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An old wine in new shari'a compliant bottles? A time-frequency wavelet analysis of the efficiency of monetary policy in dual financial systems

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Abstract

Understanding the interrelationships between Islamic and conventional banks in dual financial systems is crucial for monetary policy decision makers. Using the wavelet coherence approach, this paper empirically investigates the dependency between the LIBOR and an Islamic benchmark rate, namely the IIBR (Islamic Interbank Benchmark Rate). This approach allows us to study the dynamics of the relationship between the LIBOR and the IIBR in the time-frequency space, then, to analyze to which extent Islamic financial institutions react to interest rate and, finally, to conclude whether the presence of Islamic banks enhance (or not) the efficiency of monetary policy. The result suggests not only that Islamic and conventional banks are alike, in terms of their business model, but also that Islamic banks react to changes in interest rates with some delay, which may affect the effectiveness of the monetary policy transmission mechanism.

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1. Introduction

Despite having achieved, in some countries, systematic size[1], Islamic banks operate in an environment dominated by conventional banks. Thus, monetary policy should consider possible interactions that may occur between Islamic and conventional banks. Indeed, in a dual financial system dominated by conventional finance, the practices of Islamic banks, in terms of pricing, are likely to be correlated with those of conventional banks, particularly because of the possible tradeoffs that can take place between these two different forms of banking. The speed and the magnitude of the responsiveness of Islamic banks to changes in interest rates affect the efficiency of the transmission of monetary policy impulses: if Islamic banks do not react quickly to changes in interest rates, and if they are systematically important, then the transmission of monetary policy via the interest rate channel will be less effective, and *vice versa*.

In dual financial systems, *i.e.* coexisting of conventional and Islamic financial institutions, a proper understanding of the nature of interaction between Islamic and conventional banks enables central bankers to identify the sequence of reactions that may occur further to their policy decisions, and, then, to assess the efficiency as well as the time needed for the transmission of monetary policy impulses.

Using wavelet coherence approach to analyze the co-movement between the LIBOR and an Islamic benchmark rate, namely the IIBR, in the time-frequency space, this paper tries to provide a deeper understanding of the nature of possible dependencies between Islamic and conventional banks, which provide to central banks information that may be useful for the improvement of their monetary policy decisions in the presence of Islamic banks.

2. The IIBR as a *Shari'a* compliant Benchmark

Interbank rate is the variable that balances the interbank transactions on the conventional money market, *i.e.* supply and demand for central bank money on the interbank market in the short term. Since this variable is, by definition, absent from the world of Islamic finance, it was necessary to find a way which would not only enable transactions between Islamic banks in the money market, but also serve as a benchmark for them when pricing mark-up contracts. During the eighteenth International Conference of Islamic banks held in Bahrain from 21 to 23 November 2011, Thomson Reuters announced the launch of IIBR, the first international reference rate for *Shari'a* compliant transactions (Fig. 1). According to its designers[2], this benchmark makes it possible both to activate transactions between Islamic banks in the money market and determine the margin of the mark-up contracts without resorting to the interest rate.

However, IIBR is nothing but an interest rate concealed to attract customers who are sensitive to the compliance of financial products with the Islamic law. Indeed, this indicator summarizes the cost of obtaining funds through the interbank market by a panel of Islamic banks and Islamic subsidiaries of conventional banks[3]. On the interbank money market, Islamic banks

[1] According to the IFSB definition, the Islamic banking sector is systematically important when it accounts for more than 15% of its total banking assets (IFSB, 2016:3).

[2] This benchmark was established with the cooperation of the IDB (Islamic Development Bank), the AAOIFI (Accounting and Auditing Organization for Islamic Financial Institutions), the SESRIC (Statistical, Economic and Social Research and Training Centre for Islamic Countries), the AIBIM (Association of Islamic Banking Institutions Malaysia), the BAB (Bahrain Association of Banks), the HICG (Hawkamah Institute for Corporate Governance), and a number of Islamic banks.

[3] To calculate the IIBR, every working day (at 10:45 am, Mecca time), Thomson Reuters asks the selected panel of banks (18 at least) to provide it with the rates they are willing to pay to refinance themselves in dollars through the interbank market for different maturities. Once the agency (*i.e.* Thomson Reuters) retrieves all the requested data, it sorts them, then excludes the upper and lower quartiles. Finally, it calculates the average of the remaining rates to obtain the IIBR.

often resort to *commodity murabaha* to raise or park funds (IFSB, 2010:1)[4], and the pricing of these operations is based either on the LIBOR or on local interest rates.

Figure 1: IIBR *vs* LIBOR

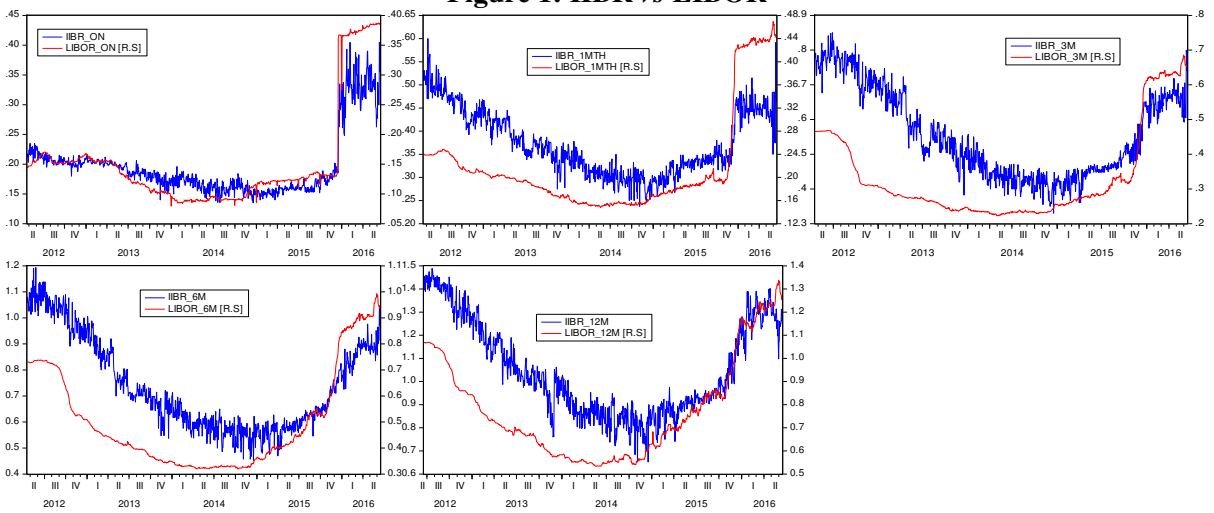

Figure 1. Red line: LIBOR. Blue line: IIBR. Source: Datastream

Since most financial systems that have hosted Islamic finance are mixed and have fairly developed conventional money markets, Islamic banks are *de facto* constrained to operate in an interest-rate dominated environment. In such an environment, and because of the trade-offs that may occur between conventional and Islamic financial systems, the returns, to depositors, of profit-sharing investment accounts (PSIA) and the costs, to debtors, of Islamic financing are likely to converge towards the deposit and credit rates of conventional banks (Ben Amar et al. 2015). However, the reaction of Islamic banks to changes in interest rates is not necessarily instantaneous: it can be done gradually to reduce the reputational risk. Thus, the transmission of monetary policy via the interest rate channel is likely to be slower and less effective in the presence of Islamic banks. To empirically verify this hypothesis, we can use the wavelet coherence approach to measure the magnitude of the local correlation between different pairs of IIBR and LIBOR rates in the time-frequency domain. This approach will allow us to clearly observe how the dependence between the different pairs of rates has developed over time and on different frequencies, and therefore to identify the frequency and time intervals where the rates move together significantly[5].

3. The wavelet coherence approach

To study the interaction between two stationary time-series of length T, $x(t)$ and $y(t)$, in the time-frequency space, Torrence and Webster (1999) define the squared cross-wavelet coherence, $R^2(u,s)$, as:

$$R^2(u,s) = \frac{\left|S\left(s^{-1}W_{xy}(u,s)\right)\right|^2}{S(s^{-1}|W_x(u,s)|^2)\, S\left(s^{-1}\left|W_y(u,s)\right|^2\right)} \quad , R^2(u,s) \in [0,1]$$

[4] The *commodity murabaha*, introduced for the first time by Bank Negara Malaysia on February 8, 2007, is an operation through which Islamic banks can refinance in the short term. According to the IFSB (2010:1), the *commodity murabaha* is among the most used instruments by Islamic financial institutions for the management of their liquidity. It is composed of three independent bilateral contractual relationships. First, a bank (**B1**) buys an asset (usually a commodity) on credit (respectively for cash) from a broker (**A**), at a price (**P1**). Then, it resells this asset for cash (respectively on credit) to a bank (**B2**) at a price (**P2**) lower (respectively higher) than (**P1**). Finally, the bank (**B2**) resells the asset for cash to another broker (**B**).

[5] For applications in economics of the wavelet coherence approach, see, among others, Aguiar-Conraria et al. (2008), Rua and Nunes (2009), Vacha and Barunik (2012), Haque et al. (2017), Abid and Kaffel (2018).

where $R^2(u,s)$ ranges between 0 and 1 and can be conceptualized as a localized correlation coefficient between $x(t)$ and $y(t)$, S is a smoothing operator[6], u and s are the control parameters of the wavelet (u is a location parameter that determines the exact position of the wavelet, and s is a scale parameter that defines to what extent the wavelet is stretched or dilated[7]), $W_{xy}(u,s)$ is the cross-wavelet transform of two time-series $x(t)$ and $y(t)$[8]. $|W_x(u,s)|^2$ et $|W_y(u,s)|^2$ are the wavelet powers of $x(t)$ and $y(t)$, respectively. $|W_{xy}(u,s)|$, the cross-wavelet power, represents the local covariance between $x(t)$ and $y(t)$ at each scale s: it reveals areas in the time-frequency space where the time-series show a high common power. As the theoretical distribution of $R^2(u,s)$ is unknown, we use Monte Carlo methods to test the statistical significance, following the approach of Torrence and Compo (1998) and Grinsted et al. (2004).

4. Empirical results

To study the dependence between Islamic and conventional banks, we use the IIBR and LIBOR interest rates, which are the main reference interest rates of Islamic and conventional financial sector, respectively. Figure 1 shows the plots of different pairs of IIBR and LIBOR rates at different maturities. The data were collected from Datastream on a daily basis and cover a period of approximately 4 and ½ years beginning on November 15, 2011 and ending on June 15, 2016. Thus, the sample include 1197 observations for each interest rate. Since the wavelet coherence coefficient measures the local linear correlation between two stationary time-series $x(t)$ and $y(t)$ at each scale s, we use the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test to check the statistical properties of the selected rates, expressed in logs. Table I in Appendix suggests that all the interest rates are integrated of order 1. Table II in Appendix provides descriptive statistics for the log differences of the interest rates used in the research.

In Figure 1 we can observe that IIBR and LIBOR are related, and have some common trends for all considered maturities. To explore dependencies in detail, we will look at the evolution of the dependence between all examined pairs of rates in time as well as frequency domain. Figure 2 shows the estimated wavelet coherence, $R^2(u,s)$, and the phase difference, $\phi(u,s)$[9], for all pairs of interest rates, with the same maturity, from scale 1 (2-4 trading days, which includes intraweek scales) up to scale 8 (256-512 trading days, which includes annual scale)[10]. Time (from 11/15/2011 to 06/15/2016, *i.e.* 1197 observations) appears on the x-axis, while frequencies (or scale), expressed in days, on the y-axis; the lower the frequency, the higher the scale. The cone of influence where edge effects should be considered is shown as a lighter shade. The color scale represents the magnitude of R^2. The black line contours denote areas

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[6] Smoothing is achieved by convolution in both time and scale. The time convolution is performed with a Gaussian window, while the scale convolution is done with a rectangular window. See Grinsted et al. (2004) for more details.

[7] The scale s has an inverse relation to frequency. Thus, a lower (higher) scale means a more (less) compressed wavelet, which is able of detect higher (lower) frequencies of a time series.

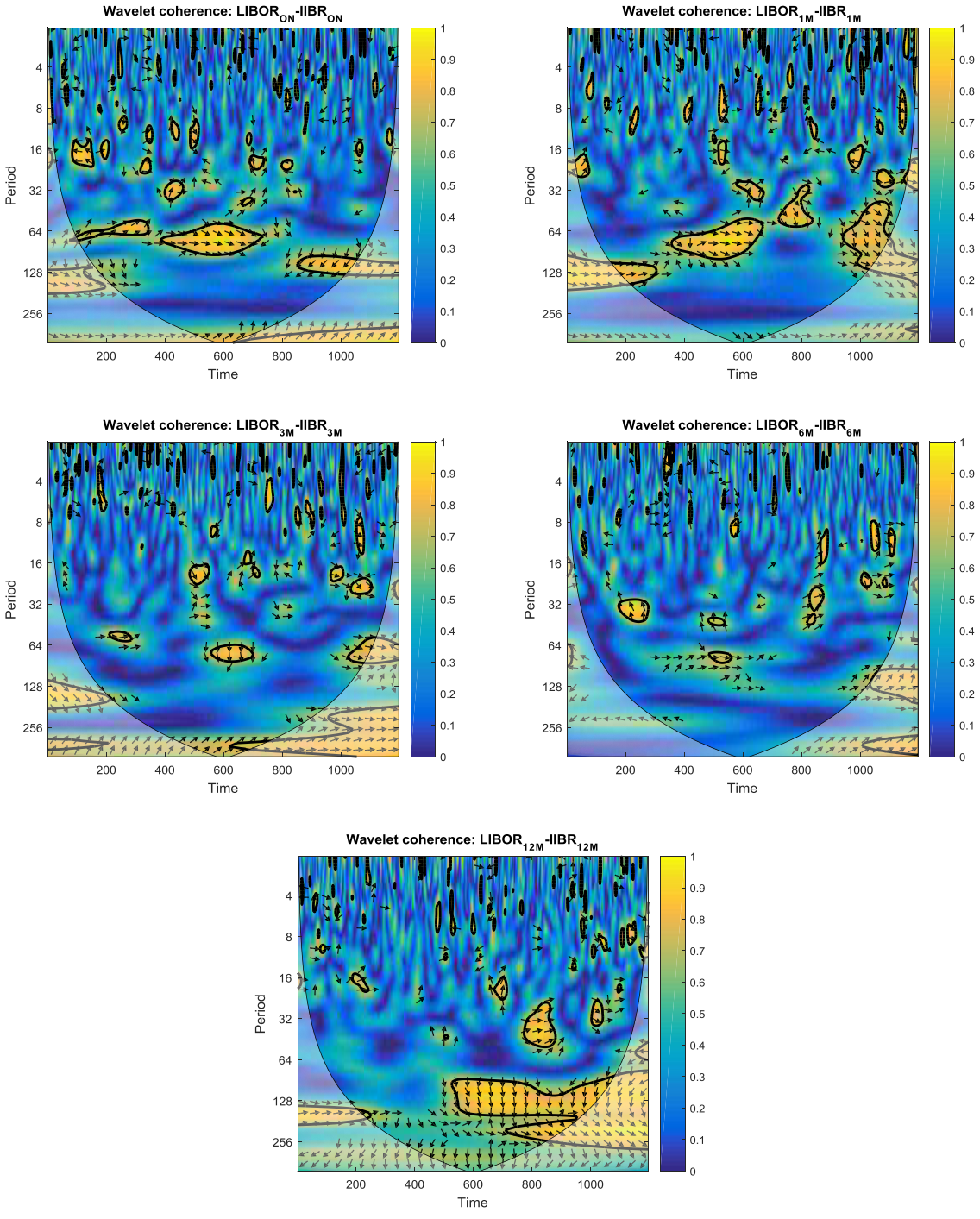
[8] Torrence and Compo (1998) define the cross-wavelet transform of two time-series $x(t)$ and $y(t)$ of length T as : $W_{xy}(u,s) = W_x(u,s)W_y^*(u,s)$, where $W_x(u,s) = \int_{-\infty}^{+\infty} x(t)\frac{1}{\sqrt{s}}\psi\left(\frac{t-u}{s}\right)dt$ and $W_y(u,s) = \int_{-\infty}^{+\infty} y(t)\frac{1}{\sqrt{s}}\psi\left(\frac{t-u}{s}\right)dt$ are the continuous wavelet transforms of $x(t)$ and $y(t)$, respectively. The symbol $(*)$ indicates the complex conjugation. In this research we use the Morlet wavelet, consisting of a plane wave modulated by a Gaussian: $\psi^M(t) = \pi^{-1/4}e^{i\omega_0 t}e^{-t^2/2}$, and we set the central frequency (also called the nondimensional frequency) of the wavelet, ω_0, equal to 6 to satisfy the admissibility condition (Farge, 1992).

[9] The complex argument $\phi(u,s) = \tan^{-1}\left(\frac{\Im\{S(s^{-1}W_{xy}(u,s))\}}{\Re\{S(s^{-1}W_{xy}(u,s))\}}\right)$ represent the relative phase between $x(t)$ and $y(t)$, where $\Im$ and $\Re$ are imaginary and real part operators, respectively.

[10] Like Abid and Kaffel (2018), the wavelet scales are such that the first one includes intraweek scales (2-4 trading days), the second one includes weekly scale (4-8 trading days), the third one includes fortnightly scales (8-16 trading days), the fourth one includes monthly scale (16-32 trading days), the fifth one includes monthly to quarterly scales (32-64 trading days), the sixth one includes quarterly to biannual scales (64-128 trading days), the seventh one includes biannual scale (128-256 trading days) and the eighth one includes annual scale (256-512 days).

with significant coherence ($p < 0.05$). Yellow time-frequency areas that appear inside the black lines represent the spaces with high dependence, i.e. where R^2 is close to 1. Regions with low dependence are those containing the blue color. The darker the blue is, the less dependent the series are (R^2 close to 0). Relative phases, represented by arrows, reveal details about the delays in oscillation between each pair of time-series under study. Arrows are rightward pointing when the two time-series under study are in-phase (i.e $\phi(u, s) = 0$), and they are leftward pointing when the two time-series are anti-phase (i.e. $\phi(u, s) = \pi$). Arrows point up (down) when the first (second) time-series leads the second (first) one.

Figure 2: Wavelet coherence of LIBOR and IIBR



From the wavelet coherence analysis (Fig. 2), very interesting results can be deduced. It shows that, over most of the whole period considered, the dependency between the IIBR and the LIBOR is low on high frequencies (from 1 to 32 days), and that it is more important on low frequencies (from 32 to 128 days). Relative phases reveal that, on low frequencies, the IIBR and the LIBOR interest rates fluctuate synchronously in a clear in-phase relationship, i.e. significant local correlations are positive (rightward pointing arrows), and that the LIBOR leads the IIBR by $\pi/2$ most of the time (downward pointing arrows). In other words, although IIBR reacts to changes in LIBOR, this response is not instantaneous, but occurs gradually[11]. Indeed, to reduce reputational risk without increasing "displaced commercial risk"[12], Islamic banks exhibit relative "temporary insensitivity" to changes in the LIBOR rate, *i.e.* in terms of their pricing practices of financial products, Islamic banks tend to be in line with changes in LIBOR, but with some delay. Thus, if the IIBR is a relevant reference rate of Islamic banking activity, we can deduce that the presence of Islamic banks is likely to slow down the transmission of monetary policy. This result seems to disapprove the analyses of Ben Amar et al. (2015:244) who suggest that dual financial systems are likely to improve the responsiveness of Islamic banks to monetary policy impulses as the Islamic banks pricing practices are too close to the conventional banks ones, and as banks play a major role in financing of the economy in most countries which have adopted Islamic finance[13].

But there are structural factors that may explain why the presence of Islamic banks is likely to weaken the transmission of monetary policy, namely the strong concentration of the Islamic banking system and its high liquidity (El Hamiani Khatat, 2016:13). As Islamic banks are highly liquid, they do not follow the conventional banks pricing practices instantaneously. Therefore, the presence of systematically important Islamic banks may reduce the effectiveness of monetary policy.

5. Summary and concluding remarks

This paper contributes to the literature on the monetary policy transmission channels in dual financial systems by studying the interferences between conventional and Islamic banks benchmark rates, namely the LIBOR and the IIBR, respectively.

As Islamic banks operate in an interest-rate dominated environment, Islamic banks pricing practices are likely to converge towards conventional ones. To measure the magnitude of the local correlation between different pairs of IIBR and LIBOR rates, this study uses the wavelet coherence approach. This approach allows to observe how the dependence between the different pairs of rates has developed over time and on different frequencies, and therefore to identify the frequency and time intervals where the rates move together significantly.

Results provided by this methodology seems to confirm that the responsiveness of Islamic banks to conventional banks pricing practices is not instantaneous but phased gradually. In other words, the presence of systematically important Islamic banks may harm the transmission of monetary policy.

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[11] This result can be explained by the fact that Mark-up financial product are the main component of Islamic banks assets' (Hachicha and Ben Amar, 2015).

[12] In dual financial systems, displaced commercial risk, which is specific for Islamic banks, may be defined as the risk of incurring losses resulting from both the volatility of investment accounts returns and the willingness of Islamic banks to ensure a competitive return to the holders of those accounts.

[13] Indeed, the low liquidity of secondary market in most of the countries that have hosted Islamic banks, which is explained by the tendency of investors to hold securities until maturity and by the lack of investment banks, reduces the attractiveness of the primary market (Al-Jasser and Banafe, 2002), and thereby reinforces the role of banks in financing the economy.

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Appendix

Table I: KPSS stationarity test

Variables	$IIBR_{ON}$	$IIBR_{1M}$	$IIBR_{3M}$	$IIBR_{6M}$	$IIBR_{12M}$	$LIBOR_{ON}$	$LIBOR_{1M}$	$LIBOR_{3M}$	$LIBOR_{6M}$	$LIBOR_{12M}$
Variables expressed in logarithm										
KPSS-t	**0.45**	**0.59**	**0.67**	**0.70**	**0.79**	**0.83**	**0.90**	**1.01**	**1.02**	**1.05**
First difference of the variables expressed in logarithm										
KPSS-t	**0.11**	**0.13**	**0.19**	**0.18**	**0.13**	**0.08**	**0.09**	**0.10**	**0.16**	**0.16**
CV 1%	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
CV 5%	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
CV10%	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11

« CV X% » means « Asymptotic Critical Value of the test » at a level of significance X% (X=1, 5 or 10).

Source: Author's estimations

Table II: Descriptive statistics of the daily logarithmic returns for IIBR and LIBOR rates

(November 15, 2011 to June 15, 2016)

Variables	$IIBR_{ON}$	$IIBR_{1M}$	$IIBR_{3M}$	$IIBR_{6M}$	$IIBR_{12M}$	$LIBOR_{ON}$	$LIBOR_{1M}$	$LIBOR_{3M}$	$LIBOR_{6M}$	$LIBOR_{12M}$
Mean	0.00095	0.00043	0.000389	0.000289	0.000107	0.000823	0.000478	0.000287	0.000286	0.000204
St.dev	0.06096	0.060551	0.057754	0.053694	0.047794	0.033901	0.009272	0.007382	0.006492	0.007793
Skew	1.80955	1.013714	0.715226	0.42818	0.334947	13.86585	1.449581	0.445779	0.29899	-0.292048
Kurt	26.4751	13.45221	10.37317	9.836588	7.360131	377.5131	34.9466	21.92394	12.65793	28.34347
Min	-0.2901	-0.25713	-0.21465	-0.23478	-0.24405	-0.29644	-0.09818	-0.07801	-0.05200	-0.08571
Max	0.76833	0.573872	0.530628	0.470288	0.32133	0.867422	0.110597	0.067176	0.041523	0.075405

Source: Author's estimations