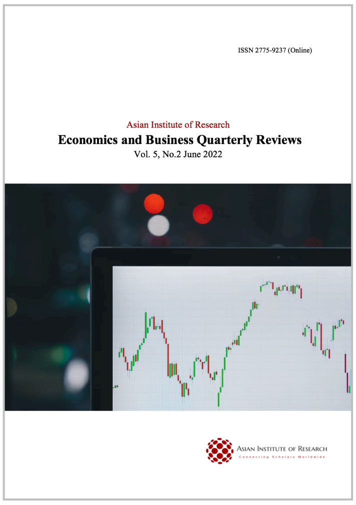

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The Role of Financial Structural Factors in Retail Rate Adjustment: Evidence from Sri Lanka

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Abstract
This paper examines the interest rate channel of monetary policy transmission. It assesses the impact of banking structural factors on commercial bank pricing decisions and their pass-through in Sri Lanka. The empirical analysis uses aggregate monthly interest rates data from January 2008 to December 2018, a total of 132 observations. The findings suggest that the interest rate pass-through is significant overall, but incomplete. The credit quality, operational efficiency and excess liquidity play essential roles in explaining the adjustments of the bank lending and deposit rates. Non-performing loans increase the lending rate, and this result is robust to different combinations of the control variables. This suggests that banks with higher proportions of non-performing loans attempt to pass their credit losses on to customers. Further, bank inefficiency is passed on to customers in the form of lower deposit rates and excess liquidity in the banking system, both of which have a negative effect on the interest rate adjustments of both lending and deposit rates. A puzzling negative relationship is observed between the lending rate and operational inefficiency. The findings of this paper support the claim that banks in Sri Lanka take into consideration their structural factors as well as the monetary policy rates when setting the lending and deposit rates.

Keywords: Bank Retail Rates, Financial Structural Factors, Interest Rate Pass-Through, Monetary Policy

1. Introduction

One of the pillars of modern monetary policy decision making is a good understanding of the transmission mechanism; that is, the process by which the monetary policy actions of a central bank impact the price level and aggregate demand of an economy (Gigineishvili 2011). The monetary policy decisions of the central bank influence the economy through various different transmission channels, such as the interest rate channel, the credit channel, the exchange rate channel, and the asset price channel. According to Keynesian theory, the interest rate is the most important channel of monetary transmission, which emphasises that the money demand and supply determine the equilibrium interest rate. This channel of monetary transmission operates under the assumption that changes to the policy rate pass-through to the short-term market interest rates (i.e., the interbank rate and the short-term treasury bill rates), and commercial banks then adjust their lending and deposit rates accordingly (broadly known as bank retail rates). Like advanced economies, emerging economies rely on the policy interest rate as their primary monetary policy tool, and employ the interbank rate as an intermediate target (Mishkin 1995).

In the above framework, a proper knowledge of the interest rate pass-through process is of paramount importance for the successful conduct of monetary policy operations, as it affects both the cost and the availability of credit in the economy. This was emphasised by (Borio & Fritz 1995, p. 3), who claimed that "bank lending rates are a key, if not the best, indicator of the marginal cost of short-term external funding in an economy." The central bank starts out by setting policy rates. It then exerts influence on the money market through open market operations in order to steer toward its operating target, generally keeping the overnight money market rates close to the monetary policy rates. Finally, the money market rates feed through to influence the economy's bank lending and deposit rates (commonly known as retail interest rates) and to affect target the variables, output and inflation. However, as was pointed out by Bernanke & Gertler (1995), the extent and timing of monetary transmission depend on other factors which are generally outside the direct control of the monetary authority. Such factors could be related to the external financing premium of banks, as is accounted for in the balance sheet and bank lending channels of monetary policy. Hence, if financial intermediaries fail to adjust their retail interest rates promptly in response to changes in the policy rates, the changes may not achieve the results that monetary authorities expect (Hofmann & Mizen 2004). Therefore, the responses of financial intermediaries, especially banks, are more important in developing countries than in developed countries, as direct financing between lenders and borrowers is limited (Cottarelli & Kourelis 1994, p. 588).

The interest rate pass-through process is essential to monetary policy for both the economic and financial stability of an economy (De Bondt 2005). A policy-induced change in interest rates affects market interest rates based on the term structure of interest rates, including retail bank interest rates, albeit to varying degrees. Notably, a quick and full pass-through of the policy rates to retail bank interest rates reinforces the effectiveness of monetary policy transmission and price stability. Banks' decisions on the lending rates charged their borrowers and the deposit rates paid to their depositors affect the expenditure and investment behaviour of economic agents, and thus real economic activities. Moreover, commercial bank lending and deposit rates influence their interest margin and profitability, which in turn affect a country's financial stability and the soundness of its banking system.

Similarly, a stickiness of such retail rates with respect to changes in the short-term market rates severely impairs the smooth transmission of monetary policy (Cottarelli & Kourelis 1994). Hence, the strength of the interest rate pass-through from the monetary policy rates to retail rates reflects the extent to which monetary policy can assist in managing economic activities and stabilising prices, i.e., the effectiveness of the monetary policy. Thus, an understanding of the effectiveness of monetary policy and the factors that affect this transmission is of primary interest to central bankers in many countries.

The theoretical and empirical literature discusses several factors that ultimately influence the adjustment of bank retail interest rates. These can be summarised into two broad categories: (i) macroeconomic conditions such as inflation, capital mobility and exchange rate flexibility, excess liquidity, and financial sector developments; and (ii) financial structural factors such as bank competition, capital, liquidity, non-performing loans, and non-interest income. As the adjustments in retail interest rates depend on several factors, a rich understanding of such factors can assist in the formulation of appropriate policies and the necessary measures for improving the effectiveness of monetary policy. However, while substantial empirical work has been conducted on a variety of markets and products, some issues in the transmission mechanism still remain, especially in emerging economies.

Despite its importance, the effectiveness of the interest rate pass-through in the Sri Lankan context has not been examined extensively to date. As the prevailing empirical literature has shown, the degree and speed of interest rate pass-through can vary significantly across countries, markets, financial products and financial institutions, as well as over time (See Cottarelli & Kourelis 1994; Gigineishvili 2011). It is of pivotal importance for monetary policy decisions that developments in interest rate pass-through in Sri Lanka be monitored, given the leading role that the banking sector plays in financing the non-finance private sector of the economy.

The discussion above, together with the commonly-observed fact of price stickiness in retail rates, show that it is important to determine which financial structural factors influence or prevent the complete adjustment of retail rates following a monetary policy change in the Sri Lankan context. Accordingly, this paper estimates a model that can describe the way in which monetary policy is transmitted to commercial bank retail rates when controlling for financial structural factors that could affect the retail rates mark-up and the degree of pass-through. This paper contributes to the empirical literature as, to the best of my knowledge, this is the first study to examine the effect of financial structural factors on the retail rates mark-up and the strength of interest rate pass-through in the Sri Lankan context. A lack of availability of published data on banking sector performances (either aggregate or bank-level) could be the reason for the absence of empirical analyses in this area to date. This paper uses critical financial structure variables, such as credit risk, bank competition, excess liquidity, bank operational diversification and cost efficiency, to uncover the structural impact of pass-through in the Sri Lankan context.

Using the baseline linear ARDL model without any controlling financial structural factors, this study finds overall significant but incomplete interest rate pass-through from the monetary policy rates to the lending and deposit rates, over the period 2008–2018. In general, the credit quality, the operational efficiency of the bank and the excess liquidity play important roles in explaining the adjustments of the retail rates. In particular, non-performing loans increase the lending rate, a result that is robust across all specifications. Further, the estimated results support the notion that bank inefficiency is passed on to customers in the form of lower deposit rates. However, contrary to the theory, the results show a negative relationship between the lending rate and operational inefficiency. This puzzling relationship requires further examination and confirmation in future research. Moreover, our results show that an abundance of liquidity in the banking system could have a negative effect on interest rate adjustments for both the lending and deposit rates.

The rest of the paper is organised as follows. Section 2 describes the data and the econometric methodology. Section 3 then discusses the empirical results, after which Section 4 provides the summary and conclusion, including the empirical implications of the empirical findings.

2. Empirical strategy

2.1. Data

I investigate the effects of financial structural factors on the interest rate pass-through using aggregate monthly interest rate data from January 2008 to December 2018, a total of 132 observations, which is generally considered to be a reasonable sample size for standard time series regression. The key variables used in the analyses are the central bank's policy rate and bank retail rates. Empirical studies typically rely on a proxy rate for the central bank policy rate, and the standard proxy is either the interbank call money market rate or the short-term treasury bill rate. The interbank call money market rate (MMR) is not used for our baseline model due to its high volatility, the result of frequent liquidity fluctuations in the interbank market.[1] Following the literature, for instance Cottarelli & Kourelis (1994) and Gigineishvili (2011), this study employs the three-month treasury bill rate (TBR) as the primary exogenous variable for representing policy rates in the economy. This paper examines the impact of structural factors on the lending and deposit rates and the interest rate margin. The average weighted lending rate (LR) is calculated from the retail lending rates of all outstanding rupee-denominated loans and advances extended by commercial banks to the private sector. The average weighted deposit rate (DR) is calculated from the retail deposit rates of all outstanding interest-bearing deposits held with commercial banks. Finally, the difference between these two rates represents the banks' interest rate margin. The data are obtained mainly from the Central Bank of Sri Lanka (CBSL) statistical publications. In addition, I employ several control variables as potential

[1] The interbank market is the most important market in the financial system, as commercial banks use it to hedge the liquidity shock, and it is the focus of the central bank's implementation of monetary policy. When liquidity shock heading opportunities are limited, the interbank market may exhibit excessive price volatility. Central banks fix interest rate volatility through the appropriate use of open market operations (Allen et al. 2009). As a developing economy, Sri Lanka experiences higher volatility in the interbank market, mainly due to commercial banks' involvement in foreign exchange operations and fiscal financing through state commercial banks. Hence, the interbank money market rate may not be the best proxy for the policy rate in this case (Perera 2016). Furthermore, Fuertes & Heffernan (2009) argue that the money market rate is not a good proxy for the policy rate because it is driven largely by the demand and supply of the interbank fund.

determinants of the interest rate pass-through.[2] The data series used or calculated are listed in Table 1, along with their sources.

A bank's asset quality is the first explanatory variable representing financial structural factors. I use the Non-Performing Loan ratio (NPL) as an indicator of bank assets' quality/credit risk. As has been suggested by the market discipline literature, a higher credit risk is associated with higher returns in terms of retail rates (Bikker & Gerritsen 2018; Demirgüç-Kunt & Huizinga 2010). Moreover, some scholars argue that banks with higher levels of bad assets on their balance sheet are expected to capture increases in interest rates in order to compensate for higher bank losses (Gregor & Melecký 2018; Grigoli & Mota 2017). It is known that credit risk has a negative impact on interest rate pass-through. Riskier loan portfolios are typically associated with higher loan yields (Gambacorta 2008). Similarly, banks with riskier loan portfolios may have to offer depositors higher deposit rates in order to attract funds and cover the credit risk to providers of bank finance (Bikker & Gerritsen 2018). In contrast, Maudos & De Guevara (2004) show that credit risk can have a positive impact on the deposit rate and the interest margin.

The degree of competition in loans and the deposit market is another prominent determinant of bank pricing behaviour. I test whether market power affects the pass-through in Sri Lanka using commercial bank concentration. The level of concentration of commercial banks indicates the extent to which they contribute to the output of an industry. The relative market power hypothesis (also known as structure–conduct performance), put forward by Berger (1995), states that banks with large market shares are able to set less competitive interest rates. Existing empirical findings suggest that the interest rate pass-through tends to be higher in a more competitive banking system (See Leroy et al. 2015; Sørensen & Werner 2006; Van Leuvensteijn et al. 2013). In the literature, banking sector competition is commonly measured using either the Hirschman Herfindahl Index (HHI) or the Lerner index. However, neither of these measures can be used here due to the lack of availability of individual bank-level data. Hence, I calculate the ratio of commercial bank assets to financial system assets in Sri Lanka (Com) as a proxy of the market power. Based on the literature (Berger 1995; De Graeve et al. 2007), I hypothesise a positive (negative) relationship between the lending (deposit) rate and the banking sector concentration, while I anticipate a negative effect on the interest rate pass-through.[3]

As was suggested by Mojon (2000), a more highly diversified portfolio of bank activities, reflected through a higher non-interest income as banks rely less on traditional banking activities, will have a positive impact on monetary policy adjustments. The rationale is that banks which generate higher fee-based incomes from other services tend to set their retail rates closer to the market interest rates. However, this may not be the case in less competitive environments where banks are less sensitive to movements in the market rate. Accordingly, I examine the impact of banks' pricing efficiency by including a proxy variable of non-interest related activities as a percentage of total income (NII). The hypothesis is that having banks engaged in non-interest generating banking activities will tend to improve the interest rate pass-through.

The next explanatory variable that is likely to influence the extent of the interest rate pass-through is related to banks' cost-efficiency. The hypothesis is that a bank's pricing decisions are driven by its degree of operational efficiency (De Graeve et al. 2007). If banks set their retail rates by adding a margin on top of their cost of funds as per the mark-up theory, efficient banks should have an incentive to use their cost-effectiveness to price their lending rate below average and their deposit rate above average. This paper measures the cost efficiency as the ratio of operational cost to gross income (OPC) when investigating whether more inefficient bank pass their inefficiency on to customers (Horváth et al. 2004). Thus, it is expected to have a positive (negative) relationship with the estimated lending (deposit) rate. The same argument applies to the long-term pass-through.

Excess liquidity in the banking system is the last variable representing the bank structural factor in this paper. Highly liquid banks can insulate interest rate shocks (Gigineishvili (2011). For instance, banks that do not hold excess liquidity in their asset portfolios will be forced to reduce their lending in times of monetary contraction,

[2] The bank structural variables are available only at a quarterly frequency, and are then interpolated linearly to a monthly frequency.
[3] As suggested by Cottarelli & Kourelis (1994), Mojon (2000), Sørensen & Werner (2006), and (Gigineishvili 2011).

while banks with an excess of liquidity assets buffer the impact of the monetary shock, as they can make use of their excess liquidity to finance loans and advances. Accordingly, the interest rate pass-through is less effective in a financial system where banks maintain excess liquidity without investing in loans or alternative financial securities. As a result, changes in policy rates are unlikely to cause changes in retail rates, implying a negative effect on pass-through for both loans and deposits. In this sense, excess liquidity acts as a buffer against monetary shocks and market fluctuations (see De Graeve et al. (2007); Kashyap & Stein (2000). Further, as was suggested by Gambacorta (2008), less liquid banks have less capacity to issue bonds, and therefore need to encourage more deposits by offering relatively high deposit rates. Hence, banks with excess liquidity have less demand for deposits, which is expected to have a negative effect on the deposit rate. Similarly, since the more liquid banks find it easier to fund loans on their margin, excess liquidity (ExL) is expected to have a negative effect on loan pricing. Excess liquidity is measured as the difference between the prevailing liquidity ratio in each period and the statutory liquid asset ratio.[4]

2.2. Econometric Approach

I employ a single equation Error Correction Model (ECM) derived from the ARDL model, introduced by Pesaran & Shin (1999) and Pesaran et al. (2001), to identify the expected cointegration relationships among the variables in the model.5 This model does not require all variables to be integrated in the same order (Sam et al. 2019). Thus, the main advantage of the Auto-Regressive Distributed Lag (ARDL) model is that it allows me to employ both regressors that are stationary in level and time series that are integrated of order one in the model setup simultaneously. When the variables are cointegrated, it means that there exists a long-run equilibrium relationship. Thus, I could differentiate between the short- and long-run reactions of bank retail rates to changes in monetary policy rates.6 It further determines the speed of adjustment of retail rates toward their long-run equilibrium.

Based on the mark-up equation, the difference between the exogenous treasury bill rate (a proxy for the central bank policy rate) and the endogenous retail interest rate is:

$$i_t^r = (\alpha_1 + \alpha_{2,t}) + \beta i_t^m + e. \qquad (1)$$

The interest rate spread/mark-up consists of two components: the constant α_1 and the time-varying component $\alpha_{2,t}$. The time-varying component includes the possible bank conditions and financial structural factors, which in turn determine the mark-up.[7] As per the existing literature, $\alpha_{2,t}$ is determined by a vector of financial structural factors X_t, and their relationship can be expressed as:

$$\alpha_{2,t} = \varphi X_t + u_t. \qquad (2)$$

Based on equations (1) and (2), I first model the long-run cointegration relationship as:

$$i_t^r = \alpha_0 + \beta i_t^m + \varphi \boldsymbol{X}_t + v_t, \qquad (3)$$

where i_t^r is the endogenous bank retail rate (lending or deposit rate) and α_0 is a constant that represents the long-run mark-up/markdown between the policy rate and the bank retail rates. Further, β is the long-run pass-through coefficient; i_t^m is the exogenous policy rate, proxied by the three-month treasury bill rate; φ is the estimated vector of the coefficient on the control variables X_t, and $v_t = e_t + u_t$ is the error term. If β is equal to one, there is a

[4] As per Banking Act No. 30 of 1988, Licensed Commercial Banks are required to maintain Statutory Liquid Assets (SLAR) of an amount not less than 20% of total liabilities, less liabilities to the central bank and to their shareholders.

[5] Similar specifications with a set of control variables are used by Leroy & Lucotte (2016), Gambacorta et al. (2015), and Gregor & Melecký (2018).

[6] Series are cointegrated if and only if both the *F*- and *t*-tests reject their null hypothesis and the dependent variable is stationary at I(1). In the Bound test, the *F*-test draws conclusions on the coefficients of lagged levels of all variables used in the model, while the *t*-test examines the lagged level of the dependent variables (See McNown et al. 2018).

[7] There are two basic approaches to examining the role of financial structural factors in interest rate pass-through. The first approach examines how financial structural factors determine the estimated parameter of the interest rate pass-through using the interest rate pass-through regression, i.e., $i_t^r = \alpha_0 + \beta i_t^m + u_t$. The second approach includes the financial structural factors in the pass-through regression (such as Eq. (4)) directly. Even though both of these approaches investigate how financial structural factors matter for interest rate pass-through, they aim to answer two distinct questions. The first approach examines how financial structural factors influence the long term pass-through, while the second examines whether financial structural factors matter for interest rate adjustment (See Horváth et al. 2004). This study opts for the second approach, as I have access to aggregate financial structural data for Sri Lanka.

complete pass-through. In contrast, if β is smaller than one, this indicates incomplete pass-through, and if β is greater than one, this indicates an overshooting of the retail rates. The vector of control variables, X_t, includes five structural factors that influence the retail rates beyond the monetary policy rate: (i) the Non-Performing Loan ratio (NPL), which is the share of gross non-performing loans out of all loans and advances, to represent the credit risk; (ii) banking sector concentration, to represent the bank competition (Com), measured as the share of commercial banking assets out of total assets of the financial system in Sri Lanka; (iii) excess liquidity (ExL), which is the ratio of liquid assets to total liabilities over and above the regulatory requirement; (iv) share of non-interest income in total income (NII), to account for banks' product/operational diversification; and (v) ratio of operational cost to total income (OPC), to represent banks' cost efficiency.[8]

I use the Bound test, proposed by Pesaran et al. (2001), to test for the existence of a cointegration relationship among variables. A cointegration relationship is confirmed by comparing the calculated *F*- and *t*-statistics to the tabulated critical values. If the estimated values are larger than the upper critical value, then there exists a long-run equilibrium relationship between the variables. Conversely, if the estimated statistics are smaller than the lower critical value, the null hypothesis of no cointegration is not rejected. Finally, if the estimated *F*- and *t*-statistics are between the upper and lower critical values, the results are inconclusive without additional information.

The speed of adjustment to long-run equilibrium following a shock to the system is determined by specifying an ECM derived from the ARDL as follows:

$$\Delta i_t^r = \alpha_0 + \rho_k \Delta i_{t-k}^m + \theta_k \, \Delta \boldsymbol{X}_{t-j} + \gamma (i_{t-1}^r - \alpha_1 - \beta i_{t-1}^m - \varphi \boldsymbol{X}_{t-1}) + v_t. \qquad (4)$$

In this equation, Δ denotes the first difference operator. The short-run dynamics are represented by the terms with delta (Δ), and the long-run relationship is represented by the terms in parentheses. In this model, ρ_0 measures the short-run (contemporaneous, impact) pass-through, which is the same-period change in the retail interest rate in response to changes in the money market rate. β represents the long-run relationship between the two interest rates. The coefficient γ represents the speed of adjustment towards the long-run equilibrium, which means that $\gamma \in [-1,1]$ confirms the presence of an equilibrium-restoring relationship. In general, a higher value of γ represents a faster adjustment of retail rates, and thus a more efficient pricing of bank retail rates. v_t is the error term. i_{t-1}^r, i_{t-1}^m and X_{t-1} are lagged variables, and the relevant lag structure is chosen based on the Schwarz Information Criterion (SIC). This empirical analysis follows the empirical approach of Grigoli & Mota (2017) and Gregor & Melecký (2018) closely. Our attention in this paper is on the fractions of monetary policy changes that are reflected in changes in the retail rates (expressed by β) over the long-run. This represents the pass-through parameter, which could be close to zero if the financial structural factors selected above prevent the pass-through from being complete, or greater than one if those factors cause over-pass-through.

Table 1: Variables and Descriptive Statistics

Variable	Variable Code	Description of the Variable	Source	Descriptive Statistics					
				Obs.	Mean	Median	Std. Dev.	Max	Min
Dependent Variables									
Bank lending rates	LR	weighted average lending rates of outstanding loans and advances	CBSL	132	14.91	14.20	2.51	20.13	10.96
Prime lending rates	PLR	weighted average lending rates offered to the prime customers of the banks	CBSL	132	11.67	11.37	3.50	20.79	6.35

[8] It should be acknowledged that there may be several other financial structural factors that influence bank pricing policies in addition to the factors that I have concerned in this paper. This study focuses on observable bank characteristics (supply-side) when determining the bank retail rates and its influence on pass-through.

Deposit rates	DR	weighted average interest rate of outstanding interest bearing deposits	CBSL	132	8.38	8.48	1.75	11.74	5.83
Fixed deposit rates	FDR	weighted average interest rate of outstanding fixed deposits	CBSL	132	10.94	10.81	2.83	16.92	6.87
Explanatory / Control Variable									
Monetary Policy Indicator									
Treasury bill rate	TBR	3-month government treasury bill rate	CBSL	132	9.34	8.56	3.40	19.25	0.05
Money market rate	MMR	weighted average of interbank call money rate	CBSL	132	8.98	8.43	2.47	19.34	5.77
Financial / Banking factors									
Credit risk	NPL	impaired loans / gross loans	CBSL	132	4.50	3.79	1.77	8.57	2.30
Market power	Com	commercial bank assets / financial system total assets	Calculated based on CBSL data	132	0.46	0.46	0.03	0.53	0.39
Product diversification	NII	fee-income / total income	Calculated based on CBSL data	132	0.14	0.14	0.02	0.20	0.12
Cost efficiency	OPC	operational cost / total income	Calculated based on CBSL data	132	0.25	0.24	0.03	0.30	0.19
Excess liquidity	Exl	liquidity assets ratio – statutory liquidity assets ratio	Calculated based on CBSL data	132	6.75	6.25	2.17	11.88	2.90

2.3. Empirical Results and Discussion

2.3.1. Linear Specification: Estimated Results

Before investigating the effect of bank structural factors on the interest rate pass-through, I estimate the long-run model of the interest rate pass-through (by estimating equations (3) and (4) without controlling for financial structural factors). The aim of this is to determine the effect of the interest rate channel of monetary policy transmission by assessing the extent to which the retail rates are adjusted in the long-run through monetary policy tightening without accounting for the other variables that could have an impact on the pass-through. Once the long-run cointegration relationship between the treasury bill rates and retail interest rates has been confirmed, the long-run pass-through and short-run dynamics of the lending and deposit rates are examined, and the estimated results are reported in columns 1 and 3 of Table 2. With regard to the degree of long-run pass-through (β), the estimated results indicate that the pass-through to both the lending and deposit rates is not complete. The results suggest that, in the absence of any bank structural factors, 97 percent of a change in the MMR is passed-through to the lending rate, while only 67 percent of a change in the MMR is passed-through to the DR. This suggests that if CBSL cuts its policy rate by 100 basis points, commercial banks' loan rates will decrease by 97 basis points, while their deposit rates will decrease by 67 basis points. Thus, a higher long-run pass-through is observed for lending rates than for deposit rates. This may be due to uncompetitive market forces and higher switching costs in the deposit market than in the lending market (Horváth et al. 2004). These pass-through magnitudes for LR and DR are quite similar to those obtained by Perera (2016), who calculated pass-through rates of approximately 98 percent and 63 ppercentrespectively for the 2001–2012 subsample period in the Sri Lankan context.

According to his results, the short-run (contemporaneous) pass-through coefficients (ρ) are positive and significant for both lending and deposit rates. However, he records a low level of short-run pass-through, suggesting that banks only transmit around 6 percent and 5 percent of the changes in the short-term rates to the lending and deposit rates in the following month, respectively. Meanwhile, the speed of adjustments (γ), or the error correction adjustments, are negative and statistically significant for all of the retail rates, indicating a mean reversion of the retail interest rates towards the long-run equilibrium. Under the short-run dynamics, the deposit rate exhibits the weakest pass-through and the weakest speed of adjustment to the long-run equilibrium. The results support price rigidities and incomplete-pass-through, such that the retail rate changes do not reflect the adjustments in policy rates directly. In general, these findings are consistent with prior international (Bennouna 2018; Grigoli & Mota 2017) and local (Amarasekara 2005; Perera 2016) research. Further, column 5 of the table shows that the central bank policy rate does not have an impact on the net interest margin (measured as the difference between the lending and deposit rates) in either the long-run or the short-run.

I extend our pass-through specification by adding selected bank structural variables, to determine which structural factors are associated with the interest rate mark-up (above the cost of funds, represented by the treasury bill rate). The estimated full results of equations (4) and (5) (after confirming the cointegration relationship from the Bound test) are shown in columns 2, 4 and 6 of Table 2. From the ARDL Bound test results, I can confirm a significant co-integration relationship between the explanatory variables and the retail rates, including the net interest margin. With this specification, the pass-through coefficient of the lending rate drops from 97 percent to 63 percent while the pass-through of the deposit rate remains unchanged. The short-term dynamics show a similar picture, with slow adjustments in both the lending and deposit rates. This result suggests that the financial structural factors change the lending rate pass-through, indicating that banks' structural factors hinder the effectiveness of monetary policy transmission in Sri Lanka.

Consistent with our theoretical predictions, a bank's exposure to credit risk, measured by the non-performing loan ratio, increases the lending rates significantly relative to the treasury bill rates, while reducing the deposit rate. Specifically, a one percentage point increase in the non-performing loan ratio increases the lending rate by 0.73 percentage points and decreases the deposit rate by 0.81 percentage points. This means that banks with relatively low credit quality tend to increase their lending rates, reflecting the view that banks tend to push the cost of non-performing loans onto bank customers. This is consistent with the findings of Byrne & Kelly (2019) and Gregor & Melecký (2018). The negative impact of credit risk on the deposit rate means that a part of the credit loss is charged to depositors by reducing the deposit rate. When combining the impacts on the lending and deposit rates, a one percentage point increase in credit risk increases the net interest rate margin by nearly 0.96 ppercent as is shown in the estimated results.

Bank operational costs and excess liquidity turn out to be significant when determining the retail rates. The operational cost provides insights into the operational efficiency of the bank, with a higher cost to income ratio reflecting operational inefficiency. It is observed that both retail rates react negatively to operational efficiency. A one unit increase in bank operational costs reduces the lending rate by nearly 0.2, and the deposit rate by 0.15. Thus, banks that are less operationally efficient are characterised by higher interest rates. However, the estimated results do not support the earlier argument that bank inefficiency will be passed on to borrowers in the form of higher lending rates (De Graeve et al. 2007). This result is puzzling, as it shows the opposite of the hypothesised relationship between the lending rate and operational efficiency. However, operational inefficiency is passed on to depositors in the form of lower deposit rates. As was suggested by Mojon (2000), this influence of a fixed cost (i.e. operational costs) on retail interest rate pricing confirms that the banking industry of Sri Lanka lacked competition during the period under analysis. Neither the market power nor operational diversification affect any of the retail rates in the baseline model.

Table 2: Linear Specification Estimated Results

	LR		DR		NIM	
	1	2	3	4	5	6
Long-Run Relationship						
TBR (β)	0.9723***	0.6346***	0.6792***	0.6776***	0.5432	0.0317
	(0.1401)	(0.1679)	(0.0825)	(0.1793)	(0.5250)	(0.0404)
NPL		0.7381**		-0.8118*		0.9620***
		(0.2898)		(0.4635)		(0.1118)
Com		-0.0156		-0.2392*		0.0053
		(0.1077)		(0.1385)		(0.0415)
NII		-0.2217		-0.1512		-0.0443
		(0.1921)		(0.1828)		(0.0763)
OPC		-0.2019**		-0.1468*		-0.0213
		(0.0856)		(0.0775)		(0.0281)
ExL		-0.3805**		-0.8195*		-0.1686***
		(0.1565)		(0.2779)		(0.0599)
C	0.0034***	0.0197**	0.0015*	0.0187***	0.0001	0.0087
	(0.0011)	(0.0104)	(0.0657)	(0.0053)	(0.0010)	(0.0109)
Speed of Adjustment (γ)	-0.0664***	-0.0897***	-0.0781***	-0.1535***	-0.0200	-0.2044***
	(0.0078)	(0.0096)	(0.0103)	(0.0103)	(0.0110)	(0.0333)
Short-Run Dynamics						
Short-Run Pass-through (ρ)	0.0660***	0.0569***	0.0531***	0.0375***	0.0108	0.0065
	(0.0079)	(0.0116)	(0.0071)	(0.0072)	(0.0072)	(0.0117)
No. of Observations (After Adjustments)	131	129	131	128	131	129
Adj. R-squared	0.3509	0.4016	0.3044	0.7296	0.0172	0.2187
ARDL Bounds Test (F-statistic)	35.3556	11.8281	46.4756	29.7895	1.8670	5.1267
	[4.94-5.73]	[2.45-3.61]	[2.45-3.61]	[2.45-3.61]	[4.94-5.73]	[2.45-3.61]
Covariance Matrix	White	HAC				HAC

Notes: ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels. Standard errors are shown in parentheses, and critical values of the ARDL Bound test are given in square brackets. White (HAC) represents the White covariance matrix (the Newey-West HAC covariance matrix), used to handle the observed heteroscedasticity (autocorrelation and heteroscedasticity) in the residuals of the estimated model. The model covers the sample from January 2008 to December 2018. The lag structure is chosen based on the Schwarz Information Criterion (SIC), allowing a maximum lag length of three.

As per the study by Agénor & El Aynaoui (2010), our results show that an abundance of liquidity in the banking system could have negative effects on the interest rate adjustments for both the lending and deposit rates, decreasing them by nearly 0.38 and 0.82 percentage points, respectively. This result is consistent with the observations of De Graeve et al. (2007) and (Gambacorta & Mistrulli 2014). Furthermore, improvement has been noticed in the short-run speed of adjustment in both the lending (from 0.06 to 0.08) and deposit (from 0.7 to 0.15) rates, once the financial structural factors are included in the model. All in all, the results show that the financial structure of banks affects both the lending and deposit rates.

2.3.2. Testing for possible structural breaks

Over the last decade, Sri Lanka has undergone significant economic and financial changes, especially in May 2009 at the end of its 30-year civil war. Therefore, I apply the Bai-Perron test (Bai & Perron 1998) in order to identify unknown structural breaks in our estimated baseline model, and the results are given in Table 3. As was suggested by Gregor & Melecký (2018), the Bai-Perron test with globally determined breaks is selected as the preferable test, because its expectation of multiple structural breaks during the sample period makes it more suitable.

The test detects one breakpoint for the lending rate (LR) model, two for the deposit rate (DR) model, and one for the net interest margin (NIM) model. The identified break date for LR is August 2013, which may represent the reaction of the lending rate to the expansionary monetary policy of reducing the statutory reserve requirement from 8 percent to 6 percent with effect from 1st July 2013. The two structural break dates that have been identified for DR are November 2009 and September 2014. The structural break in November 2009 may represent a delayed reaction to the civil war that ended in May 2009, and September 2014 may represent the Sri Lankan economy's historically low interest rates. This was due to the country's relaxed monetary policy stance and the excess liquidity in the money market in mid-2014. Finally, the unknown break of November 2011 in the net interest margin may represent the monetary policy contraction that started toward the end of 2011 and resulted in a domestic money market liquidity deficit by the end of 2011. These structural break dates are robust to the use of the Quandt-Andrews (Andrews 1993; Andrews 2003) unknown breakpoint test.

Table 3: Structural Break Test for the Baseline Model

	LR		DR		NIM	
	No. of Breaks	Estimated Break Dates	No. of Breaks	Estimated Break Dates	No. of Breaks	Estimated Break Dates
Break Type: Bai-Perron tests of 1 to *M* globally determined breaks						
Sequential F-statistic determined breaks:	1	2013M08	2	2009M11 2014M09	1	2011M11
Significant F-statistic largest breaks:	1	2013M08	2	2009M11 2014M09	1	2011M11
UDmax determined breaks:	1	2013M08	2	2009M11 2014M09	1	2011M11
WDmax determined breaks:	1	2013M08	2	2009M11 2014M09	1	2011M11
Quandt-Andrews unknown breakpoint test	1	2013M08	1	2014M09	1	2011M11

I control for structural changes that have taken place in the economy and the financial market by extending our baseline mode to include a shift dummy:

$$i_t^r = \alpha_0 + \beta i_t^m + \varphi X_t + \sigma_1 Dum_t + v_t, \quad (5)$$

where the dummy variables are specified for each retail rate and impose a value of 0 before the structural break and 1 thereafter. I re-estimate the model incorporating the unknown structural breaks using the ARDL approach, and the results are presented in Table 4.

Table 4: Results of the Model with Dummy Variables

	LR	DR	IM
	1	2	4
Long-Run Relationship			
TBR (β)	0.5418***	0.5646***	0.0202
	(0.1357)	(0.2136)	(0.0306)
NPL	0.6009**	-0.9830*	0.7213***
	(0.2366)	(0.5551)	(0.0984)
Com	0.0504	-0.3493*	-0.0343
	(0.0912)	(0.1987)	(0.0274)
NII	-0.2885**	-0.1729	-0.0009
	(0.1272)	(0.2140)	(0.0571)
OPC	-0.1540**	-0.2380**	-0.0427**
	(0.0700)	(0.0920)	(0.0194)
ExL	-0.1503	-0.9812**	-0.1241**
	(0.1754)	(0.4291)	(0.0607)
Dum 1	-0.0127*	-0.0182	-0.0078***
	(0.0067)	(0.0158)	(0.0026)
Dum 2	-	-0.0012	-
		(0.0101)	
C	0.0202**	0.0232***	0.0342***
	(0.0103)	(0.0065)	(0.0129)
Speed of Adjustment (γ)	-0.1147***	-0.0471***	-0.4118***
	(0.0121)	(0.0023)	(0.0601)
Short-Run Dynamics			
Short-Run Pass-through (ρ)	0.0621***	0.0266***	0.0083
	(0.0122)	(0.0076)	(0.0125)
No. of Observations (After Adjustments)	129	128	127
Adj. R-squared	0.4109	0.8232	0.2811
ARDL Bounds Test (F-statistic)	10.6624	34.1220	5.5286
	[2.32-3.5]	[2.22-3.39]	[2.32-3.5]
Covariance Matrix	HAC		

Notes: ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels. Standard errors are shown in parentheses, and critical values of the ARDL Bound test are given in square brackets. The term HAC represents the Newey-West HAC covariance matrix, used to handle the observed heteroscedasticity and autocorrelation in the residuals of the estimated model. The model covers the sample from January 2008 to December 2018. The lag structure is chosen based on the Schwarz Information Criterion (SIC), allowing a maximum lag length of three.

The results show that the pass-through to the lending rate drops further when the structural break is incorporated, possibly as a result of the reduced reserve requirement. Decreasing the reserve requirement increases the amount of money that banks have available to lend. In other words, the supply of money is relatively high under the reduced reserve requirement. Thus, banks do not charge higher interest for lending, which might be a cause of the lower pass-through to the lending rate. When the central bank follows a tight monetary policy, banks cut down on credit. Low credit growth and low deposit funding lead to banks with lower profits (See Borio et al. 2017).

Turning to the financial structural factors, I find only minor differences in the estimated results relative to the baseline model estimation, except for the NII. All other control variables show statistical significance in determining the retail rates, although with different magnitudes. However, the results show that NII is significant on lending rates once structural break dummies are included in the model.

2.3.3. Non-Linear Specification with Interactions

Next, I modify the initial specification to include interaction terms for testing how the financial structural variables in the X_t vector affect the pass-through of the monetary policy rate:

$$i_t^r = \alpha_0 + \beta i_t^m + \varphi X_t + \delta(X_t * i_t^m) + v_t , \quad (6)$$

where $X_t * i_t^m$ represents the interactions of the variable in a vector X_t with the monetary policy rate. I test the significance of the interaction terms one by one and include each term in the final specification only if it is jointly significant with the corresponding financial structural variable.[9] Accordingly, the interactions of the non-performing loan ratio, operational cost and excess liquidity variables with the TBR are added into all three models. The results of the models with the interaction terms are shown in Table 5.

Consistent with the findings of Gigineishvili (2011) and Sander & Kleimeier (2004), I find the interaction between the monetary policy rate (TBR) and the non-performing loan (NPL) ratio to have a significant negative effect on the lending rate. Furthermore, consistent with Egert et al. (2007) findings, our results confirm that NPL brings negative marginal effect on interest rate pass-through, confirming the dampening effect of a higher NPL ratio on the interest rate pass-through.

As was argued by Gigineishvili (2011), NPL reflects the degree of credit risk in the banking sector. Thus, lending rates will be higher for economies with higher levels of NPL, as banks demand higher risk premiums. However, increasing lending rates means that banks attract riskier projects and borrowers, which also increases the probability of default on existing credit facilities. Hence, profit-maximising banks might be less responsive to monetary policy changes when the credit risk is already high, in order to reduce the likelihood of incurring additional losses. Hence, when the credit risk is high, a large portion of the increase in the cost of funds (short-term interest rate) is absorbed by the risk premium. A weaker interest rate pass-through is reflected by the positive coefficient of NPL and the negative coefficient on the interaction term. Accordingly, our results support the argument that banks with higher credit risk insulate their customers from monetary policy shocks (Schlüter et al. 2012).

Moreover, similarly to Gigineishvili (2011) and Sørensen & Werner (2006), the interaction between the excess liquidity and TBR indicates that large excess liquidity held in commercial banks reduces the impact of monetary policy changes on the lending rate. This suggests that the effectiveness of monetary policy in the banking environment is limited when there is excess liquidity, as excess liquidity is expected to act as a buffer against market fluctuation, resulting in a negative effect on the deposit rate pass-through.

Table 5: Non-Linear Specification with Interaction Terms

	LR	DR	IM
	1	2	3
Long-Run Relationship			
TBR (β)	0.7662***	6.0221	0.2202
	(0.1738)	(4.5588)	(0.4842)
NPL	1.0053***	-4.8989*	1.1931***
	(0.2561)	(2.6839)	(0.2255)
Com	0.0793	-0.6533	0.0594**
	(0.0550)	(0.4229)	(0.0282)
NII	-0.0300	0.1506	0.1084**

[9] When performing this exercise, we closely follow the recent study of Gregor & Melecký (2018).

	(0.0825)	(0.4924)	(0.0525)
OPC	-0.0696	0.8750	-0.0638
	(0.0472)	(0.8327)	(0.0867)
ExL	-0.4217**	-2.9102	0.2966***
	(0.2297)	(1.9050)	(0.1079)
Dum 1	-0.0061**	0.0053	-0.0185***
	(0.0037)	(0.0320)	(0.0024)
Dum 2	-	-0.0025	-
		(0.0173)	
NPL*TBR	-6.5099**	27.5174	-7.1358***
	(2.8787)	(17.9626)	(2.4395)
OPC*TBR	0.1873	-14.4015	0.6902
	(0.2939)	(10.0571)	(1.0329)
ExL*TBR	-5.1123**	24.3616	-4.2181***
	(2.6306)	(17.0025)	(1.3343)
C	0.0100	0.0069	-0.0037
	(0.0111)	(0.0111)	(0.0208)
Speed of Adjustment (γ)	-0.2720**	-0.0291***	-0.3491***
	(0.0216)	(0.0014)	(0.0431)
Short-Run Dynamics			
Short-Run Pass-through (ρ)	0.1561***	0.1751*	0.0769
	(0.0469)	(0.1019)	(0.2123)
No. of Observations (After Adjustments)	127	129	129
Adj. R-squared	0.5737	0.8249	0.3349
ARDL Bounds Test (F-statistic)	12.4874	32.8378	5.4821
	[2.06-3.24]	[2.06-3.24]	[2.06-3.24]
Covariance Matrix	HAC		HAC

Notes: ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels. Standard errors are shown in parentheses, and critical values of the ARDL Bound test are given in square brackets. Term HAC represents the Newey-West HAC covariance matrix, used to handle the observed heteroscedasticity and autocorrelation in the residuals of the estimated model. The model covers the sample from January 2008 to December 2018. The lag structure is chosen based on the Schwarz Information Criterion (SIC), allowing a maximum lag length of three.

In addition to the coefficients of interest, I also performed a series of diagnostic tests on the residuals: the Breusche-Godfrey serial correlation test, and the Breusch-Pagan-Godfrey and ARCH LM tests for homoscedasticity. The White covariance matrix is used when only heteroscedasticity is present in the residuals, while the Newey-West HAC covariance matrix is used when both autocorrelation and heteroscedasticity are present. The covariance matrix used in each model is indicated in the respective table.

2.3.4. Robustness Test

The robustness of the cointegration relationships identified using the Pesaran et al. (2001) test has been cross-validated using the augmented ARDL Bound test (bootstrap ARDL test) introduced by McNown et al. (2018) and Sam et al. (2019).[10] The robustness of the results was then further confirmed by using alternative measures of the lending and deposit rates to re-estimate the models using the ARDL approach. The prime lending rate (PLR) is the interest rate that is applicable to the short-term loans and advances granted by commercial banks to their prime customers, while the fixed deposit rate (FDR) is the interest rate based on all outstanding time deposits held with

[10] This model, introduced by McNown et al. (2018), removes the risk of drawing incorrect conclusions on cointegration relationships due to degenerated lagged dependent or independent variables. Hence, we validate the results of the cointegration relationship obtained during our estimation procedure using the third *F*-test on the lagged level of the independent variable (except for the overall *F*-test on the lagged level variables and the *t*-test on the lagged level of the dependent variable).

commercial banks. IM-1 represents the interest rate difference between PLR and FDR. The estimated results of the non-linear specification with interactions using the PLR and the FDR are given in Table 6.

Table 6: Robustness Tests with Alternative Measures

	PLR	FDR	IM-1
	2	4	6
Long-Run Relationship			
Long-Run Pass-Through (β)	1.1344***	0.4064	0.7778
	(0.1427)	(0.3552)	(0.5014)
NPL	0.5296**	-1.8319*	1.2343**
	(0.2645)	(1.0135)	(0.6468)
Com	0.0886	-0.2912*	0.3872**
	(0.0601)	(0.1730)	(0.1937)
NII	0.2279*	-0.0084	0.1210
	(0.1333)	(0.2796)	(0.2751)
OPC	0.0210	-0.4217	0.0134
	(0.0521)	(0.4670)	(0.0947)
ExL	-0.7116***	-0.2793*	0.8021
	(0.2598)	(0.1269)	(0.5182)
Dum 1	0.0120***	0.0316	-0.0215**
	(0.0042)	(0.0245)	(0.0104)
Dum 2		0.0036	
		(0.0129)	
NPL*TBR	-6.9108**	8.4820	-16.4499**
	(3.0494)	(9.0296)	(8.3918)
OPC*TBR	0.9714	1.0779	6.2159
	(0.7491)	(1.1451)	(3.0841)
ExL*TBR	-6.5682*	1.7997	-3.9284**
	(3.6273)	(6.3460)	(1.9172)
C	-0.0225	0.0285***	-0.0794***
	(0.0159)	(0.0120)	(0.0294)
Speed of Adjustment (γ)	-0.2565***	-0.0802***	-0.2211***
	(0.0176)	(0.0048)	(0.0288)
Short-Run Dynamics			
Short-Run Pass-Through (ρ)	0.2910***	0.0326	0.1720
	(0.0370)	(0.0312)	(0.1351)
No. of Observations (After Adjustments)	127	127	127
Adj. R-squared	0.7832	0.8335	0.4575
ARDL Bounds Test (F-statistic)	17.6904	20.9723	4.8853
	[2.06-3.24]	[2.06-3.24]	[2.06-3.24]
Covariance Matrix	HAC		HAC

Notes: ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels. Standard errors are shown in parentheses, and critical values of the ARDL Bound test are given in square brackets. Term HAC represents the Newey-West HAC covariance matrix, used to handle the observed heteroscedasticity and autocorrelation in the residuals of the estimated model. The model covers the sample from January 2008 to December 2018. The lag structure is chosen based on the Schwarz Information Criterion (SIC), allowing a maximum lag length of three.

As the table shows, the estimated results using alternative measures of the lending and deposit rates reinforce most of the previous findings. Most importantly, the NPL has a negative and significant impact on the mark-up of the PLR, but a positive impact on the FDR, although with a different magnitude. The interactions of NPL and Exl with TBR turn out to be negative and significant for both PLR and IM-1, as with our main estimated results. These findings are consistent with the prior literature, as discussed above.

2.3.5. Stability Tests

Next, I perform stability tests of the estimated non-linear specifications with interaction terms using the CUSUM tests. These models are the best-fitting models of this study, with the highest explanatory power (Adj. R-squared). The results of the CUSUM and CUSUM square tests are given in Figure A1 in the Appendix. The results of both tests confirm that the parameters of our estimated models are stable overall.

2.4. Conclusion

This paper has examined how changes in the monetary policy rate affected retail interest rates in Sri Lanka from 2008 to 2018. In particular, the paper has focused on the impacts of financial structural factors on bank retail rate adjustments, with the aim of filling that literature gap in the Sri Lankan context. To this end, an empirical analysis was undertaken to examine the responses of the lending and deposit rates after controlling for financial structural factors that could affect the retail rate mark-up. This uncovered the effects of selected financial structural factors on the pricing of the interest rates above their variable cost. In addition to the lending and deposit rates, I also modelled the relationship with the net interest margin, represented by the difference between the lending and deposit rates.

Using the ARDL model, I found significant and incomplete interest rate pass-through prior to the incorporation of financial structural factors in the model. A higher long-run pass-through is observed for the lending rate than for the deposit rate, indicating that commercial banks prioritise the adjustment of their loan rate over their deposit rate. Interestingly, commercial banks also consider other bank-specific structural factors when making pricing decisions. The most important determinant of the mark-up across all specifications is the bank's exposure to credit risk, measured by the non-performing loan ratio. It increases the lending rate significantly relative to the treasury bill rate, while reducing the deposit rate, a result that is robust across different specifications. In addition, operational efficiency and excess liquidity also influence bank retail rates significantly. It is observed that both retail rates react negatively to operational efficiency, meaning that the estimated results do not support the earlier argument that bank inefficiency is passed to the borrowers in the form of a higher lending rate. This puzzling relationship remains to be solved in future empirical research. Based on these findings, it seems that the effectiveness of monetary policy can be limited in a banking environment with excess liquidity. Overall, the results suggest that banks in Sri Lanka consider structural factors as well as the monetary policy rate when setting their lending and deposit rates.

As banks have a unique role in the financing of economic activities, their pricing behaviour is of particular importance to policymakers when making effective monetary policy decisions. Accordingly, this research work attempts to bridge the gaps in the existing academic literature on the interest rate pass-through, especially in an emerging country context, while also having important policy implications for policymakers in Sri Lanka. Incomplete and slow pass-through is a possible market imperfection that constrains the effectiveness of monetary policy for steering the economy while taming inflation to the desired extent. Furthermore, the findings in this paper provide monetary policymakers and the banking regulator with insights about how well the process of financial intermediation works and the extent to which financial structural factors influence a bank's retail rate adjustments when coupled with changes to market rates. Furthermore, the CBSL plans to move to an inflation targeting framework from 2021 (Central Bank of Sri Lanka 2016). One of the key necessary conditions for effective inflation targeting is the controllability of monetary instruments, with the interest rate as the primary operating target

(Gerlach & Svensson 2003). Thus, it is crucial to guarantee that retail rates will reflect the changes in policy rates quickly and fully.

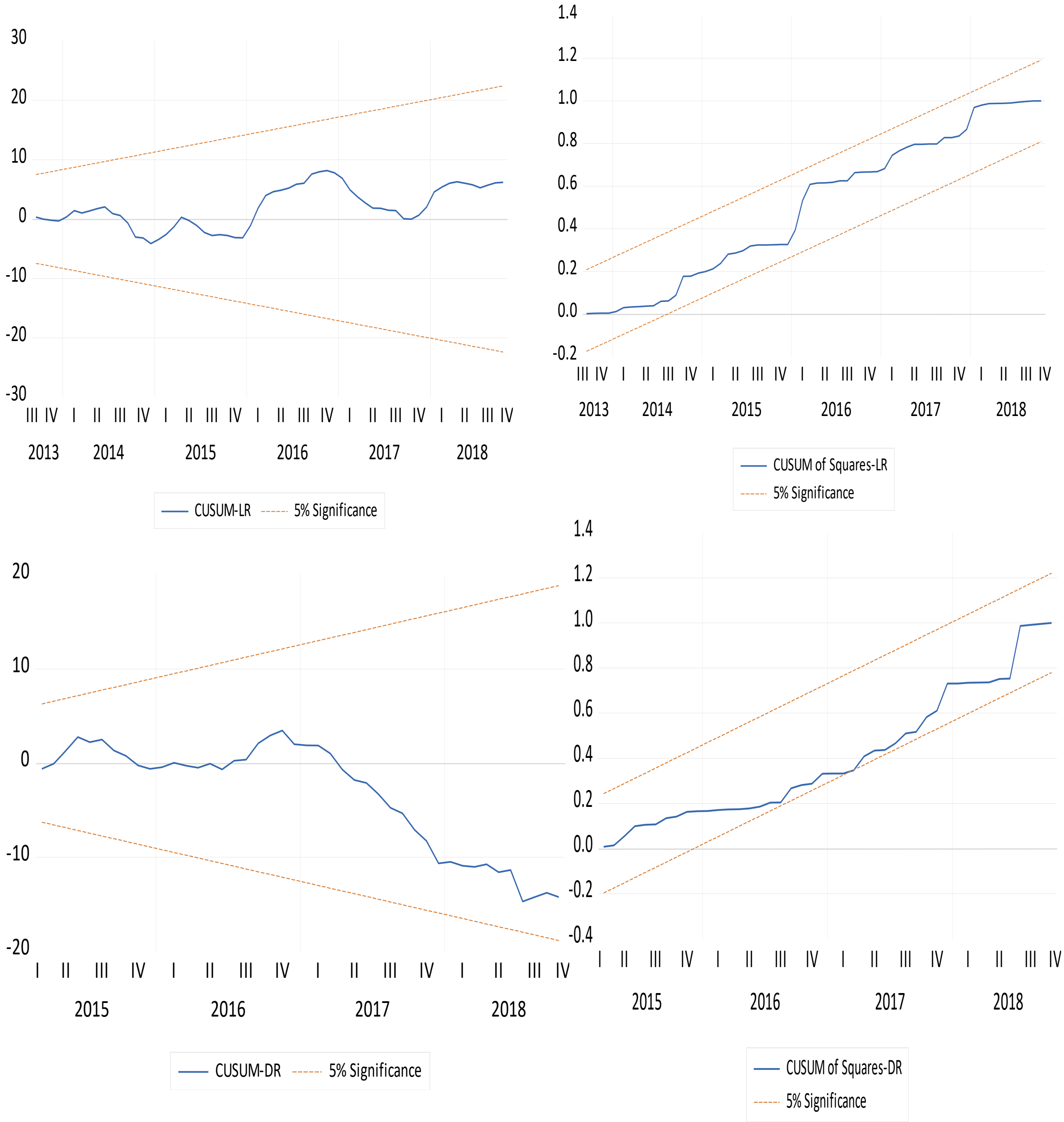

Figure A1: CUSUM for best fit models

Declarations

Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author at antonette.sfernando@yahoo.com or antonette@cbsl.lk

Competing interests

The author declares no competing interests.

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