR. In addition, currency forecasts from January to October 2016 are included to also show possible trends in the new SDR basket.[5] Three different RMB inclusion weights were selected and the weights of the other constituent currencies scaled down in order to arrive at an equal starting value in USD. When the results of the simulated SDR are plotted against the current SDR, it is noted that the value of the SDR increases over time as the weight of the RMB is increased.

TABLE 11: RISK AND RETURN CHARACTERISTICS OF THE PREVIOUS AND THE SIMULATED SDR

	Previous SDR Weights	RMB weight at 10.92 percent	RMB weight at 15 percent
MEAN	1.5099	1.5240	1.5322
PERIOD RETURN (%)	-11.3	-9.5	-8.6
STD DEVIATION (%)	6.59	5.46	4.94

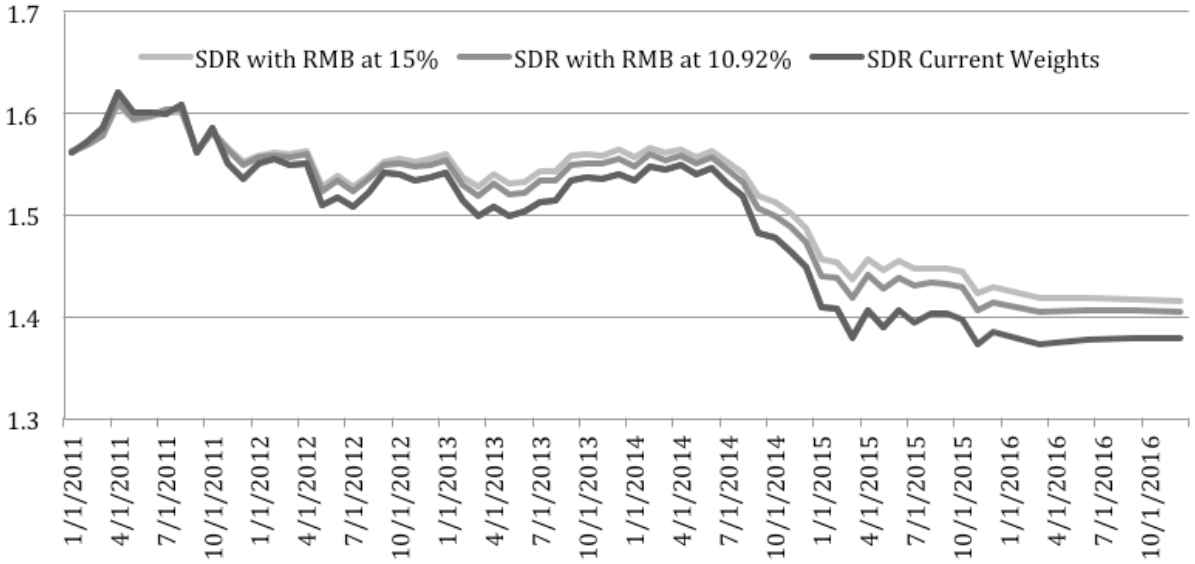
Source: Authors' calculations
Note:
1. *Volatility is measured by the standard deviation*
2. *Return is expressed as a percent*

Over the period from January 2011 to December 2015, the SDR depreciated by 11.3 percent against the USD. However, if the SDR had included RMB with a weight of 10.92 percent, per the new weights, the results indicate that the SDR would have depreciated by 9.5 percent, a smaller decline compared with the former SDR. If more weight was allocated to the RMB (e.g., 15 percent) the results improve further, indicating that the SDR would depreciate by 8.6 percent. Furthermore, an improvement is observed in the volatility of the SDR when the weight of the RMB is increased. The standard deviation is 6.59 percent for the former SDR, while with the new weights the standard deviation reduces to 5.46 percent and reduces further to 4.94 percent when the RMB is allocated a weight of 15 percent. In short, the risk adjusted return of the SDR against the USD improves as more weight is allocated to the RMB. Figure 1 highlights these results. In addition, Figure 1 (overleaf) reflects quarterly forecasts of the USD against all the SDR members' currencies in order to project the trajec-

4 Rule O-1 informs the valuation of the SDR. In particular, the value of the United States dollar in terms of the SDR is equal to the reciprocal of the sum of the equivalents in United States dollars of the following currencies: US dollar (0.660), euro (0.423), Japanese yen (12.1), and pound sterling (0.111).

5 Forward rates sourced from Bloomberg are used as forecasts. The forward rates are considered because they are not biased in their calculation compared with economic forecasts.

FIGURE 1: SIMULATION OF THE SDR/USD EXCHANGE RATE WITH VARYING RMB WEIGHTS



tory for the SDR. The forecast values underscore the conclusion that the value of the SDR improves (i.e., strengthens) as more weight is allocated to the RMB. Specifically, it is noticeable that the USD is generally appreciating against the SDR, but the extent of the appreciation is smaller when the RMB is allotted more weight.

5. Comparative Analysis of China's Bond and Equity Markets With Those of SDR Member Countries

Bond Market

China has the third largest bond market in the world and is estimated at USD4.24 trillion. China is rated AA- and A1[6] by Standard & Poor's and Moody's, respectively, which is comparable to Japan, a notch below France and above both Italy and Spain. The credit ratings, coupled with the vast amount of foreign exchange reserves (i.e., approximately USD3 trillion at the end of 2016) that China has, support confidence (especially on the part of risk averse investors) regarding the ability to repay principal and interest by the Chinese Government. Furthermore, Table 12 illustrates China's favourable credit position relative to many advanced market economies. In particular, China's public debt-to-GDP ratio is significantly lower than that of the major developed markets.

An analysis of the maturity profile of the Chinese bond market shows that more than 40 percent of bonds mature in 3 years or less. This compares with less than 20 percent and 10 percent for the US and Japanese bond markets, respectively. In particular, the US and Japanese bond markets are heavily concentrated in the long-end of the market with more than 65 percent and 40 percent of bonds in the US and Japan maturing in 10 years or more. In contrast, China has about 12 percent of bonds with maturity of 10 years and beyond.

TABLE 12: CREDIT ANALYSIS OF THE BOND MARKETS

	Sovereign Ratings		Debt Outstanding	2016
Country	Standard & Poor's	Moody's	(USD trillion)	Debt to GDP (percent)
US	AA+	Aa1	20.0	105.9
Japan	AA-	Aa3	9.6	250.4
UK	AAA	Aa3	2.6	89.3
China	AA-	A1	5.1	46.2
Italy	BBB-	Baa2	2.7	132.6
France	AA	Aa2	2.5	96.0
Germany	AAA	Aaa	0.6	68.3
Spain	BBB+	Baa2	1.3	99.4

Source: Bloomberg and authors' calculations

Note: China fixed income market features a Policy Bank Bond Market, which refers to bonds issued by three state owned banks which carry the same rating as the state.

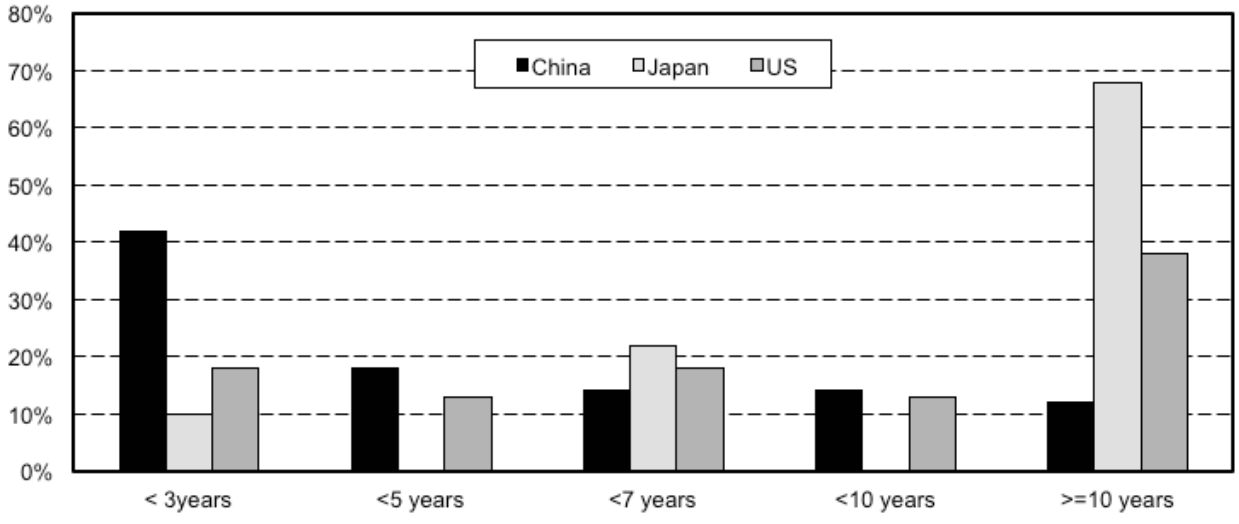
TABLE 13: A COMPARISON OF GLOBAL EQUITY MARKETS

Ranking	Country/Exchange	Market Capitalisation (USD Trillion)
1	*United States*	*26*
2	*China*	*10*
	Shanghai Stock Exchange	*4*
	Hong Kong Exchange	*3*
	Shenzhen Stock Exchange	*2*
3	*United Kingdom*	*6*
4	*Japan*	*4*
5	*NYSE Euronext (Europe)*	*3*

Source: World Federation of Exchanges (data as at December 2014)

6 In May 2017 Moody's downgraded China's rating to A1 from Aa3 amid concerns over rising (total) debt and slower future economic growth.

FIGURE 2: MATURITY PROFILE OF CHINA, US AND JAPAN BOND MARKETS



Source: Bloomberg

Stock Markets

China has the second largest equity market in the world with a market capitalisation of USD 9.6 trillion. Furthermore, according to the World Federation of Exchanges, Shanghai and Shenzhen combined are the most liquid markets in Asia, measured in terms of daily turnover. This notwithstanding, foreign investors are estimated to hold less than 3 percent in Chinese equity given constraints associated with capital account convertibility and limited detailed knowledge of individual stocks by global investors.

As shown in Table 14, China presents attractive total returns across both fixed income and equity markets, which are consistent with the investment priorities of the typical long-term investment portfolio or sovereign wealth fund. This, in turn, underscores that the inclusion of RMB into SDR would enhance the attractiveness of the SDR, particularly if an institution has selected the SDR as an investment benchmark or asset allocation reference.

TABLE 14: TOTAL RETURN FOR GLOBAL BONDS AND EQUITIES FROM JANUARY 2011 TO JUNE 2015.

Country	Equity Market – Total Return (percent)	Fixed Income – Total Return (percent)
United States	73.1	11.6
Euro-19	19.9	-6.5
United Kingdom	26.4	14.0
Japan	35.6	-30.7
China	33.1	9.1

Source: Bloomberg
Notes:
1. *Total Return includes price appreciation of the investment (capital gains) and interest or dividend. Total return is expressed in US dollar terms.*
2. *The fixed income total return pertains to the 3 to 5 year Bloomberg index.*
3. *China's total return fixed income index begins in January 2013.*

Risks of Investing in China

Investors report that, while Chinese equity and fixed income markets are large, these markets have fragmented structures with myriad policies and regulations, as well as limited secondary market liquidity (Morgan Stanley, 2015). This, in turn, may hamper the ability to enter or exit positions. This may, in turn, constrain timely portfolio execution or optimisation. China's fixed exchange rate peg presents another source of concern. In particular, RMB exchange rate risk has come to the fore, as a consequence of the slowdown in the Chinese economy and volatile capital outflows. More generally, investors have indicated that the risks of financial instability in China are increasing in the context of rising indebtedness of companies and the commensurate increase in non-performing loans (IMF, 2016). Furthermore, the IMF has noted that China is restructuring its economy towards a slower and more balanced pace of growth and a more market-based financial system. The complexity of this transition process means that the Chinese authorities have to be diligent and resolute in their commitment to fully implement the reform agenda.

6. Modelling Returns and Correlations

Bond Markets

In order to evaluate the merits of incorporating China into a SDR-based fixed income benchmark, a bond portfolio is constructed assuming the old SDR weights and compare it with portfolios invested in the SDR with RMB allocations of 10.92 percent and 15 percent. The bond portfolios are formed using the aggregate bond indices sourced from Bloomberg. The Sharpe Ratio is used to compare the performance of the portfolios, and the results show that the Sharpe Ratio

increases as more weight is allocated to the RMB.[7] The bond portfolio derived from the old SDR weight has a Sharpe Ratio of 0.336 and the ratio increases to 0.365 and 0.375 when the RMB weight is increased to 10.92 percent and 15 percent, respectively. In other words, from the perspective of an overall fixed income portfolio, risk-adjusted returns are superior in the extended SDR portfolio relative to the old (i.e., excluding China) SDR portfolio.

TABLE 15: COMPARISON OF BOND PORTFOLIO RETURNS ACROSS VARIOUS SDR BASKETS

	Previous SDR	RMB at 10.92 percent	RMB at 15 percent
MEAN (%)	*0.38*	*0.37*	*0.37*
STD DEVIATION (%)	*0.98*	*0.88*	*0.86*
PERIOD RETURNS (%)	*24.0*	*24.2*	*24.2*
SHARPE RATIO	*0.336*	*0.365*	*0.375*

Source: Authors' calculations
Notes:
1. The data pertains to a portfolio constructed from 2011 to 2015.
2. the standard deviation is denoted STD DEVIATION.

Stock Markets

In order to examine how the inclusion of Chinese equities in a SDR-based benchmark (i.e., an equity allocation which replicates the proportions of the current SDR and the SDR with RMB allocated weights of 10.92 and 15 percent, respectively) Sharpe Ratios are derived, which allow the evaluation of various portfolios across varying exposures of Chinese (RMB) equities. The results show that risk-adjusted returns improve progressively in line with increased RMB equity exposure. An equity strategy that reflects the old SDR benchmark has a Sharpe Ratio of 0.152. When RMB equities, with weights of 10.92 and 15 percent, respectively, are introduced into the benchmark equity portfolio, the Sharpe Ratio rises to 0.16 percent in both cases. These results indicate that inclusion of RMB equities enhances the risk-adjusted returns of an SDR equity index or benchmark.

TABLE 16: COMPARISON OF EQUITIES PORTFOLIO ACROSS VARIOUS SDR BASKETS

	Previous SDR	RMB at 10.92 percent	RMB at 15 percent
MEAN (%)	*0.61*	*0.61*	*0.61*
STD DEVIATION (%)	*3.65*	*3.53*	*3.51*
PERIOD RETURNS (%)	*37.5*	*38.5*	*38.3*
SHARPE RATIO	*0.152*	*0.160*	*0.160*

Source: Authors' calculations
Note: The data pertains to a portfolio constructed from 2011 to 2015.

7 The Sharpe Ratio is a standard measure used to calculate risk-adjusted returns. It is defined as the average return earned in excess of the risk-free rate per unit of volatility.

Low Correlation is a Source of Diversification

One important aspect of portfolio theory is that it is not the stand-alone volatility of returns that matters to investors, but how the individual asset influences the volatility of the overall portfolio. A highly volatile return profile presents a risky investment on a stand-alone basis. However, the same asset may be desirable if the returns are negatively or less correlated with the existing portfolio. Adding assets with low correlation leads to diversification and well diversified portfolios are desirable as they protect capital effectively, particularly, during turbulent market conditions.

The Chinese 2-year bond displays low correlations with all the other 2-years bonds, particularly the US and Japanese 2-year bonds where correlations are 0.066 and 0.097, respectively. All the other markets generally have exhibited higher inter-market correlations. Both the Chinese 2 year and 10 year bond yields have low correlations with the yields of the SDR members. Meanwhile, China's 10-year bond has low correlation (0.281) with the 10-year German bond and a slightly negative and very low (-0.007) correlation with that of Japan. In terms of the US and UK bonds, China's 10-year bond is evidently correlated at 0.696 and 0.693, respectively. However, in relation to the US and British 10-year bonds, whose correlation is more than 95 percent, China's 10-year bond is comparatively less correlated.

TABLE 17: 2 YEAR YIELDS CORRELATION MATRIX

	China	US	Germany	UK	Japan
China	1.000	0.097	0.140	0.354	0.066
US	0.097	1.000	0.291	0.709	-0.097
Germany	0.140	0.291	1.000	0.725	0.817
UK	0.356	0.709	0.725	1.000	0.477
Japan	0.066	-0.098	0.817	0.477	1.000

Source: Authors' calculations
Note: The German 2-year is used to proxy Euro-19 2-year yields.

TABLE 18: 10 YEAR YIELDS CORRELATION MATRIX

	China	US	Germany	UK	Japan
China	*1.000*	*0.696*	*0.281*	*0.693*	*-0.007*
US	*0.696*	*1.000*	*0.635*	*0.950*	*0.359*
Germany	*0.281*	*0.635*	*1.000*	*0.793*	*0.918*
UK	*0.693*	*0.950*	*0.793*	*1.000*	*0.555*
Japan	*-0.007*	*0.359*	*0.918*	*0.555*	*1.000*

Source: Authors' calculations
Note: The German 10-year yield is used to proxy 10-year Euro-19 yields.

Equity market returns from the Shanghai index show the lowest correlation with all the SDR members' stock indices. The correlation between the Shanghai index and the S&P500 and FTSE100 are 36 percent and 26 percent, respectively. At the same time the correlation between the S&P500 and the FTSE100 and Nikkei is 92 percent and 96 percent, respectively, highlighting that these markets closely move together

in the same direction and, therefore, offer little diversification benefits. In contrast, the more modest correlations associated with the Shanghai index would have reduced the risk of the overall portfolio because of its low correlations with the other markets.

TABLE 19: STOCK MARKET RETURN CORRELATION MATRIX

	China	US	Euro-19	UK	Japan
China	1.000	0.358	0.553	0.261	0.510
US	0.358	1.000	0.868	0.921	0.960
Euro-19	0.553	0.868	1.000	0.884	0.892
UK	0.261	0.921	0.884	1.000	0.903
Japan	0.510	0.960	0.892	0.903	1.000

Source: Authors' calculations
Note: China (Shanghai), US (S&P 500), Europe (Eurostoxx), UK (FTSE 100) and Japan (Nikkei 225)

6. IMPLICATIONS FOR RESERVE MANAGEMENT IN BOTSWANA

Botswana's foreign currency reserves are managed by the Bank of Botswana on behalf of the Government. In addition, the reserves are included in the balance sheet of the Bank, with income from the invested securities accruing to the Bank. These reserves are sub-divided into two main portfolios, namely, the Pula Fund (a long-term investment fund) and the Liquidity Portfolio (which provides a buffer against short-term balance of payments fluctuations). The main policy objective for the investment of the foreign exchange reserves is the maintenance of value in terms of purchasing power (i.e., the safety objective), while the secondary policy objectives focus on generating returns and maintaining sufficient liquidity in the portfolio. The benchmark currency composition that has been adjudged to be consistent with these goals is the SDR. This was based on the SDR constituent currencies' importance in international financial markets, i.e., their liquidity and well developed markets and infrastructure. However, the asset markets of these advanced market economies have become increasingly integrated; such that the variation in market returns and other economy-wide risk factors have diminished. In other words, performance of the SDR economies' financial markets is highly correlated, and consequently the scope for inter-market diversification is diminished. This development is potentially a disadvantage from a portfolio construction perspective.

The Pula Fund, which is a long-term fund and whose investment mandate emphasises maximising returns within acceptable risk, has exposure to both global equities and fixed income instruments referenced to the currencies of the SDR. Since 2011, the strategic asset allocation of the Pula Fund has comprised 65 percent fixed income and 35 percent equities. Applying this asset allocation framework to data, the aggregate behaviour of a two-asset portfolio is modelled, wherein exposure levels reflect the constituents of the former SDR. Furthermore, a scenario analysis is performed wherein; three different weights of the RMB are modelled into the SDR in order to measure the attractiveness of the SDR at different levels. The results are presented in Table 20.

It is found that composite portfolio volatilities decline in tandem with increasing overall portfolio returns as the exposure level of RMB-denominated assets is raised. This relationship is succinctly captured by the rising trajectory of the Sharpe Ratio. Specifically, when the 65 percent fixed income/35 percent equity rule is mapped on to the SDR basket, the results show that the delivered Sharpe Ratio or risk-adjusted returns is 0.30. On the other hand, when RMB-denominated equity and fixed income assets are incorporated into the model the Sharpe Ratio rises. When the SDR comprises 10 percent RMB, the combined investment portfolio generates a Sharpe Ratio of 0.317; and when the allocation to RMB is increased to 15 percent of the portfolio, the Sharpe Ratio rises to 0.321. These findings corroborate the positive diversification benefits associated with the inclusion of the RMB-denominated assets into a benchmark reflective of the SDR across both equities and fixed income.

TABLE 20: PULA FUND PERFORMANCE ACROSS THE VARIOUS SDR COMPOSITIONS

	Previous SDR	RMB at 10.92 percent	RMB at 15 percent
MEAN (%)	*0.44*	*0.44*	*0.44*
STD DEVIATION (%)	*1.31*	*1.24*	*1.22*
PERIOD RETURNS (%)	*29.0*	*29.6*	*29.8*
SHARPE RATIO	*0.300*	*0.317*	*0.321*

Source: Authors' calculations

As a corollary of this discussion, one of the key features of reserve management in Botswana is the contribution that the income earned from the reserves makes to government revenues. To the extent that total returns in China in both fixed income and equity investments exceed those of other SDR member economies, then the potential for the Pula Fund to earn more and, therefore, contribute more to government revenues, all else equal, would likely be a benefit to Botswana. Table 21 shows the evolution of

TABLE 21: DIVIDENDS FROM RESERVES MANAGEMENT TO GOVERNMENT UNDER VARIOUS SCENARIOS

Year	2011	2012	2013	2014	2015
Dividend to Government (P 'billion)	*0.47*	*2.30*	*6.40*	*1.90*	*0.74*
With RMB at 10.92%	*0.53*	*2.45*	*6.42*	*2.20*	*0.85*
With RMB at 15%	*0.67*	*2.52*	*6.55*	*2.31*	*1.07*

Source: authors' estimates calculations
Note: The 2015 dividend to Government is as at the end of June 2015. In addition, the current dividend to Government is calculated on projected returns of the former SDR, while the other scenarios refer to counterfactuals in which various weights of RMB are included.

dividends from the Bank of Botswana to Government from 2011 to 2015. However, these calculations are just demonstrative. First, prior to inclusion of RMB in the SDR, there was no scope for the Bank investing in RMB. Second, safety and liquidity considerations can supersede return-generation if the economic and market conditions and constraints are judged to be unfavourable; indeed, the anticipated returns and benefits may not be realised due to constraining controls and bottlenecks.

Furthermore, possible dividend scenarios are explored whereby projected returns are based on various versions of the extended SDR. The analysis shows that the dividend to government would have generally increased, albeit modestly in most instances over the period 2011 to 2015. In terms of summary statistics, the average dividend to Government would have risen in tandem with the increase in the RMB weight in the SDR. Furthermore, and perhaps more important, the volatility of the dividends would also have reduced somewhat, although it is evident that the changes in the standard deviation are very slight. For this reason, the coefficient of variation is used to evaluate the risk-return trade-off. The results indicate that, as the exposure of RMB in the SDR is broadened, the coefficient of variation decreases, showing that the variability of dividends to Government would have decreased in line with the increase in RMB weight. In other words, the risk-return trade-off in the profile of dividends is more attractive in the extended SDR basket. However, a major caveat of this calculation is that past performance need not be a reliable indicator of future performance, especially given the inherent volatility in financial markets. Nonetheless, the results are interesting from an analytical perspective and show the benefit of including RMB in the SDR basket. In addition, these results corroborate the findings presented above, which suggest that investment performance is superior across assets (i.e., bonds and stocks) individually or collectively when RMB exposure is included in the SDR.

TABLE 22: DESCRIPTIVE STATISTICS UNDER VARIOUS SCENARIOS

	Mean	Standard Deviation	Coefficient of Variation (in %)
Dividend to Government (P' billion)	2.36	1.95	82.42
With RMB at 10.92%	2.51	1.91	76.04
With RMB at 15%	2.62	1.90	72.43

Source: Authors' calculations

Note: The coefficient of variation (CV) reflects the extent of variability in relation to the mean, i.e., standard deviation divided by the mean. The lower the CV the lower the dispersion in dividends.

7. CONCLUSION

The main objective of portfolio management is to generate superior returns and risk reduction through diversification. In this context, the introduction of the RMB (and RMB-denominated assets) into the SDR improves the return-generation and diversification benefits of the SDR, particularly when it is used as a benchmark for asset allocation. Indeed, the modelling exercises show that portfolio Sharpe Ratios are consistently higher when there is exposure to the RMB or its associated assets (i.e., equity and/or fixed income). This is particularly relevant for (long-term) investment portfolios that comprise both global bonds and stocks and have the explicit objective to deliver higher risk-adjusted returns within the confines of the SDR asset allocation framework. Thus, the inclusion of the RMB into the SDR may catalyse a portfolio reallocation, particularly with respect to reserve managers in countries with close economic and financial ties with China. However, to the extent that the absence of full capital account liberalisation, as well as bottlenecks to accessing investment opportunities in financial markets hamper timely portfolio execution and optimisation, then a more cautious approach to investing in RMB-denominated assets may be warranted for certain categories of investors.

REFERENCES

International Monetary Fund, 2015, 'Review of the Special Drawing Rights (SDR) Currency Basket', August 4, 2015, IMF, Washington, DC.

International Monetary Fund, 2015, 'Review of the Method of Valuation of the SDR – Initial Considerations', August 3, 2015, IMF, Washington, DC.

International Monetary Fund, 2013, 'Assessing Reserve Adequacy – Further Considerations' and Reserve Asset Adequacy – Specific Proposals', IMF Policy Papers, Nov 2013

International Monetary Fund, 2015, Global 'Vulnerabilities, Legacies and Policy Challenges: Risks Rotating to Emerging Markets', Global Financial Stability Report, October 2015

Kowalczyk, D. and Wang, S., 2015, 'CNY: The Case for the SDR,' Emerging Market Focus, Credit Agricole Corporate & Investment Bank (Credit Agricole CIB), August 6, 2015.

Mackel, P., Chew, J., and Pinder, A., 2015, 'RMB in the SDR – To Extend or Not to Extend,' HSBC Global Research, Asian FX Research, August 5, 2015, The Hong Kong and Shanghai Banking Corporation Limited, Hong Kong SAR.

World Federation of Exchanges, 2015, Various Statistic Bulletins.