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Excess reserves, interbank markets and domestic money market intervention

By

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Executive Summary

This paper considers whether relationships exist between the daily weighted average 7-day interbank rate, the change in the daily 7-day interbank rate, the daily level of commercial banks excess reserves and the change in the daily level of excess reserves, which may guide domestic money market intervention. Monetary survey data for the period 1st June 2011 – 13th September 2013 (i.e. inflation targeting lite period) is used.

Results show no correlation between excess reserves and interbank rate movements, even though a Granger causality test shows that in the absence of money market intervention, the level of excess reserves may determine both the level of and changes in the interbank rate. There is also highly significant causality from Central Bank intervention to the target interbank rate, but no correlation between the two. Furthermore, there is no evidence of correlation or causation between excess reserves and interbank rates when the interbank rate falls outside of the target. In conclusion, the relatively shallow nature of the Ugandan financial system prevents a distinct relationship between the interbank money market interest rate and commercial banks excess reserves, as a result a rules-based intervention policy is not suitable to Uganda.

JEL classification:

Key words: Monetary policy, Intervention, Excess reserves, interbank interest rate

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1 Introduction

At present, the Bank of Uganda hold a daily meeting, during which the Financial Markets Operations sub-committee (FMOS) considers a number of indicators including liquidity forecasting, daily exchange rate and interbank interest rate movements and market intelligence. This is aimed at deciding how the Bank should act in money markets over the day. The guideline is that financial markets and operation will intervene in the domestic money market if the weighted average 7-day interbank rate is deemed to be at risk of exceeding the band surrounding the Central Bank Rate. However, the aforementioned band is +/- 2 percentage points, which the monthly weighted average 7-day interbank rate has not fallen beyond since the 2nd July 2012, despite frequent money market interventions. One may argue then, that the Bank of Uganda's interventions may have kept the interbank rate within the set boundary, or interventions may be deemed to occur too frequently or unnecessarily.

Therefore there is perhaps reason to develop a set of guidelines for when intervention should be deemed necessary and when markets should be left to clear independently. Guidelines may be for internal use only or widely disseminated amongst financial markets. They may outline a level of volatility beyond which necessitates intervention, or an absolute level that if excess reserves or the interbank rate exceeds necessitates intervention. Furthermore, the nature of intervention may be clear-cut or deliberately vague. There are advantages to all of the aforementioned practices; keeping guidelines internally known only and keeping intervention guidelines deliberately vague allow for greater monetary policy space and discretion surrounding concerns other than inflation, but would still increase operational efficiency through aiding the decision-making process. Whereas a set of clear-cut and/or externally broadcast practices may enhance Central Bank credibility, and consequently the efficiency of any interventions.

Finally, there is also ample debate upon the optimal level of Central Bank intervention. Neo-classical economic theory might argue that a laissez-faire approach would enhance the depth and efficiency of financial markets and that central bank intervention essentially stifles domestic financial markets; that allowing commercial banks' the opportunity to maximise profits whilst encouraging free market competition to benefit the consumer should fathom the greatest aggregate utility gains obtainable. Comparatively, the neo-Keynesian school of thought and believers of the infant industry protectionism argument might argue in favour of central bank intervention; where markets do not behave perfectly, a free market approach may lead to an undesirable and highly inefficient outcome, therefore establishing a need for central bank intervention to force financial markets towards an equilibrium state. The shallow nature of the Ugandan financial system, affected by considerable information asymmetries and market concentration may thereby demand central bank intervention if the prevailing market failures will always prevent convergence to optimal market equilibrium. Alternatively, heavy central bank intervention may be maintaining the shallow nature of the Ugandan economy and preventing optimal market equilibrium from being obtained, thereby necessitating the need for a laissez-faire approach. However, it is important to highlight that a rules-based approach may adopt either school of thought; it may permit greater interventionism or it may demand less; the bottom line is that a rules-based approach may increase operational efficiency.

Following consideration of the optimal level of central bank intervention and what nature of rules-based approach may be most beneficial to the Ugandan economy, questions arise surrounding how to choose a rules-based framework. Currently the Bank of Uganda periodically intervenes in domestic financial markets to steer the weighted average 7-day interbank rate as close to the CBR as possible, within the target band.

This paper considers whether there are grounds for a rules-based approach to money market intervention, by considering the level of correlation and causation between the interbank rate and excess reserves and, upon finding some relationship, whether there is a certain level of excess reserves that creates a significant deviation of the 7-day interbank rate from target and thus warrants intervention. Finally, the paper discusses other findings arising from the calculations that hint towards a substitution effect between the interbank markets when excess reserves are particularly high. The daily weighted-average 7-day interbank rate and commercial banks' daily excess reserves position will be evaluated as intervention is intended to directly affect excess reserves and consequently the 7-day interbank rate; certainly the effect upon the interbank rate will determine the impact of intervention upon the monetary policy target and thus the success of the initial stage of the monetary policy transmission mechanism. A daily indicator is essential as intervention decisions are taken on a daily basis.

The rest of the paper is structured as follows: section 2 examines intervention practices in countries that adhere to a rules-based approach; section 3 considers whether a relationship exists between the interbank rate, excess reserves and domestic money market intervention in order to ascertain the effectiveness of money market intervention; section 4 assumes that money market intervention is an effective monetary policy tool and judges whether a rule may be constructed in accordance with the level of excess reserves in the financial system; section 5 presents the potential interbank substitution effect, an unexpected outcome in the relationship between excess reserves and interbank markets; whilst section 6 concludes.

2 Rules-based intervention practices in operation: some reflections

The Bank of England seeks to allow the market to self-regulate its liquidity requirements, therefore does not decide on a daily basis what level of liquidity to allow in the system, or what operations to adopt.

“The Bank intends the framework for its operations to be as transparent as possible. And it seeks to avoid discretion on its part in its regular operations, including in response to unexpected events.” (Bank of England, 2012, ‘The Framework for the Bank of England’s Operations in the Sterling Money Markets’, p. 13) As a result, its open market operations tend to follow a fairly automatic and rules-based procedure, as outlined below:

The Bank of England initially used a reserves-averaging scheme intended to automatically flatten the risk-free money market yield curve (up to the point of the next MPC decision date) and to minimize short-term volatility in the interbank money market. At the start of each maintenance period, banks' express a target for their average reserves over the coming maintenance period; however the actual level of reserves is allowed to fluctuate over the period in order to lessen potential interest rate volatility. Even on the final day of a maintenance period a bank can vary its reserves holding but still be remunerated at Bank Rate, so long as its average for the period remains within the target range. On the final day of each maintenance

period, the Bank adopts ‘fine-tune OMOs’, in order to exactly align banks’ reserves with their target. However, this is a transparent procedure that is not subject to any decision making process. *“This minimises the probability that the OSFs will need to be used, and should ensure that market rates on the final day of the maintenance period are in line with Bank Rate.”* (Bank of England, 2012, ‘The Framework for the Bank of England’s Operations in the Sterling Money Markets’, p. 5)

However, the adoption of quantitative easing would have created an excess of reserves and thereby offset money market rates, therefore the reserves average scheme was suspended in 2009. Since 2009, the Bank operates a ‘floor system’ whereby all reserves are remunerated at Bank Rate; this is designed to flatten the reserves demand curve beyond the point where daily liquidity needs are covered. *“As long as the Bank continues to supply reserves in excess of the quantity required for day to day liquidity needs, market interest rates should stay in line with Bank Rate”.* (Bank of England, 2012, ‘The Framework for the Bank of England’s Operations in the Sterling Money Markets’, p. 9)

Operations tend to occur according to the wants of the commercial banks, rather than according to what the Bank of England thinks will benefit the market; commercial banks may make payments to and from reserve accounts at anytime throughout the day (until the system closes), and may hold any level of reserves.

Within the markets department of the Bank, there are three committees that meet at regular intervals to discuss developments within different aspects of the interbank money markets. However these are much more official meetings that do not deal with specific daily needs; the sterling money markets liaison group and the securities lending and repo committee meet quarterly and the London foreign exchange joint standing committee meet approximately every two months.

To summarise, at the beginning of each maintenance period, commercial banks announce the level of excess reserves on their balance sheets that they assume will be necessary to align the domestic money market interest rate, the London Interbank Overnight Rate (LIBOR), with the Bank Rate. In this respect, the Bank of England and Bank of Uganda’s monetary frameworks are similar in that the Central Bank Rate targets a domestic money market interbank rate. The largest difference is that the interest rate targeted by the Bank of England is an overnight interbank rate, whilst that targeted by the Bank of Uganda is a 7-day interbank rate. The interbank market is then left to transact according to market forces, but it is known in advance that the Bank of England will intervene at the end of the maintenance period if excess reserves did not match banks’ initial projection. The operational standing facilities, or corridor surrounding Bank Rate, act to keep LIBOR within 25 basis points of the target band, as it would be unprofitable for banks to transact outside of this corridor. Perhaps unlike Uganda, commercial banks will tend to make use of the operational standing facilities in the UK instead of participating in unprofitable lending. Thus banks may assume that the interbank rate will average the Bank Rate over the maintenance period. If some banks overstate their profitable level of excess reserves for the period, and hold less than stated, LIBOR will rise towards the upper bound of the Bank Rate corridor, causing those banks to borrow at more expensive lending rates. At the end of the period, if banks’ excess reserves remain below their projection then the Bank of England will intervene to increase those banks’ balance sheets at the most expensive market rate, the upper bound of the Bank Rate. The story holds in reverse, if banks understate their profitable level of excess reserves for the period and hold more than initially stated. In this scenario, there will be an excess of excess reserves in the system and LIBOR will fall. Banks who

hold more excess reserves than stated will have missed out on alternative, and potentially higher yielding, investment opportunities, and will be forced to lend at a less profitable interbank rate. At the end of the maintenance period, if banks' excess reserves remain above their projected amounts then the Bank of England will intervene to decrease banks' balance sheets at the cheapest market rate, the lower band of the Bank Rate. The relationship between the interbank rate and excess reserves is taken as a given, but is left for the individual bank to calculate.

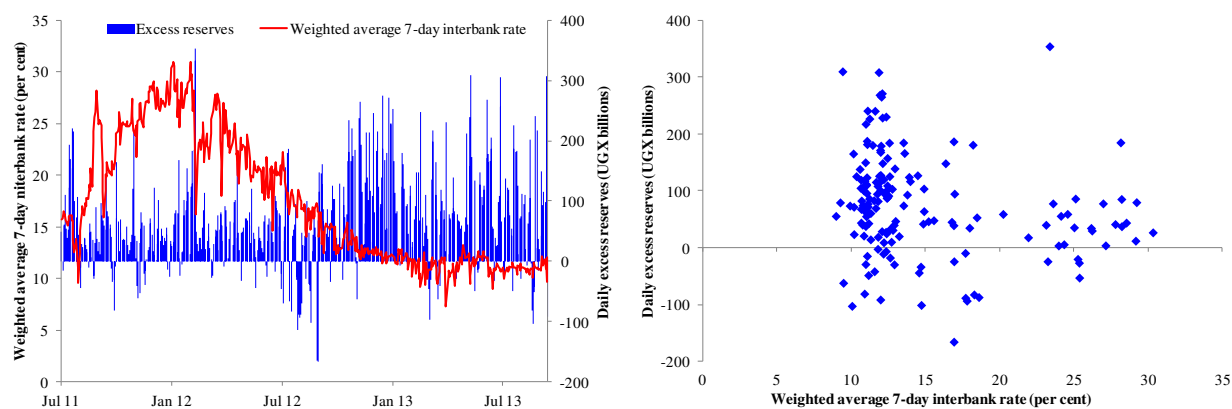
3 Are there grounds for a rules-based intervention mechanism?

Excess reserves and the interbank rate

Typically, excess reserves may be expected to lower interbank money market rates through alleviating commercial banks' money demand. Therefore one may expect negative correlation between the two variables. *Figures 1a* to *1b* attempt to capture the correlation between excess reserves and the weighted average 7-day interbank rate visually, using a dataset that has removed all of the effects, on the day, that an intervention in the domestic money market might have triggered in addition to the effects of intervention in the foreign exchange market, which are considered to experience a lag of two days.

Perhaps rather surprisingly, *figures 1a* and *1b* present almost no correlation between the weighted average 7-day interbank interest rate and the level of commercial bank excess reserves.

Figures 1a and 1b: The weighted average 7-day interbank rate vs. excess reserves



The weak correlation (-0.21) may be a result of the large movement in the interbank reference rate, the Central Bank Rate, over the period examined. Low excess reserves should theoretically be more likely to cause the interbank rate to increase, than to be at a 'high' level, given that the interbank rate may only be considered high in comparison to other rates in the economy. A fall in excess reserves should decrease liquidity supply and increase liquidity demand so that the price of liquidity rises, which should be reflected in increasing interbank interest rates. Thus stronger, negative correlation may be observed when the interbank rate is benchmarked against other rates in the economy.

Consequently, we may consider whether a relationship exists when the interbank rate and the level of excess reserves are benchmarked, against either the CBR or the maintenance period average. *Figures 2a*

to **3b** present the persistent lack of correlation between the interbank rate and excess reserves even when compared against seemingly sensible benchmarks.

Figure 2a: Excess reserves against the interbank rate premium above the CBR

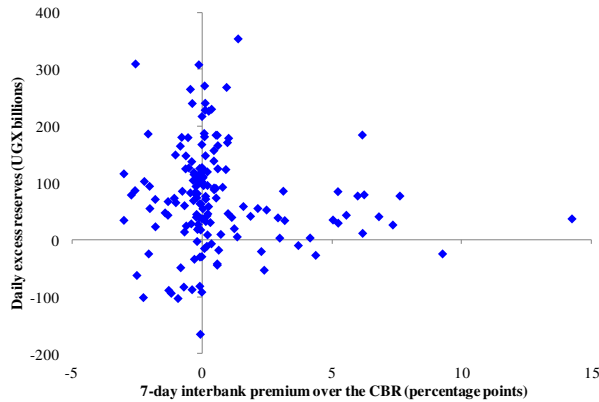


Figure 2b: Excess reserves against the difference between the interbank rate and the maintenance period average

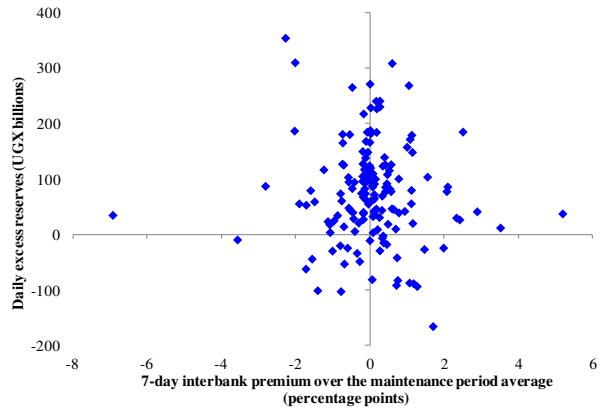


Figure 3a: The difference between excess reserves and the maintenance period average against the interbank rate premium above the CBR

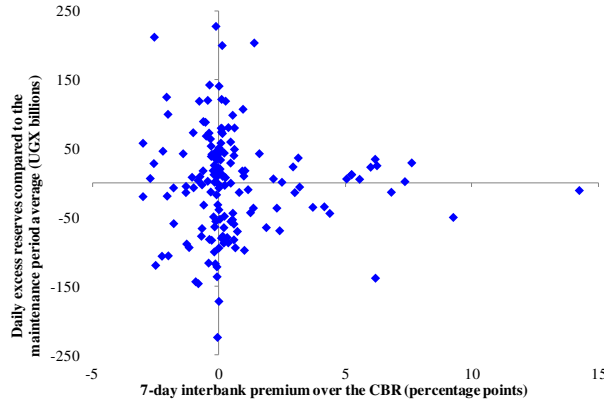


Figure 3b: The difference between excess reserves and the maintenance period average against the difference between the interbank rate and the maintenance period average

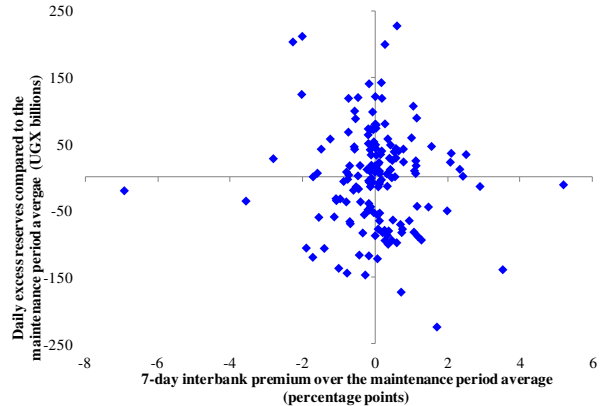


Table 1 confirms, as the scatter graphs illustrate, no correlation between excess reserves and interbank rate movements. The greatest correlation is actually demonstrated as a negative relationship between the daily level of excess reserves and the daily weighted average 7-day interbank rate (-0.21). Furthermore, Granger causality tests prove that, in the absence of money market intervention, the aggregate level of excess reserves may determine the aggregate level of the interbank rate and any deviations of the interbank rate from the CBR. The causality discovered runs in the direction expected, as the level of excess reserves should determine money demand experienced by commercial banks, and thereby the cost that they place on liquidity in the form of the interbank rate. However, the evidence also highlights that as the interbank rate strays from the maintenance period average, it is likely to drive excess reserves; this may be related to an end-of-period pattern whereby the interbank rate tends to drop at the end of each

maintenance period as banks seek to dispose of excess reserves that they may have been holding for precautionary purposes².

Table 1: Correlations and causations between developments in the interbank rate and excess reserves

		Excess reserves	
		Daily level	Difference from maintenance period average
Weighted average 7-day interbank rate	Daily level	<p><i>Correlation: -0.21</i></p> <p>Causation: <5% probability that excess reserves do not Granger-cause the weighted average 7-day interbank rate (P-value 0.0119)</p>	<p><i>Correlation: -0.05</i></p> <p>Causation: <10% probability that a difference in excess reserves against the maintenance period average does not Granger-cause the weighted average 7-day interbank rate (P-value 0.0645)</p> <p>>90% probability that the weighted average 7-day interbank rate does not Granger-cause a difference in excess reserves against the maintenance period average</p>
	Difference from CBR	<p><i>Correlation: -0.09</i></p> <p>Causation: <5% probability that excess reserves do not Granger-cause the interbank rate premium upon the CBR (P-value 0.0235)</p>	<p><i>Correlation: -0.05</i></p> <p>Causation: <10% probability that the difference in excess reserves against the maintenance period average does not Granger-cause the interbank rate premium upon the CBR (P-value 0.0747)</p>
	Difference from maintenance period average	<p><i>Correlation: -0.06</i></p> <p>Causation: <1% probability that the difference between the interbank rate against the maintenance period average does not Granger-cause excess reserves (P-value 0.0099)</p>	<p><i>Correlation: -0.08</i></p>

The results calculated in *table 1* reassuringly support the argument for domestic financial market intervention as causality typically runs from developments in excess reserves to those in the interbank market. If the level of excess reserves affects the weighted average 7-day interbank rate, which the Bank of Uganda seek to control, then the level of excess reserves should logically be observed and brought under control, through intervention, if they threaten the position of the 7-day interbank rate. Unfortunately this analysis provides no guide as to what level of excess reserves may threaten the 7-day interbank rate, owing to the lack of correlation observed. Therefore, it may only support an argument for a rules-based approach, but offer no further instruction.

Impulse response shocks may offer some further insight into the relationship behind the interbank rate and excess reserves. Given that causality may be assumed to run from excess reserves to the interbank rate, it is sensible to evaluate the effect upon the interbank rate of a shock to excess reserves. Furthermore, a shock to excess reserves may also be considered as a surprise intervention in the domestic money market.

Figures 4a and *4b* present the impact of a one standard deviation shock, defined as an exogenous, unexpected, temporary increase in excess reserves in period 0 with a 95 per cent confidence level, upon

² For more analysis into banks tendency to hold greater excess, or precautionary, reserves over the maintenance period than the statutory requirement see ‘Managing bank liquidity for achieving the CBR objective’ by Thomas D. Simpson

excess reserves and the interbank rate; *figure 4c* presents the impact of a one standard deviation shock, defined as an exogenous, unexpected, temporary increase in the interbank rate in period 0 with a 95 per cent confidence level, upon the interbank rate.

Figure 4a: The response of excess reserves to a shock in excess reserves

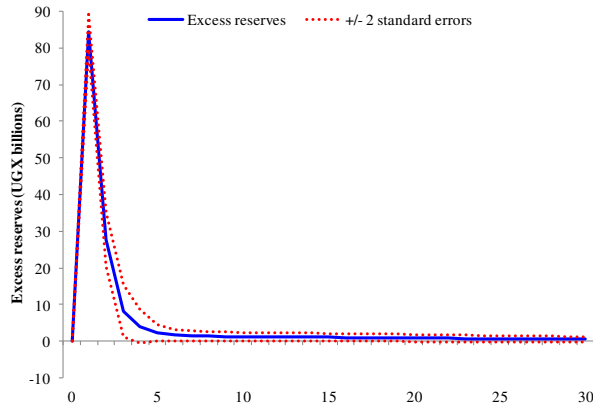


Figure 4b: The response of the interbank rate to a shock in excess reserves

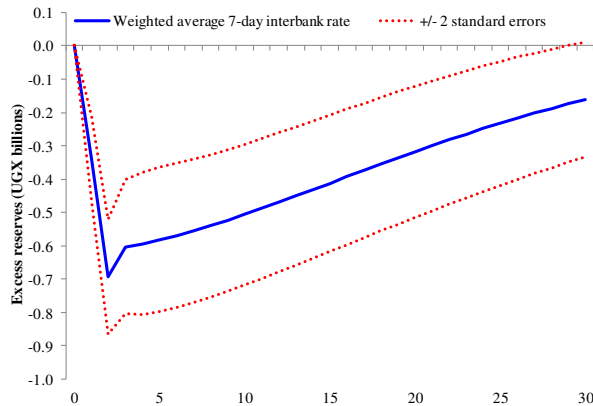
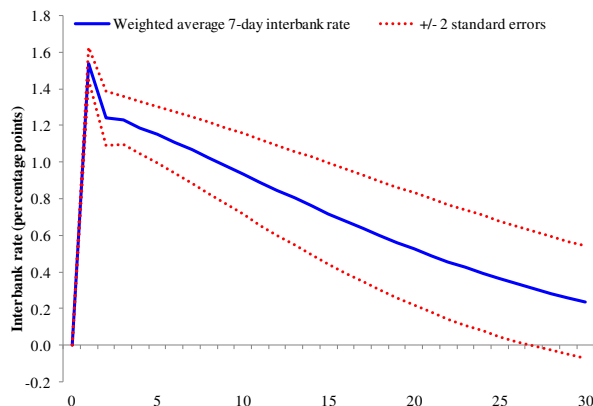


Figure 4c: The response of the interbank rate to a shock in the interbank rate



A one standard deviation shock to excess reserves, equal to UGX 84 billion in period 1, will disappear very quickly; the increase in excess reserves compared to their initial level will fall to below UGX 10 billion by period 3 and will remain at a negligible level for a sustained period before returning to the initial level after 58 periods.

The same shock to excess reserves will cause the interbank rate to fall immediately, by 0.3 percentage points in period 1, but will demonstrate the greatest impact upon the interbank rate in period 2: a decrease in the interbank rate of 0.7 percentage points. Subsequently the interbank rate will stabilise at a relatively constant rate; the impact of the shock will no longer be noticeable after 55 periods, but will be less than 0.1 percentage points after 35 periods.

One may interpret the above results to state that if the interbank rate increased by 0.7 percentage points above the CBR, it would necessitate a repo issuance worth UGX 84 billion to realign the two. However, note that there would also be some automatic realignment of the weighted average interbank rate. *Figure 4c* illustrates that a one-standard deviation shock to the weighted average interbank rate would be equal to 1.5 percentage points and would naturally disappear after 48 periods; however it would have halved with 13 periods and will be less than 0.5 percentage points above its initial level in less than 20 periods. Perhaps one may interpret that intervention may not be necessary unless the interbank rate has not fallen within this time frame, although this presents a wait-and-see

approach to policy implementation that may not be desirable.

The exchange rate and the interbank rate

Uganda has an extremely open capital account and relatively small domestic financial sector and thus accordingly international capital flows may also have a large effect upon domestic liquidity conditions and the interbank rate. Therefore, the exchange rate may also need to be considered to better understand the relationship between the interbank rate and excess reserves, or financial sector liquidity.

Table 3, below, presents correlation and Granger causality analysis between the USD/UGX bilateral exchange rate and the weighted average 7-day interbank rate, both at their daily levels and compared against logical benchmarks. **Figures 7a** and **7b** additionally illustrate the greatest correlations uncovered: between the daily interbank and exchange rates and between the difference between the interbank rate and the CBR and the difference between the exchange rate and its maintenance period average, using a dataset that has removed all of the effects, on the day, that an intervention in the domestic money market might have triggered in addition to the effects of intervention in the foreign exchange market, which are considered to experience a lag of two days..

Table 3: Correlations and causations between developments in the interbank and exchange rates

		UGX/USD exchange rate	
		Daily level	Difference from maintenance period average
Weighted average 7-day interbank rate	Daily level	Correlation: -0.38 Causation: <1% probability that the weighted average 7-day interbank rate does not Granger-cause the bilateral exchange rate (P-value 0.0031)	Correlation: 0.17 Causation: <10% probability that the weighted average 7-day interbank rate does not Granger-cause a difference in the exchange rate against the maintenance period average (P-value 0.0931)
	Difference from CBR	Correlation: 0.07	Correlation: 0.22 Causation: <5% probability that the difference in the exchange rate against the maintenance period average does not Granger-cause the interbank rate premium upon the CBR (P-value 0.0255)
	Difference from maintenance period	Correlation: -0.05	Correlation: 0.16

Figure 7a: The weighted average 7-day interbank rate against the daily UGX/USD exchange rate

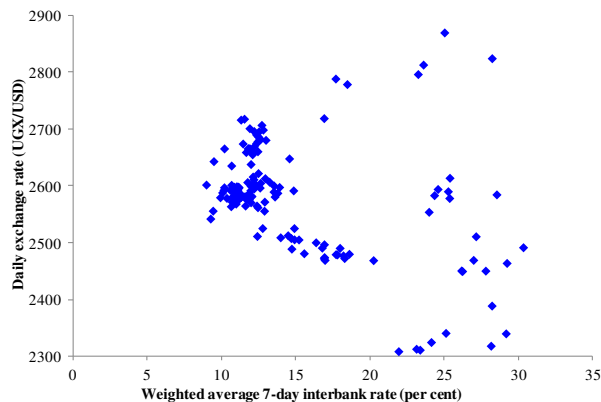
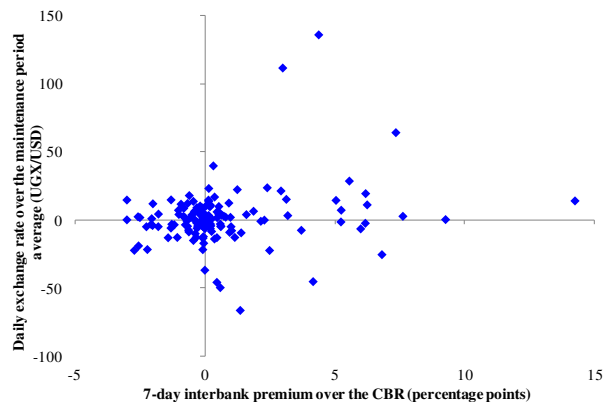


Figure 7b: The interbank rate premium above the CBR against the difference between the exchange rate and the maintenance period average



The results present the greatest correlation as a negative relationship between the daily weighted average 7-day interbank rate and the UGX/USD exchange rate, whilst Granger causality tests point to causality running from the interbank rate to the exchange rate. It is therefore likely that a low interbank rate, theoretically associated with surplus liquidity and thus low domestic money demand, may also foster depreciation. Alternatively, a high interbank rate may be considered to bring about an appreciation through attaching a higher price on domestic currency and increasing demand. So long as the exchange rate does not drive excess reserves, creating a circular relationship, then the exchange rate need not be considered alongside domestic money market interventions. Although interventions may affect the exchange rate, if there are no second round effects then the exchange rate should be allowed to fluctuate in accordance with the free-floating exchange rate regime³.

Nonetheless, it may be useful to acknowledge the expected path of the exchange rate following a shock to the interbank rate, as the Granger causality would anticipate. For policy purposes, this may be considered as a second round effect of domestic money market intervention: a shock to excess reserves in the form of intervention may create a shock to the interbank rate, which may drive the exchange rate.

Figures 8a and **8b** present the impact of a one standard deviation shock, defined as an exogenous, unexpected, temporary increase in the 7-day interbank rate in period 0 with a 95 per cent confidence level, upon the interbank and exchange rates.

³ Please see Montiel (2013) for proof that the exchange rate regime may be described as free floating, both de facto and de jure.

Figure 8a: The response of the weighted average 7-day interbank rate to an interbank rate shock

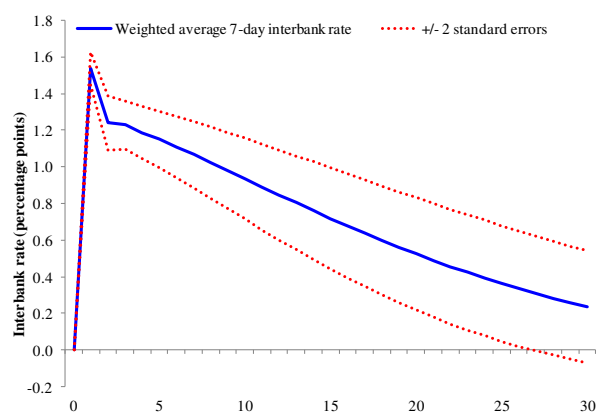
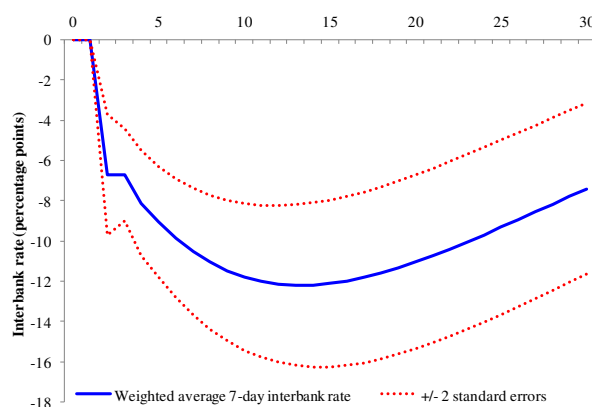


Figure 8b: The response of the UGX/USD bilateral exchange rate to an interbank rate shock



A shock to the interbank rate of 1.5 percentage points in period 1 will instantly fall by 0.3 percentage points in period 2 and then will stabilise at a relatively constant linear pace; it would take 48 periods for the full effect of the shock to disappear, but the effect would be at relatively low levels for some time before: after 30 periods the effect would already be below 0.25 percentage points.

Interestingly, the same shock to the interbank rate would have a much more long-lasting effect upon the exchange rate. The exchange rate will immediately react to a 1.5 percentage increase in the interbank rate by appreciating by 6.7 UGX in the second period; however, the exchange rate will continue to appreciate for 12 periods following the shock, reaching a total appreciation of 12.2 UGX. Subsequently the exchange rate will slowly stabilise, but will take 67 periods in total to return to its initial level.

Excess reserves and the exchange rate

Finally, to justify the above assertion that exchange rate developments may be unimportant to domestic intervention practices, it is important to assess whether any relationship exists between excess reserves and the exchange rate. If causality simply runs from excess reserves to the interbank rate to the exchange rate then domestic intervention need simply consider by how much one should change excess reserves when the interbank rate strays from target; if causality additionally runs from the exchange rate the excess reserves then this will complicate the decision making process surrounding intervention practices.

Table 4, below, presents correlation and Granger causality analysis between excess reserves and the USD/UGX bilateral exchange rate, both at their daily levels and compared against logical benchmarks, using a dataset that has removed all of the effects, on the day, that an intervention in the domestic money market might have triggered in addition to the effects of intervention in the foreign exchange market, which are considered to experience a lag of two days..

Table 4: Correlations and causations between developments in excess reserves and the exchange rate

		UGX/USD exchange rate	
		Daily level	Difference from maintenance period average
Excess reserves	Daily level	Correlation: 0.00	Correlation: -0.14
	Difference from maintenance period average	Correlation: -0.10 Causation: >95% probability that the difference in excess reserves against the maintenance period average does not Granger-cause the exchange rate (P-value 0.9615)	Correlation: -0.12 Causation: >90% probability that the difference in the exchange rate against the maintenance period average does not Granger-cause the a difference in excess reserves against the maintenance period average (P-value 0.9125)

Reassuringly there is no correlation or causation between excess reserves and the exchange rate. Thus causality may be considered to run from excess reserves to the interbank rate to the exchange rate, with minimal repercussion effects. The results above may allow policymakers to simplify the domestic intervention decision making process by omitting the exchange rate from any deliberations.

Whilst the lack of correlation in the above analysis fails to provide a clear rule for domestic money market intervention, the causation uncovered supports the effectiveness of domestic intervention. Intervention decisions may need to remain discretionary, although the impulse responses may help to demonstrate whether or not the interbank rate is following a path that may trend back to equilibrium.

4 Is there an optimal rule for intervention practices?

This section considers what degree of shortage, or surplus, in excess reserves, and thus financial market liquidity, should be tolerated before the Central Bank intervenes. The underlying assumption is that if a particular deviation of excess reserves from neutral, or a certain level of daily volatility exists and is likely to cause a definite shift in the 7-day interbank rate beyond what may plausibly be deemed as daily volatility, then this may guide the Bank of Uganda in its domestic financial market intervention practices. Ultimately, any money market intervention should be engineered in accordance with the Bank’s mandate to maintain the interbank rate within the target band.

An alternative way to analyse the data is to only consider occasions when the interbank rate falls outside of the target band. Using the evidence above that causality runs from excess reserves to the interbank rate to the exchange rate, if excess reserves are particularly extreme when the interbank rate falls outside of the target, then this may also help to guide intervention practices.

Table 5, below, presents correlation and Granger causality tests between excess reserves and the weighted average 7-day interbank rate in the following period in addition to the differences in the two variables compared to the maintenance period average and between the interbank rate and the CBR. The data only covers instances when the interbank rate falls more than 2 percentage points from the CBR; however the data includes days of intervention, as frequently such large interbank deviations from target would trigger some form of intervention and thus the sample would be extremely small otherwise. Furthermore, the data also compares excess reserves with the weighted average 7-day interbank rate in the next period; because

the impulse response results above demonstrate excess reserves to take greatest effect upon the interbank rate after a one period lag.

Table 5: Correlations and causations between developments in excess reserves and the interbank rate in the following period⁴

		Excess reserves	
		Daily level	Difference from maintenance period average
Weighted average 7-day interbank rate in following period	Daily level	<p><i>Correlation: 0.13</i></p> <p>Causation: <1% probability that excess reserves do not Granger-cause the interbank rate in the following period (P-value 0.0000)</p>	<p><i>Correlation: 0.16</i></p> <p>Causation: <1% probability that the difference between excess reserves and the maintenance period average does not Granger-cause the interbank rate in the following period (P-value 0.0002)</p>
	Difference from CBR	<p><i>Correlation: 0.21</i></p> <p>Causation: <1% probability that excess reserves do not Granger-cause the interbank rate premium above the CBR in the following period (P-value 0.0001)</p>	<p><i>Correlation: 0.23</i></p> <p>Causation: <1% probability that the difference between excess reserves and the maintenance period average does not Granger-cause the interbank rate premium above the CBR in the following period (P-value 0.0008)</p>
	Difference from maintenance period average	<p><i>Correlation: 0.29</i></p> <p>Causation: <10% probability that excess reserves do not Granger-cause the interbank rate premium above the maintenance period average in the following period (P-value 0.0651)</p>	<p><i>Correlation: 0.28</i></p> <p>Causation: <5% probability that the difference between excess reserves and the maintenance period average does not Granger-cause the interbank rate premium above the maintenance period average in the following period (P-value 0.0290)</p>

Figures 9a to 9d present some of the above correlations graphically. The greatest correlations may be seen in **figures 9a** and **9b**, between the difference in the weighted average 7-day interbank rate from the maintenance period average in the following period and excess reserves and between the former variable and the difference in excess reserves from the maintenance period average. Whilst the greatest causation may be seen amongst all other comparisons in **table 5**; **figures 9c** and **9d** present both the daily level of excess reserves and the difference in excess reserves from the maintenance period average against the difference in the interbank rate above the CBR in the following period; these charts still show some correlation, but mostly very high Granger causation.

⁴ Removing the effects of intervention from the same analysis would provide a dataset with only 35 data points and even lower correlation values.

Figure 9a: Excess reserves and the interbank rate premium above the maintenance period average in the following period

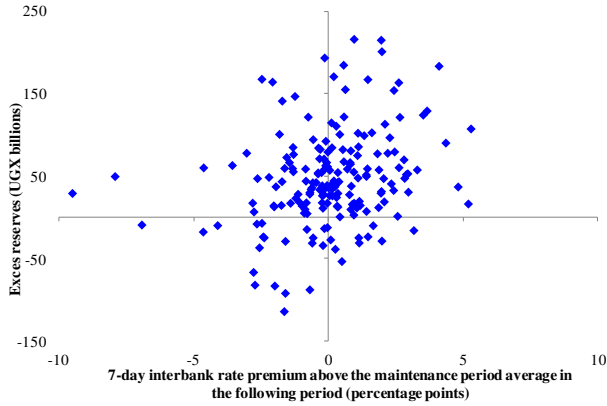


Figure 9b: Excess reserves over the maintenance period average and the interbank rate over the maintenance period average in the following period

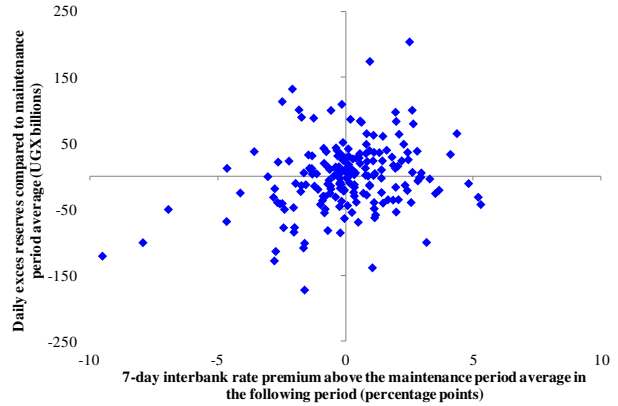


Figure 9c: Excess reserves and the interbank rate premium above the CBR in the following period

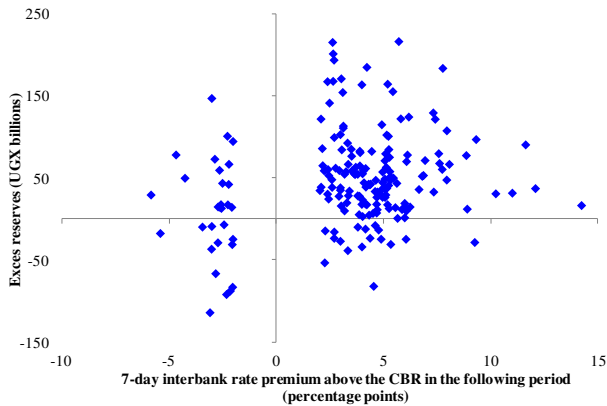
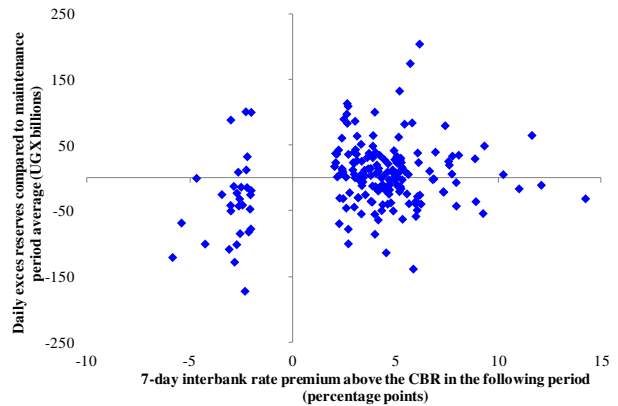


Figure 9d: Excess reserves over the maintenance period average and the interbank rate premium above the CBR in the following period



The correlations illustrated above are much stronger than previously, although still may not be considered particularly strong. Furthermore, the above analysis points towards positive correlation between excess reserves and the interbank rate, which contradicts monetary theory.

However, when the dataset only considers instances when the interbank rate falls more than 2 percentage points above the CBR, there is extremely strong causation from excess reserves and any differences between excess reserves over the maintenance period average to the weighted average 7-day interbank rate and the difference between the interbank rate and the CBR. Thus when the interbank rate differs by more than 2 percentage points from the CBR, it is very likely that the divergence was caused by some development in the level of excess reserves. This is as one might expect (ignoring the correlation outliers): that extreme interbank rates, or liquidity prices, are triggered by either restrictive or virtually unlimited liquidity supply.

As may be expected from the above correlations, excess reserves are not exceptionally high when the interbank rate falls markedly below the CBR, nor are they exceptionally low when the interbank rate falls markedly above the CBR. **Table 6**, below, demonstrates that there are 160 instances when the interbank rate rises more than 2 percentage points above the CBR, yet excess reserves average UGX 47.7 billion under such circumstances, compared to an average of UGX 64.3 billion since July 2011. Furthermore, there are 257 instances when excess reserves fall below UGX 47.7 billion, almost 100 more days than the interbank rate rises more than 2 percentage points above the CBR. Similarly, there are only 30 instances when the interbank rate falls more than 2 percentage points below the CBR; excess reserves average UGX 66.2 billion under such circumstances, compared to an average of UGX 64.3 billion since July 2011. Furthermore, there are 234 instances when excess reserves rise above UGX 66.2 billion, almost 200 more days than the interbank rate rises more than 2 percentage points above the CBR.

Table 6: Simple statistics for the interbank rate and excess reserves

	All data points	All data points removing the effects of central bank interventions	All instances when the interbank rate >2 percentage points above the CBR	All instances when the interbank rate >2 percentage points below the CBR
Weighted average 7-day interbank rate <i>(per cent)</i>	17.3	14.9	24.2	14.1
Premium attached to the interbank rate above the CBR <i>(percentage points)</i>	1.2	0.6	4.8	-2.9
Excess reserves <i>(UGX billions)</i>	64.3	74.0	47.7	66.2
The difference in excess reserves compared to the maintenance period average <i>(UGX billions)</i>	-0.1	-0.4	-0.2	13.8
Observations	556	156	160	30

There is some pattern between high interbank rates and low excess reserves and vice versa, but no established pattern. In total there are 190 instances, over a 556 day time period, when the interbank rate is more than 2 percentage points apart from the CBR; there are 491 instances when excess reserves fall outside of the average levels set by the boundaries above.

Low excess reserves should be expected to create greater liquidity demand and thus push up the price of liquidity in the form of the interbank rate, whilst high excess reserves should be expected to have the opposite effect to lessen liquidity demand and thus the interbank rate. Yet, excess reserves demonstrate more day-to-day volatility than the interbank rate, and thus the interbank rate may not respond to all changes in excess reserves.

Another point to consider is that high excess reserves may create a substitution from the 7-day interbank market to the overnight market, instead of lowering the weighted average 7-day interbank rate, and this may distort the theoretical relationship⁵. It is also likely that the underdeveloped Ugandan financial market prevents market clearing, encourages banks to hold surplus excess reserves and offers little investment alternatives. Khemraj (2007) proposes that the optimal amount of liquidity, or excess reserves,

⁵ Please see a note entitled 'excess reserves and interbank substitution' for more information

is much higher for commercial banks in developing economies than in developed economies; attributing higher transaction and transportation costs and a general lack of economies of scale in banking to a greater need to hold onto liquidity. Indeed, many developing financial markets are characterised by liquidity surpluses, which tend to diminish monetary policy efficiency.

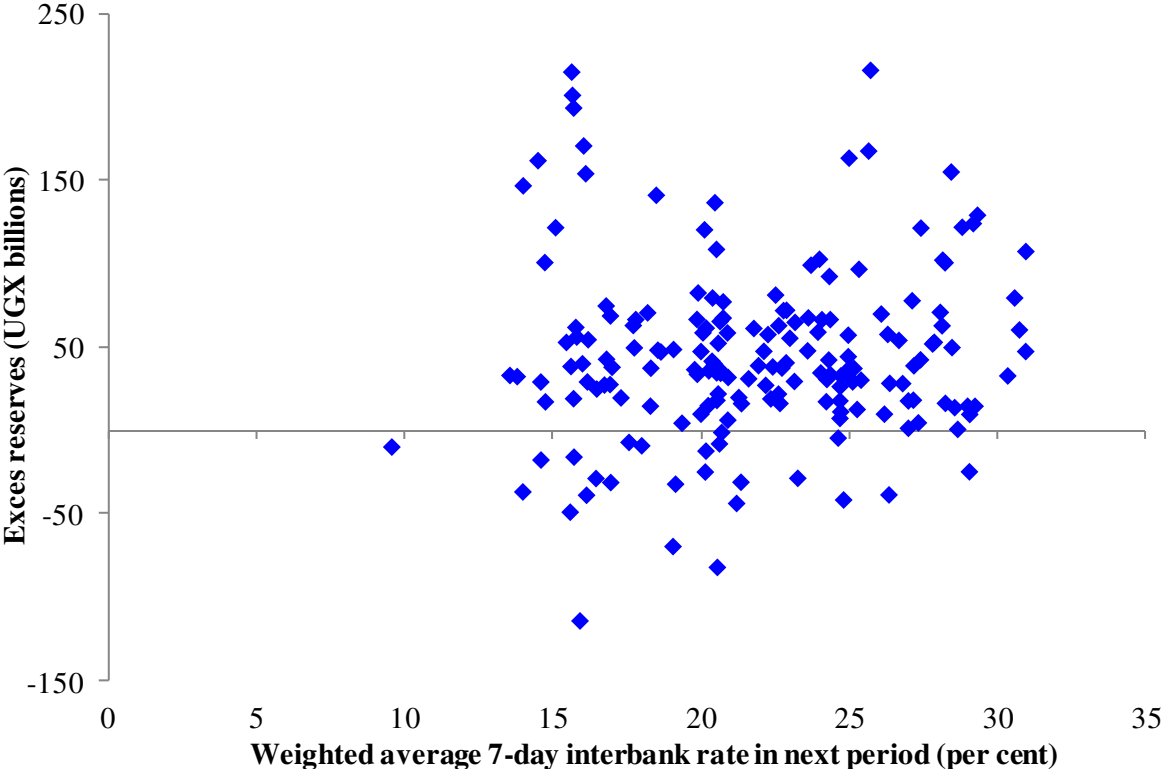
Therefore the data is unfortunately unable to present any clear indication as to what level of excess reserves might create the 7-day interbank rate to fall out of line with the target, and thus cannot guide policy in terms of money market intervention best practice.

5 The effect of intervention

Thus far the results indicate that excess reserves drive interbank rates, which in turn drives the exchange rate; high excess reserves tend to be associated with low interbank rates and low excess reserves with high interbank rates, however the correlation is weak. Therefore, intervention may well affect the interbank rate, via excess reserves, however daily intervention may have to be undertaken by discretion and analysis on the day.

This section will assess the effectiveness of intervention by evaluating the relationship between excess reserves on the day of intervention in the domestic money market and the weighted average interbank rate on the following day. Figure 10 presents the aforementioned data points graphically, whilst table 7 presents the correlation and causation results.

Figure 10: Excess reserves against the next period interbank rate under domestic money market intervention



There is weak, but negative correlation between excess reserves and the interbank rate following domestic money market intervention. Therefore a reverse repo, to inject liquidity in the financial system and increase commercial banks' excess reserves, may be considered to lower interbank rates in the following period; this is as monetary theory would assume and is how monetary policy is intended, thus provides some grounding for monetary policy effectiveness. Furthermore, there is very strong causation from excess reserves to the weighted average 7-day interbank rate and the premium attached to the interbank rate over the CBR, combined with a very unlikely probability that an interbank premium over the CBR will affect excess reserves. The latter is particularly reassuring to policymakers as it implies that interventions affect the interbank rate, but that the interbank rate is not likely to necessitate an intervention, thereby preventing arbitrage incentives amongst the dominant commercial banks.

Table 7: The effect of excess reserves upon the interbank rate following domestic money market intervention

		Weighted average 7-day interbank rate in the following period		
		Daily rate	Premium over the CBR	Difference from the maintenance period average
Excess reserves	Daily level	<p>Correlation: -0.16</p> <p>Causation: <1% probability that excess reserves do not Granger-cause the interbank rate in the following period (P-value 0.0000)</p>	<p>Correlation: 0.01</p> <p>Causation: <1% probability that excess reserves do not Granger-cause the interbank rate premium over the CBR in the following period (P-value 0.0004)</p> <p>Causation: >99% probability that the interbank rate premium over the CBR in the following period does not Granger-cause excess reserves (P-value 0.9974)</p>	<p>Correlation: 0.19</p>
	Difference from the maintenance period average	<p>Correlation: 0.04</p> <p>Causation: <5% probability that the difference in excess reserves against the maintenance period average does not Granger-cause the interbank rate in the following period (P-value 0.0243)</p>	<p>Correlation: 0.08</p> <p>Causation: <5% probability that the difference in excess reserves against the maintenance period average does not Granger-cause the interbank rate premium over the CBR in the following period (P-value 0.0362)</p>	<p>Correlation: 0.16</p>

It is plausible that a rules-based approach might almost automatically maintain the interbank rate within the target range as banks may be certain of the maximum/minimum levels of liquidity permitted in the system and thus extreme interbank rates, on account of heightened liquidity concerns, should not occur.

7 Conclusion

This paper has considered whether a rules-based approach may be used that would denote a particular level of excess reserves that might cause extreme values in the weighted average 7-day interbank rate and thus demand domestic money market intervention. It has analysed the weighted average 7-day interbank rate, the daily level of excess reserves and the daily UGX/USD exchange rate in an attempt to uncover some relationship between the variables. Furthermore the dataset initially removed all of the effects of

intervention to investigate a 'pure' relationship between the samples and subsequently investigated solely the effects of intervention to assess the effectiveness of monetary policy.

The evidence points to some correlation, in the expected direction, between the variables, although this correlation is very weak. Even extreme interbank rates, whilst most likely caused by developments in excess reserves, are not necessarily caused by particularly extreme values in excess reserves, or large deviations even from the maintenance period average. However, the paper highlights strong causation from excess reserves to the interbank rate and next to the exchange rate, which is as theory anticipates and comfortingly is in line with policy actions.

The paper uncovers particularly strong causality from excess reserves to the next day weighted average 7-day interbank rate on days of domestic money market intervention and a very unlikely probability of reverse causation. Again, this reassures policy in that domestic money market intervention is efficient, yet is unfortunately unable to present any policy implications pertaining to a rules-based intervention approach.

To conclude, the lack of correlation between excess reserves and interbank interest rates, even at more extreme interest rates, provide no evidence that a rules-based approach to money market intervention might work. Theoretically, a rules-based approach might still enhance market confidence, smooth volatility and create a system where the targeted interbank rate automatically stays within the target range, yet this is likely to be more applicable to well developed financial markets and instances where central bank credibility is unshakeable. Indeed, the difference between the Ugandan and English financial markets are stark. London may be considered as a global financial centre, and frequently deals with some of the most complex financial instruments in existence. By contrast, the Ugandan financial system is still developing; commercial banks make up the majority of financial institutions and instruments traded rarely stretch beyond government securities.

Furthermore, the size of the British financial system allows for greater competition, which lessens market imperfections, and greater information dissipation. As a result, British banks prefer to hold a minimum level of excess reserves, instead investing in profitable opportunities. Consequently, there is likely to be a higher degree of correlation between excess reserves and the interbank rate, or LIBOR, in the UK, thereby establishing space for a rules-based intervention approach to work efficiently.

Realistically, the level of financial market imperfections in Uganda, in that the shallow nature of the financial system allows anomalies to have greater influence upon the average rate and level of transactions, in addition to other distortions such as market concentration and information asymmetry, may cause difficulties for the ability of a rules-based mechanism to act so effectively, even as a credible signal to markets.

One final factor that may be important to note is that in the UK banks are allowed to independently judge the profitable relationship between excess reserves and the interbank rate, whereas this piece of analysis crudely attempts to judge a relationship across the whole financial sector in Uganda. It may be plausible that the correlation exists in Uganda, but varies across banks. Nonetheless, allowing banks' to independently assess their profitable level of excess reserves, that would align the CBR and interbank rate

over the maintenance period would require greater analysis given the room for arbitrage in Uganda's comparatively shallow financial sector.

However, it may be important to note that when excess reserves become particularly high a substitution effect may appear in favour of the overnight market, which monetary policy is currently unable to influence. Therefore, whilst our analysis does not support a rules-based intervention practice, it may suggest that high excess reserves should be contained in order to maintain the efficiency of monetary policy.

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