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SIGNS OF JIBAR MANIPULATION?

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We declare that the manuscript or a similar one has not been published and is not, nor will be, under consideration for publication elsewhere while being reviewed for the SAAA conference.

Abstract:

The JSE has recently come under pressure in the financial media to defend the integrity of the Johannesburg Interbank Agreed Rate (JIBAR) in the midst of the revelations of the long-term and systematic manipulation of the London Interbank Offer Rate (LIBOR) in the United Kingdom. The purpose of this paper is to investigate the extent to which there may be anomalies in the historical JIBAR that merit further investigation.

The paper finds that there is insufficient publicly available data from the JSE to test for profit-seeking manipulation by individual banks. In considering the available data, discrepancies were identified in the historic JIBAR obtained from different sources, and inconsistencies were noted in the types of data used to calculate the JSE zero coupon yield curves.

Based on the available data, no evidence was found of "day of the month" type manipulation of JIBAR. In seeking indications of possible "lowballing" activity, the 3 month JIBAR behaved very similarly to the 3 month British pound LIBOR. In contrast, over the height of the financial crisis, the 1 month JIBAR behaved in ways that cannot be readily explained. The anomalies in this rate support the need for further investigation.

Introduction

That LIBOR was manipulated extensively and over an extended period of time is now a matter of public record. The banks that were the first to be implicated have already received record-breaking fines, and the investigation into at least twenty banks across three continents continues (The Economist (1), 2013). The manipulation of LIBOR has been found to be systematic, widespread and continued for a number of years. Accusations of manipulations in the financial press were continually denied until academic research substantiating the claims made further denial impossible. The substance of these denials was often based on reasoning similar to that currently provided by the defenders of JIBAR in South Africa. Some of that reasoning has already been found by the South African press to be flawed.

This study proceeds on the assumption that there is need for rigorous academic investigation into whether there is any evidence of manipulation of JIBAR. This paper serves as an initial investigation, from which the merit of further investigation may be assessed. The following is a timeline of the significant events in the development of the LIBOR scandal:

15 November 2007	Minutes of the Bank of England Sterling Money Markets Group indicates concern that banks may be understating their submissions for LIBOR (Bank of England, 2007).
March 2008	The Bank for International Settlements in its quarterly review indicates that the data available does provide evidence of LIBOR manipulation (BIS, 2008: 70).
16 April 2008	A *Wall Street Journal* article suggests that banks may be submitting knowingly incorrect estimates of borrowing costs to manipulate LIBOR (Mollenkamp, 2008).
29 May 2008	A second *Wall Street Journal* article highlights discrepancies in banks' LIBOR submissions.
October 2008	The International Monetary Fund's *Global Financial Stability Review* supports the integrity of the US Dollar LIBOR (IMF, 2008).

April 2010	Paper by Snider and Youle (2010) identifies anomalies in banks' LIBOR submissions, including anomalies that corroborate the *Wall Street Journal* claims.
March 2011	The *Wall Street Journal* reveals that regulators are investigating the actions of Bank of America, Citigroup Inc. and UBS AG.
February 2012	Reuters reveals that investigations include criminal investigations by the US Department of Justice into LIBOR fixing.
30 April 2012	The city of Baltimore files a civil case against 19 banks for losses sustained on LIBOR-based instruments (US District Court, 2012).
27 June 2012	The United Kingdom regulatory body, the Financial Services Authority, finds that Barclays Bank Plc took into account the requests of its own derivatives traders in making LIBOR submissions, attempted to influence the submissions of other banks, and knowingly submitted understated submissions in order to manage market sentiment towards the bank. Barclays is fined £59.5 million by the FSA, $200 million by the Commodity Futures Trading Commission, and $160 million by the United States Department of Justice (FSA, 2012).
2 & 3 July 2012	Barclays chairman Marcus Agius and Barclays CEO Bob Diamond resign on successive days (BBC(1), 2012).
4 July 2012	Bob Diamond appears before United Kingdom Parliament. Diamond insists he did not know of LIBOR fixing until a month ago (Trotman, 2012).
9 July 2012	Paul Tucker voluntarily appears before parliament and states that he did not encourage banks to manipulate LIBOR (The Guardian, 2012).
10 July 2012	The United States Congress announces its own investigation into LIBOR manipulation, focusing on possible complicity of the New York Federal Reserve (Nasiripour, 2012).
15 July 2012	Canadian Competition Bureau releases information of its investigation into the fixing of yen-denominated LIBOR, based on information obtained from a whistle-blower.

27 July 2012	A *Financial Times* article claims that LIBOR manipulation had been occurring since 1991 (Douglas, 2012).
July 2012	Released documents show that in 2007 the New York Federal Reserve was aware of LIBOR manipulation (Gongloff, 2012).
25 September 2012	The British Bankers' Association agree to hand over future responsibility for the setting of LIBOR to the FSA (Wilson, 2012).
4 October 2012	Republican senators announce an investigation into the possible involvement of US Treasury Secretary Timothy Geithner (HITC Business, 2012).
15 October 2012	Class action filed by Alabama homeowners claiming losses suffered in mispricing of variable rate home loans due to LIBOR manipulation (Tourvalai, 2012).
3 November 2012	The Federal Housing Finance agency indicates that losses of $3 billion incurred by the Federal National Mortgage Association ("Fannie Mae") and the Federal Home Loan Mortgage Corporation ("Freddie Mac"), whose failure of which was integral to the precipitation of the 2007 financial crisis, may have been caused by manipulation of LIBOR (Benson, 2012).
19 December 2012	The US Commodity Futures Trading Commission finds UBS guilty of attempting to manipulate LIBOR between 2005 and 2010, both for profit and to manage market sentiment, and of more than 2 000 instances of unlawful conduct by its employees, including collusion with other banks to manipulate the rate (CFTC, 2012). Fines against UBS levied by the US Department of Justice, the Commodity Futures Trading Commission, and the United Kingdom FSA amount to is fined $1.2bn (BBC(2), 2012).

The purpose of this paper is to identify the tests used to identify LIBOR manipulation, to determine to what extent these tests can be reperformed in a South African context, and to perform initial investigations into whether there is evidence of data anomalies within the historical Johannesburg Interbank Agreed Rate (JIBAR) that merit further investigation.

The paper proceeds as follows: section 2 reviews the literature surrounding the manipulation of LIBOR, as well as considering the debate that has already emerged in the financial press over the possibility of JIBAR manipulation. Section 3 considers the availability of comparable South African data and defines how this may limit the testing that may be performed on JIBAR. Section 4 presents the findings of the statistical analysis of the South African data based on the possible tests identified. Section 5 discusses the implications of these findings, and identifies areas for further research. Section 6 concludes.

Literature review

How is LIBOR calculated?

The London Interbank Offered Rate (LIBOR) serves as a benchmark for $350 trillion in financial contracts (Masters et al, 2012). The rate is quoted daily at 11am, and until recently was overseen by the British Bankers' Association. LIBOR is calculated on the daily submissions of a panel of banks for ten currencies and fifteen maturities, of what each estimates it would be charged to borrow from other banks in the market. The most significant LIBOR is that of the three-month Dollar rate (The Economist (2), 2012), for which sixteen banks make daily submissions (BIS, 2008). The highest and lowest four estimates are discarded, and the remaining eight are averaged to arrive at LIBOR.

The rate submitted by each bank is considered a measure of its estimate of its own creditworthiness, since it represents the risk premium it would have to pay above the risk-free rate in order to borrow money. The submission is however an estimate; while the submissions made are in the public domain, they do not represent the rates at which any actual transactions have occurred.

Why did the banks manipulate LIBOR, and how was it identified?

The incentives to submit accurate estimates had previously been thought sufficient to safeguard the integrity of LIBOR. In its March 2008 quarterly review, the Bank for International

Settlements pointed to the reputational damage that a bank would suffer if it were to submit an estimated rate at which it was subsequently found to be unwilling to transact. Banks' submissions were matters of public record in order to promote this incentive. The report acknowledged that in certain circumstances this risk might be outweighed by other incentives to manipulate the rate, but argued that a single bank should in theory be unable to do this; since the highest and lowest four submissions are discarded, it would take in theory take collusion or at least similar intent among five banks to influence the rate in a particular direction. At the time, perceived anomalies in the LIBOR were attributed to lack of market liquidity and changes in strategic focus of individual banks in a time of crisis (BIS, 2008: 70).

However, as the truth about the long-term manipulation of LIBOR has emerged, three primary incentives for banks to manipulate LIBOR have been identified. Although these had been previously speculated upon in investigations by the financial press, it was research by Snider and Youle (2010) that provided the statistical evidence to support these suspicions.

Firstly, since banks may trade in instruments that are priced against LIBOR while at the same time being involved in the determination of LIBOR, a bank that was able to shift the rate in its favour could profit from the change in the market prices of the instruments. The exposure of Barclays to such instruments in 2007 was significant enough to result in a daily gain or loss of $40m from changes in interest rates.

Evidence of manipulation for profit was provided through the identification of "bunching" of around the fourth or twelfth quotes used to determine the day's LIBOR. Snider and Youle found that the LIBOR submissions of banks that had a significant trading exposure to LIBOR-referenced instruments were more likely to be found at the upper and lower ends of the range of quotes included in the eight used to determine LIBOR than banks without such exposure. This supported the proposition that these banks were trying to move the rate without submitting estimates that would be excluded from the sample (Snider and Youle, 2010).

The second reason cited is that the LIBOR submissions of each bank are a measure of credit risk, and therefore potentially both reflect and influence market sentiment. Prior to the financial crisis this may not have been a major concern, but in the midst of the crisis there was real concern that

banks would either go bankrupt or be nationalised. British banks were intent on avoiding a 'run on the banks' – a sudden mass withdrawal of funds beyond the level that the bank's liquidity could bear – the likes of which spelt the end of Northern Rock. To do this they would need to control market sentiment, which could (it was thought) be turned by banks' rate estimates. Banks might therefore wish to submit artificially low rates to indicate that there was no perceived problem with its credit risk. In this scenario the bank on its own is not trying to influence the overall LIBOR; it is not concerned with whether its submission forms part of the average or is discarded. But, when every bank is subject to the same threat and identifies the same means of managing it, the LIBOR could be artificially suppressed.

Snider and Youle found evidence of this by examining the market price of credit default swaps (CDS). Since banks do not trade on the rates they submit for LIBOR, a traded rate is needed for comparison. This was achieved by comparing the difference between the bank's CDS rate and its submitted rate. Since the CDS rate represents the market's perception of the bank's credit risk, and the submitted rate represents the bank's borrowing cost, the difference between the two should be the risk-free borrowing rate, which should remain constant. Snider and Youle however found that there were significant movements in this difference, and that often it fell below the risk-free rate, which could only occur if the estimate was understated or the market were willing to accept a guaranteed loss on CDS's. The lack of a strong correlation between the bank's estimate and corresponding CDS rate, and in particular an underrecognition of credit risk, indicates that banks were knowingly understating their submissions. This understatement had previously been identified (Thornton, 2009), but at the time had been attributed to a failure of the financial market to recognise the rising credit risk in that period.

The same article also compared LIBOR submissions among banks across different currencies. Since the currency risk implicit in each submission is constant across all submitting banks, the difference in banks' submissions should depend only on its assessment of its own credit risk, which is not currency dependent. The ranking of banks' submissions on any given day should therefore be constant across currencies, i.e. if Bank A submits the highest rate and Bank B the lowest in its Dollar estimate, Bank A should also be the highest and Bank B the lowest in their respective Yen estimates. Snider and Youle found that this was not consistently the case. This

further supports the hypothesis that banks were engaged in attempts to manipulate particular LIBOR rates.

The final possible reason for LIBOR manipulation is to influence the repricing of agreements that directly or indirectly reference LIBOR. In particular, mortgages in the US housing market are periodically repriced. Since this repricing occurs on a limited number of dates, if LIBOR could be influenced on those dates in favour of the lenders (the banks), interest income for the next period could be artificially inflated.

This is alleged to have been the case between 2007 and 2009, with rates being as much as 7.5 basis points higher than average on the first day of each month between August 2007 and February 2009 (Halahtouryalai, 2012). Further evidence was obtained from internal trader emails requesting manipulation of JIBAR specifically for this purpose (Binham, 2012).

Could JIBAR have been subject to manipulation?
The Johannesburg Interbank Agreed Rate (JIBAR) is South Africa's version of LIBOR. It is published daily at 11am by the Johannesburg Stock Exchange (JSE), which is responsible for its calculation in a manner similar to LIBOR – 9 banks submit quotes, the highest and lowest two rates are discarded, and the remaining five are averaged to arrive at JIBAR.

In the wake of the collapse of faith in LIBOR, the SARB was quick to respond to suggestions that South Africa's JIBAR might also have been open to manipulation. Central to the SARB's argument in its media release of 24 July 2012 was that, whereas LIBOR is based on estimates of a hypothetical transaction, JIBAR submissions are based on the rates at which each bank actually transacts on its negotiable certificates of deposit (NCD's). Banks' submissions are in the public domain, and since the submissions are meant to reference actual transaction rates, if a counterparty were unable to transact with the bank at that rate a complaint would be lodged against the bank. The SARB states that no such complaints have ever been received.

Furthermore, South African banks are required to submit both bid and offer rates, whereas United Kingdom banks submit only their offer rates. Submitting both rates is considered more

reliable because banks would either have to manipulate both rates or show a large bid-offer spread, which would be a warning sign to the SARB. The SARB also indicated that it had initiated a review of the JIBAR process in 2011 by the Financial Markets Liaison Group, the results of which were expected by the end of August 2012 but have not yet been released (South African Government Online, 2012).

Standard Bank CEO Jacko Maree also came out in support of the credibility of JIBAR. Maree cited "better governance and leadership values" and "an ethos and culture which is much stronger than in Europe and the USA" as the reasons why SA banks had not participated in rate manipulation (Moneyweb, 2012).

The soundness of the JSE's argument was quickly challenged by online financial site Moneyweb. In its investigation into JIBAR it revealed that it had identified 23 instances between 3 November 2008 and 14 December 2009 where the bid rate of an individual bank was lower than its corresponding offer rate (Rees, 2012). When pressed, the JSE indicated to Moneyweb that these had arisen due to capturing errors inverting the two rates. It also pointed out that since the JIBAR is calculated on the bid/offer spread this would not have had an effect on the day's JIBAR. Although the inversions in themselves are not evidence of attempted manipulation, it is clear that there is lack of control over the input data, and undermines the JSE's contention that the public nature of the quotes protects against misstatement. Moneyweb also noted that with a wide bid/offer spread of 15-25 points there was a lack of a meaningful benchmark against which anomalies in the spread could be identified.

Subsequent to the confirmation of LIBOR manipulation responsibility for the determination of JIBAR has been transferred from the JSE to the Reserve Bank.

Research approach and data

Research approach

The purpose of this study is to explore the possibility of the manipulation of the JIBAR around the time period of the global financial crisis. Exploratory research is sometimes claimed to be inferior to explanatory research, but when "we are in relatively uncharted waters and the most

useful thing to concentrate on is to explore" (Robson, 2011) the use of exploratory research is justified. Mathematician George Ellis (2007) concludes, in the context of complexity, that an "open minded explorative approach enables a freedom to engage with the whole". It is in this spirit that the paper progresses, to find not a definitive answer but one that acknowledges the limitations (and data shortcomings) faced. This social science study will make use of a qualitative approach. Some of the typical features of qualitative social research (as identified by Robson (2011)) that is emphasised in this study are:

- An inductive logic is used; i.e. the study starts with the data and what emerges from the data.
- The South African context is seen as important with JIBAR and its possible manipulation being specific to South Africa.
- The design of the study is flexible and might change as evidence emerges throughout the study.
- The findings are not meant to be generalisable and are purely specific to South Africa.
- The research will not take place inside a controlled environment but will be in a natural setting.
- The social world is viewed as a creation of the people involved.

The choice of a qualitative approach is not at the total exclusion of quantitative data. Most of the evidence used will be based on quantitative secondary data. The research strategy employed is that of a case study. Yin (2009) defines a case study as "a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence". This study will be an empirical investigation of the possibility that JIBAR has been manipulated (JIBAR immediately places the study within the South African context) and multiple sources of evidence will be considered.

The methods employed and data used will differ between the types of manipulation identified in the case of LIBOR.

Data and method

Three types of LIBOR manipulation became evident in the literature survey; traders that influenced the daily LIBOR submission; a day of the month effect where it was noted that on the day used to determine the rates charged on certain mortgages the reference LIBOR was higher than normal; and an industry wide "lowballing" of LIBOR during the height of the global financial crisis (undertaken in order to make the financial system appear healthier). The three types of manipulation and the data required to test for it is mapped to the data available in South Africa in the following table:

Manipulation type:	Data available:	Description:	Original source:
Trader influence on daily rate submission. Typically tested for by analysing daily individual bank submissions + internal bank communications	Bank submissions from 1 Jan. 2010	The input data for the calculation of Jibar	JSE
	Internal bank communication not available	Emails etc.	NA
Day of the month effect. Typically tested for analysing the daily quoted rate at month-end	Daily Jibar mid rates available	Rates as calculated off the daily submissions	JSE
Industry "lowballing" during crisis. Typically tested for by analysing the spread between the daily quoted rate and an actual rate	Daily Jibar mid rates available	Rates as calculated off the daily submissions	JSE
	OIS swap rate	What is used overseas for the actual rate. Market not liquid enough in SA	NA
	South African benchmark overnight rate on deposits (SABOR)	The Sabor is calculated with a 95 per cent weight to interbank funding at a rate other than the current repo rate and the Top 20 call rate (highest rates paid on non-bank deposits) and a 5 per cent weight to the implied rate on short-term funding through FX swaps	SARB
	Rand overnight deposit interest rate (RODI)	Weighted average interest rate received on SAFEX deposits	JSE
	Three month treasury bill rate	Treasury bills represent claims on the government payable on a certain date in the future	SARB

Table 1: Rate manipulation types mapped to money market data available in South Africa

To investigate the first type of manipulation it is necessary to have bank specific data. Ideally one would need access to email data and other communication between a bank's traders and the JIBAR submission department. At the very least one would need the daily JIBAR submission data. In January 2011, for the purposes of another study, the JSE made available to one of the authors the daily bank JIBAR submissions for the period August 2008 – December 2008. When the daily submission data was requested from the JSE (in July 2012) for 2007 – 2012 for the purposes of this study the JSE indicated that they only have the data available from January 2010 (JSE, 2012). This study will thus not investigate the first type of manipulation due to a lack of data.

To investigate the second type of manipulation the daily JIBAR is required. This is available from the original source, being the JSE. The data is also available from Bloomberg and as a first step we will compare the 1 and 3 month JIBAR received from the JSE with that from Bloomberg for the period 1 January 2007 to 31 December 2011. A dummy variable on the last or first day of each month will be used (for 1 month and 3 month JIBAR) to test for this type of manipulation.

Date	JSE		BLOOMBERG		JSE - BLOOMB.		
	JIBAR1M	JIBAR3M	JIBAR1M	JIBAR3M	1M	3M	
09 May 2007	9.21	9.39	9.04	9.21	0.17	0.18	Considering day before and after Bloomberg seems correct
19 November 2007	10.56	10.83	10.55	10.92	0.01	-0.09	No obvious explanation
16 January 2008	11.28	11.36	11.28	11.37	0.00	0.00	No obvious explanation
29 February 2008	11.15	11.31	11.15	11.32	0.00	-0.01	No obvious explanation
29 April 2008	10.65	11.83	11.65	11.83	-1.00	0.00	Obvious mistake in JSE
29 May 2008	10.20	12.58	12.20	12.58	-2.00	0.00	data
24 June 2008	12.14	12.33	12.15	12.33	-0.01	0.00	No obvious explanation
09 December 2008	11.70	11.78	11.70	11.58	0.00	0.19	Considering day before and after Bloomberg seems correct
23 April 2009	9.12	7.68	9.12	8.55	0.00	-0.87	Considering day before and after Bloomberg seems correct
19 October 2009	0.00	0.00	6.97	7.18	-6.97	-7.18	
20 October 2009	0.00	0.00	6.98	7.18	-6.98	-7.18	
21 October 2009	0.00	0.00	6.98	7.18	-6.98	-7.18	Observations missing in JSE data
22 October 2009	0.00	0.00	6.98	7.22	-6.98	-7.22	
23 October 2009	0.00	0.00	6.98	7.23	-6.98	-7.23	
19 January 2011	5.44	5.50	5.44	5.55	0.00	-0.05	Considering day before and after Bloomberg seems correct

Table 2: Differences identified when comparison is done between source JIBARs (JSE) and information provider JIBARs (Bloomberg)

When comparing the JIBARs available from the source (JSE) and the JIBARs available from an information supplier (Bloomberg) for the period 1 January 2007 to 31 December 2011 for maturities of 1 month and 3 months, 15 instances where differences exist can be identified. Excluding the missing observations in the JSE data for October 2009 most of the differences are concentrated in 2008 and specifically the time period around the global financial crisis. Implications that arise are: first, that Bloomberg JIBAR data seems more reliable and will be

used in any of the tests conducted and second, that the lowest detail available on Bloomberg for JIBAR rates is the daily midrate quotation. The last point became apparent when the "last price" and the "Ask price" data received from Bloomberg for 1 month and 3 month JIBAR turned out to be exactly the same; in other words JIBAR quotations and spread information are not available on Bloomberg.

The last type of manipulation will also be investigated by this study as again it relates not to individual and unavailable bank data but rather to industry aggregated data. Overseas the spread of LIBOR over an actual traded reference rate was often analysed as an indicator of this type of manipulation:

$$Quoted\ rate - actual\ traded\ rate = spread \qquad\qquad (1)$$

In its defence of the integrity of JIBAR, the JSE argued that the JIBAR is an actual rate and not a quoted rate like LIBOR. In practice it is not obvious how the JIBAR differs from a quoted rate; the Moneyweb investigation clearly showed that it is not possible to trade on the submitted JIBAR. If JIBAR was an actual rate then the spread calculated according to formula *(1)* would have been nonsensical; our expectation is that the spread will exist and have information content. The first step in the study of the "lowballing" type of manipulation would be to calculate a suitable spread for JIBAR and compare it to a similar spread for LIBOR. Any large differences will be highlighted and investigated.

JIBAR 1 month and 3 months for the period 1 January 2007 to 31 December 2011 as supplied by Bloomberg will be used as the quoted rate. The two rates are compared in the following graph:
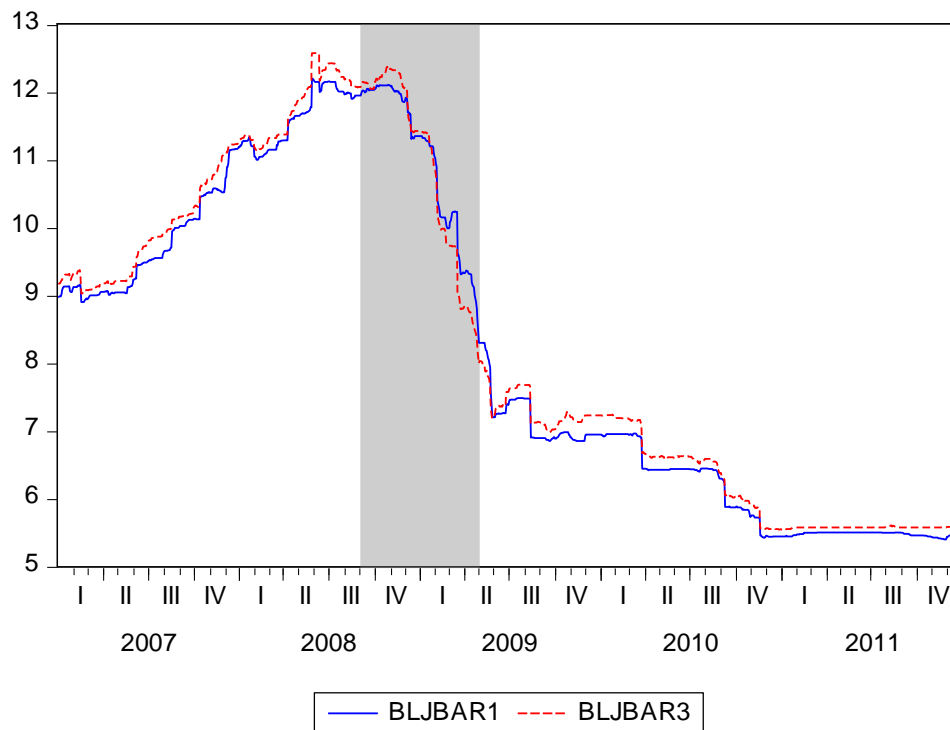
Graph 1: 1 month JIBAR compared to 3 month JIBAR (all from Bloomberg). The period highlighted is the peak crisis period 1 September 2008 – 30 April 2009

What is apparent from the graph is that during the peak of the crisis period the yield curve in South Africa inverted, in that short maturity JIBAR was higher than longer maturity JIBAR. A similar comparison of LIBOR shows that this did not happen in the United Kingdom, and is perhaps suggestive of strange happenings in the South African money market.
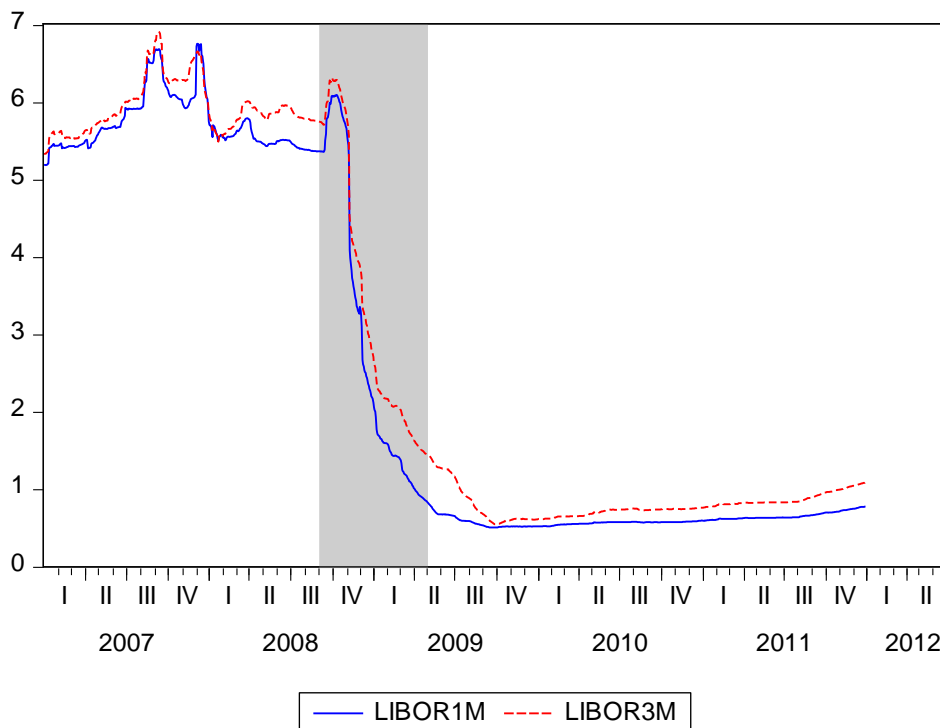
Graph 2: 1 month GBP LIBOR compared to 3 month GBP LIBOR (all from Bloomberg). The period highlighted is the peak crisis period 1 September 2008 – 30 April 2009

The actual rate to use in calculating the spread is more difficult. The overnight indexed swap (OIS) rate became popular as the actual rate overseas when the problems with LIBOR started to emerge (West, 2011:1). An OIS is a swap of fixed interest for floating accrued interest, where the floating rate is an overnight rate, and capitalisation occurs daily throughout the period of the swap. OIS rates are not available in South Africa, and another interest rate will therefore have to be used for the actual rate in the spread calculation.

It is easier (than for the 1 month JIBAR) to find an actual rate for the spread calculation of 3 month JIBAR, as a risk free instrument trades in our market with the same maturity; the 3 month treasury bill. The source of the data is the SARB, which makes this discount rate available on a weekly basis. As JIBAR is a yield, it cannot be directly compared to a discount rate. Bloomberg provides the rate as a yield, but only from 1 April 2008. Data for the period 1 January 2007 to 1 April 2008 was sourced from the SARB and converted to a yield. To summarise: the 3 month JIBAR can be compared to the 3 month treasury bill which is unfortunately only available weekly; the implication is that this will bring some noise into the spread. This spread can then be

compared to the spread between the 3 month British pound LIBOR and the 3 month British treasury bill rate.

For the 1 month JIBAR spread calculation a 1 month treasury bill rate is not available (as it is in the United Kingdom). We will have to make use of another actual interest rate and unfortunately the only options available have overnight maturities and not 1 month maturities. The implication is that we will bring some yield curve movement noise into our spread calculation (we will later attempt to correct for this noise). To summarise: the 1 month JIBAR can be compared to an actual overnight interest rate; the implication is that this will bring some noise into the spread. This spread can then be compared to the spread between the 1 month British pound LIBOR and the 1 month British treasury bill rate.

The actual overnight rate to use is a choice between the South African benchmark overnight rate on deposits (SABOR) from the SARB and the Rand overnight deposit interest rate (RODI) from the JSE. SABOR is calculated with a 95 per cent weight to interbank funding at a rate other than the current repo rate and the Top 20 call rate (the highest rates paid on non-bank deposits) and a 5 per cent weight to the implied rate on short-term funding through foreign exchange swaps. The SARB gives no indication of what portion of the 95% is allocated to interbank funding and what portion is allocated to the Top 20 call rate. RODI is the weighted average interest rate received on SAFEX deposits. It is obvious that RODI is an offer rate whilst it is probably safe to assume that SABOR is also an offer rate as the Top 20 call (thus an offer rate) rate is included in SABOR. The implication is that, notwithstanding which actual rate we use, we will be comparing a midrate (JIBAR) with an offer rate. When we compare the GBP 1 month LIBOR as a quoted rate with GBP treasury as an actual rate we are using an offer rate (LIBOR) minus a midrate (treasury). The following table summarises:

	Spread calculation		Correction needed for comparability
SA 1 month	JIBAR - SABOR	Midrate – offer rate	-0.1%
UK 1 month	LIBOR - TREASURY	Offer rate – midrate	+0.1%
SA 3 month	JIBAR – Treasury	Midrate - midrate	No adjustment
UK 3 month	LIBOR - Treasury	Offer rate - midrate	+0.1%

Table 3: Comparability between JIBAR spreads and LIBOR spreads

The rationale behind the correction in Table 3 above is based on the assumption that the average spread between bid and offer rates in the United Kingdom and in South Africa is 20 basis points and that the ideal calculation is midrate minus midrate. As an example of the logic applied, in the case of JIBAR minus SABOR (midrate minus offer rate) the spread that results will be larger than if SABOR was also a midrate; to correct we reduce the calculated spread by 0.2/2=0.1%.

In our analysis we will use SABOR as the actual rate, since SABOR contains actual interbank transactions. Our goal is to compare a bank quoted rate with an actual bank traded rate. The graph of the differences between SABOR and RODI over the peak of the crisis period 1 September 2008 to 30 April 2009 supports this approach:
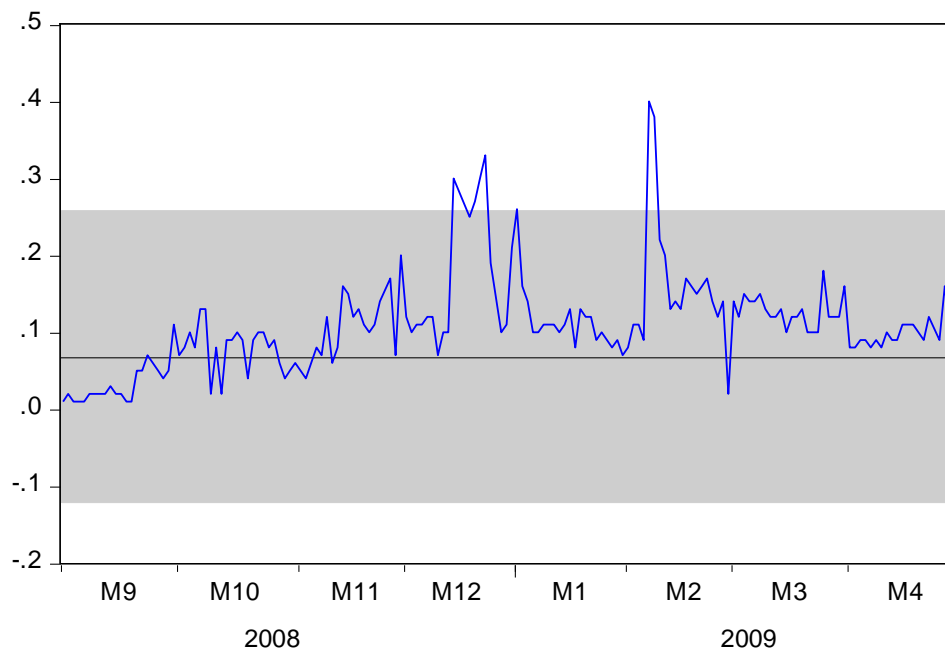
Graph 3: SABOR minus RODI during the height of the global financial crisis. The line is the average difference for the period 1 January 2007 to 31 December 2011 and the shaded area represents 1 standard deviation away from the mean for the same period

Graph 3 shows that during the peak of the crisis period SABOR was consistently higher than RODI. If we thus use the higher rate in the calculation of the spread it will result in a smaller or more conservative spread estimate.

As a final comment on South African money market interest rates emerging from our investigation, it is worth expressing concern over the inputs used to construct the JSE zero-coupon yield curves. The SAFEX overnight rate is used to anchor the short end of the nominal bond curve and the nominal swap curve (JSE, 2013). It could be seen above that SAFEX is consistently below SABOR, and arguably reflects higher credit risk than SABOR. For this reason SABOR may perhaps be a more appropriate rate to use. More importantly, SAFEX (and SABOR) is an offer rate. Treasury bills for 91, 182, 273 and 365 days are also used as inputs into the nominal bond curve calculation. With the use of the treasury bill rates there is no problem with credit risk, but it is significant to note that these rates are midrates. In this short part of the yield curve there is therefore a lack of consistency in terms of bid, offer or midrates used. Similarly, the nominal swap curve uses JIBAR 1 month and JIBAR 3 month as inputs in addition to SAFEX, with the implication that this is also a mix of an offer rate and midrates.

Results

Day of the month manipulation

We investigate the second type of manipulation by using regressions with JIBAR as the variable to be explained and explanatory variables a constant and dummies for the last day and first day of the month. The results are presented below:

Dependent Variable: BLJBAR1
Method: Least Squares
Date: 02/13/13   Time: 14:04
Sample: 1/02/2007 12/30/2011
Included observations: 1251

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.271089	0.071232	116.1140	0.0000
FDOM	0.015994	0.317365	0.050396	0.9598
LDOM	-0.037823	0.317365	-0.119177	0.9052

R-squared	0.000014	Mean dependent var		8.270042
Adjusted R-squared	-0.001589	S.D. dependent var		2.393672
S.E. of regression	2.395573	Akaike info criterion		4.587517
Sum squared resid	7161.985	Schwarz criterion		4.599823
Log likelihood	-2866.492	Hannan-Quinn criter.		4.592143
F-statistic	0.008696	Durbin-Watson stat		0.000423
Prob(F-statistic)	0.991342			

Table 4: 1 Month JIBAR regression with dummies for first and last days of the month

For the period 1 January 2007 to 31 December 2011 the average daily 1 month JIBAR was 8.27%, while on the first day of the month the average is 0.02% higher and on the last day of the month the average is 0.04% lower. The size of these coefficients are a lot lower than the 7.5 basis points increase observed in LIBOR, according to a lawsuit in the United States of America (Binham, 2012), and these dummies are not statistically significant. The conclusion is thus that we cannot find evidence of a day of the month JIBAR manipulation (1 month JIBAR).

Dependent Variable: BLJBAR3
Method: Least Squares
Date: 02/13/13   Time: 14:14
Sample: 1/02/2007 12/30/2011
Included observations: 1251

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.400286	0.071431	117.5993	0.0000
FDOM	0.024064	0.318251	0.075615	0.9397
LDOM	-0.033886	0.318251	-0.106474	0.9152

R-squared	0.000014	Mean dependent var	8.399815
Adjusted R-squared	-0.001588	S.D. dependent var	2.400358
S.E. of regression	2.402263	Akaike info criterion	4.593095
Sum squared resid	7202.044	Schwarz criterion	4.605401
Log likelihood	-2869.981	Hannan-Quinn criter.	4.597721
F-statistic	0.008956	Durbin-Watson stat	0.000420
Prob(F-statistic)	0.991085		

Table 5: 3 Month JIBAR regression with dummies for first and last days of the month

For the period 1 January 2007 to 31 December 2011 the average daily 3 month JIBAR was 8.40%, while on the first day of the month the average is 0.02% higher and on the last day of the month the average is 0.03% lower. The size of these coefficients are similarly a lot lower than the 7.5 basis points increase in Libor referred to earlier and these dummies are not statistically significant. The conclusion is thus that we cannot find evidence of a day of the month JIBAR manipulation (3 month JIBAR).

JIBAR "lowballing"

We investigate the third type of manipulation by calculating a spread for 1 month and 3 month JIBAR as elucidated above. The 1 month JIBAR spread has been reduced by 0.1%, and the resultant spreads are then compared to similarly calculated United Kingdom spreads.
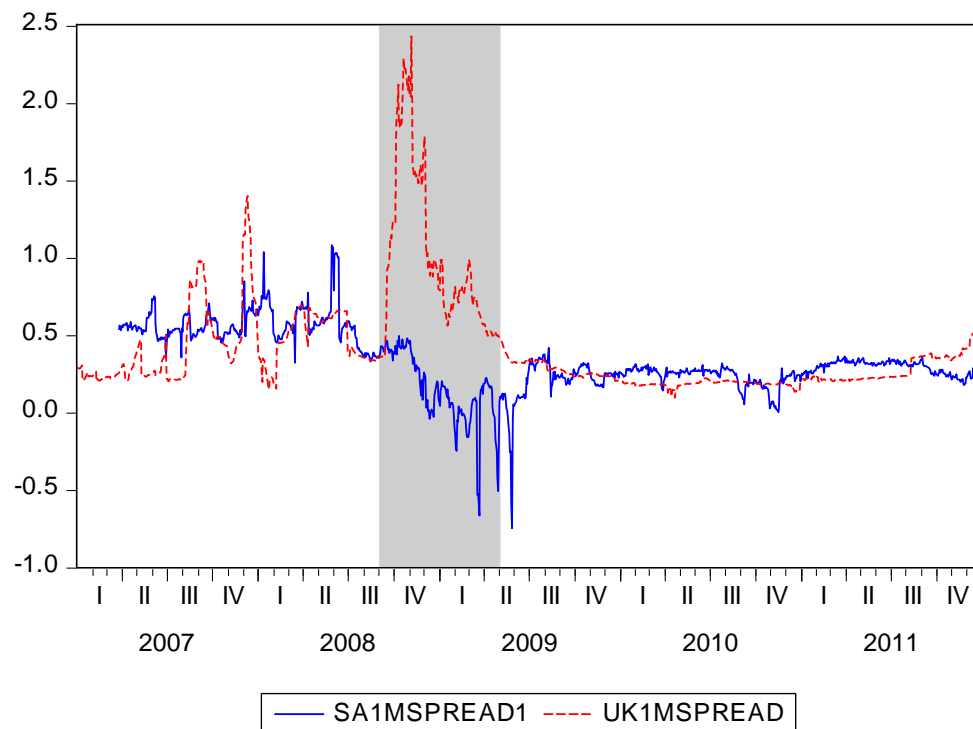
Graph 4: 1 month JIBAR spreads versus 1 month Libor spreads (unadjusted for yield curve effects). The period highlighted is the peak crisis period 1 September 2008 – 30 April 2009

Regressions for both series with the spread as variable to be explained by a constant and a dummy for the height of the crisis period give some summary statistics:

Dependent Variable: SA1MSPREAD1
Method: Least Squares
Date: 02/13/13   Time: 14:55
Sample (adjusted): 3/27/2007 12/30/2011
Included observations: 1169 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.355311	0.006143	57.83859	0.0000
CRISISDUM	-0.197348	0.016502	-11.95892	0.0000
R-squared	0.109171	Mean dependent var		0.327962
Adjusted R-squared	0.108408	S.D. dependent var		0.206454

S.E. of regression	0.194942	Akaike info criterion		-0.430520
Sum squared resid	44.34879	Schwarz criterion		-0.421856
Log likelihood	253.6388	Hannan-Quinn criter.		-0.427252
F-statistic	143.0158	Durbin-Watson stat		0.092212
Prob(F-statistic)	0.000000			

Table 6: 1 Month South Africa spread regression with a constant and crisis dummy

Dependent Variable: UK1MSPREAD
Method: Least Squares
Date: 02/13/13   Time: 14:57
Sample: 1/02/2007 12/30/2011
Included observations: 1255

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.322258	0.007942	40.57637	0.0000
CRISISDUM	0.695060	0.021643	32.11539	0.0000

R-squared	0.451497	Mean dependent var		0.415856
Adjusted R-squared	0.451059	S.D. dependent var		0.353250
S.E. of regression	0.261725	Akaike info criterion		0.158550
Sum squared resid	85.83064	Schwarz criterion		0.166733
Log likelihood	-97.48984	Hannan-Quinn criter.		0.161625
F-statistic	1031.398	Durbin-Watson stat		0.048139
Prob(F-statistic)	0.000000			

Table 7: 1 Month United Kingdom spread regression with a constant and crisis dummy

Graph 4 shows that before and after the height of the crisis the South African 1 month spread and the United Kingdom 1 month spread was very similar in terms of its mean value. Before the height of the crisis the volatility of the United Kingdom spread was more than that of the South African spread but after the crisis period the two series are very similar again. It was during the height of the crisis that the South African 1 month spread diverged substantially from the United Kingdom 1 month spread. In South Africa the spread even turned negative. This is quantified by the regression results in Table 6 above, which shows that the South African average over the period was 0.36% decreasing to 0.36%-0.2%=0.16% during the crisis; the United Kingdom average was 0.32% increasing to 0.32%+0.70%=1.02% during the crisis. As indicated previously this extreme divergence could be due to the inversion of the yield curve in South Africa (this has an impact on our spread as 1 month JIBAR and overnight SABOR is not of the same maturity).

To quantify the possible size of this effect the following regression was used that explained 1 month JIBAR with a constant, 3 month JIBAR and a crisis dummy:

Dependent Variable: BLJBAR1
Method: Least Squares
Date: 02/13/13   Time: 15:31
Sample: 1/02/2007 12/30/2011
Included observations: 1251

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.019094	0.014032	1.360732	0.1738
BLJBAR3	0.977715	0.001683	580.8865	0.0000
CRISISDUM	0.290542	0.011935	24.34362	0.0000
R-squared	0.997082	Mean dependent var		8.270042
Adjusted R-squared	0.997078	S.D. dependent var		2.393672
S.E. of regression	0.129400	Akaike info criterion		-1.249416
Sum squared resid	20.89708	Schwarz criterion		-1.237110
Log likelihood	784.5097	Hannan-Quinn criter.		-1.244790
F-statistic	213240.4	Durbin-Watson stat		0.031591
Prob(F-statistic)	0.000000			

Table 8: 1 Month JIBAR explained by a constant, 3 month JIBAR and a crisis dummy

The dummy indicates that during the height of the financial crisis the average relationship between 1 month JIBAR and 3 month JIBAR moved up by 0.29%; this is our estimate of the yield curve effect during the crisis period. Thus, during the crisis the South African spread moved from an average of 0.36% to 0.36% - 0.2% + 0.29% = 0.45%; an increase of 0.45% ÷ 0.36% = 1.25 times. In the United Kingdom the change was 1.02% ÷ 0.32% = 3.19 times; very similar to what was found on the 3 month spread for the United Kingdom. Even after the adjustment for yield curve effects the South African 1 month spread is very dissimilar to the United Kingdom 1 month spread (and to the South African 3 month spread that follows).
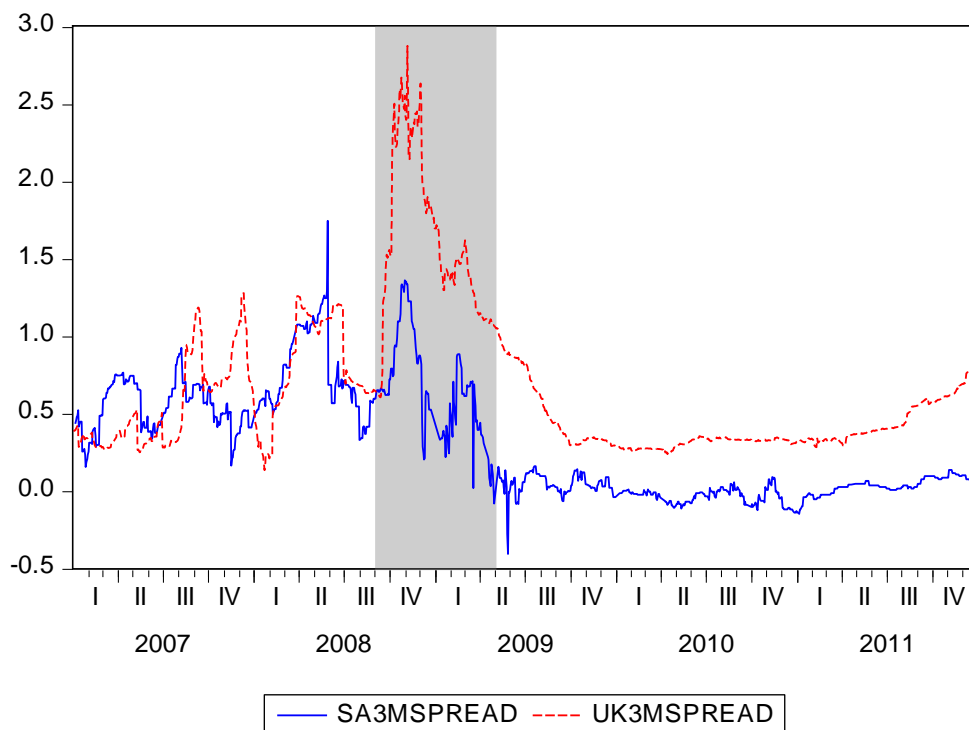
Graph 5: 3 month JIBAR spreads versus 3 month Libor spreads. The period highlighted is the peak crisis period 1 September 2008 – 30 April 2009

Graph 5 shows that for the 3 month spread the UK and South Africa moved in a broadly similar manner over the period except that after the height of the global financial crisis a permanent gap between the two series emerged. Unlike the 1 month South African spread the 3 month South African spread never turns negative. Summary statistics are obtained by running similar regression as above with the results as follows:

Dependent Variable: SA3MSPREAD
Method: Least Squares
Date: 02/13/13   Time: 15:10
Sample (adjusted): 1/05/2007 12/30/2011
Included observations: 1213 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.246366	0.010223	24.09883	0.0000
CRISISDUM	0.423004	0.028692	14.74312	0.0000
R-squared	0.152174	Mean dependent var		0.300070
Adjusted R-squared	0.151474	S.D. dependent var		0.361161
S.E. of regression	0.332685	Akaike info criterion		0.638405
Sum squared resid	134.0325	Schwarz criterion		0.646816
Log likelihood	-385.1928	Hannan-Quinn criter.		0.641572
F-statistic	217.3595	Durbin-Watson stat		0.037601

Prob(F-statistic)	0.000000			

Table 9: 3 Month South Africa spread regression with a constant and crisis dummy

Dependent Variable: UK3MSPREAD
Method: Least Squares
Date: 02/13/13   Time: 15:12
Sample: 1/02/2007 12/30/2011
Included observations: 1255

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.509785	0.009723	52.42933	0.0000
CRISISDUM	1.113021	0.026497	42.00611	0.0000
R-squared	0.584757	Mean dependent var		0.659666
Adjusted R-squared	0.584426	S.D. dependent var		0.497054
S.E. of regression	0.320426	Akaike info criterion		0.563260
Sum squared resid	128.6488	Schwarz criterion		0.571443
Log likelihood	-351.4456	Hannan-Quinn criter.		0.566336
F-statistic	1764.513	Durbin-Watson stat		0.041280
Prob(F-statistic)	0.000000			

Table 10: United Kingdom 3 Month spread regression with a constant and crisis dummy

Graph 5 shows as that the South African spread is consistently lower than the United Kingdom spread after the end of 2008. Before then they were closer together and seemed to move similarly. The regression results shows us that the South African average spread is 0.25% and during the crisis the average was $0.25\% + 0.42\% = 0.67\%$; an increase of $0.67\% \div 0.25\% = 2.68$ times. In the United Kingdom the average spread was 0.51% and during the crisis the average was $0.51\% + 1.11\% = 1.62\%$; an increase of $1.62\% \div 0.51\% = 3.17$ times.

Discussion of findings and opportunities for further research

Discussion of findings

In the spirit of the exploratory nature of this paper the first few paragraphs serve to briefly summarise interesting information that came to light during the analysis of the available data in South Africa.

At the outset, inaccuracies in the available data may be cause for concern. The JIBARs available from the JSE and Bloomberg were found to be different on 15 occasions between 1 January 2007 and 31 December 2011. In 4 of those instances it was not obvious which data provider was

correct, but in general the JIBARs from Bloomberg were deemed more accurate and complete even though the JSE is the original source of JIBAR.

The lack of available data restricts the scope of this study. The lowest level of data available from Bloomberg that relates to JIBAR is the daily midrate; individual rate submissions and the spread between bid and offer rates are not available. South African treasury bill rates are only available from the SARB as source on a weekly basis and Bloomberg also only provides the rates on a weekly basis. A difference between Bloomberg and the SARB is that Bloomberg provides the rate as a yield and the SARB provides the rate as a discount. No actual 1 month maturity reference rate is available in South Africa unlike the United Kingdom that has a 1 month treasury bill rate available. There is an inconsistency in the inputs used to calculate the nominal bond curve and the nominal swap curve; SAFEX is an offer rate whilst midrates are used for the rest of the curves' inputs.

No evidence was found of a "day of the month" type manipulation of JIBAR. This result is not very surprising as few home loans in South Africa are referenced against JIBAR. Most South African home loans are referenced against the prime interest rate. SA Home Loans' loans are referenced against the 3 month JIBAR[19], but they are a relatively small player in the market and do not take part in the JIBAR setting process. What are referenced against 3 month JIBAR, and may possibly be significant, are the funding instruments issued by South African banks and their securitisation vehicles (bonds and commercial paper[20]). One would then expect a reduction in rate effect, but nothing significant was observed.

The results for the 3 month spreads show that the South African spread broadly followed the movement in the United Kingdom spread, except that the increase during the crisis in South Africa was 15% less than the increase in the United Kingdom. If the United Kingdom system is accepted as having "lowballed" their submissions, then these results might be interpreted as the South African system having further "lowballed". But it may be argued that, since the South

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[19] Different reference dates are used for different products. On the 18th or the 22nd of the month, every quarter, SA Home Loans references to the average 3 month JIBAR for the previous three months (SA Home Loans, n.d.).
[20] Commercial paper references JIBAR on the day on which the paper is sold and that can vary (Standard Bank, 2013). An interesting question that arises is whether a relationship can be found between an individual bank's rate submission and its instrument issuance.

African banks proved to be safer (none failed during the crisis), the interest rate movements simply reflected that fact. Another relevant factor is that South African banks tend to fund themselves with short term debt, and thus the movement on the 1 month spreads is arguably of more interest.

The results for the 1 month spreads show that the behaviour of the South African spread was very different when compared to the United Kingdom spread (or the South African 3 month spread). This difference could not be explained by yield curve effects and justifies further research focusing on the 1 month portion of the South African money market.

The Graph 1 evidence of the inversion of the yield curve during the height of the crisis tempers this finding somewhat. If 1 month JIBAR was already higher than 3 month JIBAR and 1 month JIBAR was "lowballed" then the inversion effect would have been worse without "lowballing".

Opportunities for further research

In order to more conclusively interrogate the integrity of JIBAR this investigation needs to be expanded to bank specific data away from industry aggregated data. An analysis of the JIBAR submissions made by each bank would be ideal. This data can possibly be sourced by the SARB from the individual banks. Internal bank documents such as minutes of meetings and emails between traders and JIBAR submitters could also prove to be significant in any subsequent investigation. A comparison between the rates submitted by each bank and movements in the credit default swaps of that bank should also provide an indication of whether that bank's submission is reasonable or not. A question that arose during an investigation into the day of the month type manipulation is whether a relationship exists between an individual bank's rate submission and that bank's issuance of financial instruments.

Conclusion

The manipulation of LIBOR is currently in the news. Numerous international banks have admitted guilt and paid large fines. In South Africa, both the JSE and the SARB have argued that the South African equivalent interest rate, JIBAR, is unlikely to have been manipulated. The purpose of this study was to explore the possibility of the manipulation of JIBAR. The

exploration started by first identifying the types of LIBOR manipulation that took place. The data available in South Africa was then mapped to these types of manipulation and a decision made as to what can be tested for, given the data and time constraints.

As part of the South African data availability analysis, interesting aspects of the local market came to light that should be of interest for other researchers and market participants. The JIBARs available from the JSE and Bloomberg were found to be different on several occasions, and in general the JIBARs from Bloomberg appeared more accurate and complete, even though the JSE is the original source of JIBAR.

The availability of data restricted the reperformance of tests used in overseas rate studies to generate significant findings. The lowest level of data available from Bloomberg that relates to JIBAR is the daily midrate; individual rate submissions and the spread between bid and offer rates are not available. SABOR is preferable to RODI as an actual overnight rate but more information is needed in the public domain as to the interbank component of SABOR. South African treasury bill rates are available from the SARB on a weekly basis and Bloomberg also only provides the rates on a weekly basis. A difference between Bloomberg and the SARB is that Bloomberg provides the rate as a yield and the SARB provides the rate as a discount. No actual 1 month maturity reference rate is available in South Africa, unlike the United Kingdom that has a 1 month treasury bill rate available. There is an inconsistency in the inputs used to calculate the nominal bond curve and the nominal swap curve; SAFEX is an offer rate whilst midrates are used as inputs for the rest of the curves.

We found no evidence of a "day of the month" type manipulation of JIBAR. We also found that the 3 month JIBAR behaved very similarly to the 3 month British pound LIBOR. We did find that the 1 month JIBAR behaved in ways that cannot be explained over the height of the crisis period. This finding should be tempered by the fact that without these anomalies the inversion of the South African yield curve over the crisis period would have been worse, but the anomalies found are at least supportive of the need to conduct further research into the 1 month JIBAR setting process over the period of the financial crisis.

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