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Financial Innovation and Monetary Policy Transmission in Kenya

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Abstract

In the recent past, Kenya's financial system has experienced remarkable financial innovation with possible implications on monetary transmission mechanisms and hence on the conduct of monetary policy. However, whereas there is some theoretical literature on the effects of financial innovation on monetary policy transmission mechanism, little empirical evidence exists on these relationships particularly in Kenya. This paper addresses this gap by empirically examining the effect of financial innovation on monetary policy transmission focusing on the interest rate channel through which the Central Bank implements monetary policy. The study used Two Stage Least Squares (2SLS) and monthly data covering the period, 1996-2007 and established that financial innovation dampens the interest rate channel of monetary transmission mechanism. The paper concludes that financial innovation poses complex challenges to the conduct of monetary policy which would necessitate constant revision of policy and instruments, targeting frameworks and operating procedures to enhance monetary policy effectiveness.

1. Introduction

The Kenyan financial sector has undergone tremendous changes in the last two decades. A lot of reforms have been undertaken in the sector that have led to proliferation of financial products, activities and organizational forms that have improved and increased the efficiency of the financial system. Advances in technology and changing economic conditions have created impetus for this change. All these developments coupled with changes in the international financial environment and the increasing integration of domestic and international financial markets have led to rapid financial innovation.

Although this evolution in form of new financial instruments and new and more efficient methods of offering financial services constituting the now widely accepted definition of financial innovation has affected the entire global financial system, relatively little research concerning this subject is documented. Only scanty attempts dwelling on its definition, effects on money demand and effects on monetary policy exist in the literature (Hasan, 2009; Sukudhew, 2007; Noyer, 2007; Scott and White, 2002; Glennon and Lane, 1996; Arrau et al., 1995; Niehans, 1993). No systematic qualitative and quantitative analysis of the effects of financial innovation on macroeconomic variables and monetary policy exist in the literature especially on Kenya. Moreover, there is no consensus on the linkages between financial innovation and monetary policy transmission mechanisms even in the on-going debate in the more developed economies. Conflicting opinions abound in the literature regarding the effects of financial innovation not only on monetary policy in general but also on various monetary transmission mechanisms (Exchange rate, asset prices; credit; interest rate; expectations) identified by Mishkin (1995) and Era and Holger (2006).

While some authors have highlighted the importance of financial innovation in monetary policy effectiveness based on the various channels, others have pointed out risks and uncertainties associated with financial innovation, particularly with respect to the complexities it poses to the conduct of monetary policy (Pradhah, 2008; Mario, 2007; Noyer, 2007: Iris and Grimes, 2003). In the latter scenario, central banks operate monetary policy efficiently only in the short term. After sometime, when new instruments are introduced to the market, new challenges emerge which disrupt the conduct of monetary policy. Moreover, new developments in the financial system also require new regulations to ensure the effectiveness of monetary policy is not compromised. Financial innovation and change in monetary procedures and control follow each other. Central banks have therefore to change their tools, targets and operating procedures from time to time so as to cope with innovation and ensure the sustainability of the financial system.

Whether financial innovation has facilitated or hindered the conduct of monetary policy in Kenya remains unclear. Fully addressing this concern requires a broad approach of examining financial innovation-monetary policy nexus in general and the linkages between financial innovation and all the major monetary policy transmission mechanisms as identified by Mishkin (1995). As a first step, this paper empirically examines the financial innovation-monetary policy nexus and in particular the linkages between financial innovation and the interest rate channel in Kenya.

Two opposing views dominate the literature regarding the relationship between financial innovation and the interest rate channel of monetary policy transmission. On the one hand, some authors argue that financial innovation enhances the pass-through effect of interest rate, firstly, by facilitating faster dissemination of information from the policy rates to the entire term structure made possible within an environment of increased financial deepening. Secondly, rapid financial innovation, which in turn increases efficiency within the financial system, enhances the role of expectations implying that actual and expected changes in interest rates are readily transmitted to a wider range of financial assets thus influencing long term interest rates with implications on consumption and investment. Thirdly, with increased menu of financial assets available to investors, it is easier to take risks in search of higher yields which enhances interest rate pass through since changes in risk premium is highly pro-cyclical. Moreover, with increased financial innovation, investors easily access products that allow hedging of interest rate risks which in turn encourages portfolio diversification amongst investors with positive implications on the pass-through effects of policy rates (Jurgen, 2008; Mishra and Pradhah, 2008; Weber, 2008; Mario, 2007; Mohan, 2007: Noyer, 2007; Pais, 2006; Roldos, 2006; Eugenio, 2003; Aktar, 1983).

On the other hand, however, other authors, notably, Ooi sang (2005) and Mario (2007) contend that greater reliance on alternative sources of funds facilitated by financial innovation may reduce the speed and magnititude of transmission of policy rates to the cost of financing. This is particularly important if the alternative sources have different funding structures not directly influenced by Central Bank policy actions. Moreover, financial innovation may facilitate emergence of bubbles and

imbalances, particularly if policy actions diverge from investor expectations. In this case, financial markets may be upset leading to increased volatility and disorderly effects on liquidity and asset prices which may create ineffectiveness in policy actions through the interest rate channel.

The need to closely monitor the financial innovation- monetary policy transmission mechanism linkages by central banks therefore arises, evoking a number of research questions. Would it be possible that financial innovation has changed monetary policy impact in general? Does financial innovation strengthen the standard interest rate transmission channel or not? And what implications do these possible changes if they exist have on future monetary policy operations? While it may not be possible to fully exhaust answers to these questions in this paper, this paper attempts to provide some answers by: identifying financial innovations that have taken place since liberalization of the financial sector and analysing their impact on the interest rate channel of the monetary policy transmission mechanism in Kenya.

The rationale of studying possible implications for monetary policy of existing changes in the financial systems and expected new innovations and developments emanates from the need to, first, inform monetary authorities of what to incorporate in future policy formulations and interventions for effective monetary policy. Second, it is also important for central banks to monitor developments in financial innovation and try to predict the consequences of innovations before any distortions to the financial system emerge. Such an understanding will provide insights on the risks associated with financial innovation that is not properly regulated or monitored. Third, understanding the behaviour of monetary policy variables in a changed financial sector environment, particularly in the context of rapid financial innovation is necessary so as to predict the likely effects of changes in such policy variables on the key macroeconomic variables, which constitute the overall goals of any monetary authority.

The rest of the paper is organized as follows: The next section highlights innovations in the financial sector while section three provides literature review. The methodology is developed in section four while section five provides analysis of the results. The last section provides conclusions and policy implications.

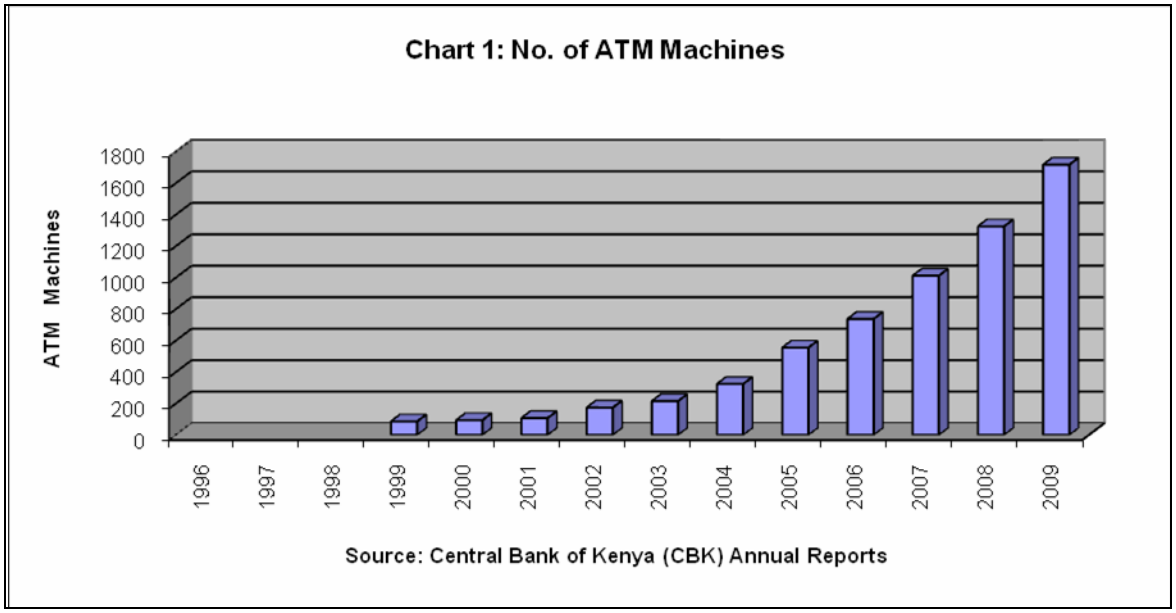
2. Developments in Kenya's Financial Sector

The financial sector development in Kenya can be reviewed in three phases. The first phase is the 1970s to early 1980s. During this time, the financial sector was largely dominated by the banking sector, which was characterized by financial repression. The government played a key role in allocating credit to investments by utilizing direct instruments of monetary policy such as interest rate controls, exchange rate controls and allocation of credit to priority sectors among other government restrictions. As argued by McKinnon (1973) and Shaw (1973), this phase encouraged insignificant interest rates on deposits, low savings and hence low investments.

The second phase began with the advent of Structural Adjustment Programmes and liberalization policies in the late 1980s and early 1990s. Over this period, relaxation of the interest rate, exchange rate and capital accounts controls were witnessed. The essence of the financial sector reforms this time was to trigger narrow interest rates spreads, increase availability of financial resources through increased savings, enhance efficiency in credit allocation and increase investments. Liberalization was also meant to encourage usage of indirect tools in monetary policy formulation. However, analysis of this phase in terms of influencing interest rate spreads indicate a disappointing scenario in which the lending rates remained high while the deposit rates remained low, with the real interest rates sometimes in the negative zones (Ndung'u and Ngugi 2000).

The third phase which is the main focus of this paper is the late 1990s to date and can be classified as the era of financial innovation and emerging financial instruments. The period witnessed emergence of new products such as Islamic banking, automatic teller machines (ATMs), plastic money and electronic-money (e-money) amongst others within the banking sector. As shown in Chart I below,

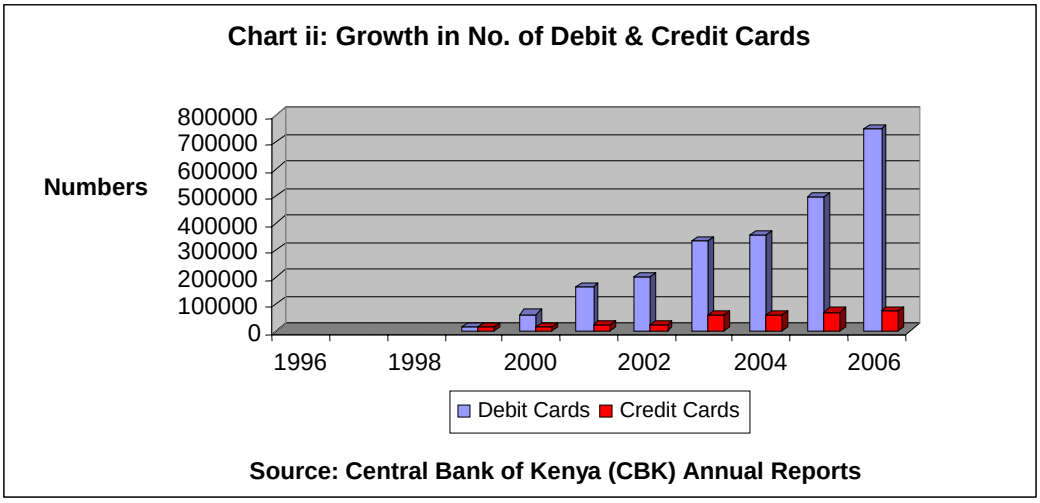
the number of ATMs has increased steadily indicating reduced demand for cash at hand because they improve access to cash to those holding them. The emergence of new products has also been experienced outside the banking sector. Some of the innovations are noticeable in the financial markets, for instance, the introduction of Central Depository System (CDS) accounts, automation of Nairobi Stock Exchange (NSE), among others and developments in the ICT sector, which has increased the use of e-money and importance of e-money balances.



Developments have also been witnessed in the insurance market, pension funds market, emergence of unit trust funds among other developments. Such new developments triggered increased interest by investors in raising funds from alternative sources, mainly the stock market.

2.1. Financial innovations

The developments in the financial sector have not only led to the increase in the number of financial institutions, but also the development in level of sophistication with new payment systems and asset alternatives to holding money. This has resulted mainly from technological advancement and increase in competition as the number of institutions increase. Developments in payment systems have started to create close substitutes for hard currency, thus affecting a core part of central banking.



This is, for example, the case with the use of debit and credit cards, which have also increased steadily from the late 1990s (see Chart ii). They have facilitated the use of electronic means of payment and sometimes substituted for the use of physical cash. More importantly, payment cards have also enabled the issuance of electronic money (e-money), which not only directly rivals physical cash in small value payments but also bank deposits through holding e-money balances. This reduces the amount of money that an individual can hold at hand at any particular time, thus affecting the demand for money. As these cards and e-money balances, e.g., M-PESA[1] and ZAP[2] balances, gain wider acceptability, demand for money and even motives for holding cash change significantly with implications on monetary policy transmissions.

Other innovations in the banking sector include: increased use of paper money instead of cash. Cheques are the main paper based mode of payment accounting for 48% of non-cash payments. Use of Magnetic Ink Character Recognition (MICR) ensures clearing of cheques speedily and efficiently. The Central Bank of Kenya launched a Real Time Gross Settlement (RTGS) system known as the Kenya Electronic Payments and Settlement System (KEPSS) in July 2005 in an effort to modernize the country's payment system in line with global trends. The main objective of introducing KEPSS was to: reduce the dominance of cash as a financial instrument in the payment system; reduce risk arising from payment exposure; enhance safety and efficiency of exchange in value between transacting parties, and provide an on-line settlement system that would enable both banks and individuals to transfer funds electronically on a real time basis. The KEPSS system operates on a credit push basis whereby final irrevocable settlements only occur when funds are available in the commercial bank's account with Central Bank.

3. Literature Review

Literature on financial innovation is diverse ranging from the developments in information technology to linkages between innovation, monetary policy, inflation and economic growth. Financial deregulation, development of new financial products and technological developments are some of the innovations in the financial system featuring most in the literature. In the context of financial innovation and monetary policy, most authors have focused on the effects of innovations on various channels of the monetary transmission mechanism with the interest rate, exchange rate and asset price channels dominating the literature. In general, it is conjectured in the literature that financial innovation has widespread effects on monetary policy that have various implications on transmission mechanism and thus on the effectiveness of monetary policy operations in influencing macroeconomic variables.

According to Ignazio (2007), financial innovation has not only opened up new opportunities for the sector participants, but also increased new market players arising from new products in the financial market. These developments have increased the range of financing and investment opportunities available to economic agents besides changing the role of banks with expanded diversification choices in terms of portfolio and sources of financing. Such developments affect the speed and strength of the channels of monetary policy transmission mechanism in the economy. In this case, as financial markets become more liquid and complete, changes in official interest rates are more readily transmitted to the whole term structure and more generally to financial asset prices. This in turn affects the whole economy through the cost of investment financing and return on saving. In addition, the increasing weight of financial and non-financial assets in firms and households' balance sheets implies that the effects of monetary policy through changes in asset prices and related wealth effects are likely becoming larger while weakening the bank lending channel (Martin, 2007). This is partly explained by the fact that a wider range of borrowers are now able to shift to financial markets as a substitute for banking sources of financing. Consequently, the relevance of the bank lending channel is affected negatively by the emergence of non-bank lenders. In pursuit of price stability therefore,

[1] M-PESA is a mobile phone money transfer service for SAFARICOM mobile phone service provider
[2] ZAP is a mobile phone money transfer service for ZAIN mobile phone service provider

monetary authorities need to monitor more closely developments in asset prices that can eventually have an impact on inflation and growth.

Resina (2004) concurs with this argument by contending that financial innovation tends to make existing relations between monetary and non-monetary variables much more unstable and unpredictable. This is because the broader range of financial assets available and their increased substitutability have made monetary aggregates more difficult to interpret. Thus there has been a trend towards downgrading quantitative targets and focusing instead on key prices such as the level of interest rate and the level of exchange rates. Consequently, in a changing financial environment, it is inappropriate to use any one monetary variable as the sole guide for monetary policy.

Ho (2006) focused on the linkages between financial innovation, growth and monetary policy transmission mechanisms. He argued that monetary policy targeted at certain macroeconomic variables is essentially a financial process, with the financial system as the interface linking central bank policies and the real economy through the monetary policy transmission mechanism. Hence, any innovation development that affects the structures and conditions of financial markets will have the potential to exert effect on the transmission mechanism. The author identified the interest rate channel, exchange rate channel and asset channel as the three main channels through which financial innovation can affect monetary policy. He further argues that financial innovation can work against policy effects of transmission. For instance, new financial instruments such as futures and options significantly increase the ability of economic agents to lock in current interest rates for future funding needs, countering fluctuations in the cost of finance and improving the inter temporal substitution of income streams. In this case, current income is no longer the major determinant of current expenditure, while the net worth would gradually replace cash flows as the primary factor of investment expenditure. Hence, the inter-temporal substitution effect of the monetary transmission mechanism will be contained due to the increased insurance possibility induced by financial innovation.

In addition, Ho (2006) points out that evolution of electronic means of payment (e-money) which is basically an alternative form of money has the potential to substitute for traditional form of money. Electronic payments to the extreme, could replace bank demand deposits and other types of highly liquid deposits, undermining the functioning of monetary transmission mechanism, as the link between change in bank deposits and change in real sector activities is weakened. The implication is that the reduced demand for traditional form of money could lead to a reduction in the amount of reserves held by financial institutions with central bank. Moreover, technological advances in payment systems which allow for a more efficient settlement of interbank transactions reduce the necessity of holding excess reserves with central bank for precautionary motives. The usage of credit cards and electronic banking is one such innovation that contributed to what was previously observed as stable medium to long-run relation between the stock of money and aggregate nominal income. This instability between the money stock and nominal income eventually led countries to abandon monetary targeting (Iris and Grimes 2003).

According to Noyer (2007), financial innovation fosters faster dissemination of information and its more rapid incorporation into financial market prices. This is true for monetary policy decisions and can therefore increase the effectiveness of monetary policy, particularly via the interest rate channel. In addition, financial innovation contributes to an increased holding of financial assets by lowering transaction costs and facilitating arbitrage, hedging, funding and investment strategies. Financial innovation also gives firms broader access to securities markets, which may reduce information asymmetries at the source of the credit channel and thus weaken it.

Related studies with empirical content include Sukudhew et al. (2007) who used two-step Engle-Granger ECM approach to obtain a long-run relationship between market rate of interest and policy rate, whose residual was used to develop a short run model. The authors then used simple cross-country correlations to gauge the strength of the association between interest rate pass-through and various measures of financial developments including financial innovation indicators. Their results indicated that financial market development strengthens asset price channel; weakens impact of

monetary policy on bank lending channel and has mixed impact on the balance sheet channel. According to their results, financial market development leads to faster and larger interest rate pass-through. While some aspects of financial market development strengthen the interest rate channel, advancement of payment technology which enables consumption smoothening weakens the importance of the interest rate channel.

Arturo (2001) examined the effects of securitization on the transmission mechanisms of monetary policy using an estimated structural IS equation. The author found that the sensitivity of both real output and housing investment to the real federal funds rate declined significantly as the degree of asset securitization increased in the 1980s and 1990s. This implies that securitization largely affected channels not directly related to interest rates such as bank lending or credit channels. Aoki et al. (2004) assessed the impact of monetary policy on the real economy through its effect on housing prices and finds that the recent financial innovations such as flexible refinancing terms and increased consumer access to unsecured credit may have changed the transmission mechanism through housing prices.

Ooi Sang (2005) argues that the effectiveness of monetary transmission mechanism hinges on changing forms and character of financial diversity and depth of financial markets. In this context, the author contends that with an increasing role of the capital market, investors have greater options to diversify their financing away from banks through the issue of bonds and equities. Accordingly, such changes in the financial system impact on the effectiveness of monetary policy by increasing or decreasing lags from changes in the Central Bank policy rate to the cost of funds to business and households, as well as relative returns of different asset classes for savers and investors. For instance, greater reliance on alternative sources of financing by business and corporations may delay speed and magnitude of transmission of policy rates to the actual cost of financing. This is especially important if alternative sources of financing have significantly different funding structures not directly influenced by Central Bank's policy rate. The author further conducted some descriptive analysis using data from Malaysia. The results of his analysis indicate that a diversified source of financing especially from the capital market had not impacted on monetary transmission in any significant way.

In summary, the foregoing literature show that financial innovations have widespread effects on monetary policy transmission mechanism, with differing implications on the effectiveness of monetary policy. Financial innovation creates new products and systems of financial services delivery that monetary authorities cannot ignore in their conduct of monetary policy yet it is not clear how best to incorporate some of these developments. This has the danger of impairing monetary policy effectiveness. It is therefore important that effects of financial innovation are well understood and considered in the formulation of monetary policy.

4. Methodology

Various approaches have been used to construct theoretical frameworks for analysing transmission mechanisms and their linkages to macroeconomic variables. Some authors have focused on the analysis of the major transmission mechanism identified as the interest rate channel, the exchange rate channel, the credit money channel, asset prices and expectations channel (Era and Holger, 2006; Ebson and Ikhide, 2002; Mishkin, 1995; Artulo, 2001; 2002; Ireland, 2005) and related them to output, inflation and other macro economic variables. Others have, however, focused on one or two channels of transmission in their analysis.

In the context of financial innovation, this paper follows similar approaches by specifically focusing on the interest rate channel which facilitates capturing the monetary policy stance as practiced in the Kenyan economy. In Kenya, the monetary authority target reserve money and uses the Open Market Operations (OMOs) to attain that target. As such, the interest rate plays a significant role as a link to other macro economic variables, mainly output which also forms one of the overall goals of any monetary authority. The theoretical basis of this study is embedded on the traditional Keynesian view which postulates that monetary policy influences the real cost of borrowing by setting nominal short-

term interest rate. Changes in nominal interest rate are expected to influence real rates and eventually have an impact on investment and consumption both of which are key components of output.

Following from the foregoing discussion, this study incorporates various measures of financial innovation within the interest rate channel framework as discussed in the following sub-section.

4.1. Model and data description

The theoretical foundation of the empirical model used in this paper is based on the explicit analysis of the maximizing behaviour of rational economic agents (Kobayashi, 2004; Nelson, 2002; Rudesbusch and Svensson, 2002; Glubin, 2001; Walsh, 2001; Clarida et al., 1999; McCallum and Nelson, 1999; Goodfriend and King, 1997).The economy is assumed to consist of numerous individual households, with each household maximizing the following time separable utility function.

$$\sum_{\tau}^{\infty} A^{\tau} u(c_{t+1}, m_{t+1}) \tag{1}$$

Where $A \in (0,1)$ is the household's discount factor, c_t is household consumption at time t, and m_t is the stock of real money balances held at the start of the period. In this equation, money provides transaction services that facilitate utility maximization. Each household is assumed to specialize in producing a single good based on the following production function although they consume combinations of commodities

$$y_t = f(L_t, k_t) \tag{2}$$

Where y_t is output, L_t is labour input and k_t is the capital stock, all at the start of time t and equations (1) and (2) are assumed to be well behaved. The use of the production function makes it possible to analyse the underlying components of potential output and to explain output gap fluctuations. The household inelastically supplies one unit of labour per period. By assuming that the real interest rate on government bonds is denoted by r_t, representing the main form of investment for households, and denoting the real wage as w_t, the budget constraint for a household is given as:

$$f(L_t, k_t) - T_t = c_t + k_t - (1-\delta)k_t + w_t(L_t - 1) + (1+\pi_t)m_{t+1} - m_t + B_{t+1}(1+r_t)^{-1} - B_t \tag{3}$$

Where $\prod_t$ is the rate of inflation, B_{t+1} is the number of real bonds purchased in time t, T_t is the magnitude of lump-sum taxes levied on households, δ is capital stock depreciation. Using equation 1 and 3, we obtain:

$$Max \sum_{\tau}^{\infty} A^{\tau} \mu(c_{t+\tau}, m_{t+\tau}) + \lambda_t \left((f(L_t, k_t) - T_t) - c_t - k_{t+1} + (1-\delta)k_t - w_t(L_t - 1) - (1+\pi_t)m_{t+1} + m_t - B_{t+1}(1+r_t)^{-1} + B_t \right) \tag{4}$$

The household's optimality conditions become:

$$\mu_1(c_t, m_t) - \lambda_t = 0 \tag{5}$$

$$A\mu_2(c_{t+1}, m_{t+1}) - \lambda_t(1+\pi_t) + A\lambda_{t+1} = 0 \tag{6}$$

$$-\lambda_t + A\lambda_{t+1}[f_2(L_{t+1}, k_{t+1}) + (1-\delta)] = 0 \tag{7}$$

$$f_1(L_t, k_t) - w_t = 0 \tag{8}$$

$$-\lambda_t(1+r_t)^{-1} + A\lambda_{t+1} = 0 \tag{9}$$

$$f(L_t, k_t) - T_t = c_t + k_t - (1-\delta)k_t + w_t(L_t - 1) + (1+\pi_t)m_{t+1} - m_t + B_{t+1}(1+r_t)^{-1} - B_t \tag{10}$$

These differential equations determine household choices of the sequence for ct, Bt+1, mt+1, Lt, kt+1 and □□t [in response to the paths taken by wt, rt, Πt, vt and which households face. We solve this system of equations by first, substituting equation 5 into equation 9 to obtain:

$$\mu_1(c_t, m_t) = A\mu_1(c_{t+1}, m_{t+1})(1+r_t) \tag{11}$$

We assume that $\mu(c_t, m_t)$ takes an explicit form such that

$$\mu(c_t, m_t) = \theta\sigma(\sigma-1)^{-1} c_t^{\frac{\sigma-1}{\sigma}} + (1-\theta)\varphi(m_t) \tag{12}$$

where $\theta\epsilon(0,1)$, $\sigma > 0$ with $\varphi'(.) > 0 \;\&\; \varphi''(.) < 0$ over the relevant range. It therefore follows that for $\sigma > 0$, $\mu(c_t, m_t) = \theta c_t^{\frac{\sigma-1}{\sigma}}$ which we substitute into equation 11 to get,

$\theta c_t^{\frac{\sigma-1}{\sigma}} = \theta c_{t+1}^{\frac{\sigma-1}{\sigma}} A(1+r_t)$ which simplifies to $c_t = c_{t+1}[A(1+r_t)]^{-\sigma}$, and taking natural logarithms gives

$$\log c_t = \log c_{t+1} - \sigma \log(1+r_t) - \sigma \log A \tag{13}$$

For very small changes, $\log(1+r_t)$ approximates r_t and along the business cycles, fluctuations in c_t approximate fluctuations in output. In addition, following other studies that analyze the impact of financial innovations, we use the output gap since deviations from permanent output are normally not permanent, after some time they evoke price response that restores the equilibrium between actual and potential output. In addition, the output gap provides insight into the sensitivity of financial innovations to cyclical developments. Since the potential output describes the supply side of the economy and reflects the production level at normal utilization of the factors of production at the current state of technology, it is ultimately determined by the availability of factors of production and technological progress, and therefore tends to correspond to the economy's sustainable long-term growth of output. The idea underlying output gaps is that due to the presence of short-term price rigidities demand shocks provoke a supply reaction, causing actual and potential output to differ. The output gap cannot, however, last in the long term and will trigger a price adjustment process to restore equilibrium, implying that output gap approximates output but with the stated advantages besides being algebraically tractable (Bolt and Van Els, 2002).

Taking this into consideration, the analogue of equation 13 with the output gap (y_t,), can be expressed as

$$\log y_t = \alpha_0 + \alpha_1 r_t + \alpha_2 \log y_{t+1} \text{ with } \alpha_1 < 0 \tag{14}$$

We extend this model by introducing additional lags and noting that $r_t = i_t - \pi_t$, along Rudebush-Svensson (1999) IS equation to get our estimated equation as:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 (\bar{i}_{t-1} - \bar{\pi}_{t-1}) + \eta_t \tag{15}$$

Where y_t is the output gap, $\bar{i}_t$ is an average of lagged short term interest rates, $\bar{\pi}_t$ is an average of lagged inflation and η_t is a random disturbance term. The output gap is defined as the difference between actual and potential real GDP, inflation is defined as change in the CPI. The short term interest rate is the REPO rate which reflects the monetary policy stance in Kenya. The model includes lags of the dependent variable on the right hand side of the equation because changes that central banks make on target variables do not have instantaneous effects on output. For instance, if the central bank changes interest rates through OMOs or the Bank rates, economic agents take time to react to the interest rate changes and for the agent's reactions to affect output (Florin and Twaddle, 2004).

All data are monthly from M1 1996-M2 2007. For variables such as GDP whose data is not reported in high frequency format in statistical year books, methods of interpolation are used to obtain monthly estimates from easily available annual data. The main sources of data for this study are Central Bank of Kenya publications.

Various approaches have been used to model financial innovation depending on the measure or proxy adopted. Some authors have modelled financial innovation by using M2/M1 and other related proxies such as bank assets/GDP ratio (King'ori, 2003). In other cases, financial innovation is considered as a shock in which case the innovation is assumed to involve technological progress in transactions and policy changes such as financial regulation or deregulation. In this framework financial innovation is modelled as a non-stationary process or deterministic trend (Arrau and Gregorio, 1991). Other approaches model financial innovation based on new financial products associated with innovation. Under this framework, some authors have used the number of ATM

terminals to represent financial innovation while authors using data from developed countries have used securitization as their main variable to proxy for financial innovation (Arturo, 2001).[3]

This study adopts the approach used by Arturo (2001) and modifies equation 15 in order to test for the effects of financial innovation on the reaction to monetary policy moves. This is by allowing the coefficient of the real interest rate, β_3 in equation15 above to vary with the extent of financial innovation. This modification gives:

$$y_t = \beta_0 + \beta_1 Z_t + \beta_2 y_{t-1} + \beta_3 y_{t-2} + \beta_4 Z_t (\bar{i}_{t-1} - \bar{\pi}_{t-1}) + \eta_t \quad (16)$$

Where financial innovation variable is represented by Z_t in equation 16 with bank assets-GDP ratio and ratio of M3 to M1 as its proxies, which are alternately, entered in the regression equations

4.2. Estimation Technique

The model specified in the previous section is classified as an Autoregressive Distributed Lag (ADL) models since some of the explanatory variables are lag variables of the dependent and independent variables. Estimation of such models using the traditional OLS will result in inconsistent estimates since the lagged explanatory variables may be correlated with the error term (Gujarati, 2005). In addition, inclusion of financial innovation as part of the explanatory variables implies that simultaneity problem can not be ruled out since the relationship between financial development and output is still unclear in terms of direction of causality. Consequently and coupled with the fact that the specified estimable equation is a single-equation, an instrumental variable estimator or Two Stage Least Squares (2SLS) is used to obtain consistent and efficient estimators for the model (Gujarati, 2005)

5. Regression Results and Analysis

In obtaining regression results three models were estimated using the 2SLS. As shown in Table I below, the first model in column 2 represents the basic IS model without any financial innovation term. In columns, 3 and 4, the two financial innovation terms, that is, bank to GDP ratio and M3/M2 are interacted with interest rate and added to the base model to capture the effect of financial innovation on policy stance of the bank[4]..

The base model in column 2, Table I is the standard IS equation that models the effect of a change in the real interest rate on the output gap. As Table I shows, the model signs for output gap_1, outputgap_2 are as expected. The sign for real interest rate is negative which is expected according to theory and which has been validated by previous empirical results (Rudesbusch and Svensson 1999; Arturo 2001). An increase in interest rate discourages lending that in turn depress investment and impact negatively on economic growth. This result implies that actual output is less than full capacity output and that there is excess capacity within the economy hence the higher the interest rate the more negative the output gap. However, even if the coefficient is highly significant, the magnitude is not significantly different from zero thus much weight should not be accorded to the relationship.

[3] Securitization involves a process of transforming otherwise non-liquid financial assets such as residential mortgages into marketable capital market securities. It involves pooling and repackaging loans into securities that are sold to investors.

[4] The data series for the number of ATMs and M-PESA transanctions, which are direct indicators of financial innovation was shorter than the sample series used in this study. Nevertheless attempts were made to interact the ATM data with interest rate, which however provided insignificant results and is therefore not reported here. No attempts were made using the M-PESA data because the data series available was for only 12 observations.

Table I: The Dependent Variable is output gap.

Independent Variable	Base Model (without financial innovation)	Model with financial innovation-bank/GDP interacted with interest rate	Model with financial innovation-M3/M1 interacted with Interest rate
y_{t-1}	0.72(8.45)***	0.67(7.85)***	0.86(9.81)***
y_{t-2}	-0.14(-1.65)*	-0.14(-1.69)*	-0.27(-3.18)***
Rinterest	-0.0004(-0.16)	-0.001(-2.56)***	-0.14(-1.66)*
Bank/GDP			
M3/M1			3.4(6.87)***
InterB		0.001(2.86)***	
InterM3			0.13(1.65)*

For all the coefficients the t-statistics are in parenthesis; *, **, *** denote 10%, 5% and 1% significance levels, respectively.

§: y_{t-1} =output gap lagged one period; y_{t-2} =Output gap lagged two periods; R= Real interest rate; Bank/GDP=Bank assets to GDP; InterB=Bank to GDP*Real interest rate; InterM3=M3*Real interest rate

In the columns 3 and 4, the results incorporate Bank/GDP and M3/M1 interacted with real interest rate. Comparing the base model and the models in columns 2 and 3 reveal that inclusion of the interacted variables generally improves the models in terms of both magnitude and significance. However, even if the interest rate variable is now significant with the same sign as expected in column 3 the magnitude is still relatively small to warrant any meaningful conclusion with respect to its elasticity to output gap. It is only in the last column where it may be argued that inclusion of innovation terms has enhanced the elasticity to regions above zero which also depends on the offsetting effect from the coefficient of the interacted term.

In both the models in columns 3 and 4, the coefficients of the interacted terms are positive and significant at 1% and 10%, respectively. The result of the interaction terms implies that financial innovation reduces the output gap which would be explained by arguing that financial innovation increases the efficiency with which money is transmitted in the economy. With increased efficiency, institutions and households are expected to access finances easily since interest rate is reduced with minimized transaction costs arising from innovation and are therefore able to consume and invest more. This will increase output thereby creating excess demand in the economy implying that as financial innovation intensifies, the more positive the output gap is likely to be. The implication of this result is that with financial innovation, the effectiveness of the interest rate channel in monetary policy transmission is weakened since the relationship between the interacted term and output gap is positive. Following Lowell (2006) who has expounded on product-variable models, the interpretation of this result means that the effect of financial innovation on output gap through interest rate is positive not negative as expected when there is no financial innovation interacting with interest rate.[5] These results are consistent with other studies in which financial innovation terms seemed to weaken the interest rate channel of transmission (Arturo, 2001).

6. Conclusions and Policy Recommendations

Financial innovation is sometimes an unobservable process that is often unquantifiable and therefore difficult to measure. Nevertheless, using banking assets to GDP ratio and M3/M1 as indicators of financial innovation in an econometric framework, the results of this paper indicate that financial

[5] Further understanding of interactive terms and their intepretation, see Hayes et al, 2008; Schofer, 2007; Brambor et al, 2006; Chunrong and Norton, 2003; Franzese et al. 2001; Aiken and West, 1991 and Friedrich, 1982 among others.

innovation has implications for monetary policy and thus for output. To the extent that the normally expected negative effect of interest rate on output gap is reversed when the interest rate is interacted with a financial innovation term in the regression equations implies that the effect of Central Bank actions through the interest rate channel on output is dampened. Since in Kenya major financial innovations have been realized through technological developments, it is possible that advancements in payment technology may have enabled consumption smoothening and therefore contributed to the weakening of the importance of the interest rate channel in transmission mechanism. The major policy implication of this study is that financial innovation poses constant complex challenges to the Central Bank which would necessitate regular revision of not only policy targeting frameworks and instruments but also consideration of a mix of these tools to capture changes in transmission mechanism.

The fact that financial innovation weakens the interest rate channel implies that other channels of transmission mechanism are enhanced. Thus similar research needs to be conducted on other transmission mechanisms such as asset price, exchange rate or expectations channels to establish their linkages to financial innovation. This will provide a complete analysis of the transmission mechanism which will be useful in directing the Central Bank on where to place more weight in terms of policy instruments for effective monetary policy conduct.

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