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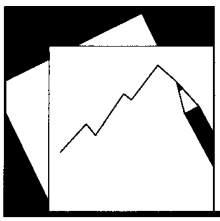

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Monetary Policy Transmission in Ghana: Does the Interest Rate Channel Work?

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Monetary Policy Transmission in Ghana: Does the Interest Rate Channel Work?

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Abstract

This paper analyzes interest rate pass-through in Ghana. Time series and bank-specific data are utilized to highlight linkages between policy, wholesale market, and retail market interest rates. Our analysis shows that responses to changes in the policy interest rate are gradual in the wholesale market. Prolonged deviation in the interbank interest rate from the prime rate illustrate the challenges the Bank of Ghana faces when targeting a short-term money market interest rate. Asymmetries in the wholesale market adjustment possibly relate to monetary policy signaling, weak policy credibility, and liquidity management. In the retail market, pass-through to deposit and lending interest rates is protracted and incomplete.[1]

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I. INTRODUCTION

Monetary policy implementation in countries where financial markets are sufficiently deep and liquid rests on the interest rate channel whereas monetary aggregates usually are less important for monetary policy.[2] This increased "market orientation" of monetary policy implementation involves a short-term market interest rate as the operating target of monetary policy. In this type of framework, for monetary policy to have a desired impact on the real economy and inflation, which is the ultimate objective of monetary policy, it is essential that changes in the short-term market interest rate eventually translate into changes in other interest rates in the economy (that is, interest rate changes are passed through to retail interest rates for loans and deposits), which then influence the overall level of economic activity and prices. The interest rate channel is increasingly relevant in many developing and emerging market countries as well, as countries find it difficult to achieve their quantitative targets (in these countries, monetary policy usually operates through the targeting of the quantity of reserve money). These countries often have less developed, shallow financial markets, which itself introduces challenges for monetary policy implementation and contributes to the weaknesses in the transmission through the interest rate channel. One such country is Ghana where monetary policy is presently implemented in the context of an inflation-targeting framework which Ghana formally introduced in 2007. This replaced "money targeting" as the operating model for monetary policy. The Bank of Ghana uses a short-term money market interest rate as its operating target where changes in the short-term interest rate are expected to influence the cost of funding for banks and eventually the level of retail deposit and lending interest rates.

The ability to hit the interest rate target consistently plays a critical role in monetary policy effectiveness. It is also essential for the communication of central bank's policy stance to the public (see, for instance, Ennis and Keister (2008) in the context of U.S. monetary policy). If the market interest rate were to deviate time and again from the central bank's announced target, the public might begin to question whether these deviations represent a glitch in the implementation process or whether they amount to an undisclosed change in the stance of monetary policy. Such easing or tightening by "stealth", as one might call it, would undermine the credibility of monetary policy. An important issue in this respects is whether central bank's liquidity forecasting and liquidity management are adequate or whether shortcoming in these areas contribute to the rate deviations from the target. Furthermore, when short-term market interest rates are sensitive to changes in the supply and demand for liquidity, small errors in central bank's liquidity forecasts could lead to large swings in the short-term interest rates.[3] In such an environment, the central bank might find it difficult to

[2] An important exception is the European Central Bank, which has assigned a role for broad money in monetary policy. In the U.S., on the other hand, monetary aggregates are considered to be of limited importance.

[3] The effects of these shocks may be amplified by illiquid or shallow financial markets.

consistently achieve its target interest rate, which would then influence the effectiveness of monetary policy.[4]

The transmission of interest rate changes through the interest rate channel should ideally take place over a relatively short period of time (for discussion, see Goodfriend (1991)), as a faster transmission would strengthen the impact of monetary policy on the real economy. Due to a confluence of factors, however, the short-run interest rate pass-through may be less than complete in reality and interest rates may also adjust asymmetrically to rising and falling policy interest rates. The sluggishness of pass-through is evident in the many studies that have examined the speed of interest rate adjustment (Table 1 provides a summary). These studies conclude that the rate adjustment differs across countries, financial institutions and financial products (for instance, Cottarelli and Kourelis (1994), Borio and Fritz (1995), Hofmann and Mizen (2004), Bondt (2002), and Liu et al. (2008)). Even in countries with deep and well developed financial markets, such as the U.S. and the European common currency area, the speed and completeness of the interest rate pass-through differ (Kwapil and Scharler (2010) and Karagiannis et al. (2010)). These differences in part reflect the country-specific features of financial markets (for instance, in Europe the banking system plays a more significant role in lending than in the U.S.). In developing countries, due to the underdevelopment and shallowness of financial markets and the transmission process dominated by bank lending channel, the structure of financial markets plays an important role in the transmission process (Mishra, Montiel, and Spilimbergo (2010)). Deficiencies in the financial system and high concentration among banks reduces competitiveness, while large excess reserves make central bank's monetary policy less effective and impairs the interest rate channel. Sander and Kleimeier (2006) note that in the Southern African Customs Union (SACU) countries the interest rate channel works differently for deposits and lending rates. While the pass-through is rather uniform and complete for retail lending interest rates, there is a great deal of heterogeneity across the national markets and differing degrees of interest rate stickiness and asymmetry in the adjustment of retail deposit interest rates. Tieman (2004) examined the transmission process among the Central European emerging market economies.

[4] The central bank aims to adjust the supply of liquidity (banks' reserve balances) so that it equals the demand for reserve balances at the targeted interest rate. This process involves some estimation since the central bank does not know exactly the demand for reserve balances, nor does it completely control the supply of reserves.

Table 1. Summary Results from Other Studies on Interest Rate Pass-Through

Author(s)	Country/ region	Dependent variable	Independent variable	Short-term pass-through			Adjustment speed	Long-term pass-through complete
				T	T-1	T-2		
Ghartey (2005)	Ghana	Treasury bill rate	Policy rate					
(Monthly data)		91 days		0.40				
		182 days		0.44				
		1 year		0.62				
Sander and Kleimeier (2006)	SACU							
(Monthly data; panel)		Retail rates						
		Deposits	National discount	0.42				No
			South Africa discount	0.30				No
			National treasury bill	0.36				No
			South Africa treasury bill	0.47				No
		Lending	National discount	0.54				Yes
			South Africa discount	0.39				Yes
			National treasury bill	0.66				Yes
			South Africa treasury bill	0.69				Yes
Bondt (2002)	Euro area	Deposits	Overnight interest rate	-0.04			-0.06	No
(Monthly data)			Up to 3 month notice	0.11			-0.11	No
			Over 3 month notice	0.00			-0.03	Yes
			Up to 2 year maturity	-0.08			-0.14	Yes
			Over 2 year maturity	0.21			-0.21	No
		Lending	Up to 1 year to firms	0.04			-0.09	No
			Over 1 year to firms	0.25			-0.12	Yes
			Consumer lending	0.52			-0.09	Yes
			House purchase	0.43			-0.26	Yes
Tieman (2004)	Central Europe	Deposits						
(Monthly data)		Short term rate	Policy rate		0.16		-0.28	No
		Long term rate			0.05		-0.21	No
		Lending	Policy rate					
		Short term rate			-0.03		-0.16	No
		Long term rate			0.01		-0.13	No
Hofmann and Mizen (2001)	UK	Deposit interest rate	Base rate	0.20	0.29		-0.08	No
(Monthly data)		Mortgage interest rate	Base rate	0.20	0.06	0.21	-0.18	Yes
Kwapil and Scharler (2010)	US	Deposits	Money market rate					
(Monthly data)		1 month		0.76				Yes
		3 months		1.02				Yes
		6 months		1.03				Yes
		1 year		1.08				No
		Lending	Money market rate					
		Short-term business		0.44				Yes
		Long-term mortgages		0.71				No
		Short-term consumer		0.30				No
		Weighted average		0.79				No
	Euro area	Deposits	Money market rate					
		Up to 3 months		0.09				No
		Over 3 months		0.32				No
		Up to 2 years		0.36				No
		Over 2 years		0.40				No
		Weighted average		0.16				No
		Lending	Money market rate					
		Business, up to 1 year		0.27				No
		Business, over 1 year		0.47				No
		Mortgage		0.35				No
		Households, short-term		0.09				No
		Weighted average		0.34				No

Despite its increasing relevance for monetary policy implementation, the interest rate transmission process is not extensively studies in Ghana. An exception is Ghartey (2005) who examines the impact of monetary policy on the term structure of interest rates in Ghana during 1994-2004 and reports that there is a significant effect from monetary policy to

treasury bill interest rates (Table 1). Our research not only update the analysis of Ghartey, but also complements it in several ways. First, we use more recent data, which incorporates the period of inflation-targeting in Ghana. Second, we broaden the set of interest rates included in the analysis by examining the pass-through from monetary policy to wholesale money and treasury market interest rates and to banks' retail deposit and lending interest rates. In addition to the wholesale market interest rate data, we utilize bank-specific interest rate data which provide insights into the pricing behavior at the bank level, which was not available in Ghartey's study.

We research the implications of changes in the monetary authorities' interest rate (the prime rate) on short-term wholesale market interest rates (comprising short-term money and treasury bill market interest rates) and the pass-through to retail deposit and lending interest rates in Ghana during the period 2005-2010. A specific policy issue that is a concern to the policy-makers relates to the apparent lack of downward responsiveness of retail lending interest rates to changes in the wholesale market interest rates. This apparent stickiness has complicated policy implementation at a time when the government wants to promote private sector-driven growth. Section II highlights recent trends in interest rates in Ghana. In Section III, we introduce a simple model to illustrate how banks determine their lending and deposit interest rates based on their liquidity forecasts and how these rates respond to changes in the monetary authorities' interest rate. While such a model is a simplification of banks' real-life decision-making process, it is appropriate for our purposes and highlights a number of features, which we test empirically. First, the model links wholesale market interest rates (these comprise money and treasury bill rates in our sample) to the monetary policy interest rate (which in our study is the Bank of Ghana prime rate). Notwithstanding possibly short-term deviations, the wholesale interest rates are expected to move together with the policy interest rate in the long-run.

Second, the model shows that retail deposit and lending interest rates are expected to reflect funding costs in the wholesale market and therefore over time respond to changes in the wholesale interest rates. If the transmission process were to be effective, then changes in the monetary policy interest rate would be transmitted to the retail lending and deposit interest rates in a reasonably short period of time. In Section IV, we analyze empirically the dynamic interaction between various interest rates in Ghana using two different data sets for the period 2005-2010. The first data set is monthly and comprises wholesale market interest rate data for the period 2004M12 through 2010M4. This data set is useful for examining monetary policy influences on the wholesale interest rates in Ghana (i.e., interbank and treasury bill interest rates). Appendix Table 1 gives the details of each variable used in the study and Appendix Table 2 provides a statistical summary of the data. The second data set contains quarterly, bank-specific data for the 20 largest banks in Ghana for the period 2005Q1 through 2010Q1 (Appendix Table 3 provides a statistical summary of the data). The panel data permit us to examine the pass-through from changes in wholesale interest rates (reflecting the cost of funding) to banks' retail deposit and lending interest rates in Ghana,

thereby providing valuable insight into the interest rate transmission process. Section V concludes the paper.

II. Recent Trends in Ghana's Interest Rates

Ghana's financial system has experienced rapid growth during the past decade, which has transformed the financial markets. The rapid growth can be explained in part by the increase in prosperity (Ghana's per capita income rose almost ten-fold during the past decade and the country is now considered as a low-middle income country), which has increased the demand for financial and banking services. Furthermore, the government has taken an active role in the development of the financial markets in Ghana through a sequence of reforms which started in the 1980s. In Ghana, similar to countries with comparable characteristics, the financial system is dominated by banks which comprise about three-fourths of the financial system. The number of commercial banks rose from 16 in 2000 to 26 in 2010, largely due to the entry of new private, foreign-owned banks (banks' branch networks expanded by three-fold during the past decade, which has improved public access to banking services). Non-bank financial services have also shown rapid growth, but these segments are yet to develop more fully. Notwithstanding the rapid growth of the industry, the financial sector is still relatively small (total assets of the financial sector in 2010 were only about US$16 billion or equal to 50 percent of Ghana's nominal GDP). The banking sector is also highly concentrated (five largest banks control almost one-half of the market).

Interest rates in Ghana have generally been responsive to changes in macroeconomic and financial market conditions (Table 2). Macroeconomic conditions improved during the period through 2006. The fall in inflation and faster real growth, combined with improved fiscal balances and a stable currency, permitted the Bank of Ghana to ease monetary policy. Improved liquidity contributed to lower lending interest rates, which declined in nominal and real terms during this period, and faster credit growth. For instance, the average retail lending interest rate declined from 29 percent in December 2004 to 24 percent at the end of 2006, and after adjusted for inflation, fell by 3 percentage points to 12.1 percent during this period. Notwithstanding, the spread between deposit and lending interest rates narrowed only marginally.

Table 2. Selected Economic Indicators, 2003-2010

	Policy easing				Policy tightening			Policy easing
	2003 Act.	2004 Act.	2005 Act.	2006 Act.	2007 Act.	2008 Act.	2009 Act.	2010 Act.
GDP growth (percent)	5.1	5.3	6.0	6.1	6.5	8.4	4.0	7.7
Inflation (annual percentage change)								
Period average	26.7	12.6	15.1	10.2	10.7	16.5	19.3	15.8
End-of-period	23.6	11.8	14.8	10.9	12.7	18.1	16.0	8.6
Exchange rate (GHc per U.S. dollar; eop)	0.9	0.9	0.9	0.9	0.9	1.1	1.4	1.5
Interest rates (annual percent)								
Bank of Ghana prime rate	...	18.5	15.5	12.5	13.5	17.0	18.0	13.5
Treasury bill rate (91 days)	...	16.4	11.4	9.9	10.3	23.2	22.4	11.9
Deposit rate	...	11.0	9.3	6.6	7.2	13.5	15.0	8.6
Lending rate	...	28.8	26.0	24.3	24.2	27.3	32.8	27.6
(in real terms)	*...*	*15.2*	*9.7*	*12.1*	*10.2*	*7.8*	*14.5*	*17.5*
Domestic credit (annual percentage change)								
Nominal	12.7	44.4	21.3	28.7	31.0	59.5	21.1	26.9
Real	*-8.8*	*29.2*	*5.7*	*16.0*	*16.2*	*35.0*	*4.4*	*16.9*
Fiscal deficit (percent of GDP)	-3.3	-3.0	-2.8	-4.7	-5.6	-8.5	-5.8	-7.4

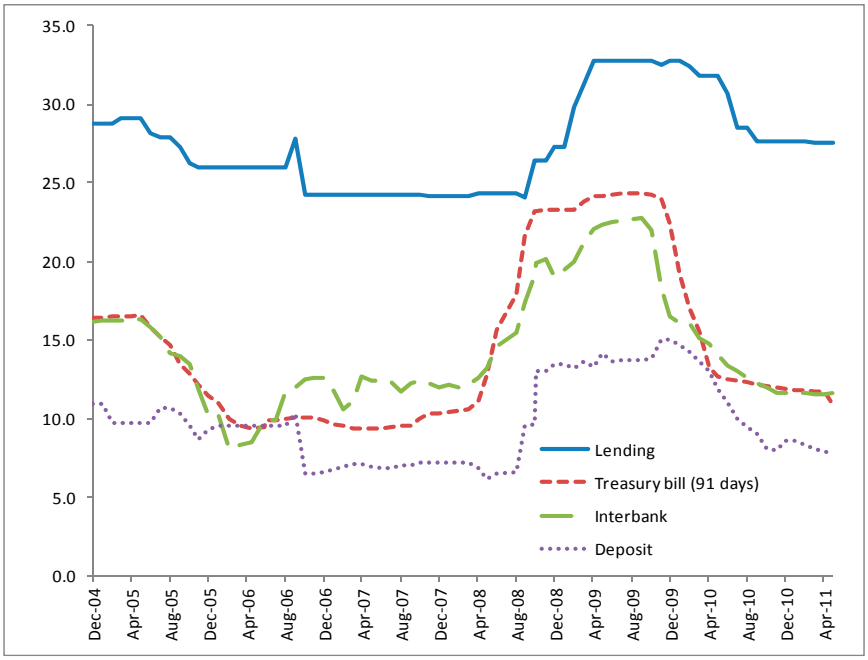
Sources: Ghanaian authorities, and authors' estimates.

The favorable downward trend in interest rates was reversed in 2007. Rising inflation, reflecting both higher global food and fuel prices and domestic demand pressures, prompted the Bank of Ghana to tighten monetary policy during 2008-2009, which led to higher interest rates across the board. Retail deposit and lending interest rates increased sharply both in nominal and real terms, in part reflecting the global financial crisis (Figure 1). The average retail deposit interest rate doubled between July and October 2008 (the rise was largely due to higher interest rates on time deposits, which followed the rising trend of treasury bill interest rates). The average lending interest rate reached levels in excess of 32 percent in early 2009. The higher cost of borrowing, combined with slowing economic activity, stifled credit growth and also led to debt service difficulties among borrowers (an important factor was government's overdue payments to private contractors and the energy sector).

The Bank of Ghana started to ease monetary policy in November 2009 as inflation pressures begun to ease, which led to sharp declines in interbank and treasury bill interest rates. Banks' retail deposit interest rates also fell significantly, in large part due to lower time deposit interest rates, but on average retail deposit interest rates stayed above the 2008 levels. Retail lending rates also came down, albeit with a lag, as the cost of funding subsided, but lending rates appeared to have stalled at levels well above those in the period preceding the monetary tightening. With the fall inflation, real lending interest rates rose sharply and at close to 20 percent were the highest in years. This has raised questions about the underlying causes of high lending interest rates, at the time when the government has been eager to promote economic activity and credit growth. Banks attribute the high lending interest rates to rigidities in their funding costs, particularly related to banks' term deposit liabilities, but the lending interest rates have remained high despite the fact that by now all term deposits would likely have been rolled over at much lower interest rates, corresponding to the fall in treasury bill interest rates. However, the ratio of non-performing loans to total loans remains

high and at 17.2 percent (May 2011) is still 10 percentage points higher than in the end of 2008. The cost of provisioning for bad loans could therefore partly explain the high lending interest rates and the high interest margins. Furthermore, Ghana's past experience with high inflation and large fiscal deficits might raise concerns about the sustainability of current low inflation environment and fiscal consolidation, and consequently could contribute to the uncertainty and unwillingness by the banks to lower their retail lending rates rapidly.

Figure 1. Selected Interest Rates, 2004M12-2011M5
(annual percentages)



III. Interest Rates and Monetary Policy—An Illustrative Model

The 2002 Bank of Ghana Act sets the stage for the transition to inflation targeting by recognizing the independence of the central bank to set interest rates.[5] The Act mandates that the primary objective of the Bank of Ghana's monetary policy is price stability (in the law, growth and exchange rate stability are secondary policy objectives). The monetary policy committee (MPC) was created in 2002 and was charged with the formulation of monetary policy. Formal inflation targeting started in May 2007, but in the preceding period the Bank of Ghana developed the institutional capacity necessary for implementing the inflation targeting regime (Addison, 2008), and during this transition period Ghana's central bank

[5] Prior to moving to inflation targeting, the Bank of Ghana targeted reserve money, similar to most central banks in developing countries. Ghana and South Africa, which adopted inflation-targeting in 2000, are the only countries in sub-Saharan Africa who formally implement monetary policy by directly targeting inflation.

moved away from the traditional monetary policy framework that was focused on targeting a monetary aggregate, towards analyzing a broader range of indicators to assess its monetary policy stance.

The shift to inflation targeting was preceded by other important changes in the financial system, including the liberalization of exchange and interest rate controls, and the partial opening of Ghana's external capital account, which allowed for the first time foreigners to participate in the longer-end of the domestic bond market, while Ghanaian residents would be able to hold foreign currency bank accounts. The exchange rate is floating but has remained remarkably stable against the U.S. dollar during the past year. Domestic capital markets have also started to develop, which has brought new investment options to the Ghanaians (such as stocks, treasury bills and bonds). Furthermore, new payment instruments, such as credit and debit cards, have started making inroads in the Ghanaian economy and are expected to reduce the demand for cash in daily transactions, while modern payment technology and electronic banking are expected to expand banking services to the rural communities deprived of such options (see, for instance, Buchs and Mathisen (2005) and International Monetary Fund (2011) for discussion on Ghana's financial system).

Such changes in the financial system often lead to instability in the demand for money and can cause important shifts in the monetary transmission mechanism, complicating monetary policy implementation. In particular, when a central bank in such instances continues to target a money aggregate, such as reserve money, policy effectiveness resting on the stability of the monetary transmission mechanism and the constancy of money velocity may be compromised due to the loss of stability in reality. An important argument, therefore, for moving to inflation targeting, and adopting a short-term interest rate as the operating target, is that such a regime does not depend on the stability of money demand (for instance, Mishkin, 1999). When the relationship between money and inflation is subject to unexpected shifts, as is often the case when the financial sector goes through significant reforms, monetary targets lose their transparency and cannot accurately signal the underlying stance of monetary policy.

To illustrate how monetary policy influences market interest rates, we take as given that at the operational level the Bank of Ghana targets the interbank money market interest rate (denoted by, i^{IB}), and sets its policy interest rate, the prime rate, at a particular level. Through open market operations, the central bank is able to manage liquidity in the interbank market and thereby the cost of borrowing in this market. In the long-run, therefore, the interbank interest rate is expected to reflect the monetary authorities' policy stance. Let us assume that a risk-neutral bank determines at the beginning of each business day the size of its loan (L) and deposit (D) portfolios and the level of reserves (R^d) it plans to hold in the end of the day.[6] Any anticipated shortfalls (excesses) in the end of the business day would be

[6] For simplicity, we assume that banks are not subject to reserve and liquidity requirements.

covered in the interbank market (from the balance sheet identity, we determine that the bank's net interbank position must equal $D-(L+R^d)$, which can be either positive or negative). In the absence of expected liquidity injections or leakages by the central bank, the bank's end-of-day settlement needs are symmetrically distributed around a zero mean (see, for instance, Henckel, Ize, and Kovanen (1999)). Assuming that the central bank leaves the money market short in the end of the day (in the model denoted by the term u), this will increase the demand for bank reserves at the central bank.

Furthermore, we introduce uncertainty in the bank's end-of-day settlement positions, denoted by v in the model, which provides another link to central bank's reserves. In the absence of any uncertainty, provided that borrowing from and lending to the central bank is always costly, banks would not come to the central bank window for funds. However, sometimes incoming or outgoing payment transactions do not arrive as planned, but are subject to delays or arrive earlier than initially thought, suggesting that banks do not usually know ex ante their end-of-day balances with full certainty. As discussed in Henckel, Ize, and Kovanen (1999), settlement uncertainty will be higher when the interbank and securities markets do not operate efficiently and the clearing and settlement systems are weak. Uncertainty about the central bank's liquidity management would also increase settlement uncertainty, hence the demand for reserves, and when the central bank does not offset the liquidity impact of its own operations but leaves the wholesale market in aggregate short or long.

Taking into account deficiencies and limited competitiveness in the banking systems of developing countries, we argue that the banking system is characterized by imperfect competition. Consequently, banks have a degree monopoly power in the pricing of retail credits and deposits but in the interbank money market they all behave as price-takers. We incorporate costly intermediation into the model, along the lines of Mishra, Montiel, and Spilimbergo (2010), which is a function of the size of bank's loan portfolio. Taken together, the profit maximization problem of a risk-neutral bank can be written as follows:[7]

$$\pi = i^L L - i^D D - c(L) + i^{IB}[(D-L)-R^d] + \frac{i^{CB,D}}{2v}\int_{-R^d}^{v+u}\left(R^d+x\right)dx + \frac{i^{CB,L}}{2v}\int_{-v+u}^{-R^d}\left(R^d+x\right)dx \quad (1)$$

where $i^L(L)$ is the bank's lending interest rate and a decreasing function of the loan portfolio, $i^D(D)$ is the bank's deposit interest rate and an increasing function of deposits (as noted earlier, there are no statutory reserve requirements), and c(L) is the intermediation cost function where the marginal cost of lending is an increasing function of the loan portfolio (c'>0 and c''>0). The difference $(D-L)-R^d$, as noted earlier, refers to the bank's net

[7] To keep the model manageable, we abstract from other asset and liabilities that banks often have in their balance sheets, including fixed assets, securities (such as treasury bills and bonds) and foreign exchange.

interbank market position and can be either positive or negative. The last two terms in equation (1) relate to the overnight deposit and credit operations with the central bank. The shock to the end-of-day liquidity is assumed to be distributed normally with a zero mean.[8] Furthermore, we assume that the central bank has adopted an asymmetric band around its policy rate (i^{CB}); that is, the deposit rate equals $i^{CB,D} = i^{CB} - h'$ and the lending rate equals $i^{CB,L} = i^{CB} + h''$, where h' and h'' are positive constants.[9]

Each bank maximizes its profits, equation (1), with respect to L, D, and R^d, which leads to the following first-order conditions:

$$i^L = \frac{1}{\left(1+\frac{1}{\varphi_L}\right)}[i^{IB} + c'(L)] \quad (2a)$$

$$\mathrm{i^D} = \frac{1}{\left(1+\frac{1}{\varphi_L}\right)}\mathrm{i^{IB}} \quad (2b)$$

$$i^{IB} = i^{CB} + \frac{h''-h'}{2v}(R^d + u) + \frac{h''+h'}{2} \quad (2c)$$

The interest rate on bank's lending, i^L, depends on the term $(1 + \frac{1}{\varphi_L})$, which is mark-up over the marginal cost of loanable funds, where the latter is given by the interbank market interest rate, i^{IB}, and the marginal intermediation cost, $c'(L)$. The size of the mark-up reflects the lack of competition in the banking system; that is, it is larger in less competitive banking systems. The marginal cost of intermediation is assumed to reflect banks' lending activities (overhead costs, provisioning, and so on). Hence, banks with higher costs of operation would charge higher interest rates on their loans. The pass-through from interbank market rates to lending interest rates, i.e., $\frac{\partial i^L}{\partial i^{IB}}$, which refers to the change in the lending rate over the change in the interbank rate, is also related to the marginal intermediation cost. That is, banks are less likely to adjust their lending rates to changes in the policy rate when the costs of intermediation are steeply rising (when c'' > 0). Regarding deposits interest rates, these are also determined by the interbank interest rate and are lower for higher reserve requirements.[10] Furthermore, in this model the deposit interest rate does not directly enter equation (2a).

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[8] More formally, this can be presented by $f(x) = \frac{1}{2v}\int_{-v}^{v} x dx$ where x stands to for random shock.

[9] In Ghana, the deposit rate equals the prime rate minus 200 basis points and the lending rate equals the prime rate plus 100 basis points on reserve maintenance days (Wednesdays) and on other days equals the prime rate.

[10] That is, the term on the right-hand side of equation (2b) would become $i^{IB}(1-r)$ when the statutory reserve requirement is added, where r refers to the statutory reserve ratio.

Regarding the interbank interest rate, equation (2c), the model establishes a link between the policy interest rate and the interbank market interest rate (changes in the policy rate are often called *signaling*). That is, the level of the policy interest rate would be reflected in the interbank market interest rates. The *liquidity effect* and its impact on interbank interest rates is present in the model, as indicated by the terms R^d and u. In the end, the supply and demand for reserves must be equal. By lowering available reserves, the Bank of Ghana can push interbank interest rates higher by increasing the demand for liquidity in the money market. When the band around the policy interest rate is symmetric, that is, $h' = h''$, then the second term drops out and the spread between the interbank and policy interest rates will equal h.

IV. ECONOMETRIC ANALYSIS OF INTEREST RATE PASS-THROUGH

The primary purpose of this paper is to shed light into the interest rate transmission process in Ghana. The effectiveness of the interest rate transmission channel has important implications for monetary policy effectiveness as we have already noted. When the transmission from policy interest rates to short-term wholesale market interest rates and eventually to banks' retail deposit and lending interest rates works adequately, monetary policy would have a desirable effect on the real economy and prices after a short delay. The model outlined in Section III illustrates the pass-through, but for empirical analysis we introduce a more practical representation of this model that is appropriate for examining both the short-run and long-run pass-through effects. Such a model could take the following generic form:

$$\Delta i_t = \sum_{j=1}^{K} \beta_j \, \Delta i_{t-j} + \sum_{l=0}^{N} \gamma_l \, \Delta r_{t-l} - \mu[i_{t-1} - \alpha - \delta r_{t-1}] + \varepsilon_t$$

which we can also write as follows:

$$\Delta i_t = \alpha\mu + \sum_{j=1}^{K} \beta_j \, \Delta i_{t-j} + \sum_{l=0}^{N} \gamma_l \, \Delta r_{t-l} - \mu i_{t-1} + \mu\delta r_{t-i} + \varepsilon_t \qquad (3)$$

In this equation, α, μ and δ are assumed to remain constant over time. A one-period change in a variable x is denoted by $\Delta x_t = x_t - x_{t-1}$. The dependent interest rate is denoted by i_t (this could be, for instance, the wholesale interbank money market interest rate, i_t^{IB}, or banks' retail lending interest rate, i_t^L, depending on the model specification, while r_t is the independent interest rate variable (this could equal i_t^{BOG}, the Bank of Ghana prime rate, or any other interest rate depending on the model specification). The short-run dynamics are estimated using current and past changes (denoted by Δ) of these variables, whereas the long-run convergence is measured by the lagged level term. The model therefore provides an independent estimate of the long-run interest rate elasticity, denoted by δ, as well as an estimate of the speed of convergence towards the long-run equilibrium, denoted by μ. The error term, ε_t, is normally distributed and has a zero mean and a constant variance.

A. Wholesale Market Interest Rates

We begin by examining the linkages between wholesale market interest rates and the Bank of Ghana policy interest rate (the prime rate). When the transmission from the policy interest rate to wholesale market interest rates is effective, these two rates are expected to converge within a relatively short period of time. For the purpose of this paper, we focus on two short-term wholesale market interest rates that are expected to be relevant benchmarks for the pricing of retail lending and deposit interest rates: the interbank money market interest rate and the 91-day treasury bill interest rate. Figure 2 illustrates the evolution of these interest rates and shows that the treasury bill and interbank market interest rates tend to move broadly in concert. At times these two interest rates experience significant and persistent deviations from the Bank of Ghana policy interest rate, which could indicate unannounced (stealth) changes in monetary policy and create ambiguity about the monetary authorities' policy stance among the public. For instance, during the period 2008-2009 the interbank and treasury bill interest rates were significantly higher than the Bank of Ghana policy interest rate for a long period of time, suggesting that the liquidity conditions in the wholesale markets were tighter than implied by the announced monetary policy stance.

Figure 2. Bank of Ghana and Wholesale Market Interest Rates
(2004M12 – 2011M7; annual percentages)

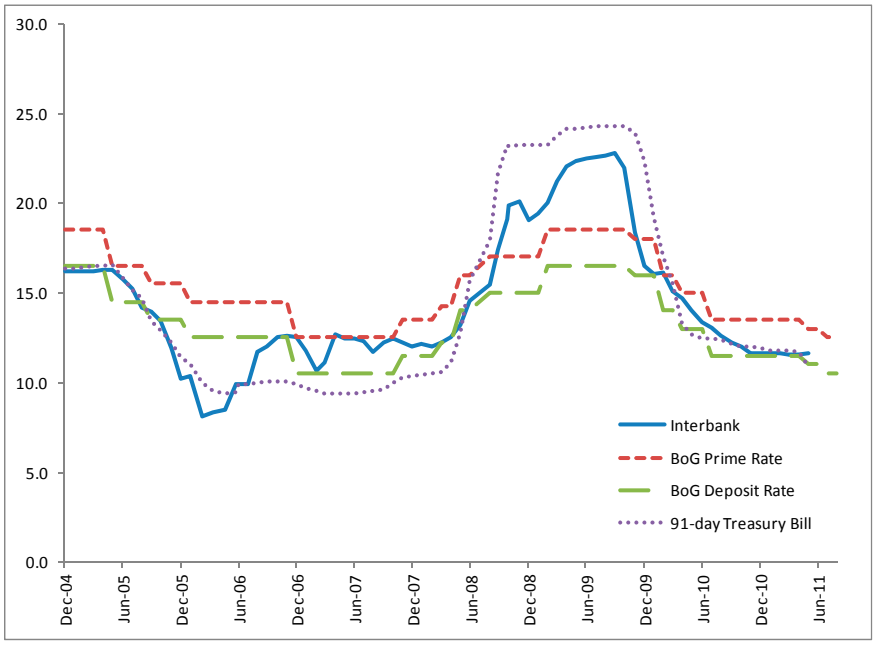


Table 3 reports the estimation results for the interbank interest rate and shows that the interbank interest rate does respond to changes in the Bank of Ghana policy rate with a one-month lag (all Models).[11] There is statistically significant inertia in the interbank rate adjustment as evidenced by the significant first lag of the dependent variable (all Models). In the long-run, however, the results suggest that the interbank and the prime interest rates move closely together. Using the model developed in equation 3, the estimation results confirm that the constant term (α) and the slope term (δ) are not statistically different from zero and one, respectively. But the adjustment speed towards the long-run parity is slow since the estimated coefficient (μ) is only -0.07 and statistically significant. These estimation results, therefore, raise questions whether the monetary authority is fully capable of controlling the short-term interbank market interest rate, which is its operating target, and the liquidity in the wholesale money market. One needs to be cautious, however, when interpreting these results since the data sample is quite short (comprising only 65 observation).[12] Be as it may, deviations in the interbank interest rate from the policy rate nonetheless suggest that the prime rate may not always have provided an accurate reference point for the interbank money market and during such periods, it could be argued, the prime rate may have become less relevant for pricing liquidity in the interbank market. This uncertainty could contribute to the high volatility of the interbank interest rate (Appendix Table 2).[13] In Model 6 we incorporate the same-period change in the 91-day treasury bill rate in the estimation, but the estimate is not statistically significant (lags of this variable were not significant).

[11] A one-period change in a variable, from period t-1 to period t, for instance for the interbank interest rate, is noted as D_IB_RATE is Table 2. The same naming convention is applied to other variable throughout the paper.

[12] Extending the sample period to cover earlier periods is not without its problems, including due to the changes in the monetary operating environment. For instance, Ghartey (2005) utilizes several policy interest rates in his study. In addition, substantial drop in statutory reserve requirements in 2006-07 and the instability associated with the global financial crisis could have contributed to the divergence of the interbank rate from the prime rate.

[13] Bank of Ghana's liquidity management operations and the shallowness of Ghana's money market could also add to the volatility of the interbank market interest rate.

Table 3. Determinants of Interbank Interest Rates, 2004M12—2010M4
(Dependent variable is monthly change in the interbank interest rate)

Variable/Model [1]	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
CONSTANT	0.02					
D_IB_RATE(-1)	0.34 ***	0.45 ***	0.44 ***	0.43 ***	0.41 ***	0.37 ***
D_BOG_RATE	0.06	0.13	0.13	0.16	0.09	0.07
D_BOG_RATE(-1)	0.57 ***	0.54 ***	0.54 ***	0.57 ***	0.54 ***	0.47 ***
D_BOG_RATE(-2)	0.26					
D_91D_TB						0.16
IB_RATE(-1)		-0.08 **				
BOG_RATE(-1)		0.07 **				
SPREAD # 1(-1)			-0.07 **			-0.07 **
SPREAD # 1(-1), when BOG_RATE falling				-0.10 **		
SPREAD # 1(-1), when BOG_RATE rising					-0.03	
R-squared	0.36	0.38	0.38	0.39	0.34	0.40
Adjusted R-squared	0.32	0.34	0.35	0.36	0.31	0.36
S.E. of regression	0.79	0.77	0.77	0.76	0.79	0.76
Sum squared resid	35.74	34.41	34.54	34.21	36.84	33.70
Log likelihood	-70.90	-70.34	-70.46	-70.16	-72.49	-69.68
F-statistic	8.05	...	...		...	...
Prob(F-statistic)	0.00	...	...		...	...
Mean dependent var	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
S.D. dependent var	0.96	0.95	0.95	0.95	0.95	0.95
Akaike info criterion	2.45	2.39	2.36	2.35	2.43	2.37
Schwarz criterion	2.62	2.56	2.50	2.49	2.56	2.54
Hannan-Quinn criter.	2.52	2.46	2.42	2.41	2.48	2.44
Durbin-Watson stat	2.04	2.23	2.22	2.15	2.17	2.15

Sources: Bank of Ghana and author's estimates.

[1] Statistical significance indicated below the estimated coefficient.
*** p < 0.01, ** p < 0.05, and * p < 0.10.
Optimal lags determined by Akaike criterion.

The estimation points to an asymmetry in the adjustment of the interbank interest rate to changes in the policy interest rate. Asymmetries in the adjustment appear to be rather common and have been reported for other countries and regions (for instance, Sander and Kleinmeier (2006) for the SACU region, and Karagiannis et al. (2010) and Kwapil and Scharler (2010) for the U.S. and the euro zone). A theoretical explanation for the asymmetry can be found from the menu-cost models. For instance, Hofman and Mizen (2004) analyze asymmetries in the banks' interest rate adjustment in the United Kingdom and argue that when banks possess a degree of monopoly power over the pricing of retail loans and deposits interest rates and changing these rates is costly (menu cost), it leads to a situation where banks do not always adjust their deposit and lending interest rates to the changes in the policy interest rate. The authors suggest that only when banks anticipate that there will be successive rate changes in the same direction in the future, will they have an incentive to adjust their retail interest rates. In the case of Ghana, during periods when the policy interest rate has been falling (Model 3), the convergence towards the long-term equilibrium appears

to be faster and statistically significant. On the other hand, during periods of rising policy interest rates, the convergence is not statistically significant (Model 4), indicating that the interbank interest rate is slow to adjust to the rising policy interest rate. This asymmetry seems to be consistent with the menu-cost models, but may also reflect the weak monetary policy credibility; that is, monetary policy tightening may be perceived as not fully credible by the banks.[14]

Regarding treasury bill interest rates, Ghartey (2005) concludes that monetary policy has a statistically significant contemporaneous impact on the term structure of treasury bill interest rates (91-day, 182-day, and 1-year interest rates) in Ghana. This is confirmed by our estimates, which show that there is a strong pass-through from the prime interest rate to the 91-day treasury bill interest rate in Ghana during a more recent period (Table 4; all Models). However, changes in the policy interest rate seems to influence the short-term treasury bill interest rate within a one-month lag whereas the same-period effect is not significant. Inertia in the treasury bill interest rate is stronger than in the interbank interest rate (all Models). The treasury bill rate converges to the policy rate and the interbank rate over time (Models 2-4 and 7). There is a significant asymmetry in the adjustment process, similar to the interbank interest rate. Furthermore, there is a highly significant contemporaneous effect from the interbank interest rate to the treasury bill interest rate (all Models).

[14] Policy credibility is difficult to measure in practice. We experimented with squared difference between the interbank and policy interest rates as a proxy for it, but it failed to receive a statistically significant parameter estimate.

Table 4. Determinants of Treasury Bill Interest Rates, 2004M12—2010M4
(Dependent variable is monthly change in the treasury bill interest rate)

Variable/Model [1]	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
C	-0.03						
D_TB_91_D(-1)	0.74 ***	0.75 ***	0.75 ***	0.67 ***	0.61 ***	0.70 ***	0.69 ***
D_IB_RATE	0.24 **	0.24 ***	0.24 ***	0.18 **	0.15 **	0.20 **	0.15 *
D_BOG_RATE				0.16	0.20	0.16	0.20
D_BOG_RATE(-1)				0.32 ***	0.36 ***	0.29 **	0.32 ***
TB_91_D(-1)		-0.09 **					
IB_RATE(-1)		0.09 **					
SPREAD # 2(-1)			-0.08 ***	-0.08 ***			
SPREAD # 3(-1)							-0.04 **
SPREAD # 2(-1), when BOG_RATE falling					-0.11 ***		
SPREAD # 2(-1), when BOG_RATE rising						-0.07	
R-squared	0.70	0.74	0.74	0.77	0.76	0.74	0.75
Adjusted R-squared	0.69	0.72	0.73	0.75	0.75	0.73	0.74
S.E. of regression	0.57	0.54	0.53	0.51	0.51	0.53	0.52
Sum squared resid	19.29	17.00	17.00	14.88	15.15	16.54	15.87
Log likelihood	-52.12	-48.13	-48.13	-43.93	-44.49	-47.26	-45.97
F-statistic	69.96	...	...	...	...	...	...
Prob(F-statistic)	0.00	...	...	...	...	...	...
Mean dependent var	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
S.D. dependent var	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Akaike info criterion	1.75	1.65	1.62	1.55	1.57	1.66	1.62
Schwarz criterion	1.85	1.79	1.73	1.72	1.74	1.83	1.79
Hannan-Quinn criterion	1.79	1.71	1.66	1.62	1.64	1.73	1.68
Durbin-Watson stat	1.86	1.93	1.93	2.01	1.91	2.01	2.05

Sources: Bank of Ghana and author's estimates.

[1] Statistical significance indicated below the estimated coefficient.
*** p < 0.01, ** p < 0.05, and * p < 0.10.
Optimal lags determined by Akaike criterion.

The interbank and 91-treasury bill interest rates move closely together. We therefore estimate a vector autoregressive model (VAR) that takes into account this simultaneity. This model incorporates lags of the two short-term market interest rates as well as current and lagged values of the prime interest rate. The results are reported in Table 5 and confirm the results of the previous analyses. Changes in the prime rate influence both wholesale market interest rates with a month lag (one-half of the pass-through occurs in this period), although the results also point to a significant contemporaneous effect from the prime rate to the 91-day treasury bill interest rate. The estimation results show significant convergence, which is somewhat faster for the interbank interest rate (the difference is statistically significant). The pass-through is complete in the long run, but takes some time. The low adjusted R-squared in the interbank interest rate equation (Tables 3 and 5) point to substantial variation in the data, which is not explained by the policy interest rate.

Table 5. VAR of Interbank and Treasury Bill Interest Rates, 2004M12—2010M4
(Dependent variables are monthly changes in these interest rates)

Variable/Model [1]	Model	
	D_TB_91_D	D_IB_RATE
C	-0.01	-0.09
D_TB_91_D(-1)	0.55 ***	-0.11
D_TB_91_D(-2)	-0.03	0.22
D_IB_RATE(-1)	0.13	0.37 ***
D_IB_RATE(-2)	0.15	0.07
D_BOG_RATE	0.20 *	0.10
D_BOG_RATE(-1)	0.44 ***	0.46 ***
D_BOG_RATE(-2)	0.20	0.23
SPREAD # 1(-1)	-0.03	-0.11 ***
SPREAD # 2(-1)	-0.06 *	0.05
R-squared	0.78	0.45
Adj. R-squared	0.74	0.36
Sum sq. resids	14.11	30.70
S.E. equation	0.52	0.77
F-statistic	20.55	4.75
Log likelihood	-42.08	-66.18
Akaike AIC	1.68	2.46
Schwarz SC	2.02	2.80
Mean dependent	-0.05	-0.02
S.D. dependent	1.03	0.96

Sources: Bank of Ghana and author's estimates.
[1] Statistical significance indicated below the estimated coefficient.
*** p < 0.01, ** p < 0.05, and * p < 0.10.
Optimal lags determined by Akaike criterion.

B. Retail Deposit and Lending Interest Rates

We turn our attention to banks' retail deposit and lending interest rates in Ghana. We use quarterly bank-specific interest rate data to analyze how changes in the short-term wholesale market interest rates are passed through to retail deposit and lending interest rates.[15] In order for monetary policy to have an impact on real activity, retail market deposit and lending interest rates need to respond to changes in the policy interest rate. This effect takes place via the short-term wholesale market where interest rate responds to changes in the policy rate. For instance, a monetary easing would reduce wholesale interbank and treasury bill interest rates and prompt banks to reduce their retail lending and deposit interest rates.

[15] We focus on savings and term deposit interest rates only because demand deposit interest rates have changed infrequently during the estimation period and therefore may not be informative.

Retail deposit interest rates

Tables 6 and 7 report the results for the bank-specific retail time and savings deposit interest rates. The results provide strong evidence of the linkages between various interest rates at the retail level. The treasury bill interest rate is significant in the estimation of both time and savings deposit rates (all Models), while the interbank rate is only significant in the estimation of the time deposit interest rate (Models 2 and 3 in Table 6). The data also suggest that changes in banks' other retail deposit interest rates, particularly the demand deposit interest rate, affect time and savings deposit interest rates (Models 3-7 in Table 6 and Models 3-7 in Table 7). This suggests that banks would set interest rates for the entire terms structure of deposits at the same time.

Concerning long-term adjustment in time deposit interest rates, there is evidence of a strong convergence between time deposit and two wholesale market interest rates (Models 5-7 in Table 6). This effect is more pronounced when fixed effects are included in the estimation, indicating that there are differences between commercial banks in the adjustment (Model 6-7 in Table 6). In Model 7, for instance, the speed of adjustment to close the gap between time deposit and interbank interest rates is -0.28, which is highly significant and complete in the long-run. The convergence between time deposit and other deposit interest rates is not statistically significant (Model 7 in Table 6). For savings deposit interest rates, the long-term convergence is less strong (Models 4-7 in Table 7). There is significant convergence to the treasury bill interest rate and the time deposit interest rate (Models 6-7 in Table 7), but the adjustment is incomplete (that is, δ is less than one in equation 3). Bank-specific effect are important for the determination of savings interest rates (Models 6-7 in Table 7).

Table 6. Determinants of Retail Time Deposit Interest Rates, 2005Q1—2010Q1
(Dependent variable is the change in bank-specific time deposit interest rate)

Variable/Model [1]	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
C	0.21 *	0.18	0.21 *	-0.61 *	-0.20	-1.55 ***	-1.61 ***
D_TB_91_D	0.35 ***	0.31 ***	0.25 ***	0.31 ***	0.28 ***	0.20 ***	0.20 ***
D_IB_RATE		-0.11	-0.11	-0.09	-0.11	0.04	0.04
D_IB_RATE(-1)		0.26 ***	0.25 ***	0.11	0.06	-0.01	-0.01
D_DD_INT			1.08 **	0.95 **	1.00 **	0.95 **	0.97 **
D_SD_INT			0.47 ***	0.38 ***	0.36 **	0.37 **	0.43 **
TD_INT(-1)				-0.11 ***	-0.28 ***	-0.26 ***	-0.27 ***
TB_91_D(-1)				0.12 ***	0.20 ***		
IB_RATE(-1)						0.28 ***	0.28 ***
DD_INT(-1)							0.05
SD_INT(-1)							0.09
Fixed effects	NO	NO	NO	NO	YES	YES	YES
R-squared	0.15	0.18	0.23	0.29	0.36	0.35	0.35
Adjusted R-squared	0.15	0.17	0.22	0.27	0.31	0.30	0.29
S.E. of regression	2.18	2.17	2.12	2.04	1.99	2.01	2.01
Sum squared resid	1727.30	1664.67	1568.35	1442.26	1301.01	1324.07	1318.53
Log likelihood	-799.90	-779.70	-767.43	-752.55	-734.26	-737.37	-736.63
F-statistic	63.50	25.73	20.47	20.14	7.05	6.71	6.27
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean dependent var	0.26	0.27	0.27	0.27	0.27	0.27	0.27
S.D. dependent var	2.36	2.39	2.39	2.39	2.39	2.39	2.39
Akaike info criterion	4.41	4.40	4.36	4.28	4.29	4.31	4.31
Schwarz criterion	4.43	4.45	4.42	4.37	4.58	4.60	4.63
Hannan-Quinn criterion	4.41	4.42	4.38	4.32	4.41	4.42	4.44
Durbin-Watson stat	1.91	1.95	1.99	1.93	1.84	1.85	1.83

Sources: Bank of Ghana and author's estimates.

[1] Statistical significance indicated below the estimated coefficient.

*** p < 0.01, ** p < 0.05, and * p < 0.10.

Optimal lags determined by Akaike criterion.

Table 7. Determinants of Retail Savings Deposit Interest Rates, 2005Q1—2010Q1
(Dependent variable is the change in bank-specific savings deposit interest rate)

Variable/Model [1]	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
C	0.02					0.02	-0.01
D_SD_INT(-1)	0.15 ***	0.15 ***	0.13 **	0.13 **	0.14 ***	0.11 **	0.12 **
D_SD_INT(-2)	-0.17 ***	-0.17 ***	-0.14 ***	-0.14 ***	-0.14 ***	-0.15 ***	-0.14 ***
D_SD_INT(-3)	0.11 **	0.11 **	0.07	0.07	0.07	0.04	0.04
D_TB_91_D	0.08 ***	0.09 ***	0.05 ***	0.06 ***	0.05 **	0.06 ***	0.06 ***
D_IB_RATE		-0.02		-0.01	0.00	0.00	0.00
D_DD_INT			0.70 ***	0.70 ***	0.70 ***	0.70 ***	0.68 ***
D_TD_INT			0.04 **	0.03 **	0.03 **	0.03	0.04 ***
SD_INT(-1)				-0.02	-0.02	-0.10 ***	-0.11 ***
TB_91_D(-1)				0.00		0.02 **	
IB_RATE(-1)					0.00		
TD_INT(-1)							0.03 ***
Fixed effects	NO	NO	NO	NO	NO	YES	YES
R-squared	0.14	0.14	0.23	0.23	0.23	0.30	0.31
Adjusted R-squared	0.13	0.13	0.22	0.21	0.21	0.23	0.24
S.E. of regression	0.65	0.65	0.62	0.62	0.62	0.62	0.61
Sum squared resid	128.54	128.50	115.59	114.92	115.08	104.90	103.65
Log likelihood	-301.01	-300.96	-284.81	-283.92	-284.14	-270.01	-268.18
F-statistic	12.62	...	...	...	...	4.25	4.42
Prob(F-statistic)	0.00	...	...	...	...	0.00	0.00
Mean dependent var	0.06	0.06	0.06	0.06	0.06	0.06	0.06
S.D. dependent var	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Akaike info criterion	2.01	2.01	1.91	1.92	1.92	1.96	1.95
Schwarz criterion	2.07	2.07	1.98	2.03	2.03	2.31	2.30
Hannan-Quinn criterion	2.03	2.03	1.94	1.96	1.97	2.10	2.09
Durbin-Watson stat	1.82	1.83	1.86	1.85	1.86	1.84	1.85

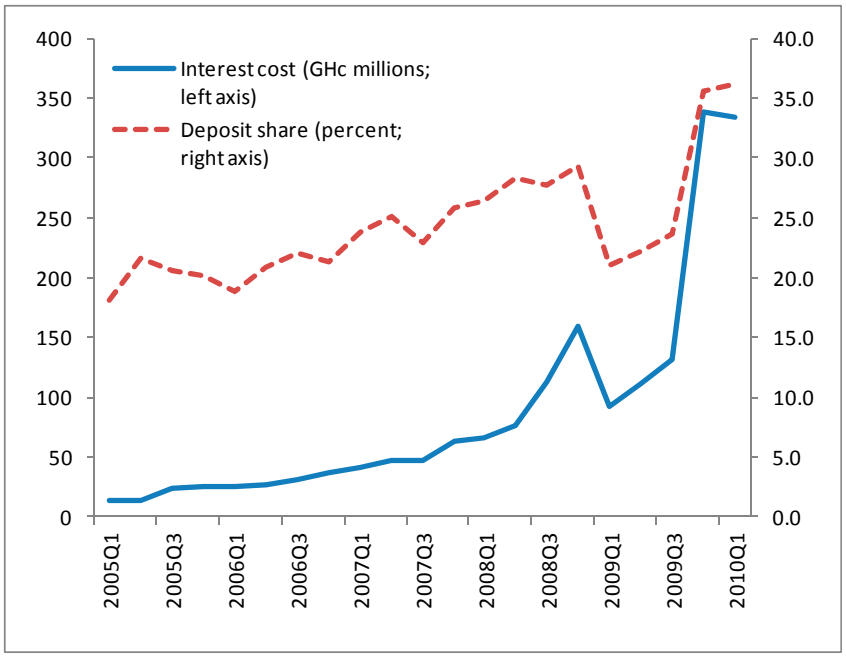
Sources: Bank of Ghana and author's estimates.

[1] Statistical significance indicated below the estimated coefficient.
*** p < 0.01, ** p < 0.05, and * p < 0.10.
Optimal lags determined by Akaike criterion.

Retail lending interest rates

Regarding banks' retail lending interest rates, the estimation results confirm the importance of wholesale market interest rates in determining banks' lending rates (Table 8). The short-run effect from the interbank interest rate is quite imminent (all Models). On the other hand, the short-run pass-through from the 91-day treasury bill interest rate is only significant when the long-run effects are excluded (Models 2-4). Time deposit interest rate has a significant short-run effect on retail lending interest rates (Model 3-7 in Table 8), which confirms the cost channel from deposits to lending interest rates. One reason for this is that increasing cost of time deposits during the estimation period coincided with the rapid rise in the of time deposits, particularly since the second half of 2009 (Figure 3).

Figure 3. Cost of Time Deposits, 2005Q1-2010Q1



The long-term (level) effects are significant (Models 5-7 in Table 8). First, none of the lagged changes in the interbank interest rate are statistically significant when the long-run effects are accounted for. Furthermore, the pass-through from the 91-day treasury bill interest rate is no longer statistically significant. Second, retail lending interest rates converge to a weighted average of the interbank and time deposit interest rates (Model 7 in Table 8), while the estimated speed of adjustment is -0.30 and highly significant. This provides evidence that retail lending rates do not adjust fully to changes in the interbank interest rate in the long-run. The significance of bank-specific fixed effects suggests that the adjustment differs between banks.

Table 8. Determinants of Retail Lending Rates, 2005Q1—2010Q1
(Dependent variable is the change in bank-specific retail lending interest rate)

Variable/Model [1]	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
C	-0.14			-0.13	3.06 ***	4.81 ***	4.30 ***
D_LEND_INT(-1)	-0.01	-0.03	-0.01	-0.03	0.09	0.08	0.10
D_IB_RATE	0.34 ***	0.27 ***	0.26 ***	0.29 ***	0.28 ***	0.15 *	0.26 ***
D_IB_RATE(-1)	0.18 ***	0.08	0.03	0.05	-0.12	-0.01	-0.09
D_IB_RATE(-2)	0.19 ***	0.13 **	0.10 *	0.13 **	-0.07	-0.02	-0.05
D_IB_RATE(-3)	0.09	0.08 **	0.05	0.07	-0.09	-0.03	-0.07
D_IB_RATE(-4)	0.03	0.05	0.02	0.02	-0.09	-0.02	-0.08
D_IB_RATE(-5)	0.31 ***	0.24 ***	0.21 ***	0.24 ***	0.09	0.10	0.08
D_TB_91_D		-0.01	-0.06	-0.08	-0.06	0.00	-0.05
D_TB_91_D(-1)		0.14 **	0.13 **	0.14 **	0.06	-0.01	0.05
D_DD_INT			0.39	0.32	0.33	0.36	0.38
D_SD_INT			0.10	0.09	0.06	0.05	0.09
D_TD_INT			0.19 ***	0.19 ***	0.16 ***	0.16 ***	0.19 ***
LEND_INT(-1)					-0.25 ***	-0.25 ***	-0.30 ***
IB_RATE(-1)					0.29 ***		0.23 ***
TB_91_D(-1)						0.16 ***	
DD_INT(-1)							0.05
SD_INT(-1)							0.11
TD_INT(-1)							0.07 **
Fixed effects	NO	NO	NO	YES	YES	YES	YES
R-squared	0.28	0.29	0.38	0.39	0.45	0.46	0.47
Adjusted R-squared	0.26	0.27	0.35	0.32	0.38	0.39	0.40
S.E. of regression	1.38	1.37	1.29	1.32	1.26	1.25	1.24
Sum squared resid	540.75	533.86	468.52	457.80	410.39	408.58	395.52
Log likelihood	-506.75	-504.86	-485.67	-482.27	-466.20	-465.55	-460.77
F-statistic	15.81	...	...	5.39	6.52	6.58	6.40
Prob(F-statistic)	0.00	...	...	0.00	0.00	0.00	0.00
Mean dependent var	0.40	0.40	0.40	0.40	0.40	0.40	0.40
S.D. dependent var	1.60	1.60	1.60	1.60	1.60	1.60	1.60
Akaike info criterion	3.50	3.50	3.39	3.50	3.40	3.40	3.39
Schwarz criterion	3.60	3.61	3.54	3.90	3.83	3.82	3.85
Hannan-Quinn criterion	3.54	3.54	3.45	3.66	3.57	3.57	3.57
Durbin-Watson stat	2.16	2.12	2.05	2.07	2.05	2.04	2.03

Sources: Bank of Ghana and author's estimates.

[1] Statistical significance indicated below the estimated coefficient.

*** p < 0.01, ** p < 0.05, and * p < 0.10.

Optimal lags determined by Akaike criterion.

Simulation exercises

What do these results mean in practice for the pass-through? In order to shed light into this question, we perform a few simulations where we utilize the estimation results from the previous sections. We begin with the wholesale market interest rates. Using the results

from the VAR model (Table 5), we are able to generate the following chart (Figure 4).[16] It simulates the dynamic impact of a 500 basis points reduction in the prime interest rate, which corresponds to the Bank of Ghana's monetary easing during October 2009-July 2010, on the interbank and 91-day treasury bill interest rates.[17] As shown in Figure 4, a reduction in the monetary policy interest rate prompts an adjustment of a comparable size in the wholesale market interest rates within a period of two months. However, the market interest rates continue their decent in the subsequent months and therefore "overshoot" the policy rate. These rates converging back towards the policy rate within a 24-month period. Assuming symmetry in the adjustment, the overshooting would also occur in response to a policy rate increase. The overshooting illustrates how the wholesale market rate deviates from the prime rate (Figure 2). The treasury bill interest rate is more volatile than the interbank interest rate, which is consistent with actual data (see Appendix Table 2). We conclude that while the wholesale market interest rates respond to changes in the prime rate, these responses are not immediate but instead gradual and full convergence is achieved only over a longer period of time. Substantial and prolonged deviations in the two market interest rates from the policy interest rate in the simulations are consistent with the actual data and raise questions about the Bank of Ghana's effectiveness in targeting a short-term money market interest rate. This issue is important for monetary policy implementation.

Another important policy question is how responsive are retail deposit and lending interest rates to changes in the monetary policy stance? The Ghanaian authorities are concerned about the apparent lack of responsiveness in the lending interest rate at the retail level. Using the estimation results for the retail time deposit[18] (Model 7 in Table 6) and retail lending interest rates (Model 7 in Table 8), and taking into account the simulation results for the wholesale market interest rates, we are able to analyze how responsive retail time deposit and retail lending interest rates would be to changes in the prime interest rate. These results are shown in Figure 5.[19]

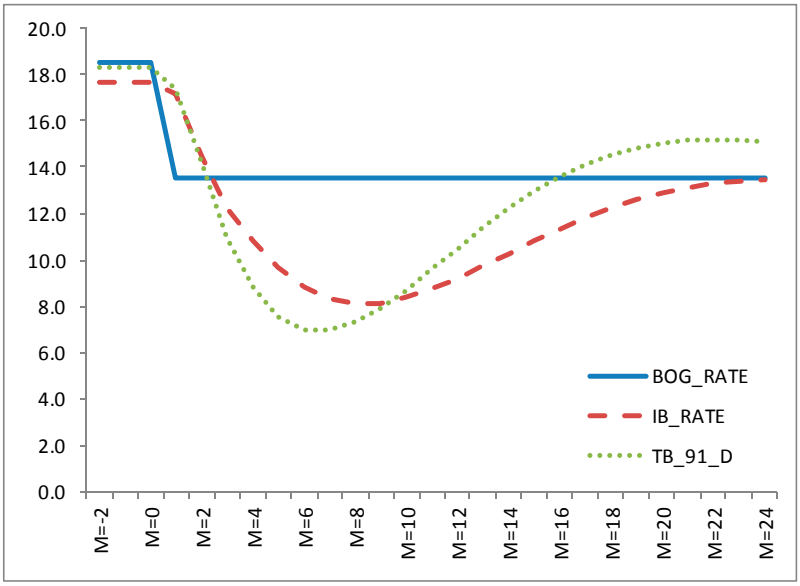
[16] The results would not be materially different if we used the estimation results reported in Tables 2 and 3.

[17] The starting values of the interbank and treasury bill interest rates are based on the long-term estimates from Table 4, which correspond closely to the actual data (see Appendix Table 2).

[18] For simplicity, we assume that banks' demand and savings deposit interest rates remain unchanged.

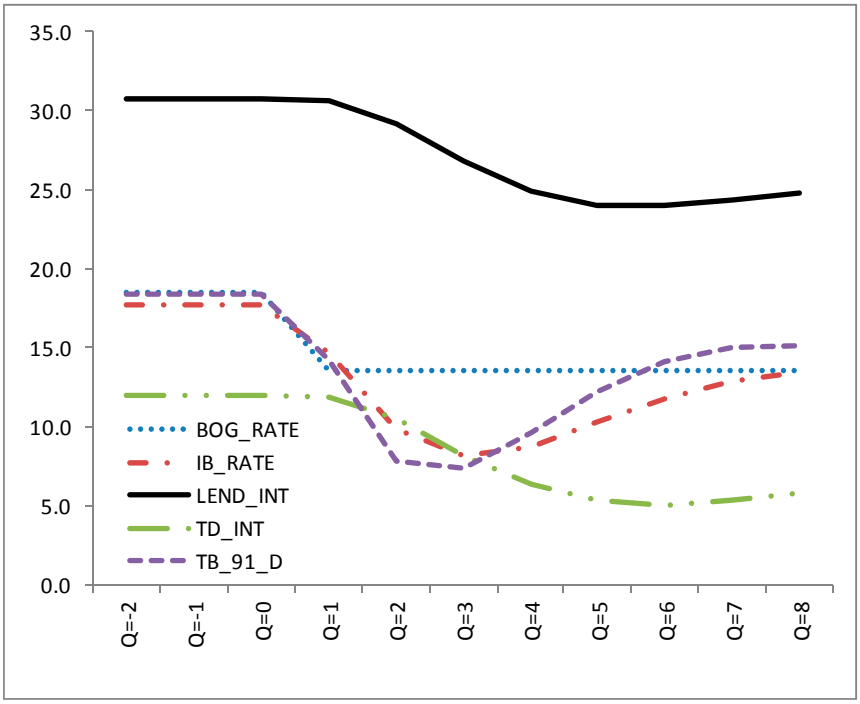
[19] The starting values of the time deposit and lending interest rates are based on the long-term estimates reported in Tables 5 and 7, which correspond to the actual data (see Appendix Table 3).

Figure 4. Responsiveness of Wholesale Market Interest Rates
(Simulation results; 24 months ahead)



The fall in the policy interest rate will lead to a lower cost of funding in the wholesale market, as we saw in the previous simulation, which then prompts banks to reduce their interest on retail deposits. With lower funding cost, the banks would also lower their lending rates. In the simulation, retail interest rates respond with a considerable lag (both deposit and lending interest rates reach their lowest points only after 5-6 quarters following the initial monetary policy easing). The retail time deposit interest rate falls from 12 percent before the policy change to 7 percent, which is similar in magnitude to what happened during 2009-2010 (Table 2). The retail lending interest rate declines from 31 percent before the policy change to 26 percent, again very similar to what actually happened during the recent period of policy easing. The spread between retail lending and time deposit interest rates remain relatively constant during the adjustment period. We may conclude that retail deposit and lending interest rates appear to adjust to changes in the policy interest rate, although the process is slow.

Figure 5. Responsiveness of Retail Market Interest Rates
(Simulation results; 8 quarters ahead)



V. CONCLUSIONS

We have analyzed the interest rate pass-through in Ghana, using a variety of data sources. There is a relatively strong short-term response from changes in the prime rate to the wholesale market interest rates (interbank and treasury bill). About one-half of the change in the policy interest rate is reflected in the wholesale market interest rates with a month lag. The estimated short-term response from changes in the policy rate to the 91-day treasury bill rate is comparable to the results reported in Ghartey (2005). The long-term responses in the wholesale interbank market interest rate are protracted, weakening the effectiveness of Bank of Ghana's monetary policy implementation. Significant deviations from the policy rate suggest that the prime rate may not always provide an accurate indication of the monetary authorities' policy stance. This has implications for monetary policy effectiveness and central bank's ability to communicate its policies to the public.

Regarding retail interest rate adjustment, we utilize a unique bank-specific data set to gain insight into banks' behavior in the deposit and loan markets. The estimation results show that banks' retail interest rates adjust to changes in the wholesale market interest rates, but the speed is rather slow and the adjustment is incomplete in the long run. Simulations suggest that deposit and lending rates would reflect changes in the underlying market and policy interest rates but only after a considerable period of time. A reason why retail lending interest rates in Ghana have stayed above their levels in 2008, after a considerable monetary

easing, may have to do with other factors that are at work in the adjustment process. These could include uncertainty about the future course of macroeconomic policies while the current high levels of problem loans are well above their earlier levels, which would impose a cost to banks.

Lack of competition in the financial markets also influences intermediation costs and interest rate spreads.[20] Cross-country studies, including some sub-Saharan African countries, show that banking systems are not always competitive and efficient. Chen (2009) provides evidence of inefficiency in sub-Saharan African middle-income countries. Similar trends have also been reported for Ghana (Buchs and Mathisen (2005) who examine the degree of competitiveness and efficiency in the Ghanaian banking system and conclude that Ghanaian banking system may be characterized by monopolistic competition, similar to other banking systems in the region (such as Kenya, Nigeria, and Uganda). High financing needs of the government often lead to a heavy reliance on government bonds as a steady source of profits for the banks, thus undermining competition between banks over private customers.

There are a number of avenues for further research. The pass-through process in the wholesale and retail markets could be examined more carefully, to better understand short- and long-run adjustment processes, and how market development would contribute to a faster and more complete pass-through.

[20] High level of non-performing loans, high overhead costs and inadequate profiling of borrowing are likely to contribute to the ineffective transmission process in Ghana.

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Appendix Table 1: Variable Definitions

Variable name	Description
IB_RATE	Interbank interest rate, annual percent
BOG_RATE	Prime rate (Bank of Ghana's policy rate), annual percent
TB_91_D	Treasury bill interest rate (91 days maturity), annual percent
DD_RATE	Retail demand deposit interest rate, annual percent
SD_INT	Retail savings deposit interest rate, annual percent
TD_INT	Retail time deposit interest rate, annual percent
LEND_INT	Retail lending interest rate, annual percent
SPREAD # 1	IB_RATE - BOG_RATE
SPREAD # 2	TB_91_D_RATE - IB_RATE
SPREAD # 3	TB_91_D_RATE - BOG_RATE

Appendix Table 2. Key Statistics (Monthly Data), 2004M12–2010M4

	BOG_RATE	IB_RATE	TB_91_D
Mean	15.67	14.84	15.15
Median	15.50	13.95	13.26
Std. Dev.	2.14	4.02	5.68
Skewness	-0.06	0.52	0.54
Kurtosis	1.69	2.30	1.71
Jarque-Bera	4.66	4.32	7.72
Probability	0.10	0.12	0.02
Sum	1,019	965	985
Sum Sq. Dev.	293	1,033	2,067
Observations	65	65	65

Sources: Bank of Ghana and author's estimates.

Appendix Table 3. Key Statistics (Quarterly Data), 2005Q1–2010Q1

	BOG_RATE	IB_RATE	TB_91_D	DD_INT	SD_INT	TD_INT	LEND_INT
Mean	15.51	14.83	15.19	0.61	2.52	9.58	29.05
Median	15.42	13.01	12.68	0.25	2.00	9.30	28.66
Std. Dev.	2.09	4.08	5.88	0.82	2.40	5.33	3.83
Skewness	0.01	0.56	0.51	2.20	1.39	0.57	0.40
Kurtosis	1.64	2.08	1.54	9.86	5.75	3.33	2.57
Jarque-Bera	29.79	33.53	50.63	1,063.09	245.08	22.29	13.26
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	5,957	5,697	5,834	233	968	3,678	11,154
Sum Sq. Dev.	1,672	6,383	13,264	258	2,209	10,866	5,619
Observations	384	384	384	384	384	384	384

Sources: Bank of Ghana and author's estimates.