Bank Liquidity Preference and the Investment Demand Constraint

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Abstract

Aggregate bank liquidity preference is postulated to engender an investment demand constraint. This idea is integrated into a stochastic dynamic structural macroeconomic model in order to analyze output and inflation fluctuations. The model has two regimes that allows for examining output and inflation adjustments over time given a change in commercial bank mark-up lending rate, monetary easing and stochastic output shocks. The two financial regimes are: (i) an investment demand constraint regime; and (ii) a bank liquidity trap regime. The adjustment of output and inflation given a change in mark-up lending rate and monetary easing depends on the financial regime in which the economy finds itself. Adjustments owing to stochastic output shock do not depend on the financial regime. The nature of the regime is determined by the level of the mark-up lending rate and its strength of adjustment over time relative to the competitive loanable funds rate.

Key Words: financial frictions, liquidity trap, real-financial nexus

1. Introduction

Recently there have been several studies and commentaries focusing on the possible existence of a liquidity trap in the advanced economies, notably the United States and Japan (Murota and Ono, 2012; Eggertsson and Krugman, 2011). A feature of the liquidity trap is the existence of a very liquid banking sector (Murota and Ono, 2012; Eggertsson and Ostry, 2005). One commentary sees the build-up of liquidity as a passive phenomenon resulting from quantitative easing, while other studies tend to emphasize asymmetric information problems and very low short-term interest rates as contributing factors[1]. However, long before the build-up of excess liquidity in the advanced capitalist economies, many developing economies have been inundated with persistent excess bank liquidity (Khemraj, 2010; Saxegaard, 2006). Central banks and commentators in the developing world often see the management of bank reserves (part of

[1] Keister and McAndrews (2009) argue that the unprecedented level of liquidity in the US merely reflects quantitative easing. In the case of Japan, the phenomenon reflects low short-term interest rates and weak banks (Ogawa, 2007).

which is excess liquidity) as a crucial aspect of the stabilization agenda of monetary policy[2]. For the purposes of the paper, we will define liquidity widely to include primary and secondary bank reserves. This would include required plus excess reserves and liquid assets such as government securities held by commercial banks.

In spite of the heightened discussion and empirical studies on excess bank liquidity, not many studies have examined the broader theoretical implication of bank liquidity preference for fluctuations in aggregate output and prices[3]. Some questions that come to mind would be: how is bank liquidity related to loanable funds? Is it the result of a regime of financial repression promoted by monetary easing similar to quantitative easing in the advanced economies? And what does it imply for the nexus between financial intermediation and the real sector? These questions are obviously important given that banks are the dominant source of external finance in developing and emerging economies (de la Torre et al, 2007). Bank dominance can be expected to continue indefinitely (Stiglitz, 1989).

This work addresses some of these questions by proposing the hypothesis that liquidity preference impacts on the demand for investment in developing economies. Rodrik and Subramanian (2009) also argued that investment demand is the dominant constraint in these economies. Their thesis however holds that investment demand is constrained when capital inflows create an appreciation of the real exchange rate. The authors argue that the appreciation of the real exchange rate causes the weakening of investment demand in the tradable goods sector, hence reducing economic growth. They further noted that "in economies constrained by investment demand, real interest rates will be low, banks will be sitting on mountains of liquidity, and it will be lenders who are running after borrowers[4]."

This paper develops a model in which bank liquidity preference produces a threshold or minimum mark-up lending rate that occurs at a percentage significantly above zero. Moreover,

[2] A look at the website of numerous central banks indicates this fact. Also several news items often report that central banks are "mopping up excess liquidity" to influence inflation. This "mopping up" is all part of reserve management. Central banks may achieve these targets by changing the required reserve ratio as done by both Peoples Bank of China and Reserve Bank of India.

[3] Khemraj (2010) proposed the hypothesis that a flat bank liquidity preference curve reflects a mark-up lending rate.

[4] See Rodrik and Subramanian (2009, pp. 16-17).

the model takes into consideration the established stylized fact of persistently liquid banks – as noted by Rodrik and Subramanian – in the narrative of the constraint on investment demand. This work however looks at a different transmission channel through which the constraint occurs. The key difference herein is a low lending rate does not necessarily result from the surfeit of bank liquidity if banks possess a liquidity preference curve that has an asymptote at a lending rate significantly above zero. Therefore, this work emphasizes a non-zero lower bound lending rate. Most of the literature focusing on the liquidity trap tends to highlight the zero bound benchmark policy rate. At the asymptote – at which point the aggregate bank liquidity preference curve is flat – relatively high interest loans and non-remunerated excess liquidity are perfect substitutes[5]. Even if the curve does not become flat, its elasticity would tend to increase as the level of liquidity rises in the banking system. Section 5 of the paper provides the liquidity preference curve for several developing and emerging economies.

The paper develops a reserve-loan (RL) curve linking loanable funds and liquidity preference. The RL curve is then embedded with an augmented IS equation with a stochastic term and a Phillips curve. The equations are solved recursively for the time paths of output and inflation – hence the structural, stochastic and dynamic nature of the macroeconomic model. As noted above, management of commercial bank reserves is an important aspect of monetary policy in developing countries, yet this is not taken into consideration in the monetary models applied to these economies. In addition to the regime of an investment demand constraint, the paper also examines the hypothetical case of a loan supply constraint that is precipitated by a shock to bank liquidity preference. Such a shock is more likely to be the result of a financial crisis; moreover, it might be more relevant to an advanced economy where banks hold a large portfolio of financial assets in off balance sheet accounts. On the other hand, the investment demand constraint occurs after years of policies intended to reform the financial sector. These reforms involve the de-repression of interest rates, the pursuit of indirect or market-based monetary policy, the privatization of commercial banks, and other measures. The investment

[5] In most economies excess reserves held at the central bank do not pay interest. However, other components of excess liquidity, such as domestic Treasury bills, may pay a rate of interest that is significantly less than the interest that could be earned if loans are made. As part of the regime of unconventional monetary policy, the Federal Reserve started to pay a very low rate of interest on excess reserves in the third quarter of 2008.

demand constraint occurs when banks have the capacity to set the lending rate to reflect the marginal cost of lending, risks and a mark-up over some benchmark interest rate.

That the minimum mark-up lending rate (the threshold) may be established above the market equilibrium – which would prevail in the case of a competitive loanable funds market – by two or three dominant oligopolistic banks is a reflection that economy may not be large enough to enable the banks to reap all economies of scale in lending. Banks must incur fixed cost of operations (buildings and infrastructure) and then incur marginal costs (analysts, workers and security expenses). These are likely to be high if the level of economic activity does not allow them to spread the fixed and marginal costs over a large market. If these costs are high, then we can expect that the threshold or minimum mark-up lending rate will also be high. Therefore, in a regime of interest rate de-repression, private banks are merely seeking the maximum return given the scope for good business opportunities.

The remainder of the paper is organized as follows. Section 2 uses a diagram to illustrate the core idea of the investment demand constraint. Section 3 looks at the theoretical possibility of a loan supply constraint precipitated by a banking crisis. Section 4 presents the discussion in a dynamic framework in order to observe the implication of bank liquidity preference for output and inflation dynamics. Section 5 presents stylized facts of aggregate bank liquidity preference in various economies. Section 6 concludes.

2. The Investment Demand Constraint

Figure 1 presents the basic idea of the connection between aggregate bank liquidity preference and loanable funds. Several simple general equations will illustrate the idea clearer. Equation 1 is the investor's demand for loanable funds. The lending rate is indicated by r_L ; N_I is the investor's net worth; and Ω indicates other factors that can shift the demand for loans. Of course, investors are not the only borrowers in developing economies. Households also borrow. For the purposes of this work we will only concentrate on investor demand for loans. The two partial derivatives are assumed to hold $\partial L_D / \partial r_L < 0$ and $\partial L_D / \partial N_I > 0$.

$$L_D(r_L, N_I, \Omega) \tag{1}$$

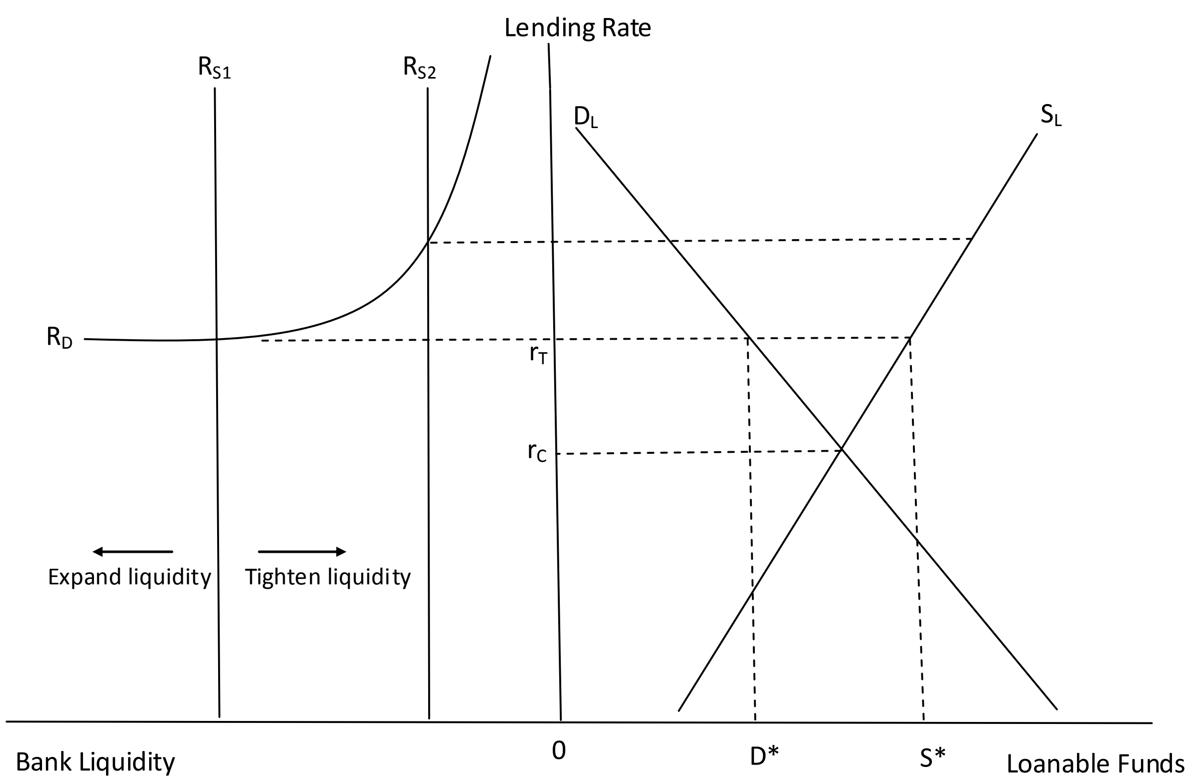
Commercial banks' supply of loanable funds is given by Equation 2. ρ indicates the probability that borrowers will default. The following relations are assumed to hold $\partial L_S / \partial r_L > 0$ and $\partial L_S / \partial \rho < 0$.

$$L_S(r_L, \rho) \tag{2}$$

Equation 3 shows the banks' inverse demand for liquidity or the liquidity preference curve with the lending rate as the subject of the formula. It is written as a reciprocal function that is an approximation of the stylized facts. The asymptote (r_T) is the threshold or minimum mark-up loan interest rate. R^* is the equilibrium level of reserves resulting from the intersection of reserve supply (R_S) and reserve demand (R_D) in Figure 1. At the threshold the market lending rate has fallen to the point where it just covers the marginal cost of lending; thus the perfect substitution between liquidity and loans.

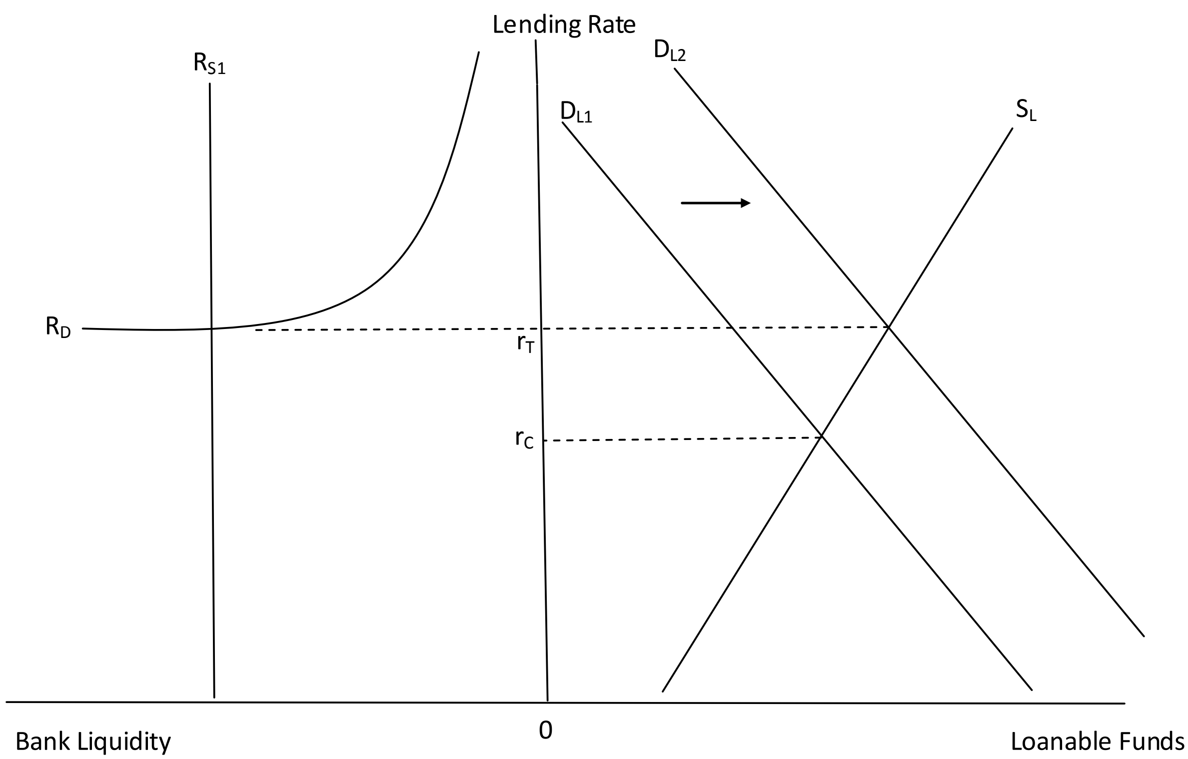
$$r_L = r_T + \beta R^{*-1} \tag{3}$$

Figure 1. Bank liquidity preference and loanable funds



The flat segment occurs above the competitive lending rate r_C. The competitive rate is determined when the demand for and supply of loanable funds are equal, indicating that no market participant has influence over the determination of the rate. The mark-up rate occurs at r_T at which point the realized investment demand ($D*$) is less than the desired supply of loanable funds ($S*$). Hence, the investment demand is constrained by the high threshold lending rate. Figure 1 suggests that if liquidity conditions are made tight, indicated by an inward shift in the supply of reserves from R_{S1} to R_{S2}, the lending rate would increase and move away from the threshold. Here the demand for investment is further reduced. On the other hand, if liquidity conditions are eased – signaled by a rightward shift in the supply of bank liquidity – the threshold would be binding and interest rate would not fall further.

Figure 2. Easing the investment demand constraint



Closing the disequilibrium would require measures that will shift outward the demand for loans (Figure 2). This involves shifting outwards the demand for loans along the threshold until the market for loanable funds is cleared. This equilibrium still occurs above the competitive interest rate. These economies are naturally high lending rate economies as the level of income may not allow for the banks to reap enough economies of scale. One way of increasing the demand for domestic loans would be to have foreign capital enter and allow new entrepreneurs to borrow from the domestic banking system. Foreign capital takes different forms. Some are short-term and volatile. These can be susceptible to sudden stops and outflows. Others can be much more stable and cannot exit overnight. This would take the form of long-term inflows like foreign direct investments. Many small open economies are typically foreign currency constrained and their economic management is fundamentally about managing the inflows and outflows of foreign exchange (Worrell, 2012)[6].

3. Loan Supply Constraint

The previous discussion shows the case where the lending rate threshold occurs above equilibrium. What would be the effect if the threshold occurs at the equilibrium loanable funds rate and the economy is shocked by a banking crisis? This section explores this possibility using our diagrammatic approach. Let us look at the case where the banks operate in a parallel financial structure where there are actively traded securities such as off balance sheet special investment vehicles (SIVs)[7]. We will now assume there is a crash in the asset values of the financial papers the banks hold (on their regular balance sheet or off balance sheet). While the value of assets fall, liabilities are unchanged, hence the net worth of banks has declined. Within the context of the model, we now need to include the net worth of banks into the liquidity preference equation. To understand how a shock to net worth affects the liquidity preference curve, let us rewrite the indirect liquidity preference function above in direct form (Equation 4). Here the level of net worth of banks can be seen as a component of the asymptote ($\bar{R}$). The

[6] Since the mark-up threshold includes the marginal cost of lending, the investment demand constraint can be made less severe if economies of scale of banking occur. This is likely to cause the threshold rate to decline in the very long-term, thereby generating lower threshold liquidity preference curves. Diminishing the cost of doing business throughout the economy may also allow for some spill over efficiency in banking. For example, creating a more secure police system would reduce some of the security needs of banks.

[7] This scenario is similar to some of the events of the recent sub-prime crisis. For a discussion of the relationship between funding liquidity and market liquidity see Gorton and Metrick (2010). The authors examined how shocks to off balance sheet SIVs can result in a liquidity crisis that requires the central bank to provide funding liquidity to banks. In the case of our model, when the central bank supplies funding liquidity it results in an outward shift of the reserve supply line.

threshold level of reserves will decline when there is a negative shock to net worth. Therefore, a negative shock to net worth results in a downward shift of the liquidity preference curve. When asset prices increases the market value of net worth rises, thus causing the liquidity preference of banks to increase as there are larger notional values of assets to which to add funding liquidity. It should be noted, however, that a rise in liquidity preference does not imply banks hold more excess liquidity in boom periods. This is ultimately determined by the central bank's provision of funding liquidity. It just implies that liquidity preference increases as net worth is inflated by market prices.

$$R_D = \bar{R} + \alpha r_L^{-1} \tag{4}$$

The negative shock implies the banks are losing liquidity as their counterparties are unable to settle their obligations. They will also lose liquidity as traders settle debts by writing checks against their accounts in the banks. Figure 3 shows how a negative liquidity shock can engender a constraint on loan supply, which is the opposite of the case we analyzed above. The decline in the price of assets cause the liquidity preference curve to shift downward from R_{D1} to R_{D2}, thereby decreasing the level (for the given loan rate) of liquidity in the banking system from R_1 to R_2. The central bank is now forced to intervene by pumping excess reserves into the system. This causes the loan rate to decline as there is a movement downward along R_{D2} until the non-zero threshold rate is obtained. There is no shift in the demand for or supply of loans. As liquidity is injected the market loan rate falls towards the threshold rate, which is now below the competitive equilibrium rate. At this point, the rate reaches a non-zero lower bound in the lending rate and the differential between desired loan demand and actual supply is farthest apart. The desired demand for loans is $D*$ but $L*$ is supplied by the banking system. Let us call this scenario the non-zero lower bound bank liquidity trap.

Figure 3. A loan supply constraint precipitated by asset price crash

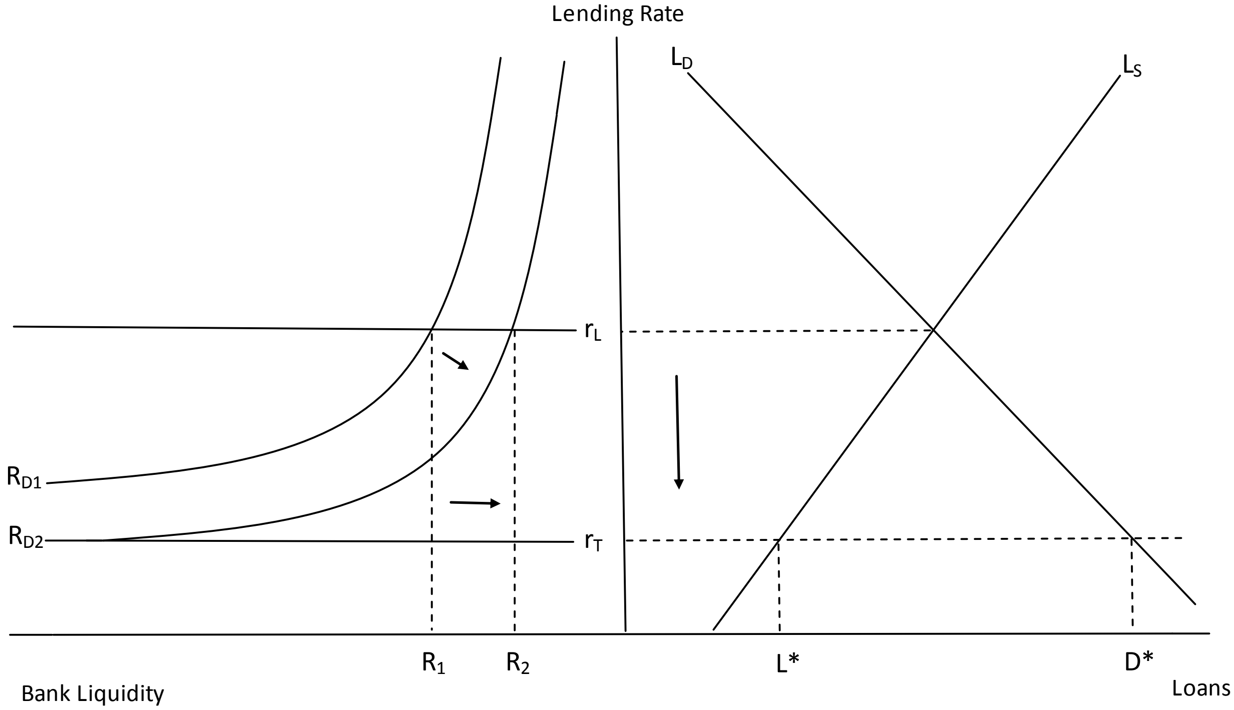
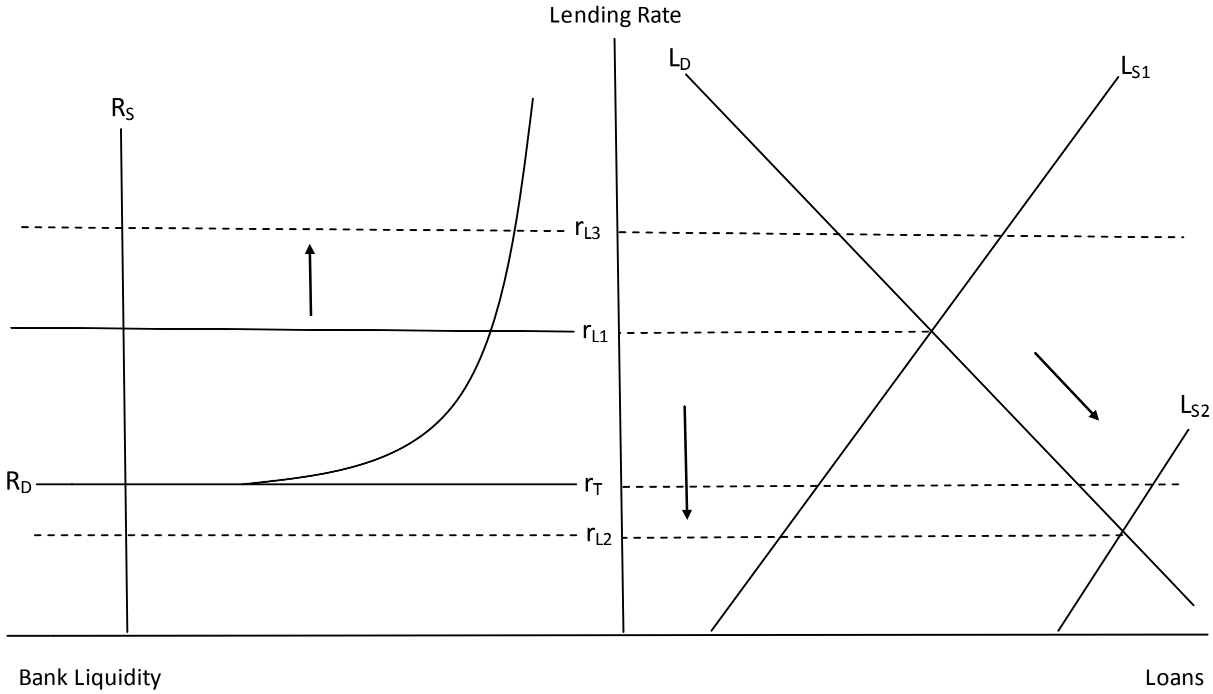


Figure 4 develops the idea further by showing that an outward shift in loan supply beyond D^* cannot occur because it will drive the market rate below the threshold. If this occurs it implies that the market interest rate r_{L2} is lower than the risk adjusted marginal cost of lending (r_T); hence banks will be lending at a loss. This is logically impossible because banks will not want to drive the market interest rate below marginal cost adjusted for risk of borrower default. To understand this point further, consider that the central bank has injected enough liquidity such that the supply of reserves is given by the vertical line R_S, which intersects the flat segment of the liquidity preference curve. Once we are in the regime of a bank liquidity trap, commercial banks will not extend loans by shifting outwards supply because this causes the market loan rate to fall further to r_{L2}. Therefore, the bank liquidity trap can only be characterized by a situation where the non-zero lower bound lending rate is reached and the desired demand for loans is greater than the actual supply.

Figure 4. In a bank liquidity trap supply of loanable funds cannot shift outward



While quantitative easing (buying up financial assets and injecting liquidity into banks) can help to take the economy into a loan supply constraint regime, excessive monetary tightening can stifle credit demand should it pressure the market interest rate above equilibrium. This could occur at a market rate such as r_{L3} in Figure 4. If liquidity is drained from the system until the interest rate r_{L3} results the desired supply of loans will now be less than the actual demand for loans. Here the economy would have exited the bank liquidity trap and entered into a regime in which investment demand is constrained.

4. Output and Inflation Dynamics in Two Regimes

This section develops a three equation dynamic model that can be used to analyze how output and inflation respond to changes in the exogenous variables in the model. The first equation is a reserve-loan (RL) equation, an augmented IS equation and a standard Phillips curve. The IS equation is augmented in keeping with the empirical findings of Goodhart and Hofmann (2005) who noted that augmenting the equation to include asset prices and monetary aggregates help to produce a negative interest rate effect on output. In this work the IS equation is augmented to include a quantity of loan intermediation.

The RL equation

Assume the lending rate adjusts according to the following specification.

$$r_{Lt} - r_{Lt-1} = \gamma(L_D - L_S) \tag{5}$$

When investment demand is constrained the quantity of loans intermediated is on the demand function. The adjustment coefficient (γ) is negative as it shows the adjustment of interest rate would tend to be downward. Therefore, Equation 5 can be rewritten as $r_{Lt} - r_{Lt-1} = \gamma L_{Dt}$. Substituting the inverse bank liquidity preference function (equation 3) into 5 and expressing L_{Dt} as the subject gives the RL model (equation 6).

$$L_{Dt} = \frac{1}{\gamma}(r_T - r_{Lt-1}) + \frac{\beta}{\gamma} R_{St}^{-1} \tag{6}$$

The augmented IS equation and Phillips curve

The augmented IS equation is as follows

$$Y_t = \alpha_r (r_L - \pi_{t-1}) + \alpha_L L_{Dt} + \sigma_Y \varepsilon_t \tag{7}$$

And the Phillips equation is as follows

$$\pi_t = \lambda \pi_{t-1} + \phi(Y_t - Y^*) \tag{8}$$

Where Y_t = aggregate level of output, π_t = inflation rate, Y^* = trend output, σ_Y = the volatility or unconditional standard deviation of aggregate output, and ε_t = stochastic output shocks where $\varepsilon_t \sim N(0, \sigma_Y^2)$ and $E(\varepsilon_t, \varepsilon_{t-k}) = 0$ for $t, k = 0,1,2,...$. These shocks can emanate randomly from export booms, new discoveries of raw materials, adverse weather patterns and so on. α_r = the interest elasticity of output, α_L = the loan elasticity of output, λ = a measurement of inflation persistence, and ϕ = a measurement of the responsiveness of inflation to the output gap. Note that α_r is a negative coefficient as the empirical work of Goodhart and Hofmann (2005) indicated.

Solving for the dynamic output equation

First substitute equation 6 into equation 7 to obtain the following model.

$$Y_t = \alpha_r(r_{Lt} - \pi_{t-1}) + \frac{\alpha_L}{\gamma}(r_T - r_{Lt-1}) + \frac{\alpha_L \beta}{\gamma} R_{St}^{-1} + \sigma_Y \varepsilon_t \tag{9}$$

From Equation 8 it is obvious that the one-period lagged inflation is $\pi_{t-1} = \lambda \pi_{t-2} + \phi Y_{t-1}$. To simplify the algebra let us suppress the term ϕY^* by setting it equal to zero Substituting for the one-period inflation into 9 will give the following stochastic first-order linear dynamic equation for output. This equation takes into consideration the negative value of α_r.

$$Y_t = \alpha_r \phi Y_{t-1} + \frac{\alpha_L}{\gamma} r_T + \frac{\alpha_L \beta}{\gamma} R_{St}^{-1} + \sigma_Y \varepsilon_t \tag{10}$$

The following terms $\alpha_r(r_{Lt} + \lambda \pi_{t-2})$ and $\alpha_L / \gamma r_{Lt-1}$ are suppressed so we can focus on the exogenous variables only on the right hand side. This equation can be used to derive dynamic multipliers to analyze how output may respond over time to changes in ε_t, r_T and R_t[8]. We are particularly interested in how changes in reserve management affect output dynamics when investment demand is constrained. As noted above, central banks view the management of reserves as an important aspect of monetary policy in developing economies. The threshold lending rate is determined by the commercial banks. We assume they possess the market power to determine this rate. Hence we can also look at how output will respond over time to a change in r_T. The solution to Equation 10 is presented in the Appendix (Equation A1).

The model also allows us to study output dynamics when there is a loan supply constraint regime (the bank liquidity trap). The loan price adjustment coefficient varies from an investment demand constraint regime to a bank liquidity trap regime. In a bank liquidity trap, the adjustment is upward because the desired demand is greater than the supply of loans – hence γ takes a positive value. On the other hand, when investment demand is the binding constraint we expect interest rate to adjust downward because the desired supply of loanable funds is greater than the realized demand, thus we have a negative value for γ. However, size of the coefficient will vary from one regime to the next. Banks with market power will be quicker to adjust the lending rate

[8] See Enders (2010) and Hamilton (1994) for the solution of first-order and second-order linear difference equations with a stochastic component.

upward than downward. Therefore, we can expect a larger absolute value for γ when there is a loan supply constraint relative to an investment demand constraint[9].

Solving for the dynamic inflation equation

Substituting Equation 10 into 8 will give us the difference equation showing the motion of inflation. This is represented by Equation 11 in which the term $\alpha_r \phi^2 Y_{t-1}$ is suppressed or set equal to zero. This equation allows us to derive the dynamic multipliers showing how inflation will respond in the regime of an investment demand constraint. The multipliers can be derived for studying how the exogenous variables (ε_t , r_T and R_{St}) affect the impact response and subsequent adjustments over t future periods given a change in one of the exogenous variables in period $t = 0$. One feature of Equation 11 is the fact that the output standard deviation and stochastic component affect inflation. This feature is intuitive since random production changes can influence the price level. The solution of equation 11 is given in the Appendix (Equation A5).

$$\pi_t = \lambda \pi_{t-1} + \alpha_r \lambda \phi \pi_{t-2} + \frac{\alpha_L \phi}{\gamma} r_{Tt} + \frac{\alpha_L \phi \beta}{\gamma} R_{St}^{-1} + \phi \sigma_Y \varepsilon_t \tag{11}$$

The dynamic multipliers

The dynamic multipliers are derived from the solution of the equation of motion of output and inflation (Appendix 1). First, the impact multipliers giving the response of output in period $t = 0$ are as follows: $\partial Y_0 / \partial R_{S0} = -\alpha_L \beta / \gamma$, $\partial Y_0 / \partial r_{T0} = \alpha_L / \gamma$ and $\partial Y_0 / \partial \varepsilon_0 = \sigma_Y$. Note also that in period $t = 0$ the output response is equal to its unconditional volatility or standard deviation. It is easy to eliminate the variable R_S^{-2} if we divide the multiplier by R_S^{-2} . However, maintaining R_S^{-2} in the various multipliers can allow us to observe how the value changes over time for different liquidity levels. Therefore, we will look at $R_S = 3$ and $R_S = 4$. The multipliers showing the output response for $t + i$ future periods are given by the following formulas.

$$\frac{\partial Y_{t+i}}{\partial r_{Tt}} = \frac{\alpha_L}{\gamma} (\alpha_r \phi)^i$$

[9] Empirical studies have documented this asymmetric adjustment in the lending rate (Scholnick, 1996).

$$\frac{\partial Y_{t+i}}{\partial R_{St}} = -\frac{\alpha_L \beta}{\gamma}(\alpha_r \phi)^i$$

$$\frac{\partial Y_{t+i}}{\partial \varepsilon_t} = \sigma_Y (\alpha_r \phi)^i$$

Second, the impact multipliers showing how inflation responds in period $t = 0$ are as follows $\partial \pi_0 / \partial R_0 = -\alpha_L \beta \phi / \gamma (c_1 + c_2)$, $\partial \pi_0 / \partial r_{T0} = \alpha_L \phi / \gamma (c_1 + c_2)$ and $\partial \pi_0 / \partial \varepsilon_0 = \phi \sigma_Y (c_1 + c_2)$. These were obtained using the solution procedure of Hamilton (1994) when the roots λ_1 and λ_2 are less than one, real and distinct. Notice that in period $t = 0$ the inflation response is dependent on output volatility. The term γ plays an important role in all the multipliers expect for the stochastic component of the IS equation. The multipliers will change depending on whether we are in an investment demand or loan supply constraint regime. In the investment demand constraint regime γ will be smaller in absolute value and will be negative. The smaller absolute value indicates that oligopolistic banks would tend to be less willing to lower interest rates than they are eager to raise them. Therefore, $|\gamma|$ is lower in the regime of an investment demand constraint. Moreover, the sticky loan interest rate would tend to give a bigger impact response. The simulations for the two loan intermediation regimes will show the impact response for $t = 0$ and for subsequent periods.

$$\frac{\partial \pi_{t+i}}{\partial r_{Tt}} = \frac{\alpha_L \phi}{\gamma}(c_1 \lambda_1^i + c_2 \lambda_2^i)$$

$$\frac{\partial \pi_{t+i}}{\partial R_{St}} = -\frac{\alpha_L \phi \beta}{\gamma}(c_1 \lambda_1^i + c_2 \lambda_2^i)$$

$$\frac{\partial \pi_{t+i}}{\partial \varepsilon_t} = \phi \sigma_Y (c_1 \lambda_1^i + c_2 \lambda_2^i)$$

The simulations below are based on the following values. In the investment demand constraint regime (hereafter regime 1) assume $\gamma = -0.2$, while for the bank liquidity trap regime (hereafter regime 2) $\gamma = 0.4$. Assume for both regimes that $\alpha_r = 0.3$, $\phi = 0.9$, $\alpha_L = 0.6$, $\lambda_1 = 0.4$, $\lambda_2 = 0.8$, $\beta = 3$ and $\sigma_Y = 1$. Figure 5 presents the first simulation showing how aggregate output and inflation respond over time given a change in bank liquidity in the initial time period. In one sense the charts show the simulated dynamic response of aggregate output and inflation given an extension of monetary or quantitative easing for the two regimes. When investment demand is the binding constraint higher levels of bank liquidity have a positive effect on both output and inflation. However, the output effect is smaller and relatively more short-lived. Inflation tends to persist for a longer period after the liquidity enhancement in period $t = 0$. When we are in a bank liquidity trap – which we said earlier is a theoretical possibility after a financial collapse – the liquidity injection in period $t = 0$ has the opposite effect, although somewhat smaller. The insight here is quantitative easing would tend to be deflationary instead of inflationary when bank lending is the dominant constraint.

Figure 6 shows the dynamic response given an increase in the minimum mark-up threshold lending rate in period $t = 0$. For the subsequent eleven periods both output and inflation decrease and move back to equilibrium after some periods. However, price deflation persists for a much longer period. On the other hand, an interesting result emerges when we are in a bank liquidity trap. Here the same increase in the threshold lending rate would elicit positive responses in both output and inflation. The natural question is how is this possible? The earlier explanation accompanying Figures 3 and 4 conjectures one possible answer. In the bank liquidity trap the lending rate is just too low for banks to make profitable lending – here the mark-up threshold is now below the marginal cost of lending at which point bank liquidity and loans are perfect substitutes. The minimum lending rate is determined by a combination of the oligopolistic pricing power of the banks and the circumstances in the economy as it relates to post-financial crisis and central bank monetary easing. In some developing economies the central bank might be able to influence the threshold by changing reserve requirement policies. Figure 7 reports the simulations for the output and inflation dynamics given a one unit positive output shock. Notice that the two financial regimes do not influence the outcome in this case. Aggregate output and inflation increase after the increase in ε_t. However, inflation tends to be relatively more persistent.

Figure 5. Dynamic output and inflation multipliers for eleven future periods given a change in bank liquidity in period $t = 0$ for two financial regimes and two liquidity levels

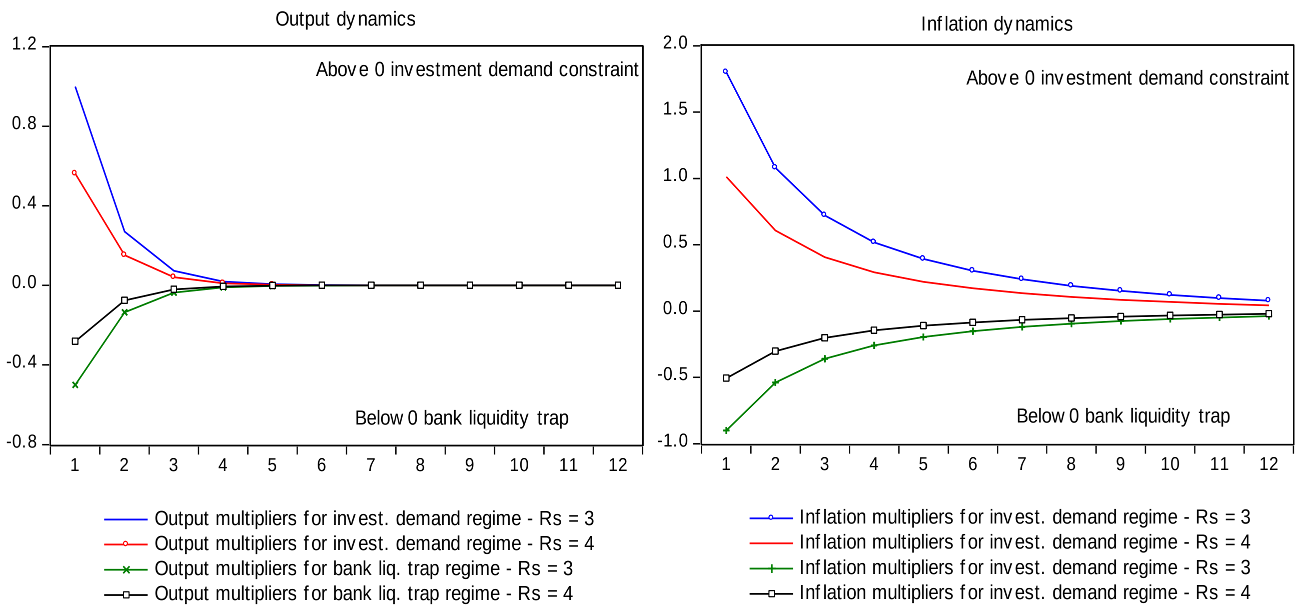


Figure 6. Dynamic output and inflation multipliers for eleven future periods given a change in threshold lending rate in period $t = 0$ for two financial regimes

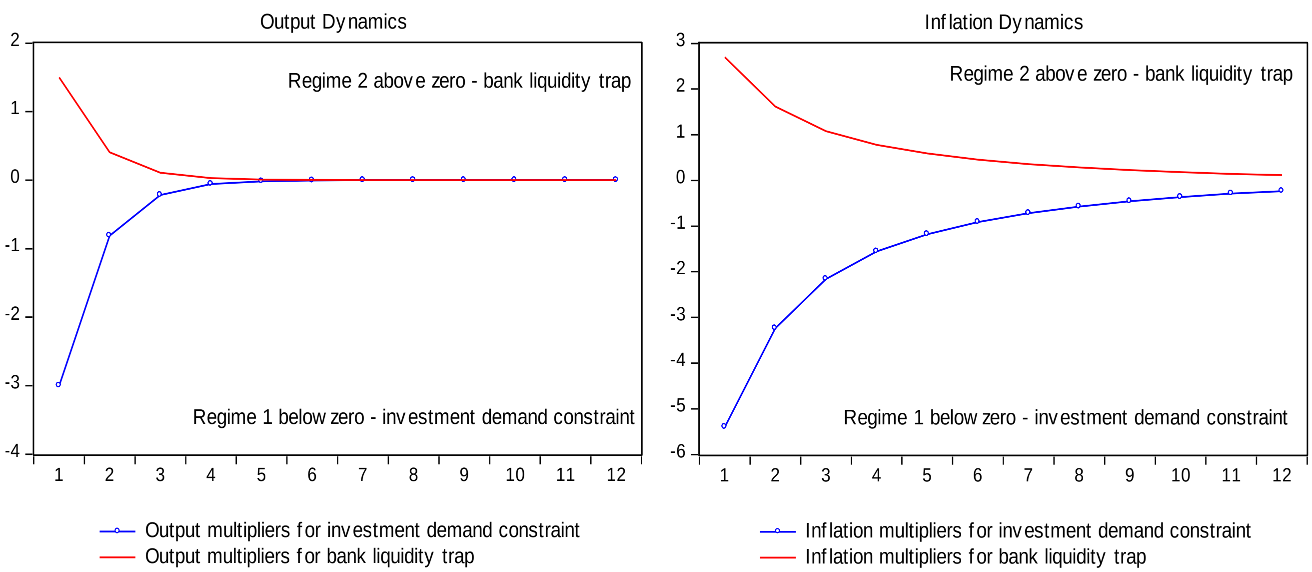
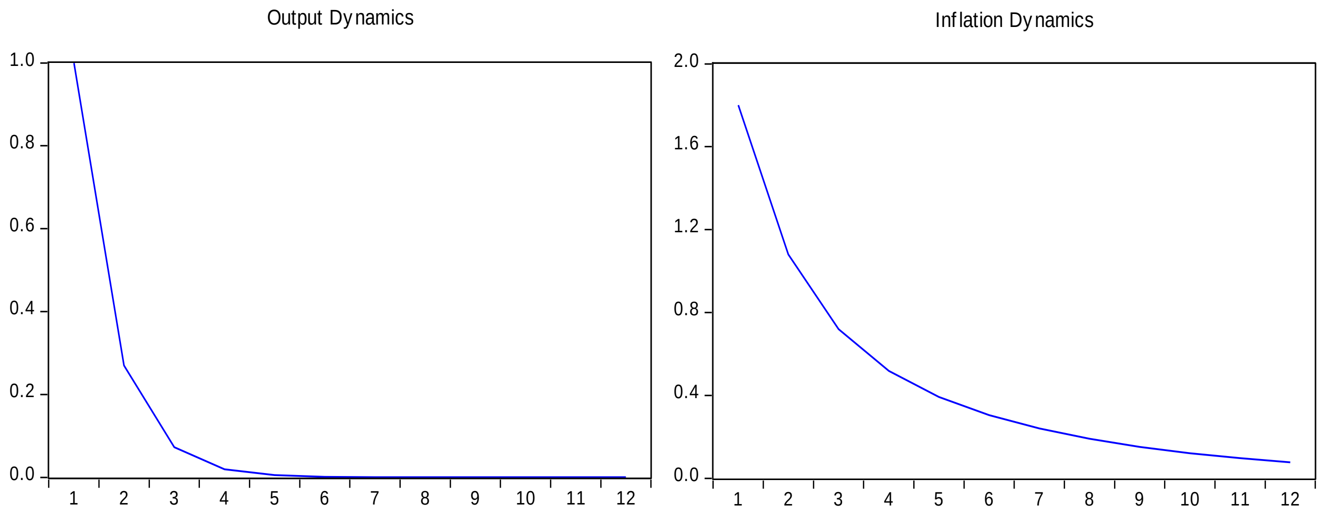


Figure 7. Dynamic output and inflation multipliers for eleven future periods given a one unit output shock in period $t = 0$



5. Stylized Facts

This section presents data to support the idea of aggregate bank liquidity preference that tends to become flat at a threshold interest rate. The method of locally weighted regressions was utilized to trace out the liquidity preference curves from scatter plots between bank reserves and prime lending rate. The data were downloaded from the IMF's *International Financial Statistics*[10].The starting period of Jan: 2000 was used so that financial liberalization would have had enough time to enable the market determination of the lending rate. The end date is determined by the availability of the data. Each chart below graphs total bank reserves on the horizontal axis and the lending rate (%) on the vertical axis. The results are presented for three categories: Africa and the Middle East, Caribbean and Latin America, and Transition and other economies. The curves indicate a tendency to become flat at some threshold interest rate. In a few cases the curves' elasticity depicts a tendency to increase even if they do not become entirely flat. The required data were obtained for a total of sixty-five developing economies. A

[10] The data were downloaded in January 2012. Subsequent efforts to download and extend the data proved futile given the change in IFS reporting standards.

discernible liquidity preference curve was found for forty-six. Below twenty-six are reported owing to limited space.

Caribbean and Latin America

Figure 8. Bank liquidity preference for Guyana and Guatemala

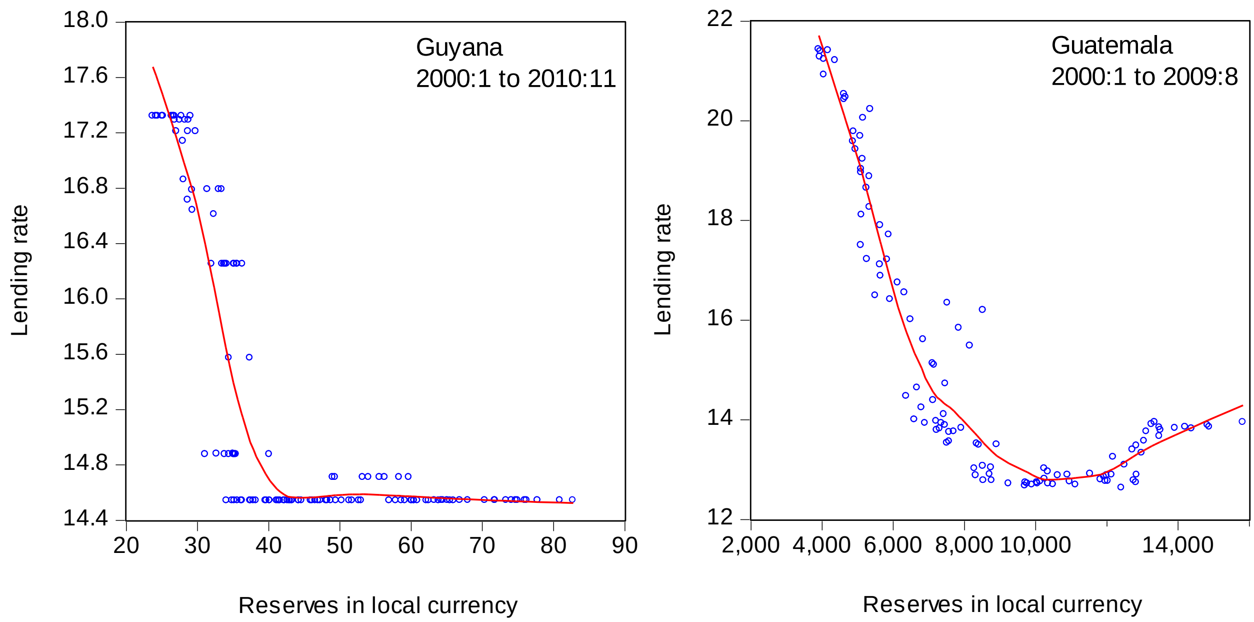


Figure 9. Bank liquidity preference for Honduras and Suriname

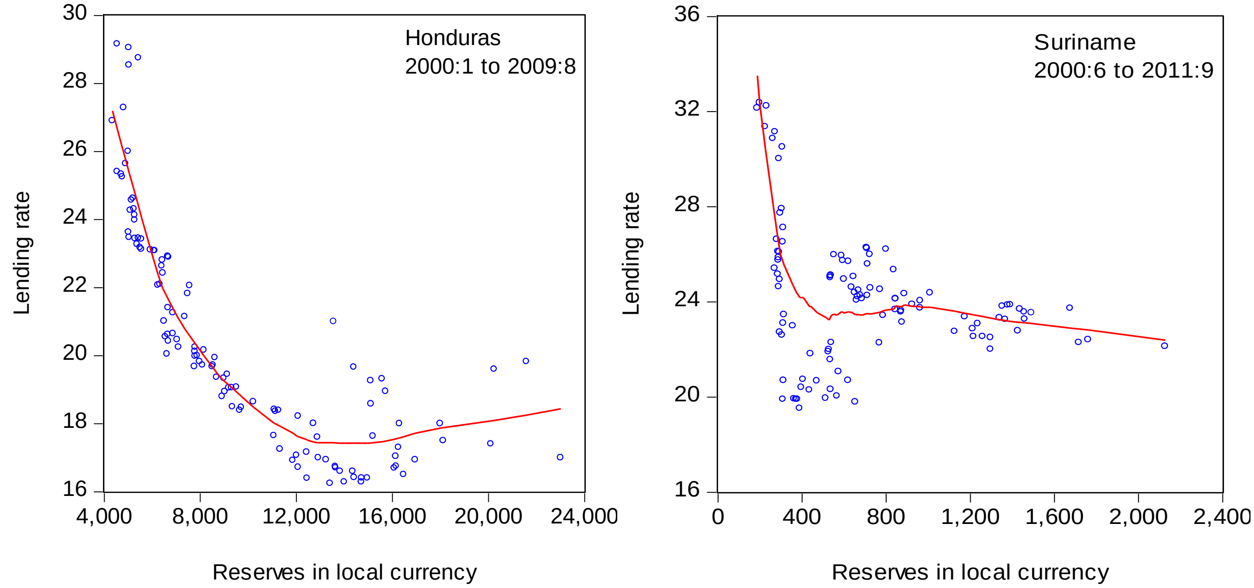
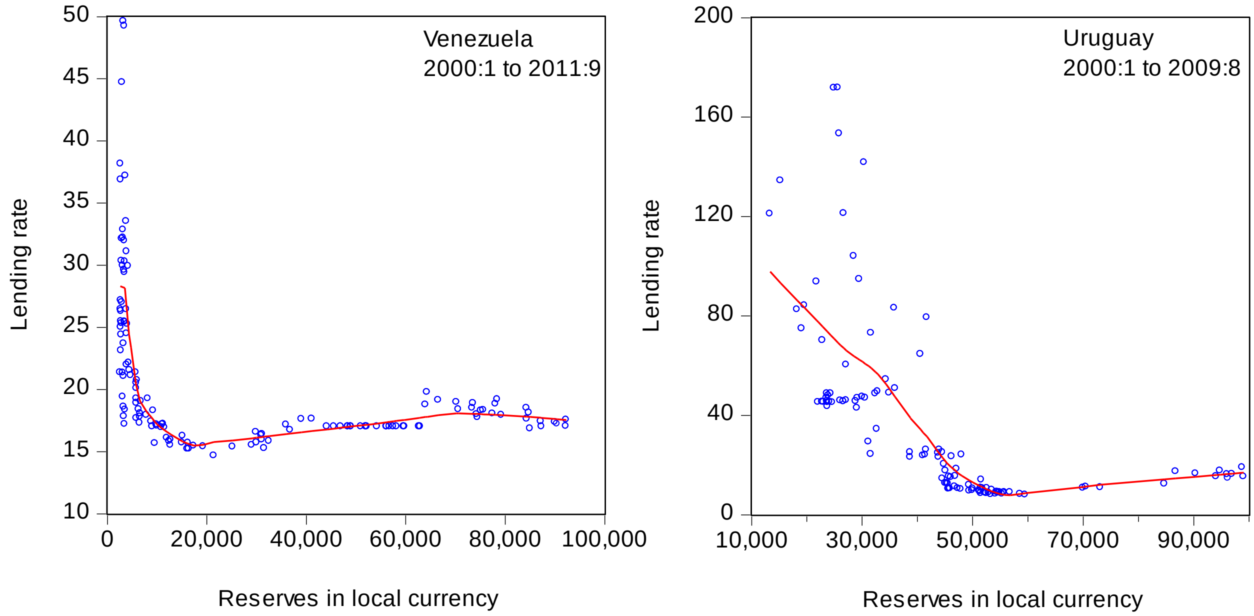


Figure 10. Bank liquidity preference for Venezuela and Uruguay



Africa and Middle East

Figure 11. Bank liquidity preference for Angola and Namibia

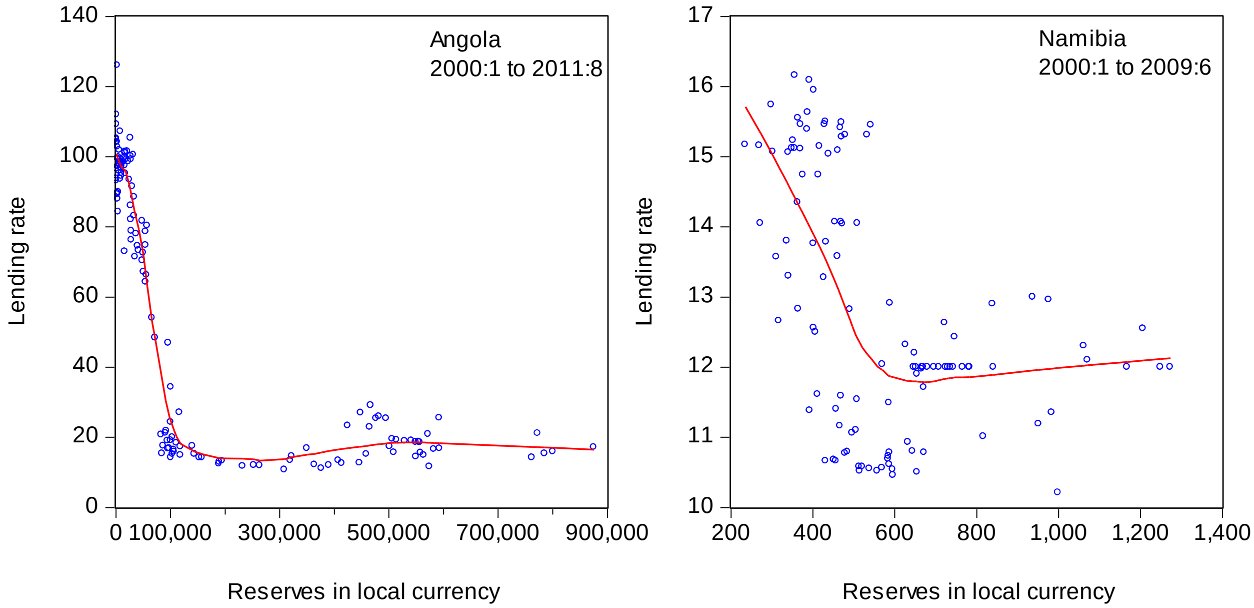


Figure 12. Bank liquidity preference for Algeria and Malawi

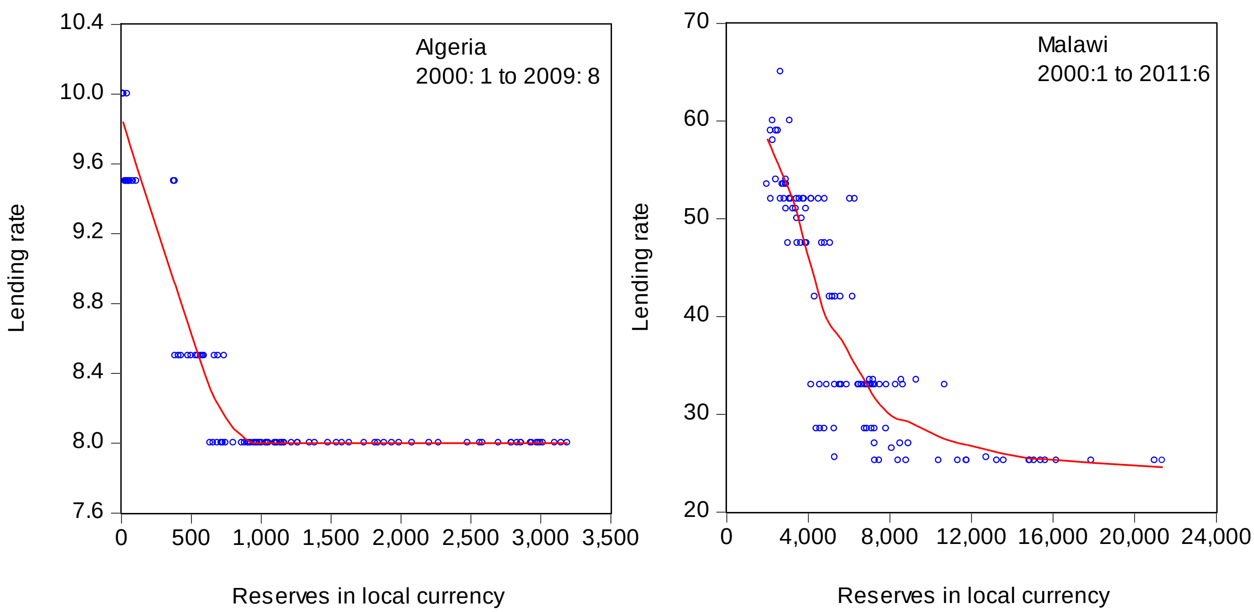


Figure 13. Bank liquidity preference for Kenya and Oman

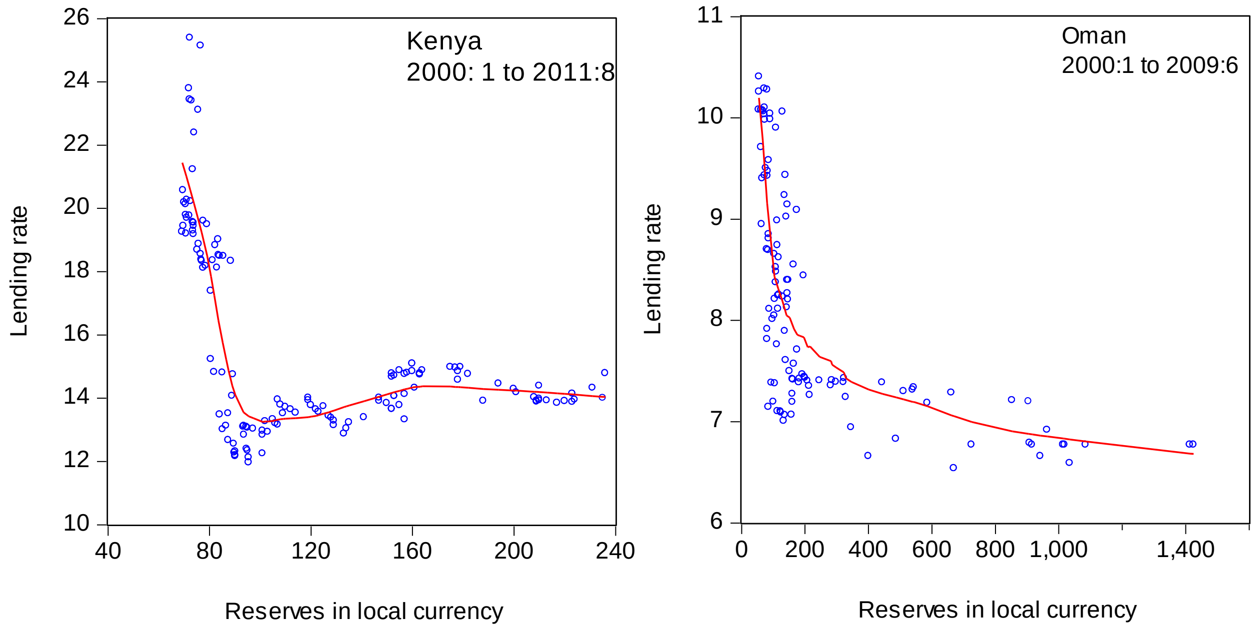


Figure 14. Bank liquidity preference for Lebanon and Jordan

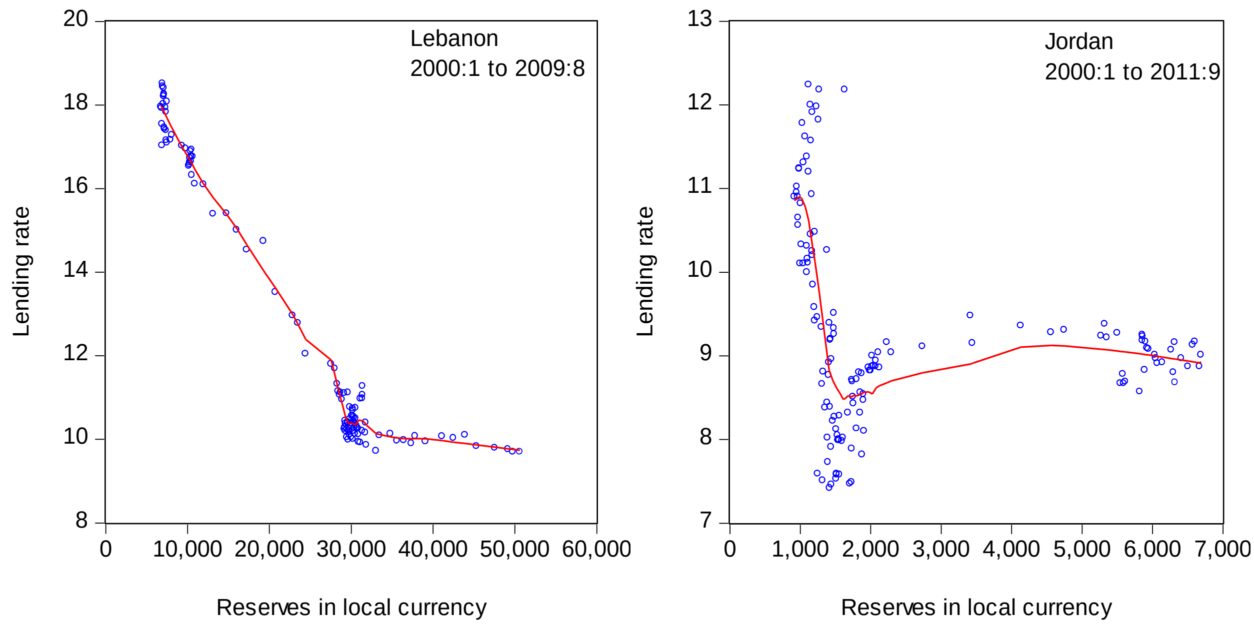
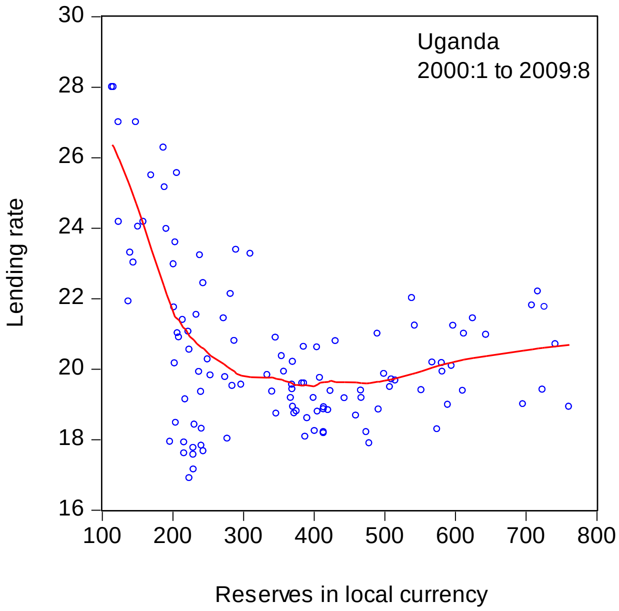
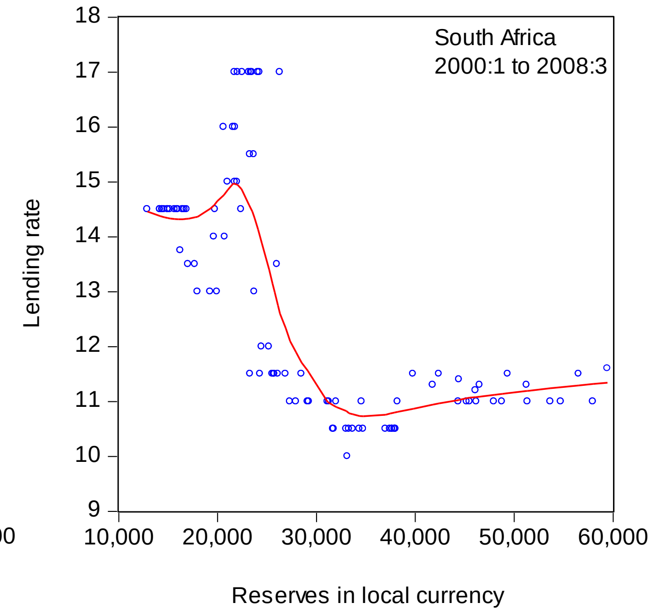


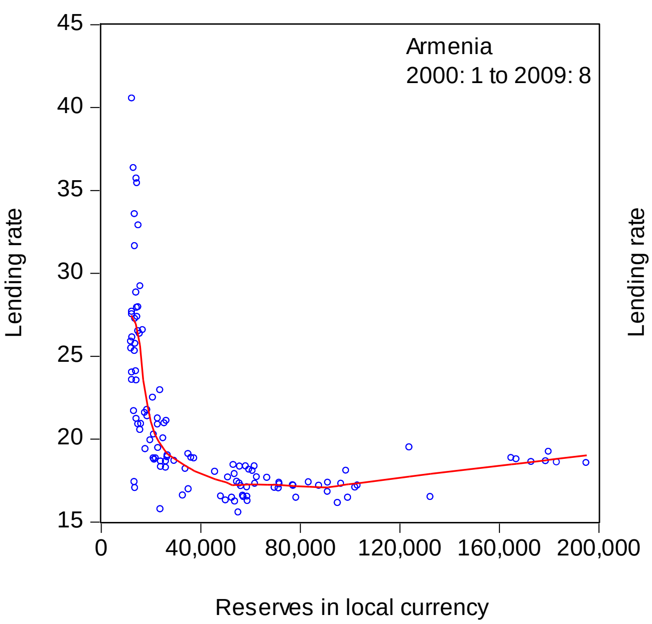
Figure 15. Bank liquidity preference for Uganda and South Africa





Transition and Other Economies

Figure 16. Bank liquidity preference for Armenia and Belarus



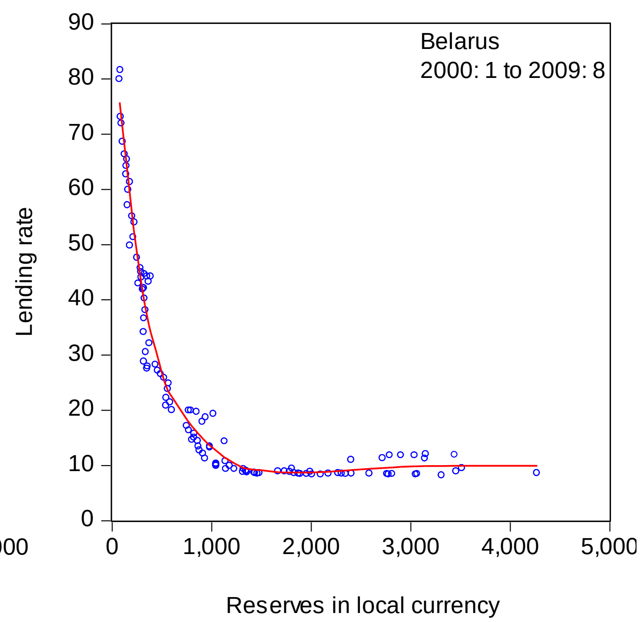


Figure 17. Bank liquidity preference for Bosnia and Herzegovina and Estonia

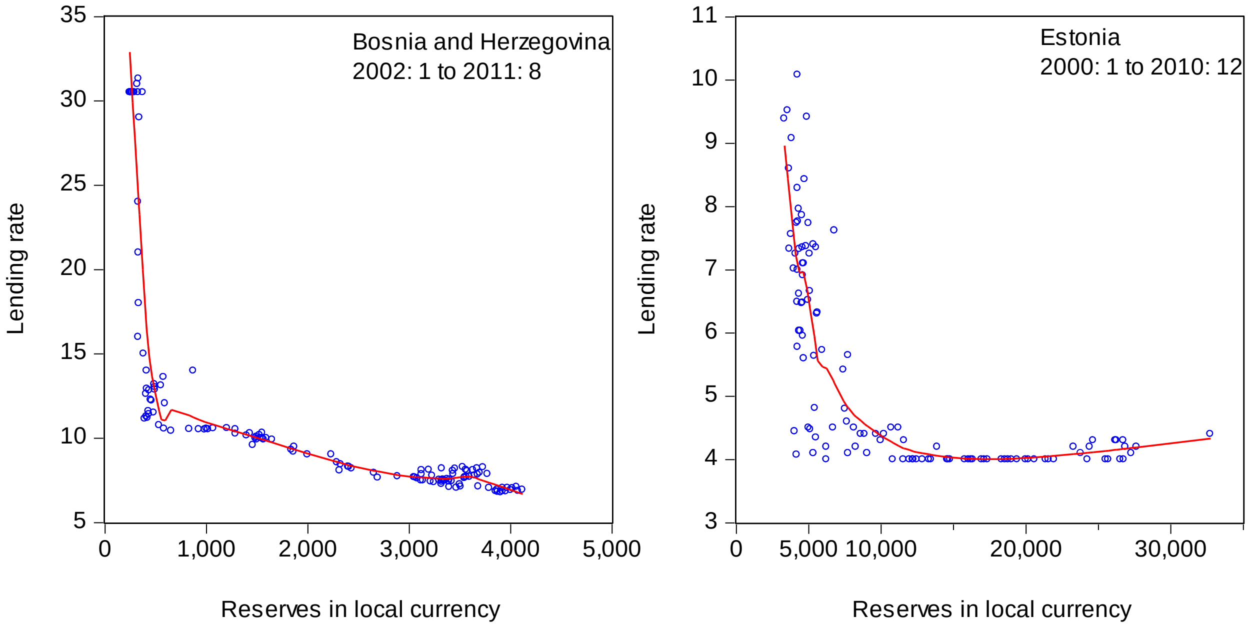


Figure 18. Bank liquidity preference for Moldova and Mongolia

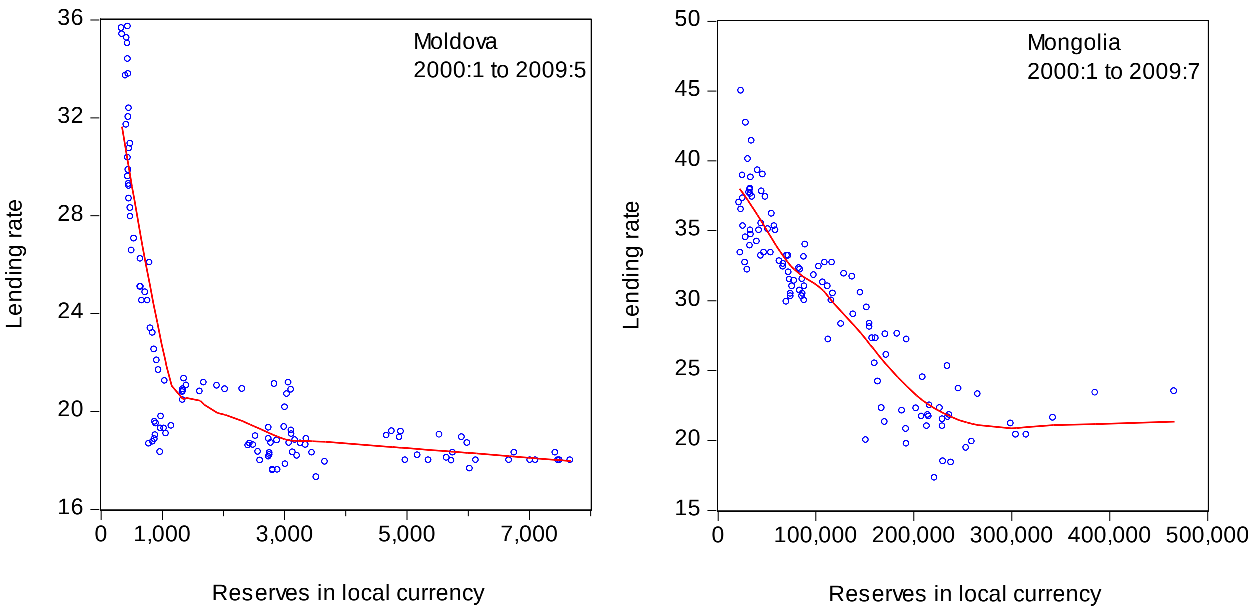


Figure 19. Bank liquidity preference for Romania and Russia

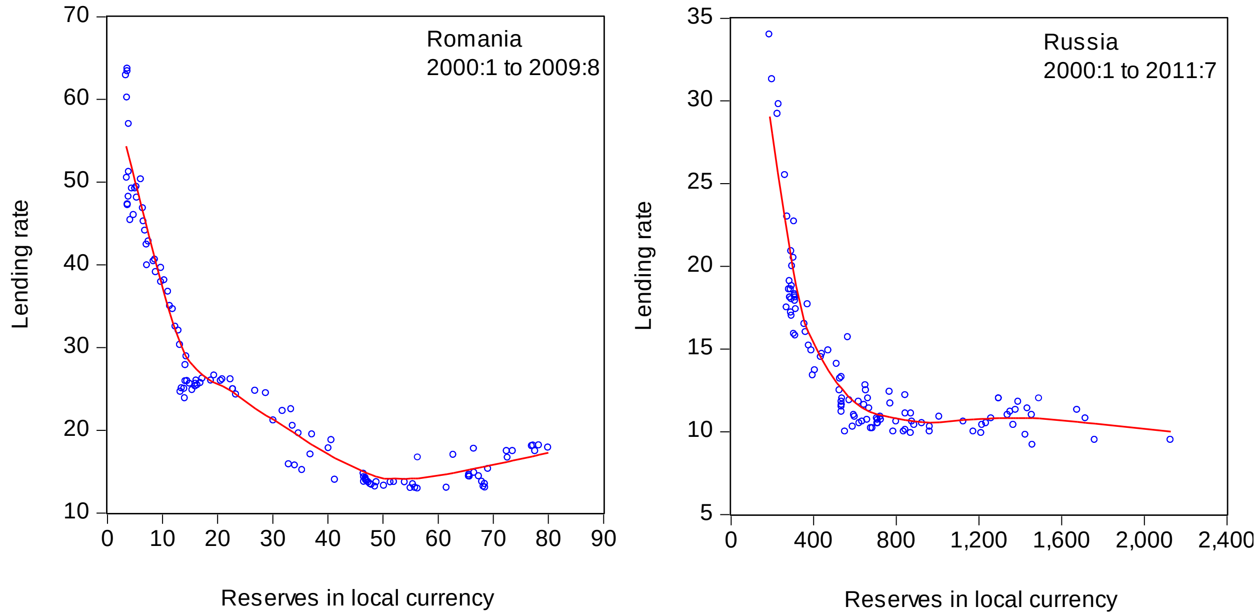
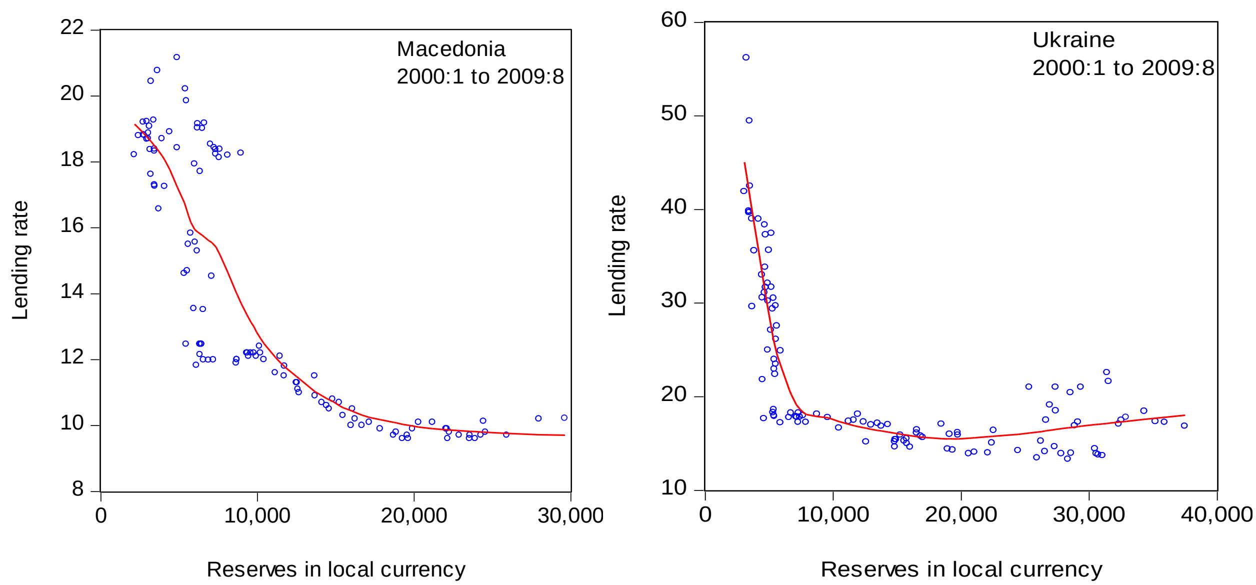


Figure 20. Bank liquidity preference for Macedonia and Ukraine



The highest threshold was found for Malawi to be approximately 24.5%, while the lowest was found to be 4.5% for Estonia. The average threshold for the twenty-six economies is 13.5% -

thus underscoring the non-zero lower bound minimum lending rate. The Appendix reports a table with the threshold rates along with several other series. Also presented in the appendix are several cursory and exploratory scatter plots. Figure A1 shows two plots. Panel A shows a positive relationship between loan-deposit interest rate spread and the lending threshold, while Panel B indicates that the lending threshold tends to be lower in economies with higher per capita GDP. The latter result is interpreted to mean more developed economies have more lending opportunities that allow banks to earn economies in lending. Figure A2 also presents two plots. Panel A looks at the relationship between the lending threshold and gross fixed capital formation (% of GDP), while Panel B gives the relation between threshold and commercial bank credit (% of GDP).

6. Conclusion

The literature on the liquidity trap highlights the existence of a zero bound benchmark policy interest rate. However, many developing economies may not confirm to the classic features of a liquidity trap (often seen to have occurred in the United States and Japan); nevertheless, a non-zero lower bound lending rate can be found in many more economies. This paper argued that the non-zero lower bound lending rate engenders an investment demand constraint. Thus it extends the literature pertaining to the investment demand constraint and went on to work out how price and aggregate output will adjust over time in this regime. A hypothetical case – which we called the bank liquidity trap – caused by a negative shock to liquidity preference was also examined. It was suggested that the hypothetical scenario may result from a collapse in the price of financial assets that spills over to the commercial banking sector. Simulations from the dynamic model show that the effect of quantitative easing in a bank liquidity trap is further deflationary instead of inflationary. On the other hand, in a regime of an investment demand constraint, monetary easing helps to stimulate prices and output, although the effect on the former is stronger and has a longer persistence.

This paper conjectured the idea that bank liquidity preference in developing economies reflects the structure of the banking system – hence the minimum mark-up threshold lending rate. The non-zero lower bound lending rate shows the minimum mark-up rate that banks charge before they can make profitable loans. Profitable loans must take into consideration the marginal cost of lending (which includes the cost of screening new borrowers and managing existing loan portfolios) plus the probability that some borrowers will default. Can the threshold rate lead to fluctuations in output and prices? The paper showed that in the hypothetical bank liquidity trap, increasing the threshold marginally can result in a positive effect on both output and inflation. In more advanced economies, the threshold lending rate itself could be a function of the benchmark policy interest rate of the central bank. This interdependence perhaps allows for the possibility of marginally increasing the zero bound policy rate instead of further quantitative easing that may result in further deflation. In advanced economies the central banks typically have more influence when they change the policy rate. This is not likely to be the case in developing economies where investment demand is the main constraint and oligopolistic commercial banks tend to have more influence determining the lending rate. In this regime if commercial banks increase the threshold it would tend to reduce output and engender deflation, according to the model simulations.

References

de la Torre, Agusto, Juan C. Gozzi, and Sergio Schmukler (2007). "Financial development: maturing and emerging issues." *World Bank Research Observer*, Vol. 22: 67-102.

Murota, Ryu-ichiro and Yoshiyasu Ono (2012). "Zero nominal interest rates, unemployment, excess reserves and deflation in a liquidity trap," *Metroeconomica*, Vol. 63: 335-357.

Gorton, Gary and Andrew Metrick (2010). "Haircuts." *Federal Reserve Bank of St. Louis Review*, November/December.

Goodhart, Charles and Boris Hofmann (2005). "The IS curve and the transmission of monetary policy: is there a puzzle?" *Applied Economics,* Vol. 37 (1), 29-36.

Eggertsson, Gauti and Paul Krugman (2011). "Debt, deleveraging, and the liquidity trap: a Fisher-Minsky-Koo approach." Unpublished Manuscript.

Eggertsson, Gauti and Jonathan Ostry (2005). "Does excess liquidity pose a threat in Japan." *IMF Policy Discussion Paper 05/5,* International Monetary Fund.

Enders, Walter (2010). *Applied Econometric Time Series,* 3ed. Hoboken, NJ: John Wiley and Sons.

Hamilton, James (1994). *Time Series Analysis*. Princeton, NJ: Princeton University Press.

Keister, Todd and James McAndrews (2009). "Why are banks holding so many excess reserves?" *Federal Reserve Bank of New York Current Issues in Economics and Finance*, Vol. 15 (8): 1-10.

Khemraj, Tarron (2010). "What does excess bank liquidity say about the loan market in Less Developed Economies?" *Oxford Economic Papers,* Vol. 62 (1): 86-113.

Ogawa, Kazuo (2007). "Why Japanese banks held excess reserves: the Japanese experience of the late 1990s." *Journal of Money, Credit and Banking*, Vol. 39 (1): 241-257.

Rodrik, Dani and Arvind Subramanian (2009). "Why did financial globalization disappoint?" *IMF Staff Papers*, Vol. 56 (1): 112-138.

Scholnick, Barry (1996). "Asymmetric adjustment in commercial bank interest rates: evidence from Malaysia and Singapore." *Journal of International Money and Finance*, Vol. 15 (3): 485-496.

Saxegaard, Magnus (2006). "Excess liquidity and the effectiveness of monetary policy: evidence from Sub-Saharan Africa." *Working Paper 06/115*, International Monetary Fund.

Stiglitz, Joseph (1989). "Financial markets and development." *Oxford Review of Economic Policy*, Vol. 5: 55-67.

Worrell, DeLisle (2012). "Polices for stabilization and growth in small very open economies." Central Bank of Barbados.

Appendix 1

Derivation of the multipliers

Equation 10 presented the dynamic structural stochastic output equation. Assume an initial value for output (Y_0) and $\alpha_r\phi < 1$. If we use a recursive method given the initial value the following solution would be obtained.

$$Y_t = (\alpha_r\phi)^t Y_0 + \frac{\alpha_L}{\gamma}\sum_{i=0}^{t-1}(\alpha_r\phi)^i r_{Tt-i} + \frac{\alpha_L\beta}{\gamma}\sum_{i=0}^{t-1}(\alpha_r\phi)^i R_{St-i}^{-1} + \sigma_Y\sum_{i=0}^{t-1}(\alpha_r\phi)^i\varepsilon_{t-i} \qquad \text{(A1)}$$

We can now obtain the following dynamic multipliers.

$$\frac{\partial Y_{t+i}}{\partial r_{Tt}} = \frac{\alpha_L}{\gamma}(\alpha_r\phi)^i$$

$$\frac{\partial Y_{t+i}}{\partial R_{St}} = -\frac{\alpha_L\beta}{\gamma}(\alpha_r\phi)^i$$

$$\frac{\partial Y_{t+i}}{\partial \varepsilon_t} = \sigma_Y (\alpha_r \phi)^i$$

It was given earlier that the structural inflation model in this paper evolves according to equation 11. Using the method of lag operator the inverse characteristic equation is given as the following. For the purpose of this work, we will assume that the roots are distinct, real and less than one. In other words, the model is stable. Let us assume that the factor of the inverse characteristic equation for Equation 11 can be expressed as follows.

$$(1 - \lambda L - \alpha_r \lambda \phi L^2) = (1 - \lambda_1 L)(1 - \lambda_2 L)\text{; } \lambda_1 < 1 \text{ and } \lambda_2 < 1$$

This allows us to rewrite Equation 11 as

$$\pi_t = (1 - \lambda_1 L)^{-1}(1 - \lambda_2 L)^{-1}\left(\frac{\alpha_L \phi}{\gamma} r_{Tt} + \frac{\alpha_L \phi \beta}{\gamma} R_{St}^{-1} + \phi \sigma_Y \varepsilon_t\right) \qquad \text{(A2)}$$

Where

$$(1 - \lambda_1 L)^{-1} = 1 + \lambda_1 L + \lambda_1^2 L^2 + \lambda_1^3 L^3 + \ldots$$

$$(1 - \lambda_2 L)^{-1} = 1 + \lambda_2 L + \lambda_2^2 L^2 + \lambda_2^3 L^3 + \ldots$$

Following Hamilton (1994, p. 33) where $\lambda_1 \neq \lambda_2$ and applying the method of partial fractions, the following operator can be obtained:

$$(\lambda_1 - \lambda_2)^{-1}\left\{\frac{\lambda_1}{1 - \lambda_1 L} - \frac{\lambda_2}{1 - \lambda_2 L}\right\} = \frac{1}{(1 - \lambda_1 L)(1 - \lambda_2 L)}$$

Therefore, we can rewrite equation A2 as

$$\begin{aligned}\pi_t &= (\lambda_1 - \lambda_2)^{-1}\left\{\frac{\lambda_1}{\lambda_1 - \lambda_2 L} - \frac{\lambda_2}{\lambda_1 - \lambda_2 L}\right\}\frac{\alpha_L \phi}{\gamma} r_{Tt} + (\lambda_1 - \lambda_2)^{-1}\left\{\frac{\lambda_1}{\lambda_1 - \lambda_2 L} - \frac{\lambda_2}{\lambda_1 - \lambda_2 L}\right\}\frac{\alpha_L \phi \beta}{\gamma} R_{St}^{-1} \\ &+ (\lambda_1 - \lambda_2)^{-1}\left\{\frac{\lambda_1}{\lambda_1 - \lambda_2 L} - \frac{\lambda_2}{\lambda_1 - \lambda_2 L}\right\}\phi \sigma_Y \varepsilon_t\end{aligned} \qquad \text{(A3)}$$

Let $c_1 = \lambda_1 / (\lambda_1 - \lambda_2)$; $c_2 = -\lambda_2 / (\lambda_1 - \lambda_2)$

This allows for rewriting equation A3 as

$$\pi_t = (c_1 + c_2)\frac{\alpha_L \phi}{\gamma} r_{Tt} + (c_1\lambda_1 + c_2\lambda_2)\frac{\alpha_L \phi}{\gamma} r_{Tt-1} + (c_1^2\lambda_1 + c_2^2\lambda_2)\frac{\alpha_L \phi}{\gamma} r_{Tt-2} + (c_1^3\lambda_1 + c_2^3\lambda_2)\frac{\alpha_L \phi}{\gamma} r_{Tt-3} + \ldots$$
$$+(c_1 + c_2)\frac{\alpha_L \phi\beta}{\gamma} R_{St}^{-1} + (c_1\lambda_1 + c_2\lambda_2)\frac{\alpha_L \phi\beta}{\gamma} R_{St-1}^{-1} + (c_1^2\lambda_1 + c_2^2\lambda_2)\frac{\alpha_L \phi\beta}{\gamma} R_{St-2}^{-1} + (c_1^3\lambda_1 + c_2^3\lambda_2)\frac{\alpha_L \phi}{\gamma} r_{Tt-3} + \ldots$$
$$+(c_1 + c_2)\phi\sigma_Y \varepsilon_t + (c_1\lambda_1 + c_2\lambda_2)\phi\sigma_Y \varepsilon_{t-1} + (c_1^2\lambda_1 + c_2^2\lambda_2)\phi\sigma_Y \varepsilon_{t-2} + (c_1^3\lambda_1 + c_2^3\lambda_2)\phi\sigma_Y \varepsilon_{t-3} + \ldots \tag{A4}$$

Or taking the sum gives a solution:

$$\pi_t = \frac{\alpha_L \phi}{\gamma}\sum_{i=0}^{t-1}(c_1\lambda_1^i + c_2\lambda_2^i) r_{Tt-i} + \frac{\alpha_L \phi\beta}{\gamma}\sum_{i=0}^{t-1}(c_1\lambda_1^i + c_2\lambda_2^i) R_{St-i}^{-1} + \phi\sigma_Y\sum_{i=0}^{t-1}(c_1\lambda_1^i + c_2\lambda_2^i)\varepsilon_{t-i} \tag{A5}$$

From Equation A5 we can obtain the following dynamic multipliers

$$\frac{\partial \pi_{t+i}}{\partial r_{Tt}} = \frac{\alpha_L \phi}{\gamma}(c_1\lambda_1^i + c_2\lambda_2^i)$$

$$\frac{\partial \pi_{t+i}}{\partial R_{St}} = -\frac{\alpha_L \phi\beta}{\gamma}(c_1\lambda_1^i + c_2\lambda_2^i)$$

$$\frac{\partial \pi_{t+i}}{\partial \varepsilon_t} = \phi\sigma_Y(c_1\lambda_1^i + c_2\lambda_2^i)$$

The threshold minimum rates

Table A1. Lending rate threshold for twenty-six economies plus other data series

	Lending Threshold %	Per capita GDP constant US$	Interest Spread %	Bank Credit % of GDP	Gross Fixed Capital Formation % of GDP
Algeria	8	2100	4.8	19	25.2
Angola	19	930	41	5	12.9
Armenia	17.5	1743	11.2	10.6	28.8
Belarus	10	1483	6.7	24.1	29.3
Bosnia & Herzegovina	6	2931	3.4	43.3	20.9
Estonia	4.5	5115	3.2	67.1	28.3
Guatemala	12.5	3450	9.1	32.9	17.6
Guyana	14.5	1012	11.4	54	23.8
Honduras	16.5	1211	8.9	40.4	25.6
Jordan	9	2161	4.5	95.2	23.8
Kenya	14	440	10.4	40.3	18.6
Lebanon	10	9737	4.5	158	24.8
Macedonia	9.5	1917	6.2	26.3	18.1
Malawi	24.5	161	21.8	19	18.7
Moldova	18.75	388	6.3	33.1	22.9
Mongolia	21	508	15.8	21.4	30.7
Namibia	11.75	1935	5.7	46.8	21.9
Oman	6.5	10005	4	35.1	25.6
Romania	12.5	1960	12.4	25.3	25.3
Russia	10.25	2400	8.9	25.7	19.7
South Africa	10.5	3200	4.5	175	17.9
Suriname	23	2288	10.9	26	21
Uganda	20	247	12.3	11	21.4
Ukraine	16.5	779	12.2	45.1	21.5
Uruguay	13.5	9841	14.8	48.1	16.5
Venezuela	16.5	4913	6.6	19.5	23

Data source: Author's calculation and World Development Indicators

Note: All series were averaged over the same period of each country's calculated lending rate threshold.

Figure A1. Lending rate threshold (%), loan-deposit rate spread (%) and per capita GDP (constant US$)

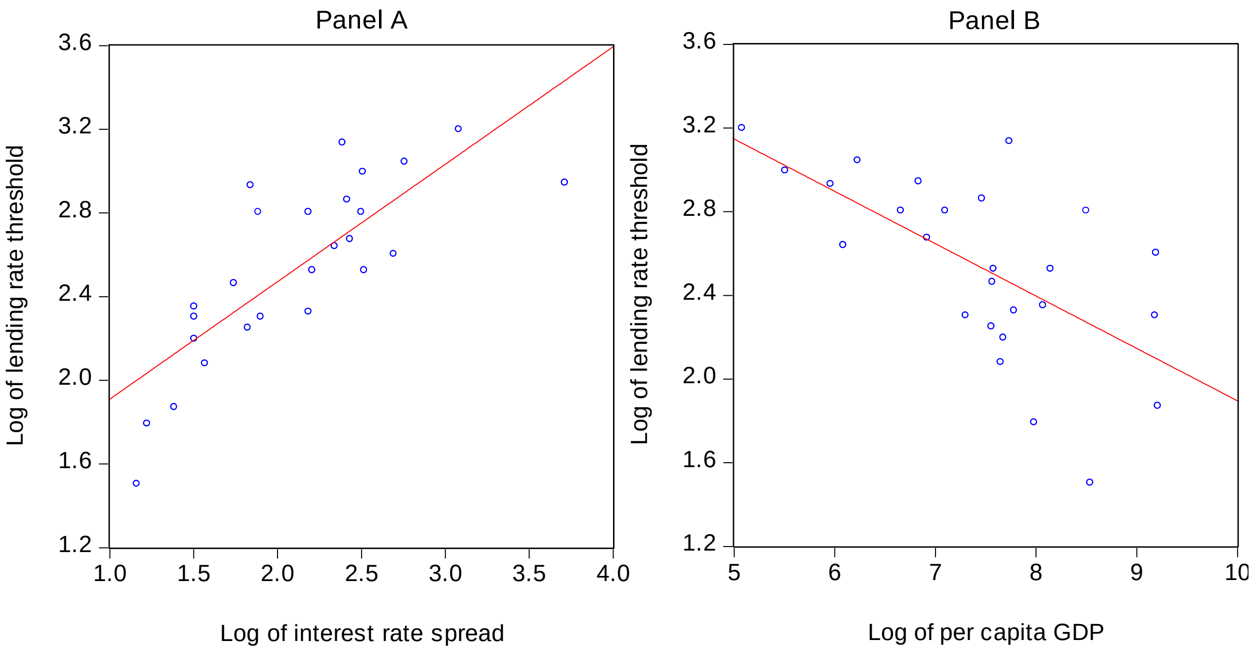


Figure A2. Lending rate threshold (%), commercial bank credit (% of GDP) and gross fixed capital formation (% of GDP)