Commentary on "Market Volatility and Retail Interest Rate Pass-Through by K. M. Wang and Y. M. Lee"

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Abstract:

Most researcher uses the cointegration technique sightlessly and persuasively follows the empirical results. Therefore, the present study uses the data visualization approach to the study of Wang and Lee (2009) and found that only a few series fulfil the assumption of the cointegration technique. Subsequently, we applied the cointegration equation to these few series and found that these equations are misspecified either because of the ARCH effect or structural break. Finally, this study revealed only one series with a valid empirical model and significantly different from the parent study. Therefore, this study enforces understanding data through visualization before applying any econometrics methodology.

Keywords: Data Visualization, Co-integration, ARCH Effect, Model Specification, Interest Rate Pass-through

JEL Classification: C8, C2, C58, C20, E4

1. Introduction

The interest rate pass-through mechanism is one of the crucial gateways for the central bank to achieve the goals of monetary policy. The central bank can manage the retail interest rate by controlling the money market rate. Thus, monetary policy affects the outcome of the banks, financial institutions, and the market behaviour of interest rates. The margin can measure the success of the monetary policy, markup, markdown, and the speed of the interest rate pass-through (Barnanke, 1990; Bredin et al., 2002; Bonds, 2002). Usually, cointegration is used to estimate this interest rate pass-through (Neumark & Sharpe, 1992; Sander & Kleimeier, 2002; Lowe & Rohling, 2002; Toolsema et al., 2002; Qayyum et al., 2005; Fuertes et al., 2009; Fazal & Salam, 2013; Mahmood, 2018; Mahmood & Zakaria, 2021). One such practical application of interest rate pass-through is Wang and Lee (2009), which used Engle and Granger (1987) cointegration method, along with the asymmetric threshold.

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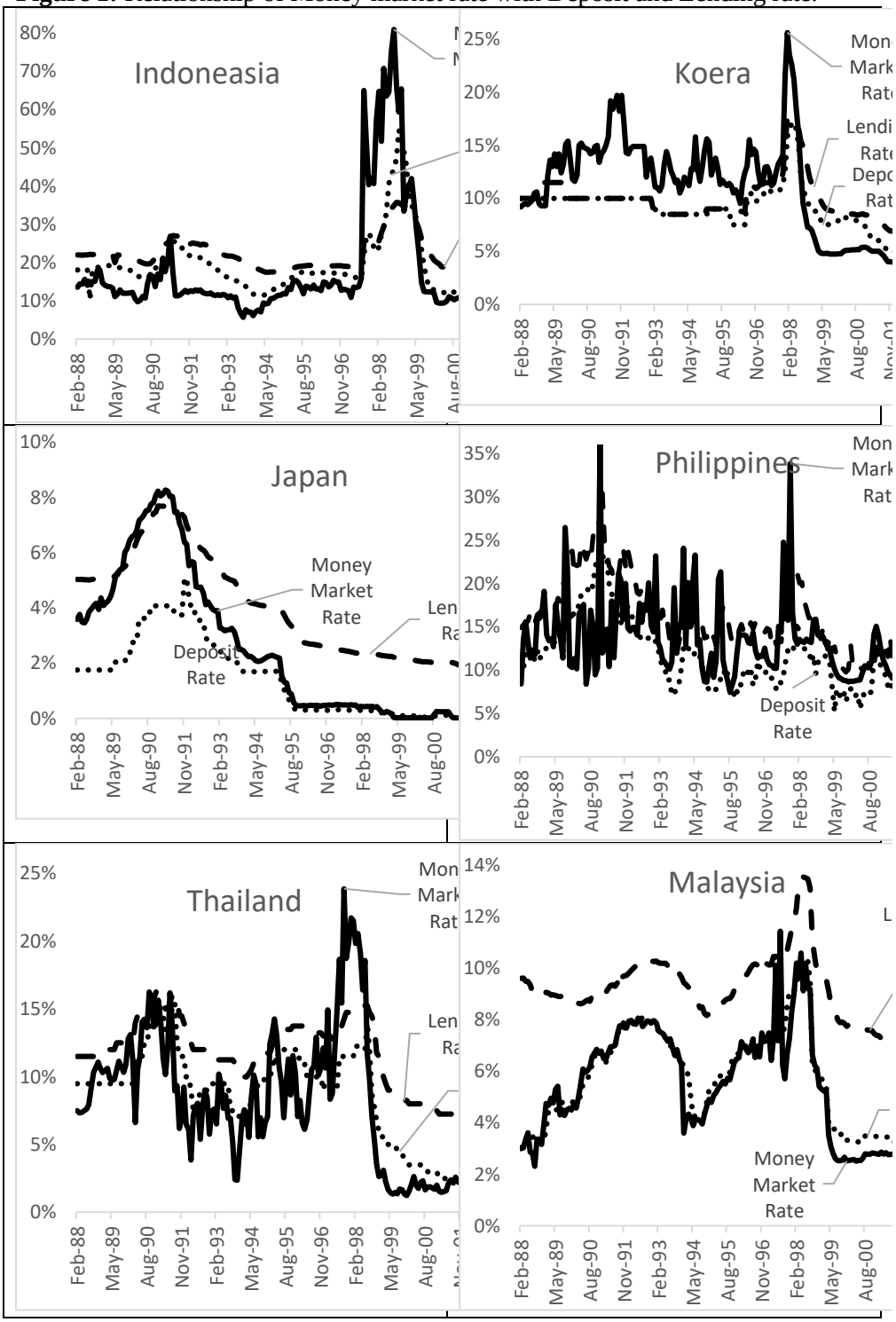
The cointegration empirical results are considered persuasive, and therefore, economic policies are constructed on these estimates. However, these empirical results are convincing only when the estimated model is specified. However, due to the ARCH effect in financial time series, cointegration is often found misspecified (Alexakis & Apergis, 1996), even if the unit root testing confirms the existence of cointegration. Similarly, the cointegration equation of Wang and Lee (2009) is misspecified (Figure 1). Second, before applying any statistical tool, it is essential to know "*what data is, and from where it has come*", i.e., whether the statistical data is according to the economic theory or not. Because researchers take data and feed it into the system without analyzing data and treat the system's output as persuasive, even though it could be misleading. Similarly, it is found that the money market rate is higher than the lending rate, which is theoretically not possible because the difference is profit for the banks. However, in the case of Wang and Lee (2009), the data violates the theory.

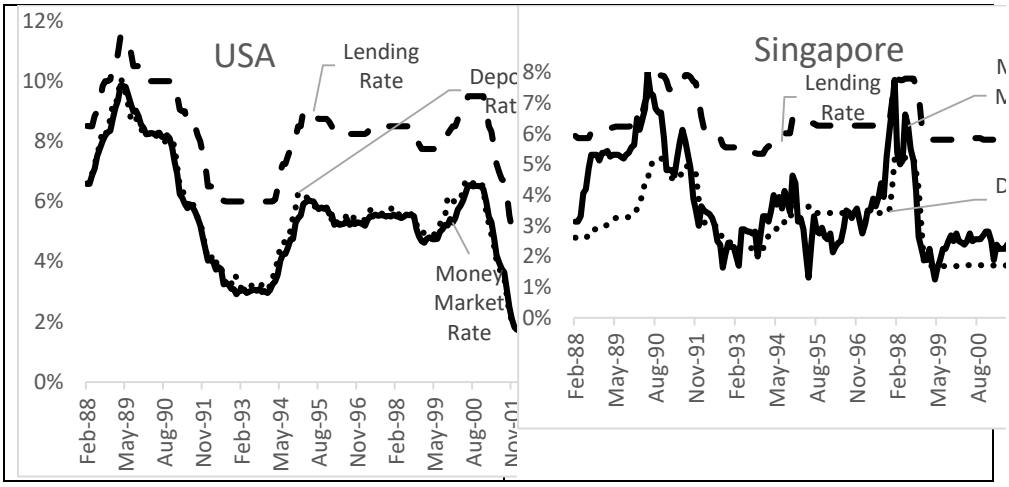
In Indonesia's case, the money market rate is higher than the lending rate, and the deposit rate is higher than the lending rate, which is against the theory. Third, cointegration implies that if one variable changes over time, then the other must follow these changes to hold the property of stationary linear combination. The dataset of Wang and Lee (2009) have many consistent constant points, which might not follow the properties of cointegration. For example, in the case of Korea (Figure 1), approximately eight years' the deposit rate and the lending rate are consistently constant. In contrast, the money market rate keeps changing, implying no cointegration for both deposit and lending rate models. Fourth, cointegration can also be interpreted as a stationary linear combination between two variables. However, it seems that the linear combination for the Philippine series is non-stationary (Figure 1). It can easily be understood that their linear combination is not stationary over time, i.e. variance is not constant over time. All these problems lead to inconsistent implications. Therefore, this study suggests appropriate solutions to these problems and concludes with a specified and reliable empirical model.

Econometric models and generated statistics from these models are persuasive. Mainly for those individuals, organizations or governments who uses these influential models and statistics for essential decisions based on organized data. However, this closed eyes persuasiveness could be right away misleading if the underlying assumptions of models and data are not compatible. Model specification is a general term; it holds for a model only when the assumptions are fulfilled. Hence, econometric models will give reliability for inference and prediction.

This paper is organized as follows: Section 2 explains the data and methodology, which is future based on visualization and econometric methods. Section 3 presents the empirical results and comparison with Wang and Lee (2009) results. The final section concludes the paper.

Figure 1: Relationship of Money market rate with Deposit and Lending rate.





2. Data and Methodology

2.1 The Data

The present study uses the same data set and source, as Wang and Lee (2009), to examine the mechanism of interest rate pass-through between the money market rate and retail rates. We used the monthly data for eight countries for deposit interest, lending, and money market rates. The sample period is from February 1988 to December 2004. Data is the same as per the study of Wang and Lee (2009), except for two countries, i.e. Hong Kong and Taiwan.[2] Figure 1 represents the time series graphical of all eight series.

The empirical part of this study consists of three steps. The first step is based on the data visualization. The second step is based on testing the long-run relationship between retail interest rates and money market rate. In the third step, the second step is further divided into two stages, i.e., estimation of the long-run and short-run relationships. If we find no long-run relationship, it will be dropped from the analysis.

2.2 Visualization of Data

The advantage of data visualization is that it allows accessing a massive amount of data in easily digestible visuals. Visualizing data is also crucial to get a basic idea about the dataset's issues, such as trends, structural breaks, etc. This study searches explicitly two points in the dataset through data visualization. First, whether the money market rate is higher than the lending rate or not. Second, this study seeks for the consistently constant number of observations.

[2] For Hong Kong, the data points are not as much of all other series, and to keep the study sophisticated we left Taiwan. Because the data of Taiwan is taken from different source.

2.2.1 Steady Constant Data Points

As econometric models and generated statistics from these models are persuasive. However, this closed eyes persuasiveness could be right away misleading the underlying assumption that the model and dataset are not compatible. Model specification is a general term; it holds for a model only when all the premises are fulfilled. Hence econometric models are reliable for inference and prediction. However, the econometric model will be misspecified if it does not fulfil all the assumptions. Therefore, the misspecified model gives spurious and misleading implications.

Co-integration can be interpreted as follows. If one variable changes over time, another variable must follow these changes, vice versa. Moreover, in one particular case of cointegration, if one variable changes over time, while the other is a steady constant over time.[3] This specific case directly implies that there is no cointegration. More precisely, non-stochastic series is unable to give cointegration with stochastic series. There is no strict rule or formula to find several steady constant observations, limiting the researcher to apply cointegration. However, for simplicity, 50% is used as a threshold level, i.e. if the number of steady constant values are more than 50%, then there is no need to test cointegration.

2.2.2 Money Market Rate is higher than Lending Rate

The money market rate is when commercial banks or financial institutions buy a fund for lending. Practically, the buyer would not sell these borrowed funds at a cost lower than the money market rate. The lender can make a profit only if it gives at a higher cost than the money market rate. Economically, there is no possibility of a higher money market rate to the lending rate.

2.3 The Methodology

The present study combines the methodology of Wang and Lee (2009) and Ding et al. (1993). Engle and Granger (1987) is employed to test the long-run relationship among retail interest rate and money market rate;

$$R_t = d_0 + d_1 M_t + e_t \quad (1)$$

where R_t is deposit or lending rate, M_t is money market rate, d_0 is markup, d_1 is the rate of pass-through and e_t long-run error term. For the stable relationship e_t should be stationary. If there is a problem of autocorrelation in e_t will be resolved in unit root testing. However, the interest rate is a financial time series, so the ARCH effect is possible, which should be handled appropriately. Therefore, this study combines Bollerslev (1986) with Engle and Granger (1987):

$$R_t = d_0 + d_1 M_t + c\sigma_t^{\delta} + \varepsilon_t$$

[3] Observation is called as steady constant value, if current and previous values are same.

$$\varepsilon_t = z_t \sigma_t$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i} + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \quad (2)$$

This model will resolve the issue found in Wang and Lee (2009). If the residual from Eq. 2 is stationary and if d_1 is significant, then it implies that cointegration exists between the money market rate and the retail interest rates. In addition, the present study also takes advantage of Enders and Siklos (2001) to confirm (i) long-run cointegration (ii) whether the long-run cointegration is symmetric or asymmetric. Moreover, they assumed asymmetric adjustment comes through the positive and negative values of the long-run error term, i.e. Eq. (2). To examine the existence of asymmetric cointegration, threshold autoregressive (TAR) model is used:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t)\rho_2 e_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta e_{t-1} + \varepsilon_t \quad (3)$$

where I_t represents an indicator variable, if

$$I_t = \{1 \text{ if } e_{t-1} \geq \tau \qquad \text{or} \qquad I_t = \{0 \text{ if } e_{t-1} < \tau$$

Since the true character of the nonlinear model remains unknown, the first difference of the error term could represent the momentum of the interest rate adjustment and reveal the asymmetric adjustment of the interest rate. This asymmetric model is called momentum TAR (MTAR);

$$\Delta e_t = M_t \rho_1 e_{t-1} + (1 - M_t)\rho_2 e_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta e_{t-1} + \varepsilon_t \quad (4)$$

where $M_t$is the indicator variable, if

$$M_t = \{1 \text{ if } \Delta e_{t-1} \geq \tau \qquad \text{or} \qquad M_t = \{0 \text{ if } \Delta e_{t-1} < \tau$$

Sufficient condition for the error term is stationary; if it holds, then OLS is consistent estimators (ρ_1, ρ_2). The null hypothesis is $\rho_1 = \rho_2 = 0$ and follows F distribution. A rejection of the null hypothesis indicates that cointegration exists. If cointegration exists, then in the second step $\rho_1 = \rho_2$ the null hypothesis is tested to confirm symmetric or asymmetric cointegration.

Interest rates are financial variables, which might have stylized properties in the short run. To deal appropriately with stylized properties present study uses a general model, which is proposed by Ding et al. (1993), in the presence of Eq. (2) along with Eq. (4) for the short-run analysis:

$$\Delta R_t = d_0 + d_1 \Delta M_t + d_2 \sigma_t^{\delta} + M_t \eta_1 e_{t-1} + (1 - M_t)\eta_2 e_{t-1} + \sum_{j=1}^{p} a_j \Delta e_{t-1} + \sum_{j=1}^{p} b_j \Delta v_{t-1} + \varepsilon_t v_t$$

$$v_t = z_t \sigma_t$$

$$\sigma_t^{\delta} = \gamma_0 + \sum_{i=1}^{q} \gamma_i (abs(\varepsilon_{t-i}) - \theta_i \varepsilon_{t-i})^{\delta} + \sum_{j=1}^{p} \vartheta_j \sigma_{t-j}^{\delta} \quad (5)$$

Wang and Lee (2009) have just discussed one of its exceptional cases. Ding et al. (1993) is a general model that can lead to the different final models by restricting other parameters. Testing H_o: $\eta_1 = \eta_2$ implies that the symmetric adjustment exists in the short run and vice versa. Comparison of absolute values of $\eta_1 \; and \; \eta_2$ shows that upwards rigidity ($|\eta_1| > |\eta_2|$) otherwise, it is downwards rigidity.

3 Empirical Analysis

3.1 Visualization of Data

Time-series graphs (Figure 1) represent several constant observations in series, and the money market rate is higher than the lending rate. The results are summarized in Tables 1-4. For example, 68% and 71% observations are steady constant observations for deposit and lending rate, respectively, for Thailand. In contrast, the money market has just 1% observation with a steady constant. It implies cointegration because the money market keeps changing while deposit and lending rates are not responding.

On the other hand, except for the US, the money market rate is higher than the lending rate for other countries. However, the lending rate of the US has 61% steady constant values. It means that there is no need to test cointegration empirically in the case of the lending rate for all countries. However, there is the possibility of cointegration for the deposit rate for Indonesia, Japan, Malaysia, the Philippines, and the US.[4]

Table 1: Results are Based on Visualization and Possible Cointegration

	1. Percentage of steady constant observations			2. Money market rate is higher than the lending rate	Possibility of cointegration (Based on 1 & 2)	
	Deposit Rate	**Lending Rate**	**Money Market Rate**		**Deposit Rate**	**Lending Rate**
Indonesia	1%	4%	0%	YES	YES	NO
Japan	24%	3%	2%	YES	YES	NO
Korea	51%	47%	9%	YES	NO	NO
Malaysia	35%	4%	0%	YES	YES	NO
Philippines	0%	0%	0%	YES	YES	NO
Singapore	58%	69%	15%	YES	NO	NO
Thailand	68%	71%	1%	YES	NO	NO
US	4%	61%	5%	NO	YES	NO

[4] For further empirical analysis, this study ignore all those series for which co-integration is not possible, based on result of Table 1.

Table 2: These Empirical Results of Wang and Lee (2009) Along With ARCH Effect								
Deposit Interest Rate Model								
	Indonesia	**Japan**	**Korea**	**Malaysia**	**Philippine**	**Singapore**	**Thailand**	**US**
d_0	10.350 (0.000)	0.124 (0.512)	4.654 (0.000)	0.876 (0.017)	4.218 (0.000)	0.628 (0.035)	2.716 (0.000)	0.167 (0.626)
d_1	0.452 (0.000)	0.521 (0.000)	0.428 (0.000)	0.876 (0.000)	0.513 (0.000)	0.637 (0.000)	0.637 (0.000)	0.990 (0.000)
R^2	0.642	0.913	0.704	0.929	0.308	0.706	0.710	0.991
Durbin Watson	0.329	0.132	0.131	1.171	0.463	0.176	0.351	0.480
ARCH effect (nR^2)	66.100 (0.000)	127.608 (0.000)	147.815 (0.000)	12.219 (0.000)	76.705 (0.000)	96.696 (0.000)	47.219 (0.000)	43.517 (0.000)
Lending Interest Rate Model								
	Indonesia	**Japan**	**Korea**	**Malaysia**	**Philippine**	**Singapore**	**Thailand**	**US**
d_0	16.870 (0.000)	2.135 (0.000)	6.445 (0.000)	5.440 (0.000)	7.925 (0.000)	5.073 (0.000)	7.063 (0.000)	3.442 (0.000)
d_1	0.253 (0.000)	0.731 (0.000)	0.323 (0.000)	0.625 (0.000)	0.582 (0.000)	0.325 (0.000)	0.524 (0.000)	0.857 (0.000)
R^2	0.592	0.955	0.508	0.737	0.344	0.595	0.718	0.971
Durbin Watson	0.187	0.067	0.067	0.274	0.601	0.145	0.316	0.091
ARCH effect (nR^2)	89.048 (0.000)	146.854 (0.000)	181.953 (0.000)	105.453 (0.000)	51.136 (0.000)	126.180 (0.000)	144.414 (0.000)	118.060 (0.000)

Table 3: ADF Unit Root Test

	Indonesia	**Japan**	**Philippines**	**Malaysia**	**US**
			Level		
Deposit Rate	-1.119	-0.975	-0.788	-0.592	-1.118
Money Market Rate	-1.563	-1.310	-1.312	-0.619	-1.311
First Difference Value					
Deposit Rate	-9.236***	-12.011***	-14.997***	-10.043***	-7.665***
Money Market Rate	-17.090***	-03.101***	-16.762***	-21.819***	-4.789***

3.1 Testing of ARCH Effect in the Cointegration

To test the presence of the ARCH effect in the cointegration, the present study uses the same methodology as Wang and Lee (2009). The empirical results of cointegration are shown in Table 2. The null hypothesis ARCH effect assumes that the error term is homoscedastic. Therefore, the probability value of the ARCH effect is relatively low, i.e., reject the null hypothesis homoscedasticity

and confirm the presence of the ARCH effect in the model. The empirical results of this study support the hypothesis of Alexakis and Apergis (1996).

Table 4: Deposit Rate Model

	Indonesia	**Japan**	**Malaysia**	**Philippines**	**US**
d_0	17.15394 (0.0000)	0.03587 (0.0000)	1.25105 (0.0000)	5.76314 (0.0000)	0.05383 (0.0105)
d_1	0.140976 (0.0000)	0.58273 (0.0000)	0.76833 (0.0000)	0.30717 (0.0000)	1.01140 (0.0000)
α_0		0.00013 (0.0345)	0.01687 (0.0033)	1.401777 (0.0001)	0.00643 (0.0000)
α_1	0.808663 (0.0000)	0.72283 (0.0306)	1.65942 (0.0000)	0.939747 (0.0002)	1.17053 (0.0000)
α_2	0.328832 (0.0000)	0.38664 (0.0767)			0.21322 (0.0167)
R^2	0.35	0.89	0.91	0.21	0.99
ARCH LM-test (nR^2)	0.75	0.03	0.81	1.32	0.37
ADF unit root test on error at level	-1.52818 (0.1185)	-2.46042 (0.0138)	-2.50595 (0.0122)	-2.34718 (0.0186)	-5.09287 (0.0000)

3.2 Long-Run Relationship

Before conducting the time series analysis, it is a prerequisite to examining the stationarity of the variables. Table 3 lists the Augmented Dicky Fuller (ADF) unit root test results at the level and first difference values for only those series for which cointegration is possible. The deposit and money market rates are stationary at first different at the 1% significance level.

Table 4 is listed the empirical results for the long-run relationship between the deposit rate and the money market rate. Statistically, no ARCH effect no longer remains in the long-run series. The value of R^2 is relatively low for Indonesia and the Philippines. The last row of the table presents the ADF unit root test for the residual of the cointegration equation. It confirms the presence of cointegration except in Indonesia. Furthermore, there is a significant markup for all countries. Such as; for the Philippines, the markup is 5.76, which seems relatively much high and is a sign of a good investment opportunity. The rate of pass-through is complete in the case of the US, while in other cases, there is a low rate of pass-through.

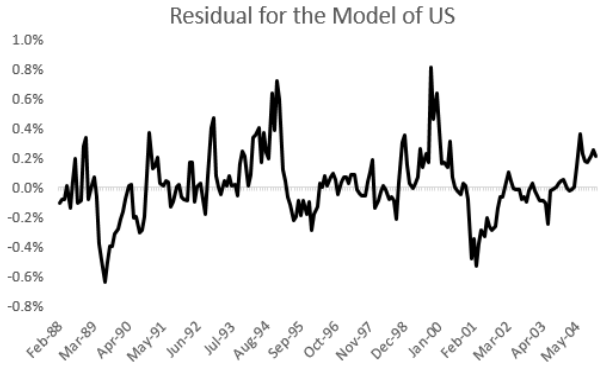
Table 5 shows the results: (1) confirming the presence of the long-run relationship and (2) either is cointegration is symmetric or asymmetric. Statistically, it is guaranteed that there is cointegration between the deposit rate and the money market rate. However, in the case of Malaysia, the cointegration is symmetric. At the same time, there is asymmetric cointegration between the money market rate and the deposit rate for Japan, the Philippines, and the USA.

A structural break in series negatively affects the power of ADF.[5] The present study uses visualization of residuals for cointegration equations, as shown in Figure 2. It represents the residuals for four countries, i.e., Japan, the Philippines, Malaysia, and the US. These plots are directly implied structural breaks, while the empirical results of Table V confirm the existence of cointegration. These results contradict visualization because of a structural break. These structural breaks make the statistic of ADF stationery for Japan, the Philippines, and Malaysia while issues in the case of the US.[6]

Table 5: TAR and MTAR Co-Integration Tests

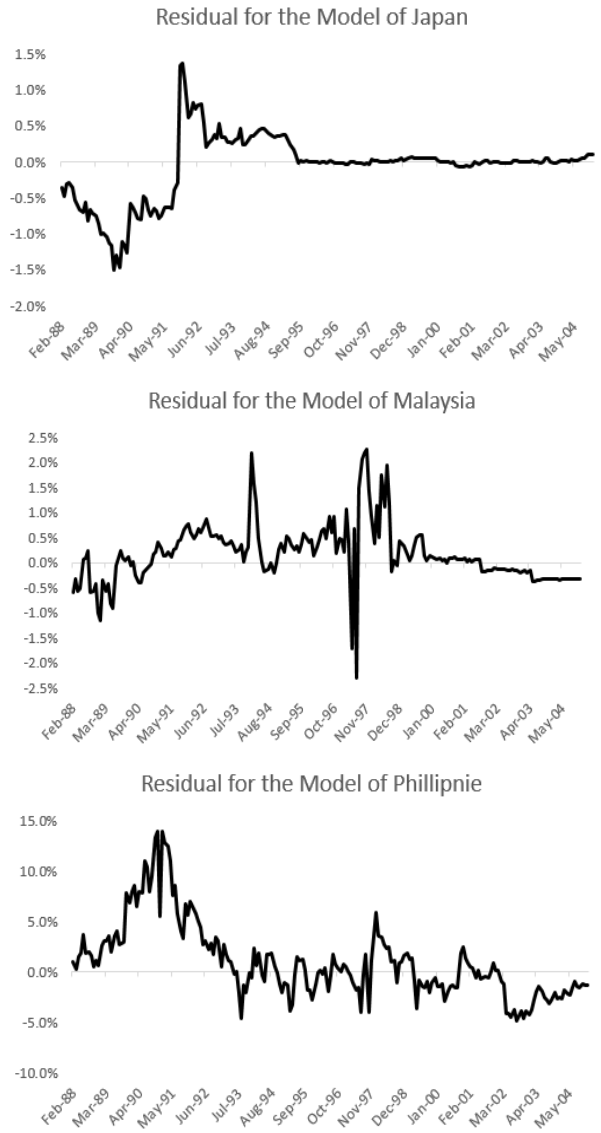
		Co-integration	Symmetric/ Asymmetric
Japan	TAR	12.18***	5.01**
	MTAR	18.89**	12.49**
Philippines	TAR	11.19***	1.39
	MTAR	30.59***	19.89***
Malaysia	TAR	46.22***	1.91
	MTAR	45.17***	1.05
US	TAR	27.10***	1.14
	MTAR	38.35***	11.10***

Figure 2: Residuals of cointegration equations



[5] Enders, pp 243

[6] As this study is comparison with actual study, i.e. Wang and Lee (2009). For this reason, we use ADF. However, there is as vast literature available to properly deal with structural breaks in unit root testing.



There is not the only difference in the empirical model but also in the implication. For example, in the case of Wang and Lee (2009), the intercept is biased because of misspecification (precisely due to the ARCH effect) and incomplete pass-through. In contrast, this study's empirical model implies a complete pass-through from the money market rate to the deposit rate with a significant intercept.

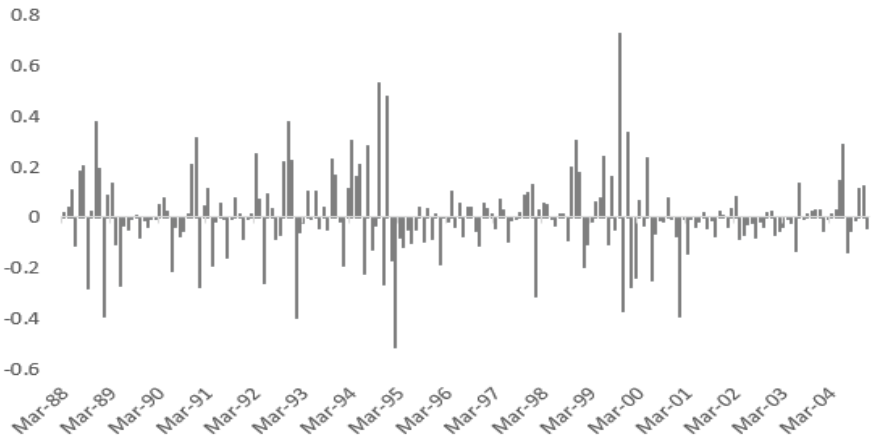
Table 6: Short-run Empirical Model for Lending Rate Model of the USA

Variable	Coefficient
ARCH-Mean	-0.54675***
d_0	0.05824***
d_1	0.98173***
η_1	-0.19057***
η_2	0.21962***
α_0	-0.55385***
α_1	-0.07205***
$EGARCH$	0.46290***
β_0	0.85797***
R^2	0.487896
Log-likelihood	136.0931

3.4. Short-Run Relationship

According to the classical approach, data is feed into the system and then searched for the appropriate model. By applying different restrictions on the various parameters, Eq. (5) leads to other empirical models. Therefore, it is possible that more than one model could be selected as an empirical model. These empirical models are compared upon the basis of model selection criteria, AIC, SBC, etc., and the best model among them will be selected for estimation. Hence, one might conclude with a different model than already expected because, in reality, the true data generating process is unknown. In addition, it is approximately impossible that the data generating process of one country is matched with another one. However, Wang and Lee (2009) have estimated the E-GARCH-ECM model for all countries. Table 6 highlights the empirical results for the short-run relationship.

Contrary to Wang and Lee (2009), the present study uses a general to a specific approach for the empirical model and chooses EGARCH-M-ECM, where all the statistics support the goodness of fit. The empirical results of Table IV imply that in the short-run if one unit changes the money market rate, the deposit rate will be changed by 98 basis points while keeping other things constant. Furthermore, 1.01 and 0.98 are the long-run and the short-run interest rate pass-through rates, respectively. The difference is very minute; for this reason, the rate of error correction is quite low ($\eta_1 + \eta_2 = 0.029$). In addition, it also implies that there are minor error corrections from positive and negative error terms(η_1, η_2). The Chi-Square value of the empirical model is 1256 at a 1% significance level; this leads to rejecting the null hypothesis and accepting the alternative. It is an indication for asymmetric adjustment in the short run, with downward rigidity ($|\eta_1| < |\eta_2|$) in the deposit rate.



3.5 Economic Significance

According to the Bertrand model (classical theory), if the financial transactions system is perfectly competitive and transparent, the market price equals the marginal cost. In this case, there is one to one relationship between the price of the market and the marginal cost. Hence the ratio of change in price leads to changes in the marginal cost. Therefore, the empirical results of this study imply that there is a complete pass-through for the US.

While in the case of the short run, the market is not perfectly competitive, and the information is not transparent entirely. In this scenario, the ratio of change in prices is not equal to the marginal cost. Nevertheless, it is a short-run process, and the phenomenon is known as an oligopoly. The empirical result of this study supports the Bertrand model in the long run and oligopoly in the short run for the US.

Why does the pass-through mechanism not exist for other countries? First, if the interest rate is determined outside the market, then the borrower and the lender are not sensitive to changes in the cost. In this situation, commercial banks will not maximize their profit. The primary factor affecting the deposit and the lending rate is government policies, for example, fixed deposit and the lending rate (steady constant). Because of this rigidity in the retail interest rate will decrease the efficiency of monetary policy. Hence, the interest rate pass-through mechanism is ineffective for these countries.

3.6 Empirical Methds

For empirical analysis, monthly data is used to examine the asymmetric cointegration for the interest rate pass-through mechanism. The variables used are the deposit rate, lending rate, and the T-Bill rate. Deposit and lending rates are weighted averages for a whole month, while the T-Bill rate is the 3-Month Treasury bill rate. The data is taken from the State Bank of Pakistan (SBP). Data is selected for the period 2004M1 to 2017M3.

3.6.1 Data Description

Visualization is essential to study the different time series properties of data sets. Otherwise, empirical results and inference could be misleading. Variables are plotted in the belwo figure. The figure reveals that all rates, i.e., lending, deposit, and T-bill rates, have the same pattern. All rates first increase; they start decreasing after reaching the maximum level. The T-bill rate has more volatility, followed by the deposit rate but with lesser volatility. The lending rate has less volatility. It implies that due to the change of the T-bill rate, there is a high pass-through rate to the deposit rate and a lower pass-through rate to the lending rate. It also indicates the possibility of cointegration among these variables, i.e., when the value of the T-Bill rate increases, then lending and deposit rates also increase and vice versa.

Table 7 provides the results of the ADF and Phillips and Perron (PP). The empirical results imply that all the series are not stationary at levels but are stationary at first differences.

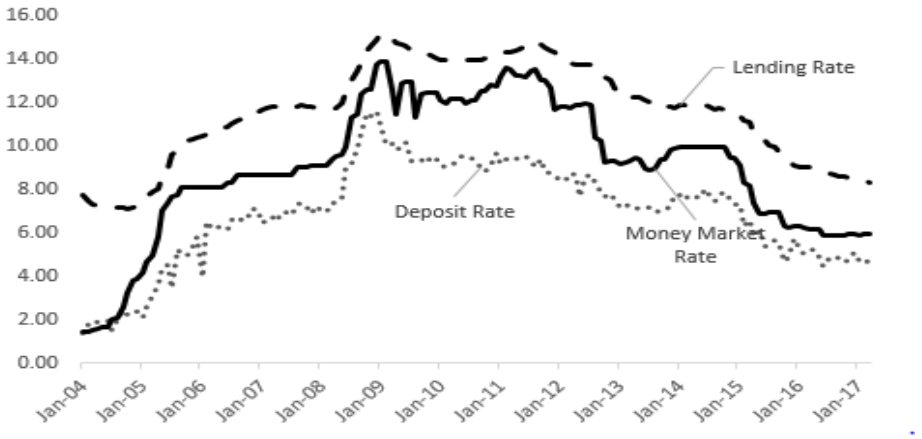


Table 7: Unit Root Test Results

	Level		1st difference	
	ADF	**PP**	**ADF**	**PP**
Deposit Rate	-1.50	-1.65	-16.88***	-16.76***
Lending Rate	-1.75	-0.66	-4.25***	-5.95***
T-Bill Rate	-1.89	-1.78	-11.48***	-11.50***

Note: The critical values refer to Mackinnon (1996). *** indicate that the value is significant at the 1% level.

3.6.2 Co-integration Test

Table 8 provides the long-run parameters for the deposit and lending rate models. It is estimated that there is a fixed markup for both models. However, the markup level is higher in the lending rate than the T-Bill rate deposit rate. Furthermore,

the pass-through is approximately the same in both models, higher than in the previous literature. However, there is an incomplete pass-through. For example, suppose the State Bank of Pakistan changes monetary policy. In that case, commercial banks do not have enough power to transfer their total cost to their consumers by improving the retail interest rates because there are already insufficient consumers dealing with banks. In this scenario, if the pass-through ratio increases, then the variability in the business cycle of banks will also increase (Khan et al., 2012).

Table 8: Estimation of Long-Run Parameters

	Long-Run Model	
	Deposit Rate	Lending Rate
$\boldsymbol{d_0}$	0.2808*	4.9342***
$\boldsymbol{d_1}$	0.7322***	0.7337***
$\boldsymbol{H_0: d_1 = 1}$	273.23***	334.14***

Note: *** and * indicate that the value is statistically significant at 1% and 10% levels, respectively.

3.6.3 Error Correction Results

To confirm the existence of cointegration between the policy and retail rates, TAR and MTAR models are employed. Empirical results of TAR and MTAR models are presented in Table 9.

Table 9: TAR and MTAR Cointegration Results

	TAR		**MTAR**	
	F-value		F-value	
Deposit Rate	104.09***	Co-integration	40.97***	Co-integration
Lending Rate	287.23***	Co-integration	113.45***	Co-integration
	Symmetric/Asymmetric			
Deposit Rate	46.19***	Asymmetric	41.99***	Asymmetric
Lending Rate	3.44**	Asymmetric	13.29***	Asymmetric

Note: *** and ** indicate that the value is statistically significant at the 1% and the 5% levels, respectively.

The null hypothesis of $H_0: \rho 1 = \rho 2 = 0$ is rejected in both models. It confirms the existence of cointegration among the retail rates. Similarly, the null hypothesis of $H_0: \rho_1 = \rho_2$ is rejected in both models, which confirm the existence of the asymmetric relationship. It indicates that asymmetric cointegration exists among policy and retail rates.

Table 10 provides the estimated error correction results in the EGARCH-M model for the deposit and lending rates. The results of the deposit rate model imply that there is a low pass-through rate due to policy rate change. Furthermore, positive values have higher error correction estimates than negative values. The null hypothesis $\eta_1 = \eta_2$ is rejected, which implies that there is asymmetric error correction. Moreover, it is found that there is an upward rigidity ($\eta_1 > \eta_2$) in the deposit rate model. Finally, there exists an asymmetric effect of bad news, which is exponential in the deposit rate behaviour. The results of the lending rate model show that there is quite a low rate of pass-through from the policy rate compared to the deposit rate model. Furthermore, the positive and negative indicators have a similar error correction mechanism and imply symmetric error correction.

Table 10: Results of the Error Correction In EGARCH-M Model

Interest model	**Deposit Rate Model**	**Lending Rate Model**
	EC-E-GARCH (1,1) – M	**EC-E-GARCH (1,1) – M**
d_0	0.1883***	-0.0079
d_1	0.2199**	0.0968***
η_1	-0.4047***	-0.0753***
η_2	-0.0207	-0.0718***
w	-2.0074***	-4.3461***
α_1	-0.4198***	0.8616
β_1	0.6758***	0.5322***
θ_1	0.8436***	0.0022
θ_2	-0.2698**	0.6394**
c	-1.1558***	-0.0276

Note: *** (**) indicate that the value is statistically significant at the 1%(5%) level.

The results reveal an incomplete pass-through rate, i.e., 73% essential points between the retail interest rate due to a change in the policy rate. The results imply that borrowing from the domestic banks for investment is more efficient as banks have low power to transfer the cost to their consumer. The deposit rate is rigid upward, which implies that commercial banks will always try to give their consumers a low rate of profit while borrowers from the bank have a higher power to reduce the margin level. Hence, based on the study's empirical results, it is concluded that the profit margin of the commercial banks depends upon the power of rigidity of the borrower, i.e., if the power of rigidity is weak. It will increase the profit margin, vice versa.

Furthermore, one objective of the present study is to compare the empirical result of the present study with Mahmood (2018). Empirically, the pass-through rate in the present study is higher than Mahmood (2018); this difference is because of the appropriate choice of proxy for the policy rate, i.e., T-Bill rate instead of KIBOR.

3.6.4 The Economic Significance of the Empirical Results

Table 11 provides a summary of the empirical results. First, there is asymmetric cointegration between retail interest rates and the policy rate. Second, there exists a markup for both models. Third, it indicates an incomplete pass-through in the case of Pakistan. Thus, some cost is transferred to commercial banks when the policy rate changes. To cover this cost, commercial banks adjust the markup ratio in the direction of the central bank.

Table 11: Comparison of Empirical Results

Model	Symmetric/Asymmetric Co-integration	Mark(up/down) (d_0)	Pass-Through Type (d_1)	Adjustment Rigidity (η_1 , η_2)
Deposit Rate	Asymmetric Co-integration	Mark-up	Incomplete	Upward
Lending Rate	Asymmetric Co-integration	Mark-up	Incomplete	No Rigidity

The possible justification for low-interest rate pass-through in Pakistan is low consumer sensitivity towards changing interest rate cost and revenues. In this situation, commercial banks will not maximize their profit; hence, the government's economic policies might be ineffective. Consequently, the efficiency of the monetary policy associated with the interest rate pass-through would decrease the possibility to achieve its objectives. Therefore, the government of Pakistan must pay close attention to the market information and structure to accomplish the aim of monetary policy.

5. Conclusion and Policy Implications

This study uses data visualization to understand the fundamental properties and issues of the data. This data visualization method is applied to Wang and Lee (2009). The results of data visualization revealed that only one country is suitable to use the cointegration test, i.e., the US. For all other countries, either the money market rate is higher than the lending rate, or one series is showing fluctuations, and others do not. Furthermore, the structural break is also one reason for unstable cointegration. The present study found significantly different empirical results from Wang and Lee (2009). The empirical results of this study imply that there is a complete pass-through for the US, which completely contradicts Wang and Lee (2009), and the reason is the presence of the ARCH effect.

We suggest three crucial points before empirical analysis based on the present study. First, data visualization is used to study the properties of data properly. Second, data visualization also gives information that either data is according to theory or not. Finally, it uses the general to specific approach for the estimation because there is a high probability that the data generating process of the two countries does not match. Therefore, selecting just a single empirical model from the literature and fitting it to different countries might lead to spurious regression.

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